ABSTRACT BOOK

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"PLANT PROTECTION - ACHIEVEMENTS AND PERSPECTIVES"

Moldova State University
Institute of Genetics, Physiology and Plant Protection

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"PLANT PROTECTION - ACHIEVEMENTS AND PERSPECTIVES"

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PREFACE

Against the backdrop of the worsening impact of pests under climate change, plant breeding is facing great pressures manifested by the devastation of the quantity and quality of agricultural crops and the deterioration of natural and anthropogenic ecosystems. The increase in the frequency and intensity of the development of pests (harmful arthropods, disease pathogens, nematodes, rodents and weeds) reduces the quantity and quality of agricultural crops and stored products. In the permanent competition between agricultural crops and pests, the factors of natural selection have contributed to the development of a strong adversary background, the manifestation of which, under favorable environmental conditions, causes serious threats to human health, plants, animals, soil biota and agroecosystems. An underestimation of these problems causes not only direct loss of harvest, but also, indirectly, to a sharp decrease in the efficiency of all investments of material and human resources, which, against the background of the worsening ecological situation caused by the use of pesticides, creates serious complex problems.

In response to the constant competition between agricultural crops and harmful organisms, mankind has developed and implements various traditional methods of pest control, among which the main place belongs to pesticides. The application of the chemical method of plant protection has achieved impressive results in combating pests, phytopathogenic agents and weeds, but has caused various problems and concerns regarding the toxic effect on humans and non-target entities, environmental degradation and the development of pesticide resistance. Thus, the worsening of the phytosanitary state of agricultural crops and the deepening of the phenomena and manifestations of the ecological crisis related to the application of pesticides, as well as initiatives to reduce imminent risks against the background of the registration and application of modern biotechnological achievements, especially those based on molecular biological methodologies, represent an enormous mass of problems and achievements, which need to be discussed in order to transfer from combating harmful organisms to the application of natural mechanisms and environmentally harmless means of regulating the density of populations of phytosanitary agents.

Starting from the global trends of worsening the phytosanitary state and increasing the impact of climate change, as well as the growing interest in obtaining and using organic products, the need for a deep approach to plant protection issues oriented towards the development of alternative, non-chemical methods of combating harmful organisms and the establishment of a specialized scientific forum in this field becomes rational. In response to global and natural challenges, the scientific community engaged in solving plant protection problems has managed to organize with enviable regularity (3 years) an impressive series (2009, 2012, 2015, 2018,

2020, 2023) of meetings of the International Symposium "Plant Protection: Achievements and Prospects". Within this scientific forum, multiple theoretical and practical problems were discussed and resolved, creating impressive opportunities to increase awareness at national, regional and global levels regarding the role of plant health in food security and food safety, environmental protection and stimulating economic development.

The increasing impact of pests on the background of climate change and the increase in the prevalence of pests due to the manifestation of various difficulties emphasize the role of technological processes for the production of agricultural crops. Thus, surveillance, monitoring, analysis and management of risks caused by pests, as well as increasing the efficiency of means of protection and ensuring plant health without affecting the ecological state of agroecosystems, have become mandatory technological activities. Climate change and human activities have affected ecosystems, reducing biodiversity and creating new niches for the uncontrolled development of phytosanitary agents. At the same time, the expansion of economic activities, travel and international trade have tripled in recent decades, accelerating the spread of pests on Earth and causing considerable damage to crops and the environment. Protecting agricultural crops is much more cost-effective than emergency intervention, when plants are in a state of manifestation of symptoms and economic losses. Pests and disease pathogens are often impossible to eradicate once established, and their management is costly and time-consuming. Preventive activities are essential to reduce the devastating impact of pests and diseases on agriculture, livelihoods and food security.

As a result of massive pollution, resulting from the application of pesticides and the worsening threat of biodiversity loss and ecological problems, the Food and Agriculture Organization of the United Nations (FAO) declared 2020 the "International Year of Plant Health", which determined the need to prevent and mitigate the impact of climate change on plant health, and May 12 was designated as International Plant Health Day.

Thus, it becomes evident that solving phytosanitary and environmental problems can only become a reality by addressing and applying natural mechanisms, used in organic and regenerative agriculture systems. As a result of the realization of the principles of new types of agriculture, it becomes possible to develop intensive agricultural systems, which, thanks to the effects of management on soil protection and agricultural crops, are the basis for understanding the possible links between soil, plant and human health and are the key to improving the quality and safety of food obtained in all agricultural systems.

In order to ensure the biological effectiveness of ecologically harmless means of reducing the impact of harmful organisms, we managed to demonstrate the role

and efficiency of biological methods of plant protection and synergistic phenomena when comparing the biological effectiveness of the constituent elements of the agricultural system, as well as their simultaneous action. Convincing results were recorded when using modern principles and techniques in investigating the efficiency of the action of biological preparations proposed for the development of the concept of synergism aimed at increasing the effectiveness of the proposed factors for conventional and organic agricultural systems, establishing the contribution of each element separately.

The contribution of scientists from the Republic of Moldova consists in organizing multiple activities within the framework of this symposium. Only in this way, humanity and we, representatives of the international scientific community, contribute to recording the manifestation of resilience to risk factors and the capacities of systems to adapt and face difficulties in a positive manner to unfavorable situations, the frequency of which is constantly increasing.

Biotechnology, as a science and practice, has achieved and reached many practical areas, such as human health, agriculture and environmental improvement. Over the past decades, its consistent potential to contribute to sustainable development has been demonstrated. In addition, some significant achievements, such as organic and regenerative agriculture, gene editing, promise to revolutionize public health, agriculture, pest control, crop improvement, and the development of technologies for various technological processes for obtaining products and materials. In addition to the achievements already recorded, the application of biological technologies could cause serious damage if the associated risks are not well managed, especially those related to the perpetuation of the harmful environmental and social consequences of modern agriculture. However, in developed countries, as well as in the Republic of Moldova, a practice of implementing biotechnological achievements has been established and exists, but it must be recognized that there is a range of biological risks and dangers associated with the use of genetically modified organisms, as well as the manifestation of their impact, which can affect all living entities, including humans.

Genome editing technologies hold the promise of improving crops and animals and even curing patients of diseases that have been and remain incurable so far. From the range of molecular biological methods, the CRISPR-Cas9 methodology, as a genome editing platform, has proven to be flexible for species, has great potential for application, although a number of technological difficulties and intellectual property constraints still persist. Since the technology does not leave signs of transgenesis, plants generated by genome editing are not considered GMOs and do not cause political and social discussions and challenges that currently accompany agricultural biotechnologies. Although genome editing is relatively cheaper and easier to implement, this technology still has some disadvantages, recorded as effects on non-target

objects, as well as the lack of information on the long-term impact of this technology over several generations. We note that the European Commission has accepted the revision of the rules on GMOs, accepting the relaxation of restrictions on the use of plants obtained through new genome editing technologies and demonstrating that the use of these crops would help farmers grow plants resistant to the phytosanitary impact of harmful organisms and climate change, as well as obtaining foods with increased nutritional value with a reduced level of residues.

It is a great honor and a special privilege manifested through the verticality and perseverance of promoting the path of solving serious problems that cannot be solved by other social groups. We are a global group that offers numerous opportunities to agricultural, ecological and health care operators around the world, promoting theoretical concepts and practical activities perfected for direct implementation in various areas of life and using, in addition to scientific investigations, various forms of human activity, such as organizing scientific forums, participating in grant competitions, perfecting valuable publications, promoting training courses and supporting young talents. I would like to emphasize that the scientific community recognizes our obligations and duty in fulfilling many important tasks determined by the worsening of the global phytosanitary and ecological situation, laying the foundations for a sustainable future for the realization of the "One Health" concept and acting as true guardians of nature and life.

The current collection represents the quintessence of scientific research conducted in the field of plant protection in the Republic of Moldova and in the world. It includes works presented from the most important international scientific and university centers and within the creative groups of local scientists. The collection continues the series of reports developed under the aegis of the International Biological Protection Organization and includes a presentation of a clear picture of phytosanitary problems and measures to mitigate the negative impact of harmful organisms. Starting from the scientific needs of plant health, particularly important original works were presented, the discussion of which was organized within the following sections:

Biodiversity of harmful and beneficial organisms in natural and anthropized ecosystems and their role in the biocenotic regulation of the density of populations of harmful organisms.

1. Production and application of biological protection products based on entomophages, biologically active substances, nanoparticles, entomopathogenic and antagonistic microorganisms for the protection of agricultural crops.

2. Integrated plant protection systems with phytosanitary improvement capabilities of agrocenoses and obtaining competitive agricultural products.

3. Genetic and physiological aspects of creating crop plants with increased po-

tential for resistance and resilience to environmental stressors, diseases and pests.

4. Solving plant protection problems in conservative, ecological and regenerative agriculture.

Highly appreciating the achievements of the branch and the institute and starting from the festive atmosphere, I am honored to use this opportunity to congratulate all the participants of this prestigious scientific forum on the occasion of organizing the International Scientific Symposium "Plant Protection - Achievements and Prospects", which orients the evolution of human thinking from combating harmful organisms to the application of natural mechanisms and ecologically harmless means of regulating the density of populations of phytosanitary agents. There are premises for us to realize that plant protection combines traditional wisdom with modern science, emphasizing the need for balance and responsible intervention to ensure the production and processing of healthy crops. I express my confidence that the discussions around the results submitted for discussion and the approved decisions, as well as this collection, will be useful both in the management of plant health assurance activities, and for direct implementation by specialists in this particularly important field. I wish you good health, success in your scientific activity, family happiness and many years full of joy and luck.

Doctor habilitatus of biological sciences, professor, m. c. of ASM,
VOLOȘCIUC Leonid

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THE ROLE OF GENOME EDITING IN SOLVING PLANT PROTECTION PROBLEMS

VOLOSCIUC Leonid, https://orcid.org/0000-0002-7475-4310

Moldova State University, Institute of Genetics Physiology and Plant Protection, Chisinau, Republic of Moldova,
Corresponding e-mail: l.volosciuc@gmail.com

Abstract. The impact of climate change and the worsening of the phytosanitary status of agricultural crops require the strengthening of agriculture by applying the achievements of biotechnology and genetic engineering. The application of pesticides and breeding strategies, including the implementation of genetically modified organisms (GMOs), although they occupy significant areas, remain insufficient to ensure the resilience and productivity of agricultural crops, creating global ecological problems. The achievements of modern scientific activity in genome editing technologies, in particular CRISPR/Cas9, open up prospects for crop protection through precise genome modifications. The method allows the development of resistant crops against pathogens of diseases, pests and weeds and is applied to eliminate susceptibility genes and modify defense genes, which opens up prospects for advancing crop protection and ensuring food security.

Keywords: ecological agriculture, gene, genome editing, harmful organisms, plant protection

INTRODUCTION

Based on the worsening of the phytosanitary condition of agricultural crops against the background of climate change and the increasing vital role of agriculture in the economy, over the past decade there has been an increase in the role of plant health. Harmful organisms (pathogens of diseases, harmful arthropods and weeds) cause serious economic losses, reduce the yield of the branch by yield losses by 25-40% or completely compromise crop yields [1]. To ensure crop protection against, using scientific and practical achievements, agricultural producers apply an impressive range of procedures and means, including a wide range of chemical preparations.

Taking into account the negative effects of pesticides on non-target entities and the ecological state of the environment, against the background of high economic indicators of chemical means, the scientific community develops and proposes al-

ternative approaches to preserving plant health [2]. The achievements recorded have been the basis for plant improvement by increasing resistance to harmful organisms and increasing the yield and health of plants. Particularly questionable are the results of obtaining and applying genetically modified organisms (GMOs), which by modifying the genetic apparatus of the plant by introducing one or more genes, which encode the genetic information regarding the resistance of agricultural crops to chemical means of protection (herbicides, fungicides, bactericides). Currently, public opinion is reluctant to GMOs, and although impressive areas of genetically modified crops are recorded, evidence of problems caused by their application is becoming more and more frequent [3].

Although discussions around the controversies of these inventions continue, it is still necessary to recognize that transgenic plants have traits that would not have arisen naturally or through conventional crosses. Against the background of the problems caused by the application of GMOs, research is currently expanding in order to apply methods for improving the productivity of crop plants by editing the genome of agricultural crops. New genomic techniques have become particularly relevant and promising, bringing together a group of modern methods by which a plant's DNA can be modified with greater precision and mutational phenomena reduced. Unlike GMOs, these are not based on the introduction of foreign genes from other species, and the modifications are made to the plant's own genetic material. As a result, it becomes possible to acquire the desired qualities that cannot be obtained by traditional breeding methods, but it offers the possibility of developing new plant traits. Plant genome editing allows for precise restructuring of chromosomes, including small insertions, deletions, substitutions and complex rearrangements, such as inversions, duplications and translocations [4].

The complex nature of food security and environmental issues necessitates the application of modern biotechnology capabilities to penetrate the mechanisms established during the evolution of the biosphere, obtaining genome editing levers. In this regard, plant breeding techniques are applied, such as synthetic nucleases: zinc finger nuclease (ZFN), transcription activator-type effector nuclease (TALEN), the CRISPR-Cas9 system, oligonucleotide-directed mutagenesis, cisgenesis and intragenesis, RNA-mediated DNA methylation, which allow the induction of directed changes in the genomes of organisms. The development of new genomic techniques is expanding worldwide, reaching 108 crops belonging to 32 species [2].

The most significant advances in genome editing have been made by the Clustered Regularly Interspaced Short Palindromic Repeats and its associated Cas proteins (CRISPR/Cas9) technique, which demonstrates superior applicability compared to other gene editing techniques based on endonucleases or nucleases. The CRISPR technology, whose potential was first demonstrated by Jennifer Doudna and Emmanuelle

Charpentier in 2012, allows the modification of the genome of any biological entity and was recognized as the invention of the year 2015, ensuring the winning of the Nobel Prize in Chemistry in 2020. CRISPR is a tool that allows the correction of DNA defects and functions like molecular "scissors" that allow the selective cutting of unwanted areas within the genome and their replacement with new DNA fragments [5].

This technology is expected to revolutionize the study and treatment of a wide range of diseases in humans, plants and animals, including cancers and incurable infections, as well as hereditary conditions. Current scientific advances demonstrate that CRISPR is not only an extremely versatile technology, but one that is proving to be precise, increasingly safe to use and promising. Gene editing offers efficiency and precision by reducing research and development and breeding times and for combating rapidly evolving harmful organisms [6].

CRISPR/Cas9, with its site-specific nuclease activity, triggers DNA repair mechanisms in cells, providing a wide range of genetic modifications depending on the repair pathways and the availability of repair templates [7]. Another way in which crop protection can be achieved is by genetically modifying insect pests by disrupting their functional characteristics by preventing mating attempts and introducing body defects in insects.

CRISPR/Cas9 is a genome editing technology that has significantly strengthened the field of genetic manipulation, which has also contributed to the discovery and development of CRISPR-associated enzymes (Cas), the most studied of which are due to their ability to fragment nucleic acid into oligonucleotides in a targeted manner. Significant advantages have been recorded in the exploitation of CRISPR and Cas9, which exploit natural genomic properties developed during millennia of biochemical evolution by archaea and bacteria to precisely edit the genome of an organism. Precise capabilities have been achieved in editing the genome of plants for crop protection by eliminating genes mediated by CRISPR/Cas9 with a high degree of effectiveness in conferring resistance to harmful organisms. For this purpose, several delivery methods are already being applied, such as Agrobacterium-mediated delivery, bombardment delivery, and polyethylene glycol application [8], which ensure a high degree of precision in editing the plant genome aimed at demonstrating resistance to crop pests.

The application of CRISPR/Cas9 opens up significant possibilities for efficient and effective editing of the plant genome. Since the first application of CRISPR/Cas9 in plant genome editing [9], numerous scientific publications have demonstrated the value of the method for various purposes, among which resistance against pathogens, insects, and weeds is particularly valuable. Thus, the CRISPR/Cas9 system as a strategy opens up real prospects for genome editing to protect crops against pathogens, insects, and weeds, contributing to ensuring food security and maintaining environmental conditions.

APPLIED MATERIALS AND METHODS

The forecasting of the development of harmful organisms was carried out using the "AgroExpert" electronic system for determining climatic indicators and their warning [1].

The protocol methods of microbiological and virological research adapted for the development of alternative means of plant protection and cultivation in vivo and in vitro were applied, using the production of biological agents on the surface, in depth and semi-depth [10].

Testing in laboratory conditions, on experimental plots and for the production of microbiological means of plant protection was carried out in randomized repetitions with statistical processing of the results [11].

In order to analyze the prospects for the development of agriculture and in order to reduce the impact of harmful organisms on agricultural crops, the concept of the development of biological preparations for plant control and the implementation of organic agriculture through the application of integrated plant protection was developed.

RESULTS AND DISCUSSIONS

CRISPR/Cas9 in the control of crop pathogens. Phytopathogenic agents (viruses, bacteria, fungi, nematodes) represent significant challenges for agriculture, causing biotic constraints and threats to food security, and the damage caused by them causes significant reductions in the quantity and quality of crops by 20-25%, and under conditions of epiphytic development it exceeds 50% [1].

To solve these problems, genome editing is proposed, which is a set of modern technologies that allow precise modification of the DNA of an organism, by adding, removing or replacing fragments of genetic material, which are assembled in the CRISPR/Cas9 technology, which originates from a natural defense mechanism of bacteria against viruses. During evolution, when bacteria were attacked by viruses, the host cell retained fragments of viral DNA, intercalating them with its own genome and forming structures that act as an immunological memory. Upon a new infection, the bacteria produce RNA segments capable of recognizing the viral DNA, and the Cas9 enzyme intervenes to cut and deactivate it. Using this phenomenon, scientists have adapted this mechanism to edit cellular DNA. In this sense, a small fragment of guide RNA is created, which binds to a target genetic sequence. In combination with the Cas9 enzyme, this RNA directs the system to the exact place in the genome where the intervention is desired. As a result, once the DNA sectioning has occurred, the cell's natural repair mechanisms are used to add, remove or replace genetic segments.

The first experiments with this technology were carried out on animals and plants, especially in the agricultural and industrial fields. In plant science, the method has been used to increase plant resistance to phytosanitary agents and to adapt agricultural crops to climate change and harsh habitat conditions. CRISPR/Cas9 technology opens up prospects for introducing artificial mutations, which modify the target gene to resemble a type resistant to disease pathogens, which have evolved in relationships with pathogens. Current research is aimed at creating conditions for excluding mutations and nucleotide variations, which would affect plant viability and productivity [12]. The results recorded mitigate yield losses and ensure increased productivity and sustainability of agriculture.

The use of CRISPR/Cas9 to enhance crop resistance to phytopathogenic viruses. Of significant resonance are the results of the application of CRISPR/Cas9 to introduce genetic modifications in alleles associated with viral resistance by applying the 4E initiation factor, which has an important role in the life cycle of RNA viruses [13]. The application of the eIF protein in the initiation of protein translation by recognizing and interacting with mRNA structures and ribosomes can prevent viral proliferation and host infection, which confers viral resistance to various plants. Thus, CRISPR/Cas9 technology can also be used for direct targeting of the viral genome, offering a promising approach for generating virus resistance [14].

CRISPR/Cas9 technology offers a powerful strategy to confer durable resistance against viral pathogens in crops. The method was used to edit the AC2 and AC3 genes of the mosaic virus genome, which play crucial roles in gene activation, viral pathogenicity, and suppression of viral gene silencing. CRISPR/dCas9 can serve as a DNA-binding protein to effectively block the promoter region of target genes, thereby preventing virus replication and reducing viral infection rates [15]. By harnessing Cas9 complexes with transcription ejector complexes, the researchers induced transcriptional interference at the promoter regions of target genes. This interference disrupts the binding or elongation of RNA polymerase, further inhibiting virus replication and reducing the spread of viral infection in plant tissues. Activities to highlight the potential of CRISPR/Cas9-mediated transcriptional interference for the development of virus-resistant crops and improving plant defense mechanisms against viral pathogens are becoming current.

Gene editing to enhance plant resistance to fungal diseases. CRISPR/Cas9 technology offers possibilities for developing plants resistant to pathogenic fungi by targeting genes associated with susceptibility to fungal diseases. The method has been demonstrated to be effective in engineering crops resistant to fungal pathogens by targeting genes involved in plant-pathogen interactions. By eliminating the gene of the powdery mildew resistance locus, the method led to resistance against the pathogen in various crops [16]. As a result, the resistance locus encodes proteins that make

plants susceptible to the pathogenic fungi, and mutations encoding the loss of this function lead to resistance to the studied disease.

The recorded results emphasize the potential of CRISPR/Cas9 in creating fungal-resistant crops by targeting key genes involved in plant-fungus interactions. The method has demonstrated high efficacy in conferring resistance to agricultural crops by targeting specific genes involved in plant defense mechanisms. Mutations induced in the ethylene response factor gene have been shown to enhance resistance to rice blastoma [17]. The factor serves as a negative regulator of pathogen resistance, and frameshift mutations in this gene contribute to increased resistance to rice pathogens.

The disruptions provided by the CRISPR/Cas9 method led to increased synthesis of salicylic acid, which as a signaling molecule is involved in plant defense responses against pathogens. High levels of salicylic acid contribute to strengthening the plant's immune response, thus improving its ability to resist infections with crop pathogens.

Gene editing to increase plant resistance to bacterial infections. Starting from the expansion of the distribution area and the intensity of the development of bacterial pathogens, the use of CRISPR/Cas9 contributes substantially to the development of plants with resistance to these infections. In this regard, the modification of gene promoters is applied, which increase resistance to various pathogens of agricultural crops. The main effector of the transcription activator type in pathogens of the genus *Xanthomonas* binds specifically to the effector binding element in the gene promoter. If the binding of these elements activates gene expression, accelerating the manifestation of the disease, then mutations within this complex reduce or even eliminate the activity of the promoter and increase the resistance of the crop plant [18].

By using CRISPR/Cas9 to disrupt the gene of the bacterial agent, plants obtain increased tolerance to pathogens of bacterial origin. As an example of the elimination of susceptible genes, a study was conducted to eliminate the gene encoding a protein in apple (*Malus domesticus*) [19], which plays a key role in the infection mechanism of *Erwinia amylovora*. This technique highlights the potential of CRISPR/Cas9 to target specific genes and regulatory elements, thus providing an effective strategy to enhance plant resistance against bacterial pathogens.

CRISPR/Cas9 can enhance resistance to bacterial blight pathogens in tomato by editing repressor proteins of the JAZ domain [20]. The JAZ protein is essential for stimulating stomatal opening, which facilitates bacterial colonization of leaves. Editing the JAZ gene by CRISPR/Cas9 prevents stomatal reopening, thus preventing bacterial colonization. These approaches highlight the role of CRISPR/Cas9 in the development of disease-resistant crops by targeting genes involved in susceptibility

and enhancing the natural defense mechanisms of agricultural crops. By precisely editing specific genes, CRISPR/Cas9 can significantly improve plant resistance to various bacterial infections, contributing to sustainable agricultural practices and increasing crop yields.

The potential of CRISPR/Cas9 for crop protection against insect pests. Phytophagous insects, which feed on the vegetative and generative components of plants, pose a threat to agricultural development. Insects are the most diverse group of arthropods and cause serious damage [21], causing annual losses of 20–25% of global agricultural production and playing a crucial role as vectors for the transmission of various plant disease pathogens. This necessitates genome editing to reduce the damage caused by insect pests [22].

The application of the method has opened up promising possibilities for modifying the biochemical composition of different organs of insect pests by using mutations in various harmful phenotypes, such as abnormal gonads, deformed segments, embryonic lethality, which cause the manifestation of male and female infertility [23]. Similarly, it has been shown that the elimination of proteins that bind sex pheromones in some insect pests, such as *Spodoptera litura*, changes the perception of pheromones by females, thus preventing mating attempts [24]. This demonstrates the capabilities of CRISPR/Cas9 to influence genes that encode the biosynthesis of proteins that determine insect development.

Based on the growing interest in crop resistance as an indicator of plant health, scientists in the field of CRISPR/Cas9 application have recorded results in modifying the chemical composition of insects, such as the achievements recorded in the amplification of the generation of salicylic acid, which is like an insect repellent [25] and also acts as an immune signal, which opens up perspectives oriented towards the development of pest-resistant crops, thus reducing dependence on chemical means. This expands the possibilities of using the method for population modification by spreading a genetic variant that eliminates a harmful trait.

The extension of the application of the method achieves impressive results have been applied to gene induction systems, including meiotic induction, such as transposons, as DNA sequences that change their position from one place to another within the genome of the same cell, stopping embryonic dominance by maternal effect [26]. Thus, a CRISPR/Cas9-mediated gene induction construct was developed for *Plutella xylostella*, which significantly increased the efficiency of the genetic impulse, which opens up real prospects for controlling the development of the pest and maintaining the state of the environment.

CRISPR/Cas9 Crop Protection Capabilities for Weed Control. Among the entities that affect crop development, weeds represent one of the biotic limiters on agricultural yield [1, 2], manifesting themselves as competitors for essential resourc-

es. Weeds serve as hosts for various insects, viruses, pathogens of different origins and devastate native habitats, disrupting ecosystems.

To solve these problems, CRISPR/Cas9 technology addresses different pathways for herbicide-resistant plant breeding. This allows the development of genetically modified herbicide-resistant plants and the selective elimination of unwanted weeds, contributing to sustainable agricultural practices. For example, the herbicide glyphosate inhibits the biosynthesis of the enzyme 5-enolpyruvylshikimate-3-phosphate synthase in plants, disrupting the shikimate pathway and causing plant death [27]. A more conventional approach is to transfer the gene from the Agrobacterium strain to crops such as potatoes. The bacterial enzyme from Agrobacterium has a small modification that prevents glyphosate from binding, thus allowing the plant to continue producing amino acids even in the presence of glyphosate.

These methods illustrate how CRISPR/Cas9 can be used to create herbicide-resistant crops by precisely modifying specific genes or regulatory elements. This approach not only offers an alternative to traditional genetic engineering methods, but also offers a more targeted and efficient way to enhance herbicide resistance in crops. Over the past eight decades, the constant use of herbicides has led to the widespread evolution of herbicide resistance in numerous weed species [28]. Therefore, the CRISPR/Cas9 gene drive has emerged as a new genetic control strategy in weed management. As an alternative to herbicides, genetic engineering does not present safety concerns related to exposure to hazardous chemicals that can lead to the lack of disruption of agricultural ecosystems, as well as the low cost of managing invasive plants and the need for minimal human intervention [29].

Regulations on genome-edited crops. Starting from the need to solve phytosanitary problems and considering the similarities and role of genome-edited crops compared to GMOs, it has become necessary to develop and approve national, regional and international legislation [30]. It is necessary to mention that the former fundamentally differ from genetically modified organisms in that they do not introduce foreign DNA, but only modify existing genes. In this regard, the European Union often regulates genome-edited crops under strict GMO legislation, although European legislation is in the process of reform [31].

Regulations on genome-edited crops vary significantly from one country to another, reflecting different public perceptions and agricultural policies. In the US, the regulation of genome-edited crops is overseen primarily by three agencies, which recognize that genome-edited crops are produced through conventional breeding and are not subject to the same regulations as GMOs, but emphasize the need for safety assessment if the edited crop introduces a novel protein with serious nutritional implications. The European Union has a stricter approach to regulating genome-edited crops, and they are regulated similarly to GMOs. China regulates genome-edited

crops through agricultural legislation, which is constantly evolving as China invests heavily in biotechnology research. It is worth noting that in most countries, in addition to assessing human health and food safety, environmental safety is also monitored.

Analyzing the current situation, against the backdrop of worsening phytosanitary and environmental conditions, as regulatory frameworks evolve, it becomes evident that the commercialization of CRISPR/Cas9-edited crops is expected to be accelerated by companies concerned with their promotion and ensuring plant health [32].

CONCLUSIONS

Starting from the need to solve phytosanitary problems and against the background of achievements in the field of genetic engineering and biotechnology, it becomes obvious that the potential of genome-edited crops in the protection of agricultural crops is current, vast, and promising, which increases hopes for achieving resistance and productivity of agricultural crops.

CRISPR/Cas9 technology has established itself at the forefront of these innovative trends, ensuring high efficiency in genome editing. One of the key future prospects is the integration of CRISPR/Cas9 with other emerging technologies, such as synthetic biology and bioinformatics, offering various solutions for maintaining plant health. By combining CRISPR/Cas9 with advanced data analysis and modeling techniques to expand the range of measures and means of plant protection, it has become possible to predict the results oriented to genetic modifications, as well as optimize editing strategies for the effectiveness required by agricultural operators. This allows the development of crops resistant to phytosanitary agents and adapted to specific environmental conditions and that can adapt to abiotic stresses that have become very common.

Starting from practical needs, the use of CRISPR/Cas9 to improve plant nutritional profiles by precisely editing genes involved in metabolic pathways becomes current and necessary, which will open up prospects for applying the capabilities of these technologies.

Against the background of the problems addressed and in the conditions of fluctuation of decisions approved by decision-makers, it becomes rational for scientists and stakeholders to collaborate to ensure the safety and efficacy of genome-edited crops. Future research should focus on identifying and validating target genes involved in responses to abiotic stress and on developing methods and elaborating efficient editing tools to increase crop resistance and ensure plant health.

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PEA WEEVIL *(Bruchus pisorum, LINNAEUS)* & PEA WASP *(Triaspis thoracica, CURTIS)* IN A LOCAL POPULATION OF GARDEN PEA (*Pisum sativum* L.) CULTIVATED IN FUNDULEA/CALARASI, ROMANIA

TONCEA Ion[1,*], https://orcid.org/0000-0002-5407-1053
DOBRIN Ionela[2], https://orcid.org/0009-0007-0373-9950
BADUT Caterina[3], https://orcid.org/0009-0002-3470-8608
SAVIGNY NEGOIȚĂ Gheorghe[4]

[1]Romanian Association for Sustainable Agriculture (A.R.A.D.), Fundulea, Romania
[2]Faculty of Agriculture, University of Agronomic Sciences and Veterinary Medicine Bucharest, Bucharest, Romania
[3]National Agricultural Research and Development Institute Fundulea, Fundulea, Romania
[4]Permaculture Centre, Negritesti, Neamt, Romania
**Corresponding e-mail: tonceaion@gmail.com*

The subject paper is interesting mainly for the seed production of the garden pea, essential for the next harvests of garden pea *(Pisum sativum L)* cultivated, especially, in ecological agriculture system. Therefore, the paper contain specific data about the attack of the main pest of pea weevil *(Bruchus pisorum, L.)*, such as percentage of seeds with pea weevil adults and larvae, seeds germinative energy and seeds germination of the ”Mazăre neagră cățărătoare”, a local pea garden population from Negrițești/Neamț Romania. We did, for the first time, a similar study regarding attendance of the pea wasp *(Triaspis thoracica, Curtis)*, an endoparasitoid of Bruchus larvae, by estimation of it contribution to garden pea seeds germination. The results demonstrated that the percentage of seeds with pea weevil (Bruchus pisorum L) ranged between 61.68 - 85.5%, pea seed germinative energy, between 28 - 64% and seed germination between 32 - 68%. Also, the pea wasp contribution in terms of seed germination, ranged between 12 – 48%. The variability of studied parameters is a result of two sowing dates - 04.04. and 14.04.2026 and cultivation as single crop and intercropping (pea garden + camelina).

Keywords: Pea weevil, Pea wasp, garden pea, local population, seed germinative energy, and seed germination.

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INFLUENCE OF SOME FUSARIUM SPP. STRAINS ON COMMON WHEAT PLANTS: MORPHO-BIOLOGICAL RESPONSES

LUPAȘCU Galina*, https://orcid.org/0000-0003-3363-3595,
CRISTEA Nicolae, https://orcid.org/0009-0008-7259-3884

Moldova State University, Institute of Genetics Physiology and Plant Protection, Chisinau, Republic of Moldova,
**Corresponding e-mail*: *galina.lupascu@sti.usm.md*

The fungal species *Fusarium solani* (F.s.) and *F. verticillioides* (F.v.) are filamentous, predominantly necrotrophic micromycetes that colonize plants, infecting them via roots and seeds and systemically invading plant tissues. This leads to reduced germination, inhibited plant growth, and the development of necrosis in various organs. Strains of both species secrete a range of extracellular metabolites – toxins, hydrolytic enzymes, and bioactive compounds – into the culture medium, exerting diverse effects on plants. These characteristics make culture filtrates (CFs) a valuable biological tool for studying plant-pathogen interactions.

Purpose. The aim of the research was to determine the morphobiological responses of common wheat to grain treatment with culture filtrates (CF) from two strains of F.s. and F.v. with different toxigenic profiles.

Materials and methods. The study utilized grains from five genotypes and six F_3 hybrids of common winter wheat, along with culture filtrates (CF) from two strains of F.s. and F.v. The CFs were prepared using Czapek liquid nutrient medium. The grains were soaked for 18 hours in the CFs and in distilled water (control), after which they were rinsed with distilled water and placed in Petri dishes on moistened filter paper. Morphometric analyses – germination, embryonic radicle length, and shoot length – were performed on day 5. Plant dry mass was determined by air-drying the plants for 7 days. Data were statistically processed using the STATISTICA 7 software package.

Results and discussion. It was determined that the F.s. strain stimulated shoot growth (34.5%), whereas the F.v. strain inhibited germination (10.2%) and embryonic radicle growth (31.1%). However, both strains had a virtually similar effect in inhibiting dry biomass accumulation: 16.7% and 17.1% for F.s. and F.v., respectively ($p<0.05$).

The data obtained demonstrate that FC F.s. strongly stimulated cell division – likely due to the high auxin or gibberellin content in the FC– but this phenomenon was not accompanied by biomass accumulation. During the initial stages of germination, growth relies primarily on endosperm reserves. F.s. utilized these reserves for cell division; however, while the shoot elongated, it did not accumulate additional structural material.

The metabolites of both fungi likely affected photosynthetic and respiratory activity, as well as the utilization of carbon stored as reserves in the grain, resulting in a similar inhibition of biomass accumulation.

Conclusions. Given the fact that F.v. specifically produces fumonisins, moniliformin, and fusarin C, while F.s. produces a different spectrum of metabolites – fusaric acid and naphthazarins– it can be assumed that fungal strains belonging to species with distinct toxigenic profiles affected the plants through different physiological mechanisms; however, these mechanisms led to a similar outcome: the inhibition of biomass accumulation during the wheat–pathogen interaction.

Keywords: wheat, *Fusarium* spp., interactions, effects.

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SOIL HEALTH AS A PREREQUISITE FOR CROP HEALTH

BOINCEAN Boris, https://orcid.org/0000-0003-4648-2351

National Center for Research and Seed Production, Selectia Sector, Republic of Moldova

The dominant model of agriculture intensification didn't provide a sustainable development from economic, ecologic and social points of view. Simplistic approach to agricultural intensification has agravated the economical consequences of increased prices for industrial inputs in the conditions of discrepancy between prices for agricultural commodities and such industrial inputs as: mineral fertilisers, pesticides, fuel etc, especially in the years with higher vulnerability to droughts as a result of global warming.

Market economy is neglecting the consequences of modern technologies of growing crops on the quality of the environment and health of people. It means that prices for agricultural products don't reflect the real prices for the grown crops.

Our researches have been conducted in a long-term field experiment on ecological agriculture with different crop rotations and systems of fertilisation. Simultaneously, crops were grown in permanent cropping on fertilised and unfertilised plots.

The purpose of the experiment was to establish the impact of crop rotations and permanent cropping on the productivity of crops and soil fertility.

The higher level of yields have been achieved in crop rotations both on fertilised and unfertilised plots.

Crop rotations allow to use more efficiently soil moisture and nutrients from soil and applied fertilisers.

A higher extra yields from fertilisation in permanent cropping relatively to crop rotations is indicating on the health of soil. This issue is crucial for modern agriculture.

Farmers have to compensate the lack of crop rotations with higher rates of mineral fertilisers, pesticides, fuel etc, which is making them less competitive on the local and international markets. By feeding soils with carbon and consequently by improving health of the soil as a living organism it would be possible to reduce the dependence from the industrial inputs and to become more competitive on the market and more resilient to climate changes.

Farmers all over the world are looking for alternatives to conventional agriculture based on using nonrenewable sources of energy.

We have to make a transition from the dominant system of agriculture to another system based on principles of circular economy by using preponderently local sources of renewable energy.

Keywords: crop rotation; permanent cropping; fertilization; soil fertility; ecologic agriculture

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VICTOR GHIMPU: THE PIONEER OF TOBACCO PHYTOPATHOLOGY IN ROMANIA

BUTNARU Gallia

University of Life Sciences „King Mihai I" from Timisoara, Romania
Corresponding e-mail: galliab@yahoo.com

Introduction. The early 20th century marked the industrialization and rapid expansion of the global tobacco trade. Global economic importance: due to industrialization, automatic cigarette rolling machines transformed tobacco from an artisanal luxury into a mass-market commodity, and thus governments around the world recognized tobacco as an important source of state revenue through taxes and monopolies.

Materials and Methods. The source materials for this study comprise the scientific papers, academic courses, and conference proceedings on plant protection and tobacco diseases published or presented by Victor Ghimpu between 1928 and 1952. The methodological framework relies on historiographical analysis.

Results and Discussions. Victor Ghimpu's Vision and Observations on Tobacco Diseases. Ghimpu conceptualized tobacco not merely as a commercial commodity, but as a complex biological system that demanded rigorous cytological and genetic profiling. He observed that intensive global monoculture triggered devastating phytopathological epidemics, particularly Mosaic Virus and Blue Mold. Consequently, Ghimpu argued that maintaining economic yield stability was unattainable without elite seed selection and standardized plant immunity protocols.

During the interwar period, Greater Romania, which integrated Bessarabia, experienced a booming agrarian economy in which tobacco cultivation served as a critical financial pillar. However, the distinct ecological variations between these regions led to divergent phytopathological profiles, characterized by different tobacco pathogens and distinct symptomatic manifestations of disease.

In his research, Victor Ghimpu identified and diagnosed local pathogens, selected resistant crop varieties for use in hybridization programs, and advocated for seed breeding and acclimatization. Furthermore, he proposed the implementation of a comprehensive phytosanitary legislation framework.

The agrarian and fiscal management of tobacco fell under the jurisdiction of the Autonomous Monopoly Administration (Regia Autonomă a Monopolurilor/Casa

Autonomă a Monopolurilor, CAM), rendering the sector one of the largest revenue contributors to the Romanian state budget. In Bessarabia, specific microclimates within regions such as Orhei and Hotin, the latter being Ghimpu's birthplace, possessed optimal edaphic and climatic conditions for cultivating high-quality Oriental tobacco varieties. Consequently, tobacco cultivation provided a lucrative alternative to traditional grain farming for thousands of smallholder peasant households.

Ghimpu's core scientific contributions lay in phytopathogen mapping, achieved through the systematic documentation and classification of regional fungal, bacterial, and viral tobacco diseases affecting Romanian fields. He spearheaded selective breeding experiments aimed at adapting disease-resistant Oriental tobacco varieties and local landraces, such as the Ghimpati, Virginia de Baragan, Drăgășani landrace to specific regional agro-ecological environments. Furthermore, his extensive body of research provided the mandatory phytosanitary protocols utilized by state agronomists to safeguard regional agricultural output, effectively laying the foundation for a formalized institutional framework.

Conclusion. The scientific legacy of Victor Ghimpu's research lies in elevating tobacco cultivation from a purely empirical craft into a highly regulated, rigorous agronomic science. Furthermore, his timely phytopathological interventions directly safeguarded state economic assets by preventing catastrophic crop failures across Romania and Bessarabia during a critical macroeconomic era.

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TRICHOGRAMMA SPP - AN ENTOMOPHAGOUS INSECT IN SPACE AND TIME (50 YEARS - 1976–2026)

GAVRILITA Lidia, https://orcid.org/0000-0001-9266-4565

Moldova State University, Institute of Genetics Physiology and Plant Protection, Chisinau, Republic of Moldova,
Corresponding e-mail: *lidia.gavrilita@sti.usm.md*

This publication presents the history and current status of the mass rearing and application of the entomophagous parasitoid *Trichogramma* at the Institute of Genetics, Physiology and Plant Protection during the period 1976–2026. It summarizes the achievements of researchers who have contributed and continue to contribute to the biological protection of plants through the use of *Trichogramma* for pest control.

The excessive use of pesticides has created serious and complex problems against the backdrop of worsening environmental conditions. This situation necessitated a comprehensive approach to plant protection issues, focused on the development of alternative, non-chemical methods for controlling harmful organisms and on the establishment of a specialized institution dedicated to this field.

From the perspective of more than four decades of activity, the importance of establishing in Moldova the world's second institute dedicated to biological methods of plant protection has become increasingly evident. The institute has served as a coordinator of research related to the development of integrated crop protection systems and the implementation of environmentally sustainable agriculture.

A retrospective analysis of its development, considering its major achievements and their practical implementation, clearly demonstrates the necessity of establishing a new laboratory focused on integrated plant protection. Particular emphasis was placed on biological control methods, especially on the use of the entomophagous parasitoid *Trichogramma*.

The validity of this decision has been repeatedly confirmed through scientific achievements, valuable practical applications, collaboration with numerous international organizations, international recognition, and successful solutions to various problems related to the biological protection of plants.

Species of *Trichogramma* parasitize a wide range of pest species and are extensively used in biological and integrated plant protection programs. According to van Lenteren (2000) [2], this entomophagous parasitoid is released annually worldwide over a total area of approximately 45 million hectares of agricultural crops. Accord-

ing to Knutson (2001) [3], *Trichogramma* is the most widely used biological control agent in the world, being released annually in agricultural and forest ecosystems across 30 countries.

The European company Biotop produces and commercializes *Trichogramma* for the control of lepidopteran pests. The parasitoid is supplied to growers for biological control programs targeting *Ostrinia nubilalis* in maize and Tuta absoluta in tomato crops. It is used annually on more than 100,000 hectares in France, Germany, Switzerland, and the Czech Republic (Frandon, 2012) [1].

In the Republic of Moldova, during the period 1984–1994, the biological control agent *Trichogramma* spp. was applied on large agricultural areas ranging from 20.000 to 663.000 hectares across various crops. During this period, a comprehensive system for the production of biological plant protection agents was established and operated until 1994. Since 1994, this system has largely ceased functioning, and currently only two biological laboratories (located in Cahul and Soroca) remain partially operational out of the original fourteen. During the active period, annual production of *Trichogramma* spp. ranged from 29 to 41 billion individuals.

Between 1994 and 2002, *Trichogramma* spp. was not produced in the Republic of Moldova. Production activities were resumed only in 2002, when biological laboratories restored the mass-rearing process of this beneficial parasitoid. During the period 2002–2011, agricultural areas protected with *Trichogramma* spp. totaled 47.7 thousand hectares and included various annual crops such as cabbage, tomato, maize, pea, sugar beet, and soybean. The treated area varied between 0.6 and 9.3 thousand hectares annually.

The scientifically substantiated application of *Trichogramma* spp. in regions favorable for its activity ensures the destruction of up to 60–80% of pest eggs and contributes significantly to increased crop yields, enhanced agricultural production, and improved economic returns.

Trichogramma belongs to the family *Trichogrammatidae,* order *Hymenoptera*, genus *Trichogramma*. The most widespread species include: *T. evanescens* Westw., *T. pintoi* Vog., *T. semblidis* A., *T. leucaniae* P. & Ch., *T. sibiricum* Sor., *T. dendrolimi* Mats., *T. aurosum* Sug., *T. piceum* Dj., *T. embryophagum* Hb., *T. sorokina* Kost., and *T. telengai* Sor. (Dyurich, 2008) [4].

The entomophagous parasitoid *Trichogramma* spp. plays a crucial role as a key component of integrated pest management (IPM) systems for both annual and perennial crops.

Biological Control of Lepidopteran Pests Using *Trichogramma*

Trichogramma is the principal biological control agent used against complexes of lepidopteran pests affecting cereal, legume, industrial, vegetable, forage, viticultural, fruit, forestry, ornamental, aromatic, and medicinal crops.

1. Vegetable Crops

Cabbage, tomato, pepper, eggplant, etc. — controlled pests include:

- Cabbage moth (*Mamestra brassicae* L.)
- Cotton bollworm (*Helicoverpa armigera* Hbn.)
- Heart-and-dart moth (*Agrotis exclamationis* L.)
- Dark sword-grass (*Xestia c-nigrum* L.)
- Black cutworm (*Agrotis ipsilon* Huf.)
- Diamondback moth (*Plutella xylostella* L.)
- Large white butterfly (*Pieris brassicae* L.)
- Small white butterfly (*Pieris rapae* L.)

2. Grain Legumes

Pea, soybean, lentil, bean, etc. — pest complexes include:

- *Mamestra brassicae*, *Helicoverpa armigera*, *Agrotis exclamationis*
- *Xestia c-nigrum*, *Agrotis ipsilon*, *Various moth species*.

3. Industrial Crops

Sugar beet, sunflower, tobacco, etc. — pests include:

- *Mamestra brassicae*, *Helicoverpa armigera, Agrotis exclamationis, Xestia c-nigrum*;
- *Agrotis ipsilon*, Beet moth (*Scrobipalpa ocellatella* Boyd).

4. Cereals

Maize, wheat, barley, oats, triticale, etc. — pests include:

- Cotton bollworm (*Helicoverpa armigera*)
- Beet webworm (*Loxostege sticticalis* L.)
- European corn borer (*Ostrinia nubilalis* Hbn.)
- Various maize moth species

5. Fruit Crops

Apple: Codling moth (*Cydia pomonella* L.)

- Oriental fruit moth (*Grapholita molesta* Busck)

Plum: Plum fruit moth (*Grapholita funebrana* Treitschke)

Other noctuid pest complexes.

6. Vineyards

Grapevine:

- European grapevine moth (*Lobesia botrana* Denis & Schiffermüller)

7. Ornamental and Floricultural Crops

Flowers and ornamentals:

- *Mamestra brassicae*, *Helicoverpa armigera*, *Agrotis exclamationis*
- Rose tortrix (*Archips rosana* L.), Vapourer moth (*Orgyia antiqua* L.)

8. Medicinal Plants

Main pests include: *Helicoverpa armigera, Agrotis exclamationis,* Various moth species

9. Forest Plantations

The most widespread pests include: Cabbage moth (*Mamestra brassicae*),

- Cotton bollworm (*Helicoverpa armigera*), Heart-and-dart moth (*Agrotis exclamationis*),

Rose tortrix (*Archips rosana*), Vapourer moth (*Orgyia antiqua*), Green oak tortrix

(*Tortrix viridana*)

- Plum fruit moth (*Grapholita funebrana*)
- Gypsy moth (*Lymantria dispar*)
- Fall webworm (*Hyphantria cunea* Drury)
- Horse-chestnut leaf miner (*Cameraria ohridella* Deschka & Dimić)
- Codling moth (*Cydia pomonella*)

As a result of extensive international research on the application of *Trichogramma* in pest management, a substantial body of scientific literature has been accumulated.

The primary objective of plant protection specialists is to reduce crop losses caused by pests without negatively affecting beneficial fauna within agroecosystems and to obtain environmentally friendly agricultural products.

In response to the national need for biological plant protection and the production of ecologically sustainable agricultural products, and at the initiative of Academician Ion S. Popușoi, the *Trichogramma* Laboratory was established on March 1, 1976, at the Institute of Genetics, Physiology and Plant Protection of the Academy of Sciences of Moldova (currently part of USM).

The laboratory was initially headed by Dr. Ala P. Adașcheevici (1976–1977), followed by Dr. Habil. A. M. Grinberg (1977–1992). From 1995 to 1999, the laboratory was directed by Dr. Vladimir A. Șleahtici, and from 1999 to 2003 by Dr. Lidia T. Gavrilita. Research on *Trichogramma* has continued to the present day (2026) within the Laboratory of Phytopharmacy and Ecotoxicology of the Institute of Genetics, Physiology and Plant Protection.

Now, fifty years after the establishment of the *Trichogramma* Laboratory, and having passed through periods of profound institutional, social, and political restructuring, the necessity of conducting both fundamental and applied research on *Trichogramma* for pest control within integrated crop protection systems remains evident. These developments have further expanded the prospects for research and practical applications involving this important biological control agent.

Senior Research Scientists

1. Boris Vasile Pânzaru, PhD in Agricultural Sciences (1976–1996)
2. Ana Tudor Rusnac, PhD in Biological Sciences (1976–1988)
3. Miron Pavel Teşler, PhD in Biological Sciences (1981–1993)

4. Ion Nicolae Boubătrân, PhD in Agricultural Sciences (1976–1988)
5. Victoria Vasile Orlovscaia, PhD in Biological Sciences (1988–1992)
6. Mihail Valentin Palii, PhD in Biological Sciences (1978–1984)
7. Constantin Victor Tărâţă, PhD in Biological Sciences (1976–1978)
8. Nicolai Ion Serâi, PhD in Agricultural Sciences (1976–1980)
9. Alexandra Tudor Vorotânţeva, PhD in Biological Sciences (1976–1987)
10. Emanuel Marc Mencer, PhD in Mathematical Sciences (1978–1982)
11. Natalia Vladimir Răileanu, PhD in Biological Sciences (2002–2009)

Research Scientists

1. Galina Tudor Diurici (1976–1992, 1998–2000)
2. Natalia Petru Bradovscaia (1995–2003)
3. Nina Nicolae Cudreavţeva (1986–1992)

Junior Research Scientists (Research Trainees)

1. Ana Crucinina (1976–1982)
2. Galina Gluşcova (1993–2003)
3. Lidia Şchiopu (1977–1998)
4. Ludmila Podberezcaia (1977–1984)
5. Ala Nesterova (1981–1983)
6. Eleonora Negru (1984–1985)
7. Nelea Voronţova (1977–1983)
8. Natalia Pşenicica (1977–1983)
9. Tatiana Bogoutdinova (2003–2004)

Entomologist

1. Galina Feodor, Category I Entomologist (1990–1991)

Agronomists

1. Elizaveta F. Moisei, Category II Agronomist (1967–2003)
2. Ana Buzatu, Category I Agronomist (1995–2003)
3. Elizaveta Zaiţeva, Category I Agronomist (1976–1982)
4. Ala Rudac, Category I Agronomist (1987–1997)

Technicians

1. Maria Florica, Category II Technician (1978–1983)
2. Elena Florica, Category II Technician (1976–1977)
3. Vera Scrob, Category II Technician (1980–1982)
4. Maria Butucea, Category II Technician (1980–1983)
5. Olga Balaclav, Category I Technician (2006–2007)
6. Vasile Anton Gavriliţa (2006–2015)

Doctoral and Habilitated Doctoral Theses Related to *Trichogramma* Defended within the "Trichogramma" Laboratory

1. Grinberg Sh. M. *Scientific Foundations of the Biotechnology for the Production and Application of Trichogramma*. Leningrad. Abstract of the Doctor of Biological Sciences Dissertation, 1991.

2. Boubătrân I. N. *Biological Justification for the Use of Trichogramma in the Control of the European Corn Borer on Maize under Intensive Cultivation Technology*. Abstract of the Candidate of Agricultural Sciences Dissertation. Tbilisi, 1988.

3. Pânzaru B. V. *Development of Technologies for the Application of the Entomophagous Insect Trichogramma in the Control of the Cabbage Armyworm on Cabbage*. Dissertation Abstract for the Degree of Doctor of Agricultural Sciences. Chișinău, 1989.

4. Şleahtici V. A. *Ecological and Physiological Characteristics of Trichogramma Diapause under Mass-Rearing Conditions*. Abstract of the Candidate of Biological Sciences Dissertation. Chișinău, 1991.

5. Gavriliţa L. T. *Biological Substantiation of Procedures and Methods for Increasing the Vitality of Trichogramma*. Dissertation Abstract for the Degree of Doctor of Biological Sciences. Chișinău, 1993.

6. Palii M. V. *Biological Justification for the Use of Trichogramma in Limiting the Population of Noctuid Moths (NOCTUIDAE) in the Forest-Steppe Zone of Ukraine*. Abstract of the Candidate of Biological Sciences Dissertation. Chișinău, 1983.

7. Teşler M. P. *Biological Justification and Optimization of the Application of Trichogramma and Biological Preparations in the Biological Control of the European Grapevine Moth in Vineyards*. Leningrad, 1985.

8. Orlovscaia V. V. *Agrocenotic Justification for the Application of Trichogramma in the Control of the Pest Ostrinia nubilalis H. in Maize Crops*. Dissertation Abstract for the Degree of Doctor of Biological Sciences. Chișinău, 1993.

9. Tărâţă C. V., Doctor of Biological Sciences (1976–1978).

10. Răileanu N. V. *Bioecological Justification of Methods and Techniques for the Multiplication and Application of Trichogramma Against the Complex of Cutworm Species*. Dissertation Abstract for the Degree of Doctor of Biological Sciences. Chișinău, 2008.

Laboratory Personnel

A total of **36 people** worked in the ***TRICHOGRAMMA***

Laboratory, including:

- Moldovans – 18; Ukrainians – 6; Russians – 9; Jews – 3

As of **2026**, only **two staff members** continue to work in the laboratory:

- **Dr. L. Gavriliţa**
- **Maria Butucel**.

CONCISE RESULTS OBTAINED DURING THE PERIOD 1976–2026

During the period 1976–2026, fundamental and applied research was carried out on the entomophagous insect *Trichogramma* spp.

Within this laboratory, various research directions were studied by the laboratory team.

The entomophagous insect *Trichogramma* spp. plays a very important role as a key element in the integrated protection of annual and perennial crops against pests.

- Identification, accumulation, and maintenance of collected *Trichogramma* spp. species from different agricultural crops for recommendation in plant protection.

Researchers: Grinberg Ș. M., Diurici G., Gavrilița L., Șchiopu L., Rudac A., Răileanu N.

The identification, accumulation, and maintenance of *Trichogramma* species were carried out according to the methodological guidelines of the author G. F. Diurici: "Collection, Identification and Maintenance of Live Cultures of Species of the Genus *Trichogramma* Westw. (*Hymenoptera, Trichogrammatidae).*" Methodological Guide, 2008.

The research direction focused on studying the fauna and systematics of the genus Trichogramma and other genera used in biological plant protection, with the general objective of studying the fauna and systematics of the genus *Trichogramma*, family Trichogrammatidae (Hymenoptera), and other related genera.

In the works of the author Diurici, G. 14 species of *Trichogramma* distributed throughout the Republic of Moldova are described. The species *T. evanescens, T. pintoi, T. semblidis*, and *T. principium* prefer field agricultural crops. The species *T. cacoeciae, T. embryophagum*, and *T. dendrolimi* prefer perennial crops such as apple, plum, and grapevine plantations.

- Study of interspecific competition among *Trichogramma* species.

Researchers: Gavrilița L., Grinberg Ș. M., Diurici G., Șchiopu L.

One of the important research issues in the mass rearing and field release of *Trichogramma* is interspecific competition. Due to the relatively specialized trophic behavior of *Trichogramma*, competitive ability directly influences the effectiveness of the entomophagous insect.

Experiments were conducted in five laboratory variants using different ratios of the indicated Trichogramma species:

T. evanescens – 100%; *T. pintoi* – 100%; *T. evanescens* + *T. pintoi* – 50% + 50%;

T. evanescens + *T. pintoi* – 10% + 90%; *T. evanescens* + *T. pintoi* – 90% + 10%.

Laboratory experiments established that over four generations of development within mixed Trichogramma populations, a gradual replacement of T. evanescens by T. pintoi occurs.

The mechanism of substitution of one species by another is explained by the different reactions of *T. evanescens* and *T. pintoi* to temperature and humidity conditions during mass rearing.

- **Development of mechanized procedures and biotechnical requirements for equipment complexes used in the production of the laboratory host *Sitotroga cerealella* Ol. and *Trichogramma*.**

Researchers: Grinberg Ș. M., Vorotânțeva A., Gavrilița L., Pâzaru B., Palii M., Boubătrân I., Orlovscaia V., Șleahtici V., Crucinina A., Mencer E., in collaboration with the mechanization group.

The purpose of this research was the modernization and testing of certain elements of the production line for *Sitotroga cerealella* eggs required for the production of the entomophagous insect Trichogramma spp.

Elements of the cereal moth egg production line were tested, T. evanescens of different ages released in capsules was verified under field conditions, and *Trichogramma* release using modern technology was evaluated.

The research direction of the *Trichogramma* laboratory included the development of methods and procedures for applying *Trichogramma* in pest control for annual and perennial agricultural crops.

In collaboration with the mechanization group, research was carried out on mechanized application of the entomophagous insect *Trichogramma* (using airplanes, helicopters, and tractors), in cooperation with institutes from Moscow, Krasnodar, Kyiv, Tashkent, and Odessa for the protection of agricultural crops. From Romania: Turda, ClujnaPoca, Timisoara, Craiova, Iasi, Arad, Bucharest.

Another research direction focused on optimizing the timing and release rates of Trichogramma in the field for pest control.

Different types of equipment were developed for the production line of the laboratory host *Sitotroga cerealella* O. used in the production of *Trichogramma* spp.

Techniques for the use and release of the entomophagous insect *Trichogramma* in controlling pest complexes in agricultural crops were developed. The technologies elaborated by the working group, together with the mechanization team, were implemented in the Republic of Moldova and in various regions of the former USSR.

Improvement and completion of the equipment (production line) for producing the laboratory host — the grain moth (*Sitotroga cerealella*) — for the multiplication of the entomophagous insect *Trichogramma* spp.

Researchers: Grinberg Ș., Gavrilița L., Boubătrân I., Pânzaru B., Vorotânțeva A.

Different types of equipment were developed for the production line of the labo-

ratory host Sitotroga cerealella O. used for the production of *Trichogramma* spp. in the protection of agricultural crops against pests.

Techniques for the use and release of the entomophagous insect *Trichogramma* in controlling pest complexes in agricultural crops were developed. The technologies elaborated by the working group, together with the mechanization group, were implemented in the Republic of Moldova and in different regions of the former USSR.

- A special device for storing *Trichogramma* spp. was constructed.
- Storage periods for *T. evanescens* in special devices were determined (together with the mechanization and design group).

Development of methods for the production and maintenance of laboratory hosts — the grain moth (*Sitotroga cerealella* O.) and the flour moth (*Ephestia kuehniella*) — for the multiplication of different *Trichogramma* spp. species.

Researchers: Grinberg Ș., Gavrilița L., Șleahtici V., Tărânță C., Palii V., Răileanu N., Moisei E., Negru E., Buzatu A., Gavrilița V., Crucinina A., Voronțova N., Bogoutdinova T., Nesterova A., Pșenicica N., Florica M., Florica E., Scrob V., Butucea M., Butucel M., in collaboration with the mechanization group.

The biological indices of *Trichogramma* are directly dependent on the laboratory host species on which the entomophagous insect is reared, as well as on the age and quality of the eggs laid.

Each species has a high capacity for host selection on which it develops. Differences are also observed among individuals of the same *Trichogramma* species emerging from different host eggs. The larger the host eggs, the larger the entomophagous insect becomes.

In the *Trichogramma* laboratory, the laboratory host *Sitotroga cerealella* O. was produced in different quantities for carrying out various research activities.

- **Development and implementation of new methods and procedures for the production of *Trichogramma* spp. with enhanced qualities for the protection of agricultural crops against pests**.

Researchers: Gavrilița L., Grinberg Ș., Rusnac A., Podberezcaia L., Mencer Ă., Răileanu N.

Within the "Trichogramma" laboratory, a Trichogramma Quality Standard was developed, according to which the entomophagous insects were classified into quality classes.

New methods and procedures were developed for the production and application of Trichogramma spp. with enhanced qualities for the protection of agricultural crops against pests.

The traditional laboratory host — the grain moth — does not correspond, in terms of biochemical composition and size, to the nutritional requirements of the parasite. During long-term rearing of *Trichogramma* on grain moth eggs, a reduction

in the size of the entomophagous insect, decreased prolificacy, reduced searching capacity of females, and lower field effectiveness were observed.

In order to increase the vitality of laboratory populations, it is recommended to annually renew the parent culture by collecting egg masses of Lepidoptera parasitized by Trichogramma from nature, carrying out 1–2 spring passages on natural host eggs, and rearing the entomophagous insect on *Sitotroga cerealella* Ol. eggs previously irradiated with gamma rays, ultraviolet rays, magnetic fluid, and other sources.

Under these conditions, the biological indices of Trichogramma increase significantly.

- To improve biological indices, supplementary feeding of adults with sugar and honey solutions was applied.
- Preservation of the gene pool of the initial colony plays a very important role during mass rearing and release of the entomophagous insect in various agrocenoses, where uncontrolled environmental humidity and temperature conditions have different effects in nature.
- **The relationship between the general quality criterion and the predicted biological efficiency of the entomophagous insect in the field under optimal hydrothermal environmental conditions was established.**

Dr. Gavrilița L. developed the following methodological guidelines:

"Methodological Guidelines for the Production of T. embryophagum with Enhanced Qualities for Apple Crop Protection";

"Methodological Guidelines for the Production and Application of T. evanescens with Different Qualities for Maize Crop Protection";

"Methodological Guidelines for the Rearing and Application of *Trichogramma evanescens* with Enhanced Qualities for Cabbage Crop Protection";

"Methodological Guidelines for the Rearing and Application of *Trichogramma evanescens* with Enhanced Qualities for Tomato Crop Protection".

- **Development and implementation of methods for applying the entomophagous insect Trichogramma spp. in the integrated protection of annual crops.**

Researchers: Gavrilița L., Grinberg Ș., Boubătrân I., Pânzaru B., Vorotânțeva A., Orlovscaia V., Răileanu N., Adașcheevici A., Palii M.

Application of the entomophagous insect *Trichogramma* spp. in the integrated protection of cabbage, maize, pea, tomato, soybean, and sugar beet crops, reared on *Sitotroga cerealella* O. eggs for the control of cutworms, moths, and whiteflies, demonstrated that in the variant where methods for improving biological indices were applied, the biological efficiency was significantly higher than in the variant where *Trichogramma* was reared on *Sitotroga cereal*ella Ol. eggs using the traditional method.

- A linear relationship between the general quality criterion of the parasite and its biological efficiency in the field was established.
- Based on the experiments carried out, models were developed describing the Host: Parasite (H:P) relationship according to pest egg density, as well as the dependence of *Trichogramma* quality on temperature (T) and humidity (W).

New methods and procedures for the production and application of Trichogramma spp. were implemented for the protection of annual agricultural crops (vegetable, industrial, cereal, and leguminous crops).

- **Development and implementation of technologies for the multiplication and application of the entomophagous insect *Trichogramma* spp. in the integrated protection of perennial crops**.

Researchers: Gavrilița L., Cudreavțeva N., Diurici G., Vorotânțeva A., Serâi N. I., Moisei E., Feodor G.

The entomophagous insect *Trichogramma* was applied in the integrated protection of perennial crops such as apple, plum, and grapevine plantations, reared on Sitotroga cerealella O. eggs for controlling pest complexes.

"Methodological Guidelines for the Production and Application of the Entomophagous Insect Trichogramma spp. for the Protection of Annual and Perennial Agricultural Crops against Pests" were developed.

- **Development of technologies for the storage of the entomophagous insect Trichogramma for the protection of agricultural crops against pests.**

Researchers: Șleahtici V., Gavrilița L., Grinberg Ș., Negru E.

Research activities within this direction focused on developing methods for long-term and short-term storage (diapause) and production of the entomophagous insect Trichogramma for plant protection.

- "Methodological Guidelines for the Production and Application of *T. evanescens* with Different Storage Periods" were developed.
- Development of technologies for the use of the entomophagous insect *Trichogramma pintoi* in grain storage facilities for the control of moth complexes.

Researcher: Gavrilița L., 2009–2010.

As a result of research carried out in the grain storage facility in Chișinău, a technology was developed for the use of *Trichogramma pintoi* V. for the protection of cereal products (flour, wheat, barley) against moth complexes in storage facilities.

"Methodological Recommendations for the Use of the Entomophagous Insect Trichogramma pintoi in Grain Storage Facilities for the Control of Moth Complexes" were developed.

- **Development of technologies for the multiplication and use of the entomophagous insects *Bracon hebetor, Choioia cunea, Uscana senex, and Podizus maculiventris* for the integrated protection of agricultural crops.**

Researchers: Bradovscaia N., Glușcova G., Buzatu A., and the mechanization group.

The main research direction focused on the development of technologies for the multiplication and use of entomophagous insects in plant protection against agricultural crop pests.

The principal field of activity is biological plant protection, with the general theme:

"Development and Improvement of Methods and Technologies for the Production and Application of Beneficial Insects for Plant Protection" (*Bracon hebetor, Podizus maculiventris, Uscana senex, Choioia cunea*), reared on laboratory hosts such as *Aphis fabae*, *Galleria mellonella*, and others.

These entomophagous insects are maintained, produced, and utilized for controlling pest complexes in agricultural crops within plant protection systems.

Development of technologies for the multiplication and use of the entomophagous insect *Trichogramma* spp. for the integrated protection of agricultural crops.

Researchers: Gavrilița L., Răileanu N., Gavrilița V., Butucel M.

Studying the basic principles underlying integrated plant protection systems, the author emphasized the enhancement of beneficial organism circulation and the necessity of reducing harmful organisms.

As a fundamental principle, a transition was proposed from total pest eradication toward methods for regulating pest population density through a systemic approach to the problem as a whole.

For this purpose, biological plant protection methods were promoted through the application of the biological agent *Trichogramma* in assessing pest population status and regulating populations at the Economic Threshold Level (ETL).

Over many years, the biology, phenology, and systematics of *Trichogramma* species collected from different regions of the Republic of Moldova and from various agricultural crops were studied and maintained for further research.

Within the fundamental research directions, new procedures and methods for producing the entomophagous insect were substantiated, developed, and implemented, including rearing *Trichogramma* on eggs of the laboratory host *Sitotroga cerealella* treated with gamma rays, ultraviolet rays, magnetic fluid, and deuterium-depleted water, in order to improve quality and field efficiency.

Within the applied research directions, procedures and methods for using the biological agent in regulating the population density of the main agricultural crop pests were substantiated, developed, and implemented.

During the period 2000–2016, the total implementation area reached 3000 hectares of vegetable, leguminous, fruit, industrial, cereal, and forestry crops through

the use of *Trichogramma* spp. with enhanced qualities for crop protection against complexes of cutworms, moths, and whiteflies.

The biological efficiency of the entomophagous insect in field conditions was significantly higher compared to the variant where *Trichogramma* was reared on traditional *Sitotroga cerealella* eggs.

Using the BioClass program — a multicriteria spatio-temporal classification and optimization system — together with initial information regarding egg density per plant during the vegetation period, digital spatial distribution maps of pest eggs were created for the development period of two to three generations.

These maps identified uneven distribution patterns and localized pest outbreak centers, enabling optimization of the release rates and timing of the entomophagous insect *Trichogramma* spp.

These developments were tested under production conditions and recommended by the Scientific Council of IGFPP for practical implementation.

"Methodological Guidelines for the Production and Application of the Entomophagous Insect Trichogramma spp. for the Protection of Agricultural Crops against Pests" were developed in 2008 and 2015.

CONCISE RESULTS OBTAINED DURING THE PERIOD 1916–2026

During the period 1916–2026, fundamental and applied research was carried out on the entomophagous insect *Trichogramma* spp.

- **Technologies for the multiplication of *Sitotroga cerealella* as a laboratory host for obtaining the entomophagous insect *Trichogramma* spp. and its application in integrated biological protection systems for various agricultural crops.**

Researcher: Dr. Gavrilița L.

- **Efficiency of certain methodological procedures for increasing the vitality of the entomophagous insect *Trichogramma* spp. reared on eggs of different hosts.**

Development of technological procedures for increasing the vitality of the entomophagous insect *Trichogramma evanescens* West. in order to enhance the reduction rate of pest population density in agricultural crops.

Researchers: Dr. Gavrilița L., Dr. habil. Nastas T., Technician Butucel M.

- **Assessment of the efficiency of biologically active substances with kairomonal properties under field conditions (sunflower crop) in increasing the pest egg parasitism potential of the entomophagous insect *T. evanescens* W.**

Researchers: Dr. Gavrilița L., Dr. habil. Nastas T., Technician Butucel M.

- **Assessment of the efficiency of biologically active substances with kairomonal properties on the behavior of the entomophagous insects *Trichogram-***

***ma evanescens* West. *Trichogramma dendrolimi* Mats., and *Trichogramma pintoi* Voeg. aimed at increasing the pest egg parasitism potential.**

Researchers: Dr. Gavrilița L., Dr. habil. Nastas T., Technician Butucel M.

- **Detection, identification, maintenance, and accumulation of *Trichogramma* species collected from agricultural crops, maintenance of live cultures, and accumulation of the laboratory host Sitotroga cerealella Ol.**

Researchers: Dr. Gavrilița L., Dr. habil. Nastas T., Technician Butucel M.

Methodological recommendations for plant protection.

Researcher: Dr. Gavrilița L.

1. During the development of 2–3 generations of pests on annual and perennial plants, entomophagous insects play a very important role in reducing pest density. For this purpose, the following integrated protection measures should be implemented:

2. During the adult stage of pests, pheromone or light traps should be installed for monitoring and mass capture of butterflies/moths (males);

3. During the pest egg stage, 5–6 releases of *Trichogramma* should be carried out at a rate of 100,000–600,000 individuals per hectare (depending on pest density);

4. During the larval stage, other entomophagous insects such as *Bracon, Apanteles*, etc., may be released;

5. Biological preparations should be applied for pest control;

6. One or two fungicide treatments should be carried out for disease control;

7. One or two selective insecticide treatments should be carried out against pest complexes if necessary;

8. Mechanical and physical measures should be applied;

9. Agrotechnical measures and crop rotation should be implemented for the respective crops.

As a result:

- Plant protection costs can be reduced by 3–4 times compared to chemical preparations;
- Beneficial organisms in nature are preserved;
- The number of chemical treatments in integrated protection systems is minimized;
- Conditions are created for reducing environmental pollution;
- Ecological and high-quality agricultural products are obtained.

Advantages of biological plant protection using the entomophagous insect *Trichogramma* spp.

Researcher: Dr. Gavrilița L.

The priorities of applying the entomophagous insect *Trichogramma* include:

- Reduction of financial costs for crop protection;
- Preservation of beneficial organisms in nature;
- Increased biological efficiency in the field;
- Reduction of agricultural production costs;
- Improvement of agricultural product quality;
- Increased agricultural yield in the field;
- Low cost;
- Establishment and maintenance of natural biological balance;
- Assurance of food product quality;
- Minimization of chemical treatments within integrated protection systems;
- Prevention of environmental pollution;
- Safety and harmlessness;
- Good quality; Ease of application; Ecological purity.

Pest eggs fresh and parasitized with Trichogramma

The developed procedures and methods enabled the integration of the obtained results into integrated agricultural plant protection practices, reducing costs by 3–4 times compared to chemical protection.

Integrated protection aims to minimize or avoid the use of polluting chemical products and to promote the use of biological methods without harmful effects on humans and beneficial entomofauna, in order to maintain an appropriate phytosanitary condition and obtain ecological agricultural production.

Results of Dr. L. Gavrilița's activity during the period 1967–2026:

1.Published articles – 350

2.Patents for inventions – 15

3.National and international projects – 10

4. Participation in conferences (national and international) – 185

5. Participation in seminars – 167

6. Participation in various exhibitions – 108

We express our sincere gratitude to the thesis supervisor, head of the "Trichogramma" laboratory, doctor habilitatus in biology, a. M. Grinberg, for the provided assistance, support, and guidance along this path of study of this useful object at the institute for 50 years, known as Trichogramma.

We thank all researchers and colleagues for their contribution to the study of this subject.

Doctor of biology, associate research professor, coordinating scientific researcher – Lidia Gavrilița, 2026.

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Section A

Biodiversity of Harmful and Beneficial Organisms in Natural and Anthropogenic Ecosystems

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ECOLOGICAL MANAGEMENT OF BENEFICIAL MICROBIOMES AND ENTOMOPHAGES FOR SUSTAINABLE AGROECOSYSTEM RESILIENCE

ADEBAYO Rufai Quadril, https://orcid.org/0009-0001-9076-5773

Department of Forestry and Wildlife, Faculty of Agriculture,
Zamfara State University
(ZAMSUT), Talata Mafara, Zamfara State, Nigeria
Corresponding e-mail: adebayotarabaurufai@gmail.com

Purpose: This study evaluates the integration of entomophages and native microbial bioproducts to suppress agricultural pest populations while restoring functional biodiversity within stressed agroecosystems.

Materials and Methods: Field experiments were conducted using a randomized complete block design integrating targeted releases of Trichogramma spp. with Bacillus-based microbial inoculants across diversified crop production systems. Arthropod diversity, pest abundance, soil microbial respiration, and enzymatic activity were monitored bi-weekly over two consecutive growing seasons to evaluate ecological responses.

Results: Integrated biological treatments reduced herbivorous pest populations by 42% while increasing beneficial predatory arthropods by 35% compared with conventional chemical control plots. Soil microbial respiration and enzymatic activity also increased significantly, demonstrating improved soil biological functioning, enhanced biodiversity conservation, and greater agroecosystem resilience.

Conclusions: The combined application of beneficial microorganisms and entomophages provides an effective ecological plant protection strategy that minimizes reliance on synthetic pesticides while improving soil health, conserving biodiversity, and strengthening sustainable agricultural production systems.

Keywords: Biodiversity; Entomophages; Microbial products; Ecological agriculture; Pest management.

Acknowledgments: The author gratefully acknowledges the academic support provided by the Department of Forestry and Wildlife, Faculty of Agriculture, Zamfara State University (ZAMSUT), Talata Mafara, Zamfara State, Nigeria, and appreciates the collaborative assistance of regional ecological monitoring networks during the conduct of this study.

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MANAGEMENT OF PLANT VIRUSES WITH AGRICULTURAL IMPACT

ANDRONIC Larisa, https://orcid.org/0000-0002-2761-9917

Moldova State University, Institute of Genetics Physiology and Plant Protection, Republic of Moldova,
Corresponding e-mail: *larisa.andronic@sti.usm.md*

According to the International Committee on Taxonomy of Viruses there are more than 2,100 plant virus species have been recognized. Several viruses cause in infected plants a wide range of morphological and physiological disorders that result in significant yield losses of important crops. The agriculture practices, intense global exchange of plant material, the new cultivars under the climate change create favorable conditions for the appearance of new pathogens and strains. The study of economically important viruses is significant in the development of various practices and strategy for sustainable agriculture.

Research on the incidence and consequences of infections in cultivated plants in the Republic of Moldova is sporadic and limited to a relatively small number of species. More ample investigations were conducted during the 1980s and 1990s, particularly on horticultural plants. In the Republic of Moldova, annual crops constitute the basis of agricultural production, both in terms of cultivated area and economic importance. They account for the majority of arable land (approximately 90–95 %) and include cereal crops (wheat, maize, barley), industrial crops (sunflower, sugar beet, rapeseed), legumes (soybean), and vegetables.

The barley yellow dwarf disease is the most significant disease of wheat-growing world regions, caused by the Barley Yellow Dwarf Virus or Cereal Yellow Dwarf Virus. Based on some reports this disease is responsible for 11 to 33% annual yield loss. Another disease with regional importance is wheat streak mosaic disease caused by alone Wheat Streak Mosaic Virus (WSMV) or in complex with Triticum Mosaic Virus, and High Plains Wheat Mosaic Virus. Among these three viruses, WSMV is widely distributed in most of the wheat growing regions, including the Republic of Moldova. In the condition of our country also can be described: Barley Yellow Dwarf Virus; Cereal Yellow Dwarf Virus; Soil-Borne Wheat Mosaic Virus, Wheat Spindle Streak Mosaic Virus and Triticum Mosaic Virus.

Numerous viruses have been identified in barley (around 33), but only a few are considered of major economic impact. In our country the most important are Barley

Yellow Dwarf Virus, Barley Yellow Mosaic Virus, Barley Mild Mosaic Virus, Barley Stripe Mosaic Virus.

Nearly 36 viruses have been reported infecting maize in different countries. In Eastern European countries and in the Republic of Moldova, the most important maize viruses are Maize Dwarf Mosaic Virus and Sugarcane Mosaic Virus. Other viruses, such as Maize Chlorotic Mottle Virus, have a more limited geographical distribution and are not considered widespread in this region.

Over 100 viruses have been identified in soybean worldwide, but only about 19 cause significant economic losses. In Europe and in the Republic of Moldova the most relevant are Soybean Mosaic Virus, Alfalfa Mosaic Virus and Cucumber Mosaic Virus (CMV) – found also in numerous legumes and cultivated plants. Bean Pod Mottle Virus is important especially in the USA, Canada, while data on its identification in our country are lacking.

Tomato Spotted Wilt Virus (TSWV), CMV, and Tomato Yellow Leaf Curl Virus (TYLCV) are important viruses infecting various vegetables around the world. TSWV infects >800 plant species and can cause yield losses of up to 100% in several vegetables. CMV has a broad host range infecting >1,200 plant species in over 100 families. Yield losses from CMV infections varied from year to year and from crop to crop, with 25 to 50% of tomato, 60% of melon, up to 80% of pepper, 30-100% in tomato. TYLCV is the causal agent of tomato yellow leaf curl disease, the most economically important virus disease, which can dramatically reduce productivity with up to 100% yield loss in susceptible tomato cultivars. Data on the occurrence and identification of TYLCV under the conditions of the Republic of Moldova are lacking, although the presence of the virus has been reported in neighboring countries. Furthermore, there is a lack of information regarding viral diseases and their causal agents affecting industrial crops.

In the absence of a comprehensive study of viral infections in cultivated plants, considering the very limited number of cultivars resistant to viral pathogens, provides effective phytopathogens management strategies and advancing sustainable agricultural systems cannot be developed.

Keywords: plant viruses, crops, diseases, annual crops.

Acknowledgments. The research was carried out within the subprogram 011101 "Genetic and biotechnological approaches to agroecosystem management under climate change conditions", financed by the Ministry of Education and Research of the Republic of Moldova.

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ECOLOGICAL PLANT PROTECTION USING BIOLOGICAL SURVEILLANCE IN CROPPING SYSTEMS

ARIYO Adekunle Sheriffdeen, https://orcid.org/0009-0005-2260-220X

Zamfara State University (ZAMSUT), Talata Mafara, Zamfara State
Faculty of Agriculture, Department of Forestry and Wildlife
Corresponding e-mail: a66975909@gmail.com

Purpose: Sustainable plant protection is increasingly important as agricultural systems face greater pest pressure, biodiversity loss, and climate variability. This study proposes an ecologically integrated framework for protecting crops by combining biological surveillance with preventive agronomic practices. The objective is to demonstrate how ecosystem-based management can reduce dependence on synthetic pesticides while maintaining crop productivity, environmental quality, and long-term agroecosystem resilience.

Materials and Methods: A conceptual framework was developed from internationally accepted principles of integrated pest management and ecological crop protection. The proposed approach incorporates systematic field scouting, disease diagnosis, pest population monitoring, conservation of natural enemies, crop rotation, sanitation, resistant cultivars, habitat diversification, and threshold-based intervention. Ecological observations are combined with routine agronomic assessments to guide evidence-based decision-making. Preventive measures are prioritised over curative pesticide applications to minimise environmental risks while maintaining effective protection against economically important pests and diseases.

Results: The integrated strategy is expected to reduce pest outbreaks through early detection and improved biological regulation. Conservation of predators, parasitoids, pollinators, and beneficial soil microorganisms strengthens natural ecosystem functions that suppress pest populations. Reduced pesticide use lowers production costs, minimises environmental contamination, and preserves biodiversity. Improved crop health, enhanced soil quality, and greater resilience to climatic stress contribute to more stable agricultural production. The framework also supports environmentally responsible farming practices consistent with sustainable development objectives.

Conclusions: Ecological plant protection based on biological surveillance provides a practical and scientifically sound pathway for sustainable crop management. Integrating preventive agronomic practices with ecological monitoring strengthens resilience against emerging pests while protecting natural resources. Wider adoption of this framework can improve food security, enhance biodiversity conservation, and promote environmentally sustainable agricultural production in diverse farming systems.

Keywords: plant protection; surveillance; resilience; biodiversity; sustainability. sustainable agriculture inspired the development of this conceptual study.

Acknowledgments. The author gratefully acknowledges Zamfara State University and researchers whose work in integrated pest management, forestry, wildlife, and sustainable agriculture inspired the development of this conceptual study.

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ADVANCING ECOLOGICAL PLANT PROTECTION USING INDIGENOUS BOTANICAL BIOPESTICIDES

AZEEZ Awal Agboola, https://orcid.org/0009-0003-3091-812X

Department of Forestry and Wildlife, Faculty of Agriculture, Zamfara State University (ZAMSUT), Talata Mafara, Zamfara State, Nigeria
Corresponding e-mail: civilmatters.ng@gmail.com

Purpose: This research assessed the effectiveness of indigenous botanical biopesticides as environmentally sound alternatives to conventional insecticides for protecting vegetable and field crops. The study investigated whether locally available plant extracts could reduce insect pest populations, conserve natural enemies, improve crop productivity and contribute to sustainable plant protection strategies under tropical production systems.

Materials and Methods: Field experiments were conducted for two consecutive seasons using a randomized complete block design. Aqueous extracts of neem, Tephrosia vogelii and garlic were applied individually and in combination and compared with a synthetic insecticide and untreated

control. Pest abundance, crop injury, beneficial arthropod diversity, marketable yield and economic returns were recorded periodically. Data were analysed using analysis of variance to determine treatment differences.

Results: Botanical treatments significantly reduced infestations of major chewing and sucking insect pests while maintaining higher populations of pollinators and predatory insects than conventional pesticide plots. Combined botanical formulations produced the greatest suppression of pest populations, reduced foliar damage, increased marketable yield and improved benefit-cost ratio. Lower chemical inputs also reduced environmental risks and enhanced ecological stability within the production system.

Conclusions: Indigenous botanical biopesticides provide an effective, affordable and sustainable approach to modern plant protection. Their integration into integrated pest management programmes can strengthen biodiversity conservation, reduce pesticide dependence and enhance resilient agricultural production in line with current achievements and future perspectives in plant protection.

Keywords: Botanical biopesticides; Integrated pest management; Crop protection; Biodiversity; Sustainability

Acknowledgments: The author sincerely acknowledges the Department of Forestry and Wildlife, Faculty of Agriculture, Zamfara State University (ZAMSUT), Talata Mafara, for academic support and appreciates colleagues who contributed valuable technical assistance during the study.

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BIOLOGICAL CONTROL PROCEDURES IN INTEGRATED PLUM PROTECTION

BATCO Mihail*, https://orcid.org/ 0000-0002-3711-4429
IORDOSOPOL Elena, https://orcid.org/ 0000-0003-3492-8045
MUNTEAN Elena, https://orcid.org/0009-0002-1756-7858

Moldova State University, Institute of Genetics Physiology and Plant Protection, Chisinau, Republic of Moldova,
**Corresponding e-mail*: *mihai.batcu@yahoo.com*

The role and prospects of using biological control processes through conservation in modern integrated plant protection systems are discussed.

The term "Conservation Biological Control (CBC)" refers to the manipulation of environmental factors and the behavior of resident populations of entomoacarifags to increase their viability, fecundity, lifespan and, consequently, their effectiveness in reducing the harmfulness of phytophagous arthropods present in agrocenoses (Barbosa, 1998, Landis et al., 2000). In critical situations, conservation biological control programs allow the application of specially modified methods of pesticide application with minimal impact on the agrocenoses.

Within the framework of State Projects and Programs, we have begun to develop procedures for the conservative biological control of harmful arthropod populations, for further use in integrated management programs for stone crop plantations. For our experiments, a 0.5 hectares plum plot with two late varieties was created. It borders a forest area dominated by acacias, an apple orchard and oilseed plantations. Insecticide treatments on this plot were only against *Eurytoma shreineri* Schr. From a wide range of approaches, we are focused on developing the most frequently used ones: 1. Providing additional nutrition to beneficial arthropods to attract and locate them in the plum orchard, increasing their survival capacity, fertility and lifespan. 2. Attracting entomoacarifagas to the agrocenosis of plum orchards by applying semiochemical attractants.

The tested nectar-producing plant mixture was the most effective in attracting entomophagous insects during the fruit growth period (June 15-21). Up to 24 entomophagous insects from eight families were recorded per sticky trap. In contrast, only one insect from two families was recorded in the control plots. Thus, the number of parasites in the experimental plots attracted by the nectar-producing plant mixture exceeded the control plots by 12 times. Egg parasites were detected in the

entomophagous collections. Comparing their occurrence with the phenology of the oriental moth, the plum worm, we conclude that they were able to parasitize the eggs of the first generation of the pests given from the second decade of May to the second decade of June. The proportion of parasitized eggs in the experimental treatments was 38%, 48% and 53%, respectively. In the control, infestation with ooparasitic insects did not exceed 27%, this being ensured only by individuals from resident populations of egg-consuming insects.

Monitoring the species composition and population size of predatory entomoacarifags. Threading on nectariferous crops revealed representatives of the orders DIPTERA (28% of the total population), from the families Agromyzidae, Phoridae, Cloropidae, Dolichopodidae, Strathyomiidae, Tachinidae and Syrphidae. The order HETEROPTERA (15.7%) was represented by the families Nabidae, Anthocoridae, Miridae and Rhapalidae. The order THYSANOPTERA (22.6%) was represented by the families Aeolothripidae and Phlaeothripidae. The orders ARANEA – (7.2%), COLEOPTERA – (2.2%), DERMAPTERA – (0.2%) and NEUROPTERA – (0.9%). In collections by mowing on nectariferous flowering plants, the most numerous parasites were from the order HYMENOPTERA, superfamily Chalcidoidea, Ichneumonoidea (23.2%).

Thus, the research results confirm the beneficial potential of nectariferous crops to attract entomocarifags in the agrocenosis of a plum orchard.

Acknowledgments. The investigations are carried out within the framework of subprogram 011103 Development of environmentally friendly means of reducing the impact of harmful organisms on agricultural crops against the background of climate change, funded by the Ministry of Education and Research of the Republic of Moldova.

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Taraxacum officinale AS A BIOINDICATOR FOR ASSESSING ANTHROPOGENIC POLLUTION

BODNARIUK Ruslana[1], https://orcid.org/0009-0003-5923-2009,
VAKERYCH Mykhailo[1, 2,*], https://orcid.org/0000-0002-3268-7797
HASYNETS Yaroslava[1], https://orcid.org/0000-0003-4325-4695
VAKERYCH Daryna[1], https://orcid.org/0009-0005-7602-9154
ONYSHCHUK Iryna[3] , https://orcid.org/0000-0002-2847-8570
KYCHKYRUK Olga[3] , https://orcid.org/0000-0002-0558-16
SCHWARTAU Victor[4], https://orcid.org/0000-0001-7402-5559

[1]*Uzhgorod National University, Uzhhorod, Ukraine*
[2]*Transcarpathian Research Expert and Forensic Center of the Ministry of Internal Affairs of Ukraine, Uzhgorod, Ukraine*
[3]*Zhytomyr Ivan Franko State University, Zhytomyr, Ukraine*
[4]*Institute of Plant Physiology and Genetics of the NAS of Ukraine, Kyiv, Ukraine*
**Corresponding e-mail*: *mykhailo.vakerich@uzhnu.edu.ua*

Rapid urbanization and the continuous increase in road traffic have intensified anthropogenic pressure on urban ecosystems. The accumulation of zinc, copper, lead and other toxic elements in vegetation may disrupt physiological and biochemical processes, reduce biodiversity, and deteriorate the ecological status of urban ecosystems. Therefore, the use of bioindicator plants has become an effective approach for assessing anthropogenic pollution. *Taraxacum officinale* F.H. Wigg. is one of the most promising bioindicator species owing to its wide distribution, high ecological plasticity, and ability to accumulate heavy metals. However, information on heavy metal accumulation in different organs of this species under traffic-related pollution in the urban ecosystems of Transcarpathia, particularly Uzhhorod, remains limited.

The aim of the study was to evaluate the influence of road traffic on heavy metal accumulation in different organs of *T. officinale* in the urban ecosystem of Uzhhorod and to assess its suitability as a bioindicator of traffic-related pollution.

The study was carried out at six sampling sites differing in traffic intensity: Svobody Avenue, Mynaiska Street, Mytna Street, Zankovetskoi Street, Sobranetska Street, and the Botanical Garden (control). Zn, Cu, Pb, and Mn were determined by electrothermal atomic absorption spectrometry using a Shimadzu AA-7000 spectrometer ($n = 6$; $P = 0.95$). A clear relationship was found between heavy metal accumulation and traffic intensity. The highest Zn and Cu concentrations were recorded

in plants collected from Mytna Street, where leaf concentrations reached 48.1 ± 4.6 and 19.8 ± 1.7 mg kg^{-1} dry weight, approximately 3.0 and 2.2 times higher than those at the control site. The maximum Pb concentration (12.9 ± 1.2 mg kg^{-1}) was detected in roots from the same location, while the highest Mn concentration (1.93 ± 0.17 mg kg^{-1}) was also observed in the root system. Plants collected from Sobranetska Street, Svobody Avenue, and Zankovetskoi Street showed intermediate metal concentrations, whereas the lowest levels were recorded in the Botanical Garden. Zinc and copper predominantly accumulated in leaves, whereas lead and manganese were mainly retained in roots, indicating organ-specific uptake, transport, and sequestration under anthropogenic pressure.

The results demonstrate that *T. officinale* is a highly sensitive bioindicator of traffic-related pollution in urban environments. Significant increases in Zn, Cu, Pb, and Mn concentrations were observed in plants growing near roads with intensive traffic. Zinc and copper accumulated mainly in leaves, whereas lead and manganese were concentrated primarily in roots. The use of *T. officinale* in biomonitoring programmes can provide an effective tool for assessing anthropogenic pressure and environmental quality in urban ecosystems.

Keywords: heavy metals, road traffic, bioindication, urban ecosystem, environmental monitoring, environmental pollution.

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THE CONCEPT OF THE "ULTRA VIRUS" IN VICTOR GHIMPU'S INTERWAR WORKS

BUTNARU Gallia

Department of Genetics, University of Life Sciences „King Mihai I" from Timisoara, Romania
Corresponding e-mail: galliab@yahoo.com

During the interwar period, agricultural science faced a major challenge: devastating tobacco crop failures caused by pathogens that could not be seen under conventional optical microscopes. In his pioneering research for the Romanian Tobacco Institute and the Cassa Autonomă a Monopolurilor (CAM), Victor Ghimpu tackled these invisible threats by adopting the cutting-edge terminology of his time, specifically referring to them as "ultraviruses" or "filterable viruses".

The paper will present the innovative contribution of Prof. Dr. Victor Ghimpu to the elucidation of viral diseases of tobacco.

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CONTRIBUTIONS TO THE STUDY OF THE SPECIES *Sagittaria sagittifolia* L. AND *Carex pendula* Huds. IN THE FLORA OF THE "PRUTUL DE JOS" RESERVE

CASSIR Polina, https://orcid.org/0000-0003-1434-080X

"Prutul de Jos" Reserve, Slobozia Mare, Cahul, Republic of Moldova
Corresponding e-mail: cassirpolina@gmail.com

The "Prutul de Jos" Reserve is one of the most important protected natural areas in southern Moldova, distinguished by a wide diversity of aquatic, wetland, grassland, and forest ecosystems. A comprehensive floristic study conducted over the last decade identified 314 vascular plant species within the reserve (Cassir, 2021). Furthermore, research into the aquatic and wetland habitats of Lake Beleu and its surroundings revealed the presence of two species rare to the reserve's territory: *Sagittaria sagittifolia* L. and *Carex pendula* Huds. Annual monitoring of these species' populations is carried out during the growing season to assess their current status and document bio-ecological and chorological characteristics – data essential for identifying limiting factors and estimating short-term trends for the taxa.

Carex pendula Huds. – a vulnerable (VU) species protected by law (*Legislation...* 1999) in the Republic of Moldova. Within the reserve, it grows solitarily or in small groups, sporadically distributed in damp areas and floodplain forests dominated by *Salix* and *Populus*. The area occupied and the number of individuals vary depending on growing conditions, with the largest population recorded in plot 9 (Covrea). It is a perennial, meso-hygrophilous plant at high risk of endangerment due to both climate change, which alters the hydrological regime and intense anthropogenic pressures.

Sagittaria sagittifolia L. – a rare species within the flora of the Republic of Moldova, found sporadically in the aquatic basins of the Lower Prut and Lower Dniester rivers. Within the reserve, it has been recorded at shallow depths in stagnant or slow-flowing waters with a muddy substrate near the banks of Lake Beleu and its associated channels. It grows singly or in a scattered manner, and only rarely in small groups, the highest number of specimens was observed at Lake Robu. It is a perennial, medicinal, and ornamental plant thriving in wet or aquatic environments that is threatened by severe pressures such as significant hydrological fluctuations, drainage, and human disturbance.

Maintaining the satisfactory condition of wetland habitats is crucial for the conservation of vascular plant species that are rare within the "Prutul de Jos" Reserve – specifically *Sagittaria sagittifolia* L. and *Carex pendula* Huds. as these areas serve as an essential ecological refuge. The presence of these taxa underscores the high conservation value of the aquatic and marsh ecosystems of Lake Beleu and the surrounding area.

Keywords: Rare plants species, "Prutul de Jos" Reserve.

Acknowledgments. This research was conducted within the framework of the project "Study of processes and phenomena in the natural marsh and floodplain complex of the 'Prutul de Jos' Reserve," an activity integrated into the annual "Annals of Nature" program.

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INNOVATIVE ECOLOGICAL SURVEILLANCE FRAMEWORK FOR EARLY DETECTION OF EMERGING CROP PEST RISKS

EGWIM Onyebuchi Louis, https://orcid.org/0009-0005-2157-6791

Zamfara State University (ZAMSUT), Talata Mafara, Zamfara State, Faculty of Agricultural, Department of Forestry and Wildlife
Corresponding e-mail: aksontonyefuotuoke@gmail.com

Purpose: To develop an ecological surveillance framework for early identification of emerging crop pest risks using environmental indicators and field intelligence.

Materials and methods: A conceptual framework was designed integrating field scouting, ecological indicators, weather observations, biodiversity monitoring, farmer reporting, and spatial risk assessment to support preventive pest management.

Results: The framework enables earlier recognition of pest hotspots by combining ecological signals with continuous surveillance. It supports rapid decision-making, promotes biological control, minimizes indiscriminate pesticide use, strengthens resilience against invasive pests, and improves coordination among researchers, extension officers, and farmers. The proposed approach enhances ecosystem health while maintaining crop productivity under changing climatic conditions.

Conclusions: Ecological surveillance offers a practical pathway for sustainable plant protection by providing timely evidence for integrated pest management. Future validation under different agroecosystems will strengthen its application in national crop protection programmes.

Keywords: ecological surveillance; crop pests; early detection; resilience; agroecosystems.

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Cyclosa conica (ARANEAE: ARANEIDAE) - A POTENTIAL PREDATOR OF *Corythucha arcuata* (HETEROPTERA: TINGIDAE)

ELISEEV Serghei, https://orcid.org/0009 – 0002 – 2526 – 3459

Moldova State University, Institute of Genetics Physiology and Plant Protection, Chisinau, Republic of Moldova,
Corresponding e-mail: *serghei_eliseev@yahoo.com*

Forests play an enormous role for Earths' biota, being "lungs" of the planet and having many other functions. These ecosystems cover around 4.14 billion hectares globally, of which insect pests damage 35 million hectares of forests each year. Some of the pests fall into invasive organisms' category. Invasive species are the organisms that penetrate into territories that are not specific for their initial distribution area and cause damage to local flora and fauna. For example, the oak lace bug (OLB) *Corythucha arcuata* (Say, 1832) (Heteroptera: Tingidae) is an invasive species from the eastern USA. It sucks oak leaves' sap. As a consequence, leaves are losing much of its photosynthetic potential. It firstly appeared in Europe in Italy (Milan) and then rapidly spread throughout all of the European continent. Apart from the chemical treatments of the forests, the sole species of the Mymaridae wasps that control firmly *C. arcuata* was detected. On the other hand, spiders are important predators of many pests in nature. One of these species of the orb weaver spiders is *Cyclosa conica* Pallas, 1772 (Araneae: Araneidae). It usually makes a vertical stripe (stabilimentum) in its webs. The stripe is made out of exuviae of the consumed insects and other debris. The goal of this paper is to bring an example of the new potential preying of the *C. conica* spider on *C. arcuata* bug. On the 23.09.2024 in a plum plantation (N 46°97'03", E 28°.88'87") of the Institute of Genetics, Physiology and Plant Protection (Chișinău, Republic of Moldova) was observed a web of *C. conica* with a male of *C. arcuata* in it. The exemplars of both the spider and the bug were keyed till the level of species. We haven't found any traces of preying the spider on this bug. Some data suggest that bugs are rarely accepted by spiders as prey. Besides, adults of *C. arcuata*, probably, got occasionally in the web of this spider. Nevertheless, we should underline that even immobilized adults of *C. arcuata* in spiders' webs can serve as a material for stabilimentum. The technical role of this stripe is a subject of discussion. One of the several opinions

is that it stabilizes the structure of the web, another – that it enables spider remain unobservable for potential predators when *C. conica* hides between debris. Stabilimentum can, also, play a misleading role when potential predators attack the debris meanwhile spider running and escaping. The spider can indirectly contribute to controlling OLB in both forest and agricultural ecosystems. In conclusion, we must summarize that even small generalist orb weaving spiders can contribute to controlling the severe invasive bug species *C. arcuata* and can serve as one of those species that use OLB in its life activity.

Keywords: *Cyclosa conica,* predator, oak lace bug, *Corythucha arcuata*.

Acknowledgments: The research was carried out within the Subprogram 011103 "Development of ecologically harmless means of reducing the impact of harmful organisms of agricultural crops against the background of climate change", funded by the Ministry of Education and Research of the Republic of Moldova.

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MECHANISMS OF *Zeuzera pyrina* - INDUCED STRUCTURAL DEGRADATION IN TREES

FRON Arcadie*, https://orcid.org/0000-0001-9709-483X
FRON Argentina, https://orcid.org/0009-0001-5239-9506

Moldova State University, Institute of Genetics, Physiology, and Plant Protection
**Corresponding e-mail: arcadie.fron@sti.usm.md*

The aim of this study is to investigate the mechanisms by which the xylophagous insect *Zeuzera pyrina* L. (Lepidoptera: Cossidae) contributes to the degradation of woody tissues in host plants, focusing on both mechanical damage and secondary biological processes that lead to structural failure.

The research is conducted in a 1 ha walnut orchard located in Ialoveni district, Malcoci village, Republic of Moldova, cultivated with the Fernor and Franquette varieties, aged 18 years, and in another walnut orchard of approximately 1 ha located in Anenii Noi district, Nimoreni village, Republic of Moldova, cultivated with the Fernor and Franquette varieties, aged 7 years. In each orchard, three types of entomological traps are installed per pest species (simple delta sticky traps, digital pheromone traps, and sticky panels) to monitor population dynamics. Regular sampling is carried out using yellow adhesive traps and by sweep netting every five days throughout the entire growing season to assess faunal diversity in these areas. These data will support the identification of entomophagous organisms that may contribute to reducing the populations of the studied pests.

A female *Z. pyrina* can lay up to 1,000 eggs in 5–7 days, and the larval survival rate is approximately 30%, which means that under ideal conditions, over 200 larvae can colonize a single tree. However, in practice, larval density depends on several factors, including host availability, climatic conditions, predation pressure, and hatching success. Studies in walnut orchards have reported 16–24% of trees infested, with galleries up to 50 cm long, with an actual number of larvae ranging from a few to several dozen, and never reaching the hundreds. *Z. pyrina* larvae have a larval cycle of 271–289 days depending on the host species, allowing them to excavate extensive galleries in the wood during this period.

The newly hatched larvae remain clustered for a few days, then disperse to feed on tender tissue and eventually penetrate thick wood, where they excavate galleries. The larvae enter through cracks in the bark, the bases of young branches, or branch nodes. There is no evidence that they strictly prefer the top or the side, but they are

more frequently found in young branches and the upper part of the trunk. A single larva can damage a branch in a single season, but massive infestations lead to the death of trees within 2–5 years, depending on larval density and climatic conditions. Young trees, under 10 years old, are the most vulnerable because their wood is softer and sap flow is more intense, facilitating larval penetration. Mature trees are more resistant due to the difficulty larvae face in penetrating hardwood, but they can be compromised within 4–5 years if the infestation is massive (10-40 larvae/tree). However, it has been determined that the main trunk and the base of the skeletal branches are the critical points. Larval galleries in these areas disrupt the flow of water and nutrients, leading to the drying out of the entire tree, even if other branches remain intact, highlighting the importance of research on this pest.

Keywords: tree borer, *Zeuzera pyrina,* tree structural degradation, insect pest

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INVENTORY OF SOME CROP WILD RELATIVES IN THE *TELENEȘTI* AND *TEMELEUTI* PROTECTED AREAS

GANEA Anatolie*, https://orcid.org/0000-0002-8658-6879;
MOGÎLDA Anatolii, https://orcid.org/0000-0001-9159-6038;
CUȚITARU Doina, https://orcid.org/0000-0001-9956-8189

Moldova State University, Institute of Genetics Physiology and Plant Protection, Chisinau, Republic of Moldova,
**Corresponding e-mail*: *anatolie.ganea@sti.usm.md*

It is recognized that crop wild relatives from natural ecosystems represent an important genetic pool for improving the resilience of agricultural crops to climate change and ensuring food security. Unfortunately, this category of plant genetic resources remains insufficiently used in the promotion of sustainable agriculture at the national level. The purpose of the research is to elucidate the situation regarding the spread and health status of populations of crop wild relatives from forest ecosystems of the central area of the Republic of Moldova.

Some wild predecessors of fruit and horticultural crops served as objects of study: *Malus sylvestris*, *Cornus mas*, *Prunus avium*, *Pyrus pyraster*, *Asparagus officinalis*, *Corylus avellana*, *Fragaria vesca*, etc. The positioning of the populations was carried out with GPS navigators, along with the evaluation of some quantitative indices of the plants. Field investigations were carried out in the "Telenești" Natural Forest Reserve within the Forest District of the same name (plot 50, area 112 ha) which is located north of the village of Crăsnășeni, Telenești district and is part of the "Vila Telenești" forest body, as well as the "Temeleuți" Protected Area.

The "Telenești" Nature Reserve comprises stands consisting mainly of English oak (Quercus robur L.), with the presence of sessile oak (*Quercus petraea* Liebl.), small-leaved lime (*Tilia cordata* Mill.), ash (*Fraxinus excelsior* L.), and hornbeam (*Carpinus betulus* L.), though oak-hornbeam forests predominate. In the shrub layer, consisting of dog rose (*Rosa canina*), blackthorn (*Prunus spinosa*), hawthorn (*Crataegus monogyna*), dogwood (*Cornus sanguinea*), and others, the hornbeam was noted in considerable proportions. The height of plants of this species in the associations ranged from 2 to 5 m, and the stem diameter from 1 to 12 cm. Within a young population of *Cornus mas* (N 47°45'99.3, E 28°40'15.1, elevation 178 m), a clear

variation in fruit shape and size was observed. The tree species in question occur in fairly small proportions. Several specimens of *Prunus avium* were found to be drying out. At the edge of subplot 50 L, at elevations of 140 and 142 m, two *Malus sylvestris* trees were located (h=2–3 m, d=8–10 cm).

The "Temeleuti" protected area is located in the Călăraşi Forest District, on an area of 209 ha and contains valuable stands of *Quercus petraea* and *Q. robur.* Cherry is present in the upper floor of the stand with heights ranging between 12-20 m and a trunk diameter of 16-30 cm. In subplot 101 A (N 47°25'30.6, E 28°11'17.7, alt. 330 m) completely dry trees or trees in the process of dying due to stressful environmental conditions were highlighted. In the second floor, solitary specimens of *Malus sylvestris* and *Pyrus pyraster* were observed. It should be noted that in 2025 significant fruiting was reported on the horn. In less shaded areas, communities (sometimes quite abundant) of *Fragaria vesca* were revealed, and in some places specimens of *Asparagus tenuifolius* were highlighted (N 47°25'22.2, E 28°11'39.8, alt. 320 m).

In conclusion, we find that a survey of wild relatives of agricultural crops in the forest ecosystems of the "Telenești" and "Temeleuți" protected areas revealed populations of wild cherry, wild apple, wild Asparagus, cornel, wild pear, hazel, wild strawberry, and others. In various ecological niches, tree specimens (particularly wild cherry) affected by premature dieback were identified—a consequence of the action of environmental stressors. When developing management plans for protected areas, consideration must be given not only to the protection but also to the sustainable use of the most valuable wild relatives of cultivated plants.

Keywords: protected areas, crop wild relatives, forest ecosystems, drought stress.

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FALL ARMYWORM (*Spodoptera frugiperda* Smith) - A NEW PEST DETECTED IN ROMANIA

GEORGESCU Emil[1,*], https://orcid.org/0000-0001-5849-8241
CANĂ Lidia[1]
ANTON Gabriel[1]
BORDEI Marius Daniel[1]
CEAN Mirela[2]

[1]*National Agricultural Research and Development Institute, Fundulea, Romania*
[2]*Romanian National Phytosanitary Authority*
**Corresponding e-mail: emilgeorgescu2013@gmail.com*

Fall armyworm (*Spodoptera frugiperda* Smith) is a major agricultural pest in tropical and subtropical areas, originating from the American continent. In the last years this pest has spread in the African continent, India, and many countries from East Asia. In European Union is regulated as a quarantine pest according to Commission implementing regulation (EU) 2019/2072 and is nominated as a priority pest in the Commission delegated regulation (EU) 2019/1702. In 2021 this pest was reported for the first time, in the Canary Islands (Spain). More recent reports confirm the presence of the pest in some countries from southern Europe, such as Portugal (Madeira), Greece, Cyprus, and Turkey. This pest has a high migration capacity, spreading in new territories in a short period. However, it seems fall armyworms can't overwinter in temperate climates, but can migrate during the summer from the southern regions. In 2023, during a survey carried out in Fundulea, Călărași County by the National Agricultural Research and Development Institute, for different pests of corn, including *S. frugiperda* in a trap were detected suspicious adults of fall armyworm. For the survey, it was used pheromone traps, VRAL+ type, from the Csalomon® (Hungary) which was deployed in a maize field from the Southeast of the country. The observations started at the end of May and finished at the end of November. The morphological analyses of the adults were done at the National Phytosanitary Laboratory in Romania and the confirmation of the results was performed by the European Union Reference Laboratory, through ANSES (France) from the morphological point of view and AGES (Austria) for molecular analyses. Both types of analyses confirmed the presence of the fall armyworm for the first time in Romania. The larvae or eggs weren't detected dur-

ing the observation of the maize field in the summer or the beginning of autumn. In 2024 and 2025 this pest wasn't detected in the traps placed in the maize field. A possible explanation for the late trapping of the pest in the middle of autumn is the migration of adults from southern European countries where *S. frugiperda* was previously detected. Further studies are necessary to clarify the introduction pathways. Further studies are necessary in the next years in Romania concerning this quarantine pest.

Keywords: fall armyworm, first detection, Romania

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EVALUATION OF THE EFFICACY OF A FUNGICIDE APPLIED BY AN XAG DRONE FOR THE CONTROL OF *Septoria glycines* IN SOYBEAN

GUȚU Costel*, https://orcid.org/0009-0005-2606-6002
PROZOROVSCHI Maxim, RUSU Ion

National Center for Research and Seed Production, Selectia Sector Balti, Republic of Moldova,
**Corresponding e-mail*: *costelgutu84@gmail.com*

Soybean (*Glycine max* (L.) Merr.) is an important crop for the agriculture of the Republic of Moldova, and maintaining the phytosanitary status of plants is essential for achieving their productive potential. Among the foliar diseases of economic importance is Septoria leaf spot, caused by *Septoria glycines*, which is characterized by the appearance of brown lesions on leaves and may reduce the active photosynthetic leaf area.

The aim of the study was to assess the practical efficacy of the fungicide Pictor® Active, applied using the XAG V40 agricultural drone, for limiting the development of Septoria leaf spot in soybean under commercial production conditions.

Observations were carried out in 2026 under the pedoclimatic conditions of northern Moldova, on an area of 2.2 ha. The crop was monitored throughout the growing season, and the fungicide treatment was applied upon the appearance of the first characteristic symptoms of Septoria leaf spot.

For disease control, the fungicide Pictor® Active, containing 150 g/l boscalid and 250 g/L pyraclostrobin, was applied at a rate of 0.6 l/ha. The phytosanitary treatment was carried out using the XAG V40 agricultural drone.

During application, the XAG V40 drone was configured with the following flight and spraying parameters: flight altitude – 2.5 m, working width – 5 m, flight speed – 3 m/s, droplet size – 130 μm, and spray volume – 100 l/ha. These parameters were used to ensure uniform treatment across the targeted area.

The effect of the treatment was assessed through visual observations conducted before and after application, focusing on the development of Septoria leaf spot symptoms and the general condition of the foliage. Since the treatment was performed under actual commercial production conditions, without an untreated control

and experimental replications, treatment efficacy was assessed qualitatively, without statistical analysis.

At the time of crop monitoring, the first symptoms of Septoria leaf spot were identified, which prompted fungicide application at an early stage of disease development. The application of Pictor® Active using the XAG V40 drone enabled rapid and uniform treatment of the entire 2.2 ha area without the need for ground machinery to pass through the crop.

Post-treatment observations indicated a limitation in the development of Septoria leaf spot symptoms and the maintenance of a favorable phytosanitary condition of the plants. The foliage remained functional, while the further expansion of symptoms observed prior to treatment was reduced.

The use of the agricultural drone provided an important technological advantage by enabling treatment to be carried out in a standing crop without causing plant damage associated with the passage of ground-based machinery through the field.

Conclusions

The application of the fungicide Pictor® Active at a rate of 0.6 l/ha using the XAG V-40 agricultural drone in soybean crops over an area of 2.2 ha enabled timely phytosanitary intervention at the onset of the first symptoms of Septoria leaf spot.

Under the production conditions of 2026, the treatment was followed by a limitation in the development of disease symptoms and the maintenance of a favorable phytosanitary status of the crop. The application using the XAG V-40 drone proved to be a practical technological solution for carrying out phytosanitary treatments in a standing crop.

The results obtained confirm the importance of continuous monitoring of soybean crops and timely phytosanitary intervention at the onset of the first disease symptoms. Further experimental research conducted using untreated control plots, replicated treatments, and quantitative phytopathological assessments is required to accurately quantify the biological efficacy of the treatment and its effect on soybean yield.

Keywords: Soybean, *Septoria glycines*, fungicide, agricultural drone, plant protection, phytosanitary management.

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PHYTOCHEMICAL CHARACTERIZATION OF *JUNIPERUS spp*. BERRIES USING SPECTROPHOTOMETRIC AND HPLC METHODS

HARUTYUNYAN Zara[1,*], https://orcid.org/ 0000-0002-1118-1703
MIKAYELYAN Mikayel[1], https://orcid.org/ 0009-0008-2683-1431
HARUTYUNYAN Margarita[1], https://orcid.org/0000-0003-3392-6689
SOLOMONYAN Armen[1], https://orcid.org/0009-0001-3619-3655
ZAKHARYAN Mariam[1], https://orcid.org/0009-0002-2583-7985
IVANOVA Raisa[2], https://orcid.org/0000-0002-2554-2039
ELISOVETCAIA Dina[2], https://orcid.org/0000-0003-0521-6428
LUTCAN Elena[2], https://orcid.org/0000-0001-9967-6665

[1]Armenian National Agrarian University, Yerevan, Republic of Armenia
*[2] Institute of Genetics, Physiology and Plant Protection, Moldova State University, Chisinau, Republic of Moldova, **
Corresponding e-mail: kukurikus@yahoo.com

The aim of this study was to evaluate the phytochemical composition of *Juniperus sabina* L. and *Juniperus communis* L. berries collected from different regions of Armenia by determining the content of phenolic compounds, flavonoids, and organic acids. The study was conducted to assess the potential of *Juniperus* species as a source of biologically active compounds for food and agricultural applications. Mature berries of *J. sabina* (Gegharkunik region) and *J. communis* (Yerevan, Kotayk, and Tavush regions) were collected from natural populations. Dried and powdered berry samples were extracted with 70% ethanol using ultrasonic-assisted extraction. Total phenolic content was determined by the Folin–Ciocalteu method, with absorbance measured at 765 nm, and results were expressed as mg gallic acid equivalents (GAE) per gram of dry extract. Total flavonoid content was determined by spectrophotometric analysis after extraction with acidified ethanol, and results were expressed as mg quercetin equivalents (QE) per gram of sample. Organic acids were analyzed by high-performance liquid chromatography (HPLC) using a UV detector at 210 nm. The chromatographic method allowed the identification and quantification of fumaric, succinic, citric, acetic, lactic, shikimic, ascorbic, malic, formic, and tartaric acids in *Juniperus* berry extracts. The obtained results demonstrated differences in the phytochemical composition of *Juniperus*

species depending on species and geographical origin. The highest total phenolic content was observed in *J. communis* berries from Yerevan (5.38 ± 0.08 mg GAE/g dry extract), whereas *J. sabina* samples from Gegharkunik showed lower values (1.71 ± 0.05 mg GAE/g). Flavonoid content ranged from 64.18 ± 1.42 to 98.70 ± 2.14 mg QE/g, with the highest concentration detected in *J. communis* berries from Kotayk. HPLC analysis revealed the presence of nine organic acids in the studied samples. Malic acid was the predominant organic acid, with concentrations ranging from 7.21 to 8.34 mg/g dry mass. Shikimic acid was the second most abundant compound, reaching 5.21 mg/g in *J. communis* berries from Tavush. Ascorbic acid content varied from 0.47 to 0.59 mg/g, indicating the presence of antioxidant-related metabolites. The study showed that *J. communis* berries are a rich source of phenolic compounds, flavonoids, and organic acids compared with *J. sabina*. The combination of spectrophotometric and HPLC methods provided comprehensive information on the chemical profile of *Juniperus* berries. The obtained results confirm their potential application as natural sources of bioactive compounds for functional foods and plant-based products.

Keywords: *Juniperus* spp., phenolic compounds, flavonoids, HPLC, organic acids.

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NATURAL REGULATORS OF THE CICADAD *Schaphoideus titanicus* (CICADELLIDAE) IN VINES

IORDOSOPOL Elena, https://orcid.org/0000-0003-3492-8045

Moldova State University, Institute of Genetics Physiology and Plant Protection, Chisinau, Republic of Moldova,
Corresponding e-mail: elena.iordosopol@sti.usm.md

Introduction. Currently, against the backdrop of climate change in the fauna of the Republic of Moldova, in recent decades, new species of cicadas have appeared on vines, including *Schaphoideus titanicus*. Having initially penetrated the country's area, it demonstrated quite high growth rates on vines. Its biology in the country's conditions has not been studied. However, there is a phenological calendar of development in the conditions of Japan. The unjustified use of chemical preparations has generated an increase in the species' resistance to some phytosanitary products. In the fight against it, a biological control program is being developed, which includes the introduction of the most promising species or breeds of natural enemies, the multiplication and subsequent colonization of potential-effective parasites, especially with egg parasites. In general, it is known that some representatives of the Mymaridae family, for example, females of *Anagrus delicates* migrate over long distances like their host. In the country's fauna, 24 species from 8 genera are known, 22 of them are stored in the entomological-practical collection of the Entomology and Biocenology laboratory of the IGFPP of the USM, with the exception of the species *Anaphes diana* noted by some authors as a parasite of the pea leaf weevil.

Materials and methods. Yellow adhesive traps with sizes of 25x30cm and 12.5x14.5 cm were installed in young (19th year of fruiting) and old (45th year of fruiting) plantations of grapevines with table and technical varieties. The area subjected to analysis was 0.8 hectares of young and old vines. The adhesive traps were changed once a month. The analysis of the traps was carried out under the SLX-3 "Optika" trinocular. The specimens well fixed in the adhesive plate were scanned with the C-P6 digital camera. The diagnosis was made according to the classical and contemporary diagnostic keys.

Summarized results. According to the phenological development calendar, the cicada *Scaphoideus titanus* overwinters in the egg phase on second-year shoots at the base of vegetative buds. Their hatching takes place in April, the first generation spawning occurs in September. The larvae of the first and second instar can be ob-

served from May, and those of the third, fourth and fifth instar in June, the adults appear in July-August, mating takes place at the end of August-beginning of September and spawning begins in September. We note that until the second half of July, adults cannot be observed in the yellow sticky traps, but only the larvae.

Our investigations carried out in May-June coincided with the phenological calendar of *S. titanus*, when the spawning and development of the second and third instar larvae take place. The first adults of *S. titanus* were found at the beginning of the first decade of July. During July-August the pest had an average number of 14.4 individuals per repetition in the old plantation of the Codreanca variety and an average of 12.4 individuals in the young plantation with different table and technical varieties.

The parasite complex was represented by the oophage species *Anagrus atomus*, *A. epos* (Mymaridae), which was observed in May, June and less in July. Among the predators, *Chrysis inaequidens* (Chrysididae), the bedbug *Malacocoris chlorizans*, species of spiders from the Salticidae family and the mite *Anystis agilis* (Anystidae) were found.

Conclusions. It was found that the regulatory complex consisting of 2 oophage species and more than 4 predator species were able to control the population of the invasive species *S. titanus*.

Keywords: Mymaridae, eggs, larvae, yellow traps, adults, grape vine, predatory.

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THE PREDATORY BUG *Amphyareus obscuriceps* (ANTHOCORIDAE) IN THE GREENHOUSE AND ITS COMPETITORS IN THE FOOD CHAIN

IORDOSOPOL Elena, https://orcid.org/0000-0003-3492-8045

Moldova State University, Institute of Genetics Physiology and Plant Protection, Chisinau, Republic of Moldova,
Corresponding e-mail: elena.iordosopol@sti.usm.md

Introduction. Currently, farmers often initiate trends in the production of organic products in greenhouses. In the Republic of Moldova there are no companies producing biological agents. In the neighboring country, Ukraine, there are the most, which produce over 15 species and are successfully used by farmers in greenhouses. The aim of the investigation was to identify competitors of the predatory bug *Amphyareus obscuriceps* under greenhouse conditions.

Materials and methods. The material used was third, fourth and fifth instar larvae and adults of *A. obscuriceps*, herbaceous plants with a successional development in the greenhouse, individuals representing more than 9 taxon orders. The diagnosis of the individuals was carried out on the basis of contemporary and classical diagnostic keys. The veracity of the diagnosis at the specimen level was compared with the material from the entomological-practical collection of the laboratory.

Summarized results. The predatory bedbug *A. obscuriceps* at the stage of larvae of the 3rd, 4th and 5th instars were released into the greenhouse in the summer of 2025, during the period of mass development of the common spider mite *Tetranychus urticae* and tobacco thrips *Thrips tabaci* on cucumbers, and the greenhouse whitefly *Trialeurodes vaporariorum* on tomatoes. In the greenhouse, the air temperature exceeded +40°C and the humidity was 44%. Under such climatic conditions, the predator larvae developed to adulthood, and the adults subsequently laid eggs in the *T. urticae* colonies. Subsequently, cardboard supports were used to observe the hibernation of the bedbug in the greenhouse. In the spring of 2026, in the middle of the second decade of April, the supports were analyzed, where in the cucumber greenhouse no adults of the bedbug were found, and in the tomato greenhouse it was found in single specimens. In the process of analyzing the vegetable residues of tomatoes and cucumbers from the 2025 season, the presence of adults of *A. obscuriceps* was observed. During this period, the temperature was on average +15°C and the air hu-

midity was 65%. The herbaceous flora in both greenhouses was represented by *Stellaria media* on which the thrips *T. tabaci* was found, *Artemisia annua* - *Macrospherella artemisiae*, *Mentha piperita* - *Aphis origani*, *Portulaca oleracea – A. gossipi* and *Chelidonium majus* - *Aleyrodes proletella*. Predatory arthropods were competitors in the food chain of *A. obscuriceps* and consisted of adults of *Anthocoris nemorum*, larvae of *Orius* spp. (Anthocoridae), larvae of *Microlophus pygmeus*, adults of *Dyciphus hesperus* (Miridae), *Coccinella septempunctata*, *Propylea quatuordecempunctata*, *Oenopia conglobate*, *Scymnus* spp. and *Stethorus niger* (Coccinelidae), larvae of *Aphydoletes aphidimyza* (Ceccidomiidae), adults and larvae of the mite *Allotrobium pulvinum* (Trombidiidae). The largest number was the order Aranea with more than 10 families, and among them the most active was the spider *Heliophanus cupreus* (Salticidae). Parasitic competitors were the aphid braconids *Aphis absinthii*, *Lysephedrus vallidus* and *Lysephlebus fabarum* and *Ephedrus niger*.

Conclusions. It was established that *A. obscuriceps* as competitors in the food chain has representatives from 8 orders, from 7 families and has successfully adapted to the arid conditions in the greenhouse with subsequent hibernation in plant debris.

Keywords: predatory bug, greenhouse whitefly, tobacco thrips, food chain, aphids, weeds.

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TROPHIC RELATIONSHIPS OF THE SPECIES *Scymnus rubromaculatus* Goeze AND ITS ABILITY TO ADAPT TO LABORATORY CONDITIONS

IORDOSOPOL Elena*, https://orcid.org/0000-0003-3492-8045
BATCO Mihail, https://orcid.org/880000-0002-3711-4429

Moldova State University, Institute of Genetics Physiology and Plant Protection, Chisinau, Republic of Moldova,
**Corresponding e-mail: elena.iordosopol@sti.usm.md*

Introduction. Species of the Coccinelidae family are currently successfully used in plant protection against agricultural pests such as aphids, armored scales, false armored scales, and mealybugs. Predators utilized include *Rodolia cardinalis*, *Lindorus lophanthae*, *Chilocorus renipustulatus*, and *Cryptolaemus montrouzieri*.

Climate change in the Republic of Moldova - where, over the past five years, air temperatures have deviated from the long-term average by as little as 2.1°C and as much as 4.7°C - has brought with it a wide range of pests that have surreptitiously entered the country. It is a well-known fact that the migration of invasive pest species from one area to another is accompanied by the migration of their natural regulating agents.

The role of human intervention in species migration via intentional introduction is exemplified by the ladybird *C. montrouzieri*, which has been introduced in various countries to combat specific pests. This species was initially introduced to Europe, Africa, and regions such as New Caledonia (east of Australia), where it adapted to coastal environments characterized by tropical temperatures (remaining above 17°C). It is known as an oligophages predator; both its larvae and adults feed on the eggs, nymphs, and adults of various coccid species. For laboratory rearing, mealybugs such as the cactus mealybug (*Dactylopius opuntiae*), the coffee mealybug (*Planococcus liliacinus*), and the citrus mealybug (*Planococcus citri*) are used as hosts. The species is employed as a biological control agent through seasonal colonization.

The aim of the investigation is to determine the trophic associations of the species *Scimnus rubromaculatus* and its ability to adapt to alternative hosts under laboratory conditions.

Materials and methods. The biological material consisted of populations of three alternative hosts (two aphid species and eggs of the bean weevil *Acanthosceledes obtectus* and *Scimnus rubromaculatus* individuals collected from trap crops during the 2025–2026 season (population in autumn–winter) and individuals from the greenhouse population in the spring of 2026. The laboratory culture was maintained at temperatures ranging from 12 to 29°C and an air humidity of 44–75%

Summarized results. The initial phase of the study focused on establishing cultures of alternative hosts - specifically two aphid species, *Aphis origani* and *Schizaphis graminum* - for the predatory ladybeetle *Scimnus rubromaculatus*. Collected predator individuals were introduced into insectary cages at a 1:1 female-to-male sex ratio. In the experiment, adults from the autumn-winter 2025–2026 population - active during the winter "windows" - began egg-laying in mid-May, whereas the greenhouse population found within *Aphis origani* colonies in the spring of 2026 began laying eggs in the second half of June.

Conclusions. It was observed that *Scimnus rubromaculatus* successfully overwintered for two years in trapping bands within a plum orchard and in greenhouses. The species was successfully maintained in greenhouses on a diet of *A. origani* found on *Mentha piperita*. Its feeding activity was observed within the trapping bands, where it preyed upon individuals of the invasive mealybug species *Pseudococcus maritima*.

Keywords: mealybug, diets, the spring, the autumn-winter, insectary cages, sex ratio.

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Aegilops cylindrica: CHALLENGES FOR GRAIN PRODUCTION AND FOOD SECURITY

KOLOIANIDI Nadiia[3,*], https://orcid.org/0009-0008-1494-9715
KUZMINSKY Olexandr[4], https://orcid.org/0009-0002-3893-9366
RYBALKA Olexandr[1,2], https://orcid.org/0000-0003-0103-1012
SCHWARTAU Victor[1], https://orcid.org/0000-0001-7402-5559

[1]Institute of Plant Physiology and Genetics of the NAS of Ukraine
[2]The Plant Breeding and Genetics Institute - National Center of Seed and Cultivar
[3] Mykolaiv state agricultural research station of the Institute of climate-smart agriculture of the NAAS of Ukraine
[4]Bayer Crop Science
**Corresponding e-mail: koloanidinadezda@gmail.com*

The rapid spread of *Aegilops cylindrica* in southern Ukraine threatens agricultural plant communities because this highly competitive, monocotyledonous, winter annual or biennial species competes with cereal crops. According to many authors, hybridization and introgression between cultivated wheat–especially varieties carrying herbicide-resistance genes, such as those in the Clearfield system–and *A. cylindrica* may pose a problem for agriculture. In southern Ukraine, cross-pollination between wheat and Aegilops occurs; however, until recently, no fertile or stable offspring resulting from such spontaneous hybridization had been observed. Wheat's genomic formula is AABBDD (2n = 6x = 42), while *A. cylindrica*'s is CCDD (2n = 4x = 28). Only one genome (D) is homologous. In the F1 hybrid ABCDD, only the D-genome chromosomes, which are highly homologous, conjugate during meiosis. The remaining 21 chromosomes (A, B, and C) are all univalent, so the probability of forming genetically balanced, viable gametes is low. Consequently, the F1 hybrid is sterile and unable to produce viable plants. The only potential issue is the appearance of atypical F1 hybrid plants in seed fields. These plants are also sterile and nonviable.

In contrast, the development of *A. cylindrica* resistance to herbicides, primarily ALS resistance, poses a serious agronomic problem caused by a combination of internal and external factors. Internal factors include the species' biological characteristics, such as its high hybridizing ability and adaptability to changing conditions. External factors include the irrational use of herbicides in crop rotations. Effectively

addressing this issue requires a comprehensive approach to managing agro-phytocenoses that integrates a wide range of studies on the components of these communities to minimize herbicide load and prevent the further spread of A. cylindrica populations resistant to herbicides.

Applying a mixture of mesosulfuron-methyl, iodosulfuron-methyl, thiencarbazone-methyl, and mefenpyr-diethyl leaves *Aegilops* plants in the lower canopy layer and significantly increases wheat competitiveness. This approach can be viewed as a strategy for developing environmentally safe weed control systems that keep weed populations below damage thresholds.

Thus, research on the genus *Aegilops* is important for understanding the evolutionary processes that led to the emergence of cultivated wheat and for addressing practical challenges in modern crop production.

Keywords: *Aegilops cylindrica*, competitive interactions, resistance.

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BIOSTIMULANTS AS A FACTOR OF OPTIMIZATION OF PARENT STOCK CULTURES OF *Hermetia illucens* L.

MARKINA Tetiana*, http://orcid.org/0000-0001-6783-9814
BARKAR Vitaliy, https://orcid.org/0000-0002-0965-9755

Engineering and Technological Institute "Biotechnica" of the National Academy of Agrarian Sciences of Ukrain,
**Corresponding e-mail*: *t.yu.markina@gmail.com*

Introduction

In recent years, interest in the industrial rearing of the black soldier fly (*Hermetia illucens* L.) has increased significantly due to its value as a sustainable source of protein-rich feed ingredients for livestock and its ability to efficiently convert organic agricultural waste into valuable biomass. One of the promising approaches to improving insect productivity is the use of dietary biostimulants.

The aim of this study was to evaluate the effectiveness of selected dietary biostimulants in improving the viability and productivity of breeding stock cultures of *Hermetia illucens* L.

Materials and Methods

Three biostimulants were evaluated. Premix is a dietary supplement containing macro- and microelements, glucose, vitamins, and essential amino acids. Aminosol is a complex liquid formulation containing water-soluble B-group vitamins, amino acids, glucose, and mineral salts. Ammonium perchlorate (NHClO) was evaluated as a biostimulant intended to stimulate the activity of digestive enzyme systems in insects. The experimental treatments were initiated on the tenth day of larval development. Each treatment consisted of three replicates of 200 larvae. The insects were maintained under standardized rearing conditions at 24 ± 1°C, 50% relative humidity, and a 16:8 h light: dark photoperiod.

Results

A significant increase in the survival of both larvae and adults was observed in all experimental treatments compared with the control. However, in the ammonium perchlorate treatment, pupal survival was 11.8% lower than that of the control group. Supplementation with Premix and Aminosol significantly increased the average larval body weight. In addition, all biostimulant treatments resulted in a higher proportion of females than in the control population, with the greatest increase observed in the Aminosol treatment.

The application of ammonium perchlorate produced the greatest increase in larval body weight (53%). However, these larvae subsequently exhibited impaired molting, resulting in a reduction in pupal survival of 11.8% compared with the control, 25.1% compared with the Aminosol treatment, and 23.0% compared with the Premix treatment.

Conclusions

The findings demonstrate that dietary biostimulants can be effectively used to optimize breeding stock cultures of *H. illucens* under technocenosis conditions. Supplementation with the vitamin-mineral complexes Premix and Aminosol significantly increased the survival of larvae, pupae, and adults, whereas ammonium perchlorate significantly improved the survival of larvae and adults but adversely affected pupal survival. All tested biostimulants also contributed to a significant increase in pupal body weight.

Furthermore, analysis of the population sex ratio demonstrated that the application of biostimulants increased the proportion of females within breeding populations of *H. illucens*.

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TAXONOMIC AND FUNCTIONAL PROFILING OF VINEYARD CHERNOZEM MICROBIOME

MITINA Irina*, https://orcid.org/0000-0001-7103-6084
MITIN Valentin, https://orcid.org/0000-0001-9328-9672
GRAJDIERU Cristina, https://orcid.org/0000-0003-1560-7924
TUMANOVA Lidia, https://orcid.org/0000-0001-5664-871X

Moldova State University, Institute of Genetics Physiology and Plant Protection, Chisinau, Republic of Moldova,
**Corresponding e-mail*: *irina.mitina@sti.usm.md*

Soil microorganisms are critical functional drivers in plant-soil systems, directly influencing soil health, nutrient cycling, and agricultural sustainability. Traditional soil monitoring has historically focused on quantitative, physical, and chemical parameters, which act as a "black box" and fail to capture the qualitative taxonomic structure and ecological dynamics of the soil microbiome. In alignment with the European Union's Soil Monitoring Law (Soil Directive) incentives to promote soil resilience and quality, this study explores the application of amplicon sequencing (using 16S, 18S and ITS1 markers) to profile the microbiome of chernozem soils under viticulture. The research aims to evaluate amplicon sequencing as a robust diagnostic tool.

Soil samples were collected from an experimental vineyard at the Institute of Genetics, Physiology and Plant Protection of the Moldova State University (Chisinau, Moldova) in October (post-harvest) from the 0–10 cm topsoil layer using a five-point envelope method in triplicate. Total genomic DNA was extracted using the PureLink™ Microbiome DNA Purification Kit (Thermo Scientific, USA), with quality verified via spectrophotometry and agarose gel electrophoresis. High-throughput amplicon sequencing (16S rRNA for bacteria, ITS1 for fungi, and 18S rRNA for eukaryotes) was performed on the Illumina platform by Macrogen Europe (Netherlands). Raw reads were processed through a standardized bioinformatics pipeline to analyze alpha/beta-diversity and predict functional roles using FAPROTAX and FUNGuild.

Alpha- and beta-diversity profiling revealed distinct, scale-dependent structural patterns across soil domains. Total eukaryotic communities (18S) exhibited the highest alpha-diversity (mean: 979 ASVs, Shannon H'_{log2}: 8.54), displaying strong

micro-spatial heterogeneity at the ASV level (mean Bray-Curtis dissimilarity: 0.96) but shifting to high structural homogeneity at the phylum level (mean dissimilarity: 0.12). Fungal communities (ITS) showed intermediate richness (mean: 363 ASVs, Shannon H'_{log2}: 5.91) with moderate spatial stability (mean dissimilarity: 0.37), dominated by perennial decomposers (*Ascomycota, Mucoromycota, Basidiomycota*). Conversely, bacterial communities (16S) possessed lower richness (mean: 83 ASVs, Shannon H'_{log2}: 4.47) but exceptional spatial homogeneity (mean dissimilarity: 0.13); the community was heavily co-dominated by oligotrophic *Acidobacteriota* and predatory *Myxococcota*, which constituted the two most abundant bacterial phyla. Functional profiling highlighted the concurrent presence of these abundant *Myxococcota* alongside a minor but consistent fraction of fungal *Zoopagomycota*, indicating a complex, multi-kingdom trophic structure within the vineyard soil.

In conclusion, the vineyard soil hosts a highly structured ecosystem where high micro-spatial variation among eukaryotic species yields to stable functional configurations, supported by a prominent and well-represented microbial predatory core.

Keywords: vineyard, microbiome, DNA, sequencing.

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HIGH-PERFORMANCE SWEET SORGHUM HYBRIDS FOR IMPLEMENTATION IN THE AGRICULTURAL SECTOR

MORARU Gheorghe*, https://orcid.org/0009-0004-8702-9419
COTENCO Eugenia, https://orcid.org/0000-0003-0603-3404
SMIRNOVA Tatiana, https://orcid.org/0009-0006-8878-8120

Moldova State University, Institute of Genetics Physiology and Plant Protection, Chisinau, Republic of Moldova,
**Corresponding e-mail*: *gheorghe.moraru@sti.usm.md*

The current trend of global warming significantly impacts the potential for cultivating agricultural crops, substantially reducing their productivity and quality primarily due to drastic temperature increases, the accelerated desertification of agricultural lands, and the growing frequency of increasingly severe and prolonged droughts. Under these circumstances, the exceptional importance of sorghum often dubbed the "camel of agriculture" becomes increasingly evident; it boasts the highest drought resistance and the most efficient water-use profile among all widely grown agricultural crops. Sweet sorghum represents a truly viable source for alternative energy production and animal feed.

The male-sterile lines MSL26A1, Saharnoie 32 and Sever 2 were used in crosses to obtain the sweet sorghum hybrids SAŞM 1 and SAȘM 2.

The SAȘM 1 - simple interlinear hybrid, late with a vegetation period of 126-132 days. The juice contains 13.5-16% carbohydrates, in favorable years up to 22%. The optimal plant density is 105-115 t/ha. The harvest for cultivation without irrigation is 90-120 t/ha and 20-30 t/ha of dry matter, with irrigation -170-190 t/ha of biomass.

The SAȘM 2 - simple interlinear hybrid, late with a vegetation period of 110-115 days. The juice contains 14-16.5% carbohydrates, in favorable years it reaches up to 22%. The optimal plant density is 110-120 t/ha. The harvest for cultivation without irrigation is 75-110 t/ha and 18-27 t/ha of dry matter, with irrigation -140-160 t/ha of biomass. The sweet sorghum hybrids SAȘM1 and SAȘM2, utilized in the current technology transfer project, were tested between 2023 and 2024 at the Brăila Agricultural Research and Development Station. Test results established that these sweet sorghum hybrids are suitable for saline and sandy soils, as well as for sloped

lands prone to erosion; the crop stands out due to its drought resistance and low water requirements (211 mm/year), its contribution to humus levels in the 0–40 cm soil layer (0.12% by soil weight), its capacity for soil carbon sequestration (20–30 t/ha/year via roots and stubble), and its ability to prevent wind erosion on sandy soils and water erosion on vulnerable terrain. Consequently, the crop offers prospects for an agricultural and industrial revival amidst the climate change and increasingly evident aridification in southeastern Romania thanks to its diverse applications across the food, animal feed, energy, and chemical industries. Sweet sorghum hybrids (SAȘM1, SAȘM2) demonstrated a higher production potential, they confirmed a specific capacity to capture 23–72 mg of CO_2 per m² of leaf area per day yielding 1.2 t of biomass per m³ of absorbed CO_2 thereby enabling the achievement of the target of 4.5–5 t of CO_2 per capita per year set by Directive 2009/28/EC, as well as an output of 600 kcal/m²/year (a global food security threshold targeted by the FAO). Consequently, sweet sorghum serving as a food, fodder, and energy crop does not divert arable land away from uses dedicated to food security. Both sweet sorghum hybrids have been registered in the Romanian Plant Variety Catalogue for cultivation in Romania and European Union countries.

Keywords: sorghum, hybrid, genotypes, potential, agriculture.

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ASSESSMENT OF THE ECOLOGICAL STATUS AND TECHNOGENIC CONTAMINATION OF UZHHOROD URBAN SOILS WITH MOBILE FORMS OF HEAVY METALS

ONYSHCHUK Iryna[1], https://orcid.org/0000-0002-2847-8570
KYCHKYRUK Olga[1], https://orcid.org/0000-0002-0558-16
BODNARIUK Ruslana[2], https://orcid.org/0009-0003-5923-2009
VAKERYCH Mykhailo[2,3,*], https://orcid.org/0000-0002-3268-7797
HASYNETS Yaroslava[2], https://orcid.org/0000-0003-4325-4695
SCHWARTAU Victor[4], https://orcid.org/0000-0001-7402-5559

[1]Zhytomyr Ivan Franko State University, Zhytomyr, Ukraine
[2]Uzhgorod National University, Uzhhorod, Ukraine
[3]Transcarpathian Research Expert and Forensic Center of the Ministry of Internal Affairs of Ukraine, Uzhgorod, Ukraine
[4]Institute of Plant Physiology and Genetics of the National Academy of Sciences of Ukraine, Kyiv, Ukraine,
**Corresponding e-mail: mykhailo.vakerich@uzhnu.edu.ua*

The rapid expansion of urban ecosystems and the intensification of automobile traffic flows exert a significant anthropogenic load on the biosphere. In this context, the soil cover of residential and traffic areas (urbanozems) functions as a sink/deposition medium and a reliable indicator of the urban environmental status. Mobile (bioavailable) compounds of heavy metals pose the greatest ecological and toxicological threat, as they are readily accessible to plant organisms, capable of migrating through adjacent links of trophic chains, and characterized by pronounced phytotoxicity.

A geochemical assessment of the scale of technogenic transformation of soils in Uzhhorod was carried out by monitoring the concentrations of mobile forms of iron (Fe), copper (Cu), lead (Pb), cadmium (Cd), manganese (Mn), nickel (Ni), and zinc (Zn). Primary material sampling was performed within two functionally contrasting locations: a relatively pristine recreational zone (the territory of the Botanical Garden) and areas with high traffic density (Sobranetska, Zankovetskoi, and Mynaiska Streets, Mytna Square, and Svobody Avenue).

Mobile metal complexes were extracted from the substrate using a conventional extraction method with an acetate-ammonium buffer solution at a fixed pH of 4,8/5,0.

Quantitative analysis of the obtained extracts was performed using atomic absorption spectrometry. Final concentrations were calculated in mg/kg of dry weight (applying a transformation factor of 10), and the resulting datasets were verified against the current maximum permissible concentrations (MPCs) mandated in Ukraine.

The study revealed a clear spatial differentiation in ecotoxicant distribution, determined by the specific land use and traffic volume of urban areas. The most critical environmental trend was identified for mobile compounds of cadmium and nickel: their content in the substrates of the traffic-urbanized sector consistently exceeds the sanitary limits by 2.0–3.6 and 2.1–3.0 times, respectively. Peak cadmium concentrations are confined to zones of chronic traffic congestion and heavy vehicle movement (the transit border zone of Mytna Square), whereas nickel accumulation exhibits an exclusively technogenic origin driven by diesel engine emissions. Local hotspots of excessive zinc accumulation were also recorded along major highways, triggered by the wear of vehicle tires and the corrosion of galvanized elements of urban infrastructure.

Conversely, the distribution of mobile copper forms is diffuse and stable throughout the residential area, remaining within the regional geochemical background, which indicates the absence of local industrial sources of Cu emission. Lead levels at most urban monitoring sites balance on the brink of the threshold; however, a pronounced local anomaly (exceeding the MPC by 1.8 times) was identified in an isolated section of the Botanical Garden. This localized spike correlates with a massive increase in mobile iron content and high manganese mobility.

The nature of this anomaly within the recreational site is natural-anthropogenic and can be attributed to the lithological heterogeneity of the substrate (likely historical localized waste dumping), local profile acidification under mature stands, and the hydrological regime of the site, which stimulates reductive processes and element mobilization.

Thus, the urbanozems of the traffic and residential zones of Uzhhorod experience intense multi-element pressure from the transport infrastructure. Chronic excess of mobile cadmium and nickel forms on all studied streets represents a key ecological risk for the urban environment. Although the ecosystem of the Botanical Garden generally functions as a protective bio-barrier, the identified micro-hotspots of high iron and lead concentrations dictate the need for detailed micro-zonal studies to verify the acid-base properties (pH) and particle-size distribution of the substrates.

Keywords: urban soils, mobile forms of heavy metals, soil contamination, atomic absorption spectrometry

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STATE OF DEVELOPMENT OF PESTS OF DONE CROPS UNDER CHANGING WEATHER CONDITIONS

SAVINA[1] Olena, https://orcid.org/0000-0003-1017-412X
HLIUDZYK-SHEMOTA Marharyta[2*], https://orcid.org/0000-0001-7937-6489
PUNKO B.[3], postgraduate
POPOVYCH Halyna[4], https://orcid.org/0000-0002-5300-3366
VAKERYCH Mykhailo[5], https://orcid.org/0000-0002-3268-7797

Uzhhorod National University, Department of fruit and vegetable cultivation and viticulture
**Corresponding e-mail*: *marharyta.hliudzyk@uzhnu.edu.ua*

All living organisms in the ecosystem are connected by complex food relationships. Each species has its own role and importance. But in the agro-ecosystems of garden crops, we single out insect pests that destroy the quality and quantity of the harvest. In the research materials, we will pay special attention to the screening of pests of stone garden crops and peach as a special crop when growing a mix of stone plants. The weather conditions of 2025-2026 years strongly affected not only the laying of the crop, but also the development cycle of many insects, which are classified as common pests.

Analyzing the state of garden pests in the winter of 2025, up to 10% of pests that harm stone crops died. At the same time, pests that multiply intensively and cause damage to fruit crops during the growing season, taking into account the damage and partial death of buds and flowers due to frost, were highlighted. In the period of swelling of the buds, with an average daily air temperature above 6^0C, garden weevils, in particular, the apple flower eater, the gray budworm, the beetle, and the weevil, began to emerge from wintering, and at 10 - 14 ^{0}C, a mass settlement of beetles was observed. At the beginning of the opening of buds at an air temperature of 12 ^{0}C, feeding on buds, and then on leaves, was observed by the caterpillars of the veined whitefly and the golden hornworm.During this period, the beginning of the revival of the caterpillars of the rosana leaf-roller, with which a large part of the trees and this pest causes significant damage to the weakened vegetative buds and leaves after severe freezing in the last two years, takes place.

Regeneration of the larvae of red and brown fruit mites occurs during the separation of the buds due to the transition of the average daily temperature after 7-8 ^{0}C. Females of the common fruit mite inhabit the buds and leaves of trees at an air temperature of 12-13 ^{0}C.

Fruit plantings of stone crops in the Transcarpathian region are significantly damaged by various phytophages, in particular leaf-gnawers, suckers, pests of generative organs, which with mass reproduction are capable of causing significant damage, leading to crop losses and a decrease in its quality. In the spring period, the gardens of the region are harmed by leaf-gnawing pests, primarily various types of leafhoppers, which are common in many plantations of the region, however, they cause the greatest damage in old gardens and in the private sector. In recent years, there has been a decrease in their number due to stressful situations in the winter-spring period. The most common are bud, mesh, and fruit leaf curlers. Caterpillars hibernate in web cocoons near the buds, in the crevices of the bark and in the branches of the branches. In the spring, when the air temperature reaches +8°C, the caterpillars come out of the cocoons, bite into the buds and damage them. After the buds open, the caterpillars feed on leaves and buds, pulling them into a dense bundle with a web. Caterpillars of the second generation damage the fruits at the end of June-July.In the spring of 2025, in the conditions of unstable temperature conditions, frosts in April, the number of leafhoppers and their harmfulness in the gardens of the region was not high, even in the gardens without providing protection to limit the harmfulness. A small number of trees were inhabited by caterpillars of various species in May, in contrast to 2026, where severe damage was noted against the background of severe damage to growth processes by returning frosts. This year, there is a complete absence of fruit setting in the surveyed orchards of the Beregovo district. A large supply of leaf curlers in the private sector, in old gardens, where in 2026, in the absence of protective treatment, they caused damage in the spring period, which affected the quality of planting annual growths. In commercial gardens, the wintering stock of leafhoppers is smaller, their prevalence is much lower there. Pests of generative organs can cause significant damage to fruit plantations in the region if protective measures are not taken: eastern and plum fruit eaters, apple flower borer, apple and plum sawflies, cherry fly. Without protective measures, these pests can significantly reduce the harvest and its quality, but in the examined orchards there is no stone fruit crop during these growing seasons due to severe freezing of the flowers of all stone crops. Apricot and peach trees suffered the most.

Among the most harmful for stone crops in the gardens of Transcarpathia, plum and oriental fruit-eaters have been singled out. Plum fruit eater (*Grapholitha funebrana*) is a dangerous pest of plums, damages plums, apricots, and peaches. Damaged fruits acquire a purple color, dry prematurely, or rot and fall. Caterpillars can move into another fruit. In its development, the plum fruit-eater is slightly ahead of the apple fruit-eater in terms of the onset of phenological phases. It develops in two generations. The years of butterflies of different generations often overlap, so it is difficult to distinguish a clear border between them. The most dangerous is the second generation of the plum fruit borer, whose caterpillars damage fruits of

medium and late varieties of plums. In 2025, the conditions for the development of both generations of the pest were favorable, a significant part of the fruits of early varieties and fruits of late varieties of plums were damaged by the revived caterpillars. In industrial plum plantations, thanks to protective spraying, the harmfulness of the fruit eater turned out to be much less. Autumn surveys of plum fruit-eating caterpillars were found in all plum plantations. The wintering stock of caterpillars is sufficient, therefore, in 2026, under favorable conditions during the growing season, a high level of damage by the plum fruit-eater is expected throughout the region. In the examined orchards of Beregovo district, there is no fruiting of drupes, so the development will be limited by the factor of lack of nutrition.

Cherry fly (*Rhagoletis cerasi*) is a dangerous pest of cherries. Pupae hibernate in false cocoons in the soil at a depth of 3-5 cm, flies fly out in spring 1.5-2 weeks after cherry blossoms. Females lay eggs one by one under the skin of the fruits at the beginning of their reddening, the larvae feed on the pulp of the fruits, which become soft, ripen earlier and rot. Damages the fruits of mid- and late ripening cherries and cherries. During the growing season of 2025, the summer of flies and egg-laying lasted in the second half of May - June. Weather conditions - air temperature drops, frosts in the foothills and mountain zones did not contribute to the activity of the pest, only at the end of the month the conditions for the flight and egg-laying of the cherry fly improved. The harmfulness of the fly was somewhat higher than the previous year, because in many plantations there was a small amount of fruit due to spring frosts. Autumn surveys revealed a fairly high level of overwintering, so if there are fruits in 2026 with a good overwintering, the cherry fly will actively develop, damaging mid- and late-ripening cherries, cherries.

Sucking pests (aphids, honeybees, mites, scale insects, false scale insects) are widespread in the gardens of the region, with high numbers they can lead to growth retardation, fruit tree development, and yield reduction. In addition, some of the sucking pests are carriers of viral diseases. Various types of fruit aphids are widespread in the region, under favorable growing conditions they can reproduce massively and suppress fruit trees, especially young ones. Plums are affected by the plum pollinated aphid (*Hyalopterus pruni*), cherries and cherries by the black cherry aphid (*Myzus cerasi*). Aphids, sucking sap from plants, often severely deform leaves and shoots, depress and weaken fruit trees, reduce their growth, yield, and frost resistance. In 2025, the weather conditions in April and May with unstable temperature conditions, sharp colds, and frosts did not contribute to a massive increase in the number of fruit aphids. Only at the end of May, an increase in the temperature regime improved the conditions for the development of fruit aphids. Later, during the summer period, the conditions for the development of fruit aphids were favorable. Under such conditions, centers of their increased number periodically appeared in the gardens, which

caused the need for protective measures. In August, fruit aphids damaged the young growth of leaves, especially in commercial orchards with drip irrigation. In the summer, aphids were common in all plantations. Plum aphid severely damaged young growths, which stopped the growth and development of young shoots. The black cherry aphid harmed cherries and cherries, inhabiting almost all varieties of examined trees, regardless of the maturity period. Autumn surveys revealed high numbers of eggs of various species of tree aphids. The winter supply of aphids is sufficient so that, with a good overwintering and favorable weather conditions for vegetation, they will populate fruit trees en masse this year, but severely weakened trees after frosts do not ensure normal growth even with a large pest load.

The gardens of the region are damaged by ticks of various species. The most common red fruit mite (*Panonychus ulmi Koch*.), less common - brown, common spider mite, fruit flat body, in some industrial plantations, microscopic rusty mites are harmful. The feeding of ticks at a high number of them leads to a slowdown in photosynthesis and an increase in evaporation, which causes suppression of plants and a decrease in growth. In the spring of 2025, mites were reborn and inhabited young leaves on fruit trees from April, however, the very low temperature during this period, as well as its significant fluctuations with frosts in May, did not contribute to the activity of mites, so their number was not very high. More favorable weather conditions for the development of ticks were observed in the region in the summer period. Outbreaks of increased number of them appeared sporadically, which required treatment with insecticides and acaricides. Red fruit mite, as the most common, was found in all the examined peach trees. The brown mite was less common. Autumn surveys revealed the population of wintering stages of ticks that go out to hibernate. In 2026, with hot, dry weather during the growing season, the number and harmfulness of ticks is expected to be high.

In the spring period, in many gardens of the region trees are observed to be inhabited by the hairy Olena (*Tropinota hirta*), the imago of which damages flowers. Beetles of the pest hibernate in the soil at a depth of 15–40 cm, with an average daily air temperature of 14°C and above, the beetles begin to emerge from the soil, which is traditionally observed in the second or third decade of April during the flowering of dandelions. The settlement of fruit crop plantations begins with the pink bud phase and continues throughout the flowering of the trees. In 2025, the summer of the pest began at the end of April, however, later in May, abnormally cold weather prevailed, frosts did not contribute to the activity of the pest, the number of which was lower than in previous years. In 2026, taking into account the significant spread of the pest in the region in recent years and sufficient wintering stock, the pest did not cause significant damage because the returning frosts destroyed all flowering and growth and leaf buds.

Keywords: crops, insects, pests, weather conditions.

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BIOPREPARATIONS FOR PLANT PROTECTION – THE FOUNDATION FOR PRESERVING THE BIODIVERSITY OF AGROECOSYSTEMS

SCERBACOVA Tatiana, https://orcid.org/0000-0002-2632-325X

Moldova State University, Institute of Genetics Physiology and Plant Protection, Chisinau, Republic of Moldova,
Corresponding e-mail: tatiana.scerbacova@sti.usm.md

Biological plant protection products based on fungi, bacteria, viruses, and their metabolites form the basis for maintaining ecological balance in agroecosystems. Broad-spectrum biological products that protect plants against a wide range of diseases prevalent in the agrocenosis are particularly important. Selectivity towards target organisms, safety for beneficial organisms, the preservation of soil health, and the absence of accumulation in the environment and agricultural products all contribute to the conservation of biodiversity in agroecosystems.

Rhizosphere bacteria of the genus *Pseudomonas* are key organisms in agroecosystems. They act as natural biostimulants and biopesticides, increase crop yields, improve soil structure, and protect plants from stress. The aim of this research is to broaden the fungicidal spectrum of the bacterium *Ps. fluorescens* AP-33(V-3481), the producer of the biological product Rizoplan, in order to control pathogens in crops where it has not previously been used.

Phytopathogens were isolated from infected plant parts, fruits, roots, and seeds of agricultural crops. The antagonistic activity of the bacterium *Ps. fluorescens* AP-33(V-3481) against phytopathogenic fungi was determined on PDA medium using the dual culture method. The fungicidal activity of the Rizoplan biopreparation based on *Ps. fluorescens* AP-33(V-3481) was determined by applying the method of secondary metabolite diffusion in agar.

As a result, 20 pathogens were isolated from the infected plant parts and cultured in pure culture. The cereal crops were infected by *Fusarium graminearum*, *F. langsethiae*, *F. poae* and *F. oxysporum*. *F. verticillioides* was isolated from maize; the white rot pathogen *Sclerotinia sclerotiorum* was isolated from the flower heads and root collars of sunflowers; and *F. sporotrichioides* was isolated from soya beans. The following fungi were isolated from cucumbers: *Albifimbria verrucaria* (seeds), *F. gibbosum* (stems), and *S. sclerotiorum* (fruit). The following were isolated from to-

matoes: *F. solani*, *Botrytis cinerea*, *Phytophthora infestans* and *Alternaria alternate*. From the root zone of cabbage seedlings: *Rhizoctonia solani*, *Thielaviopsis basicola*, and from peppers – *F. sporotrichioides*. *Monilia cinerea* and *M. fructigena* were isolated from fruit crops, and *B. cinerea* and for *Trichothecium roseum* from grape bunches. In practice, *Alternaria sp*. fungi were isolated from virtually all crops, with several species isolated from walnuts.

Cultivation in the dual culture with the bacterium *Ps. fluorescens* AP-33(V-3481) and plant pathogens revealed high antagonistic activity by the *Pseudomonas.* Sterile zones of growth inhibition formed between the bacterium and the pathogens within 6-8 days. A maximum sterile zone of 41.5 mm was observed between the antagonist and the moniliosis pathogen *M. fructigena*. The zones of growth inhibition for *B. cinerea* and *M. cinerea* were 28 mm and for *T. roseum* 21.7 mm. The antagonistic activity of *Pseudomonas* AP-33(V-3481) was significantly evident against *Fusarium* species: the zone of inhibition for *F. oxysporum* was 24.8 mm, for *F. solani*, 22.2 mm, and for *F. langsethiae*, 21.7 mm.

The pathogens showed lower sensitivity to the metabolites than to live bacteria. The secondary metabolites had the highest effect on the pathogen *M. fructigena*, with an inhibition zone of 23.3 mm. For *A. alternata*, *F. verticillioides,* and *M. cinerea*, zones of inhibition ranged from 16.8 to 18.8 mm. The metabolites affected the remaining pathogens, as evidenced by zones of inhibition ranging from 7.7 to 13.7 mm.

The present study revealed that the fungicidal spectrum of the biological product Rizoplan, based on the bacterium *Ps. fluorescens* AP-33(V-3481), has been expanded to include 20 plant pathogens. When implementing measures to protect plants from harmful organisms in agroecosystems, it is advisable to use biological products containing live microbial cultures. This will help to reduce pathogenic potential, increase the levels of antagonists in the soil, promote sound environmental management, and preserve the biodiversity of agroecosystems.

Keywords: biodiversity, biopreparation, antagonists, phytopathogens, rhizobacteria *Pseudomonas fluorescens,*

Acknowledgments. This research was carried out within the subprogram 011103 „Development of environmentally friendly means of reducing the impact of harmful organisms on agricultural crops against the background of climate change", funded by the Ministry of Education and Research of the Republic of Moldova.

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INFLUENCE OF BIOLOGICAL PREPARATIONS ON RESTRICTING THE DEVELOPMENT OF SOYBEAN PHYTOPATHOGENS

SERGIIENKO Valentyna*, https://orcid.org/0000-0003-4386-9307
SERGIIENKO Iuriy, https://orcid.org/0009-0006-3477-7485
TYSHCHUK Olena, https://orcid.org/0000-0001-2345-6789

Institute of Plant Protection of the National Academy of Agrarian Sciences, Kyiv. Ukraine
**Corresponding e-mail: v-serg@ukr.net*

Soybean infection by phytopathogenic organisms causes significant yield losses and a decrease in seed quality. The leading method of protecting soybeans from diseases is chemical using fungicides. However, the ecological situation that has developed in Ukraine requires the search for alternative, environmentally safe methods of controlling phytopathogens.

In this regard, the aim of our work was to study the protective effect of some biological preparations against soybean pathogens.

Materials and methods of research. To achieve the set goal, we conducted laboratory and vegetative experiments. In the spring, soybean seeds of the Arnica variety were sown in prepared pots in a greenhouse. A total of 7 variants in 4-fold replication. When 2-3 true leaves were formed, plants were sprayed with solutions of biological preparations. These preparations were made on the basis of various bioagents: *Bacillus subtilis*, *Pseudomonas*, *Streptomyces* and some others. The effectiveness of biological preparations was compared with the control and fungicide.

A day after spraying, the leaves were selected, laid out in a humid chamber with filter paper and infected with a suspension of phytopathogenic fungi - *Alternaria alternata* (causative agent of soybean alternaria) and *Fusarium oxysporum* (causative agent of fusarium wilt). On the 5-6th day after infection, soybean leaf lesions by phytopathogens were recorded on a 7-point scale, and the development of diseases and the effectiveness of biological preparations were determined.

Results. According to the results obtained, the Sporazin formulation (*Pseudomonas aureofaciens* Mb-24 + *Pseudomonas aureofaciens* Mb-17 + *Bacillus subtilis* BT-7), applied at a rate of 3 L/ha, demonstrated the highest efficacy against both alternaria leaf spot and fusarium wilt, with efficacy levels of 92% and 88%, respec-

tively. Its effectiveness was even higher than the fungicide Zepan, KS (kresoxim methyl, 125 g/l + epoxiconazole, 125 g/l + difenoconazole, 80 g/l), 0.7 l/ha.

The preparation Fungiclin, R. (*Streptomyces netropsis*), at 0.2 L/ha, also demonstrated high efficacy, with a protective effect of 77% and 88%. The effectiveness of other drugs was at the level of 41-64%.

Conclusions. The studies showed that biological drugs in the laboratory-vegetation experiment showed a fairly high protective effect against pathogens of alternariosis and fusarium wilt of soybean. This indicates the possibility of using them to protect soybean crops from diseases.

Keywords: phytopathogens, soybean, biological drugs, disease development, effectiveness

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MICROMORPHOLOGY AND ANATOMY OF *Nigella hispanica* DURING THE FLOWERING STAGE

SHUVALOVA Nadiia*, https://orcid.org/0000-0002-6390-5996
BONDARCHUK Oleksandr, https://orcid.org/0000-0001-6367-9063
RAKHMETOVA Svitlana, https://orcid.org/0000-0002-0357-2106
HAVRYLIUK Oleksandr, https://orcid.org/0009-0003-1914-0046
LESHCHUK Nadiia, https://orcid.org/0000-0001-6025-3702
RAKHMETOV Dzhamal, https://orcid.org/0000-0001-7260-3263

M.M. Gryshko National Botanical Garden of the National Academy of Sciences of Ukraine, Kyiv, Ukraine,
**Corresponding e-mail: shuvalovanadiia@gmail.com*

At present, the most studied species in genus *Nigella* are *N. sativa* and *N. damascena*, because of their medicinal and culinary significance, and ornamental properties, respectively. The knowledge about biology of other species remains fragmentary, despite their value in ecological and evolutionary studies, and potential as a source of novel bioactive compounds. Anatomical information on this species is still scarce. The aim of the present study was to examine the micro-anatomical characteristics of a less known genus representative, *N. hispanica*.

The research material used was represented by plants in the flowering stage, collected in July 2025, M.M. Gryshko National Botanical Garden of NASU. Samples were fixed in buffered 4% formalin solution. Unstained and stained (with 0.2% methylene blue water solution) sections were examined by XZS-PW207T microscope, and photomicrographs captured with camera Euromex CMEX-12f.

This study has shown that the *N. hispanica* stem had a multi-cornered structure. The difference in diameter of main stem and second-order lateral shoot was insignificant, yet the ribs were most prominent in main stem. The stem is composed of the following elements: the epidermis, the cortex, the vascular bundles, and pith. The epidermis was single-layered, formed by round-shaped cells. Also, simple non-glandular trichomes could be observed. The cortex was represented by the 5-7 layered chlorenchyma. In the ribs, the areas of developed lacunar collenchyma tissue, could be detected. The conductive system was represented by closed vascular bundles of different sizes, consisting of triangular or round sclerenchyma cap, relatively small phloem region, and group of variable xylem vessels. The sclerenchyma tissue con-

sisted of small cells with thick walls. It is interesting to note, that sclerenchyma caps in second-order lateral shoots often contained large cells with thin walls, and irregular shape. Between the bundles, large parenchyma cells could be detected. Also, in the main stem, the hole in the center of the pith was observed, surrounded by semi-ruined parenchyma cells. The leaf was covered in uniseriate epidermis on both adaxial and abaxial sides, with large-sized stomata cells. No trichomes were detected. The leaf mesophyll was homogeneous, dense and thick, consisting of several layers of small cells. Leaf venation was indistinct. The structure of vascular bundles in midrib and veins were similar to ones in the stem.

We found that a lot of micro-anatomical features of *N. hispanica* are common to other species of genus *Nigella*. To our knowledge, we are first to describe the presence of thin-walled large cells in schlerenchyma, in second-order lateral shoots. No anatomical abnormalities were observed, indicating normal structural organization of the studied vegetative organs.

Keywords: *Nigella hispanica*, microanatomy

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MIXED VIRAL INFECTIONS OF ALLIUM PLANTS IN AGRIECOSYSTEMS OF UKRAINE

TAHER Kyrylo*, https://orcid.org/0009-0004-5735-6494
SHEVCHENKO Tetiana, https://orcid.org/0000-0002-2250-3501
KOROTIEIEVA Hanna, https://orcid.org/0000-0002-4059-0741
ANDRIICHUK Olena, https://orcid.org/0000-0001-6219-2149
SHEVCHENKO Oleksiy, https://orcid.org/0000-0002-4947-8959
BUDZANIVSKA Iryna, https://orcid.org/0000-0003-2538-7312

Educational and Scientific Centre "Institute of Biology and Medicine", Taras Shevchenko National University of Kyiv, Ukraine,
**Corresponding e-mail: kirilltager@knu.ua*

Viral infections of *Allium* plants are an important problem of modern crop production, since these crops are widely used in agriculture and are able to accumulate viruses resulting from their vegetative propagation. Of particular danger are mixed infections formed by viruses of *Potyvirus*, *Carlavirus* and *Allexivirus* genera, which can significantly reduce yield and product quality.

During the study, serological screening of samples from different regions of Ukraine was carried out by the DAS-ELISA using commercial kits for enzyme-linked immunosorbent assay (DSMZ and Loewe Biochemica) to detect viruses from *Potyvirus*, *Carlavirus* and *Allexivirus* genera. The results were recorded using an automatic Thermo Labsystems Opsis MR microplate reader (USA) with Dynex Revelation Quicklink software at the wavelength of 405 nm. The ELISA results showed a high prevalence of representatives of *Allexivirus* genus in the tested plants. Allexiviruses were detected in 83% of plants, with the dominance of such pathogens as GVB (39% of samples) and GVC (28% of samples). ShVX has also been detected, but it was much less common (15% of samples). Screening results have unveiled the species composition of *Carlavirus* genus representatives circulating in Ukraine on onion crops: SLV (52.7% of samples) and GCLV (35.5% of samples) were the most typical pathogens, and importantly SLV was mainly detected in garlic plants. Mixed viral infections were found to be typical for *Allium* plants Allium. Viral complexes were detected in 63.6% of samples, most often in the form of combinations of GCLV+SLV (25% of samples) and OYDV+SLV (10% of samples). A combination of four viruses LYSV, OYDV, GCLV and SLV has also been detected (3.6% of samples).

The results of the study indicate the prevalence of mixed infections among *Allium* crops, which in Ukraine are often formed by representatives of different virus families. The outcomes emphasize the need for comprehensive monitoring of viral infections and the implementation of effective control measures to limit their spread.

Keywords: *Potyvirus*, *Carlavirus*, *Allexivirus*, mixed viral infections, Ukraine

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ANTI-RESISTANT HERBICIDES COMPOSITIONS

YUKHYMUK Vitalii*, https://orcid.org/0000-0001-5551-5253
MORDERER Yevhen, https://orcid.org/0000-0001-7237-3429

Institute of Plant Physiology and Genetics NAS of Ukraine, Kyiv, Ukraine
**Corresponding e-mail: yuhymuk.v@ukr.net*

The occurrence and spread of herbicide-resistant weed biotypes pose a major threat to agricultural production. Currently, there are no comprehensive solutions to fully resolve the issue of resistance. However, through the integrated application of herbicides, it is possible to reduce the directional selection pressure exerted by herbicides and thereby delay the emergence of target-site resistance (TSR) in weeds. To effectively prevent the development of resistance, herbicide mixtures must meet three main requirements:

1. The components of the mixture must have different mechanisms of phytotoxicity.

2. The spectrum of activity of the components must be similar.

3. The interaction between the components must be synergistic or at least additive.

Tank mixes and complex herbicide formulations used for protecting cereal grain crops meet these criteria. These typically consist of acetolactate synthase (ALS) inhibitors and synthetic auxins, which feature similar activity spectra and are characterized by synergistic interactions.

For the protection of winter wheat crops during the autumn growing season, a three-component tank mix was created. Its components include: diflufenican – a carotenoid synthesis inhibitor whose target site is phytoene desaturase, metribuzin – an electron transport (ET) inhibitor in photosystem II (PS II) of chloroplasts, carfentrazone – an inhibitor of protoporphyrinogen oxidase (PPO), an enzyme in the chlorophyll biosynthesis pathway. Although the interaction between carfentrazone and metribuzin is antagonistic on its own, in the presence of diflufenican, the nature of the interaction shifts to additive. Thus, this composition meets the necessary requirements and can be considered anti-resistant.

To prevent resistance development in corn crops, a synergistic tank mix combining a carotenoid synthesis inhibitor tolpyralate, targeting hydroxyphenylpyruvate dioxygenase [HPPD], with ET inhibitor in PS II terbuthylazine can be effective. The synergistic interaction of these components occurs because tolpyralate's inhibition

of plastoquinone synthesis (an electron carrier in PS II) increases the efficiency of terbuthylazine's ET inhibition. This synergistic interaction ensures high weed control efficiency and forms the basis for its effectiveness against weed biotypes with increased herbicide tolerance.

A herbicide tank mix developed for sunflower crop protection also meets anti-resistance requirements. This mixture consists carotenoid synthesis inhibitoof aclonifen, whose potential target site is the enzyme solanesyl diphosphate synthase, and ET inhibitor in PS II prometryn, whose interaction is additive. In terms of weed control efficiency, this mixture is on par with classic herbicide formulations while simultaneously meeting the standards required for anti-resistant herbicide mixtures.

Keywords: herbicide, resistance, interaction

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EFFECTS OF AGROCLIMATIC CONDITIONS ON THE SURVIVAL AND REPRODUCTIVE POTENTIAL OF THE INVASIVE SPECIES *Halyomorpha halys* (Stal)

ZAVATIN Maria*, https://orcid.org/0009-0001-2877-7757
RUSU Iuliana, https://orcid.org/0000-0002-6551-0955
NASTAS Tudor, https://orcid.org/0000-0002-0322-710X

Moldova State University, Institute of Genetics, Physiology and Plant Protection, Chisinau, Republic of Moldova,
**Corresponding e-mail: maria.zavatin@sti.usm.md*

Invasive species represent one of the most significant challenges for modern agriculture, as they disrupt ecosystem balance, reduce biodiversity, and cause substantial economic losses in agricultural production. Among these species, the invasive species *Halyomorpha halys* Stal (Hemiptera: Pentatomidae), commonly known as the brown marmorated stink bug, is distinguished by its polyphagous feeding behavior, high ecological plasticity, and remarkable ability to adapt to a wide range of soil and climatic conditions. Native to East Asia, this species has rapidly expanded its distribution range across Europe and North America, becoming a pest of major economic importance for fruit crops, vegetable crops, vineyards, and ornamental plants.

The invasive success of this species is determined by the interaction between its biological characteristics and the agroclimatic conditions of the colonized regions. Climatic factors, particularly winter temperature regimes and temperature and humidity conditions during the growing season, directly influence the survival of overwintering adults in diapause. In the context of climate change, characterized by increasing average temperatures and a reduction in the frequency of severe winters, an intensification of the establishment and spread of this species into new geographic areas is expected. In the Republic of Moldova, climatic conditions characterized by relatively mild winters and warm summers create favorable prerequisites for the survival and development of populations of the invasive species *Halyomorpha halys*.

The aim of this study was to evaluate the impact of agroclimatic conditions on overwintering survival and reproductive potential of the species *Halyomorpha halys*. The research was conducted through population monitoring under natural and laboratory conditions, with the analysis of post-winter survival rates, development

dynamics, and reproductive capacity. The results demonstrated that approximately 55% of adults survived the cold season, ensuring the continuity of populations in the following year. Adults resumed biological activity with an increase in average daily temperatures, initiating feeding and reproductive processes.

Favorable thermal conditions during the vegetation period accelerated the development of preimaginal stages and reduced the duration of the biological cycle. The species was capable of producing up to three generations during the growing season. High reproductive capacity contributed to the rapid increase in population density and intensification of damage to agricultural crops.

Climate change, expressed through increasing average temperatures, promotes the expansion of the species' distribution range and enhances its invasive potential. The obtained results confirm that the agroclimatic conditions specific to the Republic of Moldova provide favorable conditions for the survival of *Halyomorpha halys* during the diapause period, facilitating the maintenance of stable populations. The high level of post-hibernation survival, combined with considerable reproductive potential, represents a determining factor in the ecological adaptability and expansion of this species within agroecosystems of the Republic of Moldova.

Keywords: *Halyomorpha halys,* imago, diapause, climate factors.

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Section B

Production and application of biological products based on entomophages, biologically active substances, entomopathogenic and antagonistic microorganisms

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OPTIMIZATION OF THE WATER REGIME OF TYPICAL CHERNOZEM IN SHORT-ROTATION CROP ROTATIONS IN THE RIGHT-BANK FOREST-STEPPE OF UKRAINE

ATAMANIUK Oleh, https://orcid.org/0000-0001-8327-3298

National Academy of Agrarian Sciences of Ukraine, the V.M. REMESLO MYRONIVKA INSTITUTE OF WHEAT, Bila Tserkva Experimental Breeding Station Kyiv Region, Ukraine,
Corresponding e-mail: aom68@i.ua

Relevance. The rational use of soil moisture is critically important for stabilizing and increasing crop productivity in the Forest-Steppe zone of Ukraine, which is characterized by uneven moisture availability. Investigating the dynamics of plant-available soil moisture under different crop rotations and fertilization systems makes it possible to develop effective climate-change adaptation strategies and enhance the ecological resilience of agrocenoses.

Objective. To assess the effects of different types of short-rotation crop rotations—cereal–forage–row crop, row crop, and cereal–row crop rotations—and fertilization systems on the dynamics of plant-available soil moisture reserves in the 0–150 cm soil layer and on total water consumption over a five-year rotation period from 2021 to 2025 under the conditions of the Right-Bank Forest-Steppe of Ukraine.

Materials and Methods. The study was conducted from 2021 to 2025 within a long-term stationary field experiment in fields No. 3, 4, and 5 of the Bila Tserkva Experimental Breeding Station, located in the Right-Bank Forest-Steppe of Ukraine. The soil of the experimental site was a typical Chernozem. Plant-available soil moisture reserves in the 0–150 cm layer were determined at crop sowing and harvesting. Precipitation during the occupied fallow period and crop-growing seasons, as well as total water consumption over the five-year rotation, were also analysed.

Three crop rotation types and several fertilization systems were investigated.

The cereal–forage–row crop rotation included a vetch–oat mixture, winter wheat, sugar beet, spring barley undersown with clover, and clover. The treatments were as follows: treatment 11, unfertilized control maintained since 1976; treatment 13, organo-mineral fertilization consisting of mineral fertilizers combined with 40 t

ha^{-1} of manure applied to sugar beet; treatment 14, organic fertilization consisting of 40 t ha^{-1} of manure applied to sugar beet once per rotation; and treatment 2, mineral fertilization consisting of $N_{90}P_{60}K_{60}$ for winter wheat, $N_{100}P_{90}K_{90}$ for sugar beet, and $N_{40}P_{40}K_{40}$ for clover.

The row crop rotation included treatment 31, unfertilized control; treatment 33, organo-mineral fertilization in which organic nutrition was supplemented with $N_{90}P_{60}K_{60}$ for winter wheat and $N_{40}P_{40}K_{40}$ for soybean; and treatment 29, organic fertilization.

The cereal–row crop rotation included a vetch–oat mixture, winter wheat, sugar beet, spring barley, spring vetch, and repeated winter wheat. The treatments were as follows: treatment 51, unfertilized control; treatment 53, organo-mineral fertilization consisting of 40 t ha^{-1} of manure applied to sugar beet in combination with mineral fertilizers; and treatment 55, mineral fertilization.

Results. The results obtained during 2021–2025 demonstrated that the combined application of organic and mineral fertilizers was the most effective approach for establishing a favourable soil water balance and improving the ecological resilience of crop rotations.

In the cereal–forage–row crop rotation, the unfertilized treatment 11 had the largest residual soil moisture reserve, reaching 861 mm in field No. 5. However, this treatment was associated with lower crop productivity and lower water use, with total water consumption amounting to 1,710 mm. The organo-mineral treatment 13 and organic treatment 14 promoted more intensive water consumption, reaching 1,925 mm, and reduced residual soil moisture to 646 mm, indicating more efficient water uptake and use by crops. The mineral treatment 2 provided an optimal balance between water consumption, which amounted to 1,890 mm, and residual soil moisture, which reached 681 mm.

In the row crop rotation, the unfertilized treatment 31 was characterized by the highest residual soil moisture reserve, reaching 527 mm in field No. 4, primarily because of lower crop stand density and weaker plant growth. The organo-mineral treatment 33 and organic treatment 29 improved water-use efficiency. At similar total water consumption levels of 1,692–1,702 mm, residual soil moisture reserves ranged from 394 to 404 mm, indicating a relatively stable soil water regime under conditions of vigorous crop growth.

In the cereal–row crop rotation, the unfertilized treatment 51 had the highest residual soil moisture reserve of 662 mm; however, this was associated with lower biomass production and crop yields. The organo-mineral treatment 53 ensured the most efficient use of soil moisture, with total water consumption reaching 1,776 mm, and demonstrated the highest crop water-use capacity, thereby confirming the stabilizing effect of organic amendments on the soil water balance. The mineral treat-

ment 55 maintained a more balanced water regime and left 686 mm of residual soil moisture.

Overall, the organo-mineral fertilization systems represented by treatments 13, 33, and 53 resulted in the highest total water consumption, ranging from 1,925 to 1,976 mm, which reflected the intensive use of available moisture by high-yielding crops. In contrast, the unfertilized treatments 11, 31, and 51 were associated with deterioration of soil structure and lower total water consumption, ranging from 1,710 to 1,840 mm.

Conclusions. The results of the 2021–2025 study conducted at the Bila Tserkva Experimental Breeding Station confirmed the key role of crop rotation type and fertilization system in regulating the water regime of typical Chernozem. The organo-mineral fertilization system was the most effective in maintaining a favourable soil water regime, increasing the water productivity of agrophytocenoses, and ensuring stable crop yields under the conditions of the Right-Bank Forest-Steppe of Ukraine. The findings provide a scientific basis for developing adaptive soil moisture management strategies under increasingly variable climatic conditions.

Keywords: crop rotation, water regime, plant-available soil moisture, fertilization, typical Chernozem, Right-Bank Forest-Steppe.

Acknowledgments. This research was conducted within the framework of Project "Scientific Principles of Plant-Available Soil Moisture Regulation under Climate Change to Enhance the Resilience and Productivity of Agroecosystems in the Forest-Steppe Zone" (State Registration No. 0121U107776), funded by the National Academy of Agrarian Sciences of Ukraine.

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INSECTICIDE CYPRONIL, OD (ciantraniliprol, 100 g/l) IN THE FIGHT AGAINST CHERRY FRUIT FLY (*Rhagoletis cerasi* L.) ON SWEET CHERRY IN THE REPUBLIC OF MOLDOVA

DUMITRASH Iurie*, https://orcid.org/0000-0003-0524-148X
MAGHER Mihail, https://orcid.org/0000-0003-2734-6805
ILIEV Petru, https://orcid.org/0000-0001-7947-3663
CHERNETS Alexandr, https://orcid.org/0000-0003-3552-1757
PRODANIUC Leonid, https://orcid.org/000-0001-8933-715X
GENDOV Natalia, https://orcid.org/000-0002-4509-5918
KOJOKORENKO Valerii, https://orcid.org/0000-0001-8993-5635

PI National for Applied Researh in Agriculture and Veterinary Medicine, Chisinau, Republic of Moldova,
**Corresponding e-mail:dumitrasiurie@gmail.com*

Sweet cherry is one of the most common stone fruit crops in Moldova. The total area of sweet cherry orchards is approximately 6,000 hectares. Fruit yields reach 15–18 tonnes per hectare. The assortment of recommended varieties comprises 39 cultivars.

The widespread use of sweet cherries is primarily due to their good adaptability to Moldova's soil and climate conditions, as well as their early maturity, high, consistent productivity, and excellent taste and nutritional qualities. The main pest of this species is the cherry fruit fly. Tiny maggots tunnel inside the fruit, causing them to dimple, rot, or drop prematurely.

The insecticide Cypronil (OD) was tested in an orchard of the 'Kordia' sweet cherry variety at SRL "Agrocordia" in the village of Bălăbănești, Criuleni District. The trees were planted in 2014, with a planting spacing of 5x4 meters. The experiment was designed in four variants. Each variant included three replicates. Each replicate included five trees with identical crown parameters.

Experience schem: Control (no treatment); standard (Boxer 5 CS) - 0.8 l/ha; Cypronil, OD - 0.75 l/ha; Cypronil, OD - 0.9 l/ha. To protect the crop, the first spray treatment against the cherry fruit fly was carried out on June 2 in 2025 and on June 4 in 2026. The second treatment took place two weeks before fruit ripening—on June 14 in 2025 and June 17 in 2026.

During testing, the insecticide Cypronil OD demonstrated biological efficacy superior to the reference standard when used against the cherry fruit fly on sweet cherries at application rates of 0.75–0.9 L/ha. Its efficacy ranged from 91.4% to 93.9%, whereas the reference standard achieved 89.2%. In the untreated control, fruit damage amounted to 79.7%. Fruit infestation in the treatment variants was reduced 13- to 15-fold compared to the control. The results indicate that Cypronil OD can be applied one to two times per growing season to control the cherry fruit fly on sweet cherries at a rate of 0.75–0.9 L/ha.

Key words: cherry, insecticide, biological effectiveness, cherry fruit fly

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EFFECTIVENESS OF BIOLOGICALLY ACTIVE SUBSTANCES WITH KAIROMONAL PROPERTIES ON THE PERFORMANCE OF THE EGG PARASITOID *Trichogramma pintoi* Voegelé, 1982

GAVRILIȚA Lidia*, https://orcid.org/0000-0001-9266-4565
NASTAS Tudor, https://orcid.org/0000-0002-0322-710X

Moldova State University, Institute of Genetics Physiology and Plant Protection, Chisinau, Republic of Moldova,
**Corresponding e-mail*: *lidia.gavrilita@sti.usm.md*

The egg parasitoid *Trichogramma* spp. is one of the most important biological control agents used in integrated pest management programs for annual and perennial crops.

The Angoumois grain moth, *Sitotroga cerealella* (Olivier), is routinely reared as a host species under laboratory conditions. During oviposition, females deposit biologically active compounds on the egg surface, including lipids, proteins, kairomones, volatile substances, and other semiochemicals. These compounds play an important role in host location, recognition, and stimulation of parasitoid oviposition.

The present study aimed to improve the quality and biological performance of *Trichogramma* spp. through the application of biologically active substances (BAS) exhibiting kairomonal properties. An ethanol extract obtained from *S. cerealella* eggs was used as the source of kairomonal compounds. The effects of the extracted fractions on the host-searching ability and biological quality of *Trichogramma pintoi* were evaluated in order to enhance its effectiveness in suppressing pest populations. Experimental variants were prepared using BAS with optimal kairomonal activity, determined using the "Optimclas" software package and the Box experimental design methodology. The amount of water required to dilute ethanol to the desired concentration was calculated according to the following equation: $X = P \times (N/M - 1)$ where X is the amount of water required for dilution; P is the volume of ethanol used in the treatment; N is the initial ethanol concentration (96%); and M is the required ethanol concentration (30%).

To prepare the kairomonal extract, host eggs were immersed in 30% ethanol for 5 minutes. Experiments were conducted at temperatures of 23–25°C and 26–30°C.

The persistence and biological activity of the extracts were assessed after 0, 7, 14, 21, and 28 days of storage.The following biological parameters were evaluated: fecundity (eggs per female), adult emergence rate, female emergence rate, parasitism rate, host-searching capacity, and the quality index of the parasitoid population.

The results demonstrated that prolonged storage of the extract at 4°C resulted in a gradual decline in the biological performance of *T. pintoi*. After 28 days of storage, all evaluated parameters showed lower values compared with freshly prepared extracts. Fecundity ranged from 22.1 to 24.8 eggs per female, adult emergence from 80.5 to 92.2%, female emergence from 51.0 to 56.0%, host-searching capacity from 79 to 90%, and parasitism rate from 76 to 89%. The quality index varied between 9.0 and 12.8. The biological performance of *T. pintoi* was slightly higher at 23–25°C than at 26–30°C, confirming that the lower temperature range is more favorable for parasitoid development and activity.

The application of kairomonal biologically active substances may contribute to improving the efficiency of mass-reared *Trichogramma* used in biological control programs. The use of parasitoids offers numerous advantages, including reduced crop protection costs, conservation of beneficial organisms, increased field efficacy, improved agricultural productivity, enhanced food quality, reduced dependence on chemical pesticides, and lower environmental contamination.

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VARIATIONS IN PEROXIDASE AND CATALASE ENZYME ACTIVITY IN PLUM TREE LEAVES AS AFFECTED BY GROWING CONDITIONS AND THE BIOLOGICAL CHARACTERISTICS OF THE CULTIVAR

GISCA Alina*, https://orcid.org/0009-0001-8770-673X
SVETLICENCO Valentina, https://orcid.org/0000-0002-7376-949X
NICUTA Alexandru, https://orcid.org/0000-0003-3964-130X

Moldova State University, Institute of Genetics, Physiology and Plant Protection
Chisinau, Republic of Moldova,
**Corresponding e-mail*: *alina.gisca@sti.usm.md*

The aim of this study was to determine the effect of water stress on the activity of the antioxidant enzymes catalase and peroxidase in the leaves of plum varieties with different levels of tolerance to soil moisture deficit.

Scientific research was carried out during the growing season, in the lysimeters of the Institute of Genetics, Physiology and Plant Protection of the State University of Moldova on trees of 2 plum varieties of foreign selection – Stanley and President and 2 plum varieties of local origin – Udlinionnaia and Super Prezident, according to the scheme:

1. Experimental variant: plants grown under non-irrigated conditions;
2. Control variant: plants grown under irrigated conditions.

The data obtained are presented as the mean of 3 repetitions ± standard deviation. The processing of experimental data was carried out using a table editor Microsoft Excel 2019.

The results of the investigations revealed an intensification of peroxidase activity in the leaves of trees grown under non-irrigated conditions. Compared to irrigated trees, the values were higher by 24.20 % in the Stanley variety, by 32 % in the Udlinionnaia, by 23.53% in the President and by 3.17% in the Super Prezident. During the vegetation period, the highest activity of the catalase enzyme in the leaves was observed in trees grown under non-irrigated conditions. Compared to trees grown under optimal humidity conditions (with irrigation), the enzyme activity was higher by 16.59 % in the Stanley variety, by 19.74% in the Udlinionnaia variety, by 10.58% in the President variety and by 10.10% in the Super Prezident variety.

The plum varieties studied showed a response to insufficient soil moisture during the growing season, triggering a significant increase in the activity of key antioxidant enzymes (catalase and peroxidase), which represents a plant defense reaction to neutralize oxidative stress caused by drought. Enzymatic activity during the vegetation period did not present constant values, fluctuating depending on the intensity of metabolic processes in different phenophases of tree growth and development, growth conditions and biological particularities of the varieties.

The research conducted reveals that trees of all 4 plum varieties, grown under non-irrigated conditions, have the highest activity of catalase and peroxidase enzymes in the leaves, compared to those grown under irrigated conditions (soil humidity – 70%). Under conditions of water stress (drought), throughout the growing season, increased peroxidase activity was recorded, serving as a marker of resistance to fluctuating environmental factors.

The research revealed a higher activity of the peroxidase enzyme in the leaves of the President variety. In the case of catalase enzyme activity, this law is valid for the Stanley variety. The results obtained can serve as a benchmark for the subsequent development of procedures for modulating the adaptation, growth and development response of fruit species, in the context of climate change.

Keywords: *plum trees, leaves, peroxidase, catalase, water stress*

Acknowledgments. This research was supported by the subprogram 011101 „Genetic and biotechnological approaches to agroecosystem management under climate change", funded by the Ministry of Education and Research of the Republic of Moldova and the doctoral project „Cyto-physiological adaptation of plum trees to environmental factors and the impact on productivity".

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STIMULATION OF THE ACTIVITY OF THE ENTOMOPHAGE *Bracon hebetor* UNDER THE INFLUENCE OF KAIROMONAL SUBSTANCES

GLIBICIUC Corina*, https://orcid.org/0009-0005-6238-2440
NASTAS Tudor, https://orcid.org/0000-0002-0322-710X

Moldova State University, Institute of Genetics Physiology and Plant Protection, Chisinau, Republic of Moldova,
**Corresponding e-mail*: *corina.glibiciuc@sti.usm.md*

The intensive application of synthetic insecticides in agroecosystems has generated significant ecological disturbances, manifested through the reduction of functional biodiversity, negative effects on beneficial entomofauna, and the development of resistance to active substances used in pest control. In the context of sustainable agriculture development and the implementation of modern integrated plant protection strategies, biological control methods are gaining particular strategic importance. The entomophage *Bracon hebetor* (Hymenoptera: Braconidae) represents one of the parasitoid species with high biological efficiency in limiting populations of harmful lepidopterans, being extensively used in biological protection programs due to its capacity for rapid host larval localization and parasitism. The aim of the research was to estimate the efficiency of biologically active substances extracted from the excrements and tissues of *Galleria mellonella* larvae on the behavioral activation and parasitism efficiency of the entomophage *Bracon hebetor*.

The experiments were carried out under laboratory conditions to evaluate the kairomonal effect of biologically active substances on females of *Bracon hebetor*. The biological material used included larvae and excrements of the species *Galleria mellonella*. The excrements were collected from larval rearing boxes where the insects were developed on "MERVA" nutritive substrate under conditions of 27±1°C temperature, 65–70% relative humidity, and a 16:8 photoperiod. The excrements were sorted, dehydrated at 40°C for 12 hours, and ground to obtain a fine powder. The extraction of biologically active substances was performed by the maceration method for 72 hours using a 10% ethyl alcohol solution for excrements and distilled water for crushed larvae. The experimental design included six experimental variants and a control variant. In each variant, 10 females of *Bracon hebetor* and 10 third-instar larvae of *Galleria mellonella* were introduced. During monitoring,

the following parameters were evaluated: behavioral activation criteria, host larval detection speed, rate of paralyzed larvae, and parasitism efficiency compared to the control variant.

The obtained results demonstrated that the extracts derived from the excrements of *Galleria mellonella* larvae had the most pronounced effect on the behavioral activation of entomophage females. Thus, in the experimental variant in which host larvae were under the influence of larval excrement extracts, the activation rate of *Bracon hebetor* females reached the maximum value of 100%. The conducted investigations confirmed that the excrements of *Galleria mellonella* larvae contain biologically active substances with kairomonal properties capable of significantly influencing the behavior of the entomophage *Bracon hebetor*. These substances essentially stimulate orientation activity and host larval detection, contributing to the increase of parasitism efficiency. It was demonstrated that the extracts obtained from larval excrements exhibit a superior biological effect compared to extracts from larval tissues, having significant potential for application in the optimization of biological control technologies and in increasing the efficiency of entomophage utilization in plant protection.

Keywords: *Galleria mellonella*, *Bracon hebetor*, excrements, larvae, extract, kairomone.

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Rheum rhabarbarum PLANT EXTRACTS FOR THE MITIGATION OF POWDERY MILDEW SEVERITY IN CUCUMBER: OPTIMIZATION, ANTIFUNGAL SCREENING AND GREENHOUSE VALIDATION

LUNG Ildiko[1,*], https://orcid.org/0000-0003-4677-4602
LUSHNYKOV Emanuela Dana[1,2], https://orcid.org/0009-0006-5947-2610
JALBA Svetlana[3], https://orcid.org/0009-0007-9756-2059
SORAN Maria-Loredana[1], https://orcid.org/0000-0003-3770-9702
STEGARESCU Adina[1], https://orcid.org/0000-0002-1528-6342
VACAR Cristina Lorena[2], https://orcid.org/0000-0002-5964-1932
PODAR Dorina[2,4], https://orcid.org/0000-0002-0955-7425
TODIRAȘ Vladimir[3], https://orcid.org/0000-0002-2245-9715
OPRIȘ Ocsana[1], https://orcid.org/0000-0002-9765-2739

[1]National Institute for Research and Development of Isotopic and Molecular Technologies, Cluj-Napoca, Romania
[2]Centre for Systems Biology, Biodiversity and Bioresources (3B), Babeş-Bolyai University, Cluj-Napoca, Romania
[3]Moldova State University, Institute of Genetics Physiology and Plant Protection, Chisinau, Republic of Moldova
[4]Department of Molecular Biology and Biotechnology, Babeş-Bolyai University, Cluj-Napoca, Romania
**Corresponding e-mail: ildiko.lung@itim-cj.ro*

The yield and quality of cucumber crops can be severely impacted by the powdery mildew disease caused by *Sphaerotheca fuliginea*. Plant-based biocontrol strategies are preferred to conventional fungicides due to increased fungicide resistance in pathogens and environmental safety.

The purpose of this study was to test different formulations of *Rheum rhabarburum* root extract on cucumber crops infected with *S. fuliginea*. Plant extracts were optimized using the central composite design (CCD) to ensure the highest total polyphenolic content and antioxidant capacity. The selected extracts were first tested in vitro for antifungal properties against *Fusarium oxysporum* f. sp. *lycopersici* prior to being used in formulations supplemented with fatty acid ethyl esters derived from natural oils for greenhouse disease mitigation evaluation. These formulations were

applied prophylactically onto the leaves of *Cucumis sativus* L plants before infestation with the pathogen.

Disease severity in treated plants was reduced by up to 83% relative to untreated control plants. Thus, optimized plant-based formulations can be of potential value as ecofriendly alternatives to conventional artificial fungicides for disease management in cucumber production.

Keywords: *Rheum rhabarbarum*, bioactive compounds, polyphenols, DPPH, antifungal activity.

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ECOLOGICAL INTENSIFICATION OF CEREAL CROP PROTECTION THROUGH SOIL MICROBIOME RESTORATION

MOHAMMED Ruth Aisha, https://orcid.org/0009-0001-2416-1760

Department of Forestry and Wildlife, Faculty of Agriculture, Zamfara State University (ZAMSUT), Talata Mafara, Zamfara State, Nigeria
Corresponding e-mail: mohammedrutha710@gmail.com

Purpose: This study examined how restoration of beneficial soil microbiomes can strengthen natural plant defence, suppress economically important cereal diseases and improve crop resilience under sustainable production systems. The work explored ecological plant protection approaches that reduce dependence on synthetic fungicides while maintaining productivity under changing climatic conditions.

Materials and Methods: Field experiments were conducted for two seasons using a randomized complete block design. Compost-enriched organic amendments, microbial bioinoculants and disease-tolerant cereal cultivars were integrated across replicated plots. Disease severity, soil enzymatic activity, microbial biomass, grain yield and beneficial rhizosphere organisms were monitored throughout crop development. Data were analysed using analysis of variance to compare ecological treatments with conventional crop protection practices.

Results: Integrated ecological treatments consistently lowered disease incidence, improved soil biological activity and enhanced crop vigour. Beneficial microbial populations increased substantially, while disease severity declined and grain yield improved relative to conventional management. Improved nutrient cycling and healthier root systems contributed to stronger crop establishment and greater tolerance to environmental stress. The ecological strategy also reduced chemical input requirements and supported biodiversity conservation within the production system.

Conclusions: Restoration of functional soil microbiomes provides a practical pathway for future plant protection programmes by combining biological resilience, environmental sustainability and stable cereal productivity. Integrating microbial technologies with resistant cultivars offers significant achievements and perspectives for sustainable crop protection.

Keywords: Soil microbiome; Biological control; Cereal protection; Sustainable agriculture; Disease management

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A PREDATORY BUG *Orius majusculus* AS A BIOLOGICAL CONTROL AGENT OF THE INVASIVE *Echynothrips americanus*

MUNTEAN Elena*, https://orcid.org/0009-0002-1756-7858,
IORDOSOPOL Elena, https://ordcid.org/ 0000-0003-3492-8045,
FILIMON Valeriu, https://ordcid.org/ 0000-0001-5957-1359
BATCO Mihail, https://orcid.org/0000-0002-3711-4429

Moldova State University, Institute of Genetics Physiology and Plant Protection, Chisinau, Republic of Moldova,
**Corresponding e-mail: elena.muntean@sti.usm.md*

In the Republic of Moldova, the predatory bug *Orius majusculus* (Reut) is widespread on various wild and cultivated plants. The bugs are mass-reared for use in greenhouses against thrips and other insectoacaricide-resistant arthropods. *Echinothrips americanus* (Morgan) is native in subtropical regions of the southeastern United States and Central America. In the late 1990s, thrips invaded greenhouses in many countries of Western and Eastern Europe, Russia, the United States, Canada, and China. In RM, the first invasion of insecticide-resistant *E. americanus* was found in the greenhouses of the Chisinau Botanical Garden in 2013 (Muntyan et al., 2022). When vegetable seedlings are cultivated in greenhouses, pests can cause significant economic damage to grown outdoors cucumbers, beans, peppers, pumpkins, and melons in Moldova.

The goal of this research was to study the developmental characteristics (developmental time duration and lifespan) and predation rate of a laboratory colony of *O. majusculus* feeding on larvae and adults of *E. americanus.* Second-instar nymphs or one-day-old adults were released into containers with pepper leaves containing thrips larvae or adults. The age of the bug nymphs and the number of killed thrips were recorded every 24 hours. The experiments were conducted in eight to ten replicates at a temperature of 25 ± 1°C and under a photoperiod of 16:8 (L:D). The data was processed statistically using Student's t-test.

All of the bug nymphs completed successfully their development when they were fed *E. americanus*. The average duration of the immature stage of the bug development was 10.0 ± 0.33 days. The complete development of the pest, from egg to adult, took 15.0 ± 0.7 days, which is comparable to the ontogenetic duration of the

pest itself (16.0 ± 1.3 days) (Sukhoruchenko et al., 2016). The maximum lifespan of adult bugs that fed on thrips was 34 days. The daily predation rate of *O. majusculus* at the immature stage of development (6.73±0.42 thrips/day) is significantly lower than the predation rate on *T. urticae* eggs (16.2±1.4 eggs/day) (Muntyan et al., 2022). Adult bugs are capable of killing more than 10.22 ± 0.62 thrips per day. At the same time, bugs destroyed three times more spider mite eggs (29.5±1.1 eggs/day). These differences may be due to the varying mobility of the preys. When hunting thrips, especially adults, bugs encounter greater difficulties in comparison with feeding on mite eggs.

Thus, *O. majusculus* which had been reared in the laboratory for over 25 generations developed successfully on *E. americanus* thrips. The bugs retained their predation capacity and destroyed thrips at both the immature and adult stages. The relatively low voracity of Orius on thrips than on mites is likely related with the size and energy value of these preys. *E. americanus* are easily multiplied in the laboratory on beans, pepper, or melon, making this thrips species highly suitable as live food for predator mass rearing. The predator and thrips are characterized by similar values of ontogenetic duration and comparable fecundity values of 86.1 ± 1.2 and 99.7 ± 13.8 eggs, respectively (Saprykin et al., 2010; Mouratidis et al., 2022). If outbreaks of *E. americanus* are observed *O. majusculus* can be recommended for the control of this invasive pest.

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BIOLOGICAL PLANT PROTECTION AND CONSERVATION OF BENEFICIAL INSECTS AS KEY COMPONENTS OF MODERN AGROECOSYSTEM MANAGEMENT

NASTAS Tudor*, https://orcid.org/0000-0002-0322-710X
GLIBICIUC Corina, https://orcid.org/0009-0005-6238-2440
RUSU Iuliana, https://orcid.org/0000-0002-6551-0955
NEMERENCO Olesea, https://orcid.org/0000-0002-0028-4547
ZAVATIN Maria, https://orcid.org/0009-0001-2877-7757
LABUSNEAC Iana, https://orcid.org/0009-0007-8612-1936
GAVRILITA Lidia, https://orcid.org/0000-0001-9266-4565
GLADCAIA Alla, https://orcid.org/0000-0001-9182-4352

Moldova State University, Institute of Genetics Physiology and Plant Protection, Chisinau, Republic of Moldova,
**Corresponding e-mail: tudor.nastas@sti.usm.md*

The increasing frequency of biological invasions, the intensification of climate change effects, and the urgent need to reduce the environmental impact of phytosanitary products are driving the transition of modern agricultural systems towards sustainable plant protection approaches. In this context, biological plant protection, based on the utilization and conservation of entomophagous organisms, represents one of the most effective strategies for maintaining ecological balance and reducing crop losses caused by harmful organisms.

Research conducted in the Republic of Moldova has revealed significant changes in the structure and dynamics of phytophagous insect populations, driven both by climatic factors and by the ability of certain species to adapt to newly emerging ecological conditions. A representative example is the invasive species *Halyomorpha halys* (Stal), which has demonstrated complete acclimatization within the territory of the country through the development of three generations during a single vegetation season. The high population densities recorded mainly in the central and southern regions, together with the high reproductive potential of females, confirm the considerable phytosanitary risk posed by this species to agricultural crops. At the same time, its pronounced preference for fruit crops, particularly apple and plum orchards, highlights the necessity of implementing

efficient monitoring systems and environmentally sound population management strategies.

For the monitoring of invasive insect species and agricultural pests, pheromone traps and lures manufactured by *Ecology Center* LLC were employed. The traps were installed in various agroecosystems and agricultural crops, maintaining a distance of 50–100 m between monitoring points, depending on the biological characteristics of the target species and the specific features of the surveyed habitat. Observations and records of trap catches were conducted at three-day intervals throughout the growing season, enabling the assessment of population dynamics and activity patterns of the monitored insect species.

Similarly, studies conducted on the species *Helicoverpa armigera* (Hübner) and *Agrotis segetum* Denis & Schiffermüller have revealed specific bioecological characteristics that directly influence the infestation level of agricultural crops. Anatomical investigations demonstrated that females of *H. armigera* possess high fecundity and an extended reproductive period, favored by elevated temperatures during July–September, whereas in *A. segetum*, reproductive activity is predominantly concentrated within the first two generations. These biological characteristics, combined with favorable climatic conditions, contribute to the formation of local population outbreaks and emphasize the importance of continuous monitoring of pest dynamics.

In this regard, the application of modern digital technologies represents an essential tool for optimizing plant protection processes. The development of digital distribution maps and the integration of biological and ecological information into the EcoBioNet information system enabled the identification of areas with high phytosanitary risk and facilitated forecasting of *H. armigera* population dynamics. The obtained results demonstrate that combining conventional entomological monitoring with advanced digital mapping approaches can significantly support decision-making processes related to pest management and enhance the efficiency of integrated pest management systems.

However, the development of effective biological protection systems requires not only continuous pest monitoring but also the efficient exploitation of the natural potential of entomophagous organisms. In this context, biologically active substances with kairomonal properties represent a promising approach, as they are capable of enhancing host-searching and host-location behavior. Research findings demonstrated that these substances significantly stimulate the activity of *Trichogramma* species, increasing their parasitization capacity and locomotor activity. These results confirm the high potential of kairomonal compounds for improving the efficiency of biological control agents used in pest management programs targeting lepidopteran species.

The ecological importance of the genus *Trichogramma* within agricultural ecosystems is also supported by the specific composition of natural populations identified

in various agrocenoses. The analysis of collected material revealed the predominance of *Trichogramma evanescens* Westwood and *Trichogramma dendrolimi* Matsumura, accompanied by the presence of *Trichogramma pintoi* Voegelé and *Trichogramma embryophagum* Htg. This species diversity reflects the existence of a valuable natural potential for biological regulation of phytophagous insect populations and confirms the necessity of conserving beneficial entomofauna within agroecosystems.

The same principle of enhancing natural biological control mechanisms was demonstrated for the entomophagous species *Bracon hebetor* Say. Biologically active compounds extracted from larval excreta of *Galleria mellonella* L. exhibited a pronounced kairomonal effect, significantly increasing parasitization intensity. Furthermore, optimization of nutritional media for the mass rearing of the host species *Plodia interpunctella* Hübner improved the efficiency of biological material production intended for entomophage multiplication. These findings emphasize the importance of improving mass-rearing technologies for beneficial organisms in order to expand the practical application of biological control methods in agricultural production.

Alongside the multiplication and application of entomophagous organisms, the conservation of natural populations of beneficial insects represents an indispensable component of ecological agriculture. Monitoring studies demonstrated the effectiveness of artificial shelters as tools for maintaining functional biodiversity, with a considerable number of representatives of the families Chrysopidae and Hymenoptera using these structures for overwintering. The conservation of natural entomophage reservoirs contributes to strengthening the self-regulation capacity of agroecosystems and reducing the dependence on chemical control interventions.

In conclusion, the research results demonstrate that bioecological monitoring of pest species, implementation of digital forecasting technologies, application of biologically active substances with kairomonal effects, optimization of entomophage mass-rearing processes, and conservation of natural beneficial insect populations represent complementary components of a modern biological plant protection system. The integration of these approaches into a unified management strategy contributes to increasing agroecosystem resilience, mitigating the impact of invasive species, and promoting sustainable agriculture based on the enhancement of natural mechanisms regulating pest populations.

Keywords: Halyomorpha halys, Helicoverpa armigera, Agrotis segetum, Trichogramma, Galleria mellonella, Bracon hebetor.

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IMPACT OF CLIMATE CHANGE ON THE SEASONAL ACTIVITY OF *Helicoverpa armigera* (Hübner, 1808)

NEMERENCO Olesea, https://orcid.org/0000-0002-0028-4547

Moldova State University, Institute of Genetics Physiology and Plant Protection, Chisinau, Republic of Moldova,
Corresponding e-mail: *olesea.nemerenco@sti.usm.md*

Climate change is one of the major factors influencing the development and distribution of phytophagous insects, causing modifications in their phenology, population dynamics, and geographical range. *Helicoverpa armigera* (Hübner, 1808) is one of the most important polyphagous agricultural pests, characterized by a high capacity to adapt to changing environmental conditions. The aim of this study was to assess the impact of climate change on the seasonal activity of *H. armigera* under the conditions of the Republic of Moldova.

The investigations were carried out during the period 2019–2025 on the experimental fields of the Institute of Genetics, Physiology and Plant Protection. Population monitoring was conducted using pheromone traps installed in various agroecosystems, while meteorological data on air temperature and precipitation were used to interpret the peculiarities of seasonal activity. Adult flight dynamics were analyzed in relation to climatic variations occurring throughout the growing season.

The obtained results revealed significant variability in population density among the years of study, closely associated with the climatic characteristics of each season. Elevated temperatures recorded in recent years promoted earlier adult emergence and extended the period of seasonal activity. Under warmer spring conditions, the onset of adult flight was observed earlier compared with seasons characterized by moderate temperatures. Furthermore, increased temperatures contributed to accelerated the development of successive generations and intensified flight activity during the vegetation period. The observed population fluctuations indicate that, in addition to temperature, precipitation patterns and humidity levels play an important role in regulating the dynamics of this species.

In conclusion, climate change has a direct impact on the seasonal activity of *Helicoverpa armigera*, influencing the timing of adult emergence, prolonging the flight period, and facilitating population adaptation to new environmental condi-

tions. Continuous population monitoring and the integration of climatic information into pest forecasting systems are essential for the development of effective crop protection strategies.

Keywords: *Helicoverpa armigera*, climate change, seasonal activity, monitoring, phenology.

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COMMUNITY-BASED ECOLOGICAL SURVEILLANCE FOR SUSTAINABLE MANAGEMENT OF EMERGING CROP PESTS IN SAVANNA AGROECOSYSTEMS

NWODO Micheal Ifeanyi, https://orcid.org/0009-0006-5552-9798

Faculty of Agriculture, Department of Agricultural Extension, Forestry and Wildlife, Zamfara State University (ZAMSUT), Talata Mafara, Zamfara State, Nigeria
Corresponding e-mail:aderibigbemurianadr@gmail.com

This original abstract presents an ecological surveillance framework integrating agricultural extension, participatory monitoring, habitat assessment, field diagnostics and integrated pest management to improve early detection of invasive pests while reducing unnecessary pesticide use.

Multi-season field observations and comparative analyses demonstrated improved pest detection, greater conservation of beneficial organisms, enhanced farmer decision-making and reduced crop damage.

The findings indicate that extension-driven ecological surveillance offers a practical, scalable and environmentally sustainable strategy for strengthening plant protection under changing climatic conditions.

Keywords: plant protection; ecological surveillance; integrated pest management; agricultural extension; sustainable agriculture.

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IDENTIFICATION OF TECHNOLOGICAL SOLUTIONS TO ENSURE ABIOTIC FACTORS: COOLING, AIR HUMIDIFICATION, LIGHTING AND VENTILATION SYSTEMS USING AN ENGINEERING-TECHNOLOGICAL APPROACH

PISHCHANSKA Nonna[1]*, https://orcid.org/0000-0002-5337-4538
BELCHENKO Volodymyr[1], https://orcid.org/0000-0002-6117-6363
PODMAZKO Igor[1], https://orcid.org/0009-0002-9804-7116
PODMAZKO Oleksandr[2], https://orcid.org/0000-0001-8488-8606

[1]Engineering and Technology Institute "Biotechnics" National Academy of Agrarian Sciences of Ukraine
[2]Odesa National University of Technology
**Corresponding e-mail: pishchanskay@gmail.com*

Objective: To identify effective technological solutions for controlling abiotic environmental factors – temperature, humidity, lighting and ventilation – in industrial insect farming systems (entomocultures), with a focus on energy efficiency and economic viability.

Materials and methods: The study is based on an analysis of comprehensive, integrated, automated microclimate control systems comprising a central controller, environmental sensors, actuators and software, which provide real-time monitoring, automatic correction of deviations and the capability for remote control. An eight-stage engineering and technological algorithm for equipment selection was applied: 1) determination of microclimate requirements; 2) assessment of current conditions and constraints; 3) selection of technologies for each parameter; 4) energy audit (capacity, operating time, consumption, cost); 5) assessment of economic efficiency (initial costs, operating costs, maintenance); 6) comparison of alternatives; 7) integration and automation; 8) monitoring and optimisation.

A comparative analysis was carried out of renewable energy sources (solar, wind, bioenergy, hydropower, heat pumps and hydrogen) and the spectral characteristics of LED lighting with regard to their impact on the circadian rhythms, reproduction, behavioural activity and stress resistance of insects.

Results: The combination of heat pumps, LED lighting, heat-recovery ventilation and contact surface humidification has been identified as the most energy-

efficient configuration for industrial insect farming. Automated microclimate control reduces operating costs by 20-30 per cent and increases bioproductivity by 30-50 per cent. Stabilising microclimate parameters ensures a 20-40% increase in larval viability, a 20-30 % acceleration in development, a 15-25% increase in reproductive capacity when the photoperiod is maintained, and a 30-50% reduction in mortality. LED lighting consumes 5-10 times less energy than incandescent bulbs and offers an efficiency of 100-160 lm/W, compared with 70-90 lm/W for HPS lamps and 60-80 lm/W for fluorescent lamps. Among renewable energy sources, solar, wind and bioenergy best meet the criteria of safety, self-sufficiency and environmental friendliness for small and medium-sized insect farming operations.

Conclusions: The proposed engineering and technological method, which combines a structured algorithm for equipment selection, a comprehensive integrated automated control system and an energy-efficient equipment package (heat pumps + LED lighting + heat-recovery ventilation + contact humidification), enables the rational selection of process equipment, reduces operating costs, improves the stability of microclimate parameters and achieves energy savings without compromising the quality of the entomocultivation biological process.

Keywords: insect farming; microclimate; energy efficiency; automation; LED lighting.

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FORMATION OF ARUGULA PRODUCTION USING THE "LIVING FERTILIZER" BIO PREPARATION

POPOVYCH Halyna*, https://orcid.org/0000-0002-5300-3366
HLIUDZYK-SHEMOTA Marharyta, https://orcid.org/0000-0001-7937-6489
VAKERYCH Mykhailo, https://orcid.org/0000-0002-3268-7797

Uzhhorod National University, Uzhhorod, Ukraine
**Corresponding e-mail: halina.popovich@uzhnu.edu.ua*

In the technology of growing different varieties of arugula, the background of nutrition plays an important role, since this culture is green and has the ability to accumulate a large amount of nitrates. Currently, in the domestic literature, the problem of technological methods of growing arugula is of a fragmentary nature. In Ukraine, the issue of root feeding of arugula is poorly studied, which determines the relevance of our research. The purpose of the work was to study the effect of the biological preparation "Live Fertilizer" on the growth, development and formation of the crop of arugula.

The precocious variety Victoria, recommended for growing in open and closed soil conditions, was chosen as the material for research. For pre-sowing treatment of seeds and root feeding of plants, biological preparation "Live Fertilizer" with microorganisms for balanced nutrition was used. According to the manufacturer's recommendations of BTU-CENTER LLC, a 7% solution was used for pre-sowing seed treatment, and a 0.35% solution was prepared for root feeding. The dimensions and area of the leaf surface were measured, and the yield per 1 m^2 was determined.

It was established that the use of a biological preparation for feeding arugula had no effect on shortening the interphase periods of plant development. However, in the control version without the application of fertilizers, real leaves of slightly smaller sizes were formed in the plants, which ultimately led to the formation of a smaller assimilation surface of the plants. Thus, the largest area of the photosynthetic surface of plants in the phase of technical ripeness (79.4 cm^2) was in the variant where pre-sowing treatment of seeds in a solution of biological preparation was carried out. In the version with control, without the use of the drug, the difference was 23.5%. In terms of above-ground mass, plants grown with the use of a biological preparation dominated. The lowest yield was obtained on the control variant -

1.33 kg/m^2. The maximum increase in production is 30.8%, recorded on the option with pre-sowing seed treatment and subsequent root feeding (1.74 kg/m^2).

Thus, the use of the biological preparation “Living Earth” for the cultivation of arugula did not affect the reduction of the interphase periods of plant development, but had a positive effect on the formation of their assimilation surface, which increased by 25.3%-32.3% compared to the control. The yield of arugula within the experimental variants was 25.6-30.8% higher than the control.

Keywords: seed arugula, biopreparation, feeding, harvest.

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AGE AND SEXUAL STRUCTURE OF *Halyomorpha halys* POPULATION BASED ON PHEROMONE MONITORING IN MOLDOVA

RUSU Iuliana*, https://orcid.org/0000-0002-6551-0955
ZAVATIN Maria, https://orcid.org/0009-0001-2877-7757

Moldova State University, Institute of Genetics Physiology and Plant Protection, Chisinau, Republic of Moldova,
**Corresponding e-mail*: *iuliana.rusu@sti.usm.md*

Halyomorpha halys is a highly invasive polyphagous species that actively colonizes fruit, ornamental, and forest plantings. Despite the widespread use of pheromone traps for population monitoring, the features of the sexual and age structure of its population remain insufficiently studied, which limits the understanding of its demographic organization in newly colonized areas.

The study was conducted in agrocenoses and orchard plantations of IGFPP and the Botanical Garden. Standard pheromone traps baited with the aggregation pheromone of *H. halys* were used. Monitoring was carried out regularly throughout the vegetation period, recording the number of captured adults and nymphs, their sex, developmental stages, host plant species, and meteorological conditions. In total, 2619 individuals were analyzed.

The results of pheromone monitoring showed that nymphal stages dominated in the trap catches, indicating active development of the local population during the vegetation season. Among adults, a consistent predominance of females was recorded, which is typical for this type of aggregation pheromone trapping and may be associated with behavioral traits and feeding activity of sexually mature individuals.

The age structure of nymphs was characterized by the dominance of early instars, while later developmental stages were significantly less frequent. This distribution indicates continuous population reproduction and the presence of several overlapping generations during the season.

The most heavily infested crops were major fruit and woody plantings of the region, including apple, pear, grapevine, and representatives of the genus *Prunus*. These crops can be considered key elements supporting the development and persistence of the pest population in the region and form a spatially heterogeneous pattern of its distribution within the agro-landscape.

The obtained results are consistent with international studies, which report that aggregation pheromone traps often show a bias toward females and also capture a considerable number of immature stages during periods of high population density. Similar patterns have been reported in studies conducted in Europe, the United States, and East Asia, and are associated with behavioral responses to the aggregation pheromone and the population structure during periods of active reproduction.

It should be noted that such data have been obtained for the first time under the conditions of central Moldova, which allows pheromone-based monitoring to be considered not only as a tool for population abundance assessment but also as a method for evaluating the demographic structure of an invasive population. In addition, it has been established that pheromone monitoring reflects not only quantitative changes in the population but also its age–sex structure, which allows this approach to be used for indirect assessment of reproductive activity and developmental dynamics of *H. halys* in newly colonized areas.

Keywords: *Halyomorpha halys*, famel, male, nymphal stages, pheromone monitoring.

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ORGANIC CONTROL STRATEGIES USING MICROBIAL BIOPESTICIDES IN INTEGRATED PEST MANAGEMENT OF WALNUT ORCHARDS

STINGACI Aurelia[1,*], https://orcid.org/0000-0001-6621-9919
SCERBACOVA Tatiana[1], https://orcid.org/0000-0002-2632-325X
SÜTYEMEZ Mehmet[2], https://orcid.org/0000-0003-0417-6495
HARCIUC Oleg[1], https://orcid.org/0000-0003-3488-5321
STINGACI Grigorie[1], https://orcid.org/0009-0004-1914-5944

[1]Moldova State University, Institute of Genetics Physiology and Plant Protection, Chisinau, Republic of Moldova
[2] Kahramanmaraş Sütçü İmam University, Faculty of Agriculture, Department of Horticulture, Kahramanmaraş, Republic of Türkiye,
**Corresponding e-mail: aurelia.stingaci@sti.usm.md*

The decreasing number of approved synthetic plant protection products, together with the transition toward organic production, has substantially changed fruit-production practices in Europe. Crop protection in organic orchards is therefore increasingly challenging, especially because many modern cultivars have limited tolerance to pest pressure. These conditions highlight the need to integrate environmentally compatible biological tools into effective pest-management programmes.

Biopesticides based on the insecticidal proteins produced by *Bacillus thuringiensis* (Bt) are important components of integrated pest management (IPM). Among microbial bioinsecticides, *B. thuringiensis* var. *kurstaki* is particularly relevant because of its selective activity against lepidopteran larvae and its compatibility with sustainable crop-protection systems. Current research focuses on improving field performance, formulation stability, and practical adoption in commercial production.

The objective of this study was to assess the potential of *B. thuringiensis* var. *kurstaki* as a microbial bioinsecticide for sustainable walnut protection, with particular emphasis on its insecticidal activity, environmental compatibility, and practical role in IPM.

The study was conducted in a 12-year-old, 3-ha walnut orchard located in Malcoci, Republic of Moldova. The orchard was planted with the cultivars ”Franquette” and ”Fernor”, with ”Ronde de Montignac” used as a pollinizer. Treatments consist-

ing of a culture suspension of *B. thuringiensis* var. *kurstaki* were applied using a piloted drone. Pest populations were monitored with a digital trap equipped with a camera and optical sensors that automatically transmitted images of captured insects to an online analysis platform. This system enabled continuous monitoring, reduced the need for frequent field visits, and created a visual archive for subsequent species confirmation. Monitoring data showed three codling moth (*Cydia pomonella* L.) flight periods: the first during the first ten days of June, with an average of 10 males; the second during the second ten-day period of July, with an average of 16 males; and the third during the first ten days of september, with an average of 12 males. The wood leopard moth (*Zeuzera pyrina*) population was monitored using a species-specific pheromone lure, and two males were detected. Adults appeared from mid-June, did not feed, and had a short lifespan; oviposition continued until mid-August, with the greatest activity in the second half of July. The population was monitored using the *Zeuzera pyrina* pheromone lure; two males were detected. The pheromone-based system provided a cost-effective and environmentally compatible method for assessing pest risk and supporting decisions on the need for additional control measures. The results indicate that Bt-based treatments are most effective against the early larval instars of *C. pomonella* and *Z. pyrina*. Correctly timed applications at these stages can reduce pest population density before substantial damage develops in walnut orchards. The integration of *B. thuringiensis* var. *kurstaki*, drone-assisted application, and digital pheromone monitoring can support sustainable walnut protection within IPM systems.

Keywords: *Bacillus thuringiensis* var. *kurstaki*; *Cydia pomonella*; *Zeuzera pyrina*; walnut orchard; integrated pest management; digital monitoring; drone application.

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PROCESS ANALYTICAL TECHNOLOGY IMPLEMENTATION IN MICROBIAL PESTICIDE PRODUCTION

YAROSHEVSKY Vladislav*, https://orcid.org/0000-0002-1905-2092
YAROSHEVSKA Julia, https://orcid.org/0009-0003-6587-2678

Engineering and Technological Institute "Biotekhnika" of the National Academy of Agrarian Sciences of Ukraine
**Corresponding e-mail: wladscience@gmail.com*

Process Analytical Technology or PAT is a quality control system widely used in bioprocessing. Generally PAT focuses on pharmaceuticals production as the system that guaranty preparation quality from batch to batch on the basis of technological process control at different stages. However, current PAT applications are used for biological processes control in microbiological, food and chemical industry. It seems that some PAT approaches could be useful in microbial pesticide production for quality guarantying of the product – biopreparations.

The analysis of different scale microbial pesticide production was done for PAT tools implementation opportunities. System analysis methods such as SWOT analysis were used for this purpose.

Three logical elements were selected on the basis of system analysis general methodology for process quality evaluation of fermentation technology. They are an aim, an implementation strategy, and a result evaluation.

The aim of PAT using is microbial pesticides quality guaranty from batch to batch. Three main alternative implementation strategies can be distinguished:

– standard procedure compliance;

– certain number of process parameters maintaining within optimal, predetermined limits;

– adaptive regulation, based on direct or indirect measurements of parameters that characterize process variability caused by variations in microbial cultures, nutrient medium components, etc.

The results of each strategy as a rule are evaluated by separate methods. Sampling and further microbiological lab analysis (off-line methods) are used for standard procedure compliance quality evaluation. However, the results of such analyses are obtained after the finished product has been produced, which means it is

too late to respond operatively to any process changes. This method can be applied only for laboratory systems.

The second method is typical for small-scale production and pilot systems. A minimally sufficient level of automation for key technological operations ensures that they are carried out within predetermined optimal ranges of specific parameters (temperature, pH, dissolved oxygen, redox, conductivity, etc.). Quality control of the final product in such systems is carried out using express sample analysis made directly near the production line (at-line methods). However, rapid responding to specific deviations in culture growth also remains beyond the system's capabilities.

Adaptive real-time process parameter control is particularly useful in industrial systems where losses resulting from substandard products are greatest. Implementing this method requires a deep understanding of the interrelationships among parameters within the system.

As one can see three strategies combined with three quality evaluation methods described above predetermine microbial pesticide production at small (lab) scale, pilot-scale and industrial-scale. SWOT analysis of each production scale was made.

Lab-scale production strengths are implementation engineering simplicity, availability of technical specifications and requirements. The main weakness is absence of variability factors consideration. Processes investigation and production scaling are the main opportunities. The threats are touched with production losses and uncertain product quality until bioprocessing end.

Pilot-scale systems strengths are technical implementation relative simplicity, and main procedures control. The weakness of such production is limited parameters control does not guarantee the product quality from batch to batch. The main opportunity of such system is the certain production volumes achievement ability with moderate investment. Inability of products manufacturing of consistent quality is the main threat.

Finally industrial-scale production strength is connected with total process control. The weakness is uncertainty regarding the priority of the controlled parameters for product quality at different process stage. The opportunity of industrial-scale systems is results correction during the obtaining process of this result. A large amount of process data in the absence of a standard model for their organizing is the threat.

Thus, SWOT analysis showed that the greatest need of PAT tools implementation is in industrial-scale microbial pesticide production systems. However, this production scale is the most difficult for engineering and technological support of PAT. The lowest need of PAT tools is in lab-scale systems. Such systems as usual

equipped by different control devices as they generally used for researches but not for production. It seems that pilot-scale systems are the most suitable for PAT implementation into microbial pesticide production. They are widespread in this industry, and usually equipped by basical control systems. Thus, pilot-scale systems can be optimal for PAT principle adaptation for microbial pesticide production and models development for industrial-scale systems.

Keywords: PAT, microbial pesticides, production scale, SWOT analysis

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ENGINEERING SOLUTIONS FOR TEMPERATURE CONTROL SYSTEM OF BIOREACTOR FOR MICROBIAL PESTICIDES MANUFACTURING

YASYNSKYI Serhii*, https://orcid.org/0000-0003-4816-2386
YAROSHEVSKY Vladislav, https://orcid.org/0000-0002-1905-2092

Engineering and Technological Institute "Biotekhnika" of the National Academy of Agrarian Sciences of Ukraine
**Corresponding e-mail: yasinskiy20@ukr.net*

A topical issue for fermenter-sterilizers is the fast and effective cooling of the nutrient liquid medium after thermal sterilization. Simple chilling of medium in bioreactor vessel could take from several hours to a day corresponding to vessel volume. Forced cooling typically requires significant energy consumption.

This problem is particularly acute for pilot-scale bioreactors with a capacity of 100–500 l, which are the most common equipment used for the microbial pesticides manufacturing at small biofactories in Ukraine and other Eastern European countries. Such facilities usually do not have a separate heating and cooling system typical for microbiological industry. However, the volume of bioreactor's vessel requires the medium chilling with significant time losses even in combination with air cooling system in fermentation room, whilst passing tap water through the reactor jacket is extremely costly.

One way to solve this problem involves energy-efficient methods of liquid cooling by dry coolers. Such engineering solution was applied to optimize the temperature control system of the AF-0.170 self-contained bioreactor (ETI "Biotekhnika" NAAS) with 130 l working volume.

The AF-0.170 self-contained bioreactor is a fermenter-sterilizer with agitation and aeration systems. The bioreactor is equipped with a water jacket to ensure temperature control of the medium during thermal sterilization and the microorganism cultivation. There was a solution to use external cooling circuit with a dry cooler for bioreactor temperature control system optimization. The optimized temperature control system, in addition to the heat exchanger (the dry cooler) includes a wet-rotor pump and an automatic control system.

Calculations show that, compared to other methods of cooling of thermal sterilized medium, a dry cooler has a number of advantages:

– low operating costs;
– complete isolation of the system from the main bioreactor devices;
– heat recovery for fermentation room heating;
– the ability to use the system intermittently during the winter months;
– minimal support.

There was produced a prototype of cooling circuit with a capacity of 5 kW/h at ETI "Biotekhnika" NAAS. The cooling circuit control system is fully automated and features a separate control panel. Cooling of the medium after sterilization takes up to 6 hours to reach inoculation temperature (27–30 °C), which is 3–4 times faster than simple chilling in the reactor vessel. The cooling circuit can also be used while microorganism cultivation stage.

The optimized temperature control system of the self-contained bioreactor significantly reduces the duration of the pre-fermentation stage of microbial pesticides manufacturing and lowers operating costs.

Keywords: bioreactor, microbial pesticides, nutrient medium, dry cooler, temperature control

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Section C

Integrated Plant Protection Systems

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EVALUATION OF MEFENTRIFLUCONAZOLE 200 G/L AGAINST GRAPE POWDERY MILDEW (*Uncinula necator*)

ARMAȘU Svetlana*, https://orcid.org/0000-0001-6612-4733
DEGTEARI Vladimir, https://orcid.org/0000-0002-1156-9716
CEBANU Vitalie, https://orcid.org/0000-0003-3022-2432
TERTEAC Dumitru, https://orcid.org/0000-0001-7224-6606
MIDARI Andrian, https://orcid.org/0000-0001-6006-3829

National Institute of Applied Research in Agriculture and Veterinary Medicine, Chisinau, Republic of Moldova,
**Corresponding e-mail*: *armasu197612@gmail.com*

Purpose. The aim of the research is the comparative evaluation of the biological efficacy and determination of the optimal application rates of the fungicide Mefentrifluconazole, 200 g/l in controlling grape powdery mildew (*Uncinula necator* Burr.) under the conditions of the Republic of Moldova.

Materials and methods. The experiments were conducted in 2025 on the experimental plot of the Immunology and Horticultural Plant Protection Section, on the Sauvignon variety, on an area of 2,0 ha. The efficacy of the tested product (mefentrifluconazole 200 g/l) at application rates of 0,4-0,6 l/ha was evaluated in comparison with the untreated control and the standard variant (mefentrifluconazole 75 g/l – 1,5 l/ha). The treatments were carried out using the Agromehanika AGP-350 sprayer, with a spray volume of 600 l/ha, during the sensitive growth stages of the grapevine. The first treatment was applied at the „pre-flowering" stage - on June 3, and the second at the „post-bloom" stage – on June 18; the following two treatments were applied during the „berry growth" stage at 12 - 14 days intervals (on July 1 and July 12). The fifth treatment was applied at the „cluster compaction" stage on July 23. The last treatment (the fifth) was applied at the „berry softening" stage on August 9.

Results obtained Following the assessments carried out in the variants using the product mefentrifluconazole 200 g/l at rates of 0,4-0,6 l/ha, a significant reduction in the frequency and intensity of the attack was observed with increasing application rates. Thus, in the variant using the rate of 0,4 l/ha, the average attack frequency reached a level of 18,14% - 16,75% with an intensity of 4,76 – 4,41 on

leaves and berries, respectively. At the maximum application rate of the product, the attack frequency recorded values of 8,90 – 6,64 with an intensity of 2,31 – 1,68 on leaves and berries, respectively.

The biological efficacy of the product at the maximum application rate reached average values of 94,95% and 95,38%, being at the same level as the values recorded in the Standard variant (95,60% and 94,20%).

In the variant with the minimum application rate (0,4 l/ha) of the product mefentrifluconazole 200 g/l, biological efficacy values were recorded within the range of (89,40% - 87,80%) on leaves and berries, respectively, being significantly lower compared to the efficacy of the product at the maximum application rate (0,6 l/ha), a fact confirmed by the statistical analysis of the obtained data.

Conclusions. The fungicide Mefentrifluconazole, 200 g/l demonstrates high efficacy in controlling grape powdery mildew and is recommended for inclusion in disease control programs under the conditions of the Republic of Moldova, at an application rate of 0,6 l/ha.

Keywords: Mefentrifluconazole, *Uncinula necator* Burr., grapevine, biological efficacy, grapevine protection.

Acknowledgments. This research was carried out within the Institutional Program 200101 „Creation of fruit, viticultural and vegetable varieties and clones, improvement of agrotechnical cultivation practices and development of technologies for producing wines from local grape varieties and next-generation food products" for the years 2024-2027, funded by Ministry of Agriculture and Food Industry of the Republic of Moldova.

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EVALUATION OF PHEROMONE LURES IN WESTERN CORN ROOTWORM TRAPS

BOGACIOV Evghenii*, https://orcid.org/0009-0007-6467-3406
ERHAN Tatiana, https://orcid.org/0009-0008-2538-0368

Moldova State University, Institute of Genetics Physiology and Plant Protection, Chisinau, Republic of Moldova,
**Corresponding e-mail*: *bogaciov.evghenii.bogaciov@sti.usm.md*

Purpose. The western corn rootworm, *Diabrotica virgifera virgifera* LeConte, is an invasive quarantine pest that threatens maize production in the Republic of Moldova. This study aimed to determine its distribution and population density, assess the phytosanitary status of maize, and improve pheromone-based monitoring using naturally identical co-attractants.

Materials and methods. Field investigations were conducted from 3 July to 6 September 2025 in maize-growing areas of northern, central, and southern Moldova. Eleven sites covering 1,231 ha were examined by visual plant inspection and pheromone trapping. At Zaim, Causeni district, six traps baited with the standard synthetic sex pheromone (FSS) were installed in irrigated sweet and fodder maize. Lure attractiveness was evaluated at Dubasarii Vechi, Criuleni district, in a 680-ha maize field using four formulations in three replicates: FSS 1.5 mg (V1); FSS plus cinnamaldehyde 1 mg (V2); FSS plus cinnamaldehyde 5 mg (V3); and FSS plus indole 1 mg (V4), each containing an antioxidant. Traps were placed 20-30 m apart and checked every 7-10 days. Crop injury was assessed by soil and root inspection and by visual scoring of plant mortality and leaf damage.

Results. *D. virgifera virgifera* was detected in all surveyed regions. Population density ranged from 2.3 to 10.0 adults per plant, and seven of the eleven sites reached or exceeded the economic threshold of 5 adults per plant. The highest densities were recorded at Dubasarii Vechi (10.0 adults/plant) and Briceva, Donduseni district (7.2 adults/plant). At Zaim, sweet maize averaged 25.73 beetles per trap per assessment, corresponding to 5.15 adults per plant, whereas fodder maize remained below the threshold at 3.75 adults per plant. Flight activity peaked in mid-to-late August. Total male captures were 1,580, 2,060, 2,280, and 1,845 for V1-V4, respectively. Compared with the standard lure, V3 increased captures by 44.3%, while V2 and V4 increased captures by 30.4% and 16.8%, respectively. More severe crop damage was

observed in Dubasarii Vechi, with 540 affected plants/ha, moderate stand thinning, and severe leaf damage, compared with 80 affected plants/ha and lower injury at Zaim.

Conclusions. Western corn rootworm is widely established in Moldovan maize-growing areas and frequently reaches economically important densities. The FSS lure supplemented with 5 mg cinnamaldehyde provided the best monitoring performance and may improve early detection and the timing of integrated pest management. Continued surveillance, crop rotation, and targeted interventions during the August flight peak are recommended.

Keywords: western corn rootworm; maize; pheromone monitoring; cinnamaldehyde; integrated pest management.

Acknowledgments. The research was carried out within the Subprogram 011103 "Development of ecologically harmless means of reducing the impact of harmful organisms of agricultural crops against the background of climate change", funded by the Ministry of Education and Research of the Republic of Moldova.

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EXPERIENCE IN MODERNIZING STEAM STERILIZERS FOR THE CREATION OF BUBBLE BIOREACTORS

DOROVSKIKH Viktor, https://orcid.org/0009-0009-1432-2573,
DOLZHYKOVA Irina*, https://orcid.org/009-002-8197-858X

Engineering and Technological Institute "Biotechnika" of NAAS,
Khlebodarskoye village, Odessa region, Ukraine,
**Corresponding e-mail*: *dolirina85@ukr.net*

Purpose: To develop a bubble bioreactor for the production of microbial plant protection agents based on the VK-75-01 steam sterilizer.

Object of study. Technological processes for the production of biological preparations, technological processes for the sterilization of culture media, and control systems of the modernized unit based on the state parameters of the VK-75-01 as the control object.

Research methods. Calculation methodologies for heat and mass transfer equipment, methods for accounting for the spatial distribution of culture media and fermentation media parameters within the working chamber volume, experimental methods for process research on physical models, methods of correlation and regression analysis for assessing the quality of biological products, and methods for synthesizing optimal automatic control systems for state parameters.

Research results. Technical solutions were adopted for the external piping of the VK-75-01 steam sterilizer with shut-off and control valves. This allows the apparatus to carry out the processes of culture media (CM) sterilization and fermentation in the specified sequence, with the ability to control air and water flow rates and implement the sterilization formula for CM and fermentation media (FM).

For the technological scheme of the existing bubble bioreactor (BB), the use of subsystems for the preparation of sterilized air and water has provided grounds to consider it an autonomous technical system for the production of biological preparations based on the BB.

The Bubble Bioreactor Control System (BBCS) has been developed. It provides information on parameters such as media temperatures (CM, FM), air flow rate, water flow rate, the status of actuators, the water level in the BB jacket, and media pressure in the sterilization chamber and the jacket. The system also monitors the

progress of technological processes, specifically the reference points defined by the sterilization formulas for CM and fermentation (FM). The latter is reflected by a light mnemonic diagram on the front panel of the control console.

Conclusions:

1) The technical system based on the BB is a specialized instrument for studying fermentation processes. It has the capability to produce both inoculum (of a specified titer) and biological preparations in a volume of 60 dm^3 per cycle.

2) The properties of the technical system based on the BB allow for its application as a universal sterilizer for fermentation complexes of medium capacity.

Keywords: Bioreactor, bubbling, system, modernization, control.

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DETERMINATION OF β-CARYOPHYLLENE IN APPLE EXTRACT BY GC, USING A COMMERCIAL STANDARD

ERHAN Tatiana*, https://orcid.org/0009-0008-2538-0368
SMAGLII Vadim, https://orcid.org/0009-0009-9083-7966
ODOBESCU Vasilisa, https://orcid.org/0009-0006-6827-9126
JALBĂ Svetlana, https://orcid.org/0009-0007-9756-2059

Moldova State University, Institute of Genetics Physiology and Plant Protection, Chisinau, Republic of Moldova,
**Corresponding e-mail*: *igpppheromones@gmail.com*

β-Caryophyllene is a natural bicyclic sesquiterpene with the chemical formula $C_{15}H_{24}$, serving as a key volatile component in the aromatic profile of fruits, such as the peel and pulp of apples (*Malus domestica*). For pests like *Cydia pomonella*, this compound acts as a host-plant indicator, guiding them in feeding and oviposition processes, a property that makes it extremely valuable in the formulation of eco-friendly traps.

The purpose of this work consists in the optimization and application of a gas chromatography (GC) method for the quantitative determination of β-caryophyllene in apple extracts (*Golden Delicious*), specifically from the peel and pulp, using a commercial reference standard. The study aimed to validate the identity and concentration of this bioactive sesquiterpene to apply the method for dosing and monitoring its release from synthetic attractant traps used in the monitoring and trapping of the *Cydia pomonella* pest.

The apple peel and pulp extracts were prepared by hexane extraction, followed by filtration and vacuum concentration. Quantitative analysis of β-caryophyllene was performed by gas chromatography (GC, Agilent 8860 chromatograph), using a calibration curve based on an external commercial standard.

By optimizing the GC method, an excellent separation of β -caryophyllene was achieved, with the chromatographic peak being clearly defined, symmetric, and free from interferences from other matrix constituents. The identity of the compound in the extracts was confirmed by the perfect alignment of the retention time (t_R = 14.8 min) with that of the commercial reference standard.

The external calibration curve showed excellent linearity over the studied concentration range, with a statistical correlation coefficient R^2 = 0.99291.

The optimized GC method allowed the identification of a 238 mg/L concentration of β-caryophyllene in the studied apple extract. This value closely correlates with literature data (160–210 mg/L), slightly exceeding the reference range due to the efficiency of the applied extraction protocol.

The obtained results confirm the high application potential of this sesquiterpene-rich extract, which can be utilized for loading attractant traps against the *Cydia pomonella* pest.

Keywords: β-Caryophyllene, apple extract, gas cromatography, atractants, *Cydia pomonella*

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OPTIMIZATION OF CROP PROTECTION PROCESSES USING DRONE-TYPE TECHNOLOGICAL SYSTEMS

GORBAN Victor*, https://orcid.org/0000-0002-7944-2383
TODIRAS Vladimir, https://orcid.org/0009-0008-6766-5652
POPA Alexei, https://orcid.org/0009-0002-4965-6572

Moldova State University, Institute of Genetics Physiology and Plant Protection, Chisinau, Republic of Moldova,
**Corresponding e-mail: victor.gorban@sti.usm.md*

Currently, ecological agriculture involves improving existing crop protection systems. The trend towards reducing application rates for chemical plant protection products has stimulated the development of more effective non-chemical products. One of the priority areas is the use of biological plant protection methods based on new technological processes involving microbial products and beneficial biological agents.

Our scientific research aims to develop new technical solutions that will become an important element of modern, integrated plant protection technologies. This task has stimulated research into the potential use of technological devices such as small drone-type aircraft, to mechanize the transport of specialized equipment designed for distributing biorational products and releasing biological agents to combat crop diseases and pests. The main advantage of small drone-type flying devices lies in facilitating access to other technologies that enable both farmers and agricultural companies to cultivate larger areas and reduce their expenses.

In accordance with our research, two special devices were developed for distributing biorational preparations and launching biological agents to combat diseases and pests of agricultural crops. Following research, specialized equipment was selected, onto which devices designed for carrying out technological plant protection operations were mounted.

The first stage of the project involved the design and manufacture of the device in the form of a horizontal bar equipped with nozzles, suitable for the process of dispersing plant protection products. Preliminary testing of this device was conducted under laboratory conditions, followed by field experimental plots to determine optimal operating parameters, as well as the method for mounting and integrating it into the pumping system of the small drone-type aircraft.

The second stage was focused on developing the device for launching biological agents, specifically the *Trichogramma* parasitoid. The analysis of the preventive test results highlighted the need to improve the electrical operating circuit; implementing this modification enabled remote control within a 100-meter radius of the device attached to the small drone.

Drones retrofitted with additional devices serve as a means of transport for dispersing biorational and microbial preparations, as well as for launching utile insects within the framework of biological integrated plant protection methods.

Keywords: devices, biorational products, drone-type aircraft, biological agents, *Trichogramma*.

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POTATO LATE BLIGHT AND EARLY BLIGHT EPIDEMICS IN CURRENT CLIMATIC CONDITIONS FROM SOUTH EAST OF TRANSYLVANIA AND FUNGICIDE APPLICATION PROGRAMS

HERMEZIU Manuela*, https://orcid.org/0000-0002-2610-7039
HRISTEA (Adam) Lorena

National Institute of Research and Development for Potato and Sugar Beet Brașov, Brașov, Romania,
**Corresponding e-mail: manuela.hermeziu@potato.ro*

The present study aimed to compare epidemics and damage of both late blight and early blight of potato under current climatic specific conditions and fungicide application programs in south -east of Transylvania, Romania. An experiment was carried out between 2023-2024 in the experimental field from NIRDPSB Brasov, Romania to compare potato late blight (LB) (*Phytophthora infestans*) and early blight (EB) (*Alternaria* sp.) epidemics under current environmental conditions and fungicide application programs.

Lay out of the plots of the field trial: randomized complete block design with 4 replicates. Planting was made in 28th April 2023 and in 10 April 2024. Cultivation and maintenace was in line with current good agricultural practice. Potato cultivar: Darilena (Romanian potato variety), moderately susceptible to *Phytophthora*. First symptom observation: daily check for all plots after emergence till first sympotm observed in one of the plots. Trials relied on natural infection, late blight appeared in 2023, July 3rd and in 2024, June 4th and early blight in 2023, July 21st and in 2024, July 15th. The fungicides program included the following: V1: control (untreated) V2: Zorvec Endavia (oxathiapripolin+benthiavalicarb 0.4 l/ha), V3: Zetanil (cymoxanil + zoxamide 0.45 kg/ha), V4: Carial Star (mandipropamid + difenoconazol 0.6 l/ha) and V5: Banjo (fluazinam 0.4 l/ha).

The severity of LB and EB was assessed before each treatment, and the area under disease progress curve (AUDPC) was calculated for both diseases. The yield was quantified by weighing the tubers of all the plants from 2 central rows on each plot and yield data were converted into kg ha-1.

In 2023 growing season was warm but no so dry. The temperatures between May and August was higher on average by 1.8°C, compared to MAA and the rain-

falls in June and August exceeded the MAA as volume. In 2024, the summer months (June-August) recorded higher temperatures than the MAA. Also, the volume of precipitation was much lower in all three months.

ANOVA results indicated that the final late blight incidence was different ($P < 0.05$) among treatments. The maximum final percentage of disease incidence of 52.10%, were recorded by V1 (control), followed by 24.20% (V5), 22,14% (V4), 19,5%(V2) and 17.10% (V3), respectively.

Also for early blight ANOVA results indicated a maximum final percentage of disease incidence of 20.60%, were recorded by V1 (control), followed by 13.40% (V5), 12,5% (V2), 12.10% (V3), 9,12% (V4), respectively.

The severity of late blight was greater than that of early blight in both years, without affecting the yields obtained. Efficiency of diseases control was dependent on the spray timing and the number of fungicide applications. Use of forecasting systems as tools for managing potato foliar diseases is necessary for the rational and responsible application of fungicides.

Keywords: climatic conditions, early blight (EB), fungicides, late blight (LB), potato varieties

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ANALYSIS OF PHYTOSANITARY RISKS IN FIELD-GROWN TOMATOES UNDER NATURAL CYCLES OF MOISTURE DEFICIT AND EXCESS

IOSOB Gabriel-Alin*, https://orcid.org/0000-0002-8204-9814
ANTAL Andreea, https://orcid.org/0000-0001-9906-1003
CRISTEA Tina Oana, https://orcid.org/0000-0002-2511-8887
AMBĂRUȘ Silvica, https://orcid.org/0000-0002-9623-6602
BREZEANU Marian, https://orcid.org/0000-0002-1480-3360
BREZEANU Creola, https://orcid.org/0000-0002-3352-3081
BĂLĂIȚĂ Claudia, https://orcid.org/0009-0001-4730-1682
BENCHEA Carmina, https://orcid.org/0009-0002-5100-4127
CALARA Mariana, https://orcid.org/0000-0002-0989-5846
AVASILOAIEI Dan Ioan, https://orcid.org/0000-0003-3316-168X

Vegetable Research and Development Station Bacau, Bacău, Romania
**Corresponding e-mail: iosob.gabriel@gmail.com*

Current climate change, characterized by extreme and unpredictable weather phenomena, calls for a reassessment of plant protection strategies. This paper analyzes the dynamics of key pathogens affecting tomato crops (*Solanum lycopersicum*), namely *Phytophthora infestans* (late blight) and *Xanthomonas campestris pv. vesicatoria* (bacterial spot), under the influence of severe climatic fluctuations recorded in the Moldova region (VRDS Bacău) during the years 2024 and 2025.

Pathogen monitoring was conducted through periodic field observations at 10-day intervals, under conditions of natural infestation, and the degree of infestation (GA%) was calculated. Meteorological data (temperature, relative humidity, precipitation) were recorded using the iMmetos 3.3 weather station. The efficacy of certain biological products based on plant extracts (Mimoten, Funres) and copper compounds (Cuprick-L Green) was also evaluated in organic farming systems.

The results highlight a close correlation between rainfall patterns and the severity of the infestation. In 2024, a severe drought in August (0.3 mm of precipitation) followed by extreme rainfall in September (170.4 mm) created major water stress, subsequently favoring an outbreak of *Phytophthora infestans*, which peaked at 28.1% amid day/night temperature fluctuations and condensation. In 2025, rainy periods in July (up to 53 mm/decade) combined with 100% atmospheric humidity

led to an outbreak of late blight, with the incidence rate (GA%) reaching the critical threshold of 30%. *Xanthomonas campestris pv. vesicatoria* showed a maximum incidence of 15–18%, strictly dependent on warm (23–30°C) and humid periods. In terms of control, the Cuprick-L Green product (copper-based) demonstrated the highest efficacy (85–92%) in limiting both pathogens.

The study confirms that the alternation between atmospheric drought and episodes of heavy rainfall poses the greatest phytosanitary risk to field-grown tomato crops. It is recommended to adjust control strategies by applying copper-based treatments preventively immediately after heavy rains to prevent bacterial infections and to strictly monitor nighttime dew for the control of late blight.

Keywords: *Phytophthora infestans*, *Xanthomonas campestris pv. vesicatoria*, climatic stress, relative humidity, organic farming.

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SEPARATION OF CARYOPHYLLENE FROM CLOVE OIL AND ITS DETERMINATION BY GAS CHROMATOGRAPHY (GC-FID)

JALBA Svetlana*, https://orcid.org/0009-0007-9756-2059
ODOBESCU Vasilisa, https://orcid.org/0009-0006-6827-9126
ERHAN Tatiana, https://orcid.org/0009-0008-2538-0368
SMAGLII Vadim, https://orcid.org/0009-0009-9083-7966

Moldova State University, Institute of Genetics Physiology and Plant Protection, Chisinau, Republic of Moldova,
**Corresponding e-mail*: *svetlana.jalba@sti.usm.md*

Lobesia botrana - grapevine moth is widely recognized as one of the most destructive pests affecting grapevine yields and fruit quality. It is a well-known fact that insects are attracted to the volatile compounds of host plants - such as the grapevine - for purposes of feeding, reproduction, etc. One of these are blends of synthetic chemicals that mimic the natural scent of grapes or green leaves that attract insects for egg laying. Addition of this substances to sexual pheromones (which attract males exclusively), in traps for *Lobesia botrana* may increase capture efficiency, contributing to more efficient monitoring of this pest. Among the mixture of compounds found was caryophyllene. This natural compound is found in black pepper, cloves, cinnamon, rosemary, basil etc.

The objective was the extraction of clove oil, with quantitative determination via gas chromatography of caryophyllene, followed by its separation from the other compounds. The clove extract was obtained from cloves by maceration with hexane, followed by solvent evaporation. The cloves contain a large amount of eugenol which was washed away using a 2% basic solution. The organic part was separated and neutralized with an acid solution. A golden yellow oil was obtained with a yield of 2% relative to the amount of raw material used.

This was compared with a commercial caryophyllene standard on an Agilent 8860 chromatograph equipped with a non-polar capillary column. The chromatographic analysis shows that the extracted substance has the same retention time compared to commercial reference standard and appears as a well-defined and symmetrical peak at 14.8 min. Quantitative determination was performed using an external calibration curve with known concentrations of caryophyllene.

A concentration of 200 mg/L of caryophyllene was determined in the introduced sample, which was at the upper limit of the calibration curve, with excellent linearity - R^2 = 0.99291. The yield of caryophyllene obtained after separation from other compounds from clove oil being of 7%. The pure compound was added in mixed traps with the sex pheromone of *Lobesia botrana*, to determine whether a cumulative attraction effect exists in field tests compared to the standard pheromone

Keywords: *Lobesia botrana*, mixed traps, chromatographic analysis, caryophyllene, retention time.

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PRELIMINARY TESTING OF THE EFFECT OF ADDING ANALOGUES OF NATURAL COMPOUNDS TO CODLING MOTH PHEROMONE TRAPS

MUSLEH Mohammed*, https://orcid.org/0009-0005-1696-9398
ODOBESCU Vasilisa, https://orcid.org/0009-0006-6827-9126
ERHAN Tatiana, https://orcid.org/0009-0008-2538-0368
JALBĂ Svetlana https://orcid.org/0009-0007-9756-2059

Moldova State University, Institute of Genetics Physiology and Plant Protection, Chisinau, Republic of Moldova,
**Corresponding e-mail: mohammed.musleh@sti.usm.md*

The codling moth (*Cydia pomonella* L.) is an invasive pest of fruit trees, particularly apple trees, causing significant harvest damage. One widely used, environmentally friendly method for monitoring pest populations is the use of pheromone traps. Attractiveness of pheromone traps can be enhanced by adding attractants to the synthetic sex pheromone used. The attractants selected for the research were synthetic analogues of volatile compounds specific to apple fruit, which serve to attract insects to the host plant.

Our research involves testing the compositions at different dosages. Primarily, our goal was to test pheromone traps supplemented with these attractants at a dosage of 1 mg.

The field trials were conducted in an apple orchard in central Moldova, during the summer of 2025. Specimens of *Cydia pomonella* L. were found in the standard pheromone traps in the orchard. Initially, five experimental variants were prepared (in three replicates): a control variant (the codling moth's main pheromone) and four variants with the addition of volatile compounds of terpenic origin, under abbreviated names (CAR, MYR, TER, and LIN) to main pheromone, at a dosage of 1 mg. Trap catches were monitored regularly (every three days), and the number of male moths captured in each trap was recorded. The average catch per trap was calculated. Throughout the growing season, varying numbers of pests were captured in traps baited with attractants. Regarding the variants with additives, 20 males were captured on the TER- combined traps, 38 males on the CAR-combined traps, 41 males on the LIN-combined traps, and 70 males on the MYR-combined traps, compared to the trap with the standard sex pheromone, which caught 66 males. The catch results

indicated that all additives attracted males poorly at this low dosage, with the exception of the MYR-combined traps; the latter yielded a higher catch than the control with 6%, although the difference was not statistically significant.

The results obtained represent only the beginning of an experiment, and further research involving variations in the dosage applied to the dispenser is required to evaluate the correlation with trap capture efficiency.

Keywords: monitoring, mixed traps, pheromone traps, attractants, apple orchard

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CONCEPTUAL FOUNDATIONS OF THE ENVIRONMENTAL SSESSMENT OF CHEMICAL PROTECTION OF AGRICULTURAL CROPS

PANCHENKO Tetyana, https://orcid.org/0000-0002-2860-6464
CHERVYAKOVA Larysa, https://orcid.org/0000-0002-2311-9237
TSURKAN Olesya, https://orcid.org/0000-0003-3370-5229

Institute of Plant Protection of NAAS, Kyiv, Ukraine
Corresponding e-mail: lac_ipp@ukr.net

The rational use of plant protection products (PPPs) is one of the key components of sustainable agriculture that is, the creation of resilient and productive agrocenoses that prevents environmental pollution. The deterioration of the phytosanitary situation in recent years, linked to climate change, is leading to the transformation of agrocenoses, a shift in the species composition of dominant pest complexes, increased crop losses, and more acute problems with chemical control and, consequently, to an increase in the potential environmental risks associated with pesticide use.

In Ukraine, the issue of environmental risk assessment is considered in the context of environmental safety, where an important scientific task is the environmental assessment of pesticides (environmental hazards and risks associated with their use) in order to predict, prevent, and reduce their negative impact on the environment and human health in the context of achieving the Sustainable Development Goals. Safety issues are effectively addressed through the rational use of pesticides based on environmental assessments to develop a portfolio of new active ingredients; selecting the optimal, economically viable, and environmentally sound option for chemical protection for each crop under specific growing conditions and phytosanitary status; ensuring a stable supply of high-quality agricultural products as a fundamental factor in food security; and protecting the environment. Therefore, the goal of such research is to create a methodological framework for the chemical-analytical and ecotoxicological monitoring of pesticides in agrocenoses, to establish a system of criteria for their rational and environmentally safe use to protect agricultural crops from harmful organisms; to identify the environmental hazards and risks associated with the use of pesticides in agricultural technologies (based on a system of informative and representative criteria).

A multilevel conceptual system of criteria for assessing the environmental risks of pesticide use in crop cultivation technologies has been developed, with the following key indicators:

- toxicological and hygienic (LD_{50}) and ecotoxicological (T_{50}) aspects of pesticide use;
- the integrated hazard level (Cn) and the weighted average potential hazard level (Q);
- the territory's tolerance based on the self-purification index (Izon), which is closely linked to the HTC and climate change and reflects the intensity of pesticide degradation in a specific soil-climate zone (in Ukraine, ranging from 0.23 - very weak to 0.8 - intense);
- seasonal pesticide load (H, kg/ha);
- the environmental risk of chemical pest control (AETI—agroecotoxicological index), which ranges from 0 to 10 and serves as a key environmental criterion in the concept of integrated crop protection against harmful organisms, allowing the risk of pesticide use to be determined as early as the planning stage.

Such scientifically grounded methodological approaches to assessing environmental risks and the established environmental indicators allow for a comprehensive evaluation of the environmental safety and environmental risk associated with pesticide use in crop cultivation technologies, which serves as the basis for developing environmentally oriented zonal systems for crop protection.

Keywords: pesticides, environmental assessment, agroecotoxicological index

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AGROBIOLOGICAL FEATURES OF COMMON BEAN PRODUCTIVITY FORMATION IN THE RIGHT-BANK FOREST-STEPPE OF UKRAINE

REMENIUK Svitlana*, https://orcid.org/0000-0002-4407-4293
VITIUK Oleksandr, https://orcid.org/0009-0003-9373-5478

National Academy of Agrarian Sciences of Ukraine, Institute of Bioenergy Crops and Sugar Beet, Kyiv, Ukraine,
**Corresponding e-mail: svetlana19862010@ukr.net*

Common bean (*Phaseolus vulgaris* L.) is a valuable grain legume crop with a high seed protein content, the ability to perform symbiotic nitrogen fixation, and a positive effect on soil fertility. However, its productivity depends considerably on varietal characteristics, growing conditions, the activity of bean–rhizobial symbiosis, and weed infestation. Due to slow initial growth and delayed canopy closure, common bean is poorly competitive with weeds. Therefore, the optimization of biological and chemical elements of its cultivation technology is essential for obtaining stable yields.

The aim of the study was to determine the agrobiological features of growth, development, and productivity formation of common bean varieties depending on seed inoculation and selective herbicide application under the conditions of the Right-Bank Forest-Steppe of Ukraine.

Field experiments were conducted in 2025 at the State Enterprise Experimental Farm "Salyvonkivske" of the Institute of Bioenergy Crops and Sugar Beet of the National Academy of Agrarian Sciences of Ukraine, Bila Tserkva District, Kyiv Region. The soil was a deep medium-loamy chernozem containing 2.60% humus, 178 mg/kg of alkaline-hydrolysable nitrogen, 165 mg/kg of available phosphorus, and 96 mg/kg of exchangeable potassium, with a salt-extract pH of 6.76. The common bean varieties Bilosnizhka and Lastivka were studied. Seed treatments included no inoculation, Legume Fix at 225–250 g per hectare seed rate, and Bioinoculant-BTU at 2 kg/t. Weed control treatments included an untreated control, the soil-applied herbicide Gesagard 500 FW, SC at 3.0 L/ha, and the post-emergence herbicide Corum at 1.25–2.0 L/ha combined with the surfactant Metolat at 1.0 L/ha. The experiment was arranged in three replications with randomized treatment placement. Plant growth, leaf area, nodulation, weed infestation, yield components, and seed yield were determined.

Growth intensity, leaf area formation, nodulation, and seed productivity depended on varietal characteristics, seed inoculation, and weed control. In the untreated control without inoculation, the height and maximum leaf area of Bilosnizhka plants were 37 cm and 33.2 thousand m²/ha, respectively. With Bioinoculant-BTU combined with Corum and Metolat, these parameters increased to 59 cm and 49.1 thousand m²/ha. In Lastivka, plant height increased from 33 to 58 cm and leaf area from 35.1 to 49.7 thousand m²/ha. Lastivka generally formed a larger assimilating surface than Bilosnizhka.

Seed inoculation substantially enhanced bean–rhizobial symbiosis. With Bioinoculant-BTU, the number of nodules increased from 4 to 23 per plant in Bilosnizhka and from 2 to 25 per plant in Lastivka. Their weight increased from 72 to 415 mg per plant and from 36 to 452 mg per plant, respectively. The proportion of active nodules reached 78% in Bilosnizhka and 84% in Lastivka, indicating more intensive symbiotic nitrogen fixation in the latter variety.

More than 25 weed species belonging to 10 botanical families were identified. Dicotyledonous weeds accounted for 77.8% of the weed community. The predominant species were *Amaranthus retroflexus* L., *Chenopodium album* L., *Polygonum convolvulus* L., *Echinochloa crus-galli* (L.) P. Beauv., and *Setaria* spp. In untreated plots, weed density reached 138–141 plants/m², resulting in yield losses of 85–90%.

The highest seed yields were obtained after inoculation with Bioinoculant-BTU combined with Corum and Metolat. Bilosnizhka produced 1.9 t/ha, exceeding the control by 1.66 t/ha, while Lastivka produced 2.3 t/ha, exceeding the control by 2.08 t/ha and Bilosnizhka by 21%.

Thus, common bean productivity is determined by the interaction of varietal characteristics, symbiotic nitrogen fixation, and weed control. The most effective technological combination was seed inoculation with Bioinoculant-BTU followed by the application of Corum with Metolat, which enhanced growth, nodulation, photosynthetic activity, and seed yield of both varieties.

Keywords: common bean, seed inoculation, herbicides, weed infestation, leaf area.

Acknowledgments. This research was conducted within the framework of Project "Scientific Principles of Common Bean Productivity Formation under Environmentally Friendly Methods of Weed Control" (State Registration No. 0126U000153), funded by the National Academy of Agrarian Sciences of Ukraine.

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THE APPLICATION OF GLOK, WDG HERBICIDE AS A KEY COMPONENT OF INTEGRATED WEED MANAGEMENT IN TRITICALE CROPS

ROTARU Vladimir, https://orcid.org/0000-0001-6554-682X

Moldova State University, Institute of Genetics Physiology and Plant Protection, Chisinau, Republic of Moldova,
Corresponding e-mail: *vladimir.rotaru@sti.usm.md*

Purpose. Currently, significant areas of triticale are planted following grain corn and sunflowers. Planting triticale after late cover crops, along with reduced tillage depth, contributes significantly to weed infestation in the crops, particularly with annual and perennial dicotyledonous weeds. The main method for controlling perennial weeds in fall cereal crops is the chemical method of the application of selective herbicides. The purpose of the present study was to evaluate the biological efficacy of the new herbicide Glok, WDG in controlling annual and perennial dicotyledonous weeds in triticale crops.

Materials and methods. Field trial to determine the biological efficacy of the herbicide Glok; WDG were conducted following the standard method for testing herbicides in crop fields. The experiment was set up in 3 replicates with plot areas of 22 m² on the experimental field of the Institute of Genetics, Physiology and Plant Protection, MSU. The triticale crop (Ingen 40 variety) was grown following a sunflower crop. The experimental treatments were as follows: 1. Control (no herbicide application), 2. Standard herbicide Omnera at 1 L/ha, 3. Herbicide Glok, WDG at 30 g/ha + Satelit at 200 g/ha and 4. Herbicide Glok, WDG at 40 g/ha + Satelit at 200 g/ha. The application of the herbicide products was done in tillering stage of the crop (BBCH 21-29) with spraying solution 250L per hectare. Two evidences of annual and perennial dicotyledonous weeds in triticale crop were performed. Evidences of weeds across variants and biological efficiency were performed according to methods accepted in the literature of speciality.

Results. In the treatments group where the study product was applied at the low dose (30 g/ha), weed control reached 81% at the time prior to harvest. The number of dicotyledonous weeds decreased more markedly in the variant where Glok, WDG was applied at a higher dose (40 g/ha), where a weed control level of 83.6% was recorded. The species most sensitive to the herbicide's toxic action were black night-

shade and wild mustard, which was controlled at a rate of 100% in all experimental variants with the application of herbicide Glok, WDG. The ragweed species were controlled at rates of 82.6% (30 g/ha) and 87.0% (40 g/ha) at the second survey, the number of weeds in the control plot increased to 96 per square meter. In the standard treatment, this index was 24 weeds per square meter, while in the Glok, WDG treatments at doses of 30 g/ha and 40 g/ha, respectively, the number of weeds decreased to quantity of 23 and 19 weeds per square meter.

Conclusions

1. The results of the research demonstrated that the tested herbicide Glok, WDG showed high biological efficacy in controlling annual and perennial dicotyledonous weeds in triticale crops.

2. The application of the herbicide Glok, WDG in triticale crops ensured 83.6% biological efficacy in weed control and contributed to the complete eradication of black nightshade and wild mustard.

3. No phytotoxic effects were detected in treatments with the herbicide Glok, WDG on triticale plants.

Keywords: herbicide, Glok, WDG, weed control, triticale.

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MAGNESIUM NITRATE AND TRINEXAPAC-ETHYL IN THE DEVELOPMENT OF WINTER WHEAT YIELD

SCHWARTAU Victor[1], https://orcid.org/0000-0001-7402-5559
MYKHALSKA Liudmyla[1], https://orcid.org/0000-0002-0677-5574
MAKOVEYCHUK Tetyana[1,*], https://orcid.org/0000-0001-6950-0239
TRETIAKOV Vadym[1], https://orcid.org/0000-0002-1047-095X
ZOZYLYA Olexandr[2], https://orcid.org/0000-0003-3500-3423

[1]Institute of Plant Physiology and Genetics of the NAS of Ukraine
[2]Syngenta Ukraine
**Corresponding e-mail: makoveyt@ukr.net*

The yield of winter wheat is largely determined by the efficiency of the photosynthetic apparatus and the availability of mineral nutrients to the plants. Pigment content and the nitrogen balance index (NBI)/nitrogen flavonol index (NFI) are important indicators of a plant's physiological status, characterising the intensity of photosynthetic processes, nitrogen status, and the level of adaptation to stress factors. This study investigated the impact of foliar application of magnesium nitrate with trinexapac-ethyl on the levels of photosynthetic and protective pigments, the NBI/NFI, and winter wheat (*Triticum aestivum* L.) yield of the Kyivska 19 variety. Field experiments were conducted from 2023 to 2025. The plants were treated once at the BBCH 37–39 stage with either magnesium nitrate (5.0 kg/ha) or trinexapac-ethyl (0.6 L/ha), separately or in combination. SPAD values, as well as chlorophyll content index (CCI), flavonols and anthocyanins content, and the NBI/NFI, were determined in the flag and subflag leaves using SPAD-502 (Konica Minolta) and MPM-100 (Opti-Sciences).

The highest SPAD values in the subflag leaf were obtained through the combined application of magnesium nitrate and trinexapac-ethyl. This indicates that the photosynthetic apparatus remained functional during the grain-filling period. Foliar application of magnesium nitrate reduced flavonoid content; however, its combination with trinexapac-ethyl resulted in an even more pronounced decrease, accompanied by an increase in the NBI/NFI. These results suggest improved nitrogen status in the plants, more efficient utilisation of magnesium in photosynthetic processes and reduced need for defensive phenolic compound accumulation, provided the plants' physiological condition is optimised. Winter wheat yield was highest when

magnesium nitrate was applied either alone or in combination with trinexapac-ethyl. This increase in yield was accompanied by maintained high chlorophyll content, improved nitrogen status indicators, and the photosynthetic apparatus functioning for longer during the grain-filling stage.

Thus, applying magnesium nitrate with trinexapac-ethyl increases the content of photosynthetic pigments and improves the nitrogen balance index/nitrogen flavonol index, ensuring higher yields and confirming the potential of this approach in modern grain crop cultivation technologies.

Keywords: *Triticum aestivum*, nutrition, PGR, pigments, crop yield.

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PLANT HEALTH MANAGEMENT

SCHWARTAU Victor[1, 2]*, https://orcid.org/0000-0001-7402-5559
ZOZYLYA Olexandr[3], https://orcid.org/0000-0003-3500-3423

[1]Institute of Plant Physiology and Genetics of the NAS of Ukraine
[2]Institute for Evolutionary Ecology of the NAS of Ukraine
[3]Syngenta
**Corresponding e-mail: victorschwartau@gmail.com*

"Plant Health" is now an integrative paradigm, similar to the concepts of "Soil Health" and "Human Health". The evolution of integrated pest management (IPM) into the concept of Plant Health is a logical step in the development of phytosanitary science and practice, prompted by the numerous global challenges currently facing modern agriculture. This shift in focus reflects a fundamental change in approach, moving from the reactive control of harmful organisms to the proactive management of agroecosystem health. The FAO and WHO have officially incorporated Plant Health into the One Health Action Plan. The One Health concept recognises the interconnectedness of human, animal, plant and environmental health, with the health of agro-plant communities forming the cornerstone of stable crop production, food security and public health.

The Plant Health concept forms the basis of the "Farm to Fork" and "Green Deal" strategies, which currently advocate optimising pesticide use through decision support systems (DSS) and artificial intelligence (AI), transitioning to the precise application of plant protection products, minimising the environmental impact of pesticides and optimising protection systems. Finding the right balance among the appropriateness and effectiveness of pesticide use, its environmental impact, and the emergence of resistant biotypes of harmful organisms is key to creating high-quality food chains with low levels of pesticide residues and mycotoxins. Reducing excessive mineral fertiliser application and mitigating physiological stress in plants optimises nitrogen metabolism, reduces free asparagine accumulation in wheat grain, and decreases the content of the carcinogen acrylamide in final baked goods. Plant Health Management combines the principles of integrated pest management, biological control, environmental monitoring, digital solutions, AI, and sustainable agriculture. It is the foundational paradigm of 21st-century agricultural science and the cornerstone of food security. Implementing precision technologies for non-destructive testing is particularly important, including the use of portable spectrometers and

the analysis of spectral reflectance indices (such as MCARI, LCI, and GNDVI), as well as machine learning algorithms. This approach enables the selective detection of changes in ion and water status, as well as the early stages of pathogen development. It enables rapid assessment of nitrogen status, pigment content, and physiological stress levels in field crops, as well as identification of specific diseases and other factors.

Plant Health is a path already chosen by the world's leading countries. It is crucial that Ukraine does not remain on the sidelines of this transformation, but instead becomes an active participant and co-creator, leveraging its potential to develop sustainable, innovative, and competitive 21st-century agriculture.

Keywords: One Health Action Plan; Plant Health; Integrated Pest Management (IPM); Sustainable Agriculture; Food Security.

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BIOECOLOGICAL FEATURES OF *Lobesia botrana* Schiff. DEVELOPMENT AND THE EFFICACY OF MODERN INSECTICIDES IN VINEYARDS OF THE SEMI-ARID REGION OF UKRAINE

SHMATKOVSKA Katerina[1,*], https://orcid.org/0000-0002-3884-7595
SHTIRBU Andrii[2], https://orcid.org/0000-0003-4072-5826

[1]Quarantine station of grape and fruit cultures of Institute of plant protection of NAAS, Odesa; Ukraine
[2]National Scientific Centre "V.Ye. Tairov Institute of Viticulture and Winemaking", Tairove; Odesa Region; Ukraine
**Corresponding e-mail*: *k.shmatkovskaia@gmail.com*

To study the bioecological features of the development of *Lobesia botrana* Schiff. under the conditions of the Semi-Arid Region of Ukraine, determine its population dynamics, and evaluate the efficacy of modern insecticides in vineyard protection systems.

The research was conducted during 2021–2025 in vineyards of Odesa Region, Ukraine. Adult moth flights were monitored using pheromone traps (5 traps per hectare). Counts were performed daily before the peak flight period and every three days thereafter. The level of damage to inflorescences and grape clusters was assessed by examining 100 inflorescences/clusters at 3–5 sampling points. The following insecticides were tested: spinetoram (0.2–0.3 L/ha), emamectin benzoate (5 SG, 0.3–0.4 kg/ha), thiamethoxam + chlorantraniliprole (300 SC, 0.3–0.5 L/ha), and deltamethrin (EC, 0.5 L/ha) as the reference standard.

The European grapevine moth develops in three generations per year. During 2021–2025, its bioecological characteristics varied considerably. In 2021, the first-generation flight period was the longest (45 days), associated with a moderately warm spring and gradual temperature increase. In 2022–2023, the first-generation flight began on April 20–25, the second generation on June 25–29, and the third generation on August 5–10. In 2024, the earliest first-generation flight was recorded on April 10 due to elevated average daily temperatures. In 2025, the first generation was less abundant than in previous years.

Overall, the onset of first-generation flight ranged from April 10 to May 1, the second generation from June 17 to 29, and the third generation from July 30 to

August 10. Adult flight duration varied from 14 to 45 days. Oviposition began 3–5 days after the start of flight. Larval emergence of the first generation occurred from April 22 to May 15, the second generation during the first half of July, and the third generation in August. Pupation took place in the second ten-day period of May (first generation), the third ten-day period of July (second generation), and from late August to early September (third generation).

Average seasonal damage in 2024 reached 13.4% of inflorescences and 6.0% of grape clusters. During 2023–2025, spinetoram demonstrated the highest biological efficacy: 95.0% (2023), 90.1% (2024), and 85.0% (2025). Products based on emamectin benzoate and thiamethoxam + chlorantraniliprole also showed higher efficacy than the pyrethroid standard deltamethrin.

The European grapevine moth remains one of the most harmful vineyard pests in the Semi-Arid Region of Ukraine due to its high ecological plasticity and adaptability to climate change. Modern insecticides based on spinosyns, avermectins, and anthranilamides (spinetoram, emamectin benzoate, and thiamethoxam + chlorantraniliprole) provide high efficacy (85–95%) and can be successfully integrated into vineyard protection programs. The obtained results allow optimization of control measures based on pheromone monitoring data.

Keywords: *Lobesia botrana*, grapevine moth, vineyards, bioecology, insecticide efficacy

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GC APPLICATION FOR β-CARYOPHYLLENE QUANTITATIVE ANALYSIS

SMAGLII Vadim, https://orcid.org/0009-0009-9083-7966

Moldova State University, Institute of Genetics Physiology and Plant Protection, Chisinau, Republic of Moldova,
Corresponding e-mail: *vadim.smaglii@sti.usm.md*

Aim of the study: It is widely known that insect pests are attracted not only by sex pheromones, but also by the odor of volatile compounds emitted by different plant parts. One of the classes of such compounds are terpene hydrocarbons, which have a specific smell and aroma.

The content of one of the terpenes, namely β-caryophyllene, was determined in extracts from three different plant species. To achieve this goal, a powerful analytical instrument — the Agilent 8860 gas chromatograph — was used. Quantitative determination was performed using the external standard calibration method with construction of a calibration curve.

Subsequently, the obtained plant extracts were added as attractants to enhance pest capture using pheromone traps.

Materials and methods: to achieve the stated objective, the continuous solid-liquid extraction method was employed using a Soxhlet apparatus. This technique combines dissolution and repeated washing with hot solvent, ensuring a high extraction efficiency with economical reagent consumption. Since the target terpenes are non-polar compounds (containing only carbon and hydrogen atoms), hexane was selected as the extraction solvent.

It should be noted that the content of β-caryophyllene remains unchanged in both concentrated and diluted extracts. The following plant materials were used for extraction: clove *(Syzygium aromaticum)*, dried apples *(Malus domestica)*, and dried hops *(Humulus lupulus).*

For the construction of the calibration curve, a commercial standard of β-caryophyllene (Sigma-Aldrich) was used. A stock solution was prepared in hexane at a concentration of 9 mg/mL. From this, five solutions with known concentrations ranging from 0.09 to 1.8 mg/mL of caryophyllene in hexane were prepared.

The injection of these five standard solutions for analysis using the Agilent 8860 gas chromatograph was performed on the same day. This was necessary to pre-

vent degradation of the solutions, since terpenes contain double bonds and are prone to polymerization and photodegradation under sunlight.

Using the specialized OpenLab CDS software, the retention time of β-caryophyllene was determined to be 14.8 minutes. The cycle time was 22 minutes. Subsequently, the Data Analysis program was used to construct a calibration curve for the analysis of plant extracts. The data processing method was saved.

Results: the peak heights of β-caryophyllene (FID detector response, in picoamperes) were recorded. The correlation coefficient was $R^2 = 0.98435$. Based on these data, a calibration curve of peak area versus concentration was constructed. It should be noted that the shape of the calibration curve is not necessarily linear — this parameter is adjustable in the data processing software.

Subsequently, this data processing method was applied to the plant extracts, and the quantitative content of β-caryophyllene was determined in each of the samples.

Conclusions: The highest content of β-caryophyllene was found in apple extract — 238 mg/L, followed by clove extract — 195 mg/L, while the lowest was in hop extract — 20 mg/L (in this sample, caryophyllene is not the major component). The low content of β-caryophyllene in the hop extract can be attributed to the fact that the extract was diluted, and the hexane was not removed by simple distillation.

A similar approach, with appropriate modifications, can be applied for the analysis of other essential oil components in plant extracts.

Keywords: GC analysis, terpenes, plant extracts, external standard calibration, β-caryophyllene

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INTEGRATED PEST CONTROL METHODS FOR ORGANIC AUTUMN PEAS IN THE CONDITIONS OF THE MOARA DOMNEASCĂ EXPERIMENTAL STATION, ILFOV COUNTY

TOADER Maria[1,*], https://orcid.org/0000-0001-9390-7303
ION Viorel[1], https://orcid.org/0009-0004-3576-0074
EPURE Lenuța Iuliana[1], https://orcid.org/0009-0004-1056-398X
BĂȘA Adrian Gheorghe[1], https://orcid.org/0000-0002-9490-7601
GEORGESCU Emil[2], https://orcid.org/0000-0001-5849-8241
VASILE Mihaela Valentina[1], https://orcid.org/0000-0003-3326-9551
IONESCU Alina Maria[1], https://orcid.org/0000-0002-8445-2228

[1]University of Agronomic Sciences and Veterinary Medicine of Bucharest, Romania
[2]National Agricultural Research and Development Institute Fundulea, Romania
**Corresponding e-mail: maria.toader@agro-bucuresti.ro*

The experiment with organic peas (Frozen variety) at the Moara Domneasca teaching and research station of University of Agronomic Sciences and Veterinary Medicine of Bucharest, Ilfov County, Romania, was carried out within the Agroecological Living Laboratory developed in Romania through the project "SUNRISE - Supporting the Agroecological Transition through a Network of Living Labs" (Agroecology Partnership). The aim of this project is to identify, test and implement practical solutions to the main challenges in agriculture, such as soil health, crop diversification, reducing the use of agricultural inputs, optimizing plant and animal production, biocontrol of harmful organisms, preserving biodiversity and valorizing ecosystem services.

The main damaging agents of pea crop were: anthracnose (*Asccochyta pisi*); powdery mildew (*Erysiphe pisi*); weevil (*Bruchus pisorum*); pea pod moth (*Cydia nigricana*). These can cause crop losses through the appearance of various symptoms, such as spots on leaves and pods, deformations, rotting, stopping plant growth and development, abortion of flowers and pods, consumption of seeds in the milk-wax stage by insect larvae and a drastic decrease in quantitative and qualitative production.

The application of the insecto-fungicide Bioproteckt at a dose of 0.5 L/ha with the insecticide Nemmex, at a dose of 1L/ha, was carried out when the economic

damage threshold of 5% of *Erysiphe pisi*; 10-15% for *Asccochyta pisi*; 5 larvae of *Cydia nigricana* and 2 insects/m^2 of *Bruchus pisorum* was observed.

The preventive measures applied, as crops rotation, certified seeds, soil tillage, optimal density and the effectiveness of the biopesticides treatment of over 90% led to an average production of organic peas of about 2000 kg/ha in the conditions of Moara Domneasca, Ilfov County.

Keywords: Agroecology Living Laboratory, Integrated Pest Control, organic autumn pea, organic production.

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INTEGRATED PEST MANAGEMENT (IPM) STRATEGIES OF MAIZE CROP IN ROMANIA

TOADER Maria[1,*], https://orcid.org/0000-0001-9390-7303
ION Viorel[1], https://orcid.org/0009-0004-3576-0074
RADU Cristina[2], https://orcid.org/0000-0002-6154-5552
CIONGA Cristina[2], https://orcid.org/0000-0001-6665-6705
GEORGESCU Emil[2], https://orcid.org/0000-0001-5849-8241
VASILE Mihaela Valentina[1], https://orcid.org/0000-0003-3326-9551
IONESCU Alina Maria[1], https://orcid.org/0000-0002-8445-2228

[1]University of Agronomic Sciences and Veterinary Medicine of Bucharest, Romania
[2]Forum of Professional Farmers and Processors from Romania (FAPPR), Romania
[3]National Agricultural Reasearch and Development Institute Fundulea, Romania
**Corresponding e-mail: maria.toader@agro-bucuresti.ro*

Reducing the use of synthetic pesticides for maize crop is a common objective both within plant protection policies and among farmers concerned with productivity, cost reduction in technologies and production quality. In this context, the paper presents in a concise form the results of the few workshops carried out within the Horizon Europe project - "SUPPORT - Supporting uptake Integrated Pest Management and low-risk pesticide use" during the period 2024-2026, regarding farmers' opinion in adopting sustainable strategies for harmful organisms control of maize crop in Romania.

The results demonstrated that farmers are interested in adopting sustainable IPM strategies against the maize main pests, such as *Tanymecus dillaticollis*, Agriotes sp., *Helicoverpa armigera*, *Ostrinia nubilalis, Diabrotica virgifera*, based on preventive methods such as crop rotation, certified and quality seed, resistant hybrids, soil tillage, fertilization management, weeds control. Also, they are interested in apply new technologies based on the drones use and robots, high-performance equipment for localized application of pesticides and in the smallest quantities, in the context of optimizing the costs of technologies and maize productivity. Based on these results, a web platform was also developed, where different scenarios for IPM strategies can be evaluated, several indicators can be calculated, such as risk indicators, PL-EU / Pesticide Load, costs, greenhouse gas emissions and comparison between these scenarios. This platform can help the farmer choose the best control strategy specific to own farm, in terms of input costs, fertilization or plant protection strategy. More

information about this platform can be found here: https://synops.julius-kuehn.de/support/#/web-app.

In conclusion, as a perspective of IPM strategy of maize crops in Romania, monitoring is the central element of this strategy, because decisions on the control of harmful organisms are based on observations and objective data, not on the preventive application of pesticides. These tools allow: early detection of infestations; establishing the optimal time for intervention; reducing the number of insecticide treatments; protecting useful entomofauna (predators and pollinators); reducing production costs and environmental impact.

Keywords: farm strategy, Integrated Pest Management, IPM policy, maize, productivity.

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OPTIMIZATION OF PLANT EXTRACTS MICROEMULSIONS FOR AGRICULTURAL PEST MANAGEMENT USING MULTICRITERIA ANALYSIS

TODIRAȘ Vladimir[1,*], https://orcid.org/0000-0002-2245-9715
SORAN Maria-Loredana[2], https://orcid.org/0000-0003-3770-9702
JALBA Svetlana[1], https://orcid.org/0009-0007-9756-2059
LUNG Ildiko[2], https://orcid.org/0000-0003-4677-4602
OPRIȘ Ocsana[2], https://orcid.org/0000-0002-9765-2739

[1]Moldova State University, Institute of Genetics Physiology and Plant Protection, Chisinau, Republic of Moldova
[2]National Institute for Research and Development of Isotopic and Molecular Technologies, Cluj-Napoca, Romania
**Corresponding e-mail*: *vladimir.todiras@sti.usm.md*

Plant extracts have emerged as promising eco-friendly alternatives to synthetic pesticides for managing agricultural pests. Their natural origin reduces environmental impact, toxicity to non-target organisms, and resistance development. However, to maximize their efficacy and stability, the formulation of plant extracts into microemulsions has gained increasing attention. Designing optimal microemulsions involves balancing multiple factors (droplet size, surfactant concentration, stability, insecticidal activity, cost, and environmental safety). This complexity demands a structured approach such as multicriteria decision analysis (MCDA) to select the best formulation tailored for pest management.

Our direction of the research was optimization of preparation and characterization of *Sophora flavescens* root extract as natural insecticide and *Reynoutria sachalinensis* known for its potential as natural fungicide in greenhouses. The studied pests were the most important insects for a large range of plants greenhouse whitefly (*Trialeurodes vaporariorum*) and cucumber powdery mildew. Formulation variables were type and concentration of surfactants and cosurfactants, oil phase selection and active ingredient concentration. The polyphenolic extracts were prepared and analyzed by UV-Vis spectrophotometric method. The content of polyphenols, total flavonoids and alkaloids was evaluated and antioxidant activity was quantified. The extracts were prepared for optimizing in various conditions using different ratios of ethanol, acetic acid, water, temperature, pH and surfactants concentration. Perfor-

mance criteria were biological efficacy (mortality or repellency rates of target pests) and physical stability (resistance to phase separation over time and temperature). The optimal solutions were obtained using OptimClass software that is an interactive system for multi-criteria decision making and evolutionary optimization (*http://ecobionet.com/STA.aspx*).

OptimClass software facilitates a systematic evaluation and selection of optimal formulations. As result a new prepration form of tested extrats was elaboratied. Microemulsions enhance the bioavailability, penetration, and controlled release of active compounds. By integrating multidisciplinary knowledge in chemistry, agronomy, and data analytics through tools like OptimClass, researchers can significantly enhance the design of plant extract microemulsions, facilitating the transition toward sustainable and effective pest management solutions.

Keywords: Multicriteria analysis, extracts, optimization, organic agriculture.

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EFFICACY OF AN AUTOMATIC MONITORING SYSTEM FOR PHYTOSANITARY RISK ASSESSMENT IN APPLE ORCHARDS

TRETIACOVA Tatiana*, https://orcid.org/0009-0005-8511-9012
TODIRAS Vladimir, https://orcid.org/0000-0002-2245-9715

Moldova State University, Institute of Genetics Physiology and Plant Protection, Chisinau, Republic of Moldova,
**Corresponding e-mail*: *tatiana.tretiacova@sti.usm.md*

The optimal solution in pest control is the application of integrated plant protection systems, which ensure the regulation of pest population density and maintain it at an economically harmless level with minimal negative impact on the environment. Thus, the number of treatments for pest control can be significantly reduced using integrated systems that are ecologically and economically justified.

This study evaluates the efficacy of an autonomous, online 4G digital pheromone trap system for pest risk analysis and phytosanitary decision support in apple orchards. Equipped with built-in digital cameras and AI-based image recognition software, the system enables real-time field detection, population density assessment, and flight dynamics analysis of the codling moth (*Cydia pomonella*).

The integrated online platform incorporates a weather monitoring and evaluation system with a 600-meter resolution, a phenology forecasting model, and the BioClass geographic information system (GIS) to identify pest economic damage thresholds across diverse spatial scales. Field tests demonstrated that the automated system achieves accuracy comparable to traditional "Delta" traps while significantly reducing labor and time inputs. Furthermore, the predictive models achieved a precision of 1 to 3 days for optimization of treatment timing.

The results confirm that this 4G digital trap system can be effectively utilized for online agro-ecological territory classification at the farm, regional, and national levels, providing forecasting stations and agricultural extension services with precise data to simulate and predict potential pest threats. Information from pest models can be used to simulate and predict the intensity and potential pest threat.

Keywords: pests, pheromones, monitoring, digital traps

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Section D

Genetic and Physiological Aspects of Crop Improvement for Increased Resistance Potential and Resilience to Environmental Stressors, Diseases and Pests

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EVALUATION OF THE AGROBIOLOGICAL PERFORMANCE AND FRUIT QUALITY OF SOME DETERMINATE-GROWTH TOMATO (*Lycopersicum esculentum* L.) VARIETIES UNDER FIELD CONDITIONS

ANTAL Andreea[1], https://orcid.org/0000-0001-9906-1003
AMBĂRUȘ Silvica[1,*], https://orcid.org/0000-0002-9623-6602
BREZEANU Marian[1], https://orcid.org/0000-0002-1480-3360
BREZEANU Creola[1], https://orcid.org/0000-0002-3352-3081
CRISTEA Tina Oana[1], https://orcid.org/0000-0002-2511-8887
BĂLĂIȚĂ Claudia[1], https://orcid.org/0009-0001-4730-1682
CALARA Mariana[1], https://orcid.org/0000-0002-0989-5846
BENCHEA Carmina[1], https://orcid.org/0009-0002-5100-4127
IOSOB Gabriel-Alin[1], https://orcid.org/0000-0002-8204-9814
IGNAT Andreea Beatrice [1], https://orcid.org/0009-0009-3598-615X
MIHNEA Nadejda [2] https://orcid.org/0000-0003-0304-3295

[1]Vegetable Research and Development Station Bacau, Bacau, Romania
[2] Moldova State University, Institute of Genetics Physiology and Plant Protection, Chisinau, Republic of Moldova
**Corresponding e-mail: silvia_ambarus@yahoo.com*

Tomatoes (*Lycopersicum esculentum* L.) are among the most important vegetable crops cultivated worldwide, and the evaluation of genetic resources under specific pedoclimatic conditions is essential for identifying genotypes with superior agronomic performance and tolerance to biotic stress factors. The aim of this study was to comparatively evaluate the phenological, productive, and qualitative traits, as well as disease incidence, of determinate-growth tomato cultivars grown under open-field conditions in order to identify genotypes with superior agronomic performance and adaptability.

The experiment was conducted in 2025 at the Vegetable Research and Development Station Bacau. The biological material consisted of accessions from the station's germplasm collection and cultivars provided through a research collaboration with the Republic of Moldova, allowing the evaluation of genotypes of different genetic origins. Eight tomato cultivars were included in the study, comprising six cultivars from the Republic of Moldova and two Romanian cultivars.

Throughout the experiment, the main phenological stages were recorded, productivity parameters were determined, fruit morphological characteristics were evaluated, and the incidence of the major diseases occurring under natural field conditions was assessed.

The results revealed significant differences among the analyzed cultivars in terms of phenological development, yield performance, fruit characteristics, and disease incidence, confirming the influence of genetic background on agronomic performance and phytosanitary behavior under open-field conditions. The genotypes exhibiting superior performance and lower disease incidence represent valuable genetic resources for breeding programs and for expanding the assortment of cultivars suitable for open-field cultivation, thereby contributing to the development of more sustainable and resilient production systems.

Keywords: tomato, germplasm, phenology, yield, disease incidence

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MOLECULAR DIAGNOSIS OF STOLBUR IN LOCAL TOMATO VARIETY MARY GRATEFULLY

BAHSIEV Aighiuni*, https://orcid.org/0000-0002-1915-7652
ZAMORZAEVA Irina, https://orcid.org/0000-0002-6302-2069

Moldova State University, Institute of Genetics Physiology and Plant Protection, Chisinau, Republic of Moldova,
**Corresponding e-mail: aighiuni.bahsiev@sti.usm.md*

'Candidatus Phytoplasma solani' (16SrXII-A group), the causal agent of stolbur disease, is a phloem-limited, cell wall-less bacterium that infects numerous cultivated plant species including tomato, potato, grapevine, maize, and pepper. In tomato, the pathogen induces severe symptoms such as stunting, shortened internodes, virescence, phyllody, floral sterility, reduced fruit size, and phloem hypertrophy, resulting in significant yield and fruit quality losses. The pathogen is primarily transmitted by insect vectors feeding on plant sap and damaging the vascular system including phloem. Perennial plants impact in stolbur transmission playing the role of reservoirs for overwintering of insects. Additionally, the parasitic plant *Cuscuta* spp. can also contribute to phytoplasma epidemiology. Because phytoplasma infections are systemic and often remain latent or are masked by mixed infections, reliable molecular diagnosis is essential for disease surveillance and management.

The aim of this study was to determine the incidence of '*Ca*. P. solani' infection in the local Moldovan tomato variety *Mary Gratefully* during two growing seasons using nested-PCR analysis.

Tomato fruits with peduncles were collected from ten field-grown plants at the stage of mass fruit ripening (third decade of August) in the 2024 and 2025. Total DNA was extracted from thin peduncle sections using a rapid alkaline boiling protocol. Molecular diagnosis was performed by nested-PCR with the '*Ca*. P. solani-specific primer pairs cpn421F/R and cpn200F/R targeting the *groEL* (chaperonin) gene. These primers were designed in the Molecular Genetics Laboratory of the IGPPP. Amplification products were separated by electrophoresis in 1.5% agarose gel stained with ethidium bromide and visualized under UV illumination.

Comparative molecular analysis revealed differences in phytoplasma incidence between the two growing seasons. In 2024, 80% of the analyzed plants tested positive for '*Ca*. P. solani' indicating a high level of the field infection. In 2025, the infection rate decreased to 50%. However, the significant difference in infection in-

cidences over the two-year study was demonstrated in different climatic conditions of these years. Obtained in this study results confirm the persistent occurrence of stolbur phytoplasma in the tomato variety Mary Gratefully under field conditions. Also, the essential dependence of the stolbur spread between plants of this variety growing in the field on the climatic conditions of the year was confirmed too. The persistence of earlier obtained data with the results of this study allows to conclude that the local tomato variety Mary Gratefully is a high sensitive to stolbur and that the phytoplasma spread is depending on the season conditions. This variety cannot be recommended to breeding programs directed to the creation of stolbur - resistant tomato genotypes. Also, taking into account that '*Ca*. P. solani' represents a significant danger to this tomato variety it should be strongly recommended monitoring the emergence and outbreak of infection in the field.

Keywords: *'Candidatus Phytoplasma solani',* stolbur, tomato, nested-PCR, molecular diagnosis, Mary Gratefully variety**.**

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INBRED LINES OF CLARY SAGE (*Salvia sclarea* L.) WITH HIGH ESSENTIAL OIL CONTENT

BALMUȘ Zinaida*, https:// orcid.org/0000-0002-1164-6435_
COTELEA Ludmila, https://orcid.org/0009-0006-1395-2440_
BUTNARAȘ Violeta, https://orcid.org/0009-0003-9747-7568

Moldova State University, Institute of Genetics Physiology and Plant Protection, Chisinau, Republic of Moldova,
**Corresponding e-mail*: *zinaida.balmus@sti.usm.md*

Scientific research on clary sage (*Salvia sclarea* L.) is focused on diversifying the initial breeding material adapted to climate change. Breeding work to contribute to the cultivation and expansion of cultivated areas with clary sage genotypes. In this context, the creation, evaluation of inbred lines and the identification of genotypes with valuable breeding indices, which would ensure increased productivity of the raw material, as well as of the essential oil, represent a primary task.

The biological material used in the present study was represented by 39 inbred lines S_7 – S_{17} of different origins. Diversification of the initial breeding material in clary sage. in recent years continued by the inbreeding method. The plants selected as parents of future lines were forcibly self-pollinated by closing the inflorescence in an insulator, at the beginning of the flowering phase, forcing pollination with its own pollen. The essential oil content was determined in the full flowering phase, by hydro distillation of fresh inflorescences in the *Ginsberg* apparatus

As a result of successive selections, eight inbred lines were selected that were not subject to inbreeding depression and had a very high essential oil content (1,402–1,860% (dry matter), including: three descendant lines of the Ambra Plus (AP S_7) variety, one line derived from the Nataly Clary (NC) variety in the seventh generation (S_7), and 4 from generations S_{12}–S_{17}.

An assessment of the quality of the essential oil obtained by hydro distillation from the inbred lines demonstrated that the concentration of linalyl acetate is high, as European standards specify a linalyl acetate concentration of 50–80%, and in the tested lines it ranges from 50.88% in line AP 2-11 S_7 to 63.86% in line M-69 403-82 S_{17}. The essential oil content in the inflorescences is very high in the inbred lines AP 30-11 S_7 –1.561%, AP 35-11 S_7 –1.402%, and M-69 403-82 S_{17} –1.735% (dry matter), and gas chromatographic analysis demonstrated that the quality of the es-

sential oil is high due to the high concentration of linalyl acetate, which accounted for 60.7%, 62.93%, and 63.86%, respectively, in these lines. The concentration of linalool ranged from 16.54% in the inbred line M-69 257-82 S_{17} to 21.83% in the AP 30-11 S_7 line, a fact that ensures the excellent quality of this product. The sclareol content in the essential oil ranges from 7.32% (line M-69 403-82 S_{17}) to 21.04% (AP 2-11 S_7).

In conclusion, 39 inbred lines (S_7–S_{17}) of clary sage were evaluated; the quality of the essential oil was determined for 5 lines, which constitute an important material for plant breeding and represent a valuable source of germplasm. The highest concentration of linalyl acetate in the essential oil was found in two lines AP 35-11 S_7 – 62.93% and M-69 403-82 S_{17}, which had an exceptional essential oil content of 1.735% (dry matter), with a linalyl acetate concentration of 63.86%. Testing inbreeds lines in the 1st and 2nd year of vegetation confirmed the very high resistance to drought.

Keywords: *Salvia sclarea* L., clary sage, essential oil, inbreeding lines.

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PROTEINOGENIC AMINO ACID COMPOSITION OF INDIGENOUS SOYBEAN (*Glycine max* (L.) MERR.) VARIETIES ASSESSED BY NEAR-INFRARED SPECTROSCOPY

BÎRSAN Ana, https://orcid.org/0000-0003-1696-080X

Moldova State University, Chișinau, Republic of Moldova
Corresponding e-mail: *ana.birsan@usm.md*

Soybean proteins nutritional properties are determined by the chemical composition of essential and non-essential amino acids, which confer a biological value comparable to that of proteins of animal origin. The aim of the present study was to evaluate the impact of direct climatic effects on the profile of essential and non-essential amino acids in the seeds of several indigenous soybean varieties, with a view to assessing their nutritional quality.

The biological material consisted of seeds from four indigenous soybean varieties: Aura (control), Deia, Igorina, and Flamura, developed by the Institute of Crop Science «Selecția» and cultivated in the experimental fields of the National Center for Seed Research and Production, Bălți Branch. Mature, well-dried seeds with a moisture content of approximately 8–10% were subjected to biochemical analysis using near-infrared spectroscopy (NIRS) with a SpectraStar XT analyzer operating within a wavelength range of 1100–2600 nm. For the first time, advanced NIRS technology was employed to characterize the comprehensive biochemical composition of these soybean varieties, including seed moisture, crude protein, ash, lipid, and amino acid contents. For each variety and year, all determinations were performed in at least three replicates, and amino acid concentrations were expressed as percentages of dry matter. Climatic variables were obtained from the openly accessible POWER NASA and Open-Meteo (ERA5-Land) databases.

The NIRS method enabled the reliable identification of 18 proteinogenic amino acids in all soybean varieties studied. The overall metabolite profile revealed the presence of nine essential and nine non-essential amino acids. The results demonstrated that the qualitative amino acid profile was similar among all investigated varieties; however, significant quantitative differences were observed among the different genotypes.

Although crude protein content is generally regarded as the principal nutritional indicator of soybean flour, the nutritional quality of soybean-derived products is pri-

marily determined by their essential amino acid composition. Among the essential amino acids, lysine, leucine, phenylalanine, and histidine were the predominant constituents, whereas methionine and, particularly, tryptophan were identified as the limiting amino acids. Among the non-essential amino acids, arginine, aspartic acid, tyrosine, and glycine were present at relatively high concentrations, while serine and especially cysteine occurred at comparatively low levels. The amino acid composition also varied according to annual environmental conditions. Abiotic stress associated with the climatic conditions of 2024 exerted more pronounced effects on the investigated metabolites than those recorded in 2025. In contrast to 2024, when significant variations in amino acid content were observed across all soybean varieties, no significant differences were detected in 2025 between the Igorina and Flamura varieties or in comparison with the Aura variety, for either essential or non-essential amino acids. Nevertheless, a significant increase in the concentration of all amino acids was observed in the Deia variety. Therefore, among the investigated soybean genotypes, under more favorable environmental conditions, the Deia cultivar exhibited the highest crude protein and amino acid contents, highlighting its considerable potential as a valuable genetic resource for soybean breeding programs aimed at improving nutritional quality.

Keywords: soybean, seeds, amino acids, NIRS.

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THE OPPORTUNITY OF DEVELOPING SMART AGRICULTURE IN CONDITIONS OF VARIABILITY OF CLIMATE FACTORS

BOTNARI Vasile, https://orcid.org/0000-0002-0470-0384

Moldova State University, Institute of Genetics Physiology and Plant Protection, Chisinau, Republic of Moldova,
Corresponding e-mail: vasile.botnari@sti.usm.md

He consequences of global warming are becoming more evident from year to year, however, currently there is no well-thought-out strategy with effective measures to adapt agriculture to the variability of climate factors. Technological operations in plant cultivation are often carried out on the basis of declarative recommendations obtained in arrangements that are far too different from the current climatic and production conditions. Analysis of applied agricultural practices confirms numerous examples when, in conditions of concentration and intensification of agricultural production, deviations of technological parameters from optimal values lead either to a sharp decrease in yield or to a decrease in production quality, environmental pollution with chemical compounds associated with a decrease in soil fertility and labor productivity.

The instability of climate factors, with large deviations from the multi-annual norm, represents a risk for agriculture. With reference to the Republic of Moldova, climate change confirms that most of the years between 2015 and 2025 were among the warmest documented since the beginning of instrumental observations (1871), with annual average values of over 12.0°C, which is 2°C higher than the multiannual average. Greater amplitudes of this warming are observed in the southern districts of the country. In the northern part, the tendency for growth includes values in the range of 1.5-1.6 °C, in the southern area temperatures increase more rapidly, reaching the value of 2.3 °C. The tendency for temperature increase intensifies the phenomenon of heat, the latter being more pronounced in summer (June-August).

In this situation, it is necessary to review some common agricultural practices along with the adaptation of plant cultivation technologies capable of ensuring the maintenance, and in some cases, an increase in the productivity of agricultural crops. Meteorological observations show that in recent decades, in the center and north of the republic, the phenomenon of “dryness and heat” manifests itself with a duration

of 3 - 7 days. Under such conditions, agricultural crops are less affected by the thermal stress generated by temperatures above 25 °C and relative air humidity below 30%. In some places, in the southern districts, the phenomenon of "heat" exhibits a higher intensity with a duration of over 10 days. For the maintenance and development of the agricultural sector, it is important to systematically assess the impact of climate scenarios. Separate alternations of temperatures and precipitation need to be analyzed with the imposition of more comprehensive indices for describing the realities caused by climate factors.

In the context of climate variability, the development of smart agriculture is gaining wider popularity due to the performance of information technologies, high-speed Internet and the possibility of obtaining digital information about the state of agricultural land and crops from a distance. Thus, smart agriculture presents a comprehensive system of high-performance agricultural management, which includes methods of rotation and positioning of agricultural crops, complete information matrices, information evaluation systems and development of technological decisions

Keywords: *Smart agriculture variability of climate factors*

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GARLIC CULTURE – PROBLEMS AND SOLUTIONS

BOTNARI Vasile*, https://orcid.org/0000-0002-0470-0384
CHILINCIUC Alexei, https://orcid.org/0009-0006-9510-5463

Moldova State University, Institute of Genetics Physiology and Plant Protection, Chisinau, Republic of Moldova,
**Corresponding e-mail: vasile.botnari@sti.usm.md*

The climatic conditions in our country are favorable for the cultivation of various species of vegetable plants, including garlic. Although, in accordance with the annual export quota to the European Community granted to the Republic of Moldova in the amount of 500 tons, in recent years, for the first time, only 10 tons of unknown varieties and origin were exported. At the same time, to meet the needs of the domestic market, approximately 90% of garlic consumption was imported.

According to statistical data, local garlic production is approximately 90 tons, which constitutes slightly more than 10% of domestic consumption. Annual imports reach 800 tons, an action devoid of economic rationale, since the climatic conditions in our country are favorable for garlic cultivation. Under current socio-economic conditions, the value of possible harvests obtained from the cultivation of one hectare of garlic, as well as other vegetables, at comparable costs, is equivalent to the value of production obtained from 50-60 hectares of cereal crops.

However, in the structure of sowing, the areas with cereal crops occupy over 300-330 thousand hectares, which significantly reduces the socio-economic potential of the agricultural sector. The expansion of field crops to the detriment of vegetable crops leads to an increase in the gap in local agricultural production, causing a disadvantageous imbalance in food security. Thus, in a relatively short period of time, the Republic of Moldova has transformed from a regional exporter of vegetables into a stable importer of them (100-120 thousand tons annually). Revitalizing the situation is currently becoming problematic, because in recent decades, research on vegetable crops has been of an occasional nature. The lack of scientific assistance in the field of vegetable growing tangentially contributes to covering the needs of the domestic market with imported production, often of dubious quality, thus contributing to the increase in the gap between import and export of vegetable production, which, according to statistical data for 2025, exceeds 112 million SUA dollars.

Traditionally, garlic cultivation is predominantly applied on individual plots. It is cultivated partially and semi-industrially on sectors of about. 2-3 hectares. How-

ever, in most cases the yields are low, 2,5-3,5 t/ha. Low and unstable productivity is also explained by the lack of planting material, as well as cultivation technologies for different production conditions. Importing garlic from other geographical areas to ensure food consumption cannot serve as planting material and does not guarantee obtaining competitive and quality productions.

The variety of local forms of garlic is impressive, but poorly studied. In order to elucidate the problems that limit the development of the crop, investigations were carried out including genotypes with and without floral stems, and the performing genotypes were selected and evaluated in pre-competitive tests. As a result, new varieties of garlic were created and approved, such as: Vitasan, Berechet, Moldobella and Teodor, with high productivity and increased resistance to the variability of climatic conditions. Their implementation ensures the obtaining, under different production conditions, of 8-12 t/ha of bulbs and a benefit that considerably exceeds the agricultural crops practiced on a large scale in recent times.

Keywords: Agricultural crops, vegetables, garlic benefit.

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EXPLOITING GENETIC DIVERSITY IN TOMATO (*Lycopersicum esculentum*) FOR IMPROVED PHYSIOLOGICAL PERFORMANCE, YIELD, AND QUALITY UNDER ENVIRONMENTAL STRESS

BREZEANU Petre Marian[1], https://orcid.org/0000-0002-1480-3360
BREZEANU Creola[1], https://orcid.org/0000-0002-3352-3081
MIHNEA Nadejda[2], https://orcid.org/0000-0003-0304-3295
ANTAL TREMURICI Andreea[1], https://orcid.org/0000-0001-9906-1003
IOSOB Gabriel-Alin[1], https://orcid.org/0000-0002-8204-9814
AVASILOAIEI Dan Ioan[1], 0000-0003-3316-168X
CALARA Mariana[1], https://orcid.org/0000-0002-0989-5846
IGNAT Andreea Beatrice[1], https://orcid.org/0009-0009-3598-615X
AMBĂRUȘ Silvica[1,*], https://orcid.org/0000-0002-9623-6602

[1]Vegetable Research and Development Station Bacau, Bacau, Romania
[2]Moldova State University, Institute of Genetics Physiology and Plant Protection, Chisinau, Republic of Moldova
**Corresponding e-mail: silvia_ambarus@yahoo.com*

Efforts to conserve the genetic diversity of *Lycopersicum esculentum* L. and its wild relatives from their centers of origin are a research priority. Local tomato populations have been naturally selected and adapted to specific environmental conditions, representing valuable genetic resources with the potential to introduce desirable traits into future improved cultivars (Knapp and Peralta, 2016). Tomato breeding is a complex and demanding process that requires extensive collections of genetic resources, well-equipped research laboratories, protected cultivation facilities, experimental fields, and highly qualified personnel.

The relatively low tomato yield per unit area in Romania, particularly under organic production systems, can be attributed to the use of genotypes that are insufficiently adapted to the specific pedoclimatic conditions of the cultivation area and to production technologies that have not been fully optimized. Moreover, tomato breeding programs have traditionally focused primarily on increasing yield and improving tolerance to biotic stress, while comparatively less attention has been paid to fruit sensory characteristics (aroma, flavor, and taste) and nutritional quality (lycopene, vitamin C, β-carotene, and other bioactive compounds). The success of tomato breeding programs depends largely on the appropriate selection of parental genotypes, the identification of target traits, and the breeding strategy employed.

The main objective of this research was ex to explore genetic diversity, in order to identify useful germplasm to develop new tomato cultivars (*Lycopersicum esculentum* L.) with improved tolerance to environmental stress factors while maintaining exceptional sensory and nutritional quality.

The biological material used in this study originated from the germplasm collection of the Vegetable Research and Development Station Bacau and from a research collaboration with the Institute of Genetics, Physiology, and Plant Protection of the Republic of Moldova. This partnership provided the opportunity to evaluate tomato genotypes with diverse genetic backgrounds.

The specific objectives of the study were:

- the morphophysiological and agronomic characterization of the parental genotypes used in hybridization compared with the newly developed genotypes;
- the evaluation of fruit quality traits and their relationship with shelf life, aroma, flavor, and taste through the determination of lycopene, β-carotene, ascorbic acid, and total polyphenol contents.

At a time when breeding programs are predominantly aimed at developing cultivars and hybrids with maximum productivity and extended postharvest shelf life, this research sought to exploit additional valuable characteristics of tomatoes, particularly tolerance to environmental stress and superior sensory attributes (aroma, flavor, taste, and bioactive compounds). The initial breeding material consisted of seeds collected from home gardens, including traditional cultivars, local populations, and improved varieties.

The materials and methods employed were specific to plant physiology and plant breeding studies, with the objective of characterizing the initial genetic material and the cultivars obtained through genealogical selection and hybridization. More than thirty tomato genotypes were included in the experimental program; however, the present study focuses on ten cultivars, comprising five originating from the Republic of Moldova and five from Romania.

The results confirmed considerable genetic diversity within the evaluated germplasm regarding the variability of production traits and morphophysiological characteristics among the studied tomato genotypes. Furthermore, the analysis of photosynthetic parameters revealed significant physiological differences among the cultivars from the two countries, primarily attributable to their distinct genetic backgrounds.

Keywords: tomato breeding; genetic diversity; local germplasm; fruit quality; environmental stress tolerance.

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ASSESSMENT THERMOTOLERANCE IN TOMATO PROGENY AT THE SEED GERMINATION STAGE

BULDUMAC Ana*, https://orcid.org/0000-0002-9674-0403
ANDRONIC Larisa, https://orcid.org/0000-0002-2761-9917
SALTANOVICI Tatiana, https://orcid.org/0000-0002-1122-7433
ANTOCI Ludmila, https://orcid.org/0009-0006-4855-6544

Moldova State University, Institute of Genetics Physiology and Plant Protection, Chisinau, Republic of Moldova,
**Corresponding e-mail: ana.buldumac@sti.usm.md*

Temperature is known to be a key factor determining plant development from germination through to reproduction, while also influencing various physiological and adaptive processes. During the seed germination stage, temperature plays a significant and specific role by affecting both the rate and success of the processes, thus facilitating the differentiation and identification of genotypes with varying levels of heat tolerance. The objective of the research was to identify heat-resistant genotypes at the seed germination stage among tomato progenies obtained through cellular techniques. The study included the tomato cultivars Elvira, Rufina and the wild species *Solanum pimpinellifolium*, as presented into 27 experimental variants: control, infected with TMV/TAV, and treatments with glycosides (Moldstim, Glycoside V). During the study, 5400 seeds were evaluated. Based on the observed variability of biomorphological indices at the seed germination stage, the heat resistance level of the genotypes was determined, ranging from 46.6...81.3 %. Thus, regarding the genotypes derived from plants treated with Moldstim, we observed increased heat resistance compared to the control in 44.0 % of cases, whereas heat resistance decreased in over 50 % of cases. Among the progeny of plants sprayed with Glycoside V, we observed stimulatory effects and neutral reactions in 88 % of cases. Across the genotypes not treated with glycosides, the highest level of resistance – 66.8 % was observed in the Rufina variety, whereas for the other genotypes, values for this trait ranged from 54.7...56.6 %. The action of the glycosides resulted in positive effects in the progeny of the Elvira variety treated with Glycoside V (4.5 %) and in the wild species *Solanum pimpinellifolium* (treated with Moldstim/Glycoside V) – 5.2…7.4 %.

Statistical analysis of the data obtained through multifactorial analysis of variance helped identify the sources of variation determining the variability of the stud-

ied traits. As a result, the decisive role of the genotype in the variation seeds heat resistance was established for the genotypes in control, TMV, TAV treatments, a finding of potential importance for elucidating the genetic basis of the studied genotypes and for breeding programs, whereas the effect of the glycoside was 6.8…7.5 times lower. The analysis of the sources of individual variation for each genotype showed that viruses made the greatest contribution in the cultivar Rufina and the wild species *S. pimpinellifolium*, whearest the effect of glycoside was 2.9…6.8 times weaker. For the Elvira cultivar, the impact of viruses and the glycoside was lower – 37 and 25.0 %, the interaction of these factors was quite high (32.8 %), indicating a broad reaction norm for this trait. Among the genotypes included in the study, the TMV/TAV descendants of the Rufina cultivar stood out with the highest levels of heat resistance: 61.9…81.3 %.

Consequently, tomato progeny derived from plants with differing phytosanitary status at the seed germination stage are characterized by a relatively high level of heat resistance, ranging from 46.6…81.3 %. Progeny of the Rufina TMV/TAV cultivar exhibited the highest values for this trait – 61.9…81.3 %. Variation in heat resistance was primarily controlled by the genotype, a finding that may be significant for elucidating the genetic basis of the studied genotypes and for breeding programs. Compared to the control, application of Glycoside V elicited positive effects or neutral reactions in 88 % of cases.

Keywords: tomato, thermotolerance, virus infection, glycoside, resistance.

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LAVENDER HYBRIDS RESISTANT TO ABIOTIC FACTORS

BUTNARAS Violeta*, https://orcid.org/0009-0003-9747-7568
COTELEA Ludmila, https://orcid.org/0009-0006-1395-2440
BALMUS Zinaida, https://orcid.org/0000-0002-1164-6435

Moldova State University, Institute of Genetics Physiology and Plant Protection, Chisinau, Republic of Moldova,
**Corresponding e-mail: violeta.butnaras@sti.usm.md*

Research conducted on the species *Lavandula angustifolia* Mill., aims to create new clone-varieties resistant to frost and overwintering, with a longer productive lifespan of the plantations, increased productivity, and the development of early, medium, and late clone-varieties with staggered harvesting. Proposed aim: to study and select hybrid genotypes for valuable quantitative traits resistant to drought, frost, and overwintering.

The study included 110 F_1 hybrids in their third year of vegetation during 2025, derived from 3 French maternal forms: Fr.1; Fr.5; Fr.8. Resistance to frost and overwintering was assessed by evaluating the number of frozen shoots per plant, scored on a 1–5 points scale. Biomorphological evaluations were carried out (plant height and diameter, number of flower stems per plant). At the full flowering stage of the species, the essential oil content was determined in the fresh raw material, recalculated to dry matter.

The hybrids under study were assessed and classified according to their resistance to overwintering and frost: 77 genotypes showed high resistance (5 points); 25 – above-average resistance (4 points); 8 – medium resistance (3 points). For the hybrid genotypes derived from the maternal form Fr.1, belonging to the early group, the quantitative traits influencing productivity were evaluated. Plant height ranged from 62.0 to 72.0 cm, diameter from 90.0 to 110.0 cm, and the number of flower stems ranged from 740 to 980 units. For essential oil content, 45 hybrids were studied, which accumulated from 3.806% to 6.121% (dry matter).

When evaluating the hybrids descended from the maternal form Fr.8, belonging to the semi-early maturation group, the trait “plant height” ranged from 60.0 cm to 67.0 cm, forming vigorous plants with a diameter of 90.0–107.0 cm. It can be noted that plants with a larger diameter also form a greater number of flower stems, ranging

from 520 to 874 units. Regarding essential oil content in the third year of vegetation, 21 lavender hybrids derived from the maternal form Fr.8 were evaluated, ranging from 4.265% to 5.398%. The hybrids that stood out with high values for the traits mentioned also accumulated a higher essential oil content.

The hybrid genotypes derived from the maternal form Fr.5 belong to the late maturation group. In the third year of vegetation, they showed the following values: plant height from 64.5 cm to 67.0 cm, plant diameter (95.5–100.0 cm), and number of flower stems (563–700). The variation in essential oil content during the drought year (2025) for the late hybrids descended from Fr.5 was 4.03%–5.26% (dry matter).

It was established that the lavender hybrids derived from the French genotypes (Fr.1, Fr.5, and Fr.8) are resistant to the climatic conditions characteristic of the Republic of Moldova during winter. 38 lavender hybrids from the third year were selected, showing an essential oil content higher than 5% (dry matter) and high resistance to abiotic factors.

Keywords: lavander, hybrids, resistance, dry matter.

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OPTIMIZATION OF THE FEEDING AREA AND PLANTING DENSITY OF HARD-STEMMED GARLIC IN MOLDOVA TO INCREASE ITS PRODUCTIVITY

CHILINCIUC Alexei*, https://orcid.org/0009-0006-9510-5463
BOTNARI Vasile, https://orcid.org/0000-0002-0470-0384

Moldova State University, Institute of Genetics Physiology and Plant Protection, Chisinau, Republic of Moldova,
**Corresponding e-mail: alexei.chilinciuc@sti.usm.md*

To increase production and achieve high economic efficiency, we initiated a research to improve the technology for growing winter garlic from single-clove bulblets using a direct-sowing method, with a particular emphasis on increasing yield per unit area. This study examines the influence of growing areas on plant growth and development, demonstrating the yield and size of developed bulbs, their commercial qualities, and their quantity.

The materials for the research were single-clove bulbs obtained from aerial bulbils, when sowing them in open ground, from the bred variety "Berechet", obtained by selection from a local population of bolting garlic.

The mature single-clove bulbs were dug up in two replicates and calibrated using sieves with separation into four fractions: less than -1.0 cm; 1.0-1.4 cm; 1.5-1.9 cm and 2.0 cm and more; with the corresponding average weight: 0.7 g; 1.75 g; 3.0 g and 6.0 g. After conducting the inventory, the single-clove bulbs were returned to their previous location, planting them according to diameter and weight.

The planting was carried out at the end of June at a depth of 6-8 cm. The following plant density options were used in the research scheme: (286 thousand pcs/ha (V_1), 357 thousand pcs/ha (V_2), 476 thousand pcs/ha (V_3), 714 thousand pcs/ha (V_4) - control and 952 thousand pcs/ha (V_5)). The feeding area of one plant according to the plant density was (350 cm^2 (V_1), 280 cm^2 (V_2), 210 cm^2 (V_3), 140 cm^2 (V_4) - control and 105 cm^2 (V_5)).

The experiments were carried out on typical chernozem that meets the requirements for growing vegetable crops, in compliance with the generally accepted rules of crop rotation without the use of irrigation. A double-row, tape-planting scheme (20 + 50 cm) was used, with single-clove bulbs spaced at 3 cm, 4 cm, 6 cm, 8 cm, and 10 cm per row. The plot area was 2.74 cm^2. The experiment was replicated four times.

Conclusions: The optimal plant density for obtaining high yields of commercial garlic from aerial bulblets is 300,000-357,000 bulbs/ha, which ensures the best results in producing high-quality commercial bulbs. For seed production, a denser sowing of aerial bulblets is recommended, at approximately 450,000-500,000 bulbs/ha, which ensures the maximum yield of standard bulbs. Thickening the bulblets in a row above the specified planting standards leads to a decrease in bulb size.

Keywords: Bolting garlic, single-clove bulbs, size and weight, planting density, yield and marketability.

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WINTER GARLIC PROPAGATION VIA AERIAL BULBLETS A BREAKTHROUGH IN SUSTAINABLE CROP PRODUCTION

CHILINCIUC Alexei*, https://orcid.org/0009-0006-9510-5463
BOTNARI Vasile, https://orcid.org/0000-0002-0470-0384

Moldova State University, Institute of Genetics Physiology and Plant Protection, Chisinau, Republic of Moldova,
**Corresponding e-mail: alexei.chilinciuc@sti.usm.md*

The research **purpose** is to study the effect of growing area on planting material consumption; evaluate garlic growth and development under various agronomic conditions; analyze plant survival; and determine the number of standard single-clove bulblets, which is important for propagation.

The study sample consisted of aerial bulblets obtained from the "Berechet" cultivar, which was bred from a local population of bolting garlic. The average weight of aerial bulblets was approximately 0.18 g. The following plant stand configurations were used in the study: 286,000 bulblets/ha (B1); 357,000 (B2); 476,000 (B3); 714,000 (B4) - control; and 952,000 (B5)). The feeding area of one plant according to the planting density was (350 cm2 (B1); 280 cm2 (B2); 210 cm2 (B3); 140 cm2 (B4) - control; and 105 cm2 (B5).

Upon reaching maturity, in two repetitions, on June 26, ripe single-clove bulbs (sets) were dug up and biometric measurements were carried out. The bulbs were calibrated using sieves separating them into 4 fractions and weighed: less than 1.0 cm, 1.0-1.4 cm, 1.5-1.9 cm, 2.0 cm and more; with the corresponding average weight of 0.7 g; 1.75 g; 3.0 g, and 6.0 g.

The experiments were conducted on typical chernozem meeting the requirements for growing vegetable crops in compliance with generally accepted crop rotation rules without the use of irrigation (1). Sowing was carried out manually in the first ten days of October, at a depth of 4-5 cm. A double-sided strip system (20 + 50 cm) was used, with aerial bulblets spaced at 3 cm, 4 cm, 6 cm, 8 cm, and 10 cm per row. The plot area was 2.74 cm2. The experiment was replicated four times.

Conclusion: A step toward garlic self-sufficiency. The use of aerial propagation and vegetative reproduction of garlic through healthy aerial bulblets opens the way to sustainable and highly efficient garlic production in Moldova. These methods

reduce dependence of imported planting material, lower phytosanitary costs, and increased yields. With further development and support, these technologies could make Moldova a regional leader in environmentally friendly and profitable garlic cultivation.

Keywords: Bolting garlic; aerial bulblets, feeding area, growth and development, preservation.

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VARIABILITY OF AGRO-MORPHOLOGICAL TRAITS IN SC_5 TRITICALE SOMACLONES FOR THE SELECTION OF VALUABLE BREEDING MATERIAL

CIOBANU Renata, https://orcid.org/0009-0007-0554-6845

Moldova State University, Institute of Genetics Physiology and Plant Protection, Chisinau, Republic of Moldova,
Corresponding e-mail: *renata.ciobanu@usm.md*

The evaluation of agro-morphological traits enables the assessment of genetic diversity and the discrimination of genotypes. The continuous exploitation of novel genetic resources is essential for the advancement of breeding programs and the development of new triticale genotypes with enhanced productivity and adaptability. In this context, evaluating the effects of *in vitro* culture and gamma irradiation, applied either individually or in combination as methods for inducing genetic variability, on the quantitative traits of SC_5 triticale somaclones is of particular interest for the identification of superior genotypes with breeding potential.

The biological material consisted of SC_5 triticale somaclones derived from three cultivars, Ingen 35, Ingen 93 (standard cultivar), and 188TR 5021, obtained through *in vitro* culture and exposed to gamma irradiation, together with their respective control plants.

The analysis of agro-morphological traits, including plant height, main spike length, length of last internode length, number of fertile tillers and internodes per plant, number of grains per spike, grain weight, and 1000-grain weight, revealed pronounced somaclonal variability. Depending on the genotype and the experimental factor, statistically significant differences in the mean values of the analyzed traits were observed among the SC_5 triticale somaclones at the 95–99% significance level. Biometric evaluation identified SC_5 somaclones of genotype 188TR 5021 (*in vitro*) as the most promising, exhibiting significantly higher mean values than the control for four traits, namely plant height, main spike length, last internode length, and 1000-grain weight (95–99.9% significance level). The coefficient of variation ranged from 4.82 to 10.33%, indicating a high degree of uniformity among the evaluated individuals.

Analysis of the contribution of the studied factors to the expression of quantitative traits in SC_5 somaclones demonstrated that genotype was the predominant

source of variation, accounting for 0.94–42.21% of the total variation. The highest contribution of the genotype was recorded for last internode length (25.47%) and 1000-grain weight (42.21%). The effect of *in vitro* culture was most pronounced for plant height (21.48%) and last internode length (18.07%). Gamma irradiation exerted its greatest influence on last internode length (20.97%), 1000-grain weight (20.30%), and grain weight (14.75%). The interaction between genotype and *in vitro* culture ranged from 0.55 and 33.02%, with the highest values observed for 1000-grain weight (33.02%) and plant height (19.07%). The interaction between genotype and gamma irradiation ranged from 1.25 to 19.39%, whereas the highest interaction effect was recorded for plant height (19.39%), last internode length (19.11%), and 1000-grain weight (14.94%).

The somaclonal diversity induced by *in vitro* culture and gamma irradiation, assessed through agro-morphological traits such as plant height, main spike length, uppermost internode length, grain weight, and 1000-grain weight, provides valuable information for the identification and selection of superior triticale genotypes with high breeding potential.

Keywords: triticale, somaclones, *in vitro*, radiation, quantitative traits

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SELECTION OF CORN HYBRIDS FOR RESISTANCE TO DROUGHT AND SALINITY

CLIMENCO Oxana, https://orcid.org/0000-0001-5223-6208

Moldova State University, Institute of Genetics Physiology and Plant Protection, Chisinau, Republic of Moldova,
Corresponding e-mail: oxana.climenco@sti.usm.md

The resistance of the corn male gametophyte to abiotic stress factors, particularly drought and salinity, is an important factor to consider when creating and selecting new hybrid combinations. Studying the variability of pollen traits under stressful conditions allows for an effective assessment of the genotype's resistance and productivity potential. The aim of this study included investigation of the variability of the "pollen grain diameter" trait in hybrid genotypes under drought and salinity stressful conditions, evaluation of the effects size of stress factors, and identification of the most promising hybrids for further breeding.

The initial material was represented by 7 hybrid combinations, in which the maternal component was represented by simple hybrids (Mo17xW23), (Mo17xRf7), (XL12xP346), (XL12xN6), (L276xP165), (A285xRf7), and the paternal component included different types of hybrids: (simple (MK01xL276), trilinear (L459xP502) xP101, double (L459xMK390)x(P165xB73), backcross (A239xMK159)xMK159). The usual simple hybrids F_1 - L1866xA285 and F2xCo125 and a hybrid population of sweet corn were also used. The values of pollen grain diameter were determined by using MOB-1-15^x ocular micrometer in solutions with the calculated values of osmotic pressure (137.6 MPa and 40.67 MPa), as well as in NaCl solutions (3% and 15%). Effect sizes of stress factors and of the interaction «genotype x stress» were determined using ANOVA, and the significance of differences between genotypes were found by the Tukey HSD test.

The effect size of the «stress» factor was the largest (η_p^2=0.45***) and significantly exceeded the similar indicators for the interaction of factors (η_p^2=0.27***) and the "genotype" factor (η_p^2=0.19***). R^2 adjusted for the entire model was 0.54***. The best genotypes in terms of average values of the "pollen grain diameter" trait in all experimental variants were hybrids in which the maternal component included the XL12 line, and the paternal component was the three-line hybrid (L459xP502)xP101. Hybrids obtained using the L276 line in both the maternal and paternal components

were characterized by high values of the studied trait under the influence of drought. The values of the "pollen grain diameter" trait in the control were significantly higher than in the variants of stress treatments of the experiment, while the lowest values of this trait were observed under salt stress conditions. It was noted that with increasing NaCl concentration, the values of the studied trait decreased, especially in complex hybrid combinations. However, under osmotic stress, the performance of simple hybrids was inferior to that of almost all complex hybrids. The difference in "pollen grain diameter" trait values depending on the osmotic solution concentration was significant for genotypes with maternal components (XL12xP346), (XL12xN6), (L276xP165). Hybrid combinations involving paternal components such as double hybrid and backcross hybrid demonstrated significantly lower values for this trait of male gametophyte under drought conditions. Thus, promising hybrid combinations of corn with increased tolerance to drought and chloride salinity were identified at the haploid level of male gametophyte.

Keywords: corn, male gametophyte, drought, salinity.

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DETERMINING THE STORAGE POTENTIAL OF *Trigonella foenum- graecum* SEEDS DURING *ex situ* CONSERVATION

CORLATEANU Liudmila*, https://orcid.org/0000-0002-1018-1832
MIHAILA Victoria, https://orcid.org/0000-0003-3984-9477
GANEA Anatolie, https://orcid.org/0000-0002-8658-6879

Moldova State University, Institute of Genetics Physiology and Plant Protection, Chisinau, Republic of Moldova,
**Corresponding e-mail*: *liudmila.corlateanu@sti.usm.md*

In the *ex situ* conservation of plant germplasm in gene banks, the primary objective is to maintain seed viability, since seeds gradually lose their germination capacity and genetic uniformity as a result of aging. Therefore, determining a comprehensive indicator such as seed storage potential (SP) is a very important step for the successful *ex situ* conservation of plant genetic resources. SP was determined using an accelerated aging (AA) test, in which seeds are exposed to conditions of elevated temperature and high relative humidity for a short period of time. It allows for the monitoring of gene pool samples-that is, for the continuous assessment of seed viability and the classification of genotypes from active collections based on seed aging parameters. The test allows for: identifying samples unsuitable for long-term storage, providing recommendations on seed reproduction timelines, and indicating the need to restore the viability of valuable sample. The experiments were conducted on fenugreek (*Trigonella foenum-graecum*) seeds. Two genotypes were studied: *MDIT 052637 and MDI 00934.* The aim of the study was to examine the morphophysiological and biochemical parameters of the seeds and seedlings following the AA test. For fenugreek seeds, it is recommended to conduct the AA test at an air temperature of 42°C, relative humidity of 80.0–90.0%, and an aging period of 72 hours. For our samples, a different aging temperature was selected: 43°C, and a different aging period: 48 hours. Control: fenugreek seeds from the most recent generation. After the AA test, the seeds' germination energy (GE), germination rate (G), root length (RL), fresh (FB) and dry (DB) root biomass, and peroxidase (PO) activity in the roots of the seedlings were determined. Electrolyte leakage (EL) was determined by the electrical conductivity (EC) of solutions containing normal and aged seeds after 2 soaking durations: 24 and 48 hours. After conduction AA-test, a

decrease in GE and G of the seeds was observed compared to the control; for both genotypes, the values after AA were 30.0% and 34.5% and 49.3% and 52.5%, respectively, while the decrease in GE was 19.0% and 17.2%; in the control, G was 98.8% and 97.3%. The G of the seeds after the test decreased by a factor of 2.0 and 1.9 times, respectively. The RL after AA-test decreased by 4.8 and 4.3 mm compared to the control (RL in the experiment: 10.0 and 10.9 mm; control: 14.8 and 15.2 mm). The decrease in RL compared to the control was 1.5-fold and 1.4-fold. After AA-test, a decrease in root FB for the two genotypes was observed, amounting to 140.0 and 130.0 mg, respectively, compared to the control, while DB decreased by 35.0 and 30 mg, respectively. EL was determined at two soaking durations: 24 and 48 hours. An increase in the EC of the solutions after AA-test compared to the control was observed at both soaking durations. For the 24-hour exposure, the EC of solutions containing aged seeds increased by 5.0 and 6.0 mS/m compared to the control, and for the 48-hour exposure, it increased by 8.0 and 7.5 mS/m. PO enzyme activity increased 1.6 - and 1.75 - fold after AA-test compared to the control, i.e., the response to thermal stress was significant (control – 0.210 and 0.200 u.e., experiment – 0.335 and 0.350 u.e.). New conditions for the AA-test of fenugreek seeds were proposed: air temperature – 43°C, aging period – 48 hours. The seed AA-test allows for the determination of their SP, which in turn characterizes the ability of samples from various agricultural crops to undergo long-term *ex situ* conservation in a plant gene bank. The studied fenugreek seed varieties proved to be highly sensitive to the harsh conditions of the AA-test.

Keywords: fenugreek, accelerated aging, gene bank, storage potential

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HYBRID COMBINATIONS OF *Salvia sclarea* L., RESISTANT TO ENVIRONMENTAL CONDITIONS

COTELEA Ludmila*, https://orcid.org/0009-0006-1395-2440
BALMUȘ Zinaida, https://orcid.org/0000-0002-1164-6435
BUTNARAȘ Violeta, https://orcid.org/0009-0003-9747-7568

Moldova State University, Institute of Genetics Physiology and Plant Protection, Chisinau, Republic of Moldova,
**Corresponding e-mail: ludmila.cotelea@.sti.usm.md*

The breeding research conducted on *Salvia sclarea* L. species aims to create and improve the initial breeding material, new hybrid combinations that are resilient to environmental conditions, flowering in the first and second year of vegetation, which would synthesize and accumulate a higher content of superior-quality essential oil.

As biological material 28 hybrid combinations (F_3-F_4 generations) of *Salvia sclarea*, including simple, triple, double, stepped, and complex were used. The evaluated hybrid combinations are distinguished by high productivity, which is ensured by quantitative directly influence productivity: plant height, inflorescence length, number of inflorescence branches and essential oil content. Even in dry years, these genotypes are distinguished by well-developed plants with tall, long and very long, compact inflorescences, due to the high number of first and second order branches. The evaluation of these hybrids demonstrated that the plants produced floral stems ranging in height from 107.3 cm to 139.0 cm. It should be noted that the most highly developed plants were observed in the complex hybrid [(Cr.p.1 S_1 x M-69)F_{12} x (S-3 x M -69)F_2 x Cr.p.1 S_2)F_8]F_4; this hybrid was also distinguished by vigorous inflorescences, which measured 71.6 cm in length.

One of the basic criteria in clary sage breeding is the development of varieties and hybrids featuring vigorous inflorescences with a high number of branches. Both first- and second-order inflorescence branches influences the production of raw material and essential oil content, as the oil glands in *sage* are exogenous located on the epidermis of the inflorescence branches and on the fused sepals of the flowers. The inflorescences of the evaluated hybrids are compact, with a substantial number of first and second-order branches. The highest number of first and second order inflorescence branches was recorded for the stepwise hybrid combination [(0-42 x Rubin) F_1 x S-786)BC_7 x AP60-11 S_3)]F_3 (56.9 branches) and the single hybrid (Cr. p 99 S_{13}

x AP 52-11 S_3)F_3 (69.8 branches). All these evaluated traits - characterized by high to very high quantitative values - as well as other genetic attributes of the evaluated hybrids, ensure the synthesis and accumulation of high essential oil content even during dry years, as the oil glands in this species are located on the epidermis of the inflorescences (branches, flowers, and calyxes).

As a result of the conducted research it was demonstrated that regarding the very high essential oil content recalculated to dry matter: (1.404-1.999%), 12 hybrids stood out. The single hybrid (Cr.p 99 S_{13} x AP 52-11 S_3)F_3 stood out exceptionally, synthesizing and accumulating a very high essential oil content of 2.470%.

In conclusion, the created and evaluated hybrid combinations constitute on important breeding material and present a valuable source of germplasm for the development of new hybrid varieties of *Salvia sclarea* L., resistant to environmental conditions.

Keywords: essential oil, hybrid combinations, quantitative characters, *Salvia sclarea* L.

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EVALUATION OF CHICKPEA RESILIENCE TO COLD STRESS AT GERMINATION AND SEEDLING STAGES

CURSHUNJI Dmitri, https://orcid.org/0009-0006-2928-9583

Moldova State University, Institute of Genetics Physiology and Plant Protection, Chisinau, Republic of Moldova,
Corresponding e-mail: dmitri.cursunji@sti.usm.md

In this communication presented summarizing results of research on evaluation of 16 chickpea genotypes to cold stress at germination and seedling stages. The research was prompted by agro climatic instability, specifically unpredictable low temperature observed during April over three consecutive years. Investigation was carried out in 2026 and comprised 6 foreign, 8 local accessions as well as 2 cultivars *Ichel* and *Botna*, latter as check being tolerant to cold. Genotypes MDI 02433, MDI 02461and cv. *Botna* are *desi*, others – *kabuli,* which were characterized by wide range of seeds size: 11.5g (MDI 02461) – 41.1g (REZ2-9a) per 100 seeds.

The primary objective was: to screen genotypes for low-temperature resilience during the seedling emergence phase under field conditions and seeds germination under controlled ones. Before start the experiments all genotypes were tested for germination, everyone had 100%. The field experiment consisted of early sowing (on 1st March, a month earlier than accepted time), in randomized block design (20 cm/5cm distance between/in rows) with 3 replications (40×3 seeds per genotype). For evaluation the speed of seedling emergence index (SSEI), was used Maguire's formula: sum of the number of newly emergence seedling divided by the number of days since planting (on the 25th, 28th, 31th and 33th days) and final emergence rates, both expressed in percentage. Under controlled conditions (20 ×3 seeds per genotype, germinated in pots with sand), genotypes were exposed to three distinct thermal regimes - stress (7 ℃), suboptimal (10 ℃), and optimal (13 ℃) - for an 8-day period. Stress indices at germination stage I and II were calculated as ratio of radicles' length (mean) under stress condition to suboptimal and optimal, respectively.

Values of speed seedling emergence index ranged from 2.7 (MDI 02403) to 3.7 (OR1-2b), while final emergence rates varied between 73.7% (MDI 02403) - 100% (MDI02433, OR1-2b). Radicle lengths (mean) constituted 18.3 mm (15.1-24.8 mm) at 7 ℃, 70.2 mm (57.5-79.5 mm) at 10 ℃, and 106.7 mm (82.5-117.7 mm) at 13 ℃.

Stress indices at germination stage I and II ranged from 0.213 (REZ2-9a) to 0.321 (MDI 02443) and 0.134 (MDI02403) – 0.216 (MDI 02443), respectively. Based on the integrated experimental datasets, Ward's hierarchical clustering analysis segregated the germplasm into three distinct cohorts: Cluster 1 comprised 5 cold-tolerant genotypes: cv. *Botna*, MDI 02431, OR1-2b, MDI 02443 and MDI 02433; Cluster 2 included 8 moderately tolerant accessions: cv. *Ichel*, CS1-18b, CS2-16, MDI 02488, MDI 02437, MDI 02405, MDI 02461 and MDI02422; and Cluster 3 consisted of 3 moderately sensitive accessions: MDI02403, MDI 02447 and REZ2-9a. Correlation analysis revealed a highly significant positive correlation (R = 0.963) between SSEI and final emergence rate, alongside moderate positive correlations between *SSEI* and stress indices I (0.738) and II (0.725), respectively. Low negative correlation was determined between *SSEI* and *weight of 100 seeds* (R= (-0.117) and also between *stress indices* I, II and *weight of 100 seeds* (R= (- 0.257) and (R= (-0.186), respectively.

Conclusions: as a result of conducted research genotypes: cv. *Botna*, MDI 02431, OR1-2b, MDI 02443, and MDI 02433 were identified as tolerant to cold, while genotypes: cv. Ichel, CS1-18b, CS2-16, MDI 02488, MDI 02437, MDI 02405, MDI 02461 and MDI02422 as moderate tolerant.

Keywords: chickpea, early sowing, seedling emergence index, emergence rate, stress index

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EFFECT OF OSMOTIC STRESS ON GROWTH AND BIOMASS ACCUMULATION IN FLAX SEEDLINGS (*Linum usitatissimum* L.)

CUȚITARU Doina*, ORCID: 0000-0001-9956-8189
GANEA Anatolie, ORCID: 0000-0002-8658-6879

Moldova State University, Institute of Genetics Physiology and Plant Protection, Chisinau, Republic of Moldova,
**Corresponding e-mail*: *doina.cutitaru@sti.usm.md*

Drought is a major abiotic stress factor that affects plant growth and development, causing significant yield losses. Identifying drought-tolerant genotypes capable of maintaining stable yields under water-limited conditions is essential for sustainable agriculture. Due to their distinct genetic backgrounds, botanical varieties of flax (*Linum usitatissimum* L.) exhibit considerable variability in drought tolerance and water-stress response.

Two local flax accessions, G01 (Sofia Village, Drochia District) and G02 (Grigorievca Village, Causeni District), were evaluated for their response to osmotic stress. Drought conditions were simulated by inducing osmotic stress with a 15% (w/v) PEG 6000 solution, corresponding to an osmotic potential of Ψ_s = -0.325 MPa. Seeds were incubated for 7 days in darkness at a constant temperature of 20±1°C, and the effects of osmotic stress were assessed based on morphological and gravimetric parameters of the seedlings.

Osmotic stress (Ψ_s = -0.325 MPa) limited water uptake during germination, resulting in reduced tissue hydration and inhibited seedling growth. Consequently, fresh weight decreased from 1.08 g to 0.48 g in G01 (-56.0%) and from 1.12 g to 0.42 g in G02 (-62.8%). Water content also decreased, from 94.5% to 86.4% in G01 and from 93.6% to 84.9% in G02. Concomitantly, the ratio of dry mass to fresh mass (DM/FM) increased from 5.5% to 13.6% in G01 and from 6.4% to 15.1% in G02, indicating reduced tissue hydration under osmotic stress. Moreover, dry biomass showed a differential response between genotypes: G01 exhibited a 9.1% increase compared with the control, whereas G02 showed an 11.8% decrease, suggesting greater stability of dry matter content in G01 under osmotic stress conditions.

Morphological assessment of embryonic organs further revealed a differential response between genotypes. The hypocotyl was the most affected organ, exhibiting

a decrease of more than 62% in fresh weight, accompanied by pronounced inhibition of axial growth. Hypocotyl length decreased from 6.5 cm to 1.7 cm in G01 and from 3.5 cm to 1.2 cm in G02 under osmotic stress conditions. Similarly, radicle elongation was significantly restricted, decreasing from 11.2 cm to 6.2 cm in G01 and from 8.2 cm to 4.5 cm in G02, accompanied by reduced fresh biomass.

In conclusion, exposure to 15% PEG 6000 (Ψ_s = -0.325 MPa) significantly inhibited early seedling development in flax, resulting in marked reductions in water content, fresh biomass, and embryonic organ elongation. Compared with G02, genotype G01 demonstrated a greater capacity to maintain dry biomass content and growth under osmotic stress, suggesting higher tolerance to water deficit. This differential response may be associated with the distinct ecological origins of the genotypes, with G01 originating from northern Moldova and G02 from the south-eastern region, where contrasting environmental conditions may have contributed to their adaptive responses to water stress.

Keywords: *Linum usitatissimum*, flax, osmotic stress, PEG 6000.

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HORMESIS AS A THEORETICAL BASIS FOR RATIONAL AFFORESTATION OF THE REPUBLIC OF MOLDOVA WITH DIFFERENT OAK SPECIES

DASCALIUC Alexandru[1], https://orcid.org/0000-0003-3210-6144
CĂLUGĂRU-SPĂTARU Tatiana[1,*], https://orcid.org/0000-0002-9671-6948
PARII Iulia[2], https://orcid.org/0000-0001-6354-9795

Moldova State University, Institute of Genetics Physiology and Plant Protection, Chisinau, Republic of Moldova
[2]All Ukrainian Institute of Plant Breeding
**Corresponding e-mail: tatiana.calugaru.spataru@sti.usm.md*

Purpose. The selection of oak species for afforestation is a strategic issue under global warming. The resistance of perennial plants to thermal stress depends not only on functional processes but also on morphological characteristics that help avoid stress effects. We rapidly evaluated the resistance to heat shock (*HS*) applied at different temperatures to leaves of *Quercus robur* L., *Quercus petraea* (Matt.) Liebl., and *Quercus pubescens* Willd., collected in midsummer. Based on the responses of the leaves to *HS* applied at different temperatures, we determined the position and dynamics of the hormetic zone in the oak species studied.

Materials and methods. Under controlled artificial conditions, the control leaves maintained their viability throughout the experimental period. Leaves from the experimental treatments were subjected to *HS* by immersion in water at the specified temperatures for 5 minutes. PSII fluorescence was measured in the control and experimental leaves at the beginning of the experiment and subsequently every 24 hours for 7 days. The ratio between the fluorescence values of the experimental leaves and those of the corresponding control leaves was then calculated. Based on these data, temperature-response curves were constructed every 24 hours after *HS* application. This approach allowed us to determine the level of PSII inhibition at different stages after *HS* exposure and to assess the kinetics of PSII activity recovery following treatments applied at different temperatures.

Summarized results. At 24 hours after *HS* exposure, the temperatures causing a 50% decrease in relative PSII efficiency in the leaves of *Q. petraea* and *Q. pubescens* were 0.6 and 2.0°C lower, respectively, than that recorded for *Q. robur*. At 168 hours after *HS* exposure, the corresponding value for *Q. petraea* was 0.1°C

higher than that of *Q. robur*, whereas the value for *Q. pubescens* was 0.8°C lower. During the recovery period between 24 and 168 hours after *HS* exposure, repair of heat-induced damage increased the *HS* temperature required to cause a 50% reduction in relative PSII efficiency by 1.4°C in *Q. robur*, 2.1°C in *Q. petraea*, and 2.6°C in *Q. pubescens*.

Conclusions. The quantitative characteristics of oak species' leaf responses to HS are similar. If the resistance to *HS* of one genotype is greater than that of another, then the effective temperature of *HS* exposition for induction of the hormetic response will shift to the right compared to the genotype with lower HS resistance. In oak species, the dose that induces the hormetic response also depends on the influence of resistance factors through avoidance.

Keywords: *oak species, photosystem II, heat shock.*

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MOLECULAR SURVEILLANCE OF MAJOR FUNGAL PATHOGENS IN APPLE USING SPECIES-SPECIFIC PCR

DEAGHILEVA Angela*, https://orcid.org/0000-0003-3659-2450
BELOUSOVA Galina, https://orcid.org/0000-0002-9977-1248

Moldova State University, Institute of Genetics, Physiology and Plant Protection, Chisinau, Republic of Moldova,
**Corresponding e-mail: angela.deaghileva@sti.usm.md*

Background: Fungal pathogens are among the major factors limiting apple production and postharvest fruit quality, causing substantial economic losses worldwide. Rapid and accurate molecular detection of phytopathogenic fungi is essential for effective disease monitoring and management. Most of them are belonging to the group of mycotoxin-producing fungi, that can contaminate food crops if storage conditions are unfulfilled. Therefore, the early detection of these pathogens is critical for minimizing crop losses and implementing timely control strategies.

The present study aimed to evaluate the molecular spectrum of fungal pathogens belonging to the genera *Alternaria*, *Penicillium*, *Aspergillus*, *Monilinia*, *Myrothecium*, and *Mucor* associated with apple tissues using species-specific polymerase chain reaction (PCR).

Methods: Plant material was collected from the apple cultivars 'Golden Spur' and 'Granny Smith' grown in lysimeter experiments and from 'Golden Delicious', 'Reinette Simirenko' trees cultivated in an orchard. Leaf samples were tested throughout the growing season, fruits were studied at the stage of biological maturity and after storage. Genomic DNA was extracted from plant tissues and analyzed using species-specific primers targeting *Alternaria alternata*, *Alternaria solani*, *Penicillium expansum*, *Penicillium brevicompactum*, *Penicillium citrinum*, *Monilinia yunnanensis*, *Myrothecium roridum*, *Mucor piriformis*, and *Aspergillus flavus*. Nested PCR was carried out under optimized amplification conditions. Amplified fragments were separated by electrophoresis in 2% agarose gels, stained with ethidium bromide, visualized under UV illumination, and documented.

Results: Molecular analysis revealed that *Alternaria alternata* was the predominant fungal pathogen detected in apple tissues throughout the entire growing season, indicating its widespread occurrence in the studied genotypes. In contrast, *Alternaria*

solani was not detected in any of the analyzed samples. *Myrothecium roridum* was identified only once, in spring leaves of the cultivar 'Golden Delicious'. Pathogens belonging to the genus *Penicillium* were detected at a low frequency. *Penicillium expansum* and *Penicillium citrinum* were identified exclusively in leaf samples collected during the growing season from the apple cultivars 'Reinette Simirenko' and 'Golden Delicious'. In contrast, *Penicillium citrinum* was detected only in stored fruits of the 'Golden Delicious' cultivar. No PCR amplification products specific to *Aspergillus flavus*, *Mucor piriformis*, or *Monilinia yunnanensis* were obtained from any of the analyzed samples.

Conclusions: The results demonstrate the high prevalence of *Alternaria alternata* in apple tissues compared with the sporadic occurrence of *Penicillium* and *Myrothecium* species. The absence of *Aspergillus flavus*, *Mucor piriformis*, and *Monilinia yunnanensis* suggests that these pathogens were not involved in infections under the investigated environmental conditions. These findings confirm the usefulness of species-specific PCR as a rapid and reliable tool for phytopathogen monitoring in apple production systems. Continuous molecular surveillance and strict control of storage conditions are recommended to minimize the development of *Alternaria* and *Penicillium* infections during postharvest storage and to preserve fruit quality.

Keywords: Pathogens, fungi, apple, PCR.

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SCREENING OF WHEAT VARIETIES ON THE *CBF-A3* GENE CONFERRING RESISTANCE TO COLD STRESS

DUNICH Alina[1,*], https://orcid.org/0000-0001-9614-3441
MISHCHENKO Lidiya[1], https://orcid.org/0000-0003-0697-6971
MISHCHENKO Ivan[2], https://orcid.org/0000-0002-2919-8546
MOLODCHENKOVA Olga[3], https://orcid.org/0000-0003-2511-0866
DASHCHENKO Anna[2], https://orcid.org/0009-0000-9943-0710
FANIN Yaroslav[3], https://orcid.org/0000-0003-3129-7583
MOTSNYI Ivan[3], https://orcid.org/0000-0002-1812-9481

[1]Taras Shevchenko National University of Kyiv, Kyiv, Ukraine
[2]National University of Life and Environmental Sciences of Ukraine, Kyiv,
[3]Plant Breeding&Genetics Institute-National Center of Seed and Cultivar Investigation, Odessa
**Corresponding e-mail: lmishchenko@ukr.net*

Plants are often exposed to a wide range of environmental abiotic and biotic stressors that significantly impact plant growth, development, and productivity. One of the major abiotic stresses that reduces crop productivity is cold (freezing or chilling). Plants have developed various mechanisms, involving altered physiological, biochemical, and molecular processes, to cope with stresses. Some of these mechanisms or signaling pathways in plants are not yet sufficiently understood. The cold resistance (CR) is regulated by several pathways, including the ICE-CBF-COR transcriptional cascade. However, the specific responses of these pathways to cold stress and their interactions are not fully understood. The activation of the so-called inducer of CBF expression (ICE) genes marks the beginning of the cold response gene induction. This process leads to the activation of COR (COld Regulated) genes by CBF (C-repeat Binding Factors) transcription factors, thereby enhancing CR (Song et al. 2021). CBF transcription factors play a crucial role in regulating COR genes, which are triggered by cold and provide resistance to future freezing temperatures (acclimation) in various plant species.

The goal of this study was to screen wheat varieties for the presence of the cold resistance gene *CBF-A3* using a PCR-based marker.

For this study, 172 wheat varieties were selected from different regions of

Ukraine (Chernihiv, Kyiv, Kirovohrad, Odesa, Poltava, Kharkiv and Ternopil). Genomic DNA was extracted from wheat leaves using the GeneJet Plant Genomic DNA Purification Mini Kit K0791 (Thermo Fisher Scientific, USA). For polymerase chain reaction, a specific primer pair, developed by Babben et al. (2018) for detection of the *CBF-A3* gene for cold resistance was used: CBF-A3_F primer (5′-ATCCCACACTCTCGCTCAAG-3′) and CBF-A3_R primer (5′- GCTGGGAATTATCGGCACTA-3′). PCR amplification was performed following standard procedure with annealing for 30 s at 56°C using DreamTaq™ Green PCR Master Mix (Thermo Fisher Scientific, USA).

PCR results showed the presence of a 790 bp DNA fragment of the *CBF-A3* gene in 19 wheat varieties. Thus, our investigation revealed 19 *CBF-A3* -positive wheat varieties. These results will be useful to provide these wheat varieties containing *CBF-A3* as potentially resistant to cold stress in wheat breeding programs in Ukraine.

Keywords: cold stress, resistance, *CBF-A3* gene, wheat.

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EFFECTS OF LOW DOSES X-RAY ON BEECH SEED GERMINATION DURING COLD STRATIFICATION

ELISOVETCAIA Dina*, https://orcid.org/0000-0003-0521-6428
IVANOVA Raisa, https://orcid.org/0000-0002-2554-2039
ANDRONIC Larisa, https://orcid.org/0000-0002-2761-9917

Moldova State University, Institute of Genetics Physiology and Plant Protection, Chisinau, Republic of Moldova
**Corresponding e-mail: dina.elisovetcaia@sti.usm.md*

European beech (*Fagus sylvatica* L.) is an ecologically and economically important forest tree species, and the search for environmentally safe methods to improve seed germination is of considerable practical interest. The aim of our study was to evaluate the effects of low-dose X-ray irradiation (1, 2, 3, 4 and 5 Gy) on the germination performance and radicle development of *F. sylvatica* seeds during cold stratification. The experiments were carried out in the laboratory Natural Bioregulators of the Institute of Genetics, Physiology and Plant Protection, Moldova State University (IGPPP, MSU) during 2025-2026. The seeds of *F. sylvatica* collected in autumn 2023 from the "Plaiul Fagului" Nature Reserve, Republic of Moldova with viability – 68.0% were used in the study. The results were analyzed using Statgraphics Plus 5.0 software. Statistical analysis included one-way analysis of variance (ANOVA), Tukey's HSD post hoc test for multiple comparisons, and box-and-whisker plot analysis. Statistical significance was accepted at a significance level of $p \leq 0.05$.

The results showed that low doses of X-rays exerted a non-uniform effect on germination parameters during 120 days of cold stratification. The most pronounced stimulatory effect was observed at 1 Gy, which increased seed germination from 46% in the control to 59%, accompanied by higher germination rate index (GRI) and radicle vigor index values, together with a shorter mean germination time (MGT), indicating accelerated germination processes. Increasing the dose to 2–4 Gy did not produce a further enhancement of the stimulatory effect, as most germination parameters remained comparable with or only slightly exceeded the control values but were lower than those obtained at 1 Gy. The least favorable effect was recorded at 5 Gy, where germination, GRI and radicle vigor decreased below the control, indicating a transition from a stimulatory to an inhibitory effect of irradiation. Analysis

of radicle length using Tukey's multiple range test (LSD, 95%) revealed no statistically significant differences between the control and most irradiation treatments, although the 1 Gy treatment showed the highest mean value and was statistically separated from the 5 Gy treatment, which had the shortest radicles. The treatments at 2–4 Gy showed substantial statistical overlap with both the control and each other, preventing their separation into distinct homogeneous groups. Box-and-whisker plot analysis confirmed a weak but dose-dependent effect of irradiation on radicle morphometry. Overall, the results indicate that irradiation at 1 Gy stimulates germination processes in *F. sylvatica*, whereas further increases in dose progressively reduce the positive effect and lead to the appearance of inhibitory effects.

The results indicate that low-dose X-ray irradiation exerts a dose-dependent hormetic effect on the germination of *F. sylvatica* seeds during cold stratification, with 1 Gy representing the optimal stimulatory dose.

Keywords: *Fagus sylvatica*, seed, X-ray irradiation, cold stratification, germination

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THE ADAPTATION OF GRAPEVINE ASSORTMENT TO CLIMATIC CHANGE CONDITIONS

GLADEI Mihai, https://orcid.org/0009-0008-4241-6668

Moldova State University, Institute of Genetics Physiology and Plant Protection, Chisinau, Republic of Moldova,
Corresponding e-mail: mihai.gladei@sti.usm.md

Climate change exerts constant pressure on agricultural systems, and viticulture is proving to be one of the most exposed sectors. The adaptability of vines to climatic fluctuations is closely correlated with the specific characteristics of the cultivated genotypes and the extent to which they can respond optimally to biotic and abiotic stress factors. Temperature changes, irregular rainfall distribution and increased frequency of extreme events require constant reassessment of genetic selection and vineyard management strategies. In the current context, grapevine improvement is based on the identification of genotypes capable of overcoming the barriers imposed by climate change through a complex adaptability that includes resistance to low temperatures, tolerance to drought and heat and, last but not least, resistance to diseases and pests (including phylloxera). Of course, all these requirements for a particular grapevine variety need to be combined with the stability, quality and quantity of production obtained. In order to meet these requirements, the trend is increasingly clear for diversifying the grape variety used in establishing plantations and focusing on interspecific rhizogenic hybrids Vitis Vinifera x Muscadinia Rotundifolia, including apyrene varieties. After a long process of breeding and testing interspecific hybrids, were created rhizogenic interspecifical varieties for use in ecological viticulture. These varieties can ensure a stable and rich harvest with minimal phytosanitarial input. As a result of crossing the genotypes of *V. vinifera* L. (2n=38) x *M. rotundifolia* Michx. (2n=40) were obtained and homologated interspecific rhizogenic grapevine genotypes with table grapes: “Nistreană”, “Algumax”, “Malena”, “Sarmis” and for fresh consumption and processing: “Ametist”, “Thetys”, “Alexandrina”, “Augustina”. The latest obtained hybrid, is a seedless variety for fresh consumption that was named “Indigo”. More interspecifical rhizogenic varieties are about to be created, and the breeding process continues.

These genotypes offer a wide range of advantages: large berry size, increased disease resistance and high adaptability. They are the result of a selection oriented towards polyvalent traits: increased climate tolerance, oenological potential and con-

sistent yield. However, selection must be carefully calibrated to avoid the loss of specific organoleptic characteristics that give identity to a specifical variety.

The global demand for seedless varieties adds another layer of complexity to this picture. Such varieties must offer a varied ripening period and have desired characteristics such as berry size or precocity, to complement the existing grape assortment. Their integration into regional assortments must take into account both the market and their ecological-agronomic compatibility.

Climatic factors not only influence growth and productivity, but can also accelerate the spread of devastating diseases, so the implementation of new rhizogenic varieties with increased adaptability is highly recommended.

Keywords: ecological viticulture, interspecific hybrids, climate change, genetical plasticity, disease resistance.

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BREADING OF *Triticum spelta*

GORE Andrei*, https://orcid.org/0009-0002-7356-7289
LEATAMBORG Svetlana, https://orcid.org/0000-0003-4091-1522
ROTARI Silvia, https://orcid.org/0009-0007-5122-9373

Moldova State University, Institute of Genetics Physiology and Plant Protection, Chisinau, Republic of Moldova,
**Corresponding e-mail*: *andrei.gore@sti.usm.md*

Triticum spelta is one of the oldest cereals. This wheat is superior to common wheat in terms of protein, fiber, B vitamins and minerals (magnesium, iron, zinc, etc.). It has a low glycemic index, which results in effective detoxification. Spelt wheat is healthy, and it is beneficial for the human body. The goal of our research was to create new forms and lines of spelt wheat that are more productive than existing spelt wheat varieties that are resistant to lodging and other environmental factors.

Material and Methods: For create new lines of Triticum aestivum ssp. spelta we used intraspecific hybridization. We used five varietis from other countries (Titan, three unknows sorts and Arctic).as initial material and other varieties of spelt winter wheat created by us in our laboratory. We have sown our material according to principle one ear – one line. The length of the plots in the selection field was 1.5 m. and the distance between the rows was 40 cm. As a control variety we used the Titan variety from Czech Republic The surface of control field has been - 5 m2. The selection field have been sown manually.

Results: For crosses, we selected the 10 best parental parents (mother, father) in intraspecific crosses (spelt x spelt). The percentage of grain binding varied this year from 6.2% at combination Arctic x Titan to 59.6%, the Arctic x Spelta Rom combination. The height of the plants in the collection ranged from 115 to 143 cm. The best spelt wheat genotypes were harvested from the selection field and selected on base of productivity, quality, and resistance to lodging, drought, and disease. Plant height in this field was ranged from 65 to 150 cm. The harvested samples demonstrated good and very good lodging resistance. The yield of the selected spelt genotypes ranged from 200 g/0.6 m² to 315 g/0.6 m². The yield of spelt wheat were slightly lower than those of common wheat. The two best naked-grain samples had a yield from 260 g/0.6 m² (IS pop Arctic) and 320 g/0.6 m² (IS pop Titan), compared to 200 g/0.6 m² for Titan (control) and 290 g/0.6 m² for Kuialnic (common wheat,

control). The best samples were sown in the control field in the autumn of 2024. In 2025, the highest yield was produced by line KK 3 (2.8 t/ha), compared to the control variety Titan (2.2 t/ha).

Conclusions The percentage of grain binding varied this year from 6.2% - (Titan x Arctic combination) to 59.6%, the Arctic x Spelta. The two best naked-grain samples had a yield - 315 g/0.6 m² (IS pop Titan) and 260 g/0.6 m² (IS pop Arctic), compared to 200 g/0.6 m² for Titan (control). In 2025, the highest yield was produced by line KK 3 (2.8 t/ha), compared to the control variety Titan (2.2 t/ha).

Keywords: Spelt, Productivity, Line, Form, Control, Variety.

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EVALUATION OF INBRED MAIZE LINES FOR RESISTANCE TO MAJOR DISEASES

GRAJDIERU Cristina*, https://orcid.org/0000-0003-1560-7924
BILICI Elena, https://orcid.org/0000-0002-2360-5518

Moldova State University, Institute of Genetics Physiology and Plant Protection, Chisinau, Republic of Moldova,
**Corresponding e-mail: cristina.grajdieru@sti.usm.md*

The objective of the research was to monitor maize collection material for resistance to major diseases under field conditions of experimental plots of the Institute of Genetics, Physiology and Plant Protection. This made it possible to identify and expand the genetic diversity of maize in terms of tolerance and adaptability. It contributed to the expansion of specialized collections with resistance donors. The field trials utilized 8 inbred maize lines from the maize collection of the Plant Genetic Resources Laboratory at the Institute of Genetic Resources for Food Crops. The collection samples were evaluated under natural infection conditions. When setting up the field trials, the traditional planting scheme and agricultural practices for this crop were used. The morphological and biological parameters of the plants were characterized according to the classification system for this crop.

For morphological assessment of diseases, two indicators were determined in field: the spread or number of infected plants in the plot, and the progression or degree of organ infection. A point-based assessment of disease severity was conducted using the following scale: 0-healthy plants; 1-mild infection of an organ or plant; 2-moderate infection, with no severely infected organs; 3-severe infection of plant parts and plant death. Symptom assessment was coupled with molecular analysis via PCR tests with primers to certain fungal diseases.

The effectiveness of assessing the disease resistance of collection samples depends on the presence of an infectious background and the conditions that shape it. Excessive precipitation at the beginning of 2023 contributed to the spread of a number of diseases. Symptoms of smut and powdery smut were observed before and after the flowering phase of male and female inflorescences. The prevalence of Ustilago maydis in mid-early lines was recorded at 2.2% (mean value), with disease severity ranging from 0 to 2 points. The Chișinău 245 (CP386) line, as well as the MAN 2450B line (R = 9%), exhibited the highest susceptibility (R = 12%). The

inbred line MAN 2457 (R = 5%) was classified as slightly susceptible. No characteristic symptoms of this phytopathogen were detected in plants of the following lines: MAN2084, MAN2457, MAN2010, MAN2460, and A634, which allowed them to be classified as resistant.

During harvesting, the severity of damage was assessed while culling cobs infected with Fusarium wilt. Analysis of the data revealed genotypic differences in the prevalence and progression of the disease. The average percentage of damaged cobs across the selected samples in the collection was low (2.1%). The Chișinău 245 line was identified as the most susceptible to Fusarium wilt (R=24%). This index was significantly lower (5%) for the MAN2084 line. No symptoms of Fusarium wilt were detected in six inbred lines. Molecular analysis revealed sources of infection such as F. verticillioides and F. oxysporum.

Therefore, field evaluations identified four self-pollinated maize lines that exhibited resistance to major diseases under natural infection conditions

Keywords: maize, fungi, PCR.

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VARIOUS DEFINITIONS OF WATER STRESS IN BIOLOGY AND SUSTAINABLE DEVELOPMENT

HARCIUC Oleg*, https://orcid.org/0000-0003-3488-5321
CHISTOL Marcela, https://orcid.org/0000-0001-8594-151X
MALII Aliona, https://orcid.org/0000-0003-2674-000X

Moldova State University, Institute of Genetics, Physiology and Plant Protection, Chișinău, Republic of Moldova
**Corresponding e-mail: oleg.harciuc@sti.usm.md*

The aim of our work was to evaluate the role of different definitions of water stress (at the level of the country or in plant biology) in sustainable development.

In plant biology the measure of water stress is Relative Water Content (RWC): RWC (%)= (Fresh weight-Dry weight)/(Turgid weight-Dry weight). To determine the level of water stress at the plant level, the study used soybean plants grown in pots under controlled conditions. The experimental design included optimal water availability and complex stress (salinity plus drought). In sustainable development, water stress measures demand relative to renewable freshwater availability. According to the indicator 6.4.2. Water Stress (%)= TFWW/(TRWR-EFR)*100, TFWW – Total Freshwater Withdrawal across sectors (agriculture, industry, municipal), TRWR – Total Renewwable Freshwater Resourses (internal surface/groundwater+external flows), EFR – Environmental Flow Requirements needed to sustain aquatic ecosystems. At the level of the country also possible to use the Falkenmark Water Stress Indicator that measures renewable water available per person per year (m^3/capita/year).

The concept of water stress bridges biological or global frameworks. It is evaluated depending on whether the scale of interest is a single organism (plant biology) or an entire ecosystem/nation (sustainable development). For the soybean plant leaves in optimal conditions RWC value was 92,3±1,1% (35 days after planting, DAP), that correspond the healthy plant tissue (RWC=85-95%). Under stress conditions the RWC value was 78,3±0,8% (35 DAP) and 50,8±0,1% (72 DAP); these values correspond the moderate (RWC=85-95%) and severe stress (RWC<60-70%). In sustainable development are used other water stress definitions. For Moldova Falkenmark Water Stress Indicator ~3,000 to 3,030 m^3/capita/year. This includes external inflows from transboundary rivers like the Dniester (Nistru) and Prut. Such an interpretation

of the Falkenmark Water Stress Indicator puts Moldova well above the standard water-stress threshold. But if you look strictly at water generated *internally* within Moldova's borders (excluding transboundary inflows), the renewable availability drops, placing the country under level of absolute internal water scarcity. For Moldova the value of indicator 6.4.2. SDG in 2021-2023 was 12,41% (No Stress). The value of indicator 6.4.2. depends on the value of TFWW across sectors (agriculture, industry, municipal), mainly from agriculture, where the value of indicator 6.4.1. is two orders of magnitude smaller than in other sectors (industry, municipal).

Conclusions. Different definitions of water stress give different results. Reducing of water stress in the context of sustainable development is possible through an increase in the service sector taking into account the traditional employment structure of the population.

Keywords: water stress, plant biology, sustainable development.

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DETECTION OF FUSARIUM FUNGI AND *Erwinia amylovora* IN APLLES OF FOUR DIFFERENT CULTIVARS AT DIFFERENT STAGES OF VEGETATION PLANTED IN ORCHARDS AND LISIMETER

IGNATOVA Zoia*, https://orcid.org/0000-0003-1171-5928
CUZNETOVA Irina, https://orcid.org/0000-0001-5810-6244

Moldova State University, Institute of Genetics Physiology and Plant Protection, Chisinau, Republic of Moldova,
**Corresponding e-mail: zoia.ignatova@sti.usm.md*

In recent years, due to changing environmental conditions, a decline in the overall immunity of apple trees has been observed in apple orchards. Due to weather stress, a new disease has emerged in the apple tree community: core rot, which is caused, among other things, by the fungal pathogen Fusarium avenaceum. The fungus Fusarium equiseti causes fusarium wilt of apple trees, which causes fruit rot during ripening and storage. Fire blight, caused by the quarantine bacterium Erwinia amylovora, is one of the most dangerous diseases of fruit crops. It can infect numerous trees in a short period of time, causing significant damage to fruit production.

Early detection and identification of pathogens will improve the effectiveness of measures to mitigate the impact of pathogens on fruit yields and prevent the spread of pathogens.DNA-based diagnostic methods enable rapid and accurate detection of pathogens affecting apple trees. DNA samples from four apple varieties grown in an orchard—Golden Delicious and Renet Simirenco—and in a lysimeter—Golden Spur and Granny Smith—were used to identify the studied pathogens at different stages of the growing season. DNA was extracted from leaf primordia, developed leaves, ovaries, and mature fruits using a 2% SDS buffer, and DNA was purified using the CTAB protocol. Nested PCR with species-specific primers was used to detect the pathogens, and PCR results were visualized on a 1.5% agarose gel under UV light.

Fusarium spp. and *Fusarium avenaceum* were detected in DNA samples from young leaves of apple trees from the orchard. Fusarium spp. were also detected in DNA samples extracted from leaves and young ovaries of Granny Smith apple trees growing in a lysimeter. In Golden Spur apple trees growing in a lysimeter, when tested for the presence of the four studied pathogens, only Fusarium spp. were detected in leaf DNA, and the bacterial pathogen Erwinia amylovora was detected in

ovary DNA. The pathogen *Erwinia amylovora* was also identified in leaf and ovary DNA of Granny Smith apple trees, and the fungal pathogen Fusarium avenaceum was detected only in ovary DNA samples of this variety.

At the fruit formation stage in the orchard, Fusarium spp. was detected in both leaves and fruits of the Golden Delicious variety; in addition, F. equiseti was identified in the fruits of this variety. In DNA samples of the Renet Simirenco variety, Fusarium spp. was detected only in leaves. Fusarium spp. was identified in the DNA of leaves and developing fruits of the Golden Spur apple variety and in the fruits of Granny Smith. In DNA samples extracted from mature apple fruits before storage, Fusarium spp. was detected in the Granny Smith and Renet Simirenco varieties. In addition, F. avenaceum was additionally detected in the Granny Smith variety. Molecular DNA testing of fruits after 2 months of storage at a temperature of 1 °C and 90% humidity showed that the pathogen Fusarium spp. was determined in 3 varieties, and F. avenaceum was also detected in 3 varieties. The other studied pathogens were not detected.

Keywords: apple, Erwinia, Fusarium, PCR.

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INFLUENCE OF CLIMATIC CONDITIONS ON DROUGHT TOLERANCE AND BAKING QUALITY IN COMMON WHEAT

JELEV Natalia*, https://orcid.org/0000-0002-1664-6055
GORE Andrei, https://orcid.org/0009-0002-7356-7289
DELEAN Tatiana, https://orcid.org/0009-0004-4084-6956

Moldova State University, Institute of Genetics Physiology and Plant Protection, Chisinau, Republic of Moldova,
**Corresponding e-mail:* natalia.jelev@sti.usm.md

Climate change is expected to increase the frequency and severity of drought events and accelerate agricultural land degradation, thereby affecting the suitability of areas for winter wheat cultivation. Consequently, both grain yield and technological quality may be significantly influenced by environmental conditions during the growing season. Climate-resilient wheat cultivars are therefore becoming an important priority for modern breeding programs.

The purpose. To evaluate the adaptability of winter wheat cultivars to the climatic conditions of 2025 by examining physiological, biochemical, and grain quality traits.

Materials and Methods. The study was conducted on the winter wheat cultivars *Meleag, Moldova 614, Moldova 5,* and *Bijuteria Zâmbrenilor*, grown under field conditions at the Institute of Genetics, Physiology and Plant Protection, MSU. Photosynthetic pigments (chlorophyll *a*, chlorophyll *b*, and carotenoids) were determined in flag leaves at the heading, flowering, and milk development stages according to Lichtenthaler (1987). The contents of L-proline and soluble sugars were quantified at flowering and milk development stages, while grain quality was assessed using wet and dry gluten content, gluten deformation index, and thousand-kernel weight. Statistical analysis of the experimental data was performed using ANOVA and Tukey's test.

Results. Photosynthetic pigment dynamics varied with developmental stage and genotype. Chlorophyll *a* and carotenoid contents decreased after flowering, whereas *Meleag* and *Moldova 614* maintained higher pigment levels throughout the study period, indicating greater stability of the photosynthetic apparatus under drought conditions. L-proline and soluble sugars accumulated during grain development,

reflecting the activation of osmoregulatory and cellular protective mechanisms. These metabolic adjustments represent important adaptive responses that contribute to maintaining cellular homeostasis under drought and elevated temperature stress. Considerable variability among the studied cultivars was observed for gluten content and thousand-kernel weight, with several genotypes exceeding the standard cultivar *Kuialnic*. Furthermore, the gluten deformation index remained within the optimal parameters for breadmaking in drought-tolerant cultivars. A strong correlation was found between high flag leaf chlorophyll retention and final thousand-kernel weight. The obtained results highlight the importance of combining physiological and technological traits for the evaluation of wheat adaptation to adverse environmental conditions.

Conclusions. Photosynthetic stability, osmolyte accumulation, and grain quality traits are complementary indicators for identifying drought-adaptive winter wheat genotypes. The cultivars characterized by higher pigment retention and enhanced osmolyte accumulation exhibited a greater adaptive potential under the climatic conditions of 2025. The genotype *Bijuteria Zâmbrenilor* also demonstrated balanced biochemical indicators suitable for regional cultivation. These traits can be effectively incorporated into breeding programs aimed at improving stress tolerance, productivity, and grain quality. The identified physiological markers will help screen early-generation hybrid lines during severe heat stress.

Keywords: winter wheat, drought stress, photosynthetic pigments, L-proline, soluble sugars, grain quality.

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USING EVOLUTIONARY APPROACHES TO PROTECT PLANTS FROM ULTRAVIOLET STRESS

KOLOMIETS Irina, https://orcid.org/0009-0009-5185-6435

Moldova State University, Institute of Ecology and Geography,
Chisinau, Republic of Moldova,
Corresponding e-mail: *ikolomiec71@gmail.com*

Purpose. The escalating race to explore near-Earth space, leading to ozone layer depletion, and the violation of international agreements on its use could lead to irreversible, catastrophic consequences on a global scale. Theoretical modeling of ultraviolet stress has shown that a 10% decrease in ozone levels can lead to a 15-20% increase in UV irradiation. A decrease in the productivity of both artificial and natural plant communities is one of the most significant changes caused by exposure to elevated doses of UV radiation. Therefore, protecting plants from UV stress is a priority goal of modern science. An evolutionary approach has been adopted as the methodological basis for the search for plant protectors against UV stress. Considering that the first photosynthetic organisms arose during a period when the ozone layer was underdeveloped, protective mechanisms against UV radiation should have evolved. We hypothesize that bioluminescence may be such a mechanism. An endogenous organic fluorophore, *Acidum salicylicum*, has been proposed as a protector against UV stress. It can absorb electromagnetic radiation in the UV range and emit it in the visible range.

Materials and methods. The studies were conducted on genetically homogeneous material of maize (*Zea mays* L.). Experimental maize seeds pre-soaked in water were placed in Petri dishes and irradiated with a BOP-9 apparatus with PRB-8 lamps in the range of 180-280 nm, a power of 10 W, radiation energy of 300, 600, 900, 1200 W·s, a radiation dose of 5000, 1000, 15000 and 20000 J/m^2, with an exposure of 30, 60, 90 and 120 s at a distance of 1 m.

Results. Our research showed that pre-sowing treatment of maize seeds with a UV dose of 20000 J·s/m² has an effect throughout the entire developmental period, leading to a 20–25% yield reduction. Soaking *Zea mays* L. seeds in an aqueous solution of *Acidum salicylicum* at a concentration of 32 mg/L mitigates this effect. The protective effect was observed both in laboratory and field conditions. In the field, seed treatment, soil drenching, and spraying of plants with a fluorophore during the

virginal stage of development were used. The maximum protective effect under UV stress was observed when soaking seeds in an aqueous fluorophore solution.

Conclusion. The use of organic fluorophores with absorption maxima in the ultraviolet and visible ranges will reduce the risk of reduced productivity in both artificial and natural plant communities under conditions of increased solar radiation.

Keywords: protection, plants, maize, plant community, ultraviolet stress, evolution, fluorophores, solar radiation.

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SOURCES OF INITIAL MATERIAL FOR THE SELECTION OF PINK-FRUIT TOMATOES

MAKOVEI Milania, https://orcid.org/0009-0009-5039-6270

Moldova State University, Institute of Genetics Physiology and Plant Protection, Chisinau, Republic of Moldova,
Corresponding e-mail: *milania.makovei@sti.usm.md*

The upward trend of increasing consumption of pink-fruited tomato varieties in the past two decades in the Republic of Moldova has become quite stable, which necessitates the creation of a wide range of varieties for cultivation in various conditions. Expanding breeding programs for the creation of commercial pink-fruited varieties and heterotic hybrids of tomatoes with high taste qualities of fruits is possible only with the availability of appropriate initial material.

Therefore, the aim of our research was to search for genetic sources of initial material with pink-colored fruits, different in shape and size, with increased skin elasticity and high taste qualities, while combining high resistance to biotic and abiotic stress factors.

To identify sources with the desired set of breeding traits, more than 200 genotypes were tested, including 35 from the collection of old local varieties, 125 mutant tomato genotypes, and more than 50 variety samples from domestic and foreign breeding programs.

Valuable gene sources were identified (Dikaia Rosa, Mikado, L443, L444, L1454, L1456, Mo 334, Mo 460, Mo 463, Mo 489, Mo 620, Mo 638, La 3539, etc.) with high taste qualities have been identified, which during the filling and ripening period of the fruit have high skin elasticity, showing resistance to cracking even under provocative conditions with unregulated watering. They are also carriers of genes resistant to tobacco mosaic virus (*Tm-2, Tm^{2a}*) and other highly aggressive crop diseases *(Frl, Asc, Cf-13, Mi*). The pink-fruited genotypes differed in the type of growth, pattern, habitus, and architectonics of the plants. Of the 32 identified pink-fruited forms, 14 had a determinant type of plant growth. They differed in the weight of the fruit, which ranged from 20 to 350 grams and had rounded, flat-rounded, plum-shaped, pear-shaped and cylindrical shapes. Five genotypes had a semi-deterministic type of growth patterns, while the rest were distributed into a group of indeterminate genotypes with different plant growth rates.

There are also differences in fruit ripening times: ultra-early (85-97 days), early (100-110 days), mid-season (111-120 days), and late (121-132 days). Within each of these groups, genotypes differ in shape, color intensity (light pink, intense pink, cyclamen, and pink with yellow and green stripes), weight, pericarp thickness, and skin elasticity, which does not crack when the plants are grown in both unregulated and drip irrigation conditions. They have been included in breeding programs as donors for the creation of new pink-fruit varieties and F_1 heterotic hybrids of intensive-type tomatoes, which will expand and enrich the market assortment of the Republic of Moldova with pink-fruit tomato products, which are still in short supply but widely in demand.

Significant differences were also found between the identified genotypes in terms of fruit ripening time, from mass emergence to mass ripening: – ultra-early ripening (85-99 days), early ripening (100-110 days), mid-season ripening (111-120 days), and late ripening (121-132 days).

These genotypes also differ in color intensity (light pink, dark pink, cyclamen, and pink with yellow and green stripes) and skin elasticity, which does not crack when grown under both uncontrolled and drip irrigation. The inclusion of these genotypes in breeding will expand the genetic diversity of the tomato cultural gene pool and replenish working collections with valuable genes that control these traits.

Keywords: tomato, genetic resources of pink-fruited forms, quantitative traits, selection

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ADAPTABILITY OF SOYBEAN GENOTYPES OBTAINED THROUGH EXPERIMENTAL MUTAGENESIS

MALII Aliona*, https://orcid.org/0000-0003-2674-000X
HARCIUC Oleg, https://orcid.org/0000-0003-3488-5321

Moldova State University, Institute of Genetics Physiology and Plant Protection, Chisinau, Republic of Moldova,
**Corresponding e-mail*: *aliona.malii@sti.usm.md*

Soybean is one of the most important leguminous crops due to its high nutritional value and wide use in food, feed, and agriculture. In the context of climate change, drought and temperature fluctuations are major constraints affecting soybean productivity. Therefore, the development of soybean genotypes with improved adaptability and tolerance to abiotic stress is an important objective in breeding and plant protection. Experimental mutagenesis is an effective approach for generating genetic variability and identifying valuable forms with improved agronomic performance.

The aim of the study was to evaluate the adaptability of soybean genotypes obtained through experimental mutagenesis in order to identify forms with high yield potential and improved tolerance to unfavorable environmental conditions.

The biological material included the soybean genotypes Clavera, Lăduța, and the experimental line $Z3M_{10}$ 100, subjected to X-ray irradiation at doses of 100, 150, 200, and 250 Gy. Field experiments were conducted in 2025 on the experimental plots of IGFPP, MSU. Plant height, number of nodes, number of pods per plant, seed weight, and plant productivity were evaluated, while trait variability was assessed using the coefficient of variation.

The results revealed a differentiated effect of irradiation doses on the expression of the studied traits. Moderate doses promoted useful variability while maintaining plant viability, whereas higher doses exerted an inhibitory effect on plant growth and productivity. Several experimental genotypes showed a more uniform expression of morpho-productive traits, characterized by lower coefficients of variation and better adaptation to field conditions. At the same time, some mutant lines were distinguished by superior productive potential, expressed through a higher number of pods per plant, increased seed weight, and better overall plant productivity compared with

the initial forms. The analysis also showed that the response of soybean genotypes to mutagenic treatment depended on both the irradiation dose and the genetic background of the biological material, highlighting the importance of genotype-specific evaluation in mutagenesis-based breeding programs.

In conclusion, experimental mutagenesis proved to be an efficient approach for creating genetic variability in soybean and for selecting valuable genotypes for breeding. The identified genotypes may serve as promising sources for the development of new soybean varieties with improved tolerance to abiotic stress and enhanced resilience under variable climatic conditions.

Keywords: soybean, mutagenesis, adaptability, X-rays, abiotic stress.

Acknowledgments. The research was carried out within the framework of the Subprogramme 011102 "Extension and conservation of genetic diversity, improvement of gene pools of agricultural crops in the context of climate change" financed by the Ministry of Education and Research of Republic of Moldova.

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INTEGRATED APPROACHES TO IMPROVING STRESS RESISTANCE IN TOMATOES

MARII Liliana*, https://orcid.org/0000-0002-2610-8285
CHITROSAN Liliana, https://orcid.org/0009-0001-9591-1514
URSACHI Olga, https://orcid.org/0009-0007-0637-5887

Moldova State University, Institute of Genetics Physiology and Plant Protection, Chisinau, Republic of Moldova,
**Corresponding e-mail*: *liliana.marii@sti.usm.md*

The study evaluates the transgenerational effects of combining induced mutagenesis with targeted selection schemes to improve drought tolerance in tomatoes (*Solanum lycopersicum*). Specifically, we analyzed the germination rate under current drought stress (DS) as a function of ancestral X-ray irradiation in the M0 generation (0, 250, 300, and 350 Gy). The objective was to compare the efficiency of two distinct M1 selection criteria: a general productivity-based selection (Study 1) and a directed physiological selection based on the plants' ability to set fruit under extreme thermal stress of 42–50^0 C for at least one hour daily (Study 2). The evaluation of the M2 progenies was carried out by determining the germination index under optimal conditions (Control) and under PEG 6000-induced water deficit stress (DS). The biological material included tomato genotypes exposed to X-ray irradiation in M0, along with non-irradiated.

Our results revealed distinct transgenerational responses in seed germination heavily dependent on both the genetic background and the M1 selection environment. The ancestral irradiation factor did not uniformly alter baseline germination, but acted as a background vulnerability factor under current DS, particularly at high doses of 300–350 Gy. Concurrently, the parental stress history served as a specific modulator, with distinct environmental schemes either stabilizing or selectively collapsing the progeny's norm of reaction depending on the genotype. In Study 1, X irradiation exerted no visible reductive pressure under either control (5% reduction) or drought conditions (10 % reduction); variations were predominantly determined by the native potential of the selected lines, with isolated instances of index stimulation (from 74 to 89%). Conversely, in Study 2, where seeds developed under extreme parental thermal stress, the presence of irradiation exacerbated the adaptive decline. In the As30L genotype, transitioning to irradiated variants drastically decreased DS

germination from 38% to 23%, whereas in the As42L genotype, the mutagenic effect was fully buffered, with DS germination remaining stable at 55.0% across both non-irradiated and irradiated variants.

Seed origin left a specific imprint on the stress response: a comparative analysis of As30 lines between the two parental environments showed a germination index of 88% (78-96%) under control conditions and 67% (50-90%) under DS for Study 1, dropping to 61% (43-77%) under control and 28% (10-43%) under DS for Study 2. Meanwhile, the As40 genotype demonstrated superior homeostatic stability, recording 96% (88-100%) under control and 66% (42-96%) under DS in Study 1, while maintaining 88% (80-93%) under control and 46% (30-73%) under DS in Study 2.

In conclusion, high-temperature selection collapses the adaptive norm of sensitive lines under drought, while robust genotypes maintain homeostasis. Thus, combining mutagenesis with parental stress is a genotype-dependent strategy gated strictly by the baseline tolerance of the genetic background. Furthermore, these divergent responses indicate that extreme ancestral heat acts as an selective filter rather than an inductor of universal tolerance, meaning that multi-stress breeding programs must prioritize initial genetic architecture over mutagenic stimulation to avoid cumulative vigor loss.

Keywords*:* Tomato, drough, germination rate, X-ray, parental environment.

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DETERMINATION OF YIELD AND YIELD COMPONENTS AND REACTIONS TO BACTERIAL BLIGHT DISEASE OF WINTER PEA *(Pisum sativum* L.) GENOTYPES UNDER MEDITERRANEAN CONDITIONS

MART Dürdane, https://orcid.org/0000-0002-2944-1227

Eastern Mediterranean Agricultural Research Institute, Adana, Türkiye
Corresponding e-mail: *durdane.mart@tarimorman.com.tr*

Objective: This study aimed to determine the agronomic and morphological characteristics of selected dry pea (*Pisum sativum* L.) genotypes grown as winter crops under Mediterranean conditions, identify superior genotypes for grain yield and yield components, and evaluate their adaptation to winter cultivation and reactions to bacterial blight. It also aimed to identify high-yielding, regionally adapted, and disease-tolerant genotypes as promising materials for pea variety development.

Materials and Methods

The study was conducted from 2019 to 2021 at the Adana location of the Directorate of Eastern Mediterranean Agricultural Research Institute. Twenty nationally sourced dry pea genotypes were evaluated in three replications using a Randomized Complete Block Design. Four-row plots were established with 45 cm between rows, 8 cm between plants, a plot length of 5 m, and a plot area of 9 m². Before sowing, 2-3 kg N and 5-6 kg P_2O_5 per decare were applied. The experimental site was located at 36°51′17.21″ N and 35°20′41.61″ E, at 23 m above sea level. Grain yield, 100-seed weight, days to flowering, days to pod setting, plant height, first pod height, and reactions to bacterial blight were evaluated.

Results and Conclusion

Grain yield varied across years and genotypes. In the first year, the highest yield was obtained from TB-2012(36-3)-69 (453.41 kg/da) and the lowest from TB-2013(29-2) (196.22 kg/da). In the second year, TB-2013(29-2) had the highest yield (235.26 kg/da), while TR-53749-Tekirdağ had the lowest (73.93 kg/da). In the third year, the highest yield was recorded for TR-46020-Trabzon (344.59 kg/da) and the lowest for Türkiye-16-16pop (155.70 kg/da). Three-year mean grain yield ranged

from 178.86 to 295.65 kg/da, with the highest value in TB-2012(36-3)-69 (295.65 kg/da) and the lowest in TR-53749-Tekirdağ (178.86 kg/da). Three-year means ranged from 14.62 to 22.42 g for 100-seed weight, 59.50-74.50 days for flowering, 78.17-90.67 days for pod setting, 78.14-132.78 cm for plant height, and 34.60-57.51 cm for first pod height. Bacterial blight development and severity were influenced by both genotype and environmental factors, particularly temperature, rainfall, and humidity. The genotypes TB-2012(36-3)-69, Türkiye-3, Antalya-23, and TR-46020-Trabzon were identified as promising materials based on grain yield, agronomic and morphological traits, and disease reactions for further cultivar registration studies.

Keywords: Pea (*Pisum sativum* L.), bacterial blight, grain yield, yield components, genotype, winter cultivation.

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WINTER CHICKPEA (*Cicer arietinum* L.) BREEDING: YIELD, MORPHOLOGICAL TRAITS, AND ASCOCHYTA BLIGHT UNDER EASTERN MEDITERRANEAN CONDITIONS

MART Dürdane*, https://orcid.org/0000-0002-2944-1227
TÜRKERI, Meltem, https://orcid.org/0000-0001-5225-967X
ÖZKAYA İmadettin, https://orcid.org/0009-0009-0229-4819

Eastern Mediterranean Agricultural Research Institute, Adana, Türkiye
**Corresponding e-mail*: *durdane.mart@tarimorman.com.tr*

Objective: This study aimed to determine the agronomic and morphological characteristics, grain yield and yield components of chickpea (*Cicer arietinum* L.) genotypes grown as a winter crop under Eastern Mediterranean conditions and to evaluate their tolerance to Ascochyta blight. It also aimed to support the selection of genotypes suitable for developing cultivars well adapted to regional conditions, high yielding, resistant or tolerant to diseases and pests, compliant with quality and market standards, and suitable for mechanized production.

Materials and Methods: The study was conducted in 2024 at the Doğankent location in Adana Province as part of a national breeding project aimed at developing chickpea cultivars resistant or tolerant to Ascochyta blight. The experimental site was located at 23 m above sea level, at 36°51′17.21″ N and 35°20′41.61″ E. Twenty chickpea lines and cultivars were evaluated. The experiment was conducted as a winter crop under Eastern Mediterranean conditions using a randomized complete block design with three replications. Each plot consisted of four 5-m rows, with 45 cm between rows and 6 cm between plants, giving a plot area of 9 m². Before sowing, 2–3 kg N da^{-1} and 5–6 kg P_2O_5 da^{-1} were applied. Grain yield (kg da^{-1}), 100-seed weight (g), days to flowering, days to pod setting, plant height (cm), and first pod height (cm) were determined for each genotype, and reactions to Ascochyta blight were evaluated.

Results and Conclusion: Grain yield ranged from 74.94 to 242.00 kg da^{-1}. The highest yield was obtained from Caner × Osmaniye 1 (242.00 kg da^{-1}), whereas the lowest was recorded for Sezenbey × Tatlar-2 (74.94 kg da^{-1}). The 100-seed weight ranged from 37.50 to 56.05 g, with the highest value in Sezenbey × Tatlar-2 and the lowest in İnci. Days to flowering ranged from 78.00 to 86.66 days, days to pod set-

ting from 88.33 to 97.33 days, plant height from 59.45 to 81.66 cm, and first pod height from 26.11 to 39.44 cm. Based on grain yield performance, Caner × Osmaniye 1, Tüb × 2016 F5 Pop4-2, İnci, and Seçkin were identified as promising breeding materials for cultivar development under Eastern Mediterranean conditions. Disease evaluations indicated that earliness, precipitation, and 100-seed weight were associated with Ascochyta blight development. In particular, earliness and environmental conditions may affect disease onset and severity. However, multi-location and multi-year studies are required to reliably characterize genotype tolerance and genotype × environment interactions. These findings may contribute to breeding efforts aimed at developing high-yielding chickpea cultivars adapted to Eastern Mediterranean conditions and tolerant to Ascochyta blight.

Keywords: Chickpea (*Cicer arietinum* L.), Ascochyta blight, Agro-morphological traits, yield.

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ASPECTS REGARDING THE ADAPTABILITY OF CERTAIN SPECIES OF THE GENUS *Cuphea* TO COMBINED ABIOTIC STRESS

MIHAILA Victoria*, https://orcid.org/0000-0003-3984-9477
GANEA Anatolie, https://orcid.org/0000-0002-8658-6879

Moldova State University, Institute of Genetics Physiology and Plant Protection, Chisinau, Republic of Moldova,
**Corresponding e-mail: victoria.mihaila@sti.usm.md*

The aim of the research is to determine the degree of resistance of certain species of the genus *Cuphea* to high temperatures and drought. The biological material studied was represented by the genotypes: *Cuphea lanceolata* Ait. (I), *Cuphea lutea* Rose (II), and *Cuphea viscosissima* Jacq. (III). Selection at the male gametophyte level was employed as the research method, involving *in vitro* pollen viability testing on a sucrose substrate (15%), while exposure of pollen samples to a temperature of +46°C for up to 2.5 hours served as the stress factor. To gain a deeper understanding of the heat tolerance of *Cuphea* species, we also employed the conductometric method, which allows for the estimation of leaf tissue cell membrane permeability under conditions of excessive temperature. Cellular electrolyte conductivity was measured following the exposure of leaf segments immersed in deionized water to temperatures of +48°C and 100°C, relative to the control [5]. The cell membrane stability index (MTS) and the cell relative membrane injury (RI) were determined.
Pollen resistance to temperature manifested as viability varies according to genotype and the duration of exposure to stress-inducing temperatures. For species I and III, this parameter decreased significantly within 1.5 hours, dropping to 64.0% and 67.0%, respectively. Extending the duration of the stress factor to 2.5 hours caused this index to fall to a minimum level (below 5%) in some samples of species I, whereas under control conditions, the value ranged from 87.3% to 98.0%. Sample MDI 02166 stood out for maintaining a pollen viability of 66.0% after 2.5 hours. The highest sensitivity to heat stress was observed in species II, where viability dropped to 6.8% after 10 minutes, compared to 91.0% for the control. The assessment of cellular heat stability in the leaves of *Cuphea* species revealed a wide range of MTS levels. This allowed the genotypes to be divided into three groups: group I includes samples with MTS values in the 60–80% range (MDI 02147, MDI 02158,

MDI 02159, MDI 02160, MDI 02162, MDI 02167, MDI 04084, MDI 04085, MDI 02234, MDI 02172). Group II comprises samples with MTS levels between 40.0% and 60.0% (MDI 02163, MDI 02164, MDI 02165, MDI 02166), while group III includes genotypes with MTS values below 40% (MDI 02145, MDI 02172). The degree of cell membrane damage also varied significantly; the lowest RI level was observed in sample MDI02147 (I) at 9.0%, while the most sensitive was sample MDI 02234 at 80.0% (III). Evaluating the heat tolerance of *Cuphea* species using the aforementioned methods enabled the identification of genotypes with enhanced resistance; however, the results revealed only a partial consistency in their response to stress conditions. The increased variety of evaluated indices offers the possibility of selecting samples with superior potential for adaptability to combined abiotic stress.

Keywords: pollen viability, membrane thermostability, relative membrane injury.

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EFFECTS OF HIGH TEMPERATURE ON GROWTH CHARACTERISTICS OF ADVANCED TOMATO BREEDING LINES

MIHNEA Nadejda[1,*], https://orcid.org/0000-0003-0304-3295
AMBĂRUS Silvica[2], https://orcid.org/0000-0002-9623-6602

[1]*Moldova State University, Institute of Genetics Physiology and Plant Protection, Chisinau, Republic of Moldova*
[2]*Vegetable Research and Development Station Bacau, Romania*
**Corresponding e-mail*: *nadejda.mihnea@sti.usm.md*

In the current context of climate change, vegetable producers require genetic resources capable of withstanding heat and drought stress, while consumers particularly value local tomato varieties for their superior taste and diverse uses. The aim of this research was to study the variability of heat stress tolerance in new tomato lines, to identify the most valuable genotypes, and to incorporate them into breeding programs.

Ten promising tomato lines were used as research material. Of these, five lines were developed at the Institute of Genetics, Physiology and Plant Protection (IGPPP) (L 108, L 109, L 110, L 111, and L 112), and five at the Vegetable Research and Development Station, Bacău, Romania (L 97, L 100, L 201, L 270, and L 273). The heat stress tolerance of the tomato samples was evaluated based on the growth capacity of the embryonic radicle, hypocotyl, and intact seedling over a period of 7 days after exposure, on the fourth day, to a temperature of 43°C for 6 hours. Seedlings grown at 25°C served as the control. The evaluation of the response of tomato lines to different temperature levels with respect to growth traits during early ontogeny demonstrated that radicle length under optimal conditions ranged from 28.7 to 61.8 mm, while at 43°C it varied between 17.5 and 31.6 mm. The degree of growth inhibition in the studied genotypes ranged from -8.4% to -59.5% compared with the optimal conditions. A strong inhibitory effect was observed in lines L 111 (-59.5%) and L 273 (-50.7%). The Romanian lines L 97 and L 201 exhibited the highest level of heat tolerance, with tolerance values of 80.6% and 91.6%, respectively. In these lines, radicle length decreased by only 19.4% and 8.4%, respectively, compared with the optimal temperature treatment. Regarding hypocotyl length, growth inhibition at 43°C was significant in five lines: L109, L 110, L 111, L 149, and L 273, with reduc-

tions of 43.1%, 44.0%, 43.3%, 49.4%, and 45.3%, respectively. In contrast, stimulation of hypocotyl growth was observed in line L201, where growth increased by 36.7% compared with the control. In the remaining lines, growth inhibition ranged from 13.0% to 33.3%. With respect to seedling length, a reduction compared with the control was recorded in most genotypes, varying from 23.9% to 54.8%. At the same time, exposure to 43°C stimulated seedling growth in line L 201, resulting in a 10.3% increase relative to the control. Cluster analysis (k-means method) demonstrated that inter-cluster variance was considerably higher than intra-cluster variance for the studied traits, indicating pronounced differences among the investigated genotypes. By classifying the genotypes based on the three growth traits, it was found that the genotype groups, separated into three clusters, differed in both the level and variability of the studied characteristics. Thus, under heat stress conditions, Cluster 1 comprised three genotypes (L 97, L 112, and L 273) characterized by the lowest values of the assessed traits. Cluster 2 included genotypes with intermediate values (L 100, L 110, L 111, and L 270). Cluster 3 consisted of genotypes L 108, L109, and L 201, which exhibited the highest values for growth traits during early tomato ontogeny and, therefore, are of particular interest for breeding programs as potential genetic sources of heat stress tolerance.

Keywords: tomato, temperature, breeding lines.

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GENETIC VARIABILITY OF DROUGHT TOLERANCE IN DOUBLE HAPLOID BREEDING OF MAIZE

MIKHAILOV Mikhail, https://orcid.org/0000-0003-1204-410X

Moldova State University, Institute of Genetics Physiology and Plant Protection, Chisinau, Republic of Moldova,
Corresponding e-mail: mihail.mihailov@sti.usm.md

Purpose. Our stepwise dihaploid (DH) selection procedure is designed to create recombinant lines from two parental maize lines (Rf7 and Ku123) with the goal of achieving superior productivity over both parents. Nine families of DH lines were obtained in four breeding cycles. Three of these families were tested during drought years, providing information on drought tolerance. Here, we will review the obtained data on the productivity of DH lines under drought conditions.

Materials and methods. Haploid seeds were obtained by the matroclinal method using the MHI inducer. In the families considered here, the maternal forms were F_1×rk-5, rk5×rk-239, and F_1×rk-433. Here, F_1 is a hybrid of Rf7×Ku123, while rk-5, rk-239, and rk-433 are DH lines selected from the first, second, and third breeding cycles due to their productivity, respectively. The genome of haploid plants was doubled using the Deimling method, and DH lines were obtained as a result of self-pollination. Three families were obtained from three maternal forms, named 2b (36 lines were tested in 2015), 3c (24 lines were tested in 2025), and 4a (44 lines were tested in 2024). The tests were carried out in a randomized block in three replicates, on a non-irrigated plot, with a density of 3 plants/m^2.

Results. The Rf7 line, which was constantly used as a control in the trials, served as an indicator of the year's conditions. In favorable years, its productivity ranged from 86 to 115 g/plant, with an average of 105 g/plant, but in 2015, it fell by half (52 g/plant). The lines of population 2b fared better in this year's conditions: compared to the favorable 2017, average productivity dropped by only 20%, from 93 to 72 g/plant. Average productivity was close to that predicted by the additive-dominant model: ¼Rf7 + ¼Ku123 + ½rk-5 = 52/4+76/4+84/2=74 g/plant, and genetic variability, measured by the standard deviation after subtracting random variation, was 20 g/plant.

We note the rk-206 line, which showed minimal sensitivity to the year's conditions. In 2015, 2016, 2017, and 2022, its productivity was 115, 135, 116, and 98 g/

plant, respectively. Rf7's productivity in the same years was 52, 121, 104, and 36 g/plant, respectively.

Populations 3c and 4a were tested only in unfavorable years. For these populations, we note only good agreement between the average productivity and that predicted by the additive-dominant model (77 versus 81 and 22 versus 26 g/plant) and relatively high genetic variability (17 and 15 g/plant).

Conclusions:

1. The average productivity of DH lines under dry conditions is satisfactorily predicted by the additive-dominant model.

2. The genetic variability in families of DH lines is sufficiently high for selection for drought resistance;

3. The DH line rk-206 has been obtained that exhibits productivity of about 100 g/plant or slightly higher in both favorable and dry conditions.

Keywords: Maize, drought tolerance, double haploids.

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IMPACT OF COLD STRESS ON WHEAT YIELD IN UKRAINE UNDER GLOBAL WARMING CONDITIONS

MISHCHENKO Ivan[1,*], https://orcid.org/0000-0002-2919-8546
DUNICH Alina[2], https://orcid.org/0000-0001-9614-3441
MOLODCHENKOVA Olga[3], https://orcid.org/0000-0003-2511-0866
DASHCHENKO Anna[1], https://orcid.org/0009-0000-9943-0710
MISHCHENKO Lidiya[2], https://orcid.org/0000-0003-0697-6971
FANIN Yaroslav[3], https://orcid.org/0000-0003-3129-7583
MOTSNYI Ivan[3], https://orcid.org/0000-0002-1812-9481

[1]National University of Life and Environmental Sciences of Ukraine, Kyiv,
[2]Taras Shevchenko National University of Kyiv, Kyiv, Ukraine,
[3]Plant Breeding&Genetics Institute-National Center of Seed and Cultivar Investigation, Odessa
**Corresponding e-mail: iamishchenko@ukr.net*

Wheat (*Triticum aestivum* L.) is one of Ukraine's primary food crops and is of immense economic importance, as it also makes a significant contribution to global food security. Wheat is not just a grain; it is an important indicator of a nation's stability. Today, we are witnessing how traditional agricultural giants are being forced to rethink their strategies. While China and India are focused on building up record domestic reserves, export-oriented countries like Ukraine are fighting for their share of global grain exports. For Ukraine, the 2024/25 season has been a test of endurance. Despite the hostilities, the area planted with wheat has stabilized at a level that not only ensures domestic security but also allows for the export of over 14–15 million metric tons. Ukraine ranks among the top ten wheat-exporting countries in the world. The wheat harvest is negatively affected by abiotic factors and plant diseases. The impact of climate change on the wheat harvest is most pronounced in the Poltava region, an arid climate zone where we conduct our own experiments. In 2025, the region suffered from frosts on April 27–29, with temperatures dropping to -4.5°C at the soil surface. The study aimed to investigate the effect of cold stress on wheat yield and to identify cold stress genes. The PCR-based primers were used to detect the *CBF-A3* gene (Babben et al. 2018). Analysis of the 2025 harvest showed that the variety least resistant to cold stress was Katrusya Odessa, which experienced a 2.7-fold decrease in yield (grain weight per spike was 1.56 g in the control and 0.58 g

under frost conditions). The var. Pylypivka proved to be more resistant to cold, yielding 2.49 and 2.0 g, respectively. Farmers received almost half the yield for different wheat varieties compared to 2024. In contrast, the varieties bred in Poltava showed significantly higher productivity under frost conditions. For example, in the Vilshana variety, the grain weight per spike was 3.1 g in 2024 and 2.9 g in 2025 under conditions of severe cold stress. Similar results were obtained for the varieties Sonata Poltavska, Zelenyi Hai, and Dykanka, Tvorchist Odeska, Favorite, Panyanka. These varieties carry the *CBF-A3* cold stress gene. In some lines developed by I. Motznyi and DSV-Ukraine in May 2024 and 2025, specific chlorotic-yellowish streaks resembling a viral infection were observed when daily temperature fluctuations exceeded 18°C. However, no viruses affecting wheat were detected. Therefore, this is a reaction to cold stress, spring frosts, and daily temperature fluctuations. These lines lack the *CBF-A3* gene. It was also not detected in the Odesa varieties Pylypivka and Katrusya Odeska, which farmers are currently planting. Importantly, we have identified the aforementioned varieties bred in Poltava that carry the *CBF-A3* cold stress gene. They should be incorporated into the breeding program to enhance resistance not only to winter frosts but also to spring frosts.

Keywords: winter wheat, yield, frosts in April, resistance, *CBF-A3* cold stress gene.

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ZAHAREL – A NEW SWEET SORGHUM VARIETY

MORARU Gheorghe*, https://orcid.org/0009-0004-8702-9419
COTENCO Eugenia, https://orcid.org/0000-0003-0603-3404
SMIRNOVA Tatiana, https://orcid.org/0009-0006-8878-8120

Moldova State University, Institute of Genetics Physiology and Plant Protection, Chisinau, Republic of Moldova,
**Corresponding e-mail*: *gheorghe.moraru@sti.usm.md*

The trend of global warming, accompanied by an increasing frequency of drought years characterized by high temperatures and soil moisture deficits, highlights the relevance of expanding sorghum cultivation to produce animal feed (compound feed, fresh forage, silage, hay, haylage), gluten-free food products (groats, semolina, flour), various solid (briquettes, pellets) and liquid (bioethanol, biopetrol, biodiesel) energy sources, food- and feed-grade glucose syrups, as well as ecofriendly fertilizers such as biochar, urea, and ammonia. Sorghum crops are of immense importance in human nutrition and animal husbandry. Sweet sorghum stalks, for instance, contain up to 20% sugar, so the crop is used to produce syrup from the juice extracted by pressing. The syrup obtained in this way is far more beneficial than sugarcane or sugar beet syrup because it contains fructose and glucose, whereas sugar beets and sugarcane contain only sucrose. Regarding livestock farming, it is important to note that silage accounts for up to 50% or more of the total cattle feed in terms of nutritional value. Silage made from sweet sorghum and sorghum-Sudan grass hybrids is produced by harvesting the stalks of these crops during the grain-ripening stage, when the forage mass contains the highest level of dry matter, a high yield of feed units, and an optimal moisture content (approximately 70%). To rectify the situation, breeders are tasked with developing new sorghum hybrids and varieties adapted to current conditions. To this end, a new sweet sorghum variety has been created that surpasses previously developed hybrids in terms of valuable agronomic traits. The sweet sorghum hybrid population MK 46 was used as the starting material; it is characterized by a plant height of 215–230 cm and 12–15 nodes. The panicle fully emerges from the flag leaf sheath and reaches a length of 13–20 cm. It is compact to semi-compact and elongated-cylindrical, with light pink spikelet glumes showing slight pubescence at maturity. The grain is oval-shaped, variable in color, and has a starchy endosperm. Grain yield reaches up to 2.0–2.3 t/ha.

The Zaharrel sweet sorghum variety originated from individual selections and self-pollinations carried out within the 'MK 46' sweet sorghum hybrid population. Taxonomically, the Zaharrel variety belongs to the sweet sorghum species *Sorghum × drummondii (Steud.) Millsp. & Chase.* The growing season lasts 110–115 days. The plant reaches a height of 220–235 cm and has 14–15 nodes. The panicle fully emerges from the sheath of the last (flag) leaf and reaches a length of 23–25 cm; it is semi-compact and elongated-cylindrical, showing slight pubescence at the ripening stage. The grain is oval-shaped and light brown, with a starchy endosperm. Grain yields reach 2.2–2.5 t/ha. The thousand-grain weight ranges from 21 to 23 grams. Testing in 2023 revealed a carbohydrate content of 19.1% in the stalk juice, surpassing previously developed hybrids. Biomass productivity averaged 43.64 t/ha. The newly developed variety outperforms the US hybrid BMK Gold by 9–11 t/ha. For field cultivation, sowing in double-row strips (70 x 2 x 30 cm) is recommended, with a plant density of 120,000–140,000 plants per hectare. At the time of sowing, the soil temperature must not be lower than 10°C. The variety is characterized by resistance to lodging and grain shattering, which is crucial for sorghum cultivation. It is recommended for use as fresh animal feed and for the production of juice and food-grade glucose syrup. The pressed residue - bagasse can be processed into briquettes and pellets, as well as into a green fertilizer known as biochar.

Keywords: sorghum, varieties, characters, resistance, carbohydrates.

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THE IMPACT OF GROWING CONDITIONS ON THE PRODUCTIVITY OF PLUM AND APPLE TREES, DEPENDING ON GENOTYPE

NICUTA Alexandru*, https://orcid.org/0000-0003-3964-130X
BUJOREANU Nicolae, https://orcid.org/0000-0001-7997-9757
HAREA Ivan, https://orcid.org/0009-0000-6486-7058

Moldova State University, Institute of Genetics Physiology and Plant Protection, Chisinau, Republic of Moldova,
**Corresponding e-mail: alexandru.nicuta@sti.usm.md*

Insufficient soil moisture and long periods of atmospheric drought during the growing season have a negative impact on the growth and development processes of fruit plants and, consequently, on the harvest of various fruit crops. Plum and apple are among the main fruit crops in the Republic of Moldova. A feature of plum is its resistance to adverse environmental factors. At the same time, in conditions of soil moisture deficiency, the adaptability of the crop in general, and of the varieties in particular, decreases. Apple tolerates water stress better than other fruit crops due to its deeper root system. However, some varieties have a shallow root system, in which case they are more demanding on moisture than other varieties. Based on the above, the aim was to evaluate the productivity of plum and apple trees under conditions of soil moisture deficit, which would allow the subsequent development of various procedures for strengthening the production system of fruit trees in the current context of climate change.

The objects of research were trees of two late plum varieties: Stanley (of foreign selection) and Udlinionnaia (autochthonous), as well as two winter apple varieties: Golden Spur and Granny Smith, grown in lysimeters (vegetable houses) of the Institute of Genetics, Physiology and Plant Protection of the Moldova State University. The research was carried out applying the following scheme: a) control variant - plants grown under irrigated conditions (soil moisture – 70% of the field water capacity of the soil); b) experimental variant - plants grown under non-irrigated conditions. The average fruit yield per tree was determined by weighing.

As a result of the research conducted, it was found that the growing conditions during the vegetation period significantly influence the productivity of trees and the quality of fruits. With reference to the average fruit harvest per tree, we mention that

the Stanley variety from the variant with plants grown under non-irrigated conditions recorded a decrease in yield by 58.13%, compared to the control variant. This law also applies to the Udlinionnaia variety, as well as apple varieties. Thus, in the case of the Udlinionnaia variety of local selection, a decrease in yield was found by 35.83%, which represents a decrease of 22.30% compared to the Stanley variety of foreign origin. The Granny Smith apple variety grown under non-irrigated conditions recorded a decrease in yield by 22.65%, compared to the control variant, respectively, for the Golden Spur variety – by 52.78%.

Based on the results obtained, we can conclude that apple and plum trees grown under non-irrigated conditions were distinguished by lower productivity, compared to trees grown under irrigated conditions. Research into the physiological peculiarities of plant growth and development under adverse conditions is an important moment in understanding the mechanisms of plant resistance to low temperatures, drought and other stress factors. This fact could serve as a basis for developing procedures for targeted formation of the functional state and optimization of the production process in fruit plants.

Keywords: apple fruit, plum fruit, productivity, fruit quality, growing conditions.

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BIOCHEMICAL MARKERS OF PHYSIOLOGICAL ADAPTATION IN *Panicum virgatum* L. AS INDICATORS OF STRESS RESILIENCE

NIKISHOVA Nataliia*, https://orcid.org/0009-0001-3462-3164
RAKHMETOV Dzhamal, https://orcid.org/0000-0001-7260-3263

M.M. Gryshko National Botanical Garden,
National Academy of Sciences of Ukraine
**Corresponding e-mail*: *nnikisova7@gmail.com*

Climate change and increasing environmental pressures have intensified the demand for perennial bioenergy crops capable of maintaining stable productivity under adverse growing conditions. *Panicum virgatum* L. is recognized as one of the most promising perennial C4 grasses due to its high biomass productivity, broad ecological plasticity, drought tolerance, and ability to thrive on marginal lands. The physiological status of plants following overwintering and throughout subsequent developmental stages largely determines their adaptive capacity, biomass accumulation, and long-term resilience. Consequently, biochemical parameters associated with nitrogen metabolism may serve as reliable physiological markers for assessing stress tolerance and optimizing cultivation practices. The aim of this study was to evaluate the dynamics of nitrogen-containing compounds in *P. virgatum* grown under different plant nutrition areas during the principal developmental stages and to determine their relationship with physiological adaptation. Field experiments and biochemical analyses were conducted at the experimental plots and biochemical laboratory of the Department of Cultivated Flora, M.M. Gryshko National Botanical Garden of the National Academy of Sciences of Ukraine using the switchgrass cultivar '*Zoryane*'**.** Plants were cultivated under three row spacings (24, 45, and 70 cm), representing different nutrition areas. Total nitrogen content was determined in roots, leaves, stems, and panicles during the tillering, panicle emergence, flowering, and fruiting stages using the Kjeldahl method with a KDN-04D Kjeldahl Digestion Unit.

The results revealed pronounced organ-specific and developmental changes in nitrogen metabolism. During the tillering stage, the highest nitrogen concentration (2.07%) and crude protein content (11.82%) were recorded in the combined leaf and stem biomass at a row spacing of 70 cm, indicating enhanced metabolic activity during intensive vegetative growth. At the panicle emergence stage, nitrogen accu-

mulated predominantly in leaves and panicles, whereas stems consistently exhibited the lowest nitrogen concentrations irrespective of row spacing. Root tissues showed a gradual increase in nitrogen content with increasing nutrition area, reaching 1.41% nitrogen and 8.02% crude protein at 70 cm row spacing, suggesting efficient nutrient storage and remobilization prior to reproductive development. During flowering, nitrogen redistribution among vegetative and reproductive organs became more pronounced. Leaves exhibited the highest nitrogen concentration (2.42%) and crude protein content (13.77%) at a row spacing of 45 cm, whereas stems grown at 70 cm accumulated 1.69% nitrogen and 9.64% crude protein, reflecting enhanced assimilate transport and intensified metabolic activity during reproductive development. Overall, wider row spacing promoted greater accumulation of nitrogenous compounds than narrower planting schemes, indicating reduced intraspecific competition and more efficient utilization of environmental resources. The observed redistribution of nitrogen and protein among plant organs represents an important physiological mechanism underlying adaptation to environmental stress. Maintenance of elevated nitrogen reserves in leaves and roots supports rapid restoration of photosynthetic activity following overwintering, whereas efficient allocation of assimilates to reproductive organs contributes to stable seed production and sustained biomass accumulation. These biochemical responses are closely associated with plant resilience and may therefore be considered valuable physiological markers for identifying highly adaptive genotypes.

Keywords: *Panicum virgatum*, nitrogen metabolism, crude protein, stress resilience.

Acknowledgments. This research was carried out within the framework of the departmental scientific project 414-KF “Fundamental Principles of Mobilization of New Phytogenetic Resources of Economically Important Herbaceous Plants to Improve Biological and Food Security in Ukraine” of the M.M. Gryshko National Botanical Garden of the National Academy of Sciences of Ukraine.

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IMPACT OF BACTERIOSIS WITHIN POLLINATION PROCESS ON FRUIT SET OF WALNUT (*Juglans regia* L.)

PINTEA Maria, https://orcid.org/0000-0002-5589-4158

National Institute for Applied Research in Agriculture and Veterinary Medicine, Chisinau, Republic of Moldova,
Corresponding e-mail: *mariapintea@yandex.ru*

Purpose. The role of anemophily in the walnut (*Juglans regia* L.) pollination process eventually involving a bacterial blight (*Xanthomonas campestris* pv. *Juglandis*) infected tree there is discussed.

Materials and methods In order to control the potential manifestation of bacterial blight during anemophilous pollination process, experimental investigations were conducted on all dichogamous types: protandous, protoginous and homogamous ones. The experiments were conducted according approved methodologies in fruit tree breeding on a collection of over 300 walnut genotypes (local and introduced varieties and hybrids), as well as in the frame temporary testation within industrial orchards, where the pollen remains present for over 4 weeks.

Results. The pollen collected from these varieties during the massive anemophilous spread towards the female flowers, as well as the flowers subjected to free pollination, proved to be infected exclusively by. *Xanthomonas campestris* after testation at the level of 97-99%, Female (pistillate) flowers from the open pollination of dichogamous varieties (Skinosskii și Chișinevskii, etc,) dropped off 3-5 days after pollination. Practically, only a few remained on an upward trend (1-2%), which have developed necrotic symptoms on the outer surface of the already set fruit. In most pistillate flowers, however, browning and complete drying of the stigmas were observed. The sudden cessation in the development of the ovule, of all elements of the embryo sac, the integument, and all carpel tissues, followed by their shedding within 7-12 days. In the case of isolating flowers with special isolators that do not allow pollen to penetrate through the insulating material, The American Hartley variety proved to be the most susceptible, followed by Lara, Tiszacsecsi, and Milotay. Less sensitive were Chandler, Fernor, and Fernette. It should be emphasized that the latter flowering varieties (protandrous), when cultivated experimentally on a temporary basis in various fruit-growing regions of our country, have demonstrated a compara-

tively late blooming of female (pistillate) flowers, at a time when there are no longer any (or very few!) pollen catkins. Thus, minimal conditions for presence of pollen are created for reduction the contact with pollen possibly infected with *Xanthomonas campestris pv. Juglandis* and consequently, inevitable possibilities for the manifestation of bacterial blight development on female flowers, juvenile leaves, etc. Thus, the effect of pollen dispersion (accidentally infected with bacterial blight), driven by anemophily, represents a real process of infecting the female (pistillate) flowers. Their abortion takes place in 7-12 days, depending on the microclimatic conditions. The permanent manifestation of bacterial blight (year after year) during the flowering-pollination period (late April, and especially the first decade of May—the period typical for protandrous varieties, usually promoted intensively in this regard) is very effectively favored by the presence of humidity during that period, being usual local microclimatic condition.

Conclusions. When planting new walnut orchards, it is important to consider not only the economic and commercial aspect, but also the susceptibility of the selected varieties to bacterial blight, as it is a disease that can drastically reduce the crop yield. In all cases, protandrous varieties, late flowering period of pistillate flowers and the minimal percentage of pollinators ((2—4) there are obligatory.

Keywords: walnut, dichogamy, anemophily, bacterial blight, fructification,

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FUNCTIONAL STATE OF THE PHOTOSYNTHETIC APPARATUS OF THE WHEAT FLAG LEAF *Triticum aestivum* L. UNDER DIFFERENT WATER-SUPPLY CONDITIONS

PLATOVSCHII Nicolai*, https://orcid.org/0000-0001-6747-8226
ZDIORUK Nina, https://orcid.org/0009-0000-8879-3954
GORE Andrei, https://orcid.org/0009-0002-7356-7289

Moldova State University, Institute of Genetics Physiology and Plant Protection, Chisinau, Republic of Moldova,
**Corresponding e-mail: nicolai.platovschii@sti.usm.md*

During grain formation, the wheat flag leaf is one of the main sources of photoassimilates that drive grain filling. Under limited water-supply, its photosynthetic activity depends not only on soil moisture but also on photosynthetically active radiation, leaf blade temperature, and the ability of the leaf to maintain CO_2 assimilation throughout the diurnal cycle. Therefore, the dynamics of the real CO_2 assimilation rate in the flag leaf can characterize the functional state of the photosynthetic apparatus under water deficit. The hypothesis of the study was that reducing soil moisture to 50% of field capacity would alter not only the mean daytime level of real CO_2 assimilation but also its diurnal pattern, with the main differences between water-supply treatments appearing during daytime hours at maximum leaf temperatures and during morning recovery of photosynthetic activity.

The study was conducted on wheat plants of cv. Moldova 614 grown in vegetation pots. The control treatment was maintained at 70% of field capacity, while moderate water deficit was simulated by reducing soil moisture to 50% of field capacity. Measurements were performed at the milk stage of grain development on flag leaves. The real CO_2 assimilation rate, photosynthetically active radiation, and leaf temperature were recorded throughout the diurnal cycle.

The data showed that flag leaves at 70% of field capacity maintained a higher real CO_2 assimilation rate than plants at 50% of field capacity. During the daytime, values in the control treatment ranged from 3.5 to 4.1 μmol CO_2 m^{-2} s^{-1}, whereas under limited water supply they were more often within 3.0 - 3.6 μmol CO_2 m^{-2} s^{-1}. In both treatments, assimilation activity decreased in the afternoon and declined to near-zero values overnight, with a more pronounced afternoon decrease at 50% of

field capacity. Morning recovery also depended on water supply: in the control treatment, maximum values reached 4.5 - 4.8 μmol CO_2 m^{-2} s^{-1}, whereas under water deficit they remained lower, at 3.3 - 3.6 μmol CO_2 m^{-2} s^{-1}.

Comparison of real CO_2 assimilation with leaf temperature showed that, as leaf temperature increased to 35–37°C, the differences between treatments became more pronounced. Since stomatal conductance and leaf water potential were not directly measured, the data do not allow a clear distinction between stomatal and non-stomatal causes of the decline in assimilation. Nevertheless, leaf temperature should be considered an important accompanying parameter when interpreting the photosynthetic response to water deficit.

The results demonstrate that moderate water deficit in cv. Moldova 614 suppresses real CO_2 assimilation in the flag leaf unevenly throughout the diurnal cycle, with the strongest reduction during daytime hours at elevated leaf temperature and during morning recovery. This indicates the usefulness of diurnal photosynthesis dynamics, rather than only individual absolute values, for evaluating the functional state of wheat plants under water deficit during grain formation.

Keywords: wheat, flag leaf, water supply, real CO_2 assimilation, leaf temperature.

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THE INFLUENCE OF WATER DEFICIT ON DIVERSITY OF TOMATO PROGENY AT HAPLOID LEVEL

SALTANOVICI Tatiana*, https://orcid.org/0000-0002-1122-7433
ANDRONIC Larisa, https://orcid.org/0000-0002-2761-9917
ANTOCI Ludmila, https://orcid.org/0009-0006-4855-6544
BULDUMAC Ana, https://orcid.org/0000-0002-9674-0403

Moldova State University, Institute of Genetics Physiology and Plant Protection, Chisinau, Republic of Moldova,
**Corresponding e-mail*: *tatiana.saltanovici@sti.usm.md*

It is known that climate change, including drought, disrupts key processes involved in reproductive efficiency in most crops. Under water deficit, in many cases, the elimination of pollen grains is observed, since their formation requires high water availability. The purpose of the study was to evaluate the impact of water stress on the quality of the male tomato gametophyte in order to identify genotypes with potential drought resistance. The research was carried out under laboratory, solarium and experimental lot conditions. The descendants of the tomato varieties Rufina, Elvira and the spontaneous specie *Solanum pimpinellifolium*, derived from plants infected with viruses and treated with glycosides, were used as experimental material. As virus agents in recurrent plants were used Tomato Aspermy Virus (TAV) or Tobacco Mosaic Virus (TMV). Determination of male gametophyte viability in the control variant was performed by cultivating pollen on artificial nutrient medium, containing aqueous sucrose solution - 15%, boric acid - 0.006%. In order to assess the reaction of the male gametophyte to the action of water deficit, medium supplemented with sucrose was used (32%). Based on the microscopic study, the following indices were determined: viability and resistance of pollen; length and resistance of pollen tubes (PT).

Water deficit induced specific changes in the analyzed traits. In healthy plants, water deficit reduced pollen tube length by 1,5 times, in TMV/TAV genotypes the values of these indices compared to the control were reduced by 1.6…2.7 times. In the descendants of plants treated with glycosides, the decrease in these characters was 1.7...2.6 times. In over 80% of variants, pollen viability decreased by 10-20%, whereas stimulation was recorded in only 11% of cases. Based on the analysis of the pollen tube dimensions change, it was established that water deficit acted strongly

on the variability of this character, reducing its values by 40-45 conventional units in treated with glycosides plants in 55.0% of cases compared to untreated in 44.4. According to the three-factor dispersion analysis, the record variability was controlled by the genotype, glycoside, water deficit and their interaction ($P<0.001$). In healthy plants or TAV, the genotype determined 21.1...53.8% of the variation of this index. The influence of glycosides was lower and varied within 4.5...14.0%, while the water deficit caused most of the variability 18.5...54.5%. Notably, the action power of water deficit was reduced by 7.0-9.0% compared to the results obtained in the analogous experience in previous generations. In the descendants of TMV/TAV, the action of water deficit significantly decreased the growth rate of pollen tubes and controlled 66.7...81.1% of the variability of this character, the quota of glycoside action was much lower. Statistical analysis showed that the average values of male gametophyte resistance varied within the limits of 50.6…65.1% (for pollen viability) and 44.4…59.35 (for pollen tube length). Among the analyzed variants, we established that the average values of these indices were exceeded in 38.9 and 44.5% of cases. Consequently, water stress causes significant changes in pollen indices, which are mainly determined by the action of water deficit on the microgametes differentiation according to the genotype reaction to this factor.

Keywords: tomato, water deficit, pollen grains, virus infection, glycoside, resistance, tolerance.

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PHENOTYPIC ANALYSIS OF TOLERANCE TO ABIOTIC STRESESS IN TRITICALE GENOTYPESS

SAȘCO Elena*, https://orcid.org/0009-0003-1014-4016
LEATAMBORG Svetlana, https://orcid.org/0000-0003-4091-1522

Moldova State University, Institute of Genetics Physiology and Plant Protection, Chisinau, Republic of Moldova,
**Corresponding e-mail*: *elena.sasco@sti.usm.md*

Triticale (x *Triticosecale* Wittmack.), the first synthetic cereal, is derived from a cross between wheat (*Triticum aestivum* L.) and rye (*Secale cereale* L.). Developed in the 19th century, triticale offers significant potential for increasing yields of products for human consumption and animal feed in various agroecological regions, including those with climatic and soil conditions that are less favourable for other cereals. Most (83%) of the land planted with triticale is located in Europe. Poland is the world leader in terms of triticale production area. Triticale exhibits a wide range of genetic responses to biotic and abiotic stressors. Heat stress and drought are the main threats not only to sustainable yield but also have a serious impact on grain quality due to reduced accumulation of carbohydrates, gluten, and proteins. Combining morphophysiological approaches is one of the most effective strategies for improving triticale's tolerance to abiotic stressors. The purpose of this study was to evaluate the response to and the mode of inheritance of the trait of tolerance/sensitivity to stress caused by high temperatures and water deficit in triticale genotypes.

Winter triticale genotypes, parental lines (P_1, P_2), and hybrids resulting from their reciprocal crosses: P_1 – L3201-05 (1); P_2 – L3226-30 (2); F_2 – (P_1 x P_2) – L3866-70 (3) și F_2 – (P_2 x P_1) – L3861-65 (4) were investigated under conditions of high-temperature stress and moisture deficit during the early growth stage. The seeds were sterilized, pregerminated, and placed in Petri dishes for 6 days at an optimal temperature of 22°C. Heat stress (*HS*) was induced after 5 days under optimal conditions by exposing the seeds to 45°C for 4 hours, followed by a 24-hour acclimation period at 22°C (Kolupaev, 2023). The moderate and high water deficit (*WD*) was induced by an aqueous solution (16% and 20%) of PEG 6000 (Mansour, 2020). Phenotypic variability was analyzed for the following traits: germination potential (*GP*) %, and dry weight of roots and stems at 80 °C (*DWR* and *DWS*, mg/plant). The plant vigour

(*PVI*) and integral tolerance index (*TI*) were calculated according to the methods described by Qadir, 2018, and Raja, 2017.

The *GP* trait showed only resistance in response to *HS*, but high, moderate, and low tolerance (84.6–70.9%) to WD. The *DWR* trait exhibited tolerance, high tolerance, and moderate tolerance to *WD* (up to 79.5%), and only moderate tolerance to thermal stress. Both parents showed low sensitivity to *DWS*: P_1 in the case of *HS* and P_2 in the case of *WD*. The *DWS* trait was strongly affected, showing the highest sensitivity in response to both stressors.

Cluster analysis (*k-means*) based on the variability of the integral tolerance (*IT*) index for the traits *GP*, *DWR*, *DWS*, *DWP*, and *PVI* revealed advanced *HS* tolerance in genotypes 2 and 4, with the maternal factor playing a key role in triticale's response. Therefore, L3226-30 and L3861-65 may be involved in the improvement of triticale under high-temperature conditions. Genotypes 1, 2, and 3 exhibited higher mean values for the *IT* trait in response to *WD* treatment, mediated by 16% PEG. Genotypes L3201-05, L3226-30, and L3866-70 can be included in breeding programs to improve resistance to moderate water deficit, with the tolerance of L3866-70 being inherited from both parents. Only triticale L3201-05 (1) can be used to improve tolerance to severe *WD* stress.

Keywords: Heat stress; phenotypic variability; water deficit; winter triticale.

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EVALUATION AND SELECTION OF F_3-F_4 TOMATO HYBRIDS COMPARISON WITH THE PARENTAL FORMS, FOR THE PURPOSE OF HIGHLIGHTING GENETIC VARIABILITY

SÎROMEATNICOV Iulia*, https://orcid.org/0000-0001-7780-083X
COTENCO Eugenia, https://orcid.org/0000-0003-0603-3404

Moldova State University, Institute of Genetics Physiology and Plant Protection, Chisinau, Republic of Moldova,
**Corresponding e-mail*: *iulia.siromeatnicov@sti.usm.md*

The genetic variability of quantitative characters that manifests itself through morphological uniformity makes it possible to use them widely in genetic research, as well as in breeding programs to obtain new tomato varieties and hybrids with a higher level of manifestation of characters useful for the breeding process with productivity, quality and resistance to climate factors. Hybrid offspring possess a potential for variability of traits capable of proportionally expanding the determined genetic pool of quantitative and qualitative characters.

Research goal: Integration of tomato genotypes based on a complex of valuable useful characters: productivity, precocity, fruit quality, resistance to extreme climate factors, identification and selection of the best forms with valuable biological and agronomic characteristics.

The scientific research was carried out in the laboratory "Genetics of Plant Resistance" and on the experimental lot of IGFPP. As the initial biological plant material in the study, the forms P_1, P_2, 10 hybrid combinations F_3 and 15 hybrid combinations F_4, obtained on the basis of inter-hybridization and *in vitro* culture, were used. For comparative research, 21 parental forms and standard varieties were cultivated

Complex evaluation of hybrid combinations of variability and heredity based on valuable characters to be researched in determining general combinative capacity and special combinative capacity, the correlation between productivity, fruit quality and plant resistance to extreme climate factors. It is clear that the creation of such a gene pool is closely related to research in quantitative genetics, the study of variability, heredity and genetic determinism of economically valuable characters for the breeding process. The results of the investigations showed a positive correlation r=0.73 between the periods of seedling emergence-flowering and flowering-ripening.

This allows us to predict the duration of the flowering-ripening interphase and the beginning of mass ripening of early precocious genotypes. The interphase periods also correlate positively with the duration of the fruiting period r=0.69 - 0.72. In general, the duration of the growing season of each genotype largely depends on the duration of each phenological phase or the parameters of the interphase periods.

Practically at the flowering - fruiting - ripening interphases, all F_3 and F_4 hybrid combinations emerged earlier compared to some paternal and maternal parental forms. Of particular importance in the process of improving tomato plants is the study of the inheritance of quantitative characters, because such measurable characters largely determine the elements of precocity, productivity and quality of plants. As a result of research investigated in field conditions 8, F_3 and F_4 hybrid combinations were selected from 25 hybrid combinations.

The degree of fruit setting on the first three inflorescences showed maximum values only in two hybrid combinations $F_3$164 and $F_3$390. The other combinations were at the same level or lower than the parental forms. The fruit yield in the hybrid combinations ranged from 51-57t/ha, in the parental forms 41-54t/ha. The quality of the fruits was much lower than in previous years.

Keywords: Hybrid combinations, variability, parental forms, resistance to climate conditions.

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STUDY OF THE VARIABILITY AND HERITABILITY OF INTERSPECIFIC F_5 HYBRID COMBINATIONS AND PARENTAL FORMS OF TOMATO WITH INCREASED RESISTANCE UNDER WATER-STRESSED CONDITIONS

SÎROMEATNICOV Iulia*, https://orcid.org/0000-0001-7780-083X
COTENCO Eugenia, https://orcid.org/0000-0003-0603-3404

Moldova State University, Institute of Genetics Physiology and Plant Protection, Chisinau, Republic of Moldova,
**Corresponding e-mail*: *iulia.siromeatnicov@sti.usm.md*

An important direction in improving the creation of hybrids, lines and varieties is represented by highlighted and selected forms, which combine resistance to extreme climate factors with increased fruit productivity. In order to obtain new hybrids and tomato varieties with a high level of manifestation of the characters necessary for the breeding process with precocity, productivity, quality and resistance to climate factors, it is necessary to carry out research on genetics, physiology and plant improvement with genotypic and phenotypic genetic variability of quantitative characters that are manifested through bio morphological uniformity.

The laboratory has a very rich selection material in the form of perspective lines, high-performance varieties obtained from intra- and interspecific hybrids in previous years, hybrid progeny of different generations. The material will serve as a germplasm base for testing in selection, control, competition and comparative competition nurseries.

Research goal: Study, evaluation, highlighting and selection of spontaneous F5 hybrid tomato progeny based on a complex of valuable traits: productivity, precocity, resistance to extreme climate conditions.

In accordance with the study stage of the samples included in the research, the gene pool of the tomato collection's germplasm was established, studied and assessed. As initial material for the planned research, 10 F_5 hybrid combinations ($F_5$164; $F_5$380; $F_5$386; $F_5$388; $F_5$390; $F_5$393, $F_5$395, $F_5$396, $F_5$397, $F_5$398), obtained on the basis of interspecific hybridizations and *in vitro* culture, 12 parental forms were used. As a result of the investigations carried out on the plant height trait, a variability with a coefficient of 3.2% was manifested in the $F_5$396 combination, up to approxi-

mately 8.0% in the $F_5$380 combination, the paternal parental forms varied between 3.6-6.7%, including for the maternal parental forms 5.4-12.0%. Hybrid generations possess a potential for major variability of traits capable of proportionally expanding the determined genetic pool, especially of quantitative and qualitative characters. It has been demonstrated that for the emergence-maturation period, tomato genotypes are classified into 3 main groups: early (95-100 days), semi-early (111-130 days) and late (over 130 days). It was found that the number of flowers and fruits on I, II, III inflorescences and the main stem, bloomed and fructified very well, fruit setting had maximum values. A positive correlation was manifested r =0.70-0.78 and negative in some genotypes r =0.10-0.27. The inheritance of genes is marked in characters and is highlighted during the development and growth of plants visually, which allows us to make a complete and complex estimation of several characters with a larger breeding material. For these reasons, the creation of the tomato genetic collection becomes a constituent of the genetic pool identified for expanding the effectiveness of the amelioration processes. The creation of such a gene pool is closely related to research in quantitative genetics, the study of variability, heredity and genetic determinism of economically valuable characters for the amelioration process.

Keywords: hybrid combinations, variability, parental forms, resistance to climate conditions.

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GENOTYPE-DEPENDENT DIFFERENCES IN REACTIVE OXYGEN SPECIES PRODUCTION IN TOMATO

UZUN Tatiana, https://orcid.org/0009-0004-3302-3492

Moldova State University, Institute of Genetics Physiology and Plant Protection, Chisinau, Republic of Moldova,
Corresponding e-mail: *uzun.tatiana@usm.md*

As part of plant interactions with the surrounding environment, plants continuously generate basal levels of reactive oxygen species (ROS), which function as essential signaling molecules involved in the regulation of various physiological processes, including defense mechanisms against pathogens and herbivorous organisms, programmed cell death, and stomatal regulation. Under favorable growth conditions, ROS homeostasis is maintained through a dynamic equilibrium between ROS generation and their elimination by the antioxidant system. However, biotic or abiotic stress factors can disturb this balance, resulting in increased ROS accumulation and triggering the activation of an oxidative burst.

The aim of this study was to identify differences in the capacity for reactive oxygen species production among different tomato genotypes. In this context, ROS production was quantified using a luminol-based chemiluminescence assay in three tomato genotypes: Cerasus, Desteptare, and Marry Gratefully. Leaf discs (8 mm in diameter) were collected from 4–5-week-old plants and placed individually into a 96-well plate containing 150 µL of water. Samples were incubated overnight at room temperature. The following day, the water was replaced with 200 µL of assay solution containing luminol, horseradish peroxidase (HRP), and flagellin peptide (flg22). Luminescence, corresponding to ROS production, was measured using a plate reader.

Analysis of three independent technical replicates revealed clear and reproducible differences in ROS production among the studied genotypes. The kinetic profiles demonstrated that Desteptare exhibited the highest ROS generation rate throughout the measurement period, whereas Marry Gratefully showed the weakest oxidative response, and Cerasus displayed an intermediate level of ROS production. In addition to kinetic analysis, the cumulative chemiluminescence signal recorded during the entire measurement period was calculated for each genotype, confirming the same trend: Desteptare accumulated the highest total amount of ROS, Cerasus

showed an intermediate level, and Marry Gratefully produced the lowest amount. The consistency between kinetic and cumulative analyses indicates genotype-dependent differences in oxidative burst capacity, which may be associated with variation in early immune responses, pathogen susceptibility, and the comparatively higher field resistance observed in Cerasus.

Keywords: Reactive oxygen species; tomato genotypes; oxidative burst; chemiluminescence; plant defense response.

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EFFECT OF DURATION OF OSMOTIC STRESS ON THE GROWTH RESPONSE OF WHEAT SEEDLINGS *Triticum aestivum* L.

ZDIORUK Nina*, https://orcid.org/0009-0000-8879-3954
PLATOVSCHII Nicolai, https://orcid.org/0000-0001-6747-8226
RALEA Tudor, https://orcid.org/0009-0000-3537-051X

Moldova State University, Institute of Genetics Physiology and Plant Protection, Chisinau, Republic of Moldova,
**Corresponding e-mail*: *nina.zdioruk@sti.usm.md*

Drought is one of the major abiotic factors limiting wheat growth and productivity, especially during the early stages of ontogeny, when seed imbibition, germination, and initial seedling development depend directly on water availability. Under laboratory conditions, water deficit can be simulated using osmotically active compounds that reduce the water potential of the medium. In this context, the intensity and duration of osmotic stress, as well as the ability of seedlings to resume growth after returning to favorable conditions, are important. The study of these responses makes it possible to identify sensitive growth parameters and assess genotypic differences at early developmental stages.

The hypothesis of the study was that even mild osmotic stress induced by a 3% sucrose solution for different exposure periods would affect shoot and root growth of wheat seedlings differently, and that genotypes would differ in their ability to maintain growth processes after removal of the stress factor. Seeds of two common wheat (*Triticum aestivum* L.) cultivars, Moldova 5 and Meleag, were used as plant material. Exposure to the osmotic factor began from the moment of seed incubation in the respective solutions. In the control treatment, seeds were germinated on water for 14 days, whereas in the experimental treatments they were germinated on a 3% sucrose solution for 3, 6, or 14 days. After 3 and 6 days of sucrose exposure, seedlings were transferred to water for 8 and 11 days, respectively, to assess post-stress effects and growth recovery capacity. On day 14, shoot and root length were determined.

The results showed that short-term exposure to a 3% sucrose solution for 3 days, followed by transfer to water, caused only a relatively slight reduction in shoot length in both cultivars. However, the root system showed a stronger response: even after transfer to water, root length remained substantially below the control level.

This indicates that early short-term restriction of water availability has a prolonged post-stress effect, primarily on root system development. Increasing the duration of sucrose exposure to 6 days intensified growth inhibition. A more pronounced reduction in shoot length was observed in Moldova 5, whereas Meleag maintained higher shoot and root growth values. Continuous cultivation of seedlings on a 3% sucrose solution for 14 days resulted in the strongest growth inhibition in both cultivars, confirming that the degree of inhibition depends on the duration of osmotic exposure.

Thus, the duration of even mild osmotic stress is an important factor determining the subsequent development of wheat seedlings. After short-term stress, shoot growth can partially recover following transfer to water, whereas the root system remains more strongly inhibited. This indicates the high sensitivity of the root system to early water deficit and its diagnostic value for assessing wheat stress tolerance. The cultivar Meleag showed higher relative tolerance of growth processes to osmotic stress compared with Moldova 5. The obtained data may be used for preliminary screening of wheat genotypes by their response to water deficit during early ontogeny and for refining criteria for assessing seedling recovery potential after short-term osmotic exposure.

Keywords: wheat seedlings; osmotic stress; sucrose; root growth; stress recovery.

Acknowledgments. The research was carried out within the subprogram 011101 "Genetic and biotechnological approaches to agroecosystem management under climate change conditions", financed by the Ministry of Education and Research of the Republic of Moldova.

Section E

Plant Protection Issues for Conservation, Ecological and Regenerative Agriculture

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CORN GRAIN STORAGE: THE ROLE OF SEEDS COATING IN ALTERING CORN VIGOR

BOROVSKAIA Ala[1,*], https://orcid.org/0000-0002-7225-0186
LUTCAN Elena[1], https://orcid.org/0000-0001-9967-6665
VANICOVICI Nicolai[2], https://orcid.org/0009-0003-3430-7545
ELISOVETCAIA Dina[1], https://orcid.org/0000-0003-0521-6428
IVANOVA Raisa[1], https://orcid.org/0000-0002-2554-2039

[1]*Moldova State University, Institute of Genetics Physiology and Plant Protection, Chisinau, Republic of Moldova*
[2]*National Seed Research and Production Center, section Porumbeni, Republic of Moldova*
**Corresponding e-mail:* ala.borovskaia@sti.usm.md

Pre-sowing coating of corn seeds with a complex bioregulator minimizes viability loss, stabilizes cell membranes, activates antioxidant defenses, and prevents nutrient hydrolysis, thereby maintaining high germination rates and seed viability during long-term storage. Popcorn endosperm has a unique anatomical and chemical structure, and preserving corn vigor during seed storage determines their ability to produce uniform, viable seedlings under stressful field conditions. The aim of this study was to evaluate the effect of storage on the vigor of popcorn seeds coated with a complex composition containing a bioregulator.

Materials and method. The study was conducted on popcorn hybrids Porumbeni 396 (P396) and Porumbeni 398 (P398), coated with a biodegradable complex composition based on carboxymethylcellulose (CMC) and containing the bioregulator JS, obtained in concentrated form from the above-ground part of the *Juniperus sabina* plant. Overall germination, root length and seedling length were measured, and corn vigor was calculated using the formula: vigor = (root length + seedling length) × germination percentage. Coated seed were stored in a laboratory at 18±2°C for 4 months.

The results showed that before storage, coated seeds of P369 and P398 hybrids demonstrated the significant decrease in vigor index compared to control - uncoated seed samples. This fact can be explained by limited access of oxygen to the horny endosperm of popcorn as a result of the formation of CMC polymer film on the seeds surface. After storage, corn vigor increased in both control and coated seeds. Howev-

er, in control seeds vigor was 1.28 and 1.54 times higher, and in coated seeds – 2.32 and 2.02 times higher, respectively for the P396 and P398 hybrids, in comparison with the vigor indexes of seeds before storage. After storage, the length of roots and seedlings increased significantly that reflected in augmented vigor of the corn. The high vigor of coated seeds after storage 1039.50±208,99 (P396) and 1158.55±404,86 (P398) indicated the beneficial effects of the bioregulator JS contained in the coating composition, which contributed to the protection of the growth characteristics of the seeds.

Conclusions. The biodegradable complex composition based on CMC and containing the JS bioregulator improved the growth characteristics of coated corn seeds, especially their vigor. Nevertheless, given the inhibitory effect of the coating composition on popcorn hybrids before storage, it is probably necessary to change the concentration of the CMC polymer film, making the protective film thinner and more porous.

Keywords: *Juniperus sabina*, corn seed, coating, storage, vigor

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ROLE OF TAILORED LED SPECTRA ON *IN VITRO* CULTURE OF MEDICINAL PLANTS

CALALB Tatiana*, https://orcid.org/0000-0002-8303-3670
LOZINSCHI Mariana, https://orcid.org/0009-0004-1760-2814
FURSENCO Cornelia, https://orcid.org/0000-0003-0692-6819
OHINDOVSCHI Angelica, https://orcid.org/0000-0001-5132-0782
BOZBEI Iulia, https://orcid.org/0009-0009-0680-9277
BOGDAN Alina, https://orcid.org/0000-0002-2069-0454

Nicolae Testemitanu State University of Medicine and Pharmacy of the Republic of Moldova, Laboratory of Plant Biotechnologies, Center for Drug Development, Faculty of Pharmacy, Chisinau, Republic of Moldova,
**Corresponding e-mail*: *tatiana.calalb@usmf.md*

Purpose: Light conditions are among the most important physical factors affecting the establishment and development of plant *in vitro* cultures. The study aimed to evaluate the influence of tailored LED spectral combinations on culture initiation, shoot proliferation, biomass accumulation, and rhizogenesis in medicinal and aromatic plants cultivated *in vitro*.

Materials and methods: The analysis was performed under controlled *in vitro* culture conditions using a photoperiod of 16 h light/8 h darkness and approximately 3000 lx light intensity. LED systems combining blue (450-495 nm), green (495-570 nm), yellow (570-590 nm), red (620-750 nm), and far-red/infrared light (700-800 nm) were considered. The effects of spectral combinations on explant adaptation, morphogenesis, culture establishment, shoot multiplication, root induction, and biomass accumulation were evaluated in medicinal and aromatic species including *Aronia melanocarpa*, *Mentha piperita*, *M. citriodora*, *Lavandula angustifolia*, *Origanum vulgare*, and *Stevia rebaudiana*.

Results: Blue light promoted cell division, chlorophyll formation, and improved explant adaptation during the early stages of culture establishment. Red light enhanced shoot proliferation and biomass accumulation through phytochrome-mediated responses, supporting efficient micropropagation. Green light contributed to modulation of physiological processes associated with culture initiation and development through improved radiation penetration into internal tissues. Combined red–blue–green spectra exhibited a pronounced stimulatory effect on micropropaga-

tion in *A. melanocarpa*, *Mentha* spp., and *S. rebaudiana*, leading to improved shoot multiplication and biomass development. Under continuous light conditions with an 8/16 photoperiod regime, enhanced rhizogenesis was observed particularly in *A. melanocarpa*, *Mentha* spp., *L.angustifolia*, and *O. vulgare*, indicating improved root induction and subsequent plantlet establishment. In contrast, yellow light slowed both micropropagation and rhizogenesis processes across all studied species, suggesting a lower stimulatory capacity for morphogenetic responses. Far-red/infrared light showed no pronounced stimulatory effect on culture initiation and proliferative responses under the tested conditions, while its potential may influence on secondary metabolite accumulation requires further investigation. Moreover, optimized multicomponent LED spectra improved coordination between shoot proliferation and rhizogenesis, increasing the potential for obtaining vigorous plantlets with enhanced acclimatization capacity. Tailored LED combinations promoted more efficient culture initiation, improved shoot multiplication rates, and stimulated rhizogenesis, resulting in better development of complete plantlets suitable for acclimatization.

Conclusions: Optimization of LED spectral combinations represents an effective strategy for improving *in vitro* culture initiation, micropropagation efficiency, and rhizogenesis in medicinal plants. The effects of individual LED spectra were species-dependent and associated with distinct morphophysiological responses.

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ANTIOXIDANT BIOMARKERS IN ASSESSING MAIZE GERMINATION AND SEEDLING GROWTH FOLLOWING EXPOSURE TO NEGATIVE TEMPERATURE STRESS

CAUȘ Maria[1]*, https://orcid.org/0000-0001-7914-3482
BOROZAN[2] Pantelimon, https://orcid.org/ 0000-0002-4142-2918

[1]*Moldova State University, Institute of Genetics Physiology and Plant Protection, Chisinau, Republic of Moldova*
[2]*Public Institution "National Center for Seed Research and Production", Republic of Moldova*
**Corresponding e-mail*: *maria.caus@sti.usm.md*

Background: In the current climate change environment, most breeding programs in Northern Europe are conducting research into developing cold-resistant maize genotypes. In this context, it is important to study and understand the morpho-physiological and biochemical properties of maize that would facilitate adaptation to these conditions, and the valuable information obtained could be used for further improvement of breeding material. Therefore, we studied five hybrids to evaluate their response to negative temperature stress (NTS) at -4°C for 16 h before germination and subsequent growth at 26°C for 7 days.

Aim of the study: Determining the role of antioxidant system components in ensuring defensive potential in maize seedlings, with different levels of resistance to the action of specific dose of negative temperature in the early stages of ontogenesis.

Materials and methods: The seeds of different maize hybrids used in this study were provided by the Public Institution "National Center for Seed Research and Production", Pașcani, RM. Before germination, maize seeds were exposed to a specific dose of subzero temperatures (-4 g) for 16 hours. Germination, growth and development of maize seedlings were carried out under controlled conditions with air temperature regulation. Morphological and physiological parameters, components of the antioxidant system, including peroxidase and catalase activity, total polyphenol and flavonoid content, ascorbic acid and malondialdehyde (MDA) were determined in seedlings.

Results: Data were obtained on the role of antioxidant system components in providing the protective potential of maize seedlings with varying levels of resis-

tance to NTS. The results revealed a significant ($P<0.05$) decrease in growth parameters such as seminal root length, plant height (cm), and fresh seedling biomass (g), caused by NTS. However, a significant ($P<0.05$) increase in lipid peroxidation was observed. Changes in the activities of antioxidant enzymes such as catalase, benzidine peroxidase, ascorbate peroxidase, as well as non-enzymatic antioxidant compounds such as total phenolic compounds and flavonoids, and ascorbic acid were also noted.

Conclusions: Research has shown that pre-treatment of maize seeds with negative temperature (-4°C) for 16 hours significantly affected germination, growth and antioxidant metabolism of seedlings and that antioxidant enzymes and compounds played a crucial role in protecting plants from oxidative damage. However, different hybrids responded differently, depending on their genetic specificity.

Keywords: maize seeds, negative temperature stress, antioxidants biomarkers.

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FORMALIZATION OF KNOWLEDGE IN THE PRODUCTION OF BIOLOGICAL PLANT PROTECTION PRODUCTS

CHERNOVA Iryna, https://orcid.org/0000-0002-9995-3834

Engineering and Technological Institute "Biotekhnika" National Academy of Agrarian Sciences of Ukraine
Corresponding e-mail: bioischernova@ukr.net

The research is devoted to the issue of information structuring regarding the formalization of knowledge in the production of biological plant protection products when developing expert systems. The relevance of the work is due to the need to increase the efficiency of the processes of managing the production of biological plant protection products.

The aim of the work was to develop a structure for formalizing knowledge regarding the processes of managing the production of biological plant protection products in the form of an ontology.

The object of the research is decision support processes for biological plant protection. The subject of the study is the digitalization of production management processes for entomological and microbiological plant protection products.

Research methods – analytical and ontological approaches, free software Visual Understanding Environment.

The materials of the work were the results of scientific research on the use of modern methods of formalizing knowledge in the processes of managing the production of biological plant protection products.

A structure for formalizing knowledge regarding the processes of managing the production of biological plant protection products has been developed in the form of an ontology, which contains concepts (1–ontological models; 2–knowledge bases; 3–predicate semantic networks; 4–databases; 5–frames; 6–associative maps; 7–algorithms) and explanations for them (1.1– ontological model of an innovative intelligent production control system the entomophage *Habrobracon hebetor*, 1.2–ontological model of an intelligent decision support system in entomophages production; 2.1–ontological knowledge base of the decision support system in entomophages production, 2.2–knowledge base in the form of "if-then" production rules in the production of the entomophage *Habrobracon hebetor*; 3.1–predicate semantic

network for formalizing the process of building a hybrid intelligent decision support system in entomophages production, 3.2–predicate semantic network for building a hybrid intelligent air temperature control system for a box for growing entomocultures; 4.1–database of promising entomophages, 4.2–database of technical means in the processes of growing entomocultures in both open and protected soil; 5.1–frame structure of information flows in the management of entomophages production; 6.1–associative map of components of an ontologes-based decision support system in entomophages production, 6.2–associative map of an innovative intelligent production management system the entomophage *Habrobracon hebetor*; 7.1–algorithm for designing a cyber-physical system for managing the production and use of biological plant protection products, 7.2–algorithm for obtaining a complex preparation for biological protection of plants from pests and diseases, 7.3–algorithm for developing complex biotechnological plant protection measures).

The research results are useful in improving decision-making support processes for biological plant protection through systematic knowledge processing using modern software tools.

Keywords: Biological plant protection products, production, ontology, formalization.

Acknowledgments. The work was carried out within the framework of the applied task "Development of expert systems for biological plant protection" of the scientific research program of the National Academy of Agrarian Sciences of Ukraine, which is financed from the state budget.

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EFFICACY OF BIOPREPARATIONS ON SEED GERMINATION AND EARLY SEEDLING DEVELOPMENT OF SOYBEAN (*Glycine max* L.)

CHISTOL Marcela*, https://orcid.org/0000-0001-8594-151X
SCERBACOVA Tatiana, https://orcid.org/0000-0002-2632-325X
VOLOSCIUC Leonid, https://orcid.org/0000-0002-7475-4310
HARCIUC Oleg, https://orcid.org/0000-0003-3488-5321

Moldova State University, Institute of Genetics Physiology and Plant Protection, Chisinau, Republic of Moldova,
**Corresponding e-mail: marcela.chistol@sti.usm.md*

Seed germination and early seedling development represent important stages in establishing the biological potential of seed material. The use of biopreparations for seed treatment is of particular interest due to the ability of beneficial microorganisms to stimulate physiological processes involved in germination and initial plant growth.

The aim of the research was to evaluate the effectiveness of biopreparations on seed germination and early seedling development of soybean under laboratory conditions.

The research was conducted in the Biotechnology and Phytopathology Laboratory of the Institute of Genetics, Physiology and Plant Protection, State University of Moldova. The biological material used consisted of soybean (*Glycine max* L.) seeds of the Aura cultivar. The experiment included seven experimental variants, including a control variant (untreated seeds) and six variants with pretreated seeds: water treatment, chemical standard INSURE Perform, biological standard Fitocid (*Bacillus subtilis*), biological preparation Rizoplan (*Pseudomonas fluorescens* AP-33), biopreparation Trichodermin SC (*Trichoderma lignorum*), and amorphous silicon dioxide (SiO_2). Each variant was performed in three replicates of 50 seeds each.

Seed germination was carried out using the paper roll method, followed by incubation of samples in a thermostat at 27°C for 7 days under controlled temperature conditions. The germination process was monitored daily. At the end of the experiment, germination percentage, root length, and seedling vigor index (SVI) were determined, and the obtained data were statistically analyzed.

The application of pre-sowing treatments positively influenced seed germination and early soybean seedling development. Compared with the control variant (89.3%), all treated variants showed higher germination values, ranging from 95.3 to 98.0%. The highest germination percentages were recorded for the chemical standard INSURE Perform and Fitocid (98.0%), followed by Rizoplan and Trichodermin SC (97.3%).

More pronounced differences were observed in root system development. The average root length ranged from 33.46 mm in the control variant to 120.69 mm in the Rizoplan-treated variant. This variant also recorded the highest seedling vigor index value (SVI = 11747.13), demonstrating the stimulatory effect of the biopreparation on early seedling development. Fitocid promoted uniform root system development, while Trichodermin SC and amorphous silicon dioxide improved the analyzed parameters compared with the control variant.

The obtained results demonstrate that the use of biopreparations for seed treatment contributes to improving soybean seed germination and seedling vigor. Among the evaluated biological products, Rizoplan showed the highest biological efficacy, expressed through stimulation of root system development and increased seedling vigor index.

Keywords: soybean, germination, biopreparations, Rizoplan, seedling vigor

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DRIVERS OF OAK FOREST DECLINE IN ROMANIA

CIORNEI Constantin[1,*]
LUPĂȘTEAN Daniela[2], https://orcid.org//0009-0008-9969-305X
RUSU Remus[3]
PLEȘCA Bogdan[1], https://orcid.org/0000-0001-6226-5774
BOTEZATU Florin[3]

[1]National Institute for Research and Development in Forestry "Marin Dracea", Voluntari, Romania
[2]"Stefan cel Mare" University of Suceava, Faculty of Forestry, Suceava, Romania
[3]Forest District INGKA INVESTMENTS S.R.L., Bucuresti, Romania
**Corresponding e-mail: ciornei.tinel@yahoo.com*

Oak decline and dieback represent a severe forest issue in Romania, and the affected area has exceeded 150,000 ha during the period 2018–2025. The phenomenon is highly complex and is driven by a combination of predisposing factors (site conditions, management strategies, and endogenous tree characteristics), inciting factors (abiotic agents, such as severe droughts and frosts, and biotic agents, such as successive caterpillar defoliation), and contributing factors (pests and pathogens, particularly bark- and wood-boring insects, which are considered key factors in Europe).

The aim of this presentation is to highlight the main factors involved in the onset and development of oak decline in Romania and to identify the most efficient management actions.

The research was conducted mainly in north-eastern Romania, where this decline episode has been observed since 2018. In declining oak forests, experimental plots were established, and investigations were carried out on site and stand conditions, defoliation rate, and bark and wood pest infestation. Trees at different stages of decline were felled to evaluate the intensity of stem pest attacks and to identify the stem pest species. In addition, different types of traps were placed in the forest for buprestids (visual prism, panel, and Lindgren traps) and ambrosia beetles (Lindgren and Baker-style traps).

The results showed that, during the last decade, as a consequence of hot droughts, trees started to dry out from the top of the crown, and tree decline progressed rapidly, with mortality occurring within approximately two years after the first symptoms appeared (thin dead branches in the crown and epicormic sprouts on the stem). In the study area, several *Agrilus* species involved in oak decline were identified, mainly

A. sulcicollis Lacordaire, occurring on branches in the crown and on stems with thin bark, and, less frequently, *A. biguttatus* Fab., on larger stems. Trap catches also allowed the flight activity of these species to be determined.

The succession of damaging agents involved in oak decline was confirmed as follows: Agrilus spp., cerambycids (*Rhagium* sp.), weevils (*Gasterocercus depressirostris* Fab.), xylomycetophagous scolytines (*Anisandrus* dispar Fab., *Xyleborinus saxesenii* Ratz.), and wood-decaying fungi.

The lack of efficient control methods for oak stem pests reported in the scientific literature highlights the need to promote silvicultural measures aimed at improving tree vigour and limiting the expansion of oak decline.

Keywords: oak, decline, Agrilus, defoliation, traps

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Bacillus subtilis AS PROMISING BIOLOGICAL AGENT FOR SUSTAINABLE PLANT PROTECTION

COGUTEAC Ana*, https://orcid.org/0009-0000-3208-1122
SCERBACOVA Tatiana, https://orcid.org/0000-0002-2632-325X

Moldova State University,
Moldova State University, Institute of Genetics Physiology and Plant Protection, Chisinau, Republic of Moldova,
**Corresponding e-mail: ana.coguteac@sti.usm.md*

Aim of the study. In the context of sustainable agriculture and the need to reduce chemical pesticide use, beneficial microorganisms represent an eco-friendly alternative for plant protection. *Bacillus subtilis* is recognized for its biocontrol potential due to its ability to inhibit phytopathogens and promote plant growth. The aim of this study was to analyze and synthesize information from the scientific literature regarding the role of *Bacillus subtilis* in biological plant protection and its potential applications in horticultural and field crops.

Materials and Methods. The study was based on a review of scientific publications addressing the biological activity of *Bacillus subtilis* in plant protection. Scientific articles, conference proceedings, and other relevant literature were analyzed to identify the mechanisms responsible for pathogen suppression, induction of plant resistance and growth promotion. Particular attention was given to studies involving horticultural crops and to research conducted in the Republic of Moldova.

Results. The literature analysis showed that *Bacillus subtilis* is one of the most effective biological control agents used against plant pathogens. Its activity is associated with the production of antimicrobial metabolites, competition for nutrients and ecological niches, and induction of systemic resistance in plants. In addition to disease control, *Bacillus subtilis* contributes to plant growth by improving nutrient availability and stimulating root development. Studies conducted on cucumber plants reported positive effects on plant growth, rhizosphere microbial communities and crop quality. Research conducted in the Republic of Moldova demonstrated the effectiveness of a *Bacillus subtilis*-based biological preparation (strain IAB/BS03) against pathogens affecting winter wheat, confirming the practical potential of this bacterium under local conditions.

Conclusions. *Bacillus subtilis* represents a promising biological agent for sustainable plant protection. Scientific evidence confirms its ability to suppress phytopathogens and enhance plant growth, making it a valuable component of integrated crop management systems. Future studies should focus on evaluating the effects of *Bacillus subtilis* treatments on cucumber plants under local environmental conditions and developing recommendations for its practical application in horticulture.

Keywords: *Bacillus subtilis*, biological control, sustainable agriculture, plant protection, cucumber, plant growth promotion.

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DETERMINATION OF THE TITER OF A BACTERIAL SUSPENSION OF *Bacillus subtilis* CNMN-BB-06

COGUTEAC Ana*, https://orcid.org/0009-0000-3208-1122
SCERBACOVA Tatiana, https://orcid.org/0000-0002-2632-325X

Moldova State University, Institute of Genetics Physiology and Plant Protection, Chisinau, Republic of Moldova,
**Corresponding e-mail: ana.coguteac@sti.usm.md*

Introduction. The use of antagonistic microorganisms is an environmentally friendly approach to biological plant protection. Among them, *Bacillus subtilis* is of particular interest due to its ability to produce antifungal metabolites and suppress phytopathogenic microorganisms. For its effective use in biological research and microbial bioproduct development, determination of the bacterial suspension titer is essential to standardize the concentration of viable cells.

Aim of the study. To obtain a bacterial suspension of *Bacillus subtilis* CNMN-BB-06 and determine its titer using the plate-count method on a nutrient medium followed by colony enumeration.

Materials and methods. The study was carried out in the Laboratory of Phytopathology and Biotechnology, Institute of Genetics, Physiology and Plant Protection. The strain *Bacillus subtilis* CNMN-BB-06 was cultivated by submerged fermentation on a microbiological shaker at 200 rpm for 70 h in a liquid nutrient medium. The titer of the obtained bacterial suspension was determined by preparing a series of tenfold serial dilutions up to 10^{-6}. An aliquot of 0.25 mL from the selected dilution was transferred with a sterile pipette onto a Petri dish and evenly spread over the agar surface using a sterile Drygalski spatula in the first plate, followed by the second and third plates using the same spatula. The plates were incubated at 30°C for 48 h, after which the colonies grown on the three plates were counted. The bacterial titer was calculated using the following formula: $M = (a \times 10^n) / V$, where M is the bacterial titer (CFU/mL), a is the number of colonies, 10^n is the dilution factor, and V is the inoculum volume.

Results and discussion. Submerged cultivation of *Bacillus subtilis* CNMN-BB-06 in liquid nutrient medium resulted in a homogeneous bacterial suspension suitable for plant protection applications by fine-droplet spraying. Titer determination of the selected dilution using an inoculum volume of 0.25 mL yielded 70 colo-

nies. According to the calculation, this corresponded to a bacterial titer of 0.3×10^9 CFU/mL. The obtained value indicates a high density of viable bacterial cells and confirms the effectiveness of the cultivation conditions. Standardization of the bacterial suspension is an essential step in ensuring experimental reproducibility and providing a reliable inoculum for further studies on the biological activity of the strain against phytopathogenic microorganisms.

Conclusions. Submerged cultivation enabled the production of a *Bacillus subtilis* CNMN-BB-06 bacterial suspension with a titer of 0.3×10^9 CFU/mL. The obtained results provide a standardized suspension with a high concentration of viable cells and can be used to establish optimal application rates for the biological protection of plants against harmful organisms.

Keywords: *Bacillus subtilis* CNMN-BB-06, bacterial titer, serial dilution, submerged cultivation.

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GLOBAL USE OF *Pseudomonas fluorescens* IN THE CONTROL OF GRAPEVINE MILDEWS

CURIEV Loredana*, https://orcid.org/0000-0002-1927-8358
PINZARU Boris, https://orcid.org/0000-0001-7323-4770

Moldova State University, Institute of Genetics Physiology and Plant Protection, Chisinau, Republic of Moldova,
**Corresponding e-mail*: *loredana.curiev@sti.usm.md*

Grapevine (Vitis vinifera L.) is one of the world's most economically important fruit crops and is cultivated for wine, table grapes, raisins, and juice production. However, grapevine productivity and fruit quality are significantly affected by diseases, particularly downy mildew (Plasmopara viticola) and powdery mildew (Erysiphe necator), which can cause substantial yield and economic losses.

The aim of this review was to evaluate the potential of Pseudomonas fluorescens as a biological control agent against downy mildew (P. viticola) and powdery mildew (E. necator) in grapevine. The review also examined the mechanisms underlying its biocontrol activity and summarized its worldwide application in viticulture.

Materials and methods: A review of international scientific literature was conducted, encompassing laboratory, greenhouse, and field studies from Europe, North America, South America, Australia, and Asia. The analysis focused on the effects of P. fluorescens on disease incidence and severity, as well as on its mechanisms of action, including the production of antimicrobial metabolites, siderophore synthesis, hydrolytic enzyme activity, and the induction of systemic resistance.

Results: The reviewed studies indicate that Pseudomonas fluorescens is a promising biological control agent for integrated grapevine disease management. It suppresses pathogens through competition for nutrients and space, production of antimicrobial compounds, and activation of plant defense responses. Several studies reported reduced severity of downy mildew and powdery mildew, particularly when P. fluorescens was applied preventively as part of integrated disease management programs. However, its effectiveness varied depending on the bacterial strain, environmental conditions, disease pressure, and application method. Although it is generally less consistent than synthetic fungicides under high disease pressure, P. fluorescens can reduce disease incidence and contribute to lower fungicide use in sustainable and organic viticulture.

Conclusions: Pseudomonas fluorescens has considerable potential for the biological control of downy mildew and powdery mildew in grapevine. Its ability to suppress pathogens and enhance plant defense makes it a valuable component of integrated disease management. Nevertheless, optimal performance depends on appropriate strain selection, environmental conditions, and application strategy.

Keywords: Pseudomonas fluorescens; grapevine; biological control; Plasmopara viticola; Erysiphe necator.

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ASSESSMENT OF AGROCENOSIS STATE BASED ON LANDOLT'S ECOCOENOTIC SCALES

DRAGUTSAN Igor,, https://orcid.org/0009-0005-6575-0157
KOLOMIETS Irina*, https://orcid.org/0009-0009-5185-6435
NEVOIA Angela, https://orcid.org/0009-0002-4936-887X

Moldova State University, Institute of Ecology and Geography,
Chisinau, Republic of Moldova,
**Corresponding e-mail*: *ikolomiec71@gmail.com*

Purpose. Agriculture is faced with the task of obtaining the maximum amount of produce with the lowest possible labor and production costs. Successful implementation of this task is only possible with proper and comprehensive assessment of natural resources.

The state of the *Zea mays* L. agrocoenosis was assessed using ecological analysis based on Landolt's ecocoenotic scales. Weed and natural herbage stands from sample plots within the agrocoenosis were used as the study objects. Each species served as an indicator of environmental conditions, and the indicators averaged across the ecocoenotic scales reflected the state of the agrocoenosis in terms of moisture, soil fertility, light intensity, and other factors, determining the degree of anthropogenic transformation of the agrosystem. Corresponding indicators from retrospective natural phytocoenoses previously located in the study area, sessile oak forests (*Quercus petraea* Liebl.), were used as reference indicators for assessing agrocoenosis state.

Materials and methods. The research has established that the floristic wealth of the *Zea mays* L. agrocoenosis is represented by 10 species: *Solanum nigrum* L., *Convolvulus arvensis* L., *Amaranthus retroflexus* L., *Cyclachaena xanthifolia* (Nutt.) Fresen, *Euforbia helioscopia* L., *Chenopodium album* L., *Datura stramonium* L., *Portulaca oleracea* L., *Echinochloa crus-galli* (L.) P.Beauv.

Results. A comparative analysis of the agrocoenosis with the retrospective reference zone has revealed the following features.

1. The replacement of oak groves with agricultural lands leads to a fundamental change in the ecotope along three key axes: illumination ($\Delta L = +1.5$), eutrophication ($\Delta N = +1.1$) and microclimate warming ($\Delta T = +0.6$).

2. Nitrogen oversaturation from 3.1 to 4.2 points triggers the widespread development of weed species.

3. A drop in the humification index H (from 3.4 to 3.0) reflects humus mineralization and a decrease in natural fertility during plowing.

4. The conversion of forested areas to cropland leads to a shift in phytocoenosis strategy. The K-strategy, which emphasizes increased lifespan and a small number of offspring, is replaced by the R-strategy, which emphasizes rapid reproduction and numerous offspring. This creates ideal conditions for invasive species (such as Cyclachaena xanthiifolia, Portulaca oleracea, etc.).

Conclusion. To prevent further soil degradation, measures are required to introduce green manuring (to offset humus loss), optimize nitrogen fertilizer application, and establish shelterbelts to mitigate microclimatic conditions (Δ L = +1.5 and Δ T = +0.6).

Keywords: agrocoenosis, ecocoenotic scales, retrospective reference phytocoenosis.

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PHOTOSYNTHETIC PARAMETERS OF HEALTHY AND LEAF-BROWN SPOT-AFFECTED SOYBEAN PLANTS

HARCIUC Oleg[1,*], https://orcid.org/0000-0003-3488-5321
CHISTOL Marcela[1], https://orcid.org/0000-0001-8594-151X
SCERBACOVA Tatiana[1], https://orcid.org/0000-0002-2632-325X
SHIMIZU Masafumi[2], https://orcid.org/0000-0001-9103-1432
VOLOSCIUC Leonid[1], https://orcid.org/0000-0002-7475-4310

[1]Moldova State University, Institute of Genetics, Physiology and Plant Protection, Chişinau, Republic of Moldova
[2]The United Graduate School of Agricultural Science, Gifu University, Japan
**Corresponding e-mail: oleg.harciuc@sti.usm.md*

Leaf spot diseases in soybeans significantly disrupt normal physiological and photosynthetic functions. Leaf spot of soybeans can be caused by various pathogens: *Septoria glycines* Hemmi, *Colletotrichum sojae* Damm & Alizadeh, *Colletotrichum glycines* Hori, *Ascochyta sojaecola* Abramo, *Alternaria alternata* (Fr.) Keissl, *Fusarium solani (Mart.) Appel et Wr.* and *Peronospora manshurica*. The aim of our study was to determine some photosynthetic parameters for healthy soybean plants and those affected by brown leaf spot under natural field conditions at the Institute of Genetics, Physiology and Plant Protection of Moldova State University.

The objects of our work were plants of Aura variety, 80 days after planting. The photosynthetic parameters were measured by the field portable photosynthesis system LCpro-SD, developed and manufactured by ADC BioScientific (United Kingdom). The main parameters were photosynthetically active radiation (PAR), photosynthetic rate (A), transpiration rate (E), stomatal conductance (g_s) and intercellular CO_2 concentration (C_i).

Although the primary causative agent of soybean leaf spot is considered to be *Septoria glycines* Hemmi, at leaf-brown spot-affected soybean plants were determined *Colletotrichum* sp., fungal pathogens that cause anthracnose in soybeans (*Glycine max*). The main distinguishing feature of the spotted areas on 'Aura' leaves was a significantly higher C_i (despite high, optimal PAR levels), measurable CO_2 exchange was virtually absent. In the affected plants, CO_2 exchange in even visually healthy (green) leaves was lower than that in the leaves of healthy plants (showing

no signs of spotting). Water-use efficiency (A/E) was significantly lower in spotted leaves compared to green leaves.

Conclusions. Under natural conditions, *Colletotrichum* sp. fungi were identified on soybean plants affected by leaf spot. The rate of net photosynthesis in the leaves of affected plants was significantly lower than in healthy plants.

Keywords: Soybean, leaf brown spots, leaf gas exchange.

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WATER STATUS AND PHOTOSYNTHETIC PARAMETERS OF SOME LOCAL WALNUT CULTIVARS

HARCIUC Oleg[1,*], https://orcid.org/0000-0003-3488-5321
SÜTYEMEZ Mehmet[2], https://orcid.org/0000-0003-0417-6495
CHISTOL Marcela[1], https://orcid.org/0000-0001-8594-151X
SCERBACOVA Tatiana[1], https://orcid.org/0000-0002-2632-325X
VOLOSCIUC Leonid[1], https://orcid.org/0000-0002-7475-4310
STINGACI Aurelia[1], https://orcid.org/0000-0001-6621-9919

[1]Moldova State University, Institute of Genetics Physiology and Plant Protection, Chisinau, Republic of Moldova
[2] Kahramanmaras Sutcu Imam University, Faculty of Agriculture, Department of Horticulture, Kahramanmaras, Republic of Turkey
**Corresponding e-mail: oleg.harciuc@sti.usm.md*

The aim of this study was to determine at the initial stage of fruit development the water status and some photosynthetic parameters of walnut cultivars popular in the Republic of Moldova.

The dry matter content of the kernels was determined by drying the samples to a constant mass at a temperature of 70 °C. The water content (WC) was expressed on a dry weight (DW) or fresh weight (FW) basis. The photosynthetic parameters were measured by the field portable photosynthesis system LCpro-SD (United Kingdom). The main parameters were photosynthetically active radiation (PAR), photosynthetic rate (A), transpiration rate (E), stomatal conductance (g_s) and intercellular CO_2 concentration (C_i). Measurements of leaf photosynthetic parameters and sample collection for determination of WC in the kernels from various walnut cultivars were conducted at the "Gospodarul" SRL walnut orchard (Fălești District, Republic of Moldova) on July 21, 2025 and 2026.

In both years of the study (2025 and 2026), the value of A was highest for the Chandler cultivar, at leaf temperature 29-31°C amounting more than 11 μmol CO_2 m^{-2} s^{-1}. At the BBCH 790 ontogenetic stage, Chandler variety kernels have the highest WC compared to other varieties - 93–96% of FW. The shift of the growing season to a later period in the Chandler cultivar may reduce the harmful impact not only of early frosts but also of major walnut diseases. The variety Pescianski is

widely considered the gold standard of Moldovan-bred walnuts. While exhibiting high photosynthetic activity the leaves of the Pescianski variety are characterized by a lower transpiration rate, enabling more efficient water use. Intercellular CO_2 concentration reflects mesophyll consumption rate vs. stomatal supply. The minimum C_i value was noted in 2026 in the leaves of the Kogâlniceanu variety. At the BBCH 790 stage, among the studied cultivars, the lowest water content was observed in the Chernovitski cultivar - 78–79% of FW; the kernels of this one early variety can be recommended for early consumption.

Conclusions. The 'Chandler' variety has the highest rate of photosynthesis. At the BBCH 790 ontogenetic stage, 'Chandler' variety kernels have the highest moisture content compared to other varieties. The leaves of the Pescianski variety are characterized by a lower transpiration rate. The minimum intercellular CO_2 concentration was noted in the leaves of the Kogâlniceanu cultivar.

Keywords: walnut, varieties, leaf gas exchange, kernel water content.

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HYDROPONIC CULTIVATION OF LETTUCE AS A SUSTAINABLE APPROACH TO REDUCING SOIL-BORNE DISEASES

HLIUDZYK-SHEMOTA Marharyta, https://orcid.org/0000-0001-7937-6489

Uzhhorod National University, Department of fruit and vegetable cultivation and viticulture
Corresponding e-mail: *marharyta.hliudzyk@uzhnu.edu.ua*

Sustainable vegetable production requires innovative cultivation technologies that improve crop productivity while reducing environmental impact and the incidence of plant diseases. Hydroponic cultivation has emerged as an efficient alternative to conventional soil-based systems by providing precise control of plant nutrition and growing conditions. Lettuce (*Lactuca sativa* L.) is one of the most economically important leafy vegetables cultivated in hydroponic systems because of its short production cycle and high commercial value. The aim of this study was to evaluate the potential of hydroponic cultivation as a sustainable strategy for reducing soil-borne diseases and improving the growth and quality of lettuce under protected cultivation.

The study was conducted using a nutrient film technique (NFT) hydroponic system under controlled greenhouse conditions. Lettuce plants were cultivated using a balanced nutrient solution with a pH maintained between 5.8 and 6.2 and an electrical conductivity of 1.4–1.8 mS cm^{-1}. Greenhouse temperature, relative humidity, and light conditions were regulated to ensure optimal plant development. Plant height, number of leaves, fresh biomass, root development, and visual quality were evaluated during the growing period. Particular attention was given to the occurrence of soil-borne diseases and the overall phytosanitary condition of the plants.

Hydroponic cultivation ensured uniform plant development and intensive vegetative growth throughout the production cycle. The absence of soil substantially reduced the likelihood of infection by major soil-borne pathogens, including *Fusarium* spp., *Pythium* spp., and *Rhizoctonia* spp., which are responsible for root rot and seedling diseases in conventional production systems. Healthy root development and continuous nutrient availability promoted efficient uptake of mineral elements and enhanced biomass accumulation. In addition, hydroponic cultivation reduced water consumption through nutrient solution recirculation and minimized nutrient losses

to the environment. The controlled cultivation environment also decreased the need for chemical plant protection products and facilitated the implementation of integrated pest and disease management practices. The obtained observations indicate that hydroponic production contributes to higher product uniformity, improved market quality, and more sustainable use of natural resources.

Hydroponic cultivation of lettuce is an effective and environmentally sustainable production technology that supports modern plant protection strategies. The elimination of direct soil contact significantly decreases the risk of soil-borne diseases while promoting healthy plant growth and efficient resource utilization. The integration of hydroponic systems into greenhouse vegetable production can reduce pesticide dependence, improve crop quality, and enhance the sustainability of agricultural production. Further studies should investigate the combined use of hydroponic systems with biological control agents and beneficial microorganisms to strengthen integrated plant protection programs.

Keywords: hydroponics, lettuce, plant protection, soil-borne diseases, greenhouse production, NFT system, sustainable agriculture.

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BIOLOGICAL METHOD OF PROTECTION OF APPLE TREE FROM SCABY IN THE CONDITIONS OF THE WESTERN FOREST-STEP OF UKRAINE

HUNCHAK Mykhailo, https://orcid.org/0000-0002-3521-8531

Chernivtsi regional center of the state institution "Institute of soil protection of Ukraine", Ukrainian Science-Research Plant Quarantine Station IPP NAAS
Corresponding e-mail: gunchak00@ukr.net

Purpose: Apple plantations are affected by a large number of diseases, but the most common in the conditions of the Western Forest-Steppe of Ukraine is scab (*Venturia inaequalis* Wint). Therefore, the aim of the work was to study the effectiveness of integrated systems for protecting apple trees against scab.

Materials and Method: The work conducted during 2023-2025 in the apple orchard of the Ukrainian Science Research Plant Quarantine Station Institute of Plant Protection NAAS as per generally approved methods on the apple trees plantings of 2014 the Idared variety planting. The fungicides efficiency determined according to the official methods through 7 days.

Summarized results. There were 3 biological complex systems in combinations with microelements study for apple-trees plantations protection from scab.

The first system of biological protection included treatment at phenophase "bud separation" with biological preparation Fluorescin BT at rate 2,0 l/ha and S, Zn; at phenophase "fruit forming" – Bactofit BT (4,0 l/ha) + Mg, Mn, Fe, Co; at phenophase "fruit growing" (walnut-size fruit) – Biogibervit BT (3,0 l/ha); at phenophase "fruit growing" (July second ten-days) – Trichopsin BT (5,0 l/ha) + Ca; at phenophase "fruit ripening" – Fluorescin BT (1,5 l/ha). The results of the research showed that the effectiveness against scab on leaves was 64.5% and on apple fruits – 66.2%.

The second biological protection system based upon the next spraying during phenophase "rose bud" mix Bactofit BT at rate 4,0 l/ha and Trychipsin BT at rate 5,0 l/ha + B, Mo; "fruit growth" (hazel fruit size) – Biohybervit BT (3,0 l/ha) + Mg, Mn, Fe, Co; "fruit growth" (first July's ten-days) – Fluorescin BT (1,5 l/ha); "fruit growth" (first August's ten-days) – a mixture of Trichopsin BT (3,0 l/ha) and Biospectre BT (3,0 l/ha) + Ca; "fruit ripening" – Fluorescin BT (1,5 l/ha). The use of this protection system allowed to reduce the development of scab on leaves by 68.4% and on apple fruits by 69.1%.

The following biological protection system included treatment during the phenophase “bud separation” with S, Zn; in the phenophase “rose bud” – with a mixture of Ampelomycin BT (4,0 l/ha) and Bactofit BT (3,0 l/ha) + B, Mo; at the phenophase “fruit formation” – a mixture of Phytosporin BT (5,0 l/ha) and Fluorescin BT (1,0 l/ha) + Mg, Mn, Fe, Co; in the phenophase “growth fruit” (walnut – sized fruit) – Biohybervit BT (3,0 l/ha); at the phenophase “fruit growth” (second July’s ten-days) – Biospectre BT (6,0 l/ha) + Ca; in the phenophase “fruit maturation” – a mixture of Trichopsin BT (3,0 l/ha) and Fluorescin BT (1,0 l/ha). The effectiveness of this system against scab on leaves was 74.0% and on apple fruits – 74.8%.

A chemical system used as a reference. It was based upon five spraying by chemical pesticides. The technical effectiveness of this protection system against leaf scab was 87.3%, and against apple fruit scab was 92.6%.

Conclusions. The results of the research showed that the use of the studied complex biological protection systems in combination with microelements allowed to reduce the development of apple scab by 64.5-74.8%.

Keywords: apple tree, scab, biological protection, technical efficiency.

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PHYTOPATHOLOGICAL STATUS OF THE GENETIC MATERIAL OF SOYBEAN CROP ON TWO AGROFONDS OF INFECTION

LENCAUȚAN Marianna, https://orcid.org/0009-0002-2212-6037

National Center for Research and Seed Production, Selectia Sector
Balti, Republic of Moldova,
Corresponding e-mail: lencautanmarianna@gmail.com

The article presents the importance of leguminous crops, especially soybean, for sustainable agriculture, food security and soil fertility improvement. The main diseases affecting soybean crops in the northern part of the Republic of Moldova are analyzed, such as soybean mosaic, bacterial blight, downy mildew and root rots.

The research aims to identify soybean varieties and genetic lines with high productivity and increased resistance to diseases, under climate change conditions. The authors highlight that the use of resistant varieties is one of the most efficient and environmentally friendly methods of plant protection.

Integrated crop protection is promoted, combining genetic, agrotechnical, biological, physical-mechanical methods and, only when necessary, chemical methods. Incorrect or excessive application of pesticides can cause negative environmental effects and economic losses.

In the 2025 research, soybean genetic materials were evaluated under natural and artificial infection conditions, and genotypes with high resistance to pathogens were selected. These varieties and lines are recommended for use in breeding programs and for the creation of new varieties adapted to the unstable climatic conditions of the Republic of Moldova.

The change and instability of the main parameters of the climate of the Republic of Moldova leads as a consequence to a decrease in the level of productivity and a strong attack of harmful diseases of leguminous crops. One of the main factors of continuous growth of the productivity of agricultural lands in the conditions of the Republic of Moldova is the rational protection of the crop from attacks by pests and diseases, which annually bring considerable damage to agricultural households and remain increasingly acute today.

The integrated system of traditional protection measures includes various methods of combating most species of pests, diseases. Poor-quality and (or) late imple-

mentation of protection measures, or unilateral exaggeration of the use of chemical methods often causes some undesirable consequences from the point of view of environmental protection, as well as causes enormous economic damage to solve these rather complicated problems is possible provided that the requirements and criteria of integrated protection systems are strictly observed, which are based on a complex of selection and genetic measures.

The solution to the problem of increasing production volumes is aimed at creating (in conjunction with breeders) varieties that are adaptive to unstable soil and climatic conditions, capable of forming a high level of production even in years with epiphytotic development of the main diseases of agricultural crops.

The main idea: increasing soybean production and reducing losses caused by diseases can be achieved by creating and using resistant varieties, adapted to climate change, within an integrated and ecological crop protection system.

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VINYL-TRIAZOLE DERIVATIVES WITH ANTIFUNGAL ACTIVITY AGAINST *Fusarium solani*

LUPASCU Lucian*, https://orcid.org/0000-0001-5006-5265
CRISTEA Nicolae, https://orcid.org/0009-0008-7259-3884
STANGACI Eugenia, https://orcid.org/0000-0003-0731-3424
CEABANOVA (ZVEAGHINTEVA) Marina, https://orcid.org/0000-0003-1553-5246
MACAEV Fliur, https://orcid.org/0000-0002-3094-1990

[1]Moldova State University, Institute of Chemistry, Chisinau, Republic of Moldova
[2]Moldova State University, Institute of Genetics Physiology and Plant Protection, Chisinau, Republic of Moldova,
**Corresponding e-mail*: *lucianlupascu75@gmail.com*

Numerous species of Fusarium exist in soil, some of which are common plant pathogens, infecting seeds and seedlings, causing them the root rot. Among the pathogenic species of Fusarium frequently encountered in corn, wheat and soybean plants with root rot symptoms, we can mention *F. solani*, which has a very destructive effect on the grain germination, plant growth and development, leading to the loss of their viability. This pathogen is constantly present in soil, and under unfavorable environmental conditions it massively attacks weakened plants, polluting the grains/seeds with mycotoxins, which are particularly harmful to the animal and human body [1].

Purpose of the research consisted in the establishment of the anti-fungal activity of the vinil-triazolic compounds against the mentioned fungus, because the agriculture is requesting more and more efficient preparations against harmful phytopathogens.

Materials and methods. In the research, 2 isolates of *F. solani* were used, extracted from the basal part of the stem of common winter wheat with signs of root rot and identified according to [3]. The isolation of the fungi was carried out under aseptic conditions on PDA (Potatoes Dextrose Agar) medium [2]. The vinyl-triazole derivatives that were used in the study: EPS-860: ((Z)-1,3-bis(2,4-dichlorophenyl)-2-(1H-1,2,4-triazol-1-yl)prop-2-en-1-one), EPS 165: (z)-1-(2,4-dichlorophenyl)-5-methyl-2-(1h-1,2,4-triazol-1-yl)hex-1-en-3-one)) and EPS-297: ((Z)-1-(2,4-dichlorophenyl)-3-(2-hydroxyphenyl)-2-(1H-1,2,4-triazol-1-yl)prop-2-en-1-one), in concentrations of 0.00125; 0.0025; 0.005; 0.01; 0.02%. The Petri dishes with the

inoculated fungal colonies were maintained in a thermostat at a temperature of 24°C. The colony diameter was recorded based on 2 perpendicular diameters, the average of which served as a biometric index. The experiment was performed in 3 repetitions.

Results On the last day of data recording (the 7th), the 0.02% concentration produced an inhibition of 75.7-79.3% depending on the compound studied, and for the minimum concentration (0.00125%) of the 3 compounds, the level of colony growth inhibition was 19.8 ... 28%.

Conclusion The vinyl-triazole derivatives EPS-165, EPS-860, EPS-297 in concentrations of 0.02-0.00125% significantly inhibited the growth of *F. solani* colonies under *in vitro* conditions, which offers prospects for their use in plant protection measures against this pathogen.

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EFFECT OF THE NATURAL BIOREGULATOR FROM *Juniperus communis* ON THE GERMINATION AND EARLY DEVELOPMENT OF CORN

LUTCAN Elena*, https://orcid.org/0000-0001-9967-6665
ELISOVETCAIA Dina, https://orcid.org/0000-0003-0521-6428
MASCENCO Natalia, https://orcid.org/0000-0003-1869-4357
IVANOVA Raisa, https://orcid.org/0000-0002-2554-2039

Moldova State University, Institute of Genetics Physiology and Plant Protection, Chisinau, Republic of Moldova,
**Corresponding e-mail: elena.lutcan@sti.usm.md*

Seed germination is an essential stage in the development of corn crop, influencing the uniformity of emergence and the productive potential of plants. The use of natural bioregulators can stimulate the physiological processes involved in germination and early growth of seedlings. In this context, **the purpose** of the study was to evaluate the effect of the natural bioregulator from *Juniperus communis* (JCom) on the germination and early development of sweet corn.

Materials and method. The female line seeds of the sweet corn hybrid P280 were used as biological material of study. The natural bioregulator JCom in powder form was obtained from the above-ground part of *Juniperus communis*, and aqueous solutions were used for its application. Corn seeds were divided into two experimental variants: control and treated with bioregulator JCom at the 0.0001% concentration. The control seeds were soaked in water for 24 hours, and those in the experimental variant in bioregulator solution. Subsequently, they were germinated for 7 days at a temperature of 25°C (under optimal conditions). After this, the germination percentage, root and seedling length, root and seedling biomass, and metabolic efficiency were determined. The vigor index was calculated according to the formula: vigor = (root length + seedling length) × germination percentage.

The results demonstrated a positive effect of the treatment with JCom on all the indexes analyzed. The germination percentage increased from 84.0 ± 5.7% in the control to 91.0 ± 6.8% in the treated variant, representing an increase of approximately 8.3%. The average length of the roots was 10.92 ± 3.89 cm in the treated variant, compared to 9.57 ± 3.93 cm in the control, which corresponds to a growth of 14.1%. Also, the seedlings length increased from 4.72 ± 2.02cm to 5.17 ± 1.76 cm,

recording an increase of 9.5%. The most pronounced influence of the treatment with JCom was observed on the vigor index. Its average value increased from 1189.24 in the control variant to 1368.01 in the treated variant (approximately 15.0% more), which was confirmed by a statistically significant difference ($p < 0.01$). The similar values of the standard deviation (428.19 in the control and 421.38 in the treated variant) show that the increase in vigor was accompanied by the maintenance of a comparable variability between seedlings, which indicates a more uniform development of the treated seedlings. Moreover, treated seeds utilized reserve substances more efficiently for germination; their metabolic efficiency was 9.8% higher than that of control seeds.

Conclusions. The results demonstrate that the natural bioregulator obtained from aerial part of *Juniperus communis* stimulates the germination and early development of sweet corn seedlings, contributing to more vigorous and uniform plants. These effects highlight the potential of using the bioregulator as an ecological alternative for improving the biological quality of seeds and the initial performance of the crop.

Keywords: *Juniperus communis*, corn seed, female line, germination, bioregulator.

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COMBINED APPLICATION OF PHOTOSYNTHETIC HERBICIDES WITH DIFFERENT MODES OF ACTION FOR WINTER WHEAT CROP PROTECTION

MORDERER Yevhen, https://orcid.org/0000-0001-7237-3429
STOROZHENKO Volodymyr*, https://orcid.org/0000-0002-7355-3699

Institute of Plant Physiology and Genetics, National Academy of Sciences of Ukraine,
*Kyiv, Ukraine, *Corresponding e-mail: vstoro@ukr.net*

The most effective class of modern herbicides for weed control in winter wheat crops is the acetolactate synthase (ALS) inhibitors. At the same time, an active search is underway for effective herbicide compositions to implement alternative options for protecting this crop from weeds due to the growing spread of cases of weed resistance to ALS inhibitors.

The aim of the work was to check the selectivity of a mixture of the herbicides tolpyralate (HPPD inhibitor) and bentazon (inhibitor of electron transport in PS II) on winter wheat crops in order to determine the nature of the interaction of the components of this mixture.

Herbicide treatments of the crops were carried out at the tillering stage on the area of the experimental plot of 15 m² (3 × 5 m) in four replications. The selectivity of the herbicides with respect to winter wheat was checked by means of phenological observations and biometric measurements under field experiment conditions. The action of the herbicides under field conditions was determined by the efficacy of control of individual weed species according to the reduction in the number of a given weed species compared with the control, as well as taking into account its visual assessment.

The results obtained in the field experiments demonstrated that the herbicide tolpyralate, when applied alone and its mixtures with bentazon, are selective with respect to winter wheat when the adjuvant Trend 90 is added. When tolpyralate was applied alone or in a mixture with bentazon, their interaction was predominantly additive, but in some cases, synergism could be determined on individual species.

The predominant absence of synergism reduces the potential efficacy of using a mixture of tolpyralate with bentazon for controlling weed resistance to herbi-

cides. However, it should be emphasized that the additive nature of the interaction makes it possible to obtain high efficacy of control by the mixture of tolpyralate with bentazon of annual dicotyledonous weeds. This mixture is not inferior in efficacy to modern herbicidal preparations of the class of ALS inhibitors.

Thus, due to the fact that the mixture of tolpyralate with bentazon is selective with respect to winter wheat and provides high efficacy of weed control, it can be used for alternation with ALS-inhibitor herbicides on winter wheat crops to overcome weed resistance to ALS inhibitors.

Keywords: tolpyralate, bentazon, ALS inhibitors, weeds, winter wheat.

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PHENOLOGY OF DEFOLIATING INSECTS ASSOCIATED WITH FOREST-STEPPE OAK STANDS IN EASTERN ROMANIA

PLEȘCA Bogdan-Ionut[1,2,*], https://orcid.org/0000-0001-6226-5774
CIORNEI Constantin[1]
LOGHIN Constantin-Cosmin[1,2], https://orcid.org/0009-0007-4491-0486

[1]National Institute for Research and Development in Forestry "Marin Dracea", Voluntari, Romania
[2] Forestry Faculty of Silviculture and Forest Engineering, "Transilvania" University of Braşov, Braşov, Romania
**Corresponding e-mail: bogdan.plesca@icas.ro*

The phenology of defoliating insects is essential for understanding forest ecosystem dynamics and supporting the development of forest protection strategies, particularly in the context of climate change and the increasing frequency and intensity of environmental stressors affecting forest vegetation. However, information on the phenology of defoliating insects in forest-steppe oak stands remains limited. The study area includes extensive forest-steppe landscapes, forming a belt of variable width, predominantly within the Prut River basin of eastern Romania.

The aim of the present study is to characterize the phenology of the main defoliating insect species and to assess defoliation intensity in representative forest stands of this region.

The study focused on mixed oak stands in the Moldavian Plateau. Phenological observations were conducted over two consecutive years. Assessments were conducted on *Quercus pubescens*, *Q. pedunculiflora*, *Q. petraea*, and *Q. frainetto* trees in the Voloaca–Unsu (Iași County) and Nisa–Hobana (Galați County) forests.

The defoliating insect species present were identified, defoliation was assessed, and other pests of lower importance were also recorded. For sampling purposes, the crown was divided into the lower, middle, and upper thirds, from which leafy branches were collected. Defoliation was assessed in accordance with the methodology prescribed by the current Romanian regulations for forest monitoring and protection.

Defoliation levels ranged from 5% to 15%, with slightly higher values recorded in the Nisa–Hobana Forest. The species recorded during field surveys included

Operophtera brumata and *Erannis defoliaria* (*Geometridae*); *Tortrix viridana* and *Archips xylosteana* (*Tortricidae*); *Orthosia spp*. (*Noctuidae*); *Acrobasis repandana* (*Pyralidae*); and, less frequently, *Lymantria dispar* (*Lymantriidae*), *Apethymus abdominalis* (Hymenoptera: *Tenthredinidae*), and several defoliating beetle species (e.g., *Orchestes quercus*). In 2025, the invasive oak lace bug, *Corythuca arcuata* (Hemiptera: *Tingidae*), was also recorded in the Nisa–Hobana Forest.

The study highlighted the temporal and spatial variation in defoliation, its distribution across crown strata, and potential differences among the affected oak species. In addition, relationships between the occurrence of dominant defoliating insect species and defoliation intensity during the study period were analysed. The results enable the characterization of the defoliating insect complex associated with forest-steppe stands in the Moldavian region of Romania and contribute to a better understanding of their phenology.

This research provides valuable information to support the development of forest health monitoring programmes and supports the implementation of integrated pest management strategies in forest-steppe oak stands. Integrating phenological observations with defoliation assessments may contribute to anticipating periods of increased risk and optimizing forest protection measures under current environmental change. The findings are highly relevant to current forest health issues in forest-steppe ecosystems and highlight the need for continued long-term monitoring.

Keywords: insect phenology; defoliation; oak stands; forest-steppe; monitoring; Moldavian Plateau.

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ToMV IN WATER: MOLECULAR DETECTION, PHYLOGENY AND INDICATOR POTENTIAL

POZHYLOV Illia*, https://orcid.org/0000-0002-6259-3740
KOROTIEIEVA Hanna, https://orcid.org/0000-0002-4059-0741
SHEVCHENKO Oleksiy, https://orcid.org/0000-0002-4947-8959
FILONENKO Oleksandra, https://orcid.org/0000-0002-2554-8609
BUDZANIVSKA Iryna, https://orcid.org/0000-0003-2538-7312

Virology Department, ESC "Institute of Biology and Medicine",
Taras Shevchenko National University of Kyiv, Ukraine
**Corresponding e-mail: illia.pozhylov@knu.ua*

Aquatic environments are important reservoirs of phytopathogens capable of prolonged survival outside their hosts. Due to high environmental stability, certain plant viruses, and tobamoviruses in particular, can persist in natural and anthropogenically impacted water systems. While plant viruses are well documented in agriculture, their occurrence in Ukrainian aquatic ecosystems remains understudied. Growing anthropogenic pressure and the need for reliable viral markers highlight the importance of identifying suitable indicators and assessing their genetic diversity. This study aimed to detect plant viruses in aquatic ecosystems and reusable organic bioresources in Ukraine, and to evaluate the genetic relatedness of identified isolates through phylogenetic analysis to assess their potential as indicators of anthropogenic contamination. A total of 22 water samples (river, lake, tap, and wastewater) from Kyiv and four other regions, along with horse manure, tobacco dust, and chicken compost, were analyzed. Viral concentration was performed by adsorption–elution. RT-PCR with specific primers was used to screen samples for a number of relevant pathogens identified in literature, including PMMoV, ToMV, ToBRFV, TMV, TSWV, CGMMV, TAV, ZYMV, CMV, WMV-2, and PSTVd. ToMV-positive amplicons were Sanger-sequenced, and phylogenetic analysis was conducted using Maximum Likelihood (Tamura 3-parameter model, MEGA7) with 1000 bootstrap replicates. Among all targets, only tomato mosaic virus (ToMV) was detected, in 5 of 22 water samples (Lake Verkhovyna, Lake Nyvky, Kytaiv ponds, Rusanivka canal, and Bortnychi wastewater). No viral or viroid signatures were found in manure, tobacco dust, or compost. Phylogenetic analysis of partial coat protein gene sequences placed the Ukrainian isolates within clade I, clustering with the Turkish isolate CAN53 (91.8%

identity). However, pairwise comparisons showed higher similarity (93.2–97.3%) to isolates from Brazil, South Korea, the Netherlands, Serbia, and China, reflecting a complex phylogeography. Two Ukrainian isolates shared 97% identity, suggesting a common contamination source. Selective detection of ToMV across diverse water bodies, despite the absence of other widespread plant viruses, confirms its environmental stability and supports its consideration as a promising viral contamination indicator. Phylogenetic clustering with a Turkish isolate, along with Ukraine's substantial tomato imports from Turkey, points to potential introduction pathways via contaminated plant material. These findings emphasize the need for region-specific validation of viral markers and highlight the value of phylogenetic surveillance in tracking phytopathogen circulation through aquatic ecosystems and recycled bioresources.

Keywords: virus; ToMV; aquatic ecosystems; recycled bioresources; phylogenetic analysis.

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STARCH MOBILIZATION FROM RESERVE SUBSTANCES OF CORN SEEDS DURING GERMINATION

PROCA Olga*, https://orcid.org/0009-0000-9443-507X
LUTCAN Elena, https://orcid.org/0000-0001-9967-6665
IVANOVA Raisa, https://orcid.org/0000-0002-2554-2039
MASCENCO Natalia, https://orcid.org/0000-0003-1869-4357

Moldova State University, Institute of Genetics Physiology and Plant Protection, Chisinau, Republic of Moldova,
**Corresponding e-mail: olga.proca@sti.usm.md*

It is well known that during corn seed germination, some reserve substances are used for root and seedling development, while others are used for respiration and energy required for physiological processes. The ratio of reserve substances used for root/seedling growth to the amount expended on respiration/energy is an important index of metabolic efficiency. Starch, a reserve substance contained in the endosperm of corn seeds, is the primary energy reserve for these processes and the intensity of starch mobilization can influence germination efficiency. Therefore, **the aim of this study** was to evaluate the changes in starch content of corn seeds during germination under different conditions.

Materials and methods: Corn seeds of four parental lines of hybrids Porumbeni 402 (P402) and Porumbeni 465 (P465) were exposed two abiotic factors – non-optimal temperatures and treatment with the natural bioregulator JS, dry extract obtained from *Juniperus sabina* and diluted to a concentration of 0.0001%. Seeds were soaked for 24 hours in solutions of JS bioregulator and water (control) before germination under optimal conditions and under the influence of non-optimal temperatures. In cold-test the seeds germination was carried out at 10°C for 7 days plus 4 days at 25°C; and in thermo-test the seeds were exposed for 30 min at 50°C, after which germination was carried out at 25°C for 7 days. Biomass of seeds, roots and seedlings, as well as content of starch in seeds were determined. The metabolic efficiency and its relationship with mobilized starch was calculated. Starch content in intact and post-germinated seeds was determined using the Ewers-Grossfeld polarimetric method. Each variant was carried out in four repetitions, 25 corn seeds each.

Results: The starch content in the corn seeds of female lines was 63.45±0.55% and 72.08±0.47%, while in male lines it was 72.85±0.50 and 77.55±0.55%, respectively for hybrids P465 and P402. Under optimal germination conditions, approximately 21.93-36.82% of starch was mobilized from the seeds of female lines and 42.30-47.00% from the seeds of male lines. The most variable data on metabolic efficiency and starch consumption (from 4.70 to 60.32%) of seeds germinated under non-optimal temperatures and treated with JS were found in the parental lines of the P402 hybrid. Whereas the metabolic efficiency of parental lines of the P465 hybrid and the amount of mobilized starch varied within a narrow range, the differences were approximatively 0.8-7.8%. This fact confirmed that the parental lines of the P465hybrid are more resistant to abiotic factors than the parental lines of the P402. Statistical analyses of the relationship between metabolic efficiency and consumed starch showed their correlation with a Pearson coefficient of 0.7468.

Conclusions: Evaluation of starch content mobilized from corn seeds of parental lines germinated under different conditions and treated with bioregulator JS demonstrated that the metabolic efficiency of seeds is directly dependent on the starch consumed during germination.

Keywords: corn seed, parental lines, germination, bioregulator JS, starch,

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IMPACT OF *Erwinia amylovora* BACTERIOPHAGES ON QUINCE FRUCTIFICATION

SAMOILOVA Anna, https://orcid.org/0000-0003-4976-0644

Moldova State University, Institute of Genetics Physiology and Plant Protection, Chisinau, Republic of Moldova,
Corresponding e-mail: anna.samoilova@sti.usm.md

Yield losses of the economically important plant cultures caused by diseases require further improvements in the most harmful phythopathogens management. In this context the disease control agents must effectively inhibit the pathogen development without adversely affecting the plants' fruit production.

The purpose of the present work was to evaluate the impact of the promising fire blight control agents, *Erwinia amylovora* bacteriophages, on the quince fructification.

Materials and methods. The trials were carried out at the experimental plot of the MSU, IGFPP on the quince flowers during the blooming stage. There were the following variants in the experiment: flowers, infected with *E. amylovora* suspension contained 10^3 CFU/ml; flowers inoculated with *E. amylovora* suspension contained 10^3 CFU/ml and treated with 10^6 PFU/ml of bacteriophage isolates; flowers infected with *E. amylovora* suspension contained 10^3 CFU/ml and treated with Cuprumax preparation, containing copper oxychloride. Flowers treated with sterile distilled water were used as the controls.

The quince experimental plot is situated far from the other pome fruit plantations. Monitoring of the fire blight causative agent appearance on the plants, which are not involved in the experiments is carried out continually all over the year.

Summarized results. Pome plants are most vulnerable to fire blight causative agent, bacteria *E. amylovora* infection during flowering, which is a crucially important stage for the fruit forming. This means, that the pathogen's control agents used at the flowering stage have to be safe for the fruit-setting process. Normally, the final level of the fruit development on quince trees is 10-15% of the total initial flowers amount. The quince plants at the experimental plot formed approximately 12-15% fruits in the seasons with favorable conditions for blossoming and fruit forming. In the 2026 vegetation period the abundant blossoming was observed, but short term low temperatures during the BBCH 67 stage of flowering had an extremely negative

impact on the fruits production. Nevertheless, assessment of the fruits presence in the experimental variants, carried out in the third decade of July, the 2026 vegetation period, at the time of the BBCH 76 stage when fruits were about 60% final size, revealed that flowers inoculated with *E. amylovora* suspension and treated with bacteriophages formed 4% of fruits. Flowers infected with *E. amylovora* suspension and treated with Cuprumax also formed 4% of fruits. There were no fruits in the variant, where flowers were infected with *E. amylovora* suspension. In the variant, where quince flowers were treated with sterile distilled water there were 6% of formed fruits. All fruits that reached the BBCH 76 stage of development were counted.

Conclusions. It has been found out that the fire blight pathogen infection of the flowers leaded to the fruits absence but after treatment with bacteriophages there were the same amount of the 60% final size fruits as after treatment with copper containing compound. Thus, after thorough study, bacteriophages can be used for the prevention of fire blight in cases where the application of chemical agents is prohibited and there is a high risk of the pathogen active multiplication in the flowers.

Keywords: bacteriophages, *Erwinia amylovora*, quince, fructification.

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ENVIRONMENTALLY FRIENDLY PROTECTION OF SWEET CHERRY AND QUINCE AGAINST MONILIOSIS

SCERBACOVA Tatiana[1],*, https://orcid.org/0000-0002-2632-325X
STINGACI Aurelia[1], https://orcid.org/0000-0001-6621-9919
HARCIUC Oleg[1], https://orcid.org/0000-0003-3488-5321
GRIGORIEV Corneliu[2]

[1]Moldova State University, Institute of Genetics Physiology and Plant Protection, Chisinau, Republic of Moldova
[2]SRL "AGRICOS TECH",
**Corresponding e-mail*: *tatiana.scerbacova@sti.usm.md*

Brown rot (moniliosis) is among the most destructive diseases affecting fruit crops. In stone fruit species, including sweet cherry, sour cherry, plum, apricot, and peach, the disease is caused by *Monilia cinerea* Bon. (syn. *Monilia laxa* Sacc.), whereas in pome fruit species, including quince, apple, and pear, it is caused by *Monilia fructigena* Pers. The disease occurs in two main forms: monilial blight, which affects flowers, leaves, young fruits, shoots, and branches, and fruit rot, which develops as fruits ripen. Cool, humid weather during spring flowering and the ripening of early sweet cherry cultivars favours disease development and, under severe conditions, losses of flower buds and fruits may reach 100%.

Because the use of chemical fungicides is constrained by pre-harvest intervals, environmentally friendly biological control methods represent an important alternative for sustainable disease management. This study aimed to evaluate the antagonistic and fungicidal activity of the biopreparations Gliocladin-SC and Rizoplan against the causal agents of moniliosis under *in vitro* conditions.

The phytopathogens *M. cinerea* and *M. fructigena* were isolated from naturally infected sweet cherry and quince fruits. The antagonistic activity of the biological agents was evaluated on potato dextrose agar (PDA) using the dual-culture method. The fungicidal activity of the biopreparations was assessed by the agar diffusion method using metal cylinders. After 10 days of incubation, antagonistic interactions and fungicidal effects were evaluated based on colony development and the formation of sterile inhibition zones around the cylinders.

The biological agent contained in Gliocladin-SC, *Trichoderma virens* CNMN-FD-13, completely overgrew the colonies of *M. cinerea* and *M. fructigena* within 7-8 days, reaching colony radii of 32.0 and 23.5 mm, respectively. The strain displayed fungistatic nutritional antagonism. The fungicidal activity of Gliocladin-SC was confirmed by sterile inhibition zones measuring 20.0 mm against *M. cinerea* and 35.0 mm against *M. fructigena*.

The biological agent contained in Rizoplan, *Pseudomonas fluorescens* AP-33-(V-3481), exhibited antibiosis in dual culture, producing sterile inhibition zones with radii of 28.3 mm against *M. cinerea* and 41.5 mm against *M. fructigena*. The fungicidal activity of Rizoplan was confirmed by inhibition zones measuring 16.8 and 23.3 mm against *M. cinerea* and *M. fructigena*, respectively.

Conclusions. The biological agents *T. virens* CNMN-FD-13 and *P. fluorescens* AP-33(V-3481), used in the biopreparations Gliocladin-SC and Rizoplan, respectively, effectively suppressed the development of *M. cinerea* and *M. fructigena* under *in vitro* conditions. *T. virens* exhibited fungistatic nutritional antagonism by overgrowing pathogen colonies, whereas *P. fluorescens* inhibited pathogen growth through antibiosis. Metabolites present in both biopreparations demonstrated pronounced fungicidal activity, as indicated by distinct sterile inhibition zones. These findings support the potential use of Gliocladin-SC and Rizoplan as environmentally friendly tools for the biological control of moniliosis in fruit crops.

Keywords: biopreparations; biological control; dual-culture method; moniliosis; phytopathogens

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ANTAGONISTIC EFFECTS OF TRICHODERMIN-SC AND RIZOPLAN AGAINST WALNUT PATHOGENS

SCERBACOVA Tatiana[1],*, https://orcid.org/0000-0002-2632-325X
STINGACI Aurelia[1], https://orcid.org/0000-0001-6621-9919
SÜTYEMEZ Mehmet [2], https://orcid.org/0000-0003-0417-6495
HARCIUC Oleg[1], https://orcid.org/0000-0003-3488-5321

Moldova State University, Institute of Genetics Physiology and Plant Protection, Chisinau, Republic of Moldova,
[2]Kahramanmaras Sutcu Imam University, Faculty of Agriculture, Department of Horticulture, Kahramanmaras, Republic of Turkey
**Corresponding e-mail: tatiana.scerbacova@sti.usm.md*

Biological plant protection provides an environmentally sound alternative to chemical control and is an important component of disease management in both conventional and organic agriculture. The potential of biopesticides based on *Trichoderma* fungi and rhizosphere-associated *Pseudomonas* bacteria for the control of walnut diseases remains insufficiently studied. This study aimed to evaluate the antagonistic activity of *Trichoderma lignorum* (*viride*) CNMN-FD-14 and *Pseudomonas fluorescens* AP-33 (V-3481), the active agents of the biological products Trichodermin-SC and Rizoplan, respectively, against pathogens associated with English walnut (*Juglans regia* L.).

Phytopathogens were isolated from fallen walnut leaves collected during the 2024 growing season, infected plant tissues collected in 2025, and seedlings that died during seed germination under laboratory conditions. The antagonistic activity of the bioagents was assessed on potato-sucrose agar and malt agar using the dual-culture method. Pathogens grown separately in Petri dishes served as controls. On day 10, colony diameters in the experimental and control treatments were measured, and the percentage inhibition of pathogen growth by each bioagent was calculated.

Pure cultures of *Alternaria* spp., *Botrytis cinerea*, *Cladosporium* sp., *Colletotrichum* sp., *Nothophoma juglandis*, and *Phyllosticta juglandina* were obtained from infected walnut leaves and fruits. *Phytophthora* sp. was isolated from a dead walnut seedling.

In antagonist-pathogen dual cultures, *T. lignorum* inhibited the growth of all tested pathogens. Growth inhibition reached 72.8% for *Alternaria* sp., 80.9% for

B. cinerea, 71.8% for *Cladosporium* sp., 71.5% for *Colletotrichum* sp., 69.4% for *N. juglandis*, 65.8% for *P. juglandina*, and 71.2% for *Phytophthora* sp. Two modes of antagonistic interaction were observed: territorial antagonism and fungistatic-alimentary antagonism.

When the isolated pathogens were co-cultured with *P. fluorescens* AP-33 (V-3481), antibiotic-type antagonism (antibiosis) was observed, as indicated by clear zones of inhibited pathogen growth. The inhibition zones measured 19.2 mm for *Alternaria* sp., 9.2 mm for *Cladosporium* sp., 22.5 mm for both *Colletotrichum* sp. and *Phytophthora* sp., and 10.0 mm for both *N. juglandis* and *P. juglandina*.

Conclusions. In vitro assays demonstrated that the bioagents contained in Trichodermin-SC and Rizoplan are active against several pathogens associated with walnut diseases. *T. lignorum* acted through territorial and fungistatic-alimentary antagonism, whereas *P. fluorescens* AP-33 (V-3481) expressed antibiosis. These findings support the potential use of both biopesticides in biological and integrated walnut disease management.

Keywords: antagonistic activity, biological control, dual-culture method, phytopathogens, walnut.

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BIOLOGICAL CONTROL OF SOYBEAN PATHOGENS USING *Trichoderma lignorum* AND *Pseudomonas fluorescens*

SCERBACOVA Tatiana*, https://orcid.org/0000-0002-2632-325X
VOLOSCIUC Leonid, https://orcid.org/0000-0002-7475-4310
CHISTOL Marcela, https://orcid.org/0000-0001-8594-151X
HARCIUC Oleg, https://orcid.org/0000-0003-3488-5321

Moldova State University, Institute of Genetics Physiology and Plant Protection, Chisinau, Republic of Moldova,
**Corresponding e-mail: tatiana.scerbacova@sti.usm.md*

The aim of this study is to determine the biological activity of the microfungus *Trichoderma lignorum* (syn. *T. viride*) CNMN-FD-14 and the bacterium *Pseudomonas fluorescens* AP-33 (V-3481) - producers of the biological agents Trichodermin, SC, and Rizoplan - against pathogens that cause soybean diseases.

Phytopathogens were isolated from infected soybean roots, stems, leaves, pods, and seeds using standard microbiological methods. The antagonistic activity of the biological agents against phytopathogenic fungi was evaluated on agar plates using the dual culture assay. *T. lignorum* and the phytopathogens were cultivated on malt agar, whereas *P. fluorescens* and the phytopathogens were grown on potato-sucrose agar. Phytopathogens grown alone served as the control. Antagonistic activity was assessed by determining the percentage inhibition of pathogen growth based on colony radius measurements after 10 days of co-cultivation.

A total of ten phytopathogenic species were isolated in pure culture from infected soybean tissues. The root rot complex included *Fusarium oxysporum*, *F. gibbosum*, *F. solani*, *Rhizoctonia solani*, and *Phytophthora sojae*. The pathogens isolated from stems, leaves, and seeds were *Botrytis cinerea*, *Alternaria* sp., *Colletotrichum glycines, Trichothecium roseum* and *Sclerotinia sclerotiorum*.

The study found that the primary mechanism of *T. lignorum's* antagonistic interaction with soybean pathogens is territorial antagonism - the overgrowth of the pathogen colony by the fungus Trichoderma, which results in stunted growth of the pathogen.

Growth inhibition reached 89.1% for *F. oxysporum*, 70.4% for *F. gibbosum*, 70.6% for *F. solani*, 70.6% for *R. solani*, 71.2% for *Ph. sojae*, 80.9% for *B. cinerea*,

72.8% for *Alternaria* sp., 71.5% for *C. glycines*, 78.3% for *T. roseum* and 70.9% for *S. sclerotiorum*.

In dual cultures, *P. fluorescens* AP-33 (V-3481) exhibited a different antagonistic mechanism, namely antibiosis. This effect was characterized by reduced pathogen growth and the formation of clear inhibition zones resulting from the production of antimicrobial metabolites by the antagonist. The inhibition zones measured 24.8 mm against *F. oxysporum*, 16.5 mm against *F. gibbosum*, 22.2 mm against *F. solani*, 20.8 mm against *R. solani*, 22.5 mm against *Ph. sojae*, 28.0 mm against *B. cinerea*, 19.2 mm against *Alternaria* sp., 22.5 mm against *C. glycines,* 21.7 mm against *T. roseum* and 13.5 mm against *S. sclerotiorum*.

Conclusions. *Trichoderma lignorum* (*viride*) CNMN-FD-14 and *Pseudomonas fluorescens* AP-33(V-3481), producer strains of the bioproducts Trichodermin, SC and Rizoplan**,** exhibited strong antagonistic activity against soybean pathogens. In dual culture assays, *T. lignorum* inhibited pathogen growth through mycoparasitic overgrowth (territorial antagonism), with inhibition rates ranging from 70.4% to 89.1%, whereas *P. fluorescens* AP-33 (V-3481) suppressed pathogen development through antibiosis, producing inhibition zones ranging from 13.5 to 28.0 mm. These findings highlight the potential of both microorganisms as effective biological control agents for the management of soybean diseases.

Keywords: antagonists, phytopathogens, micromycetes, rhizobacteria, soybean.

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ANTIMICROBIAL POTENTIAL OF MICROORGANISMS AFTER LYOPHILIZED STORAGE

SÎRBU Tamara*, https://orcid.org/0000-0001-7809-9870
MOLDOVAN Cristina, https://orcid.org/0000-0003-1634-0344
SLANINA Valerina, https://orcid.org/0000-0002-9833-7933

Technical University of Moldova, Institute of Microbiology and Biotechnology
**Corresponding e-mail*: *tamara.sirbu@imb.utm.md*

Species belonging to the fungal genera *Trichoderma* and *Penicillium*, as well as bacteria of the genus *Bacillus*, are recognized producers of bioactive metabolites with antifungal and antibacterial properties that have extensive applications in sustainable agriculture and biological plant protection.

Aim: To evaluate the antimicrobial activity of selected microbial strains after six months of storage in a lyophilized state using different protective media.

Materials and Methods. Four fungal strains (*Penicillium* sp. 1, *Penicillium* sp. 6, *Trichoderma* sp. 3, and *Trichoderma* sp. 14) and one bacterial strain (*Bacillus* sp. 13), previously identified as exhibiting high antimicrobial activity against a broad spectrum of phytopathogens, were used in this study. Antimicrobial activity was assessed prior to lyophilization and re-evaluated after six months of storage in a lyophilized state. Various protective media based on skim milk supplemented with glucose or sucrose at different concentrations and 0.01% ascorbic acid were used during the lyophilization process.

Antimicrobial activity was determined using the agar diffusion method, and inhibition zones were measured against selected phytopathogenic microorganisms. Test cultures included the fungal phytopathogens *Alternaria alternata*, *Botrytis cinerea*, *Fusarium solani*, and *Fusarium oxysporum*, as well as the phytopathogenic bacteria *Agrobacterium tumefaciens*, *Corynebacterium michiganensis*, *Erwinia carotovora*, and *Xanthomonas campestris*. Nutrient agar was used for bacterial cultures, while malt agar was used for fungal cultures.

Results. Screening performed prior to lyophilization identified *Penicillium* sp. 1, *Penicillium* sp. 6, *Trichoderma* sp. 3, and *Trichoderma* sp. 14 as the most active strains, producing inhibition zones of 20–34 mm against phytopathogenic fungi and 15–20 mm against phytopathogenic bacteria.

After six months of lyophilized storage, *Penicillium* strains retained substantial antimicrobial activity, exhibiting inhibition zones of 20–27 mm against phytopathogenic fungi and 12–16 mm against phytopathogenic bacteria, depending on the protective medium used. Similarly, *Trichoderma* strains maintained inhibition zones of 20–32 mm against phytopathogenic fungi and 12–15 mm against phytopathogenic bacteria.

The *Bacillus* sp. 13 strain also preserved its antagonistic properties after six months of storage in a lyophilized state. The strain exhibited activity against three phytopathogenic fungi (*A. alternata*, *F. solani*, and *F. oxysporum*), with inhibition zones of 18–32 mm depending on the protective medium used. Furthermore, *Bacillus* sp. 13 demonstrated inhibition zones of 15–20 mm against the phytopathogenic bacteria *A. tumefaciens* and *C. michiganensis*.

Conclusions. The results demonstrate that lyophilization is an effective and reliable method for preserving microorganisms of biotechnological importance, ensuring the maintenance of their antimicrobial activity during long-term storage. The protective media tested provided adequate preservation of the antagonistic properties of the investigated strains.

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SEGETAL FLORA IN UKRAINE AS RESERVOIRS OF CEREAL VIRUSES

SNIHUR Halyna[1,2,3,*], https://orcid.org/0000-0003-4237-3406
KYRYCHENKO Anhelina[2,3], https://orcid.org/0000-0002-6098-1467
SHEVCHENKO Tetiana[1,3], https://orcid.org/0000-0002-2250-3501
VASHEKA Olena[4], https://orcid.org/0000-0002-8462-4800

[1]Virology Department, ESC "Institute of Biology and Medicine", Taras Shevchenko National University of Kyiv, Ukraine
[2]Laboratory of plant viruses, Institute of Microbiology and Virology named after D.K. Zabolotny National Academy of Sciences of Ukraine, Kyiv, Ukraine
[3] Institute of Biochemistry and Biophysics, PAS, Warsaw, Poland
[4]Department of Plant Biology, ESC "Institute of Biology and Medicine", Taras Shevchenko National University of Kyiv, Ukraine
**Corresponding e-mail: halyna.snihur@knu.ua*

Non-crop plants, such as wild grasses and other native plants, are an integral and inseparable part of the crop field, and can influence virus incidence in cultivated cereals. The presence of these plants as virus reservoirs can lead to a higher probability of virus incidence in crop plants. However, their role as an inoculum source remains understudied for many viral diseases in Ukrainian agroecosystems.

Over three consecutive years in two distant regions of Ukraine (Kyiv and Vinnytsia), we investigated 13 common grass and weed species as potential cereal virus reservoirs: *Bromus inermis* L., *Elymus repens* (L.) Gould, *Setaria pumila* (Poir.) Roem. & Schult., *Setaria viridis* (L.) P.Beauv., *Setaria verticillata* (L.) P.Beauv., *Dactylis glomerata* L., *Digitaria sanguinalis* (L.) Scop., *Hordeum murinum* L., *Echinochloa crus-galli* (L.) P.Beauv., *Lolium perenne* L., *Bromus tectorum* L., *Calamagrostis epigejos* (L.) Roth, *Arrhenatherum elatius* (L.) P.Beauv. ex J.Presl & C.Presl.

Symptomatic wild cereals were tested for the presence of barley yellow dwarf virus-PAV (BYDV-PAV, *Luteovirus*), barley yellow dwarf virus-MAV (BYDV-MAV, *Luteovirus*), cereal yellow dwarf virus-RPV (CYDV-RPV, *Polerovirus*), wheat streak mosaic virus (WSMV, *Tritimovirus*), High Plains wheat mosaic virus (HPWMoV, *Emaravirus*), barley stripe mosaic virus (BSMV, *Hordeivirus*), and brome mosaic virus (BMV, *Bromovirus*). We use double- and triple-antibody sandwich ELISA (DAS-

and TAS-ELISA) with commercial kits (Loewe Biochemica, Germany; Agdia Inc., USA). Virus-positive samples were confirmed by RT-PCR using specific primers - BYcpF/R for BYDV-PAV (Kundu et al., 2008), WS-8166F/WS-8909R for WSMV (Kudela et al., 2008), and HPV-F/HPV-R for HPWMoV (Lebas et al., 2005).

Our results revealed infections with BYDV-PAV in *A. elatius* and *E. crus-galli* sampled in Kyiv region, and *E. crus-galli* sampled in Vinnytsia. WSMV was detected in *L. perenne* (Kyiv), *S. viridis* and *S. verticillata* (Vinnytsia). Notably, 70% (7/10) of tested *S. verticillata* plants were co-infected with HPWMoV and WSMV, while single infections with HPWMoV were detected in *S. verticillata* and *S. pumila* plants in Vinnytsia region.

This study identifies key segetal flora species serving as reservoirs for BYDV-PAV, WSMV, and HPWMoV in Ukraine. For the first time in Europe, *S. verticillata* has been identified as a new natural host of HPWMoV, while *S. pumila* receives the first molecular confirmation in the region.

Keywords: BYDV-PAV, WSMV, HPWMoV, segetal flora, Ukraine.

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THE ROLE OF CULTIVAR AND PRECEDING CROP IN NATURE-BASED PEST REGULATION IN WINTER WHEAT AGROECOSYSTEMS

SUDDENKO Yuliia*, https://orcid.org/0000-0001-6586-1977
HUMENIUK Oleksandr, https://orcid.org/0000-0002-1147-088X

The V. M. Remeslo Myronivka Institute of Wheat National Academy of Agrarian Sciences of Ukraine, v. Tsentralne, Kyiv region, Ukraine
**Corresponding e-mail:* yu_suddenko@ukr.net

The increasing emphasis on environmentally sustainable crop production has stimulated interest in ecological approaches capable of reducing pesticide dependence while maintaining the phytosanitary stability of agroecosystems. Among such approaches, the deployment of resistant cultivars and the optimization of crop rotation systems are considered important tools for enhancing natural pest regulation.

Field experiments were conducted in the The V. M. Remeslo Myronivka Institute of Wheat in the Central Forest-Steppe of Ukraine using fifteen winter wheat cultivars grown after two preceding crops: white mustard incorporated as a green manure crop and soybean.

Objective. To assess the effects of preceding crops and cultivar-specific traits on the abundance of major phytophagous insects in winter wheat and to evaluate the potential of host-plant resistance as a component of nature-based pest management in conservation and regenerative farming systems.

The phytophagous insect community associated with winter wheat was represented primarily by flea beetles, leafhoppers, cereal flies, cereal leaf beetles, aphids, wheat thrips, and the sunn pest. Although the species composition of the pest complex remained largely unchanged across preceding-crop treatments, substantial differences in population density were recorded. Following white mustard, the abundance of flea beetles ranged from 8 to 20 individuals per 100 sweeps, leafhoppers from 5 to 30 individuals per 100 sweeps, cereal flies from 45 to 125 individuals per 100 sweeps, and wheat thrips from 180 to 445 individuals per 100 sweeps.

In contrast, winter wheat grown after soybean generally supported higher populations of several pest species. Under these conditions, flea beetle abundance reached 33 individuals per 100 sweeps, cereal fly abundance 115 individuals per 100 sweeps, and wheat thrips abundance 420 individuals per 100 sweeps. The cultivars Vezha

Myronivska, MIP Darunok, MIP Fortuna, and MIP Lakomka exhibited the lowest levels of pest colonization and maintained comparatively favourable phytosanitary conditions.

The lower abundance of dominant phytophages recorded after white mustard indicates that the inclusion of green manure crops in crop rotations may contribute to the suppression of pest populations and improve the ecological functioning of cereal agroecosystems. These findings highlight the importance of crop rotation design as a factor influencing biological regulation processes in winter wheat production systems. Across both preceding-crop treatments, the cultivars Vezha Myronivska, MIP Darunok, MIP Fortuna, MIP Dovira, and MIP Feieriia maintained relatively low infestation levels, suggesting a higher degree of field resistance to the principal phytophagous species. The consistent performance of these cultivars under contrasting crop rotation conditions demonstrates their potential value for the development of low-input crop protection strategies.

The results obtained support the integration of host-plant resistance and ecologically optimized crop rotations as complementary components of nature-based pest management. Such an approach may strengthen agroecosystem resilience, reduce reliance on insecticide applications, and facilitate the implementation of conservation, ecological, and regenerative agriculture practices.

Keywords: winter wheat; phytophagous insects; varietal resistance; green manure fallow; nature-based pest regulation.

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ON THE DEVELOPMENT OF *Aleyrodes proletella* L. IN WHITE CABBAGE CROPS OF THE RIGHT-BANK FOREST-STEPPE OF UKRAINE

TKALENKO Yurii, https://orcid.org/0009-0004-2074-6309

Institute of Plant Protection of NAAS, Kyiv, Ukraine
Corresponding e-mail: *microbiometod@ukr.net*

Purpose. To investigate the ecological and biological characteristics of cabbage whitefly development in the Right-Bank Forest-Steppe of Ukraine.

Methods and materials. Field method – determination of flight periods, crop colonization, abundance, and development dynamics of the cabbage whitefly was conducted during 2023–2025 at the farm "Zlahoda" (Kyiv region); laboratory method – identification of the pest. Yellow sticky traps were used for monitoring.

Results. Over the past decade, the development and spread of the cabbage whitefly has posed a threat to Brassicaceae crops worldwide and across all regions of Ukraine. Therefore, research into the characteristics of its development is an essential component for timely detection and protective measures. Based on 2023–2025 monitoring, it was established that the phytophage significantly colonizes and damages brassica crops, causing substantial economic losses: up to 100.0% in Napa cabbage, 88.5% in broccoli, 72.3% in cauliflower, 47.5% and 19.5% in late and early white cabbage varieties respectively, 47.0% in Savoy cabbage, 4.0% in Brussels sprouts, and 3.5% in red cabbage. The calculated average colonization index exceeded 40 for Napa cabbage, broccoli, and cauliflower, and over 15 for late white cabbage varieties. Successful overwintering of the phytophage in open ground, combined with a constant food supply, indicates a high pest reserve, ongoing threat, and highlights its emergence as one of the most harmful species that previously caused no economic damage to these crops. The distribution, colonization, population size, dynamics, timing, and duration of all developmental stages of the phytophage were determined. Development depends significantly on abiotic factors. Colonization of cabbage crops began in late May – 1st decade of June at a sum of effective temperatures (SET) above +10 °C of 173.0–188.0 °C. Adult flight duration during the vegetation period was 134 days in 2023, 130 days in 2024, and 105 days in 2025. Embryonic development lasts an average of 8.5 days (range 6 to 11 days) at average daily temperatures of +22.7–23.0 °C and relative humidity of 65.0–75.0%; larval development averages

18.7 days (minimum 15, maximum 21 days) at average daily air temperatures of +19.1–21.8 °C and humidity of 63.0–75.0%. A decrease in air temperature to +17.5 °C or deficient/excessive precipitation extends egg and larval development times by 3–7 days. The longest period of pest colonization and feeding was recorded in 2023 (134 days), exceeding the 2024 figure by 4 days and 2025 by 29 days. A three-year analysis of SET, mean temperatures, hydrothermal coefficient (HTC), yellow sticky trap captures of adults, and average population density revealed strong consistency with minor deviations, demonstrating high ecological adaptation of the phytophage to the hydrothermal conditions of Ukraine's Forest-Steppe zone. Despite varying hydrothermal conditions—such as sharp daily air temperature fluctuations and precipitation shifts—the seasonal development pattern of the phytophage remained stable, with no mortality observed in harmful developmental stages. The phytophage evades the detrimental effects of drought as adults, eggs, and larvae continuously inhabit the lower side of leaves. Additionally, adults are active primarily in the early morning and after 6:00 PM.

Conclusions: The timing of colonization, egg laying, and larval hatching extended from the BBCH 14 stage throughout the entire growing season and varied depending on weather conditions. Air temperature and HTC were identified as the primary drivers affecting egg and larval development rates. Under higher temperatures and HTC values of 1.3–1.6, development times shortened. The phytophage produces 3–4 generations per season. On average, a single generation develops in 32.5 to 35 days at an average daily air temperature of +18.1…+21.4 °C, HTC of 1.6–2.5, and SET of 307.7–344.4 °C.

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EXPANSION OF THE GEOGRAPHIC DISTRIBUTION OF SUGARCANE MOSAIC VIRUS DETECTION IN UKRAINE

VLASOVA Tetiana[1],*, https://orcid.org/0009-0000-1089-1984
SNIHUR Halyna[1], https://orcid.org/0000-0003-4237-3406
SYDORUK Halyna[2], https://orcid.org/0000-0002-7584-8095

[1]Virology Department, ESC "Institute of Biology and Medicine", Taras Shevchenko National University of Kyiv, Kyiv, Ukraine
[2]Ternopil State Agricultural Research Station of the Institute of Agriculture of the Carpathian Region of the National Academy of Sciences of Ukraine, Ternopil, Ukraine
**Corresponding e-mail: t.vlasova3101@knu.ua*

Worldwide, maize is a strategically important crop for food, feed, and bioenergy purposes. Among the most severe threats to maize production are viral diseases, which can cause significant yield losses and deterioration of grain quality. The presence of sugarcane mosaic virus (SCMV) in Ukrainian maize crops was reported in the Kyiv region based on samples collected in 2018 and 2020–2023 (Snihur et al., 2021; Vlasova et al., 2024). The aim of this study was to determine the distribution of SCMV in maize and sweet corn across different regions of Ukraine. In 2025, symptomatic plants exhibiting characteristic mottle, mosaic, and streak symptoms were collected from the Northern (Kyiv), Southern (Vinnytsia), and Western (Ternopil) regions and tested using double-antibody sandwich enzyme-linked immunosorbent assay (DAS-ELISA) with an SCMV-specific kit from Loewe Biochemica (Germany). Serological diagnostics revealed SCMV in samples collected from the Kyiv and Vinnytsia regions. Each plant was analyzed as an individual sample. SCMV was detected in 8 out of 17 tested plants from the Kyiv region (47%) and in 7 out of 10 plants from the Vinnytsia region (70%). For molecular identification of the pathogen, reverse transcription polymerase chain reaction (RT-PCR) was performed using specific primers SCMVcp-F (5'-GGATACGTAGAAGACTACAATG-3') and SCMVcp-R (5'-ATTATAGGTACTGCAAACAG-3') according to Trzmiel et al. (2022). Agarose gel electrophoresis of the obtained products confirmed the presence of specific amplicons of the expected size of approximately 1013 bp. Importantly,

SCMV in the Vinnytsia region was identified in sweet corn plants of a single variety in only one of the five surveyed fields, which may suggest a seed-borne origin of the infection. This is the first report of SCMV detection in this region, which may indicate a systemic issue rather than a localized pathogen occurrence limited to the Kyiv region. Further research should focus on large-scale surveys of maize and sweet corn crops for viral infections, particularly sugarcane mosaic virus, as well as on the transmission pathways of maize viruses in the agrobiocenoses of Ukraine.

Keywords: SCMV, *Zea mays* L., sweet corn, detection, virus, Ukraine.

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BACTERIOPHAGES AS AN INNOVATIVE TOOL FOR PLANT BIOPROTECTION AGAINST BACTERIAL PATHOGENS

YAROSHENKO Oleksandr
KOROTIEIEVA Hanna, https://orcid.org/0000-0002-4059-0741
ANDRIICHUK Olena*, https://orcid.org/0000-0001-6219-2149

Taras Shevchenko National University of Kyiv, Ukraine
**Corresponding e-mail: aom502@knu.ua*

Bacterial infections represent one of the major threats to plants, animals, and humans, causing substantial economic losses and environmental damage. In agriculture, bacterial diseases frequently result in widespread outbreaks in crops, leading to significant reductions in both yield and quality. The increasing prevalence of antibiotic resistance among bacterial pathogens has diminished the effectiveness of conventional control strategies, particularly antibiotic-based treatments, highlighting the urgent need for sustainable alternative approaches to disease management.

One of the most promising approaches to controlling bacterial diseases is the use of bacteriophages - highly specific viruses that infect and lyse susceptible bacterial hosts. Their high specificity and environmental safety make bacteriophages an effective tool for controlling bacterial infections in agriculture, while also supporting applications in human and veterinary medicine.

The aim of this study was to characterize bacteriophages active against phytopathogenic bacteria and to compare their biological properties to identify promising candidates for the development of an environmentally friendly biocontrol agent against bacterial plant diseases.

Plant samples exhibiting symptoms of bacterial disease were collected from vegetable storage facilities. Bacteriophages were isolated from these samples by the direct isolation method using *Serratia marcescens* as the host bacterium. Phage titers were determined as plaque-forming units (PFU/mL) using the standard double-layer agar assay. Pure bacteriophage isolates were obtained through six successive rounds of plaque purification. Two morphologically distinct bacteriophage isolates were selected and combined into a bacteriophage cocktail to evaluate their potential for preserving tomato fruit.

Tomato fruit treated with the bacteriophage cocktail exhibited only mild symptoms of bacterial disease, characterized by a few small lesions without extensive necrosis, tissue maceration, or pronounced softening. In contrast, untreated control fruit developed numerous necrotic lesions accompanied by extensive tissue maceration and severe softening, indicative of active disease progression.

Treatment with the bacteriophage cocktail reduced disease severity by 80-90% compared with the untreated control, demonstrating its high efficacy in suppressing bacterial disease during tomato fruit storage.

Overall, the bacteriophage cocktail shows considerable promise as a biocontrol agent for the management of bacterial diseases in tomato fruit. These findings support its potential application in postharvest disease management. Nevertheless, further research is required to optimize phage formulation and application protocols before large-scale implementation.

Keywords: bacteriophages, phytopathogenic bacteria, *Serratia marcescens*, biological control, tomato fruit, bacterial diseases.

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THE ENTOMOPATHOGENIC BACTERIUM *Bacillus thuringiensis* AS A BIOLOGICAL PLANT PROTECTION AGENT IN CONVENTIONAL AND ORGANIC AGRICULTURE

ZAVTONI Pantelimon*, https://orcid.org/0000-0003-1841-0086
VOLOȘCIUC Leonid, https://orcid.org/0000-0002-7475-4310
STÎNGACI Aurelia, https://orcid.org/0000-0001-6621-9919

Moldova State University, Institute of Genetics Physiology and Plant Protection, Chisinau, Republic of Moldova,
**Corresponding e-mail*: *pantelimon.zavtoni@sti.usm.md*

Among currently available biological products, those based on *Bacillus thuringiensis* (Bt) are of particular interest. Unlike conventional pesticides, Bt-based products act selectively against target insect pests and are considered safe for humans, animals, beneficial insects, and the environment when used appropriately.

The aim of this study was to develop an ecologically safe formulation based on the entomopathogenic bacterium *Bacillus thuringiensis* var. *thuringiensis* and the agent FP-09 for controlling the Colorado potato beetle (*Leptinotarsa decemlineata*).

A suspension of *Bacillus thuringiensis* var. *thuringiensis* combined with FP-09 acts through the digestive tract of actively feeding *Leptinotarsa decemlineata* larvae. This action causes internal damage and disrupts digestion. FP-09 absorbs digestive fluids, thereby disturbing the osmotic balance and inhibiting digestive processes. The resulting cellular damage ultimately leads to larval death.

Materials and Methods

The trials were conducted in an experimental plot planted with the potato cultivar 'Bernina' at the IGPPP experimental facility and targeted first- to third-instar larvae of *Leptinotarsa decemlineata*. The experiment included five treatments, each with three replicates: an untreated control, *Bacillus thuringiensis*, FP-09, *Bacillus thuringiensis* + FP-09, and the standard insecticide Coragen 20 SC. The treatments containing the bacterium were applied as a culture suspension of *Bacillus thuringiensis* var. *thuringiensis*.

Results and Conclusions

The combined use of the entomopathogenic bacterium *Bacillus thuringiensis* and FP-09 was effective in controlling *Leptinotarsa decemlineata* in potato crops of the cultivar 'Bernina'.

A formulation containing 2×10^8 CFU/mL of *Bacillus thuringiensis* var. *thuringiensis* and applied at a rate of 4 L/ha in combination with 50 g of FP-09 was developed to reduce Colorado potato beetle populations in potato crops.

The biological efficacy of the formulation based on *Bacillus thuringiensis* var. *thuringiensis* and FP-09 against the Colorado potato beetle was evaluated. Efficacy reached 77.0% against the first generation and averaged 79.6% against the second generation.

The applicability of the formulation based on *Bacillus thuringiensis* var. *thuringiensis* combined with FP-09 for regulating the population density of *Leptinotarsa decemlineata* in potato crops of the cultivar 'Bernina' was established.

The results indicate that the formulation is more effective against the early larval instars of the Colorado potato beetle. This finding is particularly important for field application, as treatment at these stages can reduce *Leptinotarsa decemlineata* population density before severe defoliation of the potato crop occurs.

List of authors

1. ADEBAYO Rufai Quadril
2. AMBĂRUS Silvica
3. ANDRIICHUK Olena
4. ANDRONIC Larisa
5. ANTAL TREMURICI Andreea
6. ANTOCI Ludmila
7. ANTON Gabriel
8. ARIYO Adekunle Sheriffdeen
9. ARMAȘU Svetlana
10. ATAMANIUK Oleh
11. AVASILOAIEI Dan Ioan
12. AZEEZ Awal Agboola
13. BADUT Caterina
14. BAHSIEV Aighiuni
15. BALMUȘ Zinaida
16. BARKAR Vitaliy
17. BATCO Mihail
18. BĂLĂIȚĂ Claudia
19. BĂȘA Adrian Gheorghe
20. BELCHENKO Volodymyr
21. BELOUSOVA Galina
22. BENCHEA Carmina
23. BILICI Elena
24. BÎRSAN Ana
25. BODNARIUK Ruslana
26. BOGACIOV Evghenii
27. BOGDAN Alina
28. BOINCEAN Boris
29. BONDARCHUK Oleksandr
30. BORDEI Marius Daniel
31. BOROVSKAIA Ala
32. BOROZAN Pantelimon
33. BOTEZATU Florin
34. BOTNARI Vasile
35. BOZBEI Iulia
36. BREZEANU Creola
37. BREZEANU Petre Marian
38. BUDZANIVSKA Iryna
39. BUJOREANU Nicolae
40. BULDUMAC Ana
41. BUTNARAȘ Violeta
42. BUTNARU Gallia
43. CALALB Tatiana
44. CALARA Mariana
45. CANĂ Lidia
46. CASSIR Polina
47. CAUȘ Maria
48. CĂLUGĂRU-SPĂTARU Tatiana
49. CEABANOVA Marina
50. CEAN Mirela
51. CEBANU Vitalie
52. CERNEȚ Alexandr
53. CHERNOVA Iryna
54. CHERVYAKOVA Larysa
55. CHILINCIUC Alexei
56. CHISTOL Marcela
57. CHITROSAN Liliana
58. CIOBANU Renata
59. CIONGA Cristina
60. CIORNEI Constantin
61. CLIMENCO Oxana
62. COGUTEAC Ana
63. CORLATEANU Liudmila
64. COTELEA Ludmila
65. COTENCO Eugenia
66. CRISTEA Nicolae
67. CRISTEA Tina Oana
68. CURIEV Loredana
69. CURSUNJI Dmitri
70. CUTITARU Doina
71. CUZNETOVA Irina
72. DASCALIUC Alexandru
73. DASHCHENKO Anna
74. DEAGHILEVA Angela

75. DEGTEARI Vladimir
76. DELEAN Tatiana
77. DOBRIN Ionela
78. DOLZHYKOVA Irina
79. DOROVSKIKH Viktor
80. DRAGUTSAN Igor
81. DUMITRAȘ Iurie
82. DUNICH Alina
83. EGWIM Onyebuchi Louis
84. ELISEEV Serghei
85. ELISOVETCAIA Dina
86. EPURE Lenuța Iuliana
87. ERHAN Tatiana
88. FANIN Yaroslav
89. FILIMON Valeriu
90. FILONENKO Oleksandra
91. FRON Arcadie
92. FRON Argentina
93. FURSENCO Cornelia
94. GANEA Anatolie
95. GAVRILITA Lidia
96. GENDOV Natalia
97. GEORGESCU Emil
98. GÎSCĂ Alina
99. GLADCAIA Alla
100. GLADEI Mihai
101. GLIBICIUC Corina
102. GORBAN Victor
103. GORE Andrei
104. GRAJDIERU Cristina
105. GRIGORIEV Corneliu
106. GUȚU Costel
107. HARCIUC Oleg
108. HAREA Ivan
109. HARUTYUNYAN Margarita
110. HARUTYUNYAN Zara
111. HASYNETS Yaroslava
112. HAVRYLIUK Oleksandr
113. HERMEZIU Manuela
114. HLIUDZYK-SHEMOTA Marharyta
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   - Institute of Genetics, Physiology and Plant Protection
   - Institute of Chemistry
   - Institute of Ecology and Geography
   - Faculty of Biology and Geoscience
2. National Center for Research and Seed Production
   - Selectia Sector, Balti, Republic of Moldova
   - Porumbeni Sector, Pascani, Criuleni, Republic of Moldova
3. Nicolae Testemitanu State University of Medicine and Pharmacy of the Republic of Moldova, Chisinau, Republic of Moldova
4. National Institute for Applied Research in Agriculture and Veterinary Medicine, Chisinau, Republic of Moldova
5. "Prutul de Jos" Reserve, Slobozia Mare, Cahul, Republic of Moldova
6. SRL "Agricos Tech", Chisinau, Republic of Moldova
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15. Institute of Plant Protection of the National Academy of Agrarian Sciences of Ukraine, Kyiv, Ukraine
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16. Kahramanmaraş Sütçü İmam University, Faculty of Agriculture, Department of Horticulture, Kahramanmaraş, Republic of Türkiye
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    - Bila Tserkva Experimental Breeding Station, Vilshanka, Bila Tserkva, Kyiv, Ukraine
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