

DROUGHT-TOLERANT AROMATIC AND MEDICINAL PLANTS

PLANTE AROMATICE ȘI MEDICINALE REZISTENTE LA SECETĂ

CZU: [633.82 + 633.88]:632.112

<https://doi.org/10.59295/spd2025e.04>

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Sumar. *Lucrarea are ca obiectiv evidențierea speciilor de plante aromatice și medicinale introduse și cercetate în decursul anilor în cadrul Colecției Grădinii Botanice Naționale (Institut), cu un potențialul adaptiv înalt la condițiile noi de creștere și un conținut sporit în substanțe biologice active. Cultura plantelor agricole în ultimul timp se confruntă cu un impact negativ ale schimbărilor de climă și provocărilor de mediu, principalele fiind, deficitul de umiditate în sol și temperaturile excesiv de înalte ale aerului în perioada critică de dezvoltare a plantelor. Schimbările climatice și fenomenele meteorologice extreme au crescut în frecvență și intensitate, ceea ce face ca seceta să devină o problemă stringentă pentru întreaga lume. În acest context, plantele rezistente la seceta au devenit o soluție ecologică și eficientă pentru agricultură în condiții de apă limitată. O alternativă la culturile tradiționale, cu necesități considerabile de umiditate, sunt speciile de plante aromatice și medicinale rezistente la secetă, propuse pentru a fi cultivate pe suprafețe extinse.*

Cuvinte-cheie: *mobilizare, plante aromatice, ulei volatil, secetă, schimbări climatice.*

INTRODUCTION

One of the research directions of the Plant Resources Laboratory is focused on the identification and study of aromatic and medicinal plant species, with the aim of developing an assortment of crops tolerant to abiotic stress factors, which would provide high yields with a high content of biologically active substances, in particular – high-quality essential oil, even under drought conditions. Such research has intensified significantly in recent decades, being driven by climate change, the slow but persistent processes of global warming, and the desertification of some areas, including south-eastern Europe, where agricultural crops are affected by drought, and increasingly frequent critically high temperatures [1].

Drought poses a major challenge by limiting plant productivity. Drought-induced stress can hinder vital processes such as respiration and photosynthesis, affecting various

aspects of plant growth and metabolism. In response to this stress factor, aromatic and medicinal plants have the ability to activate various adaptive mechanisms such as morphological and structural adjustments, modulation of drought-tolerant genes, increased synthesis of secondary metabolites and osmotic regulators to alleviate drought stress [2]. Under drought conditions, plants adapt by decreasing stomatal density and leaf size, thereby minimizing water loss and maintaining internal water balance [3].

Drought-induced changes have been observed in both the quantity and quality of essential oils. Numerous studies have provided evidence of essential oil accumulation triggered by drought stress, often associated with physiological adaptations to water deficit [4].

Experience has shown that the negative impact of drought can be substantially reduced by cultivating aromatic species that have evolved unique survival mechanisms during periods of drought, such as a well-developed root system that reaches deep in the soil, and waxy leaves that increase their ability to store water. Combining these characteristics, such plants become extremely valuable in drought-prone regions. Many aromatic species not only tolerate droughty conditions but also thrive on low-fertility soils, slopes, and eroded land, often helping to prevent further erosion. Further, we will explore several drought-tolerant and easy-to-cultivate species, such as: *Lavandula angustifolia* L., cv. 'Lavinie de grădină', *Salvia officinalis* L., *Perovskia atriplicifolia* Benth, *Origanum vulgare* L., *Hyssopus officinalis* L., *Thymus vulgaris* L., *Echinacea purpurea* L. Moench. These plants are notable for their high essential oil content, making them valuable for applications in aromatherapy, phytotherapy, culinary arts, and the cosmetic and food industries. Due to their wide range of uses and year-round availability, whether fresh or dried, they offer a viable alternative to traditional field crops, particularly in droughty regions.

MATERIALS AND METHODS

The research conducted covers the period from 2017 to 2024, during which a diverse gene pool of aromatic plants was mobilized and preserved in the Botanical Garden, building upon a collection established in 1950. The experiments were carried out within the Collection of Aromatic Plants, part of the Plant Resources Laboratory, located in an area characterized by rich chernozem soil, occasionally slightly sandy, which supports the normal development of the introduced species. Over time, research has focused on the ontogenetic characteristics of the plants, the content and chemical composition of essential oils, and the identification of factors limiting species adaptation to new environmental conditions. Various propagation methods were studied, and primary cultivation technologies were developed, including recommendations tailored to specific abiotic factors. Observations were made on the reaction of plants to cold waves occurring in early arrival autumn, or late spring frosts, plant resistance to low temperatures, the impact of photoperiod, the influence of shortage and excess of atmospheric precipitation, as well as the resistance of plants to diseases and pests [6]. The essential oil content of

the plants was determined by steam distillation method [7]. The chemical composition of the essential oil was determined by gas chromatography-mass spectrometry (GC-MS) analysis using an Agilent Technologies 6890N gas chromatograph coupled to a 5975 inert XL Mass Selective Detector (MSD). Phytochemical analyses were performed at the “Stejarul” Biological Research Center, Piatra Neamț, Romania.

RESULTS AND DISCUSSIONS

Lavender is one of the most famous drought-tolerant aromatic plants, being appreciated for its unique, distinctive aroma. Native to the Mediterranean region, it has demonstrated excellent adaptability to local pedoclimatic conditions and is capable of surviving and flowering even under prolonged drought stress. Lavender (*Lavandula angustifolia*) Mill cv. ‘Lavinia de grădină’, is a patented cultivar developed at the Botanical Garden. It is notable for its high essential oil content, ranging from 1.7% to 1.9%. Analysis of the chemical composition of the essential oil revealed linalool (70.8%) and linalyl acetate (5.4%) as the primary constituents, followed by compounds such as lavandulol and eucalyptol.

The active compounds found in lavender flowers exhibit antiseptic, mild antispasmodic, depurative, and calming properties. These make the plant suitable for use in managing a variety of conditions, including neurocardiac disorders, renal diseases, rheumatism, biliary dyskinesia, colds, coughs, migraines, and epilepsy. Additionally, both the flowers and essential oil of lavender are known for their culinary applications as flavoring agents.

Lavender is propagated generatively – through seeds, or vegetatively – by rooted cuttings and marcottes obtained from 3-4 year old plants. It is a low-maintenance species with minimal soil requirements, offering a distinct advantage over crops that depend on nutrient-rich soils. Its deep root system enables access to water from lower soil layers, thereby reducing the need for frequent irrigation. Additionally, its leaves are coated with a thin waxy layer that significantly minimizes water loss through evaporation. This cultivar is resistant to diseases and pests, reducing the reliance on pesticides and other harmful agrochemicals. However, it is intolerant of waterlogged soils and prefers full sun exposure, making it especially well-suited to arid climates with limited water availability. The cultivar is not only drought-tolerant but also naturally repels harmful insects. In addition, it exhibits high ornamental value and strong melliferous (honey-producing) potential. Once established, plantations of this cultivar can remain productive for a long period, about 10 to 15 years. Due to its adaptability, low requirements, and multiple uses, the cultivar demonstrates a high level of economic efficiency and presents numerous advantages for agricultural cultivation.

Common sage (*Salvia officinalis* L.) is a species cultivated in the Republic of Moldova that has been valued since ancient times for its aromatic, medicinal, and culinary properties. It was among the first aromatic species to be grown on an industrial scale in the country. Native to the Mediterranean region, sage has successfully adapted to

the hot and dry pedoclimatic conditions of Moldova, demonstrating the ability to survive prolonged drought while producing high-quality essential oil. Sage prefers well-drained soils and full sun exposure. The plant has waxy leaves that help reduce water loss through evaporation. The root system is a branched, lignified, taproot that reaches in the soil depths of up to 1.5 m, making it possible to access water from deeper soil layers. Another merit of sage is its role in traditional cuisine, being used to flavor meat and other various dishes. Its multiple properties, combined with its drought-tolerance, make sage a valuable plant to be cultivated. Sage has medicinal properties, being traditionally used to treat various conditions, such as inflammation and respiratory disorders.

Salvia officinalis is a thermophilic species, germinating at temperatures of +8...+11 °C. It requires warm summers and mild winters for optimal growth. The synthesis of essential oil is most active at high temperatures, particularly during long, sunny summer days. While sage prefers full sunlight, it can also be cultivated in partial shade and on less fertile soils, such as limestone slopes or sandy areas, making it suitable for the rehabilitation of degraded lands. Sage cultivation can be initiated by direct seeding in the field. For smaller plots, propagation by seedlings is recommended, with transplanting typically carried out in late April to early May. The species can also be propagated vegetatively using young, lignified shoots. In spring, mature stems are cut back to a height of approximately 10 cm above the ground, stimulating the development of vigorous new shoots with large leaves, thereby enhancing the yields. *Salvia* thrives in hot, dry climates. It is considered an excellent honey and ornamental plant.

Russian sage (*Perovskia atriplicifolia* Benth.) is a relatively new crop in the Republic of Moldova and is currently cultivated on a limited scale. Introduced and studied at the Botanical Garden for its aromatic and medicinal properties, the plant forms a bush with 17-18 stems and reaches a height of 80-90 cm under local climatic conditions. During the full flowering phase, the essential oil content reaches 0.54%. The chemical analysis identified 39 compounds in the essential oil, with the major constituents being 1,8-cineole and limonene (40.13%), followed by α -pinene (17.87%), δ -3-carene (9.13%), β -pinene (6.59%), camphene (6.17%), and camphor (5.36%). These compounds contribute to a range of biological activities, including antibacterial, antiviral, anti-inflammatory, and antitumor effects. It can be propagated both generatively and vegetatively – through cuttings taken in summer from green or partially lignified shoots. Russian sage is resistant to pests and diseases and is characterized by a strong aroma. Its high drought tolerance and low water requirements make it well-suited for cultivation even in arid or drought-prone areas.

Oregano (*Origanum vulgare* L.), which is native to southern Europe, is another well-known species present in the wild flora of the Republic of Moldova. Although introduced to industrial cultivation quite recently, oregano has adapted well to the country's ecological conditions and is now grown on a small scale as an aromatic and medicinal plant with significant melliferous (honey-producing) potential. The aerial parts of the plant contain essential oil rich in compounds such as thymol, carvacrol, cymol,

and origanene. This essential oil is widely utilized in the cosmetic and pharmaceutical industries due to its valuable bioactive properties.

Due to the high global demand for oregano essential oil, some enterprises have begun introducing various genotypes of this species into large-scale cultivation. Oregano is a long-day plant that is undemanding in terms of soil quality and moisture availability. It demonstrates strong resistance to both low winter temperatures and extreme summer heat. In the wild, it commonly grows along forest edges, in shrublands, and along roadsides throughout the country. Oregano plantations can be established either by direct sowing in the field or by transplanting seedlings produced in nurseries during the spring. The vegetative method by division can serve as an alternative. The plants typically flower from July to August. Oregano can be used both fresh and dried, the dried form being preferred due to its longer shelf life.

Thanks to its special therapeutic effects, oregano is an economically profitable, drought-tolerant medicinal plant that deserves to be cultivated on larger areas.

Hyssop (*Hyssopus officinalis* L.) is a perennial subshrub, native to Central Asia. In Moldova it is cultivated on small areas as an aromatic and medicinal species. It produces essential oil, the main components of which include pinocamphone, followed by camphene, myrtenol, tannins, flavonoids, and bitter principles. The plant is used in the cosmetic industry, in the production of liqueurs, in gastronomy, and in medicine.

Hyssop is a light-loving species requiring a warmer climate, and is known for its high essential oil yield. During winter, it can withstand severe frosts of -25°C to -30°C, if the soil is covered. It has low humidity requirements and can tolerate drought conditions from the second year of growth. Propagation can be carried out vegetatively, through cuttings or division, or generatively, by sowing seeds directly into the soil in early spring or late autumn. Hyssop thrives on calcareous soils, though its overall soil requirements are minimal, making it suitable for anti-erosion measures on steep slopes and for stabilizing mobile sands.

Common thyme (*Thymus vulgaris* L.), native to the Mediterranean region, grows naturally in countries such as Spain, France, and Portugal. It is a perennial subshrub that develops a taproot and begins to branch extensively from the second year of cultivation. The stem reaches a height of approximately 40 cm and becomes lignified at the base. In the Botanical Garden, it is studied for its aromatic, medicinal, and melliferous properties. Flowering occurs from May to July.

The aerial parts of the plant have a strong aromatic scent and intense flavor, attributed to the presence of essential oils rich in compounds such as carvacrol, borneol, cineole, geraniol, and linalool. The essential oil content typically ranges from 0.2% to 0.9% in the green biomass, depending on cultivation practices and climatic conditions. Thyme is widely used in the cosmetic and pharmaceutical industries due to its antiseptic properties, as well as for culinary purposes, including the flavoring of dishes, vinegars, and wines. It is a light- and heat-demanding species. While cultivated, thyme is generally drought-tolerant, but may require watering during the germination phase. It grows

optimally on fertile, calcium-rich, well-drained soils, with the southern and southwestern regions of the country being most suitable for cultivation. Propagation can be achieved both vegetatively - by dividing plants from older plantations - and generatively, either through direct sowing in the field or by transplanting nursery seedlings.

Another notable drought-tolerant species is the eastern purple coneflower (*Echinacea purpurea* L. Moench), a perennial plant native to North America. It is valued both for the striking appearance of its pink-purple flowers and for its medicinal properties. Its exceptional drought tolerance is attributed to a deep root system and the ability to retain water efficiently. Research has demonstrated that *Echinacea purpurea* can be successfully cultivated under the climatic conditions of the Republic of Moldova, where it exhibits abundant flowering and fruiting, and the quality of the seed material supports the expansion of the crop in line with the increasing demand. Preferring well-drained soils and sunny locations, eastern purple coneflower is well-suited for large-scale cultivation in dry regions. The cultivation cycle typically spans 2-3 years and, in some cases, up to 4 years. The plant can be propagated through cuttings, seeds, or transplanted seedlings. *Herba* can be harvested as early as the first year, although the yield is generally low. If planted early, flowering may occur within the first year; however, it is recommended to harvest flowers starting in the second year, when yields are more substantial. For the extraction of active compounds from the roots, harvesting is performed in the second or third year of cultivation, at the end of the growing season. The leaves of this plant are covered with fine hairs that reduce water loss through evaporation. The flowers attract a wide range of pollinators, such as bees and butterflies, making this plant a valuable nectar source during the summer and autumn months, thus increasing its melliferous value. In addition to its ornamental value, eastern purple coneflower is widely used in traditional medicine, particularly, to enhance the immune system and to alleviate symptoms of the common cold. Due to its aesthetic appeal, medicinal benefits, and strong adaptation to arid environments, *Echinacea purpurea* is a valuable addition to both botanical collections and sustainable agricultural systems. This species not only adds aesthetic value to a plant collection, but also can provide health benefits and can be successfully grown in arid areas.

CONCLUSIONS

Research demonstrates that the negative impact of drought can be significantly reduced through the cultivation of drought-tolerant aromatic and medicinal plant species such as *Lavandula angustifolia* L. cv. 'Lavinie de grădină', *Salvia officinalis* L., *Perovskia atriplicifolia* Benth, *Origanum vulgare* L., *Hyssopus officinalis* L., *Thymus vulgaris* L. and *Echinacea purpurea* L. Moench. These species provide a stable supply of high-quality raw materials for the pharmaceutical and cosmetic industries, characterized by a high content of active compounds. Over time, the cultivation of aromatic and medicinal plants has become an important source of income for rural communities. Their diverse applications have driven ongoing research on their chemical composition, qual-

ity and potential health benefits. The favorable pedoclimatic conditions of the Republic of Moldova have supported the introduction of both native species and those from other geographical regions into large-scale cultivation.

Many aromatic and medicinal plants are naturally resistant to abiotic stressors (frost, wintering, drought) as well as biotic factors (diseases and pests). Therefore, they easily adapt to the challenges posed by climate change and global warming. When selecting species for cultivation in a given area, it is essential to consider the complex interaction between environmental factors, ensuring a balanced match between local pedoclimatic conditions and the biological needs of the plants. The development and implementation of optimal cultivation technologies and recommendations play a key role in growing successfully aromatic plants under arid conditions. In the Republic of Moldova, traditional species such as sage, mint, lavender etc. are already cultivated using established agrotechnical practices. At the same time, ongoing research is aimed at expanding the range of cultivated aromatic plants.

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N.B. The research was carried out with the support of the research Subprogram 010101 „Research and ex situ and in situ conservation of plant diversity in the Republic of Moldova”.