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METHOD OF ACTIVATING ENTOMOPHAGES AND POLLINATORS HYMENOPTERA ORDER NATURAL POPULATIONS WITH THE AIM OF INCREASING THE AGROSYSTEM PRODUCTIVITY

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Abstract. *Insects provide important ecosystem services of great economic value. We investigated a method for activating of entomophages and pollinators of Hymenoptera order natural populations ("field breeding"), consisting of a combination (synergy) of overseeding spice plants and placing Fabre hives nearby the fruit garden. The objects of the study were entomophages and pollinators of the Hymenoptera order. The experiment was conducted in three different biotopes: an apple orchard near a forest belt, a collection of spice plants near a pear orchard, and a field of Miscanthus sinensis. The maximum number of Megachilidae bee nests were found in artificial dark-colored shelters: made of cylindrical dark plastic (70,8%), and deltoid dark cardboard (20,8%). The bees preferred to build nests in the agrocenosis of the pear orchard nearby a plot of spice plants (91,7%). It has been established that the optimal strategy for the method of entomophage's activating consists of combining a variety of different family's spicy plants and ensuring continuous flowering (conveyor).*

Keywords: entomophages, field breeding, artificial shelters, Hymenoptera, aromatic plants.

INTRODUCTION

Insects provide important ecosystem services of great economic value. Proper management of agro-landscape resources can contribute to the biodiversity conservation. In this context, agri-environmental schemes (AES) were included in the EU agricultural policy in 1985 and have become the main instrument for biodiversity conservation in Europe [1]. We investigated a method for activating of entomophages and pollinators of Hymenoptera order natural populations ("field breeding"), consisting of a combination (synergy) of overseeding spice plants and placing Fabre hives nearby the fruit garden, which contributes to an increase in the beneficial insect's survival and activity, and supports the formation of stable self-developing and self-regulating agrobiogeocenoses [2]. Since many predators are also anthophiles, their survival, productivity and performance are enhanced, when

flowering herbaceous plants are present within the agrocenosis. Research by scientists has shown, that strips of flowering plants near gardens and fields increase the biodiversity of pollinators and entomophages [3]. Flowering plants of the Apiaceae and Lamiaceae families significantly increase the number of beneficial insects in agroecosystems [4]. Wild bees (e.g. *Osmia* spp.) are more effective in pollinating fruit crops than honey bees. The placement of Fabre hives for *Osmia* increases the yield of fruit orchards several times [5]. *Osmia* bees prefer high-lipid pollen with a high content of sterols (fam. Asteraceae) [6]. Analysis of the nectar of essential oil plants showed that maltose and sucrose dominate in plants, pollinated by bees [4]. The key amino acid for the energy metabolism of solitary wasps (Sphecidae) and bees is proline, and the amino acids tryptophan and phenylalanine increase the survival and fertility of parasitoid wasps (Braconidae) [7, 8]. Terpenoids (linalool, geraniol) in the nectar of lavender and mint attract bees and repel unwanted insects [9]. To adapt the method to a specific garden, it was important to study local bee species and the optimal set of partner plants.

The aim of our work was to study the method of entomophage's natural populations activating, which involves the inclusion of a spice plant's plot in the industrial garden array, in combination with the use of artificial shelters to attract of Hymenoptera entomophages and pollinators to the agrocenosis.

MATERIALS AND METHODS

The place and time of the research are laboratory and field conditions of the Institute of Genetics, Physiology and Plant Protection of the Republic of Moldova, 2024. The development of technological elements of artificial shelters for attracting economically important Hymenoptera order entomophages was carried out on the basis of certain modifications of Fabre hives. The objects of the research were entomophages and pollinators of the Hymenoptera order. In order to evaluate the most attractive filling materials, we used hollow tubes (reed and plastic) in each shelter. Four variants of the enclosure were considered: 1) white cardboard; 2) dark cardboard; 3) transparent plastic; 4) dark plastic. The experiment was conducted in three different biotopes: an apple orchard near a forest belt, a collection of spice plants near a pear orchard, and a field of *Miscanthus sinensis* (provides insects with natural tubular stems for nesting).

The sowing of spicy plants, which are widely used in medicine, culinary and perfumery, contributed to the increase in the economic efficiency of the method. The diversity of species that make up the collection of spicy-aromatic plants differs not only in botanical origin, but also in the period of flowering and secretion of nectar and pollen. The attractiveness of artificial shelter options and agrocenoses was assessed by comparing the density of the tubes with Hymenoptera. The insects

were counted by sequentially inspecting of artificial shelter's sections, determining the taxonomic affiliation of individuals and counting them.

RESULTS AND DISCUSSION

A dependence of the Hymenoptera nests number on the artificial shelter structure and the type of agrocenosis was established. The maximum number of solitary bees (Megachilidae) nests were found in cylindrical shelters made of dark plastic (70,8%), delta-shaped shelters made of dark cardboard (20,8%) and 8,4% in delta-shaped shelters made of white cardboard. Tubular reed stems with a diameter of 0,7–0,9 mm were populated, and bee nests were not found in plastic tubes. Thus, bees prefer dark-colored shelters and tubular reed stems (Figure 1).

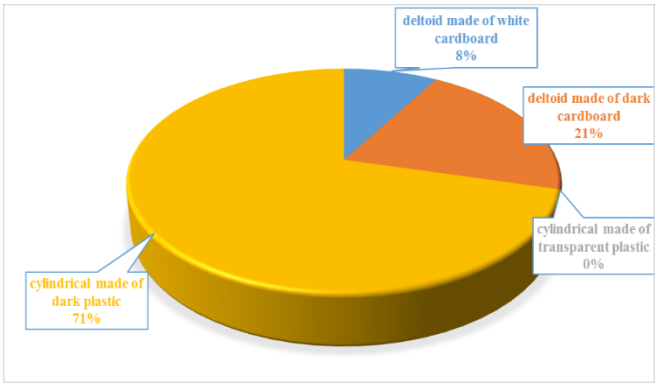


Figure 1. Population of artificial shelters by wild solitary bees depending on the type of body and material

In the agrocenosis of the pear orchard near the spice plot nested 91,7 % of bees, in the agrocenosis of the apple orchard - 4,2 %, and 4,1 % - in the agrocenosis of the *Miscanthus sinensis* field. In our studies in 2024, we obtained imagoes and nests of solitary bees from two genera (Megachilidae): one of the largest genera of bees in the family, the genus *Osmia* Panzer, 1806 (mason bees) and the genus Stelis Panzer, 1806 (cuckoo bees) (Figure 2).

Inside the cavity of the reed stems, *Osmia* bees divided the passage into brood chambers. Each chamber was supplied with enough pollen to feed one larva. The bee laid an egg on each pollen mass and sealed the chamber. The end of the tunnel was sealed with mud, plant resins, pieces of leaves or flower petals. *Osmia* bees pollinate an extremely wide range of flowering plants. *Stelis* bees lay eggs in the nests of other bees (Figure 3).

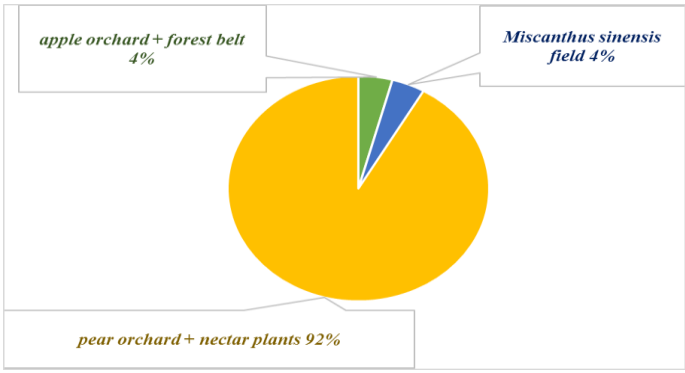


Figure 2. Population of artificial shelters and agrocenosis types by Megachilid family bees in various agrocenoses



Figure 3. Nesting of solitary bees (Megachilidae).
Bee nests in tubular reed stems with multi-colored plugs (1), open bee nests (2), imago of the genus Osmia bees (3), imago of Stelis (4).

The hosts of *Stelis* are other Megachilinae. In most cases, the parasite, having discovered the host's nest, returns to it repeatedly to lay an egg in each of several host cells before they close. The ability of bees to populate anthropogenic cavities of suitable sizes and the wide polytrophism of species allows us to consider Megachilidae bees as very promising species for field breeding in artificial shelters in order to increase the economic efficiency of agroecosystems.

In order to maintain and activate the population of Hymenoptera order entomophages and pollinators in the agrocenosis, a food base was provided from the continuous flowering of spice plants throughout the season. The flowering period in the collection of spice and aromatic plants in 2024 began on April 17 with the flowering of *Bergénia crassifólia* L. (Saxifragaceae) and *Adonis vernalis* L. (Ranunculaceae), which lasted for 18-20 days, respectively, and the visit (mainly

by bumblebees) was average. Then, from April 24 (flowering for 25 days), the flowering of *Nepeta transcaucazica* L., (Lamiaceae) and *Veronica officinalis* L. (Plantaginaceae) began. Their flowering is shorter 13-15 days, as well as *Rumex acetosa* L., *Rheum officinale* Baill. visits by insects, which are more numerous and varied.

Starting from April 25 and for 25-30 days, species, such as *Thymus vulgaris* L., *Thymus serpilium* L., *Thymus longicaulis* L., *Salvia officinalis* L. (Lamiaceae) bloomed, and at the end of April, beginning of May – *Rosa gallica* L. and *Sanguisorba officinalis* L. (Rosaceae). From the beginning of May and for 20-25 days *Thymus x citriodora* Schreb., *Asparagus officinalis* L., *Ruta graveolens* L. (with inconspicuous flowers, but very much visited by insects), *Veronica chamaedrys* L., *Matricaria chamomilla* L., *Plantago lanceolata* L., *Linum usitatisimum* L., *Centaurea cianus* L., *Allium shoenoprasum* L. bloomed. In early June and for 25-30 days, most species of the Lamiaceae family bloom and secrete nectar, which are well visited by insects. Among them are *Lavandula angustifolia* Mill., *Melissa officinalis* L., *Hyssopus oficinalis* L., *Dracocepalum moldavica* L.

The month of July is rich in flowering of the Apiaceae family species, which are visited by insects from the moment of the budding phase of plants (lasts from 5 to 13 days for different species). During this period, from July 2 to 5, insects "check" the umbrellas for nectar. The most frequent visits by insects are observed during the period of the flowering beginning and until the flowers in the umbrella have completely faded. This period begins on July 5 and lasts from 25 days for the annual species *Anethum graveolens* L. to 25 days and up to 30-35 days for the biennial species *Passtinaca sativa* L., *Apium graveolens* L., *Foeniculum vulgare* Mill., *Ammi visnaga* L., *Anhtriscus cerifolium* L. – equal to 25-35 days. In August-September, such species as *Allium ramosum* L., *Satureja montana* L., *Inula helenium* L. bloom. Thus, the site saw continuous flowering (conveyor) of 34 species of spice plants throughout the growing season (April-September).

CONCLUSIONS

1. The degree of artificial shelters attractiveness for Hymenoptera order entomophages was established, depending on the design and materials from which they are made. The maximum number of bee's nests of the *Osmia* and *Stelis* (Megachilidae) genera were found in artificial shelters of a dark color: from cylindrical dark plastic (70,8%), from deltoid dark cardboard (20,8%). Bees preferred to build nests in the agrocenosis of a pear garden near a plot of spice plants (91,7%);

2. It was established that the optimal strategy for the activating entomophages method consists in combining a variety of spice plants of different families and ensuring continuous flowering (conveyor). This composition of the

collection has a long flowering of species and provides sufficient food for insects living nearby, an eco-friendly environment, and is also important for creating favorable conditions for pollination and increasing seed productivity of spicy-aromatic and garden crops.

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