UDC: 632.937:595.79:634.22 https://doi.org/10.53040/gppb8.2024.95

THE STUDY OF cis-JASMONE ADDITIVES FOR PARASITOID HYMENOPTERA ATTRACTION

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Summary. The evaluation of common activity of phenylethanol and methyl salicylate with cis-Jasmone additives was tested and discussed. Phenylethanol paired with cis-Jasmone proved to attract *Trichogrammatidae* specimens.

Keywords: cis-Jasmone, semiochemicals, phenylethanol, methyl salicylate, hymenopterans, parasitic wasps, plum, orchard.

Introduction

The humanity faces multiple challenges in the XXI century. One of them is a rapid climate change. Its consequences influnce dramatically numerous fields of human activity, in particular, agriculture. Driven by climate change multiple harmful organisms that originate from the southern parts of the planet move up in Northern Hemisphere gaining new areas occupied already by agricultural lands. To combat noxious species on these lands a huge arsenal of pesticides was invented and deployed. The massive pesticide' usage inevitably affects sustainable agriculture development and food quality.

The good alternative measure against destructive pesticide effects are semiochemicals. These are chemical compounds produced by both plants and animals that can cause physiological or behavioral reply in organisms of the same or another species. Thus, they are not as toxic as traditional pesticides towards non-target organisms, ecosystems, crops and food products resulting out of the crops. One of the semiochemicals is cis-Jasmone (CJ). It is an organic compound, a volatile part of jasmine flowers' oil and is used as wheat insect pests' e. g. thrips, aphids and sawflies deterrent [1]. The important role is played by cis-Jasmone also in manipulating natural beneficial agents in control strategies of *Halyomorpha halys* bug [2]. The other paper [3] shows that cis-Jismone attracts and grows the Scelionidae wasps' number without significantly affecting *H. halys*. Two other semiochemicals used in this study are phenylethanol (PE; essential oils' component) and methyl salicylate (MeSA; utilized in plant protection).

Hymenoptera is a huge insect order that includes vast number of both beneficial (bees, parasitic wasps) and harmful (sawflies) animals. Parasitic wasps are insects that diminish the agricultural pests' population.

Materials and methods

In this paper we used cis-Jasmone in an experiment to find out whether it influences beneficial Hymenoptera complex structure when introduced in PE and MeSA compositions. Hereinafter CJ experiment. Then, we compared the results with the experiment that uses pure PE and MeSA that was performed the same year. Hereinafter, pure PE and MeSA experiment. The goal of this study is the evaluation of common activity of PE and MeSA with CJ additives.

The CJ experiment was carried out in I.G.F.P.P. plum orchard in Chisinau, Republic of Moldova. Time periods of the CJ experiment were April – September 2022. Angelino was the variety of plum used in the experiment. Plum orchard was sprayed with pesticides. The experiment featured three variants – PE+CJ, MeSA+CJ and control. Each variant included four repetitions. The distance between plots was 20 m to prevent mixing of different odors. Each plot included eight dispensers (Eppendorf test tubes 1.5 ml.) containing in first variant MeSA+CJ additives (16.0%), the second variant - PE+CJ additives (16.0%) and third variant – control.

MeSA dispensers are equipped with a wick that enables this substance evaporation from the dispenser. PE dispensers are left with an opened lid to facilitate substance evaporation because PE is less volatile than MeSA. When it is raining the water is not mixing with PE+CJ and used to be poured out of the dispenser while adding the new portion. Each variant had four yellow sticky traps situated diagonally inside of the plot. Once in two weeks the biomaterial from the yellow sticky traps was collected and examined in the laboratory. Himenopterans were keyed mostly to families using "Hymenoptera of the World: An Identification Guide to Families" [4]. There were 12 dates of collection from April to September.

Results and discussion

The total number of 342 individuals from 22 families of Hymenoptera were collected. The hymenopteran biomaterial was weak represented in yellow sticky traps due to extremely dry weather conditions of 2022. The most numerous fauna of Hymenoptera was collected in MeSA+CJ plot – 41.5%, Ph+CJ plot had 23.0% and control showed 36.3%. The experiment with pure PE and MeSA showed somehow similar result with more specimens collected in MeSA and control. The mean number of himenopterans was 2.9 individuals/trap for MeSA+CJ. PE+CJ had 1.6 individuals/trap. Control showed 2.5 individuals/trap. The results obtained from pure PE and MeSA experiment demonstrated that MeSA and control had 1.69 individuals/trap and 1.27 individuals/trap for PE. In both experiments PE shows very weak results due to, in our opinion, very slow volatility of PE compared to MeSA. PE paired with CJ didn't manage to attract the additional himenopterans.

The main five families overall attracted in yellow sticky traps in CJ experiment were as follows: Mymaridae (20.2%), Encyrtidae (14.3%), Ceraphronidae (12.3%), Aphelenidae (9.6%), Scelionidae (6.7%). All these families are important being parasitoids of many noxious species and play a significant role in biological control. All of the Mymaridae are all egg parasitoids, their hosts are mostly Homoptera, Hemiptera, Psocoptera, Orthoptera, Coleoptera and Diptera. Encyrtidae is one of the most important families of Hymenoptera playing a great role in biological control. They are Coccoidea (Homoptera) endoparasitoids. They parasitize also eggs and larvae of Coleoptera, Neuroptera, Orthoptera, Hemiptera, Lepidoptera. Ceraphronidae are Thysanoptera and Lepidoptera endoparasitoids. They also parasitize Diptera puparia. Aphelenidae are primary endoparazitoids of Aleyrodoidea, Coccoidea (Homoptera) Aphidoidea, Psylloidea (Hemiptera), They also parasitize Orthoptera and Lepidoptera eggs. Scelionidae are egg parasitoids of many insect and spider species and are useful in biological control. The rest (Platygastridae, Cynipidae, Torymidae, Trichogrammatidae, Eulophidae, Bethylidae, Braconidae, Megaspilidae, Ichneumonidae, Diapriidae, Pteromalidae, Signiphoridae, Figitidae, Eurytomidae, Formicidae, Lioperidae, Eupelmidae) compile 36.9%. There are small differences in dominant families between experimental plots, e. g. Platygastridae and Megaspilidae occupy fifth position in top five in control. Cynipidae hold fifth position in top five in MeSA+CJ plot, but they are present mostly in spring. Platygastridae hold fourth position in PE+CJ plot. The most number of families (18) was found in MeSA+CJ plot, then PE+CJ plot (17) and control plot (16). Figitidae, Liopteridae, Eupelmidae are found just in MeSA+CJ plot. Formicidae are found just in PE+CJ plot. The number of hymenopteran individuals in MeSA+CJ was often much higher than in the control. Cynipidae were nine times higher in MeSA+CJ than in control. Trichogrammatidae are six times more popullous in MeSA+CJ than in control. Scelionidae are 2.6 times higher in MeSA+CJ than in control. Ceraphronidae are 2.2 times more numerous in MeSA+CJ than in control. In PE+CJ plot just Trichogrammatidae were found to be three times higher than in control. PE+CJ might be attractive for these parasitoids, although thorough future experiments must be held to sustain this statement.

The vast majority of collected Hymenoptera are parasitoids and participate actively in noxous species regulation on plum. CJ experiment share approximately the same top families with that of pure PE and MeSA experiment with the exception of Torymidae that is not present in top five in CJ experiment.

Hymenoptera specimens' dynamic is manifested more or less uniformly throughout the vegetation season (fig.). The dynamics curve of control plot, generally, has three peaks alternated

by two depressions created by pesticide treatments. PE+CJ mostly repeat the same trajectory with the elevation in the II decade in August. The most spectacular elevation is shown, after all, by MeSA+CJ curve with the highest peak registered in the first decade of August. PE+CJ and MeSA+CJ serves as additional false food source when the most of the flowers are already bloomed at the end of summer. The curves of CJ experiment are smoother than pure PE and MeSA experiment.

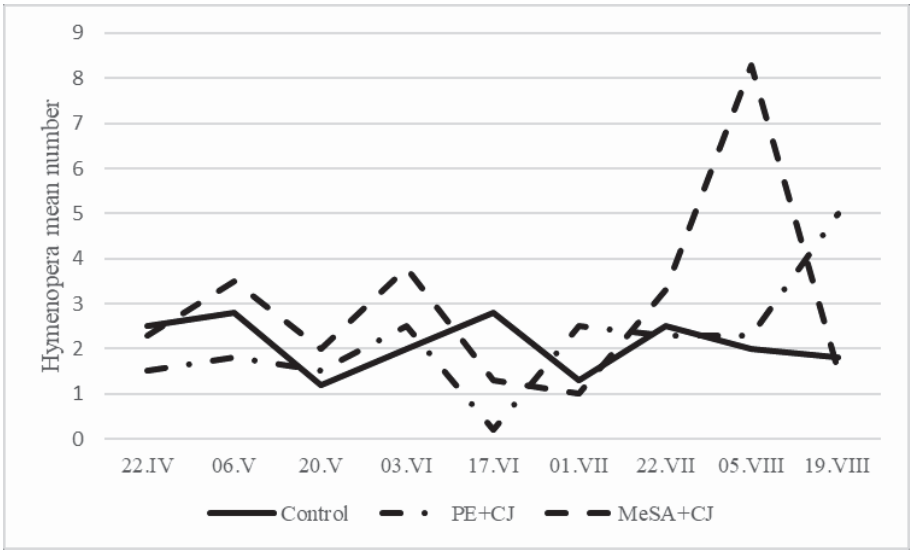


Figure. Hymenoptera specimens' mean number dynamics in CJ experiment in the plum orchard by plots (except September)

The main animal taxa in CJ experiment are Diptera (44.8%), Hemiptera (37.8%), Hymenoptera (6.1%), Thysanoptera (5.3%) and Acari (1.9%). Diptera and Hemiptera serve as a good source of food for numerous parasitoid himenopterans. The same picture was observed for control plot. It differs, however, in MeSA+CJ plot where Thysanoptera occupies the second place. They hold the third position in PE+CJ plot. Coleoptera are situated at fifth place. In all but one (PE+CJ) plots, Hymenoptera hold the third position. They are represented mostly by parasitoids which influence on pests' populations is crucial.

Some other groups of animals showed deterrent behaviour towards CJ, others were attracted by PE+CJ. The CJ experiment proved that CJ can work as deterrent for noxious Hemiptera. Coccidae were five times less attracted and Cicadidae were 1.5 times less attracted in PE+CJ plot than in control. Spiders were found 1.7 times more often in PE+CJ plot than in control, though we can't clearly state that PE+CJ attracts spiders due to poor spider physiology knowledge.

Statistical analysis of the collected Hymenoptera specimens is presented below.

Table

Deviation of the number of Hymenoptera individuals on plots from X average (excepting the III decade of April and September)

X / Variants	X May	X June	X July	X August
Control	±0.1	±0.3	-0.2	-0.2
PE+CJ	-0.5	-0.7	±0.3	-0.2
MeSA+CJ	-0.5	±0.4	-1.6	±2.8

LSD $P_{0.05} = 1.8$

The difference was not significant between the plots. Thus, CJ didn't manage to influence significantly the number of Hymenoptera specimens in the experimental plots. The same situation is observed in pure PE and MeSA plots.

Conclusions

The biggest number of Hymenoptera specimens was collected in MeSA+CJ plot – 41.5%, Ph+CJ plot had 23.0% and control showed 36.3%. The experiment with pure PE and MeSA showed similar result with more specimens collected in MeSA and control.

In both experiments PE shows very weak results due to very slow volatility of PE compared to MeSA. PE paired with CJ did not manage to attract the additional himenopterans.

The main five families overall attracted in yellow sticky traps in CJ experiment were Mymaridae (20.2%), Encyrtidae (14.3%), Ceraphronidae (12.3%), Aphelenidae (9.6%), Scelionidae (6.7%). CJ experiment share the same top families with that of pure PE and MeSA experiment with the exception of Torymidae that is not present in top five families in CJ experiment.

In PE+CJ variant just Trichogrammatidae were found to be three times higher than in control. PE+CJ might be attractive for these parasitoids.

The main animal groups in CJ experiment are Diptera (44.8%), Hemiptera (37.8%), Hymenoptera (6.1%), Thysanoptera (5.3%) and Acari (1.9%). Diptera and Hemiptera are a good source of nutrition for parasitoid himenopterans.

Some other taxa of animals showed deterrent behaviour towards CJ, others were attracted by PE+CJ. The CJ experiment showed that CJ can work as deterrent for noxious Hemiptera. Coccidae were five times and Cicadidae were 1.5 times less attracted in PE+CJ variant than in control.

The two experiments showed similar results, without great differences between them.

Acknowledgements. The researches were 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*, financed by the Ministry of Education and Research of the RM.

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