Effects of applying safe methods for protecting fruit plantations from pests

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Abstract. The broad definition of biological suppression of pests, i.e. the use of various organisms or products of their vital activity to cause damage to a harmful insect, includes many new unique and promising methods. Understanding the need for further study of the biology and ecology of harmful insects and their current potential natural enemies resulted in a number of new methods. They, in turn, led to the emergence of terms such as regulated pest control, bioecological control, an integrated control method, ecologized and ecological plant protection, and pest control systems. The components and methods of biological control used and studied now include parasitoids, predators, various pathogenic agents, and in addition, pheromones, attractants and hormones. Based on traditional objects used in the biotechnology, genetically modified organisms are created that can independently resist phytophages. Ecologically safe methods of protecting plants from pests and diseases are everywhere included in agricultural practice, and systems of organic farming are being actively introduced. Thus, studies on the use of safe methods for plant protection from pests in relation to specific climatic and geographical conditions are relevant. In this regard, the current paper presents the results of a study of the effectiveness of Shin-Yetsu dispensers in relation to the conditions of cultivation of fruit trees in the North Caucasus region.

1. Introduction

Every year, the need for environmentally friendly products increases. In the Russian Federation, a law on growing environmentally friendly apple fruits was passed in 2018 and also a program on growing organic apples is being developed. The production of organic foods without the use of pesticides or with its minimum quantity and low toxicity is possible by replacing chemical insecticides with biological and/or using non-chemical measures to control pests, since insecticides are the most toxic component of the general system of protecting an apple tree from a complex of harmful organisms [1-7].

Studies on establishing the effectiveness of Shin-Yetsu dispensers were carried out at the “De-Gusto” Agricultural Production Cooperative (APC) (piedmont zone of the Republic of North Ossetia-Alania) on the Liberty variety and Svetlovodskoye LLC (piedmont zone of the Kabardino-Balkarian Republic) on the Williams Pride, Gala and Idared varieties. These dispensers are designed for sexual disorientation of males of the codling moth. Due to the unique Shin-Yetsu dispenser technology, the release of pheromones is guaranteed to occur throughout the growing season.
Experiment Options:
1. Insecticidal protection (standard economic scheme) from the codling moth;
2. Pheromone protection using dispensers "Shin-Yetsu" in the amount of 500 pcs/ha.

2. Research results
Due to weather conditions 2019 was very favorable for the development of the codling moth, the main pest of the apple tree, as well as all harmful species of insects and ticks. In the previous 2 years, quite good results of applying the Shin-Yetsu dispensers against the codling moth were obtained in this area. However, the appearance of aphids, ticks and scoops, which do not fall into the spectrum of action of these dispensers, was noted. That is why one-time control measures for these pests were taken. By the time of harvesting, damaged fruit with the use of pheromone protection was not detected, as well as with the application of insecticidal protection. After flowering, the entire garden was sprayed with Calypso, 0.35 to control a pest complex.

In 2019 - the third year of production tests - dispensers on the site were hung up after flowering at the rate of 500 pcs/ha and around the perimeter of the site on May 14. Due to the fact that the site is in the immediate vicinity of the forest, several pheromone traps for codling and oriental fruit moths were hung to control the summer of Lepidoptera pests.

According to the results of the development of the first generation ending June 25, 2019, no damaged fruits were found. Flying period of the codling moth first generation began at the end of flowering and was extended. Three waves were noted. At the peak of summer, there were 20 - 30 insects per trap. In traps for the oriental fruit moth, butterflies were found, identified by the quarantine infection of the city of Pyatigorsk as a plum fruit moth.

In the third decade of June, the flying of the second generation began. In the beginning, the flying was weak. For instance, 2-3 moths were found in the traps on June 20. Then, with an increase in the temperature, the flying became more numerous: 8-10 pcs on June 26. In July, in the heat, the flying was very numerous: 17-20 pcs on July 4, to 43 pcs on July 12.

In the first decade of July, wormy fruits were found on pollinators, the wild apple trees that ripen earlier.

Judging by the multiple moves, this was damage of the oriental fruit moth, probably of the second generation, which developed in late June.

The first wormy fruits were also found on the Liberty variety. It should be noted the peculiarity of the Liberty variety, which consists in the fact that the stalks are very short and the fruits grow crowded, like sea buckthorn. Therefore, several fruits are damaged at once. By the time the damage by the second generation of the codling moth was taken into account, there was already a small amount of drop which included more than 15% of wormy fruits in the case of pheromone protection; in crown - 3.3%.

In the case of insecticidal protection, there were no damaged fruits in the crown, 0.6% in the drop. These were damage caused by the oriental fruit moth. The third generation was also numerous and extended: from late July to mid-September. At the peak of summer, there were up to 33 butterflies per trap.

De Gusto Gardens are located in the immediate vicinity of the corn fields, where from the third decade of July the owlet moth spread and its migration to gardens was noted. In this regard, on July 26, the experimental plots were cultivated by Avant 0.4, and closer to picking up on August 10, repeatedly by Proclaim 0.4. Both preparations affect not only owlet moths, but also codling moths - both codling and oriental. Therefore, the result on the action of Shin-Yetsu pheromones cannot ideally be considered pure. After the development of the third generation, counting and analysis of worm fruits was carried out for three pests that have similar symptoms: codling moth, oriental moth, and owlet (table 1).
Table 1. The number of damaged fruits after the development of the codling moth.

| Options                  | Damaged fruits, % |     |     |     |     |
|--------------------------|-------------------|-----|-----|-----|-----|
|                          | by codling moth   | by oriental moth | by owlet moth |
|                          | in crown          | in drop          | in crown       | in drop          | in crown       | in drop          |
| First generation         |                   |                 |                 |                 |                 |
| Insecticidal protection | 0                 | 0               | 0               | -               | -               | -                |
| Pheromone protection     | 0                 | 0               | 0               | -               | -               | -                |
| Second generation        |                   |                 |                 |                 |                 |
| Insecticidal protection | 0                 | 0               | 0               | 0.3             | -               | -                |
| Pheromone protection     | 0                 | 0               | 3.3             | 9.6             | -               | -                |
| Third generation         |                   |                 |                 |                 |                 |
| Insecticidal protection | 0                 | 0               | 0               | 0.3             | 0               | 0                |
| Pheromone protection     | 0                 | 0.6             | 2.5             | 18.0            | 1.6             | 12.4             |

With the application of insecticides the damaged fruits were completely absent in the crown, and in the drop there was damage caused by the oriental fruit moth 0.3% and by codling moth 0.3%.

Analysis of fruit damage caused by the codling moth third generation showed that pheromone protection is equivalent to insecticidal against the codling moth. However, with the pheromone protection, despite additional chemical treatments directed against the oriental fruit and owlet moths, although a protective effect was exerted, the damaged fruits were still found: in the crown - below the ETH - 1.6 - 2.5%, and in the drop - 12.4 - 18.0%. This indicator, although lower than last year (when spraying was not carried out at the end of the summer), is still significant.

In the upper part of the piedmont zone of the KBR, where the development of the codling moth due to climatic features takes place 10-12 days later than on the plain, the moth control is less relevant. In this zone, small population of pests is noted, which makes it possible to reduce and even completely reject insecticides. In order to study the possibility of growing fruits without pesticide application technology, the experience of using Shin-Yetsu dispensers on the summer Williams Pride variety which is resistant to scab and does not require fungicidal treatments was conducted in 2017.

In 2018, a search experiment using Shin-Yetsu dispensers in this farm was carried out on three varieties: the immune variety Williams Pride (summer ripening), scub- and powdery mildew-susceptible Gala (late-summer ripening) and Idared (winter ripening).

The counts were carried out in 3-fold repetition for each variety of 100 fruits in the crown and in the drop. Fruit damage records were carried out in May, June, July for the Williams Pride variety; in May, June, July, August for the variety Gala; in May, June, July, August, September for the variety Idared. The number of counts depended on the harvesting period of each term.

Dispensers were hung immediately after flowering on May 12, which is later in this zone than on the plain. On May 17 (phenophase ovary 0.5 - 0.8 cm), the trees were treated with Mospilan 0.4 l/ha against the complex of other orders pests (aphids, beetles and sawflies). This preparation also affects the codling moth. This chemical treatment of the Williams Pride variety was the only one in the area where Shin-Yetsu dispensers were hung. For the Gala and Idared varieties, due to the later harvesting period, there was a risk of damage by owlet moths migrating to gardens from nearby corn fields. Therefore, on August 6, Gala and Idared were sprayed with Avant 0.4 kg/ha and on September 4 Idared was retreated with Avant 0.4 kg/ha.

During three (Williams Pride, Table 2), four (Gala) and five (Idared) (Table 3) accounting periods no fruit damage (wormy apples) was found in the crown.

Table 2. Fruit damage by pests, Williams Pride variety.

| Options | Number of wormy fruits | Biological efficiency, % |
|---------|------------------------|--------------------------|
| in May  |                        |                          |
Insecticidal protection 0 - 100
Pheromone protection 0 - 100
in June
Insecticidal protection 0 0 100
Pheromone protection 0 0 100
in July
Insecticidal protection 0 0 100
Pheromone protection 0 0 100
in August
Insecticidal protection 0 0 100
Pheromone protection 0 0.3 100
in September
Insecticidal protection - - -
Pheromone protection - - -

Table 3. Fruit damage by pests, Gala and Idared varieties.

| Options               | Number of wormy fruits | Biological efficiency, % |
|-----------------------|------------------------|--------------------------|
|                       | in crown               | in drop                  |
| in May                |                        |                          |
| Insecticidal protection | 0                     | -                        | 100                      |
| Pheromone protection  | 0                      | -                        | 100                      |
| in June               |                        |                          |
| Insecticidal protection | 0                     | 0                        | 100                      |
| Pheromone protection  | 0                      | 0                        | 100                      |
| in July               |                        |                          |
| Insecticidal protection | 0                     | 0                        | 100                      |
| Pheromone protection  | 0                      | 0                        | 100                      |
| in August             |                        |                          |
| Insecticidal protection | 0                     | 0                        | 100                      |
| Pheromone protection  | 0                      | 0                        | 100                      |
| in September          |                        |                          |
| Insecticidal protection | 0                     | 0                        | 100                      |
| Pheromone protection  | 0                      | 0                        | 100                      |

Williams Pride variety is suitable for ripening and harvesting at the time when owlet moth appears on the plots. This is the very beginning of its harmfulness and spraying with an insecticide of even a short duration is impossible. Therefore, in the drop for 300 counted fruits, one was found damaged by an owlet moth, which amounted to 0.3%. This indicator is insignificant.

Gala was treated with Avant 0.4 kg/ha in August, that is why no wormy fruits were found in the drop. Idared, harvested at the end of September, was retreated with Avant in early September (the first treatment was carried out at the same time as on the Gala in August). For Idared, there was no damage in the drop.

Thus, the results of the studies indicate 100% efficiency of pheromone protection of fruit trees in the upper part of the piedmont of the KBR.

3. Conclusion
More careful monitoring of the oriental fruit and owlet moths is required to establish a more accurate time for spraying against these pests, and it would also be preferable to have dispensers with a complex effect, for example, against the codling and oriental fruit moths at the same time.

In case of poor development of the codling moth, Shin-Yetsu dispensers in the upper part of the piedmont were effective on three varieties: Williams Pride, Gala and Idared. Moreover, on all
varieties, Calypso treatment 0.35 l/ha was carried out for a complex of pests after bloom, and Gala and Idared were treated with Avant 0.4 kg/ha before harvesting. The use of Shin-Yetsu dispensers on scab-immune Williams Pride variety indicates the possibility of using dispensers in low-pesticide and organic technologies for producing fruits.

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