Assessment of the apple fruits` quality in orchards with Shin-etsu® MD ST, D.

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Abstract. The article presents the results of the industrial field trial with pheromones Shin-Etsu ® MD STT, D, conducted in 2019-2022 at JSC «Novomikhailovskoe», Tuapse area, Krasnodar region. Twin tubes were hung at every second tree inside the block in the "rosebud" phenophase before flying of the codling moth`s overwintered generation. To track the flying of the phytophage at the experimental site a monitoring pheromone developed for gardens Shin-Etsu ® MD STT, D was hung. It was found that in the trial variant more than 14.5 t/ha of harvest in comparison to the control was saved with standard quality of 98.1-98.9%, with costs reduced by 70%.

1 Introduction

Horticulture is considered a priority industry in agricultural development that meets the growing demand of the population, but the yield loss of fruit crops annually amount to about 40% [1]. In the Russian Federation the main areas of fruit crops are located in the Krasnodar region. In the southern gardening zone, coddling moth *Cydia pomonella* L., a representative of the Lepidoptera order of the Tortricidae family, is a key pest of the apple tree. In many countries of apple production this pest leads. The territory of Kazakhstan is an example, where the loss of the gene pool of wild apple trees is under threat due to a high number of coddling moth and insufficient control measures for its development. In the Republic of Belarus, Komardina V.S. noted that coddling moth is one of the dominant pests in the pear orchard, with the damage reaching 23.2% [2].

Due to the high harmfulness of *C. pomonella* L. (more than 70 %), the Government of India imposed restrictions on export of all fresh fruits (apples, apricots, walnuts and other fruits) from Ladakh to other states of the Indian Union in accordance with the law "Destructive insect Pest Act 1914 (II)" [3].

According to V.V. Vasilyeva, such factors as the average annual temperatures` increase and the phytophage`s decreasing sensitivity to pesticides affect the population dynamics of the phytophage and contribute to the habitats` expansiono through migration [4].

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Such high carpophagous` harmfulness is caused by several generations` presence generations and by considerable extention of each generation` flying for 1.5 – 2 months [5]. Each generation`s numerosity and development character can significantly vary, both from year to year and in cultivation zones. Thus, under conditions of the northern horticulture zone, one full coddling moth`s generation develops, while in the southern regions of Russia there are three full generations of *C. pomonella* [1, 6].

Nowadays, chemical insecticides are mainly used to control the number of harmful species with their negative effect to the environment. Ecological approach in protection systems is possible through transition (full or partial) to alternative protection methods [7].

In Russian and foreign literature, there is data on effective way of coddling moth` control without negative effect on human health and environment with the use of granulovirus *Cydia pomonella* (CpGV), a virus with double-chained DNA from the genus Betabaculovirus of the Baculoviridae family. Granulovirus causes systemic infection in coddling moth`s larvae, including the adipose body, tracheal cells, and malpighian tubules, and usually leads to larvae `s death within 7 days after infection [8, 9, 10]. In Russia in 2022 two granulosa viruses Madex Twin, SK and Carpovirusin, CS were registered on fruit plantations, the efficacy of these products is up to 92-95% [11].

V.I. Dolzhenko notes that pheromones – Shin - Etsu and Breeze used for *Cydia pomonella* control in apple tree entered the list of biological plant protection products. Scientists from various research and development institutions confirmed the high efficacy of pheromones in coddling moth control, that amounted to 80-96% [12, 13, 14].

The aim of the research is to access a possibility of using alternative protection methods in control of *Cydia pomonella* L. in orchards of the Black Sea Coastal area of the Krasnodar region.

2 Materials and methods

Apple tree plantings, apple coddling moth *Cydia pomonella* L., family Tortricidae were objects of the research.

Production field trials (with 2 ha area) for studying regulations for Shin-Etsu ® MD STT, D pheromones` use were conducted in 2019-2022 at JSC «Novomikhailovskoe», Tuapse area. Twin tubes were spread inside a block on every second tree in the "rosebud" phenophase before overwintered coddling moth generation flying. The flying density of *C. pomonella* in control and trial plots was monitored with the help of an enhanced pheromone developed for monitoring orchards where Shin-Etsu ® MD STT, D was used.

The definition of biological efficacy of insecticides was carried out according to the "Guidelines for registration tests of insecticides, acaricides, molluscicides, and rodenticides in agriculture" [13]. Indicators of biological efficacy were calculated according to the Abbott formula [13].

3 Results and discussion

The "Handbook of pesticides and agrochemicals approved for use on the territory of the Russian Federation" in 2022 includes chemical, biorational, baculovirus, microbiological pesticides for *Cydia pomonella* L. control. It was found out that numerosity and harmfulness *C. pomonella* vary greatly in different horticultural zones of the Krasnodar region. It is a common knowledge that in the southern regions of the Russian Federation there are 3 full generations of the coddling moth. To protect the apple tree from *C. pomonell*, 2 to 3 treatments are carried out for each generation, and 4 treatments with insecticides of different action mechanisms are used for the 3rd generation. Currently, the pesticide load on apple

agrocenoses is increasing and due to it phytosanitary situation in the gardens is destabilized. Therefore, an urgent task is to minimize the toxic load still maintaining protection measures` efficacy. This became possible with the appearance of the Shin-Etsu ® MD CTT, D pheromones, whose action mechanism implies males` *Cydia pomonella* L. disorientation due to a high female pheromones` concentration. The pheromone is within twin tubes and depending on weather conditions (temperature and humidity) is released within 130-160 days. Trials conducted in apple orchards in various regions of the Russian Federation indicate positive results on apple coddling moth` disorientation [12, 13, 14].

In the quarter where Shin-Etsu ® MD STT, D pheromones were used (at JSC «Novomikhailovskoe», Tuapse area), only 5 males of coddling moth were caught in 2019 all in all, in 2020-22 2-3 butterflies both for the 1st and for the 3rd overwintered generation 6-9 species were caught during the whole season. The flying dynamics of the coddling moth in 2019-2021 is shown in Figure 1.

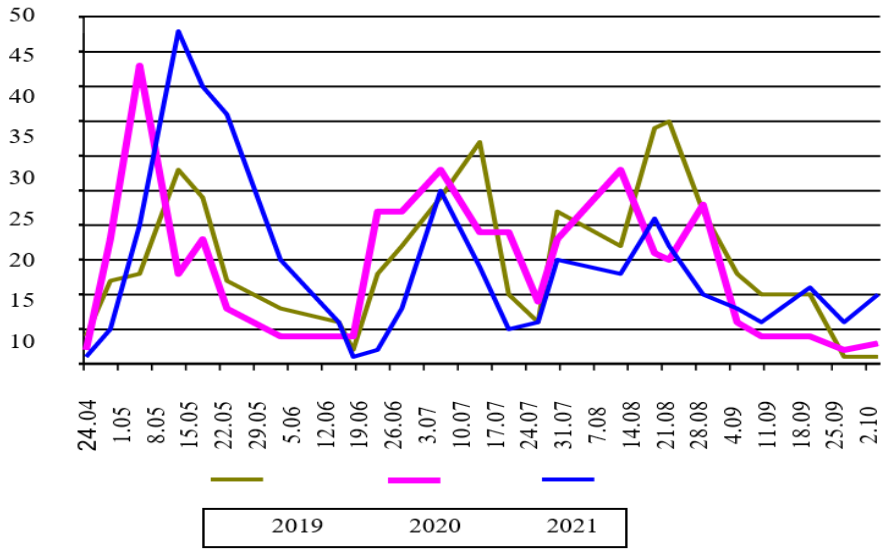


Fig. 1. Flying dynamics of *C. pomonella* at JSC «Novomikhailovskoe».

The ration of the damaged fruits in the fallen fruit stock of the control variant was fixed within 26.2 to 36.1% during the years of research, and that in the yield was from 30 to 38.9% (Figure 2).

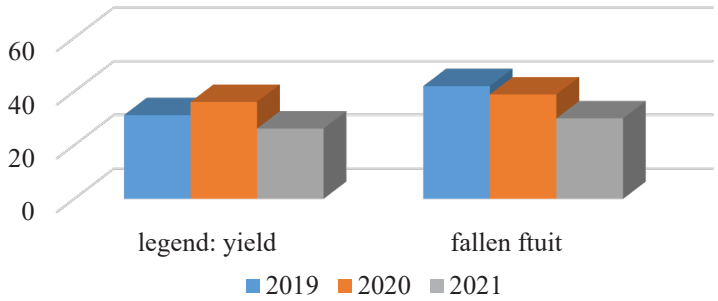
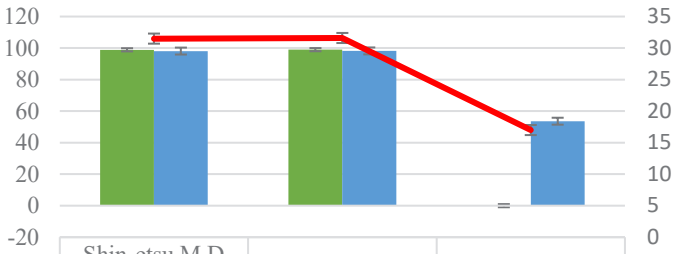


Fig. 2. Dynamics of fruit damage caused by coddling moth in control variant trees, the Black Sea horticultural zone, at JSC «Novomikhailovskoe».

In the period of 2019 to 2022, 8 treatments were annually cancelled at the site with the use of Shin-Etsu M ST (while there were carried out 10 in the standard variant). High biological efficacy (98.9-100%) of Shin-etsu M ST pheromone in control of apple coddling moth numerosity was found, it is equal to the indicators obtained in the standard. In the trial period more than 14.5 t/ha of the harvest was saved with standard quality rate being 98.1-98.9% (Figure 3).



	Shin-etsu M D ST, D	Standard	Control
Biological efficiency, %	98.9	99	0
Standard,	98.1	98.2	53.6
Crop productivity, t/ha	31.5	31.6	17

Fig. 3. Economic efficacy of Shin-etsu M ST pheromone use, Golden Delicious variety, 2019-2021.

4 Conclusion

In the Black Sea horticultural zone of the Krasnodar region *Cydia pomonella* L. is a dominant pest of apple and pear trees. It was established that under conditions of Tuapse area the pest develops 3 generations, and with no control of the phytophage numerosity loss can reach up to 40%.

For the Black Sea zone of the Krasnodar region, a technology was developed to protect apple trees from coddling moth with the use of Shin-Etsu MD STT pheromones, which allows pesticide load reduction and saves costs for insecticides by 70% and helps to preserve the yield of more than 14.5 t/ha with a standard quality of about 98.1%.

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References

1. I. M. Mityushev, Agro-industrial technologies of the Central Russia, **3,** 55-58 (2020) https://doi.org/10.24888/2541-7835-2020-17-55-58
2. V. S. Komardina, N. E. Koltun, S. I. Yarchakovskaya, Agriculture and crop production**, (1)**, 27-32 (2022) https://crop.belal.by/jour/article/view/24/23
3. B. Hussain, K. Z. Masoodi, A. R. WarA. S. Hakak, N. Ahmad, & T. Masoodi. VirusDisease, **31(4),** 517-525 (2020) https://doi.org/10.1007/s13337-020-00638-3
4. V.V. Vasilyeva, Current issues of student science (2021)
5. M. V. Minko, V. A. Khilevsky, Plant protection from harmful organisms, 165-167, (2019)
6. V. A. Yakovuk, et al. Agriculture, **7,** 39-43 (2020) https://doi.org/10.24411/0044-3913-2020-10708
7. G. V. Bystraya, M.A. Kazim, Fruit growing and viticulture in the South of Russia, **44,** 164-176 (2017)
8. J. Fan, et al. Virology, **541**, 32-40 (2020) https://doi.org/10.1016/j.virol.2019.11.016
9. B. Hussain, K. Z. Masoodi, A. R. War, A. S. Hakak, N. Ahmad, T. Masoodi, VirusDisease, **31**(4), 517-525 (2020) https://doi.org/10.1007/s13337-020-00638-3
10. M. Perrin, J Moiroux, S. Maugin, J. Olivares, M. Rault, M. Siegwart, Pesticide Biochemistry and Physiology, **185,** 105139 (2022) https://doi.org/10.1016/j.pestbp.2022.105139
11. T. V. Dolzhenko, V. I. Dolzhenko. Agrochemistry, **4,** 26-33 (2017)
12. A. A. Borodavchenko, Plant protection and quarantine **5**, 23-24 (2017)
13. M. Podgornaya, et al. BIO Web of Conferences, **34,** 04013 (2021) https://doi.org/10.1051/bioconf/20213404013
14. M. E. Podgornaya, Plant protection and quarantine, **12,** 32-34 (2018)