Caspian Journal of Environmental Sciences
Online ISSN: 1735-3866
Print ISSN: 1735-3033

Biological protection of black currant from phytophages

Nagima Tumenbayeva[1]*, Bekzat Mombayeva[2]*, Aliya Kushenbekova[3]*, Laila Kaliyeva[3]*, Meiramgul Mussina[3], Gulbaram Nurgaliyeva[3], Rinat Sarsengaliyev[3], Roza Sarmanova[1]

1. Department of Biology, Plant Protection and Quarantine, Faculty of Agronomy, Kazakh Agrotechnical Research University named after S. Seifullin, Astana City, Kazakhstan
2. Department of Biology, Faculty of Natural Sciences, M.H. Dulati Taraz University, Taraz, Kazakhstan
3. Institute of Veterinary and Agrotechnology, Zhangir Khan West Kazakhstan Agrarian Technical University, West Kazakhstan Region, Uralsk, Kazakhstan

** Corresponding author's E-mail: nagi_kosi@mail.ru, bekzat.mombaeva@mail.ru, aliya.kushenbekova@mail.ru, kalieva231273@mail.ru*

ABSTRACT

Protecting fruits from tick damage can lead to increased productivity of agricultural products and the production of healthy products. Using biological protection methods against ticks, which are considered organic and healthy methods, is presented in this article. For this purpose, in the studies conducted in 2020-2022, data were collected on three types of plant mites on fruit trees in Kazakhstan. In a number of host trees, branches with swollen buds and no leaves were observed. For the purpose of definitive diagnosis, the buds were separated, and the mites were directly isolated. The samples were stored in clarifying solutions and prepared as microscopic slides, and their diagnosis was carried out with the help of new scientific resources. The results showed that the mentioned mite belongs to the phytophages family. Then, using biological protection and fungal and bacterial biocontrol, the method of pest control of blackberries from this mite was investigated. These mites can be separated from blackberries within a period of one month, leading to biological protection of this fruit in subsequent years.

Keywords: Biological protection, Blackberry, Fruit mite, Phytophages.
Article type: Report.

INTRODUCTION

Over 30 species of fungi cause rot on strawberry fruit, the most important of which is the fungus *Botrytis cinerea* Pers, which causes gray mold or botrytis fruit rot. Mites of the genus *Aceria* Keifer, 1944 belong to the family phytophages, suborder Prostigmata, and order Trombidiformes (Bakalova *et al*. 2017). Mites of this genus live in different parts of plants, such as leaves, flowers, buds, and green organs of the host, and may cause damage to the plant by changing the shape of plant organs or creating galls, blisters, and felt. The relationship between the mite and the plant host is specific, and several different species of this genus may be present on one plant. The host is active in different parts of the plant (other than the root). All developmental stages of the mite are spent on different host organs, sometimes accompanied by specific symptoms on the plant at each stage of life (Gulyaeva *et al.* 2021; Alhammadi *et al.* 2024). Accoeding to Koltun & Yarchakovskaya (2006), this mite is introduced as a pest of mulberry buds in India. They stated that this species is found inside unopened mulberry buds covered with scales, and the buds eventually die due to the mites' feeding. Also, Gajek *et al.* (2000) conducted a study on seasonal changes in the population of this species, stated that the increase in the population of *A. mori* in India starts in December, reaches a maximum at the end of January, and decreases in May. The black currant tree belongs to the Moraceae family. This tree is distributed in India, western Afghanistan, southern Europe, northern Africa, America, and other temperate regions of the world. The leaves of this plant are mainly used as food for silkworms. Its fruit is also eaten fresh and dried and has food and medicinal uses. In Kazakhstan, this tree is

Caspian Journal of Environmental Sciences, Vol. 22 No. 5 pp. 1285-1291Received: March 05, 2024 Revised: June 24, 2024 Accepted: Aug. 27, 2024
DOI: 10.22124/CJES.2024.8344

Publisher: University of Guilan

distributed in the steppe areas of the north of the country, the forests of the north, and is also observed in most of the country's mountainous areas (Zabrodina *et al.* 2022). In the study of Popov *et al.* (2020), it is considered a dangerous disease wherever strawberries are grown. This fungus is a ubiquitous pathogen of cruciferous plants, leading to plant rots, are one of the most common and widespread diseases of vegetables, ornamental plants, and fruits of various plants, both in the garden and in the field and in the warehouse (Viktorovna *et al*. 2019). Due to the frequent and excessive use of fungicides, this disease is the main reason why strawberries are among the most dangerous food crops. It is considered to be a pest of the world in terms of chemical pesticide residues. This fungus infects strawberries throughout the year, and also flowers, leaves, and fruits are affected by this pathogen. Although strawberry flowers are more susceptible to the disease than other plant organs, symptoms of the disease mainly appear on the fruit. Infection of developing fruits and their eventual decay usually originate from infected flowers, and the fact that the infection of flowers remains hidden is the main reason for the appearance of fruit rots at the end of the season (Agasyeva *et al*. 2021). The fungus *B. cinerea* overwinters in the form of mycelium and hardy fungi, and the primary sources of the disease include dead leaves, mummified fruits, adjacent fields, and weeds. The pathogen initially causes large brown spots on strawberry fruits, which, under moist conditions (free water), are covered with a gray mass consisting of mycelium, conidiophores, and conidia of the fungus (Melenti *et al*. 2020). The damage from the disease is serious when moderate and moist conditions prevail during the strawberry fruiting period. Under favorable temperatures (15-25 ℃) and humidity conditions (high relative humidity and long wetness of aerial parts) for the patient during flowering and harvest, the ground is prepared for the rapid spread of the disease and the reduction in crop yield will reach over 50% (Zabrodina *et al*. 2020). In addition to the damage it causes in the field, this disease also causes fruit rot during storage, transportation, and market after harvest. It is considered one of the reasons for the short shelf life of strawberries. Therefore, by adding post-harvest losses to the reduction in yield before, it is unsurprising that gray rot is the most important disease of strawberry fruit. Although agronomic practices such as increasing the distance between plants and removing old limbs (the sources of the disease) are used to control strawberry gray rot, they do not have much effect in reducing the disease. Weekly application of various fungicides is the main method of controlling this disease, which has been successful (Zabrodina *et al*. 2020). Improper application of chemical pesticides has led to the development of resistant pathogen strains. Unfortunately, to solve this problem, a higher amount of fungicide is sometimes used. Also, most fungicides have a temporary effect and die within several application cycles. Chemical pesticides cause contamination of groundwater, surface water, and food supplies, causing serious harm to humans and other living organisms. In addition, some fungicides increase disease by inhibiting the growth or eliminating pathogenic antagonists.

MATERIALS AND METHODS

Types of tree mites are pests that attack trees and use the tree's sap to survive. Types of tree mites and biological control methods are presented in this study. Mites are a type of arthropod that is considered a garden pest. One type of tree mite is the Tetranychidae mite. This mite is a pest that has many host trees. It has many hosts and is present inside tree debris or loose soil in the cold winter season. By the onset of spring and the weather warming up, the mites that lived under the tree debris in the winter will leave their shelters and move to the host tree. As a result, they begin feeding or damaging the trees. The period before the mite lays eggs takes six days. Also, this type of annual pest can produce 8 to 16 generations of mites. The decrease of this type of mite is directly affected by the elevation in humidity and temperature as well as the drop in the number of mite eggs. Notably, the activity of its natural enemies, especially ladybugs and larvae, as well as predator mites, are very effective in controlling this type of mite. It is good to know that predator mites have the ability to reduce the population of Tetranychidae mites remarkably. Accordingly, with the presence of a predatory mite, there will be no need to use chemical pesticides. Another type of tree pest is the European red mite. Mulberry trees are the main host of this mite. This red pest has been recognized as the main enemy of mulberry trees in Kazakhstan and various parts of the world. This pest has four pairs of legs as an adult insect that cannot be seen with the naked eye. The size of this mite is 0.2 to 0.8 mm. It should also be said that the eggs of this mite are bulbous and red. It is present in the form of eggs on the branches and trunks of trees in the cold winter season. This pest causes the first damage to young leaves and small fruits. One of the important methods of combating this pest is winter control, since the damage caused by mites to trees is greatly reduced in hot and cold weather. In this method, winter oil spraying is done by Nisuron and Envidor. Also, a neuron, Ortus, or nisuron is recommended for spring control. Brown, long-legged mites are

usually found in most areas with fruit trees. Their host trees are cherry, mulberry, apricot, and plum trees. The appearance of this mite is egg-shaped and has a smooth top. Its body's lateral and dorsal sides also have a steep slope. Short, fan-shaped hairs are easily visible on the body of Brown long-legged mites. This small pest easily pierces the walls of spongy tissue cells and feeds on the contents inside the cell. Notably, leaves damaged by this type of mite usually turn brown and in the case of severe damage to the leaves, they separate from the tree and begin to fall. One of the methods of combating this type of pest is to use acaricides such as Merocide. Noteworthy, winter oils can also be used to eliminate this small pest. The use of natural enemies of this mite has also been found to be very effective in reducing the population of this pest. Types of biological pesticides or biological control agents are divided into four categories:

1. Microorganisms (microbial pesticides): viruses, fungi, bacteria, nematodes, protozoa;
2. Macroorganisms: insects, predatory mites, metaozoa;
3. Biochemical agents: chemical signaling substances (pheromones and allelochemicals), insect growth regulators, plant regulators and enzymes;
4. Natural products have a natural origin; they are obtained from plants and microorganisms. These are obtained from alkaloids (amino acid derivatives) or glycosides (non-essential sugars for the plant) obtained in flowers, roots, stems, or even seeds. In addition, biological control agents of several plants have entered the market and contain genes resistant to several pests and diseases.

Of these four biological control agents, microorganisms are the most widely used. Insects, like other living things, get sick, and this disease causes the death of insects. So, they can become sick using viruses, fungi, bacteria, and nematodes. Some of these microorganisms can be easily cultivated in the laboratory. However, viruses need living organisms to reproduce. Therefore, they are used more in microbial pesticides than bacteria. So, to control plant diseases (root, stem, aerial organs, flowers, and fruit diseases), antagonists (living organisms that produce metabolic compounds that lead to the destruction of other living organisms) are used. For example, several antagonistic agents can be used to control root diseases, such as crown and root rot. Due to the problems and risks that chemical pesticides have created and continue to create for farmers and the environment, today, there is a great emphasis on non-chemical control of plant pests and diseases. Biological control of plant diseases using antagonists could be a promising alternative to chemical pesticides (Ualiyeva 2024). The most important microbial agents with the greatest potential in controlling diseases caused by *B. cinerea* include fungal and bacterial biocontrol agents. In this study, sampling was carried out from 12 blackberry orchards in Kazakhstan. The soil around the roots (rhizosphere) and the blackberry's aerial parts (leaves, flowers, and fruits) were collected and transported to the laboratory. The soil samples were stored in plastic bags at room temperature (20-25 ℃), and the aerial parts were kept in a refrigerator at about 4 ℃.

RESULTS

Using scientific sources, the tick was accurately identified. The main and distinguishable characteristics of this species from other individuals of this genus are: Dorsal shield (complete, sub-median line, and admedian line; interrupted, median line); Dorsal shield edges with numerous granules; Abdominal hairs with the complete arrangement; Feather-claw with one axis and five branches; Cover flap with ten longitudinal lines in a row; Idiosoma region covered with microtubercles of equal size (Fig. 1). Phytophytes are a group of microscopic, fungus-like organisms commonly referred to as water-loving fungi. Various species of Phytophytes cause root and crown rot in many crops and horticultural crops (4). Root and crown rot caused by phytophytes is one of the most important diseases of mulberry trees worldwide, stopping the movement of water and nutrients in the plant. It is enough to note that the science of pathology in its modern form began in the 19th century with the study of blackberry phytophthora, and during the 11th and 22nd centuries, about 54 new species were identified (Zabrodina *et al*. 2020; Ualiyeva 2024). Despite years of research on this pathogen, Phytophthora continues to be a major challenge in agriculture, and in recent years (early 21st century), the number of identified species has doubled to more than 112 species (Viktorovna *et al*. 2019). This pathogen produces three types of spores: zoospores (motile flagellated spores), chlamydospores, and oospores. Zoospores play an important role in infecting plants. These spores can swim in moist, moisture-saturated soils and reach the crowns of host trees. Zoospores are produced and maintained inside an organ called a sporangium. Sometimes, the sporangium itself, as a spore, can germinate and produce new organs. Sometimes, each sporangium produces a large number of zoospores. This group of spores plays an important role in the study of the epidemiology of the disease. Chlamydospores, like zoospores,

are considered asexual spores, but unlike zoospores, which are active for only a few hours, chlamydospores can survive for several years in plant debris and soil. Oospores are sexual spores and, like chlamydospores, play a key role in the long-term survival of the fungus. Although various species of Phytophthora have been isolated from mulberry trees, *P. cactorum* has been identified as the most important pathogen on mulberry, attacking more than 222 plant species, including pome fruits and strawberries. When only mulberry seed rootstocks were used in orchards, the spread of this disease was very limited, but with the expansion of the use of vegetative rootstocks in mulberry orchards, this disease gradually spread. High soil moisture is crucial for the survival and development of the disease (Popov *et al*. 2020). The hyphal thickness of this species is less than six micrometers and shows irregular hyphal swelling (Bakalova *et al*. 2017).

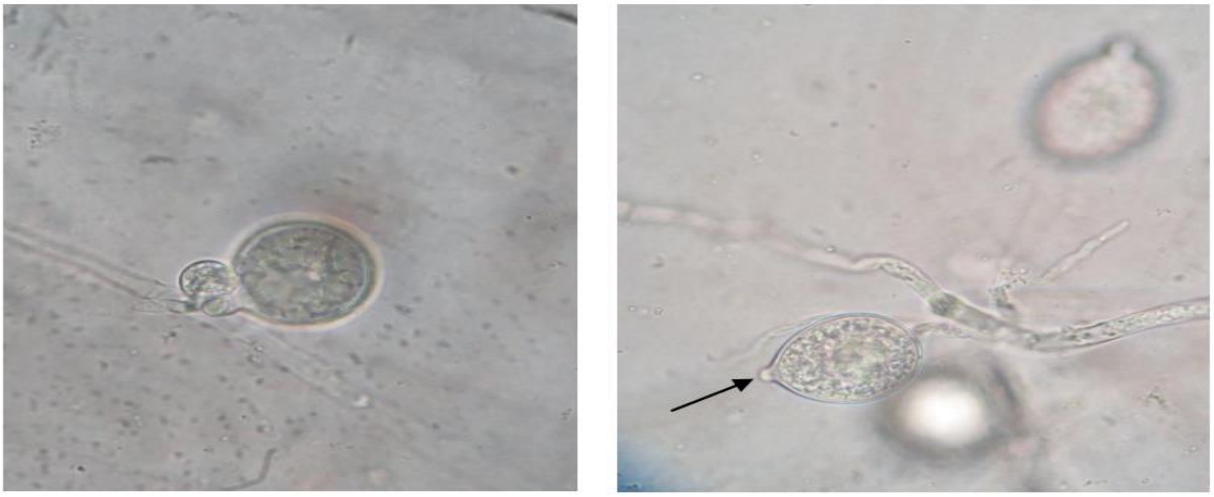

Fig. 1. Microscopic organs of *P. cactorum*, the causative agent of crown and root rot.

Phytophthora fruit rot is another important disease caused by the activity of two species, *P. syringae* and *P. cactorum*, in all regions of the world under orchard and storage conditions. Both soil-dwelling species can infect fruits near the ground surface or store fruits under favorable environmental conditions. *P. cactorum* is usually active in summer and at higher temperatures (optimum temperature 12-18 °C), however *P. syringae* is most active at cooler temperatures (optimum temperature 12-14 °C). All berry varieties and also apple fruits are susceptible to *P. syringae*. Symptoms of Phytophthora fruit rot vary depending on the variety and environmental conditions. Fruit rot is usually accompanied by a pungent odor similar to vinegar, and symptoms may be similar to brown rot caused by *Monilinia* spp. (Khairullin *et al*. 2023; Turenko 2023). Both *P. cactorum* and *P. syringae* overwinter as sexual spores or oospores in fruit and fallen leaves on the ground. Fruit infection occurs two to three weeks before maturity through the lenticels. However, if infection occurs at harvest, symptoms are not detectable, and infected fruit can produce hyphae in cool storage conditions (3-4 °C) and infect other fruits (Fig. 2).

Biological control of pests using ladybugs

Many pests, such as aphids and various types of thrips, appear in the spring on various plants and feed on the plant sap of these hosts, weakening them. In addition to direct nutritional damage, aphids can also destroy various crops, including vegetables, by transmitting many viruses, increasing this pest's importance. In nature, a group of insects at different stages of their development can directly feed on this pest insect and destroy it. One of these beneficial insects is ladybugs. Ladybugs are beetles with spots on their wing covers that vary in color, pattern, and number depending on the genus, family, or species. These insects feed on aphids in the larval stage, and if these insects are present in a field and their population is maintained, they can effectively control aphids.

Biological control of pests and diseases

In the case of biological control of pathogens, some other biological agents such as fungi, bacteria, or viruses are used, which destroy pests and pathogens by acting on them. This method of biological control is called the use of microorganisms, a practical and modern method. For example, *Trichoderma* fungus or *Bacillus* bacteria can control many fungi and pests. These agents are also commercially available. In nature, there is always a predator-prey relationship between different organisms. This can be effective in controlling many pests (Fig. 3). By identifying the population of a particular pest predator in a field or garden, efforts are made to preserve its

population and reduce the population of its prey (pest insect). Some other biological control methods have also been developed based on modern methods, including male sterility, in which male insects sterilized using genetic methods are released into a population. These insects mate with females, and due to their sterility, eggs will not be formed, or if they are formed, they will not be fertile, thus reducing the pest population. Using effective biological acaricides, in addition to preventing the development of resistance in the mite population, has led to their diversification and greater losses and is particularly important in managing plant mite control. Recent research results have shown that biological acaricides have had a good effect on this pest. In addition, using some acaricides in the pre-hatching stage of overwintering European red mite eggs has an acceptable control on the spring population of the pest by up to 30% and eliminates the need for re-control of the sprayed garden until the end of spring. Notably, observing correct spraying methods and complete and uniform coverage of the poison on the surface of the host plant leaves increases the effectiveness of the poisons.

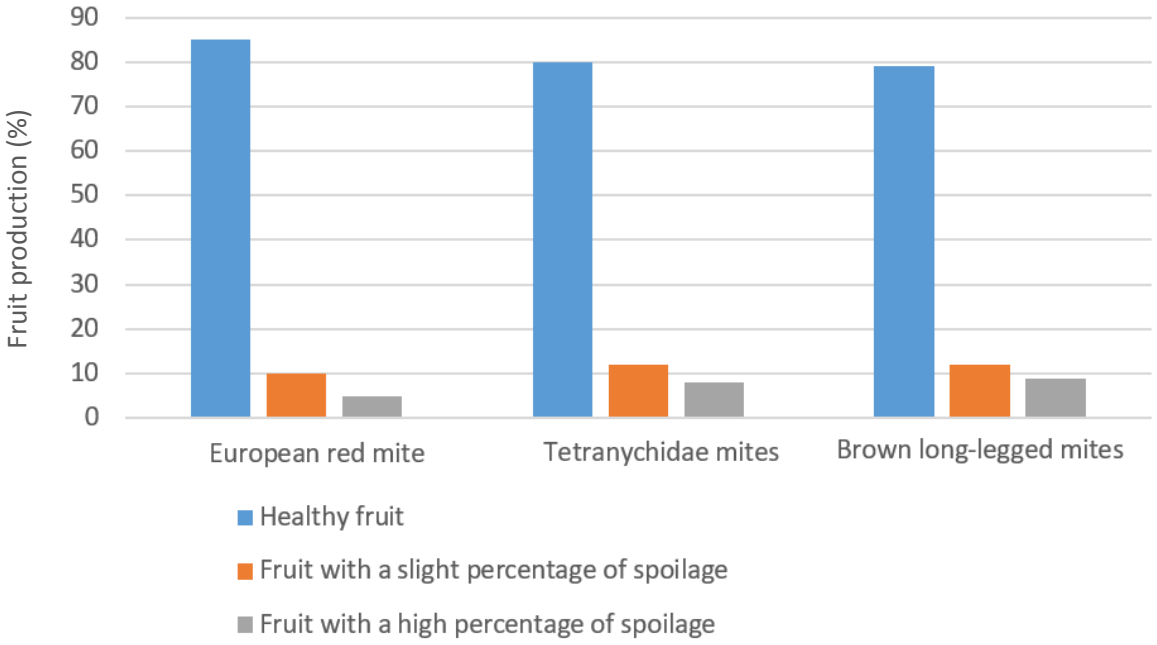

Fig. 2. Effect of mites on fruits.

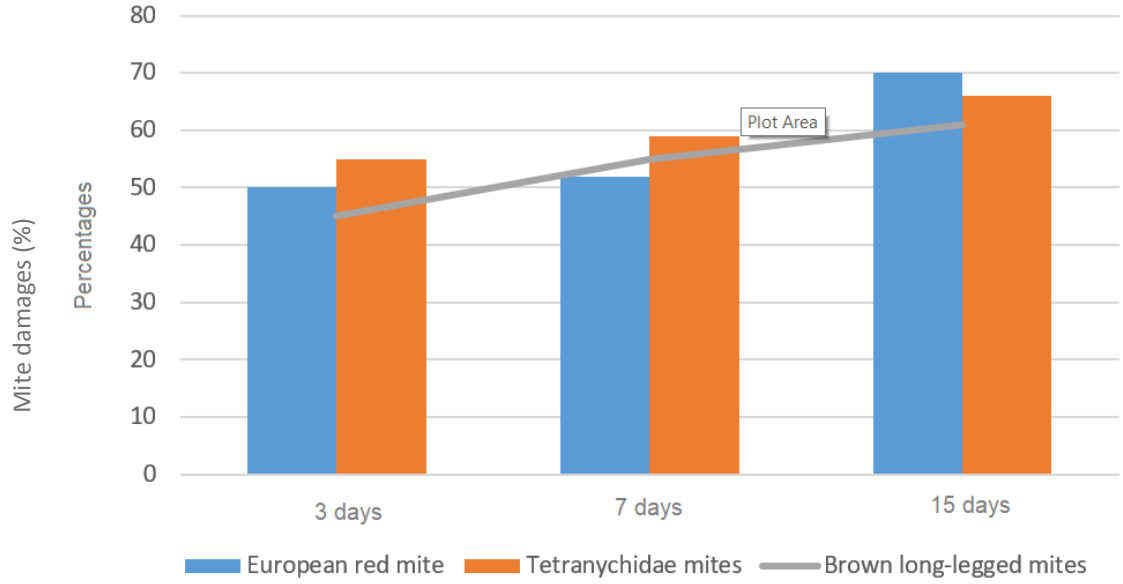

Fig. 3. The rate of tick damages in three treatments (3 days, 7 days and 15 days).

CONCLUSION

With the advancement of science and different societies and the increasing need for food, especially healthy food, it is necessary to pay more attention to using biological compounds and methods of pest and disease control so

that the health of the environment and future generations and the present generation is not endangered. This study tried to summarize the types of biological methods of pest and disease control. We examined three types of mites: European red, Tetranychidae, and Brown long-legged mites, as well as the effect of biological protection on their reproduction. The results showed that using biological protection if the spread of mites in blackberry fruit is not over 50%, the growth and reproduction of this mite can be reduced and eliminated in the following years. The best way to fight mites is to prevent the formation of iron. If we can fight mites before they emerge, there is no need for expensive chemical control, and fewer chemical pesticides can be used in the garden. The best ways to prevent this, based on the research results, are as follows:

1. **Tree nutrition**: A tree is like a human. The stronger the tree, the less pests and diseases attack it. Weak trees are attacked by mites sooner and faster, which is the cause of their spread. Tree nutrition is one of the principles of gardening that, if done correctly, does not require any chemical pesticides in the garden and, in addition, strengthens the tree and improves plant activities.

2. **Using compounds containing silicon**: Silicon in plants increases the leaf surface. When the leaf surface increases, mites are damaged and can no longer feed on the leaves. As a result, foliar spraying of fertilizer such as potassium silicate is one of the best and most effective ways to prevent the outbreak of mites. Of course, you should be careful that foliar spraying of this fertilizer should only be done when the mite population has not increased because this fertilizer does not have a killing effect and is only suitable for prevention and prevention.

3. **Eliminating the focus of mites**: Mites usually live in the soil and are moved by the wind. Usually, trees on the edge of the road are the first to get ticks, and this pest gradually spreads to all trees. So, the best way is to have a dirt road in the garden and replace it with cement or something else to eliminate the initial focus of ticks.

4. **Increasing the humidity of the garden**: Humidity is the enemy of ticks. If we can reduce the irrigation cycle and keep weeds in the garden under control, we can significantly reduce the tick population.

5. **Washing trees**: Another way to control ticks in trees is to wash trees with water or foliar soap. This will cause the ticks to fall off the leaves. To do this, we can use special foliar soaps or a mixture of water and detergent in a ratio of 1:1000.

REFERENCES

Agasyeva, IS, Nefedova, MV & Nastasiy, AS 2021, Study of the efficiency of the entomophage habrobracon hebetor say to control the number of *Etiella zinckenella* Tr. on Soybean Crops. *OnLine Journal of Biological Sciences*, 21: 217-222.

Alhammadi, A, Rahmani, F, Izadi, A, Hajati, F, Farahani, SSS, Jabr, A & Barzamini, R 2024, Prediction of environmental conditions of the greenhouse using neural networks optimized with the grasshopper optimization algorithm (GOA). *Journal of Power System Technology*, 48: 622-635.

Bakalova, A, Tytarenko, V, Radko, V, Klymenko, T & Trembitska, O 2017, Improving the design elements of sprayers to improve technologies in the protection of black currant against pests. *Eastern-European School of Transmission Technology*, 3: 4-10, DOI: 10.15587/1729-4061.2017.101080.

Gajek, D, Niemczyk, E & Sekrecka, M 2000, Effectiveness of different methods of blackcurrant gall mite control (*Cecidophyopsis ribis* Westw.) and their influence on population of phytoseiid mites and two-spotted spider mite. *IOBC WPRS Bulletin*, 23(11): 47-52.

Gulyaeva, II, Kraynov, OO, Hubych, OY, Stankevych, SV, Zabrodina, IV & Matsyura, AV 2021, Dominant sucker pests on industrial vineyards and protective measures in the regulation of their abundance in the conditions of the Northern Black Sea. *Ukrainian Journal of Ecology*, 11: 373-384. DOI: 10.15421/2021_186.

Khairullin, RM, Sorokan, AV, Gabdrakhmanova, VF & Maksimov, IV 2023, The perspective properties and directions of *Bacillus thuringiensis* use for plant protection. *Applied Biochemistry and Microbiology*, 59: 408-424. DOI: https://doi.org/10.1134/S0003683823040075.

Koltun, N & Yarchakovskaya, S 2006, Mass trapping of *Synanthedon tipulifornis* on blackcurrants and *Grapholitha funebrana* on plums with pheromone glue traps in Belarus. *Journal of Fruit and Ornamental Plant Research*, 14.

Melenti, VO, Lezhenina, IP, Stankevych, SV, Shapetko, EV, Matsyura, AV, Zabrodina, IV, Filatov, MO & Molchanova, OA 2020, Entomophages of spruce bud scales (Hemiptera: Coccidae) in the Ukrainian eastern forest-steppe. *Ukrainian Journal of Ecology*, 10(6): 219-224, DOI: 10.15421/2020_285.

Popov, I, Rhyzhaya, A, Hliakouskaya, E & Kremneva, O 2020, Phytophages of linden under the conditions of Grodno Ponemany (Belarus) and Krasnodar (Russia). In *BIO Web of Conferences*, 21: 00008. EDP Sciences. DOI: https://doi.org/10.1051/bioconf/20202100008.

Turenko, V 2023, Protection of apple plantations from main pests. *Scientific Progress & Innovations*, 26(4): 60-65.

Ualiyeva, RM 2024, Monitoring of phytophages in spring wheat agrocenoses in view of applying different agrotechnological methods in the conditions of the North-East of Kazakhstan. *Bulletin of the Karaganda University Biology. Medicine. Geography Series*, 11329: 67-78. DOI: https://doi.org/10.31489/2024bmg1/67-78.

Viktorovna, VT, Vasilievna, CO, Ivanovna, DA, Yurievna, IV & Aleksandrovna, SN 2019, Protection of Sinapis alba seed crops from phytophages. *EurAsian Journal of BioSciences*, 13(2).

Zabrodina, I, Stankevych, S, Leus, V & Sirous, L 2022, Biological protection of apple-tree from apple-blossom weevil (*Anthonomus pomorum* Linnaeus, 1758). Modern trends in the development of agricultural production: problems and perspectives. Monograph. pp. 83-96, https://repo.btu.kharkov.ua//handle/123456789/44091.

Zabrodina, IV, Yevtushenko, MD, Stankevych, SV, Molchanova, OA, Baidyk, HV, Lezhenina, IP, Filatov, MO, Sirous, LY, Yushchuk, DD, Melenti, VO & Romanov, OV 2020, Ukrainian and international experience of integrated protection of apple-tree from apple-blossom weevil (*Anthonomus pomorum* Linnaeus, 1758). *Ukrainian Journal of Ecology*, 10: 277-288. DOI: 10.15421/2020_44.

ibliographic information of this paper for citing:

Tumenbayeva, N, Mombayeva, B, Kushenbekova, A, Kaliyeva, L, Mussina, M, Nurgaliyeva, G, Sarsengaliyev, R, Sarmanova, R 2024, Biological protection of black currant from phytophages, Caspian Journal of Environmental Sciences, 22: 1285-1291.