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FEATURES OF ECOLOGY OF THE COMMON SPIDER MITE AND CONTROL METHODS

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Summary

This paper is devoted to the analysis of preventive measures and effective methods of controlling spider mites of the subfamily Tetranychinae, which are serious pests of agricultural crops. The peculiarities of the ecology of the common spider mite Tetranychus urticae Koch. T. Special attention is paid to the problem of resistance of mites to insecticides and acaricides, which makes their control difficult. Our research emphasizes the importance of proper organization of preventive measures to prevent the reproduction and growth of mite populations. Emphasis is placed on the need for a combination of chemical, biological, and agronomic means to minimize the damage caused by these pests. The main chemicals used to control spider mite populations and the importance of rotating their use to prevent the development of resistance are discussed. Acaricides such as vertimec, abamectin, demitac, orthus and zoom are used for effective spider mite control. The effectiveness of control depends on the stage of mite development, mite population density and the frequency of treatments. To effectively manage the number of mites and avoid habituation of mites to drugs, it is recommended to alternate between chemical and biological means, as well as to carry out timely preventive measures and continuous monitoring of the mite population. Practical significance of the research is to offer recommendations on the selection of effective methods of control and management of spider mites, which contributes to increasing crop yields and sustainability of agricultural crops.

Keywords: *spider mite, ecology, pest, agriculture, prevention, control methods.*

Introduction. Spider mites are perceived as a minor problem in modern agriculture. However, there are many species in the family Tetranychidae that are serious pests of cultivated plants. In particular, a particularly significant species in terms of pest damage is the common spider mite *Tetranychus urticae Koch. T.*, which has a wide distribution in many agricultural crops, as well as in ornamental woody and herbaceous plants from various botanical families. Spider mites are becoming a serious control problem. The resistance of spider mites to insecticides is known, while their predators die, and that further aggravates the problem. Thus, properly organised and timely prevention and control of numerous spider mites is one of the urgent problems. The aim of this article is to study the features of the ecology of the common spider mite *Tetranychus urticae Koch. T.* and to analyse preventive measures and effective methods of its control.

Of spider mites, the most serious pest of agriculture is undoubtedly *Tetranychus urticae*, so the biology of this particular mite is studied in detail and comprehensively. The first information on the biology of *Tetranychus urticae* was obtained in the former Soviet Union by Vasiliev. Starting from the 20s, the biological study of this mite in the former Soviet Union was greatly expanded; especially fruitful work was carried out in Central Asia,where studies were carried out on a large scale [1-3].

Material and methods. Within the framework of this work we analyzed literature sources devoted to the peculiarities of the ecology of the common spider mite (*Tetranychus urticae*) and modern methods of its control. The material for the analysis was domestic and foreign scientific articles, reviews, abstracts of reports, conference materials, as well as patents available in specialized databases. The following resources were used: Web of Science, Scopus, Elsevier (Science Direct), Russian Scientific Electronic Library (eLibrary), Scien-

-entific Electronic Library (eLibrary), Scientific Electronic Library (CyberLeninka).

Information was searched using the following keywords and their combinations: “spider mite”, Tetranychus urticae, ‘pest ecology’, ‘biological control’, ‘chemical insecticides’, ‘integrated plant protection’, ‘predatory mites’, ‘acaricides’.

At the first stage of the search, abstracts and keywords of publications were analyzed to pre-select relevant studies. Then, an in-depth analysis of full texts of articles and patents was performed. The bibliography of the selected sources was examined to find additional relevant publications.

All data concerning the biology of the common spider mite, its distribution, factors affecting its abundance, and control methods (chemical, biological, agronomic and integrated) were systematized and analyzed.

Results and discussion. Peculiarities of ecology of the common spider mite *Tetranychus urticae Koch. T.*

Habitat. Spider mites live on plant leaves, where they pierce the epidermis with their chelicerae and suck tissue juices. Among the tetranychoid mites, species of the family *Tetranychidae* live on leaves mainly in groups, colonies. In other words, those that are able to make webs live in groups on leaves, while those that are not able to make webs live alone on leaves. One of the main reasons mites choose one leaf surface over another is sunlight, its direct effect on mites. Some species of mites cannot live under direct exposure to sunlight and therefore live on the lower surface of leaves. These include mainly mites of the family *Tetranychidae*.

In warm countries, individuals of all developmental phases can overwinter on evergreen plants. Wintering of adult females of some species occurs mainly on plants remaining green in winter; they can also overwinter and in cracks in the ground, under stones, under fallen leaves, under bark, in cracks of plant bark.

Many hibernating spider mites acquire the so-called ‘winter’ colour at the onset of hibernation, the reason for which many researchers find in the change of climatic and feeding conditions. Bondarenko believes that the appearance of hibernating females in the common spider mite (*T. urticae*), i.e. the appearance of mites with orange-red colouring, is not caused by a decrease in air temperature or a change in feeding conditions and other environmental factors, but mainly by a decrease in day length. He found that at the onset of a short day (14-16 hours of light per day), the mite prepares for hibernation, and at longer daylight hours the development of the mite is normal.

It seems that in nature the change of day length and the change of climatic conditions are connected with each other; when day length changes, climatic conditions almost always change, and with the change of the latter, the biochemical state of plants also changes. Therefore, the colouration of mites in general and, among others, the colouration in winter time is not the result only of the change of climatic conditions or the change of day length, but also depends on the state of food plants, i.e. on the composition of nutrients. Apparently, this also explains the fact that in many cases wintering mites of *T. urticae* living on green weeds retain their ‘summer’ colouration in winter. In the presence of favourable nutritional conditions, hibernating mites may not change to a special ‘hibernation’ state, but continue to reproduce continuously [5, 6].

The ability to excrete spiderwebs. It is known that several tetranichoid mites secrete spider webs when parasitizing on plant leaves. As it was found out, the mites of the family *Tetranychidae*. *Tetranychidae* in the majority excrete spider webs. It was also found out that some species of mites of the family *Tetranychidae* secrete web rather abundantly, others moderately, and, finally, others do not secrete it at all or secrete so insignificant amount of web that it is difficult to detect. According to observations the ability to excrete web is well expressed in representatives of genera *Tetranychus* and *Schizotetranychus*; species of genera *Neotetranychus*, *Metatetranychus* and *Parattetranychus* excrete web moderately; and in genera *Tenuipalpoides*, *Eurytetranychoides* and *Eurytetranychus* mites, apparently, excrete very little web, so that it is difficult even to establish its presence. It is possible that in the course of evolution they have lost this ability. However, it should be pointed out that there is considerable variation in web excretion ability even within the genus.

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The biological significance of spider webs is still being studied. However, it is thought that it protects the mites from some predators, from large fluctuations in temperature and humidity, from being blown by the wind and washed away by raindrops, from dust, etc. There is some evidence in the literature that the ability to produce webs appears after the second moult. There is also a suggestion that 'web threads are only produced by the adult female'. The male and larvae cannot do this", although Piontkovsky believes that "the ability to make a web is present at all stages of development, regardless of sex". Our observations have shown that individuals at all stages of postembryonic development, regardless of sex, can secrete nets. Indeed, if web secretion is a characteristic feature of mite life, and if the mite is active at all stages, then it must undoubtedly secrete webs at all stages. On the other hand, if the web were only secreted by adult females, nymphs and larvae would not be able to live without an adult female, would not be able to separate from the so-called mother colony and disperse to other leaves, live there independently and form a new colony [5, 6].

Reproduction and development. Mites reproduce by laying eggs. Eggs are laid both fertilised and unfertilised, parthenogenetically. Parthenogenesis in tetranychoid mites was first experimentally demonstrated by Vasiliev. His experiments, as well as those of some foreign authors, showed that in the cotton spider mite, only males develop from unfertilised eggs, while only females develop from fertilised eggs. Piontkovsky's experiments also confirmed that males emerge from unfertilised eggs. However, he notes that both females and males can develop from fertilised eggs apparently Piontkovsky assumed that the eggs of a fertilised female must all be fertilised, and since both females and males emerge from the clutch of such a female, he concluded that mites of both sexes can develop from fertilised eggs. It seems that not all eggs of a mated female need to be fertilised and that such a female retains the ability to lay both fertilised and unfertilised eggs. If Vasiliev's and Piontkovsky's data are correct, the phenomenon in question cannot be common to all tetranychoid mites, since there are many species among them in which the males are still unknown, but which nevertheless reproduce and produce only female off-spring [5, 6].

It was previously thought that all tetranychoid mites produce several generations during the season. In recent years it has been discovered that there are species of tetranychoid mites that produce only one generation during the summer season. Postembryonic development begins when the larva hatches from the egg. The larva has only three pairs of legs. After shedding its skin, the larva turns into a nymph with four pairs of legs. This becomes the adult form, the imago, after two subsequent moults. In other words, the postembryonic development of tetranychoid mites consists of larval, protonymphalic, deutonymphalic and imaginal phases. This development is only observed in females, while males, according to the literature, develop differently. A number of authors note that a postembryonic phase is eliminated in male development, i.e. males become sexually mature after two moults. It has been suggested that the imaginal stage is eliminated in males and that *T. urticae* males are in a deutonymphalic state. This is difficult to accept, as the number of body chetas of male tetranychoid mites is the same as that of females; the postembryonic phases of tetranychoid mites differ greatly in the number of body chetas. In other words, males fully correspond to the imaginal phase in terms of body chetum [5, 6].

In each stage, with the exception of the imaginal stage, the mite spends approximately the first half of its developmental time active, and in the second half it falls into a state of pre-larval rest. During the period of active life activity the mite moves, feeds and secretes a web, after which a new period of active life activity of the subsequent phase begins.

The duration of postembryonic development varies depending on the time of year and weather; at different times of the year there are different rates of development and longevity of generations. According to the data of Chilingaryan in Armenia, *T. urticae* produces 14-18 generations during the year, of which the shortest development lasts 7-8 days, and the longest - 21-22 days; the development of short generations was observed in July and in August during the hottest weather [5, 6].

Until recently, a number of researchers believed that the intensity of development and reproduction of *T. urticae* was regulated only by meteorological conditions - air temperature and humidity. It was found that when the temperature increases and the relative humidity decreases, the mite reproduces and develops more intensively. According to Stepantsev and Kosobutsky, a temperature of 25-29°C and a relative humidity of 40-52% are the most favourable for strong reproduction of *T. urticae*. Based on this, Uspensky considers the mass reproduction of cotton spider mite as a purely meteorological phenomenon and believes that mass reproduction occurs at a temperature of 29-30 °C and relative humidity of 35-40 %; at higher or lower values, mass reproduction allegedly does not occur [5-8].

While many researchers believe that the development process and its rates depend only on meteorological factors, other researchers have experimentally proved that fecundity and reproduction rates in tetranychoid mites depend also on nutritional conditions. Thus, Scheck, when feeding *T. urticae* on different species and varieties of plants under the same meteorological conditions, proved the existence of differences in average fecundity and life cycle of females. For example, the life cycle of a female *T. urticae* feeding on trefoil was up to 13 days, on field bindweed - 6 days and on Gossypium - 37 days. Shek in his experiments also showed that the fecundity of *T. urticae* on beans reaches 53 eggs, on field bindweed - 30, on violet - 17, on different varieties of cotton from 24 to 158 eggs. Similar data were obtained by Kosobutsky when rearing *T. urticae* on 65 different plants, 16 of which represented different cotton varieties [5-8].

So, the idea naturally arises that along with meteorological factors, which have so far been regarded as the only and universal factor determining the rate of development and reproduction of tetranychoid mites, nutritional features are of no less importance. Using his long-term observations on tetranychoid mites and analysing existing literature data, Rekk has shown the great importance of nutritional conditions in the development and reproduction of these animals. In this connection, the author gives a new explanation of the reasons for the fluctuations in the number of mites. The leading influence in the dynamics of mite numbers is attributed to the variable physiological and biochemical state of leaves of fodder plants. This conclusion is quite acceptable, since it explains the phenomena of fluctuations in the number of tetranychoid mites by the influence of not only one environmental factor, but takes them as a result of a complex factors. When considering the physiological and biochemical state of fodder plants as the main factor determining the life of mites, the importance of meteorological conditions that simultaneously affect the development and reproduction processes of tetranychoid mites is not denied. Batiashvili and Reck held the viewpoint that meteorological factors can affect mites not only directly, as earlier researchers believed, but also indirectly, through changes in plant condition. Consequently, the observed phenomena of population dynamics in tetranychoid mites are the result of many factors, including the impact of the physiological and biochemical state of forage plants, in interaction with air temperature and humidity [5-8].

Meteorological factors can have both direct and indirect effects. At the same time, the strength of their influence on different phases of development may be different. If in the postembryonic period of mites development meteorological factors at times influence mainly only indirectly, in the period of embryonic development these factors, as a rule, have a direct impact. Of course, it should not be thought that the embryonic development of mites proceeds only under the influence of meteorological factors. It should also be remembered that in addition to the ecological factors considered here, other factors remain unknown, such as biocenotic relationships, etc., which together determine the population dynamics of tetranychoid mites [5, 6].

The complex influence of not only meteorological factors but also, to a large extent, the biochemical state of the forage plants can explain that the depression of the tetranichoid mite abundance starts first on the leaves of the lower plant tiers and then spreads vertically to the upper tiers. The main reason for the vertical spread of the depression is the heterogeneity of the physiological and biochemical state of the leaves of different tiers. Variety of leaves of different layers of plants is also the main cause of vertical movement - mite infestation [5, 6].

Kurbanov's research has shown that the vertical movement of the cotton spider mite on cotton depends largely on the difference in osmotic pressure of the cell sap in different leaf layers. He found that the osmotic pressure on leaves in the upper tiers is lower than on leaves in the lower tiers, and the mite is more likely to attack leaves with lower osmotic pressure [5–8].

Some researchers consider the depression of mites to be solely the result of predator activity. Predators are undoubtedly important in the variation of tetranychoid mite numbers, but they cannot be the only factor. If mite reduction were considered solely as a result of predator activity, mite reduction would begin earlier in cotton bushes that were neither sprayed nor pollinated than in bushes that were pollinated or sprayed several times during the summer with an acaricide that kills mite predators. However, it is observed that the mite reduction starts almost simultaneously on both treated and untreated bushes.

Based on the fact that the physiological and biochemical composition of the leaves of fodder plants in some cases enhances and in other cases slows down the reproduction and development of tetranychoid mites, it seems that the time has come to find such preparations which, when introduced into the soil, would act on the mite by changing the biochemical state of the plant leaves. This method, which is a kind of 'internal therapy' for plants, is currently being tested on several pests.

The spread of mites. Mites spread in active and passive ways. The active way of settlement in the spread of mites may not be of such importance, since mites cannot move over any significant distances. The passive mode of resettlement plays an important role in the spread of spider mites over long distances. Mites can be spread by wind, water, planting material, can be carried by animals (especially birds) and by humans. Of these methods of passive resettlement, the most important role in the spread of spider mites is played by wind, planting material and man [8].

Spider mite control methods.

Settling on the bottom or the lower and upper surfaces of the leaves, mites use their chelicerae to pierce the leaf epidermis and, by inserting the latter into the cells of the polysadic or spongy parenchyma, suck their contents. In the damaged leaves, transpiration increases sharply, the water balance is disturbed, the amount of chlorophyll, xanthophyll, carotin is reduced, and the process of photosynthesis is suspended [5–8].

Mite infestation of plants leads to a general weakening of trees, reduction of yield, reduction of fruit size and colouring, as well as to weakening of fruit bud formation. Damage caused by mites in spring is especially dangerous. The damage affects the accumulation of reserve food reserves, which may serve as one of the indirect causes of frost resistance reduction. Also the damage is inflicted during the period of active growth and development of plants and affects negatively such processes as growth, formation of fruit buds and yield.

One of the main reasons for the mass reproduction of many species of plant-eating mites observed in recent years is the inappropriate, often biologically unjustified, use of new pesticides. As a result, the historically established habitat conditions of these animals are artificially changed in a direction favourable to their increased reproduction.

These changes concern biotic environmental factors: the numerical ratio of ticks and their enemies, on the one hand, and feeding conditions, on the other. At the same time, in many cases, an increase in the number of ticks may result from an increase in their fecundity, as a result of a specific reaction of the organism to the action of some drugs with physiological activity, as well as the emergence of a population resistant to acaricides.

Practical human activities aimed at the full use of natural resources to increase agricultural production eventually leads to the destruction of natural biocenoses and their replacement by artificially created, but more productive agrocenoses.

Normal life and high productivity of agrocenosis is impossible outside of artificial ecology, created using agrotechnics, i.e. with the help of a system of scientifically-based methods, the application of which affects the development of animals and plants.

In modern conditions in the fight against pests and diseases of fruit plantations the chemical method is especially widely used, the efficiency of which has sharply increased due to the rapid development of chemical science in the field of finding new pesticides.

The use of chemical method as a biologically grounded agro-approach, representing a certain system of chemical treatments of a preventive and exterminating character, aimed at simultaneous destruction of potentially more harmful species inhabiting a particular fruit plantation.

A positive solution to the issue in this regard requires not only the availability of a large variety of effective pesticides of different spectrums of action and deep knowledge of qualitative features of a particular agrocenosis, but also the ability to scientifically anticipate and timely prevent possible undesirable changes that may occur in it under the influence of constantly changing environmental conditions.

Control of spider mites in orchards is developed mainly in two directions [9–11]:

1) Use of natural enemies. The solution to the issue in this direction is not without prospects, although it is associated with certain difficulties. Preservation of the beneficial fauna requires the availability of a large variety of selective pesticides, the use of which is based on separate spraying against a very diverse composition of pests in gardens. This inevitably leads to complication of schemes and an increase in the number of treatments, as the very principle on which the use of selective poisons is based excludes the possibility of their combined application. The advantages of selective poisons will be leveled by the complex action of the compositions prepared from them, which by their nature do not differ from the action of polytoxic poisons [9–11].

It should be added that the use of selective poisons, which ensure the preservation of beneficial fauna, can only partially solve the problem.

On the one hand, the increased reproduction of mites may be not only a consequence of the absence or weak activity of natural enemies, but also of other environmental changes arising in the process of general improvement of agricultural techniques, and on the other hand, because of the discrepancy between the conditions that ensure biological equilibrium in the predator -prey system and the conditions that, from the point of view of man, should ensure maximum productivity of the plants cultivated by him [4, 7].

2) Application of acaricides. This direction is currently in the leading position and provides for the development of measures that ensure suppression of mass reproduction of spider mites with the help of chemical substances, regardless of the reasons that caused them [9–11]:

- favourable meteorological conditions;
- absence of enemies;
- changes in feeding conditions;
- emergence of resistance to acaricides, etc.

Some compounds possess acaricidal properties, chemical composition, mainly to the following groups of substances:

I. Inorganic substances:

- sulphur and its preparations.

II. Organic substances:

1) petroleum oils;

2) chlorinated terpenes:

- chlorotene, chlorphene;

3) Nitro compounds:

- DNOK, DINEX, DN-III, DINOSEB, akritcid, karatan;

4) phosphoric acid esters:

- amiton, acetoxone, vamidothione, guzathione, delnav, diazinon, carbophos, mercaptophos, methaphos, methylmercaptophos, methyl ethylthiophos, mecarbam, octamethyl, pyrazoxone, preparation M-74, preparation M-81, horog, thiophos, trition, TEPF, fak-20, phosdrin, ethion, EFN;

5) diphynyl derivatives:

- azobenzene, genitol, dimite, keltane, chlorobenzide;

6) quinoxaline derivatives [9–11].

Spraying with chemical preparations of plants against spider mites, living mainly on the upper surface of leaves, should be carried out from all sides, but mainly from above, so that mites had maximum contact with acaricide [5].

By the peculiarities of biology and the

time of appearance in tree crowns of the stages of development of mites and other pests vulnerable to chemical control, their control is carried out, advantageously, in early spring, spring and summer seasons [12].

Early spring season. Before the beginning of vegetation, hibernating eggs of spring mite species and females of summer mite species are found in tree crowns. Destruction of a considerable part of the former can be achieved by thorough spraying of trees with winter ovicides. Especially effective for this purpose is the use of 4 percent emulsion of petroleum oils activated with DNOC (0.5 %). As for hibernating females of summer species, the latter, being located in bark cracks and under its peeling areas, are mostly inaccessible for modern acaricides and their control should be provided during the growing season.

Spring season. During this period, control is aimed at destroying larvae of spring species emerging from overwintering eggs and egg-laying females of summer species leaving their hibernation sites. In case of correct selection of acaricides, timely and qualitative spraying, these species are suppressed so strongly that during the subsequent part of the season, their control can be resolved by one or two preventive treatments. The most favourable time for spraying lies within a relatively short period between the end of the hatching of larvae from overwintering eggs and the emergence of adult females that have not yet laid eggs. This period is established by direct observation of larvae hatching, but can be determined based on phenological condition of fruit trees. In the latter case, the signal for spraying is the beginning of bud pinking in apple trees or the end of flowering of plum, pear, cherry and peach. The applied acaricide should not only ensure the destruction of active stages of the animal present in the tree crown at the moment of spraying but also have a certain duration of action, which should not be shorter than the period of larvae hatching from overwintering eggs that have not yet finished development.

Summer season. With the timely and high-quality application of acaricides in spring, the number of mites usually decreases so much that subsequent, one- or two fold spraying with ovolarvicides, combined with DDT or sevin spraying against apple moths, completely excludes the possibility of their serious reproduction. This is achieved only when the population density before each ovolarvicide treatment does not exceed one mite per leaf. In conditions of higher initial infestation, ovoimagocides or ovolarvicides should be used, but with the obligatory addition of contact or systemic imagocides to the latter. It should be taken into account that of all the above-mentioned acaricides, the highest effect can be obtained with the use of fencapton. In summer, taking into account the peculiarities of mite development, spraying is carried out in such a way that during the whole possible period of their reproduction leaves would be protected from infection by acaricides applied on their surface. Taking into account that the acaricidal properties of most preparations persist for 15-25 days, this goal can be achieved by 3-4 sprayings.

З. P. Pulatova investigated effective technologies of cotton crop protection against spider mite and other sucking pests. He made the following conclusions when studying effective acaricides in early spring treatment of *Gossypium* [12–14]:

1) A single early spring preventive treatment on brambles and mulberry provides a sharp reduction in the number of sucking pests, which contributes to significant prevention of infestation of cultivated crops located between brambles by these pests in the future. The measure provides at least a reduction in the multiplicity of insectoacaricidal protection by 1 time [14].

2) The following insectoacaricides can be used for preventive early spring treatment of brambles and silkworms: Nurell-d (0.3 %), Danitol (0.3 %), Karate (0.08 %), Pegasus (0.2 %), Bi-58 (0.4 %), Mitak (0.5 %), mixture of water-wetting sulphur (WSS) with Nisoran (4 + 0.02 %). The water consumption rate for tractor spraying is 500 litres/ha [14].

3) The emergence of entomophages on weeds of intercrops in spring occurs asychronously - following the pests, so their number by the 3rd decade of May has low values. Regardless of the above, the number of entomophages on the meadows after treatment decreases. Insectocaricides from

the group of organophosphorus compounds and less specific acaricides have a more active effect. At the same time, the decrease in the density of entomophagy may be due to the lack of food [6].

4) The number of entomophages in the experimental plots decreases compared to the control plots, but this decrease is proportional to the decrease in the number of sucking pests. The density of entomophages between the variants levels out by mid-July [14].

5) The following acaricides show high biological efficiency at the level of 92-98 % against spider mites: demitak (0.8-1.0 l/ha), vertimek (0.3-0.4 l/ha), grizzly (0.3-0.4 l/In Usmonov's research the effectiveness of Abamectin 3.6 % c.e. against mites was studied. During the study, they found the following: in the application against spider mites, the biological efficacy of Abamectin 3.6 % c.e. reaches the value, which has a positive evaluation of the drug against spider mites, on the seventh day after the prophylaxis of plants [12].

ha), NK-941 (0.75 l/ha), cleared keltan (2.5 l/ha), nissoran 5 % k.e. (0.2 l/ha). Against spider mite and related sucking pests: Zipac and acaridecis (1.25-1.5 l/ha), Pegasus (0.8-1.0 l/ha), Mavrik (0.4-0.5 l/ha), Hostathion (2-3 l/ha) and Dorsan-t (3.0 l/ha) [14].

6) Nissoran ovocides provide high efficiency against spider mite on cotton. Optimal rates of consumption are: for nissoran 10 % s.p. - 0.1 kg/ha; 5 % k.e. - 0.2 l/ha. In cases of mass development of spider mites can be used ovocidal-imagocidal mixtures of acaracides. For example, danitol + nissoran (1.0 + 0.1 l/ha) or neuron + nissoran (0.5 + 0.1 l/ha), which provides higher and longer effectiveness [14].

7) Carrying out a one-time early spring preventive treatment on meadowsweet and mulberry is an economically and economically justified measure [14].

As it is known, the common spider mite is one of the pests of apple trees of Red Delicious sort (Figure 1). In the studies of Mukhammadiev B.K. and Rakhmonov A.H., the development of the common spider mite on apple tree control measures was studied. As a result of their research it was proved that the following acaricides are effective against it: ortus 5 % s.c. and zum 11 % k.e. [15].

Figure 1. Common spider mite on apple tree leaves

In Usmonov's research the effectiveness of Abamectin 3.6 % c.e. against mites was studied. During the study, they found the following: in the application against spider mites, the biological efficacy of Abamectin 3.6 % c.e. reaches the value, which has a positive evaluation of the drug against spider mites, on the seventh day after the prophylaxis of plants [12].

The pest population differs depending on the dynamics of pest development and reproduction. In many works, the use of predatory mite *Phytoseiulus persimilis Athias-Henriot* [16–19] was studied to protect cucumber from common spider mite.

Mohammadali M. T. also studied the effectiveness of using the predatory mite *Phytoseiulus persimilis* in controlling spider mite [18]. He in the study determined the following: The predatory mite *Phytoseiulus persimilis* of Iraqi lineage showed high food preference for the larval stage of *T. urticae* (30.2 % of total *T. urticae*), compared to eggs (20.5 %), nymphs (13.4 %) and adults (10.1 %). However, this was not a long-term predator strategy: in a given situation, it chooses the most efficient one for survival under the given conditions, i.e. the food behavior of *Ph. persimilis* is plastic. The overall biological efficiency of using *Ph. persimilis* against *T. urticae* was 74.2 % [14]. In addition to studying the biological efficacy of the predatory mite against *T. urticae*, the use of acaricides such as мertimek, Alert, etalon-talstar was studied. As a result of his research he concluded the following: in general, all tested acaricides had reliably high biological efficacy against *T. urticae*. Vertimek at a concentration of 0.7 ml/litre and Alert at a concentration of 0.50 ml/l were the most effective, approaching 100 %. The least effective was etalon-talstar at concentrations of 1.00-1.25 ml/l [18].

Thus, modern preparations of acaricidal action include substances of both chemical and biological synthesis. Four classes of preparations are used to protect crops from mites.

- avermectin-containing preparations: aitoverm, мertemin, acarin;
- pyrethroids: clipper, talstar;
- malathion-based organophosphates: novactin, fufanon, kemifos;
- perimiphos-methyl: actellic.

Preventive measures to control spider mites consist of several agricultural methods. During the preparatory period, greenhouse structures and soil, which are the main places of winter accumulations of mites, are disinfected [19]. In protected soil, the threshold of economic harmfulness of phytophages depends on many factors [19]:

- peculiarities of the cultivation technology of the crop (on soil or low-volume substrates);
- varietal susceptibility to damage load;
- sensitivity of plants to the pesticides used;
- temperature regime in the greenhouse during a particular season;
- the cost of the product used [19].

In some cases, the concept of pest threshold does not apply from a practical point of view, especially when it comes to a complex of pests. A more important criterion is the presence of the pest and the number of its foci. Detection of primary foci is the basis for deciding whether to carry out pesticide treatment or to start colonisation by entomophages. Pesticide treatments or biocontrol releases can often be carried out for prophylactic purposes. As flock numbers increase, permanent chemical treatments are prescribed, colonisation by predators or parasites may not be effective in some cases. Therefore, continuous phytosanitary control is necessary under greenhouse conditions, as the frequency of application and treatment depends on the mite species.

In the works of Meshkov Y. I. to determine the peculiarities of application of the preparation Vermitek were determined: the preparation vertimek 18 g/l has high efficiency in the control of spider mites on cucumbers 18 g/l in the first period of cultivation [20].

In experiments at two treatments with an interval of seven days at a concentration of 0.05 %, the biological efficacy reaches its maximum value on the seventh day after the last treatment. Along with the complete death of females and nymphs of spider mites, high mortality of larvae (more than 80 %) was observed. This method of using the drug at short intervals allows it to significantly deplete the stock of the pest in the greenhouse. Thus, two-fold treatment with vertimec provides a long-lasting protective effect on plants; the number of spider mites does not reach the initial level within 25 days [20].

The use of avermitin preparations against in the control of mites has not only a positive evaluation, but also a negative side. Consistently, mite resistance has developed during control, which has led to the elimination of many effective drugs from the system of long-used remedies. Consequently, this requires quick decisions regarding the introduction of new drugs, their consistent use or the replacement of pesticides that guarantee high efficacy and environmental safety [21]. Therefore, it is important to regularly monitor the sensitivity status of pesticides used for successful pest control. A marked decrease in treatment efficacy indicates either non-compliance with pesticide application rules or a decrease in pest sensitivity due to the development of resistance [21].

Kozlova E. G., Krasavina L. P., Orlova G. S. experimented to determine the possibility of expanding the range and rates of application of bitoxybacillin on ornamental crops (roses) against the highly resistant to Vertimec common spider mite. The experiment showed that the treatment of 3-fold treatment of bitoxybacillin at a concentration of 0.7% with an interval of seven days showed a biological efficacy of the last treatment of more than 90% [17]. Based on the results obtained in production conditions, it was found that within 10-15 years after the introduction of avermectins, the process of resistance formation is relatively slow, and then literally within the last 3-5 years, resistance to this drug sharply increases. An effective measure for a significant decrease in the effectiveness of avermectins in tick control is to stop treatment with them for the time of reversible resistance of ticks to them. In experiments, reversible resistance was observed for 33 generations. Resistance to fitoverm decreased 39 times, and to vertimek - 5 times. That is, already in a year avermectin preparations can be used again in those farms where highly resistant populations of spider mites were formed [21]. Consequently, suspension of the process of resistance development to avermectins is achieved by substitution with other drugs of biological or chemical origin. This makes it possible to coordinate the temporary contact of spider mites with the pesticide during the season, which slows down the process of resistance development and ensures the long-term effectiveness of the acaricide [21, 22].

Based on the above, the following conclusions were obtained:

- means and methods of spider mite control are selected depending on the biological and ecological features of their species and the characteristics of the host plant;
- control is carried out with the use of acaricides, as well as with the introduction of populations of natural enemies to regulate the number of mites;
- during the analysis of researchers' materials the most effective acaricides used against spider mites is Vertimek;
- the amount of applied acaricides depends on biological and ecological features of the spider mite, e.g. biological development of the spider mite.

Conclusion. The subfamily *Tetranychinae* mites are polyphagous. The mites, combined with their high reproductive rate, make them serious pests of agricultural crops in outdoor and indoor environments. Mites of the subfamily *Tetranychinae* are very widespread, as many species of this subfamily are found in ornamental and agricultural crops worldwide. One of the most common species is the common spider mite. Therefore, to this day, work is still being carried out to identify effective methods to control them.

The effectiveness of methods to control spider mites depends on the stage of development, the density of the mite population, and the frequency of acaricide treatments. According to scientific materials, the following effective preparations are used in the fight against the common spider mites: vertimek, abamectin, demitak, orthus, zoom.

A successful system of struggle against spider mite depends not only on the effectiveness of the drug to this type of population, but also on the repeated reversal of this drug. But to avoid getting used to the drug, you should not treat repeatedly with the same drug for a long time. Therefore, it is necessary to alternate between chemical and biological preparations in pest control, and timely preventive measures are the key to effectiveness against pests.

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Кәдімгі өрмекші кене экологиясының ерекшеліктері және онымен күресу әдістері

Аңдатпа

Бұл жұмыс ауыл шаруашылығы дақылдарының ауру зиянкестері болып табылатын Tetranychinae тұқымдас асты өрмекші кенелерімен күресудің алдын алу шаралары мен тиімді әдістерін талдауға арналған. Зерттеуде Tetranychus urticae Koch T. қарапайым өрмекші кенесінің экологиясының ерекшеліктерін қарастырылған. Кенелердің инсектицидтер мен акарицидтерге төзімділігі оларды бақылауға қиындататын мәселесіне ерекше назар *аударылады. Жұмыс кене популяциясының көбеюі мен өсуін болдырмау үшін алдын алу шараларын дұрыс ұйымдастырудың маңыздылығын көрсетеді. Бұл зиянкестерге келтірілген зиянды азайту үшін химиялық, биологиялық және агротехникалық құралдарды біріктіру қажеттілігіне баса назар аударылады. Өрмекші кенелердің популяциясын бақылау үшін қолданылатын негізгі химиялық препараттар және төзімділіктің дамуын болдырмау үшін оларды пайдалануды айналдырудың маңыздылығы талқыланады. Өрмекші кенелермен тиімді күресу үшін вертимек, абамектин, демитак, ортус және зум сияқты акарицидтер қолданылады. Күресудің тиімділігі кенелердің даму сатысына, олардың популяциясының тығыздығына және емдеу жиілігіне байланысты. Сандарды тиімді басқару және кенелердің препараттарға тәуелділігін болдырмау үшін химиялық және биологиялық агенттерді кезектестіру, сондай-ақ уақтылы алдын алу шараларын және кене популяциясын үнемі бақылау ұсынылады. Жұмыстың практикалық маңыздылығы дақылдардың өнімділігі мен тұрақтылығын арттыруға ықпал ететін өрмекші кенелерді бақылау мен бақылаудың тиімді әдістерін таңдау бойынша ұсыныстар беру болып табылады.*

Түйінді сөздер: *өрмекші кене, экология, зиянкес, ауыл шаруашылығы, алдын алу, бақылау әдістері*

Материал баспаға 03.11.24 түсті

Особенности экологии обыкновенного паутинного клеща и методы борьбы с ним

Аннотация

Данная работа посвящена анализу профилактических мер и эффективных методов борьбы с паутинными клещами подсемейства Tetranychinae, которые являются серьезными вредителями сельскохозяйственных культур. В работе рассматриваются особенности экологии обыкновенного паутинного клеща устойчивости клещей к инсектицидам и акарицидам, что делает борьбу с ними трудной. В работе подчеркивается важность правильной организации профилактических мер для предотвращения размножения и роста популяций клещей. Акцент делается на необходимости сочетания химических, биологических и агротехнических средств для минимизации вреда, причиняемого этим вредителям. Обсуждаются основные химические препараты, применяемые для контроля за популяциями паутинных клещей, и важность ротации их использования для предотвращения развития резистентности. Для эффективной борьбы с паутинным клещом используются акарициды, такие как вертимек, абамектин, демитак, ортус и зум. Эффективность борьбы зависит от стадии развития клещей, плотности их популяции и кратности обработок. Для эффективного управления численностью и избежания привыкания клещей к препаратам, рекомендуется чередовать химические и биологические средства, а также проводить своевременные профилактические меры и постоянный мониторинга популяции клещей. Практическая значимость работы заключается в предложении рекомендаций по выбору эффективных методов контроля и борьбы с паутинными клещами, что способствует повышению урожайности и устойчивости сельскохозяйственных культур.

Ключевые слова: *паутинный клещ, экология, вредитель, сельское хозяйство, профилактика, методы борьбы*

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Authors' contribution. The largest contribution is distributed as follows:

N.Zh. Akimbekova– idea of the work, general supervision of the work, detailed description, writing the conclusion.

Z.M. Sergazinova – writing the introduction, analysis of literary sources, participation in the interpretation of the research results.

G.K. Amanova – writing the abstract, processing the research results, editing the final version of the manuscript.

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