

PLANT PROTECTION METHODS IN ORGANIC FARMING

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Abstract

Today, producers generally aim to increase product quality and diversify, but ultimately increase efficiency. On the other hand, when the negative effects of chemical pollution in nature is in consideration, the producer can't harvest all of the produced crops, but they harvest the crops that aren't consumed by diseases and pests. The increasing human movement and trade in the world in the last few hundred years has facilitated the transfer of harmful organisms from one geographical region to another. It is estimated that there are about 20 thousands potentially harmful organisms on the globe today. However, 5 thousands of these are known to be harmful to plants. In Turkey, 6 hundreds of these organisms cause economic damage. However, in 2011, according to the records of the Department of Phytosanitary and Quarantine in the General Directorate of Food and Control (GKGM), it was determined that there were around 470 harmful organisms in Turkey, and 350 of them had technical instructions and were combated. In other words, the number of harmful organisms that threat plant health is generally increasing. Even before there was no Ministry of Agriculture in Turkey, the fight against phylloxera started and the legislation and physical infrastructures were established due to the obligation to fight against pests. However, the last 100 years of pest control studies in plant production have revealed that the fight against harmful organisms is not sustainable when only chemical control measures are taken. Because faulty or excessive chemical applications sometimes cause irreversible damages to the ecosystems, cultivation areas, water sources, human health and food chains. For this reason, it is needed to include alternative control measures, such as biotechnical and biological controls, perhaps even more so, methods such as genetic control.

Keywords: Organic Farming, Biological Control, Environmental Protection.

1. INTRODUCTION

Efficiency and production increase has been a main target in the agricultural production, which has been assigned to supply the increasing food demand. Ensuring product safety, production amount, protecting natural resources, human and environmental health remained in the secondary concern. In order to obtain the highest yield from the unit area, the risk of sustainable agriculture has emerged with the intensive application of harmful chemicals, soil erosion and groundwater pollution (Turhan, 2005; Bulut and Gökalp, 2022).

As a result of the emergence of the risk in sustainable agriculture, the production methods that are compatible with the environment and reducing the production costs have been investigated. New guest production systems such as integrated production, sustainable agriculture, ecological or biological agriculture are being developed to create a structure to make it healthy (Kadıoğlu, 2012).

In order to prevent crop losses due to disease, pest and weed infestation, alternative control measures and safe chemicals that can be used in organic agriculture must be used to reduce harmful chemical contaminations as long as possible (Bulut & Arslan, 2021).

Crop protection is the methods applied to reduce the population levels of diseases, pests, weeds, and other harmful organisms below the economic damage level in order to prevent or reduce yield losses. In order to achieve this goal, first of all, the natural balance and the economic damage threshold are taken into consideration. In crop protection, it is the basic principle to keep pest populations below the economic damage level for as long as possible without disturbing the natural balance (Kadioğlu, 2012).

In the crop protection, methods that prevent contamination or reproduction of pests to prevent crop damage with minimum input considering environment balance and human health. These methods are legal techniques, chemical, cultural and mechanical control measures. In the event that pests are a problem despite taking protective measures, environmentally friendly methods of control measures such as mechanical, biotechnical, biological methods and organic or inorganic chemicals that are allowed to be used can be applied to control the problem pests (Tanrikulu, 2019).

2. METHODS USED FOR CROP PROTECTION IN ORGANIC AGRICULTURE (Active)

The problems caused by pesticides such as disrupting the natural balance, creating health problems, polluting the environment and becoming ineffective over time, have led to take great attention on biological control measures. The main problem of biological control measures is cheap production on a large scale and the introduction of the antagonist to the plant. The developments to be achieved in these matters will constitute the most important contribution that can be made the biological control more effective in the coming decade (Altikat et al. 2013). Control measures that can be used against all pests in Turkey are included in the Agricultural Protection Technical Instructions of the Ministry of Agriculture and Rural Affairs (Anonymous, 2008; Anonymous, 2017). These instructions include the methods of control to be applied and the biology of pests, diseases (fungus, bacteria, viruses and other microorganisms), mammals, birds and weeds. In these technical instructions, all control methods, except chemical control, can also be applied in organic agriculture.

2.1. Cultural Measures

Cultural measures are defined as the protection of crop products from pests by the implementation of breeding processes that make it difficult for pests to survive, reduce or prevent their reproduction. The aim here is not to kill or stop the pest, but to protect the crop products from the damage of the pests by preventing the pest infection or reproduction of pest on the crop with the taken precautions. In order to be able to use this method as a control method against pests, the habitat, life cycle, feeding and survival behaviors of the pests should be well studied. Contamination of the pest to the organic farming area can be prevented or the population of the pests can be destroyed by considering the known characteristics of the pests, catching the weak moment of the pest and using methods against the behavior of the pests by (Kadioğlu, 2012).

2.2. Prevention of Pest Contamination

Reproduction organs of plants (seeds, seedlings and saplings) must be free of pests. At the beginning of the growing period, the reproduction organs should be checked for pests carried. If any pest is found, physical, mechanical control methods or organic toxins should be applied. If there is no control method that can be used in organic agriculture against the problem pest, these reproduction organs should not be used for organic crop production. Necessary precautions should

be taken to prevent contamination during crop production in the field, garden or greenhouse. Diseased plants and plant parts should be collected and destroyed during production. Harvested plants should not be left in the field, and they should be rooted, collected and destroyed. In greenhouse cultivation, the entrance of the pest should be prevented by stretching mesh to the ventilation openings. It should be taken into account that mesh will also prevent the entry of natural predators.

The disposal process in organic agriculture can be carried out by using the plant or its residues in composting. Thus, the biological cycle will be ensured and the residues will be reused. However, it should be ensured that pests on plants residues are killed in composting. Destroying the overwintering and breeding environments of insects is important in reducing their populations. Moreover; if farm manures, which have an important source in the transportation of weed seeds, are used, they must be well matured. The soil should not be contaminated with soil-borne pests such as fungi, bacteria, viruses and nematodes. Contaminated soils should be transported by irrigation or water running (Anonymous, 2008).

2.3. Healthy Plants Growing

Since vigorous and healthy crops will be more resistant to pests, and pests can hardly feed on such crops and reproduce less. In order for the crops to grow healthy, their demands such as suitable soil structure, irrigation and nutrients must be supplied. Adequate maintenance techniques such as tillage, pruning, watering or fertilizing should be done on time while considering the crop demands, control measures for problem pests should be applied (Anonymous, 2008).

2.3.1. Cultivation in Suitable Place

Every crop requires a suitable soil type, and climate for healthy and vigorous growth. Soil structure is the most important factor for crops to grow in a healthy way and to produce quality products. Crop plants should be selected and grown according to the soil structure and pH. These features take an important place for soil born pest control or pest that spend some periods in the soil. Because, every pest species also requires special soil structure and pH. In field selection, choices should be made in accordance with the requirement of the crop and not in accordance with the requirement of the pest. Taking these conditions into account, pests such as *Eurygaster* species, potato beetle, beet fly, May cockchafer, and diseases such as root knot nematode can be controlled more easily in crop production (Anonymous, 2008; Kadioğlu, 2012).

2.3.2. Tillage

Cultivating the soil with various methods, times and depths is an important cultural measure. Soil tillage accelerates the development of plants, ensures that the root system develops well and ensures that the plants are healthy and strong. For pest control, plowing at a depth of at least 10 cm twice after harvest or cultivating even deeper is an important method for pest control. Pests that come to the soil surface with tillage are exterminated by exposure to climatic conditions such as sun, precipitation or wind or by being eaten by predatory insects, birds and some other living things (Aykas et al. 2005).

2.3.3. Fertilization

Especially in intensive agriculture, nutrients needed by crop plants and missing in the soil should be given by fertilization. Thus, healthy and vigorous growth of the crop plant is ensured. Fertilization should be done in a balanced way. Diseases and pests can be a problem in an unbalanced fertilization, as well as physiological disorders cause product loss. Nitrogen fertilizers increase the development of the green parts of the plants and cause an increase in the amount of water in the cells of the plant. Thus, insects with sap-feeding stinging-sucking mouthparts such as aphids, bark

lice and thrips proliferate excessively (Anonymous, 2010; Anonymous, 2017). Phosphorus fertilizers encourage generative development in crop plants. Together with potassium, it provides increased resistance to insects, especially those with stinging-sucking mouthparts. Lime or lime fertilizers remove soil acidity. Intermediate agriculture with crop plants such as vetch, broad beans, peas is recommended as it fertilizes the soil and provides shelter for beneficial. If farm manure is to be used, this manure must be well matured. Because many weed seeds can be transported to the garden with fresh farm manure (Öztürk, et al. 2012; Akkeçeci & Özkan, 2022).

2.3.4. Irrigation and Drainage

The water regime can inhibit the growth of some insects while encouraging that of others. Therefore, the relationship between the sensitive period of insects and the water system can be used for combating purposes. Soil-borne diseases are an important problem in water-retaining soils or sections. For this reason, in order to prevent the accumulation of water in orchards and vegetable gardens, drainage and aeration of the soil should be provided. Drip irrigation should be done in orchards or vegetables where soil-borne diseases are a problem. Irrigation water and fertilizers should be given to the crown of the trees, not to the root collar. With proper irrigation, the cracks in the soil are prevented and the field surface remains moist. Thus, adults and larvae are prevented from entering the soil. On the contrary, when irrigated incorrectly, the soil becomes compacted, the pest easily enters the soil through the cracks formed and lays the tubers. Some pests prefer excessively moist soils. In the light of this information, irrigation and water management are important in organic farming (Demir & Doğan Demir, 2021).

2.3.5. Low Density Cultivation

Low density cultivation ensures strong and vigorous development, good ventilation and prevents moisture accumulation, as a result of plants taking more nutrients from the unit area. Pests such as aphids, whitefly, mealybugs and bark lice like moisture and therefore plants are more affected by these pests in areas with high humidity. For this reason, low crop population is recommended in areas where pests that can live in high humidity conditions are a constant problem. The distance between plants determines the relative growth rate of a plant, the pest population, and the probability of the pest finding the plant or laying eggs. It is known that plant density will be used in organic farming in plant protection, especially in cases such as weed growth (Bulut et al. 2010; Öztürk, et al. 2012).

2.3.6. Rejuvenation and Pruning

Normal pruning of perennial plants such as fruit trees and excessive pruning for rejuvenation cause the plants to develop vigorously and thus to be less affected by pests. Rejuvenation, and especially pruning, is a cultural measure that also reduces pest populations, as it ensures the removal of infested plant parts (Ames, 2019).

2.4. Growing Resistant Plant Species and Varieties

Each crop is differently affected by different pest species. This difference is due to the different resistance of the cultivated crop variety to pests. By taking advantage of this, it is possible to protect the crop from pests by cultivating resistant varieties. Some crops are not preferred by pests because their structures are not suitable for the behavior of pests such as feeding, laying eggs and sheltering. Hairy plants, being covered with a wax layer, color, smell and taste may be features that some insects do not prefer. Plants with these characteristics can be grown to protect them from insect damage. Some crops are resistant, since they contain special toxic compounds that may adversely affect the biological activities of the pests, or they do not contain enough nutrients necessary for pests. In the light of the explanations made above, the use of resistant crop species and varieties is

recommended in terms of biological control in organic farming within the framework of national legislation (Anonymous, 2010).

2.5. Adjusting the Sowing and Planting Time

It is possible to prevent some pests from laying eggs by planting the plant early or late, or to coincide with the period when the pest is sensitive to the period when the insect has not yet present or its population has not increased. In Europe, aphid damage is kept low by sowing winter barley and wheat in autumn. When the pests of the beans planted early in the fall occur, the plant tissues are hardened and the development is completed, so the pods are easily saved from aphid damage. In the early corn sowing in the Black Sea region, contamination of corn worms is 90%, while it is 35% in timely sown corn and there is no contamination in the late sowing. The second generation of corn worm transmission is more common in late sowing than early sowing. Legume seed beetles damage is less in late sown beans. As can be seen from all these practices, it is important to adjust the sowing and planting time in biological control in organic farming (Öztemiz, 2008).

2.6. Harvest Time and Shape

Harvesting can prevent damage to a plant before the damage of the pest begins. For example, when the wheat stalk harvest is delayed, the damage will be great because the larva cuts the wheat stalks and all the grains will be dropped onto the soil. Early sowing in cotton and the resultant early harvest provide less pink worm damage in cotton. Harvesting the crops early can reduce the damage to the *Eurygaster* spp. Early harvesting of beans and corn helps to avoid bean mite and maize aphid damage. In the combat against the potato moth, harvesting on time is the most important cultural measure to remove the tubers from the soil and the field. The clover proboscis damages the crop up to the first cut. For this reason, it is beneficial to do the first cut 10-15 days early. In order to reduce beetle damage, pea seed should be harvested as soon as the crop is ripe. The same is true for beans. By harvesting some crops in strips and periodically, the natural enemies in this area can be protected, and they can be transferred to other crops and a balanced coexistence in the crops can be ensured (Güçlü et al. 1997; Özcan & Yazıcıoğlu, 2013).

2.7. Crop Rotation

Some crops can be more damaged by pests. For this reason, growing the same crop for years in a region can lead to an excessive increase in the pest population that attacks that crop. In some cases, the population of problem weeds can increase. Soil, with the presence of adequate mineral nutrients in it, ensures that crops grow, develop, and do not become bushy or undersized. With a suitable fertilization to the soil, it is possible to harden the crop and increase its resistance against insect attacks. Damages caused to a crop by an insect or a fungus may be favorable or unfavorable for the development of another pest. For example, it is known that rust-infected wheat is searched by grasshoppers. By cultivating crops in rotation at regular intervals, excessive reproduction of pests specific to a crop is prevented and therefore, excessive damage of the crops is reduced (Tanrikulu, 2019; Bulut & Arslan, 2021; Bulut, 2023a; Bulut, 2023b). Alternation of crops is a method that is applied especially against underground pests and successful results are obtained. For example, it is an important agricultural warfare method recommended against underground pests such as nematodes, wireworms, chafers, and soil-borne diseases. For this reason, the rotation program should be created by taking into account the pests while creating the rotation program. The main principle in crop rotation is to activate the non-host plants in order to reduce or destroy the pest that has become a problem. It may be inconvenient to cultivate its host in the adjacent field (Aykas et al. 2005; Tanrikulu, 2019).

2.8. Trap Plants

Cultivation of the crops that the pests like and prefer attracts the pests, the pests are collected on these crops and it is easy to destroy them. This method is important especially in terms of sheltering and maintaining biological warfare organisms (Güçlü et al. 1997).

2.8.1. Cover Crops

Cover crops are grown in organic farming to protect soil, adjust temperature, humidity and light, or for other reasons. In pest management, natural balance can be achieved by growing cover crops with a selection and cropping plan made by taking into account the features that increase the density of natural enemies and reduce the density of the pest. The native flora should be given priority when choosing a cover crop. Because, this allows the proliferation of natural enemies that have adapted to the environment. Cultivation, mowing or plowing of cover crops should be done in a way that supports the natural enemy population and reduces the harmful pest population (Özeker & Ulutürk, 2006; Aykas et al. 2010).

2.8.2. Removal of Plant Residues and Weeds

In the pest control, it is of great importance to destroy the plant residues left in the field after harvest. Because, the residues on the field surface provide wintering and sheltering places for many pests. For example, in the winter, the corn worm survives in the corn stalks left in the field. The pink wolf survives in the unopened cotton fruits in the winter, unopened cotton fruits left in the field or spilled on the ground must be destroyed, crushed and buried with a plow in order to reduce populations of the pests. It is also important to burn these residues in some cases. However, burning them should not be preferred, as their natural enemies are also destroyed. The weed control in gardens and fields, a control measures should be done by mowing, hoeing or tilling. It is also possible to destroy weeds by burning, but this should be done in a suitable area outside the field. Weeds should be destroyed by hoeing or plucking until the critical period passes. In addition, weeds at the edge of the field should be controlled for pests and natural enemies. If there are no pests and natural enemies, they should be mowed without setting seeds or pulled by hand (Öztemiz, 2008).

2.9. Mechanical Control

Mechanical control is a type of control measure using hands or tools to destroy pests or prevent them. Populations of some pests, which are densely found, can be reduced by crushing them by hand or with a wire brush. Mechanical control began to be practiced in Turkey in 1928, with the hand-picking of *Eurygaster* spp. by the farmers. Both hand-picking and burning of the Milkvetches (*Astragalus criticus* Lam.) in the winter applied until 1955. In particular, pests living in groups can be cut and collected together with the plant organs they are found in, and their damage can be prevented. It is possible to reduce the damage caused by pests with ditches, fences, covers and some scary tools. Against pigs, their damage can be prevented by digging trenches or stretching fences on the edges of the gardens. In order to prevent bird damage, the approach of birds is prevented by stretching ropes on plants or hanging some parts on these ropes in fields or gardens. Traps are trapping tools developed to take advantage of the orientation and some behaviors of insects. With the help of traps, pests can be caught in masse. Insects are attracted to certain colors, and by using them, sticky substance is applied to different flat or cylindrical traps in the same color as the insects that are attracted to, so that the insects that come here are stuck and destroyed. Different types and structures of traps are used for mice and mole rats (Öztemiz, 2008).

2.10. Physical Control

The practices aimed at destroying the pests or reducing their activities by changing the physical properties of the environment in which the pests live is called physical control. Hot air treatment is

applied against insects that damage stored products. Pests are killed by placing the grain in ovens or ovens at a temperature of 52-55 °C. Before planting in nurseries and greenhouses, underground organs such as tubers, roots, onions or reproduction organs such as cuttings, saplings and seeds can be destroyed by keeping them in hot water for a certain period of time. While doing this, care must be taken to preserve the vitality of the plant organs while killing the pests. For this purpose, developed steam boilers are used. This is a general sterilization method applied especially in flower and vegetable nurseries and greenhouses. Thus, many pests can be destroyed (Aksu Altun, 2022). On the other hand, it is possible to control soil pathogens, nematodes, soil insects and weeds by disinfecting the soil with the help of the heat created by solar radiation. It can be used in the control of some insects, as low temperatures reduce or stop the living and reproduction activities of pests. In addition, when plants or soil are left under water for a while, especially some of the underground pests die (Aksu Altun, 2022).

2.11. Biotechnical Control Methods

Feeding, mating, defense, hiding, escaping, etc. are some secretions that are effective on pest behaviors. These are called pheromones. According to their functions and especially their biological activities, pheromones are called mating or sex pheromones, alarm pheromones, aphrodisiac pheromones, aggregation pheromones, trace-signal pheromones, and queen rearing pheromones. Biotechnical methods are used pheromones to control insect that are produced naturally or artificially and applied in a way that disrupts the biology, physiology or behavior of pests. Pheromones are used directly or indirectly in pest control. Pheromones are indirectly used to determine the time of war by monitoring the pest population. It is used in direct control with mass trapping or preventing mating or applying pheromone + pesticide (Anonymous, 2017).

3. BIOLOGICAL CONTROL

Other living organisms that feed on the pests of cultivated crops are called natural enemies. The use of these in the control of pests is also called biological control. In biological control, first of all, necessary measures should be taken to recognize pests and natural enemies, and to increase their effectiveness by protecting natural enemies while controlling pests (Öztemiz, 2008).

3.1. Increasing the Activity of Natural Enemies

In order to increase the effectiveness of natural enemies, their density can be increased by knowing the factors affecting them and using these elements in favor of natural enemies. Climate is the most important factor for the survival of both harmful and natural enemies. The presence of under stones, leaf debris and plants where natural enemies can take shelter in hot and dry, cold and rainy weather in an area allows them to continue their lives. Climate elements are especially important for natural enemies brought from other ecologies and used. It is the most important factor limiting their survival and the continuation of their offspring (Öztemiz, 2008).

3.2. Release of Natural Enemies

Appropriate species of predators are produced and released into cropping areas to increase the natural enemy densities. For this, first of all, native natural enemies are used. However, if this is not possible, it is used by bringing natural enemies that are naturally effective in other countries. After the natural enemies are released, they should be monitored continuously and their effectiveness and population should be checked (Anonymous, 2010).

4. CHEMICAL CONTROL (Passive)

Organic and inorganic chemicals allowed to be used in organic farming are determined by international organic agriculture organizations and vary according to the countries where the product is sold. The principles that must be followed at different stages in organic farming in Turkey, 'Regulation on the Production of Plant and Animal Products by Ecological Methods', came into law by being published in the Official Newspaper dated 24 December 1994 and numbered 22145. In this regulation, pesticides that can be used in organic farming in Turkey are included (Anonymous, 2010). In Turkey, organic pesticides such as garlic, euphorbia and soap are used by producers in organic crop production. However, their environmental impact is unknown. Licensed products have started to take their place in the market in recent years. The effect of the licensed products, the way of use such as the duration of effect, the effect on the environment are mostly known and can be used safely.

Comparison of Natural Insecticides of Herbal Origin with Synthetic Insecticides;

Today, plant-based insecticides constitute 1% of the world market and annual sales increase by 10-15% every year due to the preference of organic products. As a result of the unconscious use of synthetic insecticides, pests have become resistant, and human and environmental health have been adversely affected. For this reason, interest in plant-based insecticides has gained importance again and studies on this subject have increased in recent years. Plant-based natural insecticides are compounds that are obtained from plants by various methods and show insecticidal properties. These substances can be in forms such as raw plant materials, plant extracts, and pure compounds isolated from plants. Today, there are insecticides used in organic agriculture for this purpose, and those used within the framework of the legislation are specified in the regulation (Anonymous, 2010).

5. CONCLUSION

Growing healthy and vigorous plants in a healthy agricultural environment is the basic principle in organic agriculture. Crop protection in organic farming can be seen as the art of establishing a suitable production management that reduces the density of pests in the enterprise or prevents their contamination or encourages the increase of the density of other organisms with which it competes. In a healthy agricultural environment, pests will not be a problem. However, due to changes in climate factors such as temperature or humidity, extreme deviations, mistakes in agricultural practices or deterioration of natural vegetation, the natural balance may be disturbed and problems with pests may arise. In order not to encounter such a problem, a production pattern should be created in which natural fauna and flora will continue to live in harmony as much as possible without disturbing them. It is especially important to preserve the natural vegetation as much as possible.

Attention and priority should be given to local varieties known to be more resistant to diseases and pests in production. A production and crop rotation system should be established by taking into account the diseases, pests and weeds in the crops grown in a production period and the natural enemies fed by them. While doing this, species or varieties that are sensitive to pests that may be a problem in organic farming and those that are resistant or plants that kill, remove or reduce the density of these pests should be grown. It should be ensured that the plants that shelter or supply food for natural enemies are not included in the production system. In addition, by placing the right predator species that compete with the pests in the organic farming system in a certain order, the damage of the pests can be reduced. The most appropriate control methods should be used after the

disease outbreaks, weeds, harmful insects and natural enemies determined by surveying all plants in the field of organic farming, and after considering and evaluating the control methods that can be applied.

The most appropriate control methods should be determined after considering and evaluating the control methods to prevent weeds, harmful insects and natural enemies should be carefully chosen by surveying all plants in the field.

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