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EFFECTS OF AGRICULTURAL POLLUTING FACTORS ON THE ENVIRONMENT

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ABSTRACT

Some practices such as fertilisation and pesticide use are carried out in order to obtain high yields in agricultural production. However, as a result of these practices, agricultural pollutants may occur as a result of incorrect agricultural practices. Problems such as water pollution, air pollution, soil pollution, nutrient imbalance, salination in soils, eutrophication in waters, beneficial microorganisms in soils and damage to human and animal health occur due to faulty fertilisation and pesticide applications, misuse of agricultural soils, and inaccuracies in the disposal of plastic wastes. In this study, the literature on agricultural polluting factors was examined and it was aimed to raise awareness about agricultural pollution by explaining the harms of agricultural polluting factors to the environment and the health of living beings and by trying to offer solutions. Within the scope of this targeted awareness, this study; It is aimed to raise the awareness of producers in future production processes and to provide a stepping stone for scientific studies on this subject.

Keywords: *polluting factors, fertilizer, pesticides, environmental health, plastic waste, waste management*

INTRODUCTION

Agricultural activities have been very important for life for centuries. Over time, agricultural operations have developed gradually. In addition, new developments in agriculture have caused some environmental negativities (Dişbudak, 2008).

The rapid increase in the world population and the chemicals used to meet the consumption needs brought about by this population increase have reached levels that will harm the environment and human health. The increasing use of fossil fuels and the destruction of nature since the Industrial Revolution

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cause these negativities to increase. Considering that the use of fossil fuels has increased, it can be thought that the cause of global warming is the increase in greenhouse gas levels caused by fossil fuels (Korkmaz, 2007).

It is predicted that the world population will be 9 billion in 2050, so two types of nutritional problems, including access to sufficient and safe food, will gradually increase. Today, in order to meet the food demand of the increasing population, the nutritional value of food has decreased with the conventional production method in agriculture, and food security and human health have been endangered due to pesticides and fertilizer pollution (Koca and Somuncu, 2021).

While the inputs used in production cause goods output, they also cause environmental pollution. In our country, a significant amount of agricultural production is realized every year and large economic gains are obtained from the export of these agricultural productions. However, incorrect fertilizer and pesticide applications are very harmful to both human and environmental health and also cause economic losses (Parlakay *et al.,* 2015).

Agricultural production has an impact on the environment in many areas. While the development of agriculture in a region causes positive effects on nature, excessive use of chemicals during production causes some environmental negativities (Karaer and Gürlük, 2003). Greenhouse cultivation involves the use of more water, pesticides, fertilizers and energy than open field cultivation. As a result, more waste is generated and carbon emissions increase (Baytorun and Gügercin, 2015).

In this study, the effects of chemicals used to increase yield and quality during agricultural activities on the environment and human health were tried to be explained. In this context, the effects of pesticide use, fertilizer applications and other agricultural pollutants such as plastics in agricultural production were tried to be emphasized. The literature on this subject has been examined and it is aimed to provide a stepping stone for further studies. In addition, it is aimed to raise awareness by trying to provide solutions to reduce agricultural pollutant factors.

PESTICIDE POLLUTION

The continuous use of pesticides and chemical fertilizers is harmful to environmental health. This situation negatively affects agricultural production and has a negative impact on both environmental health and human health over time (Wilson and Tisdell, 2001).

In crop production, pesticides are generally preferred against diseases, pests and weeds. When pesticides are not used, losses of up to 60% of the products occur. For this reason, pesticide application is mandatory against harmful organisms that cause crop loss (Tiryaki *et al*., 2010).

Pesticides used in crop production are transferred to air, water and soil and then to living organisms in these environments. The movement of a pesticide in the environment is influenced by factors such as its chemical structure, physical properties, formulation type, application method, climate and agricultural conditions. Pesticides are preferred all over the world to protect agricultural products from pests, diseases and weeds and to obtain quality products, and as a result, some problems occur in terms of human, animal and environmental health (Yıldırım, 2008). The problem with

pesticides is that there is no reliable information on the stage and rate at which they enter the food chain. For example, farm animals consume and digest plants contaminated with pesticides and pesticide residues turn into "gout" bacteria. Since humans consume these animals as food, there is a possibility that chemicals may accumulate in the human body (Karaer and Gürlük, 2003).

Not all of the pesticides used in agricultural production are used by plants; while 30% of these pesticides can be used by plants, 70% of them are transmitted to ecological environments by wind, rain and irrigation (Aydın, 2002; Alper, 2010).

One of the most important outcomes of pesticide use is its negative effects on human health (Lin *et al*., 2022). Among these, it is known in the literature that it causes acute diseases (fatigue, headache, nausea, excessive sweating, visual impairment, tremors, body aches, skin disorders) and chronic diseases by weakening the immune system, even if the amount of exposure is low.Epidemiological studies on chronic diseases show that hormone-related cancer risks are related to the amount of pesticide exposure. Studies have found high levels of pesticide residue in oil samples taken from women with breast cancer (Kayişoğlu and Türksoy, 2023). In an epidemiological study conducted in Spain, it was reported that 80% of 2661 breast cancer cases were caused by high pesticide exposure (Leong *et al.,* 2020). Another disease caused by pesticide residue exposure is neurological damage. In a study determining the risk of Parkinson's disease, a linear relationship was determined between exposure to herbicides and insecticides (Leong *et al.,* 2020).

Effects of Pesticide Pollution on Soil

Contamination of agricultural soils by pesticide use is a major environmental problem. The increase in accumulated pesticides makes soil pesticide studies important. Transmission and chemical changes of organic compounds in soils occur through very complex mechanisms.

These substances may have physical mechanisms such as adsorption, leaching, evaporation or volatilization, as well as biological and chemical degradation mechanisms. These processes affect bioavailability. For this reason, studies have been conducted on the functions and transformations of pesticides in soil (Yu *et al.,* 2006). Contamination with pesticides and metals reduces soil quality and has a toxic effect, thus causing environmental pollution. In recent years, some European vineyards on steep slopes have been abandoned due to dispersion of pollutants and intense soil erosion (Komárek *et al.,* 2010).

Soil, which forms a living ground for humans, animals, plants and microorganisms, is an important substance in the ecosphere. Soil is important in the ecosphere because it is a habitat for microorganisms, plants, animals and humans. In the macro plan, they are the production areas of plants. In this environment, plants produce proteins, fats and carbohydrates needed by animals and humans through photosynthesis. Microorganisms decompose the dead plant, animal and human mass in the soil and transport the main nutrients back into the ecosphere. Pesticides are applied on the plant or on the seed in the form of seed spraying or on and in the soil surface. Most of the pesticide sprayed on the plant falls into the soil. Significant damage occurs when pesticides are persistent. Soil acts as a buffer and filter for pesticides and

retains harmful substances by biological and physicochemical means (Yıldırım, 2008).

Pesticides that enter the soil undergo photochemical degradation by sunlight and biological degradation by the effects of plants, soil microorganisms and other organisms. They are adsorbed (adherence to the surface) by soil solids (clay and organic matter), desorbed (separated from the surface) or undergo chemical degradation. Pesticides absorbed into the soil are carried to the soil surface by capillary water and from there can pass into the atmosphere. The structure of the soil, organic matter content, iron and aluminum oxide content, clay type and amount, pH and dominant microorganisms present in the soil are the factors that affect these events. By keeping the pesticide in the soil, its movement and biological uptake are prevented, and by degradation in different ways, it either loses its toxic properties or turns into more toxic metabolites. It is important to know and examine these events, as it is not desirable for the pesticide itself or its toxic transformation products to contaminate non-target sites or organisms. (Altınbaş *et al.,* 2004).

There are more than one million bacteria in each gram of soil, as well as 50000 fungal particles, 100000 yeast cells, and one gram of fertile agricultural soil contains 400000 fungi, 50000 algae, 30000 protozoans and 2.5 million bacteria (Yıldırım, 2008). Soil microorganisms affect the chemical and physical structure of the soil. If they die, this effect is broken. Pesticides become harmless by being decomposed by soil microorganisms, but sometimes they prevent the positive effects of microorganisms. For example, pesticides can cause the death of worms, which play an active role in increasing soil fertility. Damage to microorganisms, animals and plants affected by pesticides causes different conditions to be encountered. In studies on pesticide use in open areas; As a result of the accumulation of insecticides, herbicides and fungicides in the soil, minor changes occur in the microbial areas. However, when pesticides are used continuously and in high doses, wide-ranging changes occur. Microbial activities such as O_2 consumption, CO_2 production, legume nodulation, growth rate and nitrification are some indicators used to measure pesticide response (Altıkat *et al.,* 2009) There are many studies showing that pesticides affect soil fertility. This situation is especially common in forest soils. Here, only pesticides are applied but the soil is not prepared and cultivated, and as a result, the population of flies, mites and worms varies greatly (Yıldırım, 2008).

Effect of Pesticide Pollution on Water Resources

There are many different ways in which pesticides can enter aquatic environments. It can occur either from area sources (such as atmospheric precipitation, farm fields) or from point sources (such as sewage or hazardous-waste-disposed sewage in various centers). It can even be transmitted over long distances by air (Filho *et al.,* 2010). Pesticides are subjected to different processes when they are present in the aquatic environment. Physical (deposition, dilution, sedimentation and diffusion), chemical (hydrolysis and oxidation) and biochemical (biodegradation, biotransport and bioaccumulation) processes lead to an increase of these highly toxic substances. Moreover, pesticide accumulation in aquatic organisms can cause many hazards (Tankiewicz *et al.,* 2010).

Water, one of our natural resources, is the basis of life. Water is the basis of basic needs such as eating, drinking and cleaning. Clean water is essential for irrigating crops and feeding livestock. The world's main source of water is groundwater. After pesticide applications, residual pesticides are washed into the soil by rainwater and surface runoff and then into groundwater and other water sources. Depending on the vegetation cover, slope, soil type, amount of precipitation and formulation, pesticides can reach groundwater. Pesticides that reach groundwater sources continue to decompose. However, due to low levels of oxygen, temperature and light, they break down to a lesser extent. When groundwater sources are contaminated, other water sources are also contaminated. Even if contamination stops, it takes many years for these water sources to clean themselves. Since it is quite expensive and difficult to clean contaminated water resources, water resources should be prevented from pollution (Yücel, 2007).

Pesticides used against insects and plants living around water resources, pesticide residues remaining on the soil surface reaching water resources and washing empty packaging containers in water resources cause pollution of these water resources (Altıkat *et al*., 2009).

Insecticide residues in water are generally insoluble and are held in suspension form in organic matter, sediments, mud, decay residues and plankton. In this way, they can pass into the food chain and accumulate in aquatic invertebrates and fish. The insecticide, which adheres to bacteria and plankton in water, settles in the food chain up to fish; It finds the highest density in fish. Higher levels are reached in creatures that feed on fish. Fish fry are very sensitive to some chemicals. Since the survival rate of many fish species is low at this point in their life cycle, the effect of pesticides may cause the population of such species to decrease (Öden, 2009).

In the study conducted by Kalyoncu *et al.* (2009) to determine the organic chlorinated pesticide residue values of 18 fish species consumed in the Konya region, 14 different types of organic chlorinated pesticides were detected in all fish species except trout, horse mackerel and bonito.

Effect of Pesticide Pollution on the Atmosphere

During the application of pesticides, some of them are lost due to evaporation and dispersion, while some remain on the plant and on the soil surface. Pesticide mixed into the air is carried by the wind; It may fall back to earth with fog and rain. Pesticides reaching non-target organisms in this way may cause toxic effects and residue (Sofuoğlu, 2009; Öğüt and Seçilmiş, 2009).

Weather; It has the ability to transmit pesticide particles over long distances. Due to this feature of the air, drift occurs during pesticide applications. Pesticides that cannot be controlled in the atmosphere pass into waterways, green areas and households; to sensitive plants, wildlife; They can harm pets and people. Factors to be taken into consideration in order to control pesticides in the air are: Use of fillers that control drift, application of the largest effective drop diameter, selection of nozzles that produce many large particles, selection of non-volatile pesticide formulations, placement of nozzles towards the air flow, preference of the lowest applicable pressure, These can be listed as spraying under appropriate wind, temperature and

humidity conditions and applying at the most appropriate proximity to the target (Altıkat *et al.,* 2009).

One of the issues that concerns society today is the use of pesticides. Many factors that will affect the distance of the target will cause drift in the target area. Even with good application technology and sufficient sensitivity, drift can cause problems for both the environment and the practitioner. In many countries, aerial spraying is limited for these reasons. In our country, aerial spraying should be avoided because agricultural areas and living areas are intertwined (Öden, 2009).

Effect of Pesticide Pollution on Food

Rapid Alert System for Food and Feed (RASFF), an open-access network that aims to provide rapid information exchange between EU countries against risks that may arise in food and feed, is used. (Hanedar *et al.,* 2023). Durmuşoğlu and Aydın (2023) examined RASFF notifications in 2019-2021. Accordingly, the number of notifications about pesticide residues in food increased from 300 in 2019 to 1200 in 2021. According to the distribution of these notifications by country, Turkey ranked first with 372 notifications in 2021. It was reported that 65% of the notifications on products originating from Turkey in 2021 were caused by pesticide residues. According to the same evaluation, among the top 10 active substances with the highest pesticide residue reported in the 2021 RASFF notifications in our country, 6 active substances are banned in the EU (Durmuşoğlu and Aydın, 2023).

Although Turkey is not at high levels in terms of pesticide use, it is known that usage values vary depending on the region. It has been reported that pesticide use is above the world average, especially in the Mediterranean Region. Almost 40% of the total insecticide use in our country is used in the Mediterranean Region. The first three provinces where pesticides are used the most are Antalya, Manisa and Adana, and the use in these three provinces is 22.75% of our country's total pesticide use. These regions are provinces where intensive agriculture is carried out, product diversity is high, and especially produce agricultural products for export (Özercan and Taşçı, 2022).

In developed countries, pesticide residues in food cause significant acute diseases. Pesticide residue levels are very low and may not always be relative. There is little information about the contribution and synergies of pesticide residues in foods to toxicological effects. However, every food we consume may contain one or more pesticides, even at very low concentrations. In a study conducted by the US Food and Drug Administration in 2001, 19 pesticide residues were found in foods. The most frequently detected ones are pesticides such as DDT, chloropyrifos-methyl, endosulfan, malathion and dieldrin. In another study, pesticide residues were found on 7,513 samples from the California department of pesticide regulation. It was determined that more than 12% of the residue levels of these pesticides were above the tolerance levels, and 68.2% were at or below the tolerance limits. In the US Department of Agriculture's pesticide program in 2001, pesticide residues were detected in bananas, carrots, broccoli, apples, cherries, cherries, celery, peas, grapes, mushrooms, lettuce, oranges, pineapples, apples, nectarines, peaches and potatoes (Hamilton and Dennis, 2004).

When purchasing toxic chemicals (such as pesticides), analysis of chemicals is essential to make comparisons between countries. Because pesticide residue values in many developed countries show that food analyzes are inevitable. These residue values are compared with toxicity criteria (acceptable daily amount-ADI) or commercial standards (maximum residue limits-MRL). While the ADI is a measure of toxicity, the MRL value is not a toxicological variable. MRL is a standard created solely by national and international authorities (such as Codex Alimentarius) to ensure sound control of food trade in the world (Watson, 2001). Maximum residue values of pesticides vary depending on the location where the sample was taken and tolerance rates. For this reason, the limit values of pesticides used for agricultural products in our country are based on pesticide and product (Akdoğan *et al.,* 2012).

Effect of Pesticide Pollution on Human Health

Pesticides have an important position in achieving sufficient food production for world markets and in modern food production. Today, the use of pesticides is widespread in many areas in order to meet the food needs of the rising world population (Shaw and Chadwick, 2002). Pesticides can also cause various toxic effects on humans if they leave a certain residue on the products they are used on. Pesticides and their active ingredients have acute toxic effects. Many pesticides, including carbamates, organophosphates and chlorinated hydrocarbons, have toxic effects. In studies conducted on people engaged in agriculture and exposed to pesticides, structural and numerical chromosome anomalies and increases in sister chromatid exchange have been detected in these individuals. In addition to many genetic damages, disorders in the liver, kidneys and muscles have been detected in agricultural workers exposed to the chronic effects of pesticides. The effects of pesticides on living things begin from fetal life. In animal experiments, it was determined that the radioactively labeled pesticide given to the mother passed through the placenta to the fetus after 5 hours and was positioned in the eye, nervous system and liver of the fetus. Organophosphate and carbamate insecticides threaten living life by showing their effects directly on the peripheral and central nervous systems (Anonymous, 2022).
Since products grown in pesticide-contaminated soil may absorb pesticide residues, transferring these residues to animals and humans may pose a health hazard (Altıkat *et al.,* 2009).

FERTILIZER POLLUTION

While chemical fertilization in agricultural production increases productivity, it can also cause some problems. The amount and time of fertilizer applied are seen as important factors in the occurrence of these problems (Sönmez *et al.,* 2008). Intensive use of chemical fertilizers damages surface and groundwater quality and the physical-chemical structures of agricultural soils (Kashem and Singh, 2002).

The negative effects of fertilizer application on surface waters are mostly caused by the excessive use of nitrogenous and partly phosphorus fertilizers. Nitrate, which mixes with water through the use of fertilizers or accumulates

in plants, is one of the main substances that cause pollution. The drinking water nitrate nitrogen limit value can be exceeded by high nitrogen losses in water sources close to areas where intensive fertilizer use is made and in soils with high infiltration capacity. For this reason, nitrogen fertilization is restricted in groundwater protection zones in many European countries (Taşkaya, 2004).

Although the harmful effects of fertilization on the environment can be evaluated as indirect and direct effects, the degree of impact and duration are more important. When more than necessary and long-term fertilizer is used; Environmental problems such as salinization in soil, heavy metal accumulation, nutrient imbalance, deterioration of microorganism activity, eutrophication and nitrate accumulation in water, release of nitrogen and sulfur-containing gases into the air, depletion of the ozone layer, and greenhouse effect begin to occur (Sönmez *et al.,* 2008).

It has been stated that chemical fertilizers are more risky than composts in terms of creating metal mobility in the soil and preventing the uptake of bio-useful metals by plants (Karpouzas *et al.,* 2005; Nakano *et al.,* 2004).

It has been determined that excessive use of phosphate fertilizers lowers the pH of the soil and causes acidification (Lambert *et al.,* 2007), and therefore trace metals dissolve more easily. In particular, the release of aluminum and manganese has a toxic effect on plants and microorganisms (Kashem and Singh, 2002; Staley and Brauer, 2006). However, since sedimentary rocks, which are phosphate fertilizer raw materials, contain high amounts of heavy metals, heavy metals are mixed into the receiving environment during production (Marrugo-Negrete *et al.,* 2017). Excessive application of potassium fertilizer disrupts the nutritional balance of plants and prevents the uptake of zinc, calcium and iron (USEPA, 2011). For this reason, the fertility of the soil and the quality of the products decrease. It is also known that some chemical fertilizers contain elements such as mercury, cadmium, chromium, arsenic, lead, copper, nickel and zinc and that these elements cause accumulation in soil and plants (Vetsch and Randall, 2002).

It is known that the use of intense amounts of nitrogenous fertilizer causes the accumulation of carcinogenic substances such as nitrate, nitrite and nitrosamines in leafy vegetables such as lettuce and spinach (Özdestan and Üren, 2010). In addition, if nitrogenous fertilizers are used excessively, the amount of nitrate in the leaves, especially in vegetables whose leaves are eaten, reaches levels that threaten human health (Atılgan *et al.,* 2007).

It is known that the use of chemical fertilizers not only has negative effects on soil and plants, but also causes air pollution. From 1970 to 2007, global Nitrogen Monoxide emissions increased by 50% (Smith *et al.,* 2007).

Fertilizer is one of the most important inputs in agricultural production. When it is not applied adequately, it causes significant losses in yield and quality, but when it is applied excessively, it causes pollution of ground and surface waters, especially by the washing of nitrogen and phosphorus fertilizer, and air pollution with nitrogen oxide emissions. The way to ensure timely and sufficient fertilization is to conduct soil analysis before fertilization. However, producers do not show the necessary sensitivity to soil analysis. Using fertilizer without soil analysis prevents the economical use of fertilizer, increases costs, reduces product quality and quantity, and harms the soil and the environment (Atılgan *et al.,* 2007).

Although the use of nitrogenous fertilizers is a necessity to meet the needs of the increasing world population, it is known that low nitrogen use efficiencies create significant environmental problems. The use of nitrogenous fertilizers leads to deterioration of soil and water quality, pollution of underground and surface water resources, air pollution, decrease in biodiversity and also increases greenhouse gas emissions. As a result, the health of not only humans but also all living things is negatively affected. For this reason, methods of increasing the use efficiency of nitrogenous fertilizers through the use of slow and controlled release fertilizers and the use of nitrification and urease inhibitors are recommended to reduce losses and nitrogen pollution from nitrogenous fertilizers (Tolay *et al.,* 2010).

EFFECT OF AGRICULTURAL ACTIVITIES ON WATER RESOURCES

Fertilizers used in agricultural areas vary depending on the structure of the soil, the plant grown and the climate of the region. After the use of fertilizer, the fertilizer used is absorbed into the planted plants, but some of it can melt and filter out with the rains and mix with groundwater or reach water resources with surface runoff. In calculating these losses due to infiltration and surface runoff, the rate at which the nutrients (nitrogen and phosphorus) in the fertilizer are absorbed by the plants is important. Although absorption rates vary depending on the structure of the soil, the plant grown and the climate of the region, it is between 40-80% for nitrogen and 5-20% for phosphorus. Losses caused by infiltration and surface runoff are between 5-30% of the total amount of nitrogen and 0.5-5% of the amount of phosphorus contained in the applied fertilizer (Gürsoy Haksevenler and Ayaz, 2021). Irrigation is a fundamental and indispensable factor in productivity and quality in agricultural production in arid and semi-arid regions. Irrigation and drainage projects are important both in agricultural terms and in human life. These projects have both positive and negative environmental effects (Özkay *et al.,* 2008). Irrigation is very important in arid and semi-arid regions in terms of high yield and quality of products. However, environmental problems that can reach significant dimensions occur as a result of unscheduled and uncontrolled irrigation in agriculture and incorrect irrigation practices. Ground water rise, salinity, fertilizer and chemical pesticide residues sinking deeper with irrigation water, water returning from irrigation mixing with underground and surface waters by increasing their salt content, accumulation of trace elements in water resources, soil erosion and disease on living things (plants, animals and humans) that benefit from these waters. and damage are the main environmental problems caused by incorrect irrigation practices (Aydın, 2002; Taşkaya, 2004; Alper, 2010). In parallel, soil properties have deteriorated as a result of excessive irrigation, especially in the western and southern regions of Turkey, and salinity, wetnes, disease and pest rates have increased (Alper, 2010).

Eutrophication occurs due to the increase in the content of phosphorus and nitrogenous compounds in the water and the decrease in dissolved oxygen and species diversity due to the increase in organic matter production as a result of the increase in algae and aquatic plants (NOAA, 2018). However, the discharge of nutrients in surface and groundwater can have toxic effects on aquatic creatures, humans and plants (Vyas and Dave, 2010).

AGRICULTURAL PLASTIC POLLUTION

As a result of the rapid increase in the amount of plastic waste, a non-negligible level of pollution occurs in both marine and terrestrial ecosystems. The problem is growing day by day as a result of the low degradation rate of plastics and the lack of proper plastic waste management. The accumulation of plastic in the global ecosystem will increase further if current production, consumption and waste management practices remain unchanged (Akça and Sözcü Ok, 2021). While plastic mulch materials used in agriculture improved some biological indicators of soil quality, they caused a decrease in others (Jiang *et al.,* 2017; Liu *et al.,* 2014; Steinmetz *et al.,* 2016). Some studies have concluded that the accumulation of microplastics in soils negatively affects the physicochemical properties of the soil and may lead to environmental pollution (Andrés Rodríguez-Seijo, 2018). Ramos *et al.* (2015) stated that microplastic residues can cause changes in the soil habitat by accumulating pesticides in the soil. Some studies have shown that with increasing amounts of microplastic accumulation in soils, the C and N content of soil microbial biomass decreases significantly (Moreno and Moreno 2008; Wang *et al.,* 2016). The most important problem arising from the use of plastic is that plastic decomposes extremely slowly in nature. For this reason, it is expected to accumulate in nature and remain in nature for at least the next few centuries (Wright and Kelly, 2017; Hale *et al.,* 2020). Most microplastics are difficult to biodegrade and can only be broken down into smaller particles.It is seen that the enzymes of microorganisms, which are the most important decomposers of nature, are not very effective or only slightly effective against these artificially obtained materials. Plastic waste can also be degraded and broken into smaller particles by physical and chemical factors (ultraviolet rays, radiation, wind or water erosion, etc.) (Akça and Sözcü Ok, 2021). Due to the increasing use of plastic in agriculture, especially in recent years, and the lack of proper disposal of these plastics, their environmental impacts are felt more and more and continue to be a cause of emissions. The use of plastic materials in many diverse agricultural applications leads to an increase in plastic waste (Boyacı and Kartal, 2019).

Although the increasing use of plastic materials in agriculture increases productivity significantly, it also creates increasing negative effects on the environment of the agricultural ecosystem. Agriculture is responsible for energy and water inputs, chemical fertilizers and pesticides, as well as the use of a large proportion of plastic materials. In addition to the pollution that occurs during the production of plastic, plastic materials used for greenhouses, high tunnels, low tunnels as cover material, mulching, irrigation and drainage pipes can become a source of pollution when left in open areas or burned at the end of their life. Instead, if agricultural plastic waste is collected correctly, it can be evaluated as a new secondary raw material or an energy source. Adequate agricultural plastic waste management can prevent economic losses and environmental damage (Vox *et al.,* 2016; Boyacı and Kartal, 2019).

In sustainable waste management, it is necessary to examine the economic and environmental burdens of each element and to operate this mechanism continuously. The waste management system that produces the least amount of waste is the most profitable waste management system. It is

important to recycle waste as energy and/or material and to apply methods that will create the least amount of waste to reduce the amount of waste (Yaman, 2012).

Agricultural plastics produced with fossil raw materials, which begin to deteriorate depending on atmospheric substances such as wind, hail, rain, solar radiation, humidity and air temperature, pesticides used, and installation and usage conditions, create a high amount of waste (Picuno, 2014). Degradation of plastics mainly consists of the destruction of polymeric chains from ultraviolet solar radiation. Most of the plastic waste generated as a result of agricultural activities consists of greenhouses, low tunnels and mulching (Mugnozza *et al.,* 2011; Briassoulis *et al.,* 2012). The estimated amount of agricultural plastic waste in Italy is approximately 200 000 tons·year^{-1}, 55% of which consists of greenhouse covers, low tunnels and soil mulches (Picuno *et al.,* 2014). Within Turkey's total plastic product production of 10.5 million tons in 2022, plastics produced for agricultural purposes is approximately 420 000 tons·year^{-1} (Anonymous, 2023a) and within the total plastic product production of 2.7 million tons as of the first 3 months of 2023, plastics produced for agricultural purposes is 142 000 tons·year^{-1} (Anonymous, 2023b).

Agricultural plastic waste, which is an environmental and economic problem; With good waste management, environmental damage and economic losses can be prevented (Vox *et al.,* 2016). In cases where plastic waste management is not good and it is burned; Significant problems occur in the environment, air, soil, landscape and water resources. Gases such as CO_2, CO, H_2S, SO_2, NH_3 and dioxin pollute the atmosphere during combustion. Open burning is uncontrolled burning and creates more toxic effects than controlled burning. The burning of 1 kg of polyethylene produces 3 kg of CO_2 emissions, and if this combustion is not controlled, pollution occurs in the surrounding atmosphere (Mugnozza *et al.,* 2011).

Plastic waste, which takes a long time to decompose in nature, harms the environment as soil and water pollutants and disrupts the balance of the ecosystem (Durak, 2016). It is stated that plastic waste materials in nature decompose within 1 000 years (Güzey and Atılgan, 2015; Atılgan *et al.,* 2021). It is known that microplastics can remain in the soil for years without decomposing, and as a result, these plastics negatively affect organisms living in the soil (Denizli and Yavuz, 2017). Moreover; Since plastic bags do not dissolve in the soil for a long time, they prevent the roots of plants growing in these soils from growing and these plants from accessing nutrients (Kılıçer, 2018).

OTHER AGRICULTURAL POLLUTING FACTORS

Greenhouse cultivation is an important agricultural income-generating area (Saltuk, 2019). Different pollution situations occur during greenhouse cultivation activities. When plant wastes generated during and after harvest in greenhouses are not managed appropriately, they cause environmental pollution (Atılgan *et al.,* 2007; Güzey and Atılgan, 2015). Atılgan *et al*., (2021); They stated that utilizing the waste generated in greenhouse cultivation by composting would be very good for producers and very beneficial for the environment.

Use of nitrogenous fertilizer in agricultural soils; Burning savannas and agricultural wastes and burning biomass in open areas cause greenhouse gases (Aydın *et al.,* 2011). Producers' burning of stubble and weeds after production in order to make it easier to plow or create an easier seed bed destroys a large part of the organic matter source in the soil and causes the release of large amounts of CO_2 into the atmosphere (Cangir *et al.,* 2016).

Disposal of greenhouse waste poses a significant problem for producers. Greenhouse waste is tried to be destroyed by businesses by burning it or randomly throwing it around the edges of the garden, and this causes environmental pollution (Çerçioğlu, 2019). Boyacı and Kartal, (2019); They stated that fossil fuel wastes left randomly on open lands will cause pollution in soil and water resources by being carried by wind and rainfall.

CONCLUSION AND SUGGESTIONS

Fertilizers, which are important inputs in increasing efficiency and quality in agricultural activities, must be applied in a way that does not harm the environment and human health. At this point, soil and leaf analyzes become important. According to the results of soil and leaf analyses, the use of excessive amounts of chemicals as a result of not fertilizing causes soil pollution and deep infiltration, resulting in contamination of underground water resources and other water resources. Similarly, while pesticides used to control weeds, diseases and harmful organisms increase efficiency and quality in agricultural production, errors made during application emerge as environmental pollutants. Residues remaining on the soil and plant surface after pesticide application are carried deep into the soil and into water resources by atmospheric events such as precipitation. Residues left over from fertilizer and pesticide applications harm a wide range of populations, from the smallest to the largest living creatures in the ecosystem.

In addition, if pesticide applications are not made at the recommended doses and the time between application and harvest is not taken into consideration, these residues remain permanent in the bodies of the plants. These plants consumed by animals and humans can later harm the health of living beings. For this reason, it can be said that it will be important for growers to pay attention to the time between pesticide application and harvest time, and that it is necessary for producers to be aware of this issue.

It will be important for both the environment and public health that fertilizer and pesticide applications in agricultural lands near freshwater resources be carried out more carefully to avoid harming the fish and other living populations living in these water resources.

Environmental pollution will increase if greenhouse cover materials produced in areas where greenhouse cultivation is carried out are thrown into the environment and burned. As a step to prevent environmental pollution in these areas, it will be important to have recycling bins and raise the awareness of producers on this issue. It is assumed that both legal regulations and raising awareness of farmers to prevent the burning of greenhouse cover materials can prevent air pollution from increasing.

Since greenhouse cultivation is done as a small family business in our country, fossil fuels are preferred in the stoves used to heat greenhouses. Leaving these fossil wastes indiscriminately in open areas and carrying these

wastes to water resources by atmospheric events such as wind and precipitation may cause pollution. For this reason, it is thought that widespread use of garbage bins to collect fossil fuel waste may be beneficial in preventing environmental pollution.

It is thought that using the vegetal wastes generated during and after production in greenhouse cultivation as compost would be more beneficial both in terms of cultivation and environmental health.

It has been concluded that good waste management is necessary to prevent pollutants arising during agricultural activities from damaging the ecosystem. In this context, it will be more beneficial for both aquaculture and environmental health if waste management is carried out within a program through both legal regulations and awareness projects.

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