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Status of onion production in Türkiye and in the world, effects of abiotic and biotic stress factors

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Türkiye' de ve dünyada soğan üretiminin durumu, abiyotik ve biyotik stres faktörlerinin etkileri

Abstract: Onion plant is an indispensable additive for meals in the world and in our country. It is an important strategic agricultural product containing phytochemicals effective in the treatment of various diseases, as a medicinal and aromatic plant, as well as for consumption as food for humans. In the light of the statistical information examined, it is seen that there are changes in the supply of the onion plant to the market from year to year. The reasons for this seem to be annual land planning, input prices and human factors effective during production, as well as the damage rates of abiotic and biotic factors. In this study, the status of onion cultivation in Türkiye and in the world and the effects of abiotic and biotic factors encountered in cultivation are explained. In order to prevent fluctuations in supply to and prices in the market, it should be at the forefront of annual product planning, and producers should focus on raising awareness and training activities for growing healthy onions with high tolerance to diseases and pests.

Key words: Onion, production, disease, pests

Özet: Soğan bitkisi dünyada ve yurdumuzda yemeklerin vazgeçilmez katkı maddesidir. İnsanlar için besin olarak tüketiminin yanında tıbbi ve aromatik bitki olarak da çeşitli hastalıkların tedavisinde etkili fitokimyasalları içeren önemli stratejik bir tarım ürünüdür. İncelenen istatistiksel bilgiler ışında soğan bitkisinin yıldan yıla piyasaya arzında değişimler olduğu görülmektedir. Bunun nedenleri olarak yıllık arazi planlaması, girdi maliyetleri ve yetiştiricilik sırasında etkili olan beşeri faktörlerin yanında abiyotik ve biyotik etmenlerin zarar oranlarının etkili olduğu görülmektedir. Çalışmada yurdumuzda ve dünyada soğan yetiştiriciliğinin durumu ve yetiştiricilikte karşılaşılan abiyotik ve biyotik etmenlerin etkileri açıklanmıştır. Piyasaya arzda ve fiyatlarda dalgalanmaların yaşanmasına mahal vermemek için yıllık ürün planlamasında ön sırada yer alması ve hastalık ve zararlılara karşı toleransı yüksek sağlıklı soğan yetiştiriciliği için üreticilerin bilinçlendirilmesi ve eğitim faaliyetlerine ağırlık verilmesi gerekmektedir.

Anahtar Kelimeler: Soğan, üretim, hastalık, zararlılar

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1. Introduction

Onion is a plant species in the *Alliaceae* family (Brewster, 1994; Vural et al., 2000). Taxonomic name is *Allium cepa* L. (GBIF, 2023). Although the onion is a two-year plant species, the varieties that produce the bulb from the seed have been developed through breeding programs. Wild species of onion produce a smallbulb from seed in the first year, main bulb is produced in the second year and it has the potential to produce seeds by forming flowers. The onion consists of the root and the bulb the 2-5 layers of skin that surrounds and protects this bulb, remaining under the ground and the leaves that remain above the ground and have a green color (Sekara et al., 2017).

In addition to its consumption as a dry onion, the onion plant is also used as a green onion in salads and as a spice by being dried and powdered. It takes its importance in human nutrition from its taste and flavor characteristics. It is valuable due to the phytochemical content (Kumar et al., 2022). The onion plant has a worldwide importance (Brewster, 1994).

It is possible to classify the onion plant in several different ways. It is possible to make the first of these classifications as those that show maturation depending on the day length of the climate demands. This classification is as early varieties, mid-early and late varieties (Beşirli et al., 2021). Another classification is as summer and winter onions. Summer ones; has thick flesh, juicy, light color, long shape, coarse and loose structure. Due to its non-bitter taste, it is suitable for table use. It can not be stored for long time. Winter onions, on the other hand, have a tight structure. The color is dark and has a bitter taste. Unlike summer onion varieties, they could be stored for long time (Beşirli et al., 2021).

A suitable temperature and day length are important factors for growing the onion plant. In addition to these, although it can be grown in arid environment, abundant rainfall in spring is the most important factor affecting onion yield. Onion plants generally require a hot and dry environment during the day and a cool environment at night. During the growing season, there is a temperature demand between 12-30 °C. For seed germination, the soil temperature at the

time of sowing should be 10-13 °C. Increasing temperatures from the head-tie period to the harvest time are important for the development of the onion plant. In order to determine the harvest time, it is sufficient for the leaves to dry and fall and the color of the bark surrounding the bulbs to be darkened (Sekara et al., 2017).

Another important factor in onion cultivation is soil structure. Onions are grown in loose, water-holding capacity is medium, deep and soft enough to allow root and bulb development, easily workable, fertile and humus, loamy and light clay soils. The pH requirement for onions, which is sensitive to high acidity is between 6-6.5 (Beşirli et al., 2021).

Onions that are harvested and sold in a year are the varieties that produced directly from the seed, but mostly the production is made with shallots. However, by sowing directly with seeds, shallots are obtained in the first year and onions obtained by planting onions from these pinches in the second year are sown in the third year and harvested as seeds. Obtaining seeds again from an onion seed is at the end of three years.

Sowing frequency should be 25-30 cm between rows and 8-12 cm on the row in onions produced from seeds. The amount of seeds to be used per decare can vary between 0.5-1 kg. Before sowing, the soil should be plowed at a depth of 30 cm and sowing should be done while soil is in a moist. If the necessary conditions are met, seed germination will take place in 2-3 weeks (Beşirli et al., 2021).

The second option in onion production is from shallots with a diameter of 1-2 cm. For the planting of shallots, the distance between rows should be 25-30 cm and the distance on the rows should be 5-7 cm. 25-30 kg shallots are calculated per decare (Beşirli et al., 2021).

In the cultivation of onions, maintenance and fertilization are important issues that affect yield and quality, as in other vegetables. In order to remove weeds for maintenance, hoeing can be done two or three times, or the soil can be loosened by plowing between rows with the help of a tractor. Thus, both the weed removal process is carried out and the growth of onion bulbs in the soil is facilitated.

Although the fertilizer requirement may vary according to the soil structure and the amount of elemental matter, 8-10 kg/da of nitrogen, 8-10 kg/da of phosphorus and 12-15 kg/da of potassium are recommended for average yield (Anonymous, 2023b).

Onion can be grown without the need for irrigation in places where the precipitation amount is above 400 mm, but once a week irrigation is recommended until the head tying period in arid regions. Although the water demand depends on the climatic features, the soil structure is also one of the factors affecting irrigation.

Considering the necessary conditions for onion cultivation, it is seen that onion cultivation is carried out in many countries around the world.

2. Materials and Method

In the study, the status of onion cultivation in Türkiye and in the world, the description of abiotic and biotic factors that cause problems in onion cultivation, their symptoms on plants and control practices have been revealed by literature search.

3. Results

3.1. Onion production in the world

Onion cultivation is carried out in many areas in the world and it is made more than many green vegetables due to its consumption throughout the world. According to the United Nations Food and Agriculture Organization, onions are the third most produced product after tomatoes and potatoes. When the data in some years are compared, it is seen that there are years when more onion than potatoes are grown and the product is obtained (FAO, 2023).

Again, according to FAO data, 49,961,471.15 tons of onions were produced in an area of 2,915.706 hectares in 2000. This data increased to 79,142,982.25 tons from 4,214,126 ha by 2010. Considering that this increase is due to the increasing world population, it can be considered normal. However, these numerical data reached 104,563,843.11 t in 5,530,475 ha in 2020 and finally 106,592,088.85 t in 5,778,769 ha in 2021 (FAO, 2023). When these data are evaluated, it is seen that the cultivation area doubled in the ten-year period after 2000 and a product that has almost doubled again. However, in the ten-year period after 2010, it is seen that the increase in the amount of product obtained with the increase in the cultivation area is not sufficient (TÜİK, 2023). The reason for this could be effect of human and environmental factors.

The onion production by regions around the world, it is seen that the Asian region has a share of 65.1%. The Asian region is followed by Africa with 11.7%, America with 11.6% and finally Europe with 11.3% (FAO, 2023).

Considering the production averages for the years 2000-2021, China took the first place in onion production with 20.925.874.48 tons. India follows this ranking with 15,334,316.82 tons. America ranks third with 3,352,171.32 tons, and Türkiye ranks fourth with 2,013,635.91 tons onion production. This is followed by Egypt, Iran, Pakistan, Sudan, Russia and Brazil (FAO, 2023).

3.2. Onion production in Türkiye

Totally, 99,836 hectares were planted and 2,200,000 tons of onions were obtained in 2000. It is seen that these data have decreased by 2010. As a matter of fact, 1,900,000 tons of onion production was realized from the cultivation area, which decreased to 62,688 ha. Looking at the data in 2020 and 2021, it is seen that 2,280,000 t and 2,500,000 t of products were obtained in 68,491 ha and 69,895 ha, respectively (TÜİK, 2023).

When the data on the decrease in the cultivation areas and the amount of product obtained are evaluated, it is seen that there are fluctuating values in the production amounts despite the production in less areas.

Onion is produced in almost every province in Türkiye. Production in many provinces is offered to the domestic market. However, onions produced in large areas are sent to the provinces with less production in the Country or to foreign markets.

According to TÜİK data, at the years of 2010- 2021, provinces with the highest onion production are Ankara,

Amasya, Adana, Çorum, Hatay, Eskişehir, Konya, Tokat and Bursa (TÜİK, 2023).

Onion planting was done on 155,309 ha and 165,767 ha in Ankara in 2020 and 2021, respectively. From these areas, 567,788 t onions were harvested in 2020 and 835,269 t onions in 2021. In Amasya, it is seen that the onion planting, which was done on 89,290 ha in 2010, decreased to 81,534 ha in 2020 and to 70,387 ha in 2021. Due to the decrease in cultivation areas, it is observed that the amount of onions harvested also decreases. Onion production amount, which was approximately 312 thousand t in two thousand and ten years, decreased to 286,078 t in 2021 (TÜİK, 2023).

Considering the TÜİK data, it is seen that there is a decrease in the cultivation area and harvested product amount in onion production in Adana, Bursa and Tokat in 2020 and 2021 compared to previous years. When the TÜİK data is examined, it is seen that there is an increase in the onion cultivation area and production amount in Konya and Çorum (TÜİK, 2023).

The onion cultivation area in Konya, which was approximately 7,000 ha in 2010, increased to over 27,000 ha in 2020. This increase in cultivation areas was reflected in the amount of production and over 110 thousand tons of onions were harvested in 2020 and 2021 (TÜİK, 2023).

In Çorum, the cultivation area, which was approximately 31,000 ha in 2010, increased to 105,739 ha in 2021. The amount of production increased in direct proportion to the cultivation area and the amount of product, which was 73,673 t in 2010, reached approximately 300,000 t in 2021 (TÜİK, 2023).

Among the provinces where there is an increase in onion production, also in Eskişehir. There are fluctuations in onion production in Adana and Hatay provinces. When compared the TÜİK data of the years; 2020 and 2021, it is seen that there is a decrease. Despite the decrease in cultivation area and production amount, approximately 200,000 tons of onions were produced on 61 thousand hectares in Hatay in 2020. By 2021, these data have decreased to 167,653 tons per 50 thousand ha (TÜİK, 2023).

Vegetables grown for root and bulb are 3.874.902 tons and 3.860.298 tons, respectively in Türkiye in 2020 and 2021. It is seen that the largest production share of the vegetables grown for their roots and bulbs is the onion. The most produced vegetable is tomato with 13.000.000 tons in 2020 and 2021. Watermelon comes in the second place with the production amount of the two years, approximately 3.500.000 tons. Onion production comes in third place (TÜİK, 2023).

Onion production is an important food in the world as well as in Türkiye. This importance is also reflected in the amount of production, and it is among the top five vegetables produced the most. The fact that it is in the third place in our country brings this importance into consideration.

3.3. Challenges encountered in onion production

The amount of onion production increases parallel to increase in population. However, in some years, it is seen that its production has decreased. In some years, although the cultivation area is large, the production amount is below the expected amount. The factors affecting the yield can be caused by climatic reasons as well as biotic stresses.

Although the onion yield in Türkiye is above the world average of 32 tons/ha and 20 tons/ha, there are decreases in production over the years and problems occur in meeting the demand. As with other vegetables and fruits, there are reasons that affect onion production and yield. It is possible to classify these causes as abiotic and biotic.

3.3.1. Abiotic factors

Abiotic reasons can be listed as climate and soil characteristics, soil temperature and moisture at the time of germination, sowing method and time, harvest time, storage conditions of shallots and onions after harvest to be marketed.

Decreases in spring and summer rains due to global warming, which ranks first among the changes in climatic conditions, have led to decreases in irrigation waters (Çaltı and Somuncu, 2019). For this reason, people have turned to the production of products that have low water demand and will be affected at a minimum level by the low rainfall. Again, since the spring rains are less at the seed sowing times, they will delay the seed germination, affect the emergence and development stages and reduce the onion yield. The opposite is also possible. Too much rainfall at the time of sowing may cause the seeds or shallots to rot.

Sowing time and harvest time are among the factors affecting yield and product quality. As a matter of fact, the early sowing time may affect the first shoots that are subject to spring frosts. Late planting time may cause the onion head size to be insufficient. The early harvest time may affect the winter hardiness, as they are not fully mature, they may be crushed during loading. These situations will reduce the quality of the onion and therefore its market value. If post-harvest storage conditions are not met, shallots to be used as seeds may rot and may cause a slight decrease in the next planting amount. If the necessary conditions are not taken into account in the storage and transfer of onions to be put on the market, the onions may sprout and rot may occur. This will again reduce the market value (Beşirli et al., 2021).

It is possible to add the method of sowing to abiotic constraints. That is, shallots thrown deep during planting may cause late emergence, while onions planted close to the surface may dry out by not benefiting from soil moisture. These reasons are the main factors affecting onion yield and market quality in general.

3.3.2.Biotic factors

In addition to the abiotic factors that affect onion production, there are also biotic factors that have a great impact. Pests are the leading biotic factors. There are many diseases and pests that cause yield loss in onion production. The biotic factors that cause economic losses in onion production in our country; diseases and pests such as white rot (*Sclerotium cepivorum*), septoria (*Septoria apiicola*, *Septoria licopersici*), gray mold (*Botrytis cinerea*), onion downy mildew (*Peronospora destructor*), onion smut (*Urocystis cepula*), onion psyllid (*Bactericera tremblay*), onion fly (*Delia antiqua*), thrips (*Thrips tabaci* and *Frankliniella occidentalis*), leek moth (*Aceolepiopsis assectella*), wireworm (*Agriotes* spp.), leaf gallery flies

(*Liriomyza trifolii, L. bryoniae, L.huidobrensis, Phytomyza horticola*) and stem and bulb nematode (*Dityenchus dipsaci*) (EPPO, 2023). Biotic factors is presented in the form of the biological structure of the pest, damage symptoms and control methods. Weeds are also significant biotic constraints in onion production.

3.3.2.1. White rot diseases (*Sclerotium cepivorum*)

Sclerotium cepivorum, which is found in the fungal kingdom, is in the *Sclerotiniaceae* family. It causes economic losses in plants such as onions (*Allium cepa* L.), garlic (*Allium sativum* L.), leeks (*Allium ampeloprassum* L. (syn. *Allium porrum*) in the *Alliaceae* family (Anonymous, 2017).

Sclerotia, the winter spores of the fungus, become free in rotten plant tissue. They can remain dormant in the soil for many years. On the plant, they can remain dormant in a free state for several weeks. Volatile and water-soluble substances in host plants stimulate the germination of these sclerotia. These substances are especially found in *Allium* species. For the germination of sclerotia, the ambient temperature must be 9-21°C (Schwartz and Mohan, 2016; Anonymous, 2017). The wide temperature range is an indicator of the development of the pest and the extent of the damage. At the required temperatures, mycelium formation begins at several points and infects the roots of the host plant. Special cells that develop to infect the host plant in parasitic fungi are called apppressorium. With the formation of this cell, the hyphae that develop and spread on the surface of the roots and within the tissues can grow to reach the roots of neighboring plants. Sclerotia that migrate to the soil after all plant tissue has rotted remain dormant until new host plants are planted (Anonymous, 2017).

Its symptoms in the plant appear when the roots of the plant begin to develop. If the fungus infects the plant early, the plant rots and dies before it can develop. If the plant is infected during the late developmental stage, it is seen that the bulb is covered with a white cover around it. It is possible to see 0.35-0.50 mm sized sclerotia on the white fungal cover. One sclerot can infect about 30 adjacent plants. Contamination from underground can continue exponentially and drying occurs on the rows. If the onions taken from the diseased field are not kept at appropriate temperatures, the development of sclerots continues in the warehouses and rots are seen in the stored products (Anonymous, 2017).

Monitoring the disease throughout the growing season is important in preventing its spread and increasing yield. For this reason, as the temperatures begin to be suitable for the development of sclerotia, soil samples and onion samples should be collected with appropriate instructions, investigations should be made, and necessary precautions should be taken with the detection of diseased plants. Disease spread can be reduced by removing infected plants from the soil if necessary.

The disease is transmitted to the plant from its roots and from the sclerotids in the stem (CABI, 2015). Irrigation water, tools and equipment and production material are effective in the spread of the disease factor (EPPO, 2015a,b). Clean equipment, clean tools and equipment should be used to reduce the spread. Tools and equipment should be thoroughly cleaned after processing on contaminated soil.

Since the fungus distributed worldwide, its economic impact is also great. Although the disease is seen in a few plants at first, with the rapid spread of sclerotia, losses in plants are great in the following years in areas where Allium species are cultivated. Sclerotia, which is the causative agent of the disease, causes greater damage because it multiplies and spreads more and faster under 24°C. For this reason, it should be stored at appropriate temperatures and conditions.

In the following years, planting of *Allium* species should be avoided in contaminated areas, and rotation should be made for at least 5 years. Care should be taken to ensure that *Allium* species such as onions are clean. There is no registred formulation in Türkiye that can be used to combat this pest. For this reason, cultural and physical measures should be used.

3.3.2.2. Septoria leaf spot disease (*Septoria apiicola, Septoria licopersici*)

Septoria leaf spot disease is a important fungal disease that includes two species of the genus *Septoria*, belonging to the *Mycosphaerellaceae* family, and causes significant damage to cultivated plants.

Symptoms of the disease are in the form of brown spots on the leaves and petioles. The typical sign of the disease is that the spots increase in size up to 3 mm in diameter and their centers are light brown. When the severity of the disease is high, there is a significant decrease in yield. The severity of the disease is closely affected by the precipitation regimes (Anonymous, 2010).

This fungus causes disease on tomatoes, lettuce, parsley, zucchini, celery and onions. The use of clean seeds is at the forefront of the cultural methods recommended in the fight against this disease. Apart from this, cleaning of equipment and vehicles, destruction of contaminated plants and seeds, and alternation in contaminated soil are other recommended methods of management.

3.3.2.3. Gray mold disease (*Botrytis cinerea*)

Gray mold (*Botryotinia fuckeliana / Botrytis cinerea*) is a common fungus. It can survive in the bulbs of plants such as onions or as sclerotia in the soil. The resistance of sclerotia to cold and drought causes these diseases to persist in the soil for a long time.

It takes the nutrients it needs for the germination and development of spores from the cell sap of the plants under suitable humidity and temperature conditions on the plant tissues. It develops necrotrophically. It completes its development in a few days and goes into sporulation. The most suitable environmental conditions for disease development are 20-25 °C temperature and 95-98% humidity. In unsuitable environmental conditions, spores can maintain their vitality for a few days (Anonymous, 2023a).

In order to combat this disease factor, proper cultivation and maintenance of the plant is of great importance. In order to prevent the infection of onion bulbs in storage conditions, ventilation and controlled temperature and humidity conditions should be provided (Schwartz and Mohan, 2016).

3.3.2.4. Downy mildew disease (*Peronospora destructor*)

It is a type of water mold belonging to the *Peronosporaceae* family. It is especially harmful to *Allium* genus plants. The most damaging plant is the onion. It is known that the seeds are not contaminated, but it can preserve its existence as an oospore in the soil for many years (Anonymous, 2021). The spores of the disease agent are 7-18 µm in size, non-divided. Spores are violet in color (Kaynaş, 2010).

The disease is seen in onion plants by causing chlorotic lesions on their leaves. The color changes in the green leaves are in the form of pitting in the areas where the lesions are, especially in the bottom and middle areas. The lesions are covered with a layer of fungus and their middle part becomes white. The spots coalesce and the leaf dries up. Onion heads wrinkle and shoot. When the disease occurs in the early developmental stages of the plant, it is devastating (Schwartz and Mohan, 2016).

In order to combat the disease, the diseased onions seen in the field should be removed from the soil and destroyed. Diseased plant parts that remain after the onions are harvested should also be destroyed. In addition, it is not possible to store it in the warehouse for a long time. Oospores spread easily through the air. For this reason, diseased plants should not be contacted with clean areas and clean plants. Resistant varieties should be planted in disease-infected lands. In onion cultivation, especially open to the wind and well-drained lands should be preferred. Since the irrigation method is also effective in the spread of the disease factor, especially the sprinkler irrigation method should be avoided in contaminated lands (Beşirli et al., 2021).

Most of the fungicides are registered for onion is for downy mildew disease includes active gradients of %80 Thiram, %50 Captan, %60 Mancozeb + %5 Mandipropamid, %80 Mancozeb, %65 Dodine, %80 Fosetyl-Al, %80 sulfur, 160 g/l Cyazofamid, 190 g/l cupper sulfate + 35 g/l Cymoxanil, 200 g/l Azoxystrobin + 125 g/l Difenoconazole, 300 g/l Ametoctradin + 225 g/l Dimethomorph, 300 g/L Phosphorous Acid (mono ve di-potasyum tuzları) + 75 g/L Ametoctradin, 375 g/l Fluazinam + 150 g/l Azoxystrobin, 500 g/l Fluazinam and 625 g/ Propamocarb-HCI + 62,5 g/l Fluopicolide (Anonymous, 2023c).

3.3.2.5. Onion smut disease (*Urocystis cepula*)

Urocystis cepula, which belongs to the *Urocystidaceae* family, known as smut fungi of the *Basidiomycota* phylum, is the causative agent of onion smut disease. The spores of the fungus are brown, have thick walls and are elliptical in size of 12-15 µm (Kaynaş, 2010).

The agent causes more losses in shallot cultivation. The bulb develops in straight lines on the leaves and bark. The spores of the fungus fill in the lines over time. The emergence of the disease in the early stages of the development of the plant causes curls and developmental delays in the plant (Schwartz and Mohan, 2016).

At the beginning of the cultural measures recommended in the fight against the disease is the application of crop rotation for 8-10 years. Other important measures are the elemination of contaminated plant residues after harvest. The use of clean production material in production is also very beneficial in terms of preventing contamination to the field. Formaldehyde 40% and Thiram 80% are the drugs recommended for chemical control. Administering the disease at recommended doses as soon as it first appears will stop the spread (Anonymous, 2010; Beşirli et al., 2021).

3.3.2.6. Onion psyllid (*Bactericera tremblay*)

Onion psyllid, a member of the *Hemiptera* order, is 2-3 mm long and black in color. Larvae are 1-3 mm in length and yellow in color. The distinguishing features of the insect are the yellow spots on the thorax, the transparent appearance of its wings and prominent veins. The development of the insect continues throughout the summer, it has been determined that they complete their development in 18-25 days. They lay their eggs between the leaves and on the body of the plant and complete their development in this region (Anonymous, 2010).

Adults and larvae cause damage by feeding on onion leaves. Due to the growth hormone-like substances they secrete during their feeding, abnormal development and spiral curling occur in the plant. Therefore, it reduces the market quality of onions offered to the market as green. (Anonymous, 2010).

Cultural methods play an important role in the fight against this pest. Suggested cultural methods can be listed as cleaning the weeds in the field, doing the onion planting and planting operations as early as possible, good fertilization, irrigation and hoeing in order for the plant to develop well and to be affected by the pest at a minimum level. %80 Thiram is registered active gradient for the disaese (Anonymous, 2023b).

3.3.2.7. Onion fly (*Delia antiqua*)

Belonging to the *Anthomyiidae* family, this species is similar to small blackflies, but most are dull gray. It is a cosmopolitan pest. The onion fly has an ash gray body and resembles a house fly. The male has a longitudinal stripe on the abdomen that the female does not. The legs are black, the wings are transparent, and the compound eyes are brown. The eggs are white and elongated and are laid in groups on the shoots, leaves and bulbs of the host plants and in the nearby soil. The larvae are white and cylindrical and hatch in 3 to 8 days. Each batch of larvae tends to stay together and collectively form large burrows in the bulbs. Sometimes more than 50 maggots from eggs laid by several females can feed on one onion. The larvae moult three times, feed for about 20 days and grow to a length of about 1.0 cm. The pupa is brown, ringed, oval and 7 mm (0.28 in) long. Pupation occurs in the soil with the pupal phase from the spring belt lasting two or three weeks. Late generation pupae spend the winter in the soil (Anonymous, 2009a,b).

Adults begin to appear after mid-March and early April, depending on climatic conditions. Adult insects lay their eggs in the folds of the plant and into the soil. Larvae enter the plant and cause damage and secondary bacterial infections. As a result, regression and decay in plant growth occur (Schwartz and Mohan, 2016).

As a cultural control, it is recommended to plant quite late than the first generation time of the pest. The cultural struggle that can be applied on contaminated lands is to make deep plowing and to prefer chemical fertilizers instead of farm manure (Anonymous, 2010). What is recommended as a chemical control method is soil spraying before sowing, seed spraying during planting, and green

parts spraying against adult individuals during plant development stages. It is sufficient to see 2-3 adult individuals per 100 plants in order to be able to spray green parts (Anonymous, 2010).

3.3.2.8. Thrips (*Thrips tabaci* and *Frankliniella occidentalis*)

Thrips tabaci is a worldwide pest of the order *Thysanoptera*. Adult insects are 0.8-0.9 mm long and yellowish in color. It has fringe wings, which is the typical feature of this set. It has been determined that the development of the insect on the plant is completed in about 2 weeks and they give 4-6 generations in a plant development season (Anonymous, 2022b). The adults of *Frankliniella occidentalis* are between 1-1.4 mm (Anonymous, 2020b).

The form of damage caused by these pests on the plant; Adults and nymphs feed on plant sap on leaves, stems and fruits of plants. The leaves on which it feeds turn whitish or silver after a while. In arid areas, the damage is even greater. They carry virus diseases and infect healthy plants (Anonymous, 2010).

Among the cultural measures recommended in the fight against these insects, the most important one is the destruction of plant residues infested with the larvae of the pest. Soil tillage and weeds should be struggled. Among the recommended chemical control methods, the recommended drugs are Pirimicarb 50% and Deltamethrin 25 g/l (Anonymous, 2010).

3.3.2.9. Leek moth (*Acrolepiopsis assectella*)

Acrolepiopsis assectella is a species of moth in the family *Acrolepiidae* from the class *Insecta*. Its variegated brown and white wings are around 15-16 mm long. The body length of the adult is usually 1 cm. The head of the larva is brown and the body is yellowish white and is around 1 cm (Anonymous, 2010).

The damage starts with the emergence of the plants in April and continues with 3 offspring throughout a year until October. Female moths usually lay their eggs near the soil and on the underside of leaves. Eggs hatch in 4-6 days in spring and 8-11 days in autumn. As soon as the larvae hatch, they begin to gnaw the leaf. In leeks they prefer to eat the youngest leaves, but in onions they prefer to feed on the hollow parts of the leaves and form a hole by going up to the middle part of the plant. These pests usually stay away from the flower parts of plant because the flowers contain saponin which inhibits the growth of larvae. They go through five larval stages. Larval periods consist of 11-23 day processes. If the pupation process will be in an empty field, it can spend the winter in this way (Anonymous, 2017).

There is no chemical method or medicine recommended for the fight against leek moth. However, it can be recommended to plant together with insect-repellent plants, which is one of the cultural methods. Among the insect traps, pheromone traps can play a role in reducing the population level of this pest.

3.3.2.10. Wireworm (*Agriotes* spp.)

It is one of the harmful insect species from the members of the *Elateridae* family of the Insecta class. The main damage to plants are made bythe larvae of these insects. The female beetle produces up to 150 eggs and lays them in the soil at a depth of 10-15 cm, singly or in clusters of 30-40. It takes a long period of 1-6 years for the larva to become adult (Anonymous, 2020a).

In the spring, the larvae move to the upper layers of the soil and feed by cutting the plant roots that develop in this region. They also cause injuries by getting inside the onion bulbs. Secondary bacterial and fungal diseases develop from these parts and cause the bulbs to rot (Anonymous, 2010).

For the control of the pest, tilling the soil with a plow after the harvest will cause the larvae feeding in the upper soil layer to stay on the surface and die, which is a very effective cultural control practice. The criterion for chemical control is the presence of 6-15 larvae at a depth of 25 cm in the soil. Chemical control is applied with formulations such as Chlorpyrifos-ethyl 25% in the form of empty field spraying before sowing and planting (Anonymous, 2020a).

3.3.2.11. Onion leaf miner (*Liriomyza trifolii, L. bryoniae, L. huidobrensis, Phytomyza horticola*)

They are species in *Insecta* class, *Diptera* order, *Agromyzidae* family. The length of the adults is between 1.3-2.3 mm. Adults lay their eggs on onion leaves. Larvae that emerge from the eggs enter under the epidermis layer of the leaves and feed by opening galleries. The pupal stage of flies that develop holomethobol lasts 7-14 days at 20-30°C. It has been determined that onion leaf miner give 10 offspring and lay 400 eggs during plant development (Anonymous, 2022a).

During the feeding of females and larvae on leaves, symptoms such as deformities, yellowing and drying are observed (Schwartz and Mohan, 2016). There are damages in the form of growth retardation in plants and, most importantly, the decrease in market quality in green onion plants (Anonymous, 2010).

In the cultivation of green onions in the greenhouse, controlling the entrance and exit of the greenhouse in order to prevent the infection of insects and the control of weeds that will host the insects cause a significant decrease in the pest population. Mulching is also reported to be effective in killing pupae in the soil (Anonymous, 2022a). Chemical-impregnated sticky traps are also recommended for greenhouse cultivation (Anonymous, 2010).

3.3.2.12. Stem and bulb nematode (*Ditylenchus dipsaci*)

It is a member of the *Anguinidae* family in the class *Tylenchoidea*, the majority of which are plant parasitic nematodes in the phylum *Nematoda*. It is in thread form and its body length is 1-1.5 mm and the body is transversely striated. Stem and bulb nematode is a soil-borne, motile endoparasitic nematode. It develops in the intercellular spaces in the cortex of the plant by infecting the part of the onion plant where the root and the bulb meet. It has been determined that it completes its development at 15 °Cin 20 days (Brzeski, 1991). A female produces 200-500 eggs. Nematodes form collective associations called nematode wool on infected onion bulbs at harvest time. Contamination can occur from soil as well as from contaminated production material (Yavuzaslanoglu et al., 2015). It has been determined that the stem and bulb nematode is common in onion growing areas in Türkiye (Yavuzaslanoglu et al., 2019).

The nematodes that enter the onion bulbs continue to develop and reproduce within the plant. Onion bulbs have a lower weight and soft structure than expected (Ecevit and Akyazı, 2010). Stem and bulb nematode causes shapeless curls in the leaves of onions and splits in the onion bulb. The development of infected seedlings regresses and rots (Yavuzaslanoglu et al., 2015).

Since the stem and bulb nematode is a nematode subject to quarantine, quarantine practices are carried out to prevent its spread. In addition, since the host spectrum is very wide, control methods should be applied to keep the population level below the economic damage threshold in order to maintain economic production in areas where it is contaminated. It has been noted that 3–4 years of rotation with non-host plants significantly reduces the nematode population (Hooper, 1984; Roberts and Grathead, 1986). Suggested cultural methods other than the rotation; Planting clean seeds in clean soil, using resistant varieties, cleaning the equipment used in contaminated land and preventing its transfer to clean soils, cleaning processes should not be in the direction of stream or irrigation water since there is a possibility of transportation with irrigation water. It was determined that onion cultivars had partial resistance to stem and bulb nematode. Varieties with low nematode growth from commercial onion varieties are recommended for cultivation in contaminated areas (Yavuzaslanoglu, 2019). Chemical drugs recommended in the fight against nematodes are applied in the form of empty field applications and in combination with solarization in greenhouse production (Anonymous, 2010).

3.3.2.13. Weeds

In order to increase the yield and quality obtained in onion cultivation, weed control is a group that can be included in biotic stresses as well as the problems mentioned above. It has been reported that there is 70% yield loss due to weeds, which is one of the important factors affecting onion yield (Kaya and Üremiş, 2020). A study conducted to determine weeds in onion fields in Hatay, one of our important onion production provinces in Türkiye, shows that weeds can affect production as much as other pests (Kaya and Üremiş, 2019).

By controlling weeds at the right time and in the right way, the damage of weeds to onion development and growth can be reduced, at least until the head is tied. These control methods include hoeing, interrow spreading and herbicide use (Roberts and Grathead, 1986).

4. Discussions

As a result, onion cultivation in the world and in Türkiye is greatly affected by natural and human factors. There are fluctuations in production and supply to the market from year to year. Planning production and abiotic and biotic factors that are effective during production have a significant effect on production amounts. The development of abiotic and biotic factors on the onion plant affects each other. Changes in precipitation regimes with the effect of global warming affect the biology of diseases and pests and increase the damage rates. In addition, drought stress increases crop losses by decreasing plant tolerance against other diseases and pests.

In order to maintain the regular supply of onion, which is an indispensable additive of meals and as a medicinal aromatic plant, to the market and to prevent price fluctuations, it should be at the forefront of annual product planning and training activities should be emphasized to raise awareness of producers for growing healthy onions with high tolerance to diseases and pests.

Conflict of Interest

Authors have declared no conflict of interest.

Authors' Contributions

First author prepared the manuscript, second author edited the manuscript.

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