Original article

Investigation of resistance to Verticillium wilt disease (*Verticillium dahliae* Kleb.) in eggplant genotypes

Patlıcan genotiplerinde Verticillium solgunluk hastalığına (*Verticillium dahliae* Kleb.) dayanıklılığın araştırılması

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**ABSTRACT**

This study was conducted in 2015, it was aimed to determine the resistance status of 42 eggplant genotypes for breeding studies against Verticillium wilt disease caused by *Verticillium dahliae* Kleb. disease, which limits eggplant production in Turkey. Disease resistance status of eggplant genotypes were determined by classical testing. The study revealed that it was determined the severity of the disease against *Verticillium dahliae* varied between 8.25-76.53% among the genotypes of different eggplant species. As a result of classical testing E4, E5, E7, E8, E10, E24, E33, E42 eggplant genotypes of different species; *Solanum torvum*, *Solanum incanum*, *Solanum linnaeanum*, *Solanum aethiopicum*, *Solanum sisymbriifolium*, *Solanum americanum* have been found resistant at 7.98-9.87% disease severity. It was also determined that 22 eggplant genotypes were moderate-level resistant and 13 eggplant genotypes were in susceptible groups. Eggplant genotypes, where the resistance status of Verticillium wilt determined in the study will contribute to the development of new hybrid eggplant varieties in future.

**INTRODUCTION**

Eggplant (*Solanum melongena* L.) is a hot climate plant originating in India. In recent years, it is known that eggplant has important vitamin and mineral content in terms of human health, like other vegetables, low calorie and low glycemic index values, and increased production of eggplant, such as salads, jams and pickles encouraged the increase of it (Çolak et al. 2018). Therefore, the eggplant has great economic value in many countries including Turkey. China is the larger eggplant producer in the first place in the world, followed by India, The United States of America and Turkey.

According to the Turkey Statistical Institute 2019 data, vegetable production in Turkey reached approximately 31.1 million tons by increasing 3.5%. In the production of vegetables in Turkey, eggplant is in fourth place after tomato, pepper and cucumber production (TÜİK 2019). Eggplant can be grown both in open field and in greenhouse; however, since the temperature demand is 25-30 °C during the day and minimum 15 °C at night, its cultivation is limited in certain regions (Aybak 2005). In 2019, eggplant production in Turkey was 836.284 tons, and the highest production was achieved in Antalya province as 190.125 tons, followed
Verticillium wilt caused by the soil-borne wilting fungal pathogen, *Verticillium dahliae* Kleb. (VT), is one of the most important plant diseases that limits production in the eggplant cultivation areas of our country (Altınok et al. 2012, Derviş et al. 2009, Uslu-Kıran et al. 2007). It has been reported that there may be over 50% product losses in production areas where the disease is observed (Bletsos et al. 2003, Neshev et al. 1997, Tani et al. 2018). *V. dahliae* was first reported in 1970 as a wilt pathogen of eggplant in Turkey (Kamal and Saydam 1970). The disease occurs more than 200 plant species (Inderbitzin and Subbarao 2014). *Verticillium dahliae* Kleb. is a fungal pathogen of soil borne which remains in the form of microsclerotia in the soil for more than 10 years, causing wilt and blocking the transmission bundles of infected plants (Agrios 2005). The lesions are seen as V-shaped leaves and are seen in a part of the plant or leaf. While browning observed in xylem in infectious plants can reach phloem tissue in Fusarium wilt, it is limited to xylem tissue in Verticillium wilt. Both of soil-borne disease pathogens can cause more severe diseases in the infected areas with nematodes that change the physiology of the plant and open the door to the plant diseases in the infected areas with nematodes that change the physiology of the plant and open the door to the plant. While browning observed in xylem in infectious plants can reach phloem tissue in Fusarium wilt, it is limited to xylem tissue in Verticillium wilt. Both of soil-borne disease pathogens can cause more severe diseases in the infected areas with nematodes that change the physiology of the plant and open the door to the plant. While browning observed in xylem in infectious plants can reach phloem tissue in Fusarium wilt, it is limited to xylem tissue in Verticillium wilt. Both of soil-borne disease pathogens can cause more severe diseases in the infected areas with nematodes that change the physiology of the plant and open the door to the plant. While browning observed in xylem in infectious plants can reach phloem tissue in Fusarium wilt, it is limited to xylem tissue in Verticillium wilt. Both of soil-borne disease pathogens can cause more severe diseases in the infected areas with nematodes that change the physiology of the plant and open the door to the plant. While browning observed in xylem in infectious plants can reach phloem tissue in Fusarium wilt, it is limited to xylem tissue in Verticillium wilt. Both of soil-borne disease pathogens can cause more severe diseases in the infected areas with nematodes that change the physiology of the plant and open the door to the plant. While browning observed in xylem in infectious plants can reach phloem tissue in.

**MATERIALS AND METHODS**

In experiments, 42 eggplant genotypes were used as material in this study from 2015 eggplant breeding programs carried out in Alata Horticultural Research Institute, Mersin, Turkey. In classical testing studies, high resistance AGR703 (*Solanum melongena* x *Solanum aethiopicum*), Köksal F1 (*Solanum melongena* X *Solanum incanum*) commercial eggplant rootstocks, and Kemer, Aydin Siyahi eggplant cultivars were used as susceptible controls (Derviş et al. 2009, Talhouni et al. 2019).

**Classical testing for Verticillium dahliae resistance levels**

Classical testing experiments were performed according to seedling root dipping method for determining the resistance of *V. dahliae* Kleb. in 42 eggplant genotypes. For this purpose, the high virulence VT isolate obtained from greenhouse eggplant areas was developed for 10 days in PDA (Potato Dextrose Agar). Fungal mycelial developed at the end of the incubation period of VT fungus isolate were passed through double-layer cheesecloth and the spores suspension was adjusted to 1x10^7 spores/ml with Thoma slide (Çolak et al. 2019, Özcan 2004, Uslu-Kıran et al. 2007). For VT inoculation, the soil containing roots of 4-5 leaf eggplant seedlings was washed, and than the roots were shaved for seedlings inoculation by immersion in VT spore suspension containing 1x10^7 spora / ml for 4-5 minutes. Eggplant seedlings inoculated were planted in 3 pots of eggplant seedlings in each pot of 15x15 cm containing steril soil: peat: perlite (1:1:1). The control plants to be used in testing were dipped in sterile water after planting their roots and planted in pots (Çolak et al. 2018). The experiment
was conducted with 5 pots for each eggplant genotype with completely randomized design and 3 plants were planted in each pot. The pots were kept in a climatized chamber with 26 ± 2 °C temperature, under 16 hours of light and 8 hours of darkness and a relative humidity of 60-70% conditions. The chamber was located at the Directorate of Biological Control Research Institute, Adana.  

The disease severity was calculated using the Townsend-Heuberger formula according to Başay et al. (2011); the disease severity was measured with modified the 0-5 scales where 0: no disease symptoms and no color change in the root veins, 1: 30% of the leaves are yellow and very mild color change in the root veins, 2: 50% of the leaves are yellow and moderate color change in the root veins, 3: 50-70% of the leaves are yellow and substantial color change in the root veins, 4: only 1 to 2 leaves green and 71% color change in the root veins, 5: the plant dies. Plants’ symptoms were measured 45 days after inoculations in the pot experiment (Başay et al. 2011, Bora and Karaca 1970, Karman 1971). The VT % disease severity rate was calculated for each eggplant genotype according to Neshev et al. (1997) and Başay et al. (2011)'s evaluation scale. The modified scale for genotypes were: highly resistant (0%: no disease symptom), resistant (0.1-10%), moderate-level resistant (10.1-25%), moderate-level susceptible (25.1-50%), susceptible (50.1-75%), high susceptible (≥75.1%), the resistant level of eggplant genotypes has been demonstrated. The obtained data from inoculation results of the study were conducted by applying variance analysis, comparing average values, LSD (Fisher’s Least Significant Difference) test (P: 0.05). These statistics tests were performed and their results were evaluated in Jump Package Program.  

RESULTS AND DISCUSSION

As a result of classical testing studies, resistance levels of 42 eggplant genotypes have already determined against one of the most important soil borne fungal V. dahliae Kleb. pathogen causing Verticillium wilt disease. For this purpose, disease severity % and resistance status of eggplant genotypes belonging to classical test studies performed according to seedling root dipping method presented in Table 1. The differences between eggplant genotypes (Table 1) in terms of disease severity % values were found statistically significant (P<0.05). It was also determined that the severity of the disease against V. dahliae varied 8.25-76.53% among the genotypes of different eggplant species. These classical tests unveiled 8 eggplant genotypes from different genus of Solanum torvum, Solanum incanum, Solanum linnaeamum, Solanum aethiopicum, Solanum sisymbriifolium, Solanum americanum. The 8 genotypes are belonged to different eggplant species where E4, E5, E7, E8, E10, E24, E33, E42 coded plants were found to be resistant with disease severity between 7.98-9.87%. Additionally, 22 eggplant genotypes with VT disease severity varied from 10.4% to 24.53% were resembled moderately resistant, 4 eggplant genotypes (E1, E12, E15, E41) were moderately susceptible between 25.07% -46.94% disease severity, and 9 eggplant genotypes were over 52% disease severity were in susceptible groups. (Table1, Figure1).

The S. melongena accessions have revealed varying levels of sensitivity to Verticillium wilt. However, sources of resistance to V. dahliae have been found in some wild Solanum species related to eggplants such as S. torvum, S. linnaeamum, S. aculeatissimum, S. sisymbriifolium (Collonnier et al. 2001, Liu et al. 2015). S. torvum has been reported to be resistant to Verticillium wilt and bacterial wilt, root-knot nematode and mycoplasma. (Collonnier et al. 2001, Kashyap et al. 2003). However, in our conducted tests proved that reactions against different Verticillium isolates were developed 20-27% symptom on S. torvum plants whereas other eggplants had 87-100% disease symptoms likely reported by Garibaldi et al. (2005). By screening an area that was naturally infected with the disease between 1998 and 2001, it was observed that the disease resistance of back-crossed S. linnaeamum and a cultivated eggplant increased by about 60%. It is reported that S. linnaeamum is able to use to increase the resistance against Verticillium wilt (Liu et al. 2015). The most common rootstocks used in eggplant production are S. torvum, Solanum integrifolium and S. sisymbriifolium. Bletsos et al. (2003) revealed that, eggplant grafted onto S. torvum and S. sisymbriifolium rootstocks, had positive effects on plant growth, yield and disease incidence of V. dahliae without change in fruit quality, and S. torvum was more resistant than S. sisymbriifolium to V. dahliae. Neshev et al. (1997) indicated that reactions of 37 eggplant varieties to Verticillium wilt and compared with Bulgarian varieties Svetlina and Luch. In the study, approximately 35% of the varieties were found to have extremely high resistance and 54% were moderately susceptible. The plant infected with V. dahliae in different varieties ranged from 2.5 to 56.8%. The varieties included in the study reported that they were more resistance than the Svetlina variety and could be used as sources of resistance to Verticillium wilt in future breeding programs. In our study, as a result of determining eggplant genotypes in which targeted VT disease resistance status were determined; the breeder will contribute to researches in new hybridization programs and the transfer of the gene of resistance to commercial eggplant varieties.

In vegetable cultivation, in areas where soil-borne diseases are intensive the fact that solarization is insufficient in the
control alone and the use of disease-resistant varieties or the use of resistant rootstocks has gained importance. Grafting method has started to be preferred especially for varieties with insufficient disease resistance. *Fusarium oxysporum*, *V. dahliae* and *Meloidogyne* sp., in its control, significant successes has been achieved with the use of rootstocks. In the control against soil-borne diseases, it is possible for the rootstocks to provide this resistance by secreting their

| IC   | Genotypes       | Species                  | Disease severity (%) | Status of disease | IC   | Genotypes       | Species                  | Disease severity (%) | Status of disease |
|------|-----------------|--------------------------|----------------------|-------------------|------|-----------------|--------------------------|----------------------|-------------------|
| E1   | Topan 374       | Solanum melongena        | 40.80g               | MS                | E23  | V1055486*      | Solanum torvum           | 21.33bcd            | MR                |
|      | Aydın Siyah     | Solanum melongena        | 69.47kl              | S                 | E24  | V1050329*      | Solanum aethiopicum      | 9.04a                | R                 |
| E3   | V1044986*       | Solanum aethiopicum      | 22.93def             | MR                | E25  | V1050355*      | Solanum aethiopicum      | 20.78bcd            | MR                |
| E4   | V1036446*       | Solanum linnaeancum      | 9.04a                | R                 | E26  | V1050367*      | Solanum aethiopicum      | 19.7bcde             | MR                |
| E5   | SW              | Solanum torvum           | 9.87a                | R                 | E27  | V1050371*      | Solanum aethiopicum      | 22.40cdef           | MR                |
| E6   | V1034853*       | Solanum incanum          | 10.41a               | MR                | E28  | V1050380*      | Solanum aethiopicum      | 21.60bcde           | MR                |
| E7   | V1034860*       | Solanum incanum          | 9.60a                | R                 | E29  | V1050391*      | Solanum aethiopicum      | 19.20bcde           | MR                |
| E8   | V1037466*       | Solanum incanum          | 9.07a                | R                 | E30  | V1044180*      | Solanum americanum       | 60.27j              | S                 |
| E9   | V1042823*       | Solanum incanum          | 16.82b               | MR                | E31  | V1047481*      | Solanum americanum       | 18.13bcd            | MR                |
| E10  | V1038170*       | Solanum sisymbriifolium  | 9.56a                | R                 | E32  | V1042548*      | Solanum americanum       | 20.53bcdef          | MR                |
| E11  | V1037223*       | Solanum inducum           | 52.00i               | S                 | E33  | V1047620*      | Solanum americanum       | 9.82a               | R                 |
| E12  | V1042257*       | Solanum inducum           | 40.80g               | MS                | E34  | V1037767*      | Solanum melongena        | 24.27ef             | MR                |
| E13  | V1034894*       | Solanum macrocarpon       | 53.33i               | S                 | E35  | PI232079*      | Solanum melongena        | 66.93k              | S                 |
| E14  | V1047475*       | Solanum macrocarpon       | 76.53n               | HS                | E36  | V1042514*      | Solanum melongena        | 72.00lm             | S                 |
| E15  | V1050400*       | Solanum macrocarpon       | 46.94h               | MS                | E37  | V1039552*      | Solanum melongena        | 21.07bcd            | MR                |
| E16  | V1047392*       | Solanum torvum            | 22.67cdef            | MR                | E38  | V1042032*      | Solanum melongena        | 24.00ef             | MR                |
| E17  | V1054894*       | Solanum torvum            | 18.94bde             | MR                | E39  | V1055287*      | Solanum nigrum           | 24.53ef             | MR                |
| E18  | V1055295*       | Solanum melongena         | 23.73ef              | MR                | E40  | V1055104*      | Solanum nigrum           | 21.60bcd            | MR                |
| E19  | V1047482*       | Solanum villosus          | 55.21i               | S                 | E41  | V1041090*      | Solanum ferox            | 25.07f              | MS                |
| E20  | V1042539*       | Solanum villosus          | 20.00bcd             | MR                | E42  | V1041031*      | Solanum torvum           | 8.25a               | R                 |
| E21  | V1037342*       | Solanum xanthocarpum      | 17.34bc              | MR                | Kemer Variety | Solanum melongena | 75.07mn             | S                 |
| E22  | V1040261*       | Solanum xanthocarpum      | 24.53ef              | MR                | Aydin Siyah Variety | Solanum melongena | 60.67klm            | S                 |
| Köksal Rootstock | Solanum xanthocarpum | 8.77a                | R                 | 703 Rootstock     | Solanum aethiopicum | 7.98a               | R                 |

Lsd 0.5 4.554

*Genotypes were taken from World Vegetable Center in Taiwan. The resistance status, according to % disease severity values of eggplant genotypes has been demonstrated; highly resistant (0%: no disease symptoms, HR), resistant (0.1-10%, R), moderate-level resistant (10.1-25%, MR), moderate-level susceptible (25.1-50%, MS), susceptible (50.1-75%, S), high susceptible (≥75.1%, HS). IC: Institute Code
hybridization of S. torvum, S. incanum x S. melongena et al. 2019a). In the world, hybrid varieties obtained by programs (Çolak et al. 2018, Khah 2005, 2011, Sarıbaş factors should be evaluated in detail in rootstock breeding wild forms, close relative species and cross-species hybrids of grafted eggplant seedlings, primarily the culture forms, secretions in the root region. However, in the production groups plants (E24, E27, E40) in eggplants genotypes susceptible groups plants (E2, E11, E1, E19), and resistant groups plants (E24, E27, E40) in eggplants genotypes

secretions in the root region. However, in the production of grafted eggplant seedlings, primarily the culture forms, wild forms, close relative species and cross-species hybrids of eggplant; resistance to important biotic and abiotic stress factors should be evaluated in detail in rootstock breeding programs (Çolak et al. 2018, Khah 2005, 2011, Sarıbaş et al. 2019a). In the world, hybrid varieties obtained by hybridization of S. torvum, S. incanum x S. melongena and S. melongena x S. aethiopicum species are used as rootstocks in the production of grafted eggplant seedlings. In the production of grafted eggplant seedlings, S. torvum species as rootstock; It has been declared that it provides a high level of resistance to Verticillium wilt, Fusarium wilt, Bacterial wilt and root-knot nematode (Rotino et al. 2002, Sarıbaş et al. 2019b).

Çürük et al. (2009) determined that, in greenhouse soils infected with Verticillium wilt and root-knot nematode; it was determined that the yield values and the quality losses decreased in Fasalis and Pala varieties grafted on the S. torvum rootstock. It has been demonstrated that there are genes which provide resistance to soil-borne disease pathogens in the wild forms of eggplant such as S. torvum, S. aethiopicum and S. incanum and in close relative species. However, it has been revealed by research results that S. melongena has a lower level of resistance (Toppino et al. 2008). In the study conducted by Sarıbaş et al. (2019) it was stated that S. melongena X S. aethiopicum eggplant rootstock candidates developed in the breeding program were resistant to root-knot nematode (M. incognita), Verticillium (V. dahliae Kleb.) and Fusarium (F. oxysporum f. sp. melongenae) wilt diseases as a result of classical testing.

In recent years, rapid screening of disease-resistant lines using molecular markers in breeding studies, saving time, space and reliability by choosing the desired genotypes provides hundreds of plant choices in one day (Barone et al. 2005, Staniaszek et al. 2007). In the studies carried out in this context, studies of resistance to tomato against Verticillium wilt (V. dahliae Kleb.) disease have been initiated before, and SNP2827 / Tetraprimer ARMS marker developed in connection with the Ve-2 gene, which provides resistant and susceptible populations, has been developed (Acciarri et al. 2007, Arens et al. 2010). Since eggplant production has been less economical for many years than tomato production, such a study has not been possible until now. In this context, the development of these markers with the V. dahliae resistant and susceptible eggplant genotypes obtained as a result of our study contributed to the transfer of the gene of resistance to commercial eggplant varieties in the breeder's new hybridization programs.

The main goal of eggplant breeding is to develop hybrid varieties with high quality and resistant to diseases and pests. The aim of our study is to determine the resistance of Verticillium wilt caused by V. dahliae Kleb. disease in 42 eggplant genotypes. As a result of classical tests, in order to increase the effectiveness in the control against soil-borne pathogens such as V. dahliae, besides the selection of resistance varieties, the system should be considered as a whole and combined applications should be included in the disease control to protect it in environmental resistance. In this context, with the classical breeding methods, to develop a variety resistant to a single disease pathogen; in terms of productivity and quality, it is not sufficient for areas such as eggplant that have been cultivated in recent years and for a plant species with high number of diseases and pests. In today's conditions, depending on the production area and time, resistance to at least 3 or more diseases-pests is needed. Thus, it has been reported that there is a need to develop varieties resistant to nematode damage with soil-borne pathogens in countries and in Turkey, where eggplant production is intensive (Rotino et al. 2002). As the number of resistance needed increases, the breeding time becomes longer and even impossible. In recent years, while Fusarium wilt resistance has been developed, which has caused significant damage to eggplant with increased production, there is no such study so far for Verticillium wilt (Goth and Webb 1981). By determining the resistant and susceptible eggplant genotypes obtained as a result of this study, contribution was made to the infrastructure for the development of these markers. With this study results, 42 eggplant genotypes, which can be used as a source of resistance in eggplant breeding, are presented to the breeder. In addition, by identifying the parents who will be
resistant to *V. dahlia* Kleb. as a parent or father, it has also contributed to the establishment of alternative projects in terms of obtaining the new varieties through the fruit quality criterion demands which are at the forefront in the world.

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**ÖZET**

Bu çalışma, patlıcan üretimini sınırlayan *Verticillium dahliae* hastalıktan etmenin neden olduğu Verticillium solgunluğu hastalığına karşı dayanıklılık ıslah çalışmalarında kullanmak üzere 42 adet patlıcan genotipi reaksiyon durumlarının belirlenmesi amacıyla 2015 yılında yapılmıştır. Patlıcan genotiplerinin hastalıga karşı dayanıklılık durumları klasik testleme ile tespit edilmiştir. Çalışmada farklı patlıcan türlerine ait genotipler arasında *V. dahliae*’ya karşı hastalığın şiddetinin %8.25-76.53 arasında değiştiği tespit edilmiştir. Klasik testleme sonucunda E4, E5, E7, E8, E10, E24, E33, E42 kodlu farklı türlerde ait patlıcan genotipleri; *Solanum torvum*, *Solanum incanum*, *Solanum linnaeanum*, *Solanum aethiopicum*, *Solanum sisymbriifolium*, *Solanum americanum*’un %7.98-%9.87 hastalık şiddeti ile dayanıklı olduğu tespit edilmiştir. Çalışmada, 22 adet patlıcan genotipinin orta dayanıklı ve 13 adet patlıcan genotipinin hassas gruplar içerisinde yer aldığı tespit edilmiştir. Çalışmada elde edilen Verticillum solgunluğu’na dayanıklılık durumlarının belirlendiği patlıcan genotipleri gelecekte yeni hibrit patlıcan çeşidi geliştirilmesi katkı sağlayacaktır.

Anahtar sözcükler: *Solanum melongena* L., Verticillium solgunluğu, dayanıklılık

**REFERENCES**

Acciarri N., Rotino G.L., Tamietti G., Valentino D., Voltattorni S., Sabatini E., 2007. Molecular markers for Ve1 and Ve2 Verticillium resistance genes from Italian germplasm. Plant Breeding, 126 (6), 617–621.

Agrios G.N., 2005. Plant Pathology. Elsevier Academic Press. USA, p. 922.

Aldemir H., Boyacı H.F., Topçu V., 2012. Prevalence of Fusarium and Verticillium wilts in greenhouse eggplant production areas of Antalya, Mersin and Samsun provinces and geographical distribution of the virulence of the isolates. Atatürk University Journal of the Agricultural Faculty, 43 (2), 107-115.

Arens P., Mansilla C., Deinum D., Cavellini L., Moretti A., Rolland S., Van der Schoot H., Calvache D., Ponz F., Collonnier C., Mathis R., Smilde D., Caranta C., Vosman B., 2010. Development and evaluation of robust molecular markers linked to disease resistance in tomato for distinctness, uniformity and stability testing. Theoretical and Applied Genetics, 120 (3), 655-664.

Aybak H.Ç., 2005. Patlıcan yetiştiriciliği. Hasat yayincılık, ISPN: 978-975-8377-11-4, 112 s.

Barone A., Ercolano M.R., Langella R., Monti L., Frusciante L., 2005. Molecular marker-assisted selection for pyramiding resistance genes in tomato. Advances in Horticultural Science, 19, 147-152.

Başay S., Şeniz V., Tezcan H., 2011. Reactions of selected eggplant cultivars and lines to Verticillium wilt caused by *Verticillium dahliae* Kleb. African Journal of Biotechnology, 10 (18), 3571-3573.

Bletsos F.A., Thanassoulopoulos C., Roupakias D., 2003. Effect of grafting on growth, yield, and Verticillium wilt of eggplant. HortScience, 38 (2), 183-186.

Bora T., Karaca İ., 1970. The measurement of disease and pests in culture plants. Ege University Faculty of Agriculture Supplementary Course Book, No: 167, İzmir, p. 43.

Collonnier C., Fock I., Kashyap V., Rotino G.L., Daunay M.C., Lian Y., Mariska I.K., Rajam M.V., Servaes A., Ducreux G., Sihachakr D., 2001. Applications of biotechnology in eggplant. Plant Cell, Tissue and Organ Culture, 65, 91-107.

Çolak A.A., Fidan H., Özarslan E., Ata A., 2018. Determination of the resistance of certain eggplant lines against Fusarium wilt. *Potato Y Potyvirus* and root-knot nematode using molecular and classic methods. Journal Fresenius Environmental Bulletin, 27 (11), 7446-7453.

Çolak A.A., Fidan H., Karacaoğlu M., Daşgan H.Y., 2019. The identification of the resistance levels of *Fusarium oxysporum* f. sp. *radicus-lycopersici* and *Tomato yellow leaf curl viruses* in different tomato genotypes through traditional and molecular methods. Applied Ecology and Environmental Research, 17 (2), 2203-2218.

Çürük S., Daşgan H.Y., Mansuroğlu S., Kurt Ş., Mazmanoğlu M., Antakli O., Tarla G., 2009. Grafted eggplant yield, quality and growth in infested soil with *Verticillium dahliae* and *M. incognita*. Pesquisa Agropecuaria Brasileira, Brasilia, 44 (12), 1673-1681.

Dervis S., Yeşilir H., Yıldırım H., Tok F.M., Kurt S., Karaca F., 2009. Genetic and pathogenic characterization of *Verticillium dahliae* isolates from eggplant in Turkey. Phytoparasitica, 37, 467-476.
Garibaldi A., Minuto A., Gullino M.L., 2005. Verticillium wilt incited by *Verticillium dahliae* in eggplant grafted on *Solanum torvum* in Italy. Plant Disease, 89 (7), 777.

Goth R.W., Webb R.E., 1981. Sources and genetics of host resistance in vegetable crops. In: "Fungal Wilt Diseases of Plant". Mace M.E., Bell, A.A., Beckman, C.H. (Eds.). Academic Press, London, 377–409 p.

Inderbitzin P., Subbarao K.V., 2014. Verticillium systematics and evolution: How confusion impedes Verticillium wilt management and how to resolve it. Phytopathology, 104 (6), 564–574.

Kamal M., Saydam C., 1970. *Verticillium* wilt of eggplant in Turkey. Plant Disease Reporter, 54 (3), 241-243.

Karman M., 1971. Bitki koruma araştırmalarında genel bilgiler kitabı. T.C. Tarım Bakanlığı Zirai Mücadele ve Zirai Karantina Genel Müdürlüğü Yayınları. Bornova/ İzmir. Ağustos 1971. 279 s.

Kashyap V., Kumar S.V., Collonnier C., Fusari F., Haicour R., Rotino G.L., Sihachakr D., Rajam M.V., 2003. Biotechnology of eggplant. Scientia Horticulturae, 97, 1-25.

Khah E.M., 2005. Effects of grafting on growth, performance and yield of aubergine (*Solanum melongena* L) in the field and greenhouse. Journal of Food, Agriculture & Environment, 392-394.

Khah E.M., 2011. Effect of grafting on growth, performance and yield of aubergine (*Solanum melongena* L) in greenhouse and open-field. International Journal of Plant Production, 5 (4), 359-366.

Liu J., Zheng Z., Zhou X., Feng C., Zhuang Y., 2015. Improving the resistance of eggplant (*Solanum melongena*) to Verticillium wilt using wild species *Solanum linnaeanum*. Euphytica, 201, 463-469.

Miller A.S., Rowe C.R., Riedel M.R., 1996. Fusarium and Verticillium wilts of tomato, potato, pepper and eggplant. The Ohio State University Extension, Plant Pathology, HGY-3122-96. 2021 Cofey Road. Columbus, OH 432101087.

Milton J.M., Rogers W.G., Isaac I., 1971. Application of acrylamide gel electrophoresis of soluble fungal protein to taxonomy of *Verticillium* species. Transactions of the British Mycological Society 56 (1), 61–63.

Neshev G., Ivanova I., Krusteva L., 1997. Response of different eggplant cultivars to *Verticillium* wilt (*Verticillium dahliae* Kleb.). Acta Horticulturae, 462, 763-768.

Ozan S., Maden S., 2004. Ankara ili domates ekiliş alanlarında solgunluk ve kök ve kökboğazı cürükliğine neden olan fungal hastalıkların etkisi. Bitki Koruma Bülteni, 44 (1-4), 105-120.