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Evaluation of Greenhouse and Field Performances of Depar F1 Tomato Variety Grafted on Different Rootstocks

Farklı Anaçlar Üzerine Aşılanan Depar F1 Domates Çeşidinin Sera ve Açıktaki Performanslarının Değerlendirilmesi

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EVALUATION OF GREENHOUSE AND FIELD PERFORMANCES OF DEPAR F1 TOMATO VARIETY GRAFTED ON DIFFERENT ROOTSTOCKS

ABSTRACT

In this study, the effects of rootstocks on yield and some quality parameters of Solanum Lycopersicum cv. Depar F1 tomato variety grafted on three different rootstocks (Kudret, Hamarat, Pençe) were investigated in open field and greenhouse conditions. According to the results obtained, while the plants grown in greenhouses grew up 42.3% faster than those grown in the open, an increase in yield was achieved by 265%. While TA and vitamin C values, among the fruit quality characteristics, came to the fore in the plants grown in the greenhouse, the fruit firmness values came to the fore in the tomatoes grown in the field. Kudret rootstock came to the fore regarding yield and fruit quality characteristics. When the nutrient contents of the fruits were examined, the highest N, Ca and Mg were measured in greenhouse-grown tomatoes, while the highest O.M and Mn were measured in field plants. Hamarat rootstock has come to the fore in terms of fruit nutritional content. As a result, the importance of growing conditions for grafted plants to show their performance has been demonstrated again. However, it has been demonstrated for the first time that such successful results can be obtained, especially with organic plant nutrition methods.

Keywords: Grafted Seedling, Compost, Tomato, Organic Growing.

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FARKLI ANAÇLAR ÜZERİNE AŞILANAN DEPAR F1 DOMATES ÇEŞİDİNİN SERA VE AÇIKTAKİ PERFORMANSLARININ DEĞERLENDİRİLMESİ

ÖZ:

Bu çalışmada, üç farklı anaç (Kudret, Hamarat, Pençe) üzerine aşılanarak açıkta ve sera koşullarında yetiştirilen *Solanum lycopersicum* cv. Depar F1 domates çeşidinde anaçların verim ve bazı kalite parametreleri üzerine etkileri incelenmiştir. Elde ettiğimiz sonuçlara göre serada yetiştirilen bitkilerde, açıktakilere göre ortalama %42.3 daha hızla bir büyüme meydana gelirken, verimde %265 artış sağlanmıştır. Meyve kalite özelliklerinden TA ve C vitamini değerleri serada yetiştirilen bitkilerde ön plana çıkarken, meyve eti sertliği değerleri açıkta yetiştirilen domateslerde ön plana çıkmıştır. Genel olarak verim ve meyve kalite özellikleri bakımından Kudret anacı ön plana çıkmıştır. Meyvelerin besin içeriği değerleri incelendiğinde en yüksek N, Ca ve Mg serada yetiştirilen domates meyvelerinde ölçülürken, en yüksek O.M ve Mn açıkta yetiştirilen bitkilerde ölçülmüştür. Meyve besin içerikleri yönünden Hamarat anacı ön plana çıkmıştır. Sonuç olarak, aşılı bitkilerin performanslarını gösterebilmeleri için yetiştirme koşullarının önemi birkere daha ortaya konmuştur. Bununla birlikte, özellikle organik bitki besleme yöntemleri ile bu derece başarılı sonuçlar alanabileceği ilk defa bu çalışma ile ortaya konulmuştur.

Anahtar Sözcükler: Aşılı Fide, Kompost, Domates, Organik Yetiştiricilik.

1. INTRODUCTION

The use of grafted seedlings aims to increase earliness and yield by providing resistance against diseases and pests. In general, the presence of abiotic and biotic stress conditions in vegetable cultivation has made the use of grafted seedlings a common practice in vegetable growing (Yetişir et al., 2003; Yetişir et al., 2004; Yarşı et al., 2008; Şen and Özenç, 2017). Grafted plants have also been used to improve plant growth and yield, provide earliness, extend the harvesting period, influence product quality, improve water and nutrient use efficiency, etc. (Oztekin and Tüzel, 2017).

In addition, using rootstocks that are resistant/tolerant to diseases and pests ensures more substantial development of plants. Reducing the use of pesticides by providing tolerance to vigorous plants, especially soil-borne diseases, and tolerance to low soil temperatures, salinity and excessive moisture are among the advantages of grafting in vegetable growing. The use of grafted seedlings in Turkey is increasing due to soil-related problems. The fact that grafted plants have a strong root structure increases the resistance of the plants to soil-based problems and increases productivity. (Lee, 1994; Tüzel et al., 2005; Yarşı et al., 2008; Ece ve Çimen, 2013).

Especially today, the use of grafted seedlings has become widespread due to the spread of monoculture in vegetable cultivation. However, the widespread use of grafted seedlings increases the costs of producers. Monoculture vegetable production, soil-borne diseases, and nematodes cause significant yield and quality loss (Ece and Çimen, 2013; Sarıbaş, 2019). However, it has been reported by the studies that the soil structure is improved, especially in terms of soil microorganisms and significant advantages are provided in the use of seedlings without grafting and planting on the raised-beds (Öztürk and Özer, 2019; Alagöz et al., 2019).

In order to provide tolerance/resistance to soil-borne diseases in organic agriculture, grafting is an acceptable practice, especially in organic greenhouse vegetable production, as grafting contributes to sustainable agriculture by reducing the number of chemicals in agriculture (Oztekin and Tüzel, 2017).

It is reported that grafted plants continue to develop at low soil temperatures and take more plant nutrients because they have strong root structures (Yetişir et al., 2004; Yarşı and Sarı, 2006). Grafted plants show rapid growth because they are grafted on vigorous rootstocks (Tüzel et al., 2009). However, this strong growth is possible with the suitability of growing conditions and high fertilization. There are limited studies on the different growing conditions (greenhouse and field) and especially organic cultivation of grafted seedlings in tomato cultivation. This study aimed to determine the effects of greenhouse and field conditions of tomato seedlings grafted on different rootstocks on yield and some quality parameters of tomato plants.

2. MATERIAL AND METHOD

2.1. Experimental Site and Plant Materials

The study was carried out in greenhouses (glass and polycarbonate covered) and in an open field located in Ondokuz Mayıs University Faculty of Agriculture Research and Implementation area (41° 37′ 24.71″ N, 36° 21′ 11.02″ E and 137 m altitude) between April 15 and July 1, 2022. In the research, Depar F1 tomato seedlings were grafted on three different rootstocks (*Solanum Lycopersicum* cv. 'Kudret, Hamarat, Pençe').

2.2. Experimental Design and Treatments

In the study, seeds of tomato rootstocks (Kudret, Hamarat, Pençe) and scion (Depar F1) were sown in 210-well viols with 2.6 x 2.6 cm diameter cells. These viols are filled with peat. The seeds of the rootstocks were sown on April 15, 2022, while the scion was sown on April 20, 2022. The viols, in which the seeds were sown, were placed on the growing benches in the heated-glass greenhouse, and five-minute irrigations were aplied three times a day (hours: 10.00, 14.00, 16.00) untill transplanting date. Depar F1 seedlings were grafted on to rootstocks on May 24, 2022 using the tube grafting method. After grafting, tomato seedlings were kept in the intensive care unit created in the glass greenhouse for ten days in an environment containing 25/21 °C and 85% relative humidity. Then the grafted seedlings were transplanted in the greenhouse and open field.

Planting sites were prepared in greenhouses and open fields where tomatoes were not grown in previous years. 2 kg m^{-2} of animal manure was added to the raised-beds prepared with a height of 20 cm and a width of 1 m as the planting site. Drip irrigation pipes with a dripper spacing of 25 cm were placed in the prepared planting places (raised-beds) in a way suitable for double-row planting. Irrigation was carried out with a system that can irrigate according to soil moisture throughout the growing period. Then, black PE mulch was applied over the planting areas. Grafted Depar F1 tomato seedlings were transplanted 50 x 50 cm between and with in the row spacing in double row transplanting system in the glasshouse and open field. Texture analysis of soil samples belonging to the experimental area (greenhouse and field); pH, electrical conductivity, organic matter content, nitrogen, available phosphorus and potassium values were determined according to Kaçar and İnal (2008) (Table 1). Greenhouse and field temperature (°C) and relative humidity (%) (KT100, Kimo, France) values were measured during the seedling growing period (Table 2).

Table 1. Some physical and chemical characteristics of the soil.

	pH	E.C. (dS m^{-1})	O.M. (%)	N (%)	P (ppm)	K (me/100g)
Greenhouse	7.3 b	0.31 a	5.2 b	0.18 b	12.3 a	437
Field	8.0 a*	0.25 b	6.1 a	0.24 a	11.4 b	426

*: $P<0.05$

Table 2. Temperature (°C) and relative humidity values in the greenhouse and field.

	Greenhouse		**Field**	
	Temperature (°C)	**Humidity (%)**	**Temperature (°C)**	**Humidity (%)**
Lowest	16.1	45.6	13.1	26.4
Highest	47.3	89.2	38.3	79.8
Average	28.7	64.4	24.3	62.3

Additional organic fertilization has been made since planting. Organically grown tomato plants were fertilized with the organic plant nutrients (compost water fertilizer) that we prepared. Irrigation was carried out with compost water (500 ml/plant-EC; 1.4 dS m^{-1}) as one application for 15 days. The compost used for fertilization was prepared in the compost pool using the heap method (Inckel et al., 2005). While preparing the compost, tomato stalk waste (25 cm) was used as the primary material. On top of the tomato waste layer, 10 cm high burnt farm manure was added. As the third layer, 2 cm of the garden soil was added. This process was repeated in 3 rows and as a result, a pile of 1.6x0.9x1m was obtained. The resulting heap was watered and covered with the lid on it. Since the compost pool in which the heap is formed is ventilated, the humidity of the heap is constantly controlled. The compost water from the compost prepared in December 2021 became ready for use within three months. Compost water fertilizer analysis; pH, E.C., nitrogen, phosphorus, potassium and sodium values were determined according to Kaçar and İnal (2008) (Table 3).

Table 3. Some chemical characteristics of compost water fertilizer.

		Values
pH		7.73
EC	dS m^{-1}	3.58
Nitrogen	%	0.4
Phosphorus	ppm	6.9
Potassium	ppm	441
Sodium	ppm	25.5

Stem diameter (mm), plant height (cm), and the number of leaves and clusters were measured at 20 day measurement intervals from planting to tomato plants. The final measurement values obtained are given in Table 4.

Weights of fruits harvested from the first to last harvest were measured with a precise balance (±0.1 g). Resultant fresh fruits were used to determine the yield per plant. For fruit firmness (N) measurements, a 1 cm diameter peel was cut shallowly from the firm sections of both sides of the harvested fruits. The resistance against the 7.4 mm penetration of the 5 mm penetrometer (4301, Instron, USA) tip from the cut sections of the fruits was taken as the fruit firmness of the fruit. Soluble solids (SSC) content was measured in fruit juice of ripened fruits with a hand refractometer (ATC-I, Atago, Japan) and expressed as present (%). To determine the titratable acidity (T.A., %) of the fruits, 10 ml fruit juice was diluted with 10 ml distilled water, then 0.1 N sodium hydroxide (NaOH) solution was added until the pH value of 8.1. T.A. was determined in terms of citric acid (g 100 ml^{-1}) equivalent considering the amount of NaOH spent in titration. For the vitamin C content of fruits, 5 g fresh fruit samples were taken, and 0.4% oxalic acid solution was added to make the final volume of the mixture 50 ml. Then the mixture was filtered through a filter paper and the resultant assay was read at 520 nm wavelength in a spectrometer (Kılıç et al., 1991) (Table 5).

In order to analyze the nutrients in fruits, the harvested fruits were sliced and dried by placing them in an oven at 65 °C. The drying process was carried out for at least 64 hours. It was decided whether the drying process was completed by applying the weight change method on the samples that did not complete their drying in this period. Then, 0.5 g of the ground samples were weighed and the ash obtained was dissolved in hydrochloric acid after dry burning at 550 °C for 4-8 hours in the muffle furnace. Fruits nutrient analyses (O.M, N, P, K, Ca, Mg, Fe, Cu, Mn and Zn) were performed following the methods specified in Jones (2001).

2.3. Statistical Analysis

The study was conducted in a Randomized Complete Block Design in split-plot arrangements with three replications. Planting system treatments were placed in blocks and rootstock treatments were placed in plots. In total, 18 plants were measured for each treatment, including six tomato plants in each plot. SPSS 17.0 statistical software was used to analyze experimental results using two-way ANOVA (planting applications × rootstock). Duncan's multiple comparison test compared the differences between treatment means.

3. RESULTS AND DISCUSSION

3.1. Stem Diameter, Plant Height, Number of Leaves and Number of Clusters

Significant effects of different cultivation practices (greenhouse and field) and different rootstock practices on tomato growth were determined. According to the results obtained, significant differences were determined between the plants grown in the greenhouse compared to those grown in the open field ($P<0.05$). When we examine Table 4, an increase of 16% in stem diameter, 67% in plant height, 44% in the number of leaves and 78% in the number of clusters was detected in greenhouse-grown tomato plants compared to the field.

Table 4. The effects of different planting applications (greenhouse and field) and using different rootstocks (Kudret, Hamarat and Pençe) on tomato stem diameter, plant height, number of leaves, and number of clusters values.

Application	Rootstock	Stem Diameter (mm)	Plant Height (cm)	Number of leaves	Number of Clusters
Greenhouse	Kudret	17.4 a	239 a	44 a*	15 a*
	Hamarat	13.3 ab	241 a*	39 a	11 b
	Pençe	18.1 a*	235 a	42 a	12 ab
Field	Kudret	16.6 ab	160 b	30 b	8 c
	Hamarat	14.2 ab	129 c	28 b	7 c
	Pençe	11.2 b	140 c	28 b	7 c
Main Effects					
Application	Greenhouse	16.3 a*	238 a*	42 a*	12.6 a*
	Field	14.1 b	143 b	29 b	7. 1 b
Rootstock	Kudret	16.9 a*	200 a*	37 a*	11.2 a*
	Hamarat	13.8 b	185 b	34 b	8.8 b
	Pençe	14.7 b	187 b	35 ab	9.5 ab

*: $P<0.05$

It has been significant in different studies that temperature has important effects on leaf and plant height, which has important effects on yield (Uzun, 1996; Kandemir, 2005; Özer, 2012). In the studies carried out, it is significant that the light intensity has important effects on the stem diameter and the number of clusters. However, it is reported that light and temperature must be balanced for plant growth. This balance is disrupted in the absence of light and temperature simultaneously or in the absence of one of them. It has been reported that the highest yield, high stem diameter and plant height at a particular optimum are obtained (Cocksull et al., 1992; Uzun, 1996; 2000; 2001; Kandemir, 2005; Özer, 2012). In our study, similar results were obtained. The fact that the plants grown in the greenhouse were grown in higher temperature conditions since the light conditions were the same significantly contributed to the faster growth of the plants. In particular, the higher stem diameter and the number of leaves increased the number of clusters and, therefore the yield significantly (Table 4; 5). When the performances of the rootstocks were examined, it was determined that the Kudret rootstock stood out in all growth parameters compared to the others (Table 4).

3.2. Yield, firmness, SSC, TA and vitamin C

While different growing conditions had significant effects (P<0.05) on yield values, no significant differences were found between rootstocks. According to the results obtained, the highest yield was determined as 9.3 kg plant^{-1} in the plants grown in the greenhouse, while Kudret rootstock came to the fore. In the study where the Depar F1 variety was grown without grafting, the yield values showed a change in the ratio of 1.63-1.78 kg plant^{-1} (Alagöz and Özer, 2019). The yield values of Monroe and Belle tomato varieties grafted on two different rootstocks (P.G. 3 and Beaufort) in greenhouse cultivation were determined as 3.1-4.8 kg plant^{-1} (Maršić and Osvald, 2004). Our study measured it as 3.4-3.6 kg plant^{-1} in the field, while it was determined as 9.1-9.7 kg plant^{-1} in the greenhouse (Table 5).

Table 5. The effects of different planting applications (greenhouse and field) and the use of different rootstocks (Kudret, Hamarat and Pençe) on tomato yield, fruit firmness, soluble solids (SSC), titratable acidity (T.A.) and vitamin C values.

Application	Rootstock	Yield (kg plant-1)	Firmness (kg cm-2)	SSC %	TA %	Vitamin C (mg 100 g-1)
Greenhouse	Kudret	9.7 a	24.9 b	4.2 b	0.17 a	11.1 d
	Hamarat	9.1 a	23.5 ab	4.8 a*	0.16 a	17.0 b
	Pençe	9.2 a	24.8 b	4.3 b	0.16 a	13.0 c
Field	Kudret	3.6 b	26.2 a*	4.0 b	0.14 ab	16.0 b
	Hamarat	3.7 b	21.9 c	4.2 b	0.12 b	22.4 a*
	Pençe	3.4 b	27.1 a	4.1 b	0.11 b	19.5 A

			Main Effects			
Application	Greenhouse	9.3 a*	24.3 b	4.4	0.17 a*	13.5 b*
	Field	3.5 b	25.2 a*	4.1	0.12 b	19.3 a
Rootstock	Kudret	6.6	25.5 a	4.1	0.15	13.3 c
	Hamarat	6.4	22.7 b	4.5	0.14	19.7 a*
	Pençe	6.3	26.0 a	4.2	0.14	16.3 b

*: P<0.05

While the values of titratable acid and vitamin C, among the fruit quality parameters, were measured higher in the greenhouse, the fruit firmness values came to the fore in the field. Significant differences were found between rootstocks in firmness and vitamin C values ($P<0.05$). In vitamin C values, Hamarat rootstock stood out with 197 mg 100 g^{-1}. In a study examining the effects of grafted and un-grafted tomato cultivation on fruit quality, the contents of SSC varied between 4.17% and 4.86%. The fruit SSC contents of grafted plants were lower than those of un-grafted plants (Turhan et al., 2012). In another study, it was reported that the content of SSC in tomato plants grafted on Beaufort rootstock increased significantly compared to un-grafted ones (Mohammed et al., 2009; Turhan et al., 2012). According to our results, SSC contents showed a change between 4-4.8% and similarity with the studies conducted.

The amount of fruit T.A. in the grafted tomato plants changed between 0.12 and 0.17 % in the greenhouse and open field. No significant difference was detected between rootstocks. On the other hand, Turhan et al. (2012) found significant differences in T.A. values in grafted and un-grafted tomatoes and reported that the values varied between 0.3% and 0.39%. In a study with similar results, T.A. values varied between 0.25-0.7%. The study reported that higher values were obtained in grafted tomato plants (George et al., 2004). Ili'C et al. (2014) reported that fruit quality was characterized by titratable acidity increased with high air temperatures. In the study, similar results were obtained. It is thought that T.A. values increase with high temperatures in the greenhouse.

Vitamin C contents in tomatoes were determined at different rates in different studies. Generally, it varies between 7 and 40 mg 100 g^{-1} (Ünlü and Padem, 2009, Turhan et al., 2012; Özer, 2012; Özer, 2017; ; Öztürk and Özer, 2019; Alagöz and Özer, 2019). It is reported that the vitamin C content decreases with grafted seedlings in tomato cultivation (Turhan et al., 2012). They report that using rootstock increases the SSC, TA and Vitamin C values in tomatoes, especially under stress conditions, especially salinity (Francisco et al., 2010). In our study it is obtained similar results for vitamin C values but different for SSC and T.A. (Table 5). It is thought that these results are because the climatic conditions in the field are not optimal for tomato cultivation and the temperature difference between day and night is high.

In addition, this difference in the findings may have been caused by the preferred variety, maturity stage and vegetative development stage of conventionally grown tomatoes (Pieper and Barrett, 2008).

According to the results, the effect of rootstock and growing conditions on fruit firmness values was found to be significant (P<0.05). When the rootstocks were examined, the highest firmness was obtained from the Pençe rootstock with 26.0 kg cm^{-2}, while the highest field-grown plants came to the field with 25.2 kg cm^{-2} compared to the ones in the greenhouse (Table 5). Leafing increases with the formation of solid roots in grafted plants. The increase in leafing accelerates water and nutrient uptake (Haberal et al., 2016). They reported that as the water intake increases in plants, the cell size increases in epidermal tissues and the firmness of fruit flesh decreases in tomatoes (Ünlü and Padem, 2009). In the study, we obtained similar results. The foliation rate was high under greenhouse conditions. The increased foliation rate may have accelerated plant water uptake and decreased fruit flesh firmness.

3.3. Some Chemical Characteristics of the Fruit

Significant effects of grafting tomato plants grown in the greenhouse and field on different rootstocks on O.M, N, Ca, Mg, Fe and Mn of tomato fruits were determined (P<0.05). According to the results obtained, the highest N (1.66%), Ca (249 ppm), Mg (242 ppm) and Fe (56.3 ppm) contents in tomato fruits were measured in greenhouse-grown plants, while the highest O.M (91.2%) and Mn (10.8 ppm) contents were determined in open-grown plants. When we examined the rootstocks, the highest Fe (64 ppm) content was in the Kudret rootstock, the highest N (1.71%), Ca (232 ppm) and Mg (257 ppm) content in the Hamarat rootstock and the highest Mn (11.3 ppm) content in Pençe rootstock determined in fruits (Table 6).

Table 6. Different planting applications (greenhouse and field) and rootstocks (Kudret, Hamarat and Pençe) affect tomato O.M, N, P, K, Ca, Mg, Fe, Cu, Mn and Zn values.

Application	Rootstock	%				ppm					
		O.M	N	P	K	Ca	Mg	Fe	Cu	Mn	Zn
Greenhouse	Kudret	89.9 c	1.35 c	0.17	3.9 c	227 b	258 a*	90.1 a*	19.7 b	8.6 cd	38.2 c
	Hamarat	88.3 d	1.78 a	0.20	4.5 a*	287 a*	241 a	38.3 b	22.3 ab	11.7 b	41.8 a
	Pençe	89.8 c	1.84 a*	0.19	4.2 b	233 b	227a	40.4 b	23.9 a*	9.5 c	40.8 ab
Field	Kudret	91.3 ab	1.42 c	0.20	3.6 d	227 b	58 b	37.9 b	21.1 ab	11 b	4.2 ab
	Hamarat	90.9 b	1.64 b	0.24	3.7 d	177 d	272 a	29.3 b	22.6 ab	8.3 cd	40.1 b
	Pençe	91.5 a*	1.32 c	0.26	3.5 e	202 c	252 a	57.4 ab	21 ab	13.1 a*	32.2 c
Main Effects											
Application	Greenhouse	89.4 b	1.66 a	0.19	4.2	249 a	242 a	56.3 a	21.9	9.9 b	40.3
	Field	91.2 a	1.46 b	0.23	3.6	202 b	195 b	41.5 b	21.5	10.8 a	39.5
Rootstock	Kudret	90.6	1.38 b	0.18	3.8	227 a	158 b	64.0 a	20.4	9.8 b	39.7
	Hamarat	89.6	1.71 a	0.22	4.1	232 a	257 a	33.8 c	22.5	9.9 b	40.9
	Pençe	90.6	1.58 ab	0.23	3.9	218 b	240 s	48.9 b	22.5	11.3 a	38.9

*: P<0.05, organic matter; O.M,

Grafting has been reported to affect the absorption of minerals in plants. It was determined that nitrate, phosphate, calcium and magnesium amounts were higher in cucumber plants grafted on the pumpkin. It has been reported that phosphate absorption decreases at 10 °C in un-grafted cucumber plants, while the oxygen consumption in the roots of grafted cucumber plants is 1.5 times higher than in un-grafted plants (Ertok and Padem, 2007). The effects on plant nutrient uptake were investigated in the Falez Fı melon cultivar grafted on 12 different pumpkin rootstocks. According to the results obtained, it was determined that the grafted plants took more macro and micro elements than the control, except for Mn and K (Yarşı and Sarı, 2006). In their study, Mohammed et al. (2009) determined the significant effects of grafting the Cecilia F1 cultivar on three different rootstocks on fruit nutrient contents. Unlike our study, a significant decrease was found in Ca, Mg, K, Fe, Zn and Mn contents in un-grafted plants for control purposes compared to grafted plants. A study that showed the opposite results of these studies stated that using grafted plants did not significantly affect the nutrient content of tomato fruits (Geboloğlu et al. 2011).

4. CONCLUSION

In the literature, it is stated that grafting increases tomato yield and fruit quality by growing strongly depending on the relationship between rootstock/scion. Vigorous plants take in more nutrients from the soil. This situation increases the inputs. This brings an additional cost as grafted seedlings are already higher than un-grafted ones. Our results in the literature and our study are that grafted plants have high resistance to stress conditions and diseases. This situation supports that it may be better to produce grafted plants using organic farming methods. However, it is stated in the literature that plant nutrition methods in organic agriculture can limit this situation. Our study has detected that grafted plants have shown that they can demonstrate high yield and quality with the use of organic plant nutrients. The yield and quality results we obtained show similar values in soil cultivation using many chemical fertilizers. Researchers should work on increasing the diversity of organic nutrients for successful vegetable cultivation and enrichment of soil vitality/microorganisms. This way, the use of inputs in agriculture will be reduced to reasonable levels and profitability will increase. In addition, the situations that may occur when strongly growing grafted plants are grown in the field and greenhouse have been demonstrated by this study. As a result, it was determined that grafted seedlings should definitely be grown greenhouse.

Conflict of Interest:

The authors declare that there is no conflict of interest.

Ethics:

This study does not require ethics committee approval.

Author Contribution Rates:

Design of Study: AÇT (%20), AKS (%20), AA (%20), MÖÖ (%20), HÖ (%30),

Data Acquisition: AÇT (%30), AKS (%20), AA (%10), MÖÖ (%20), HÖ (%20)

Data Analysis: AÇT (%20), AKS (%20), AA (%20), MÖÖ (%20), HÖ (%20)

Writing up: AÇT (%20), AKS (%30), AA (%10), MÖÖ (%10), HÖ (%30)

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