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EFFECT OF GRAFTING ON YIELD AND FRUIT QUALITY OF PEPPER (*CAPSICUM ANNUUM* L.) GROWN UNDER OPEN FIELD CONDITIONS

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Abstract

The aim of the study, determining of grafting could improve the agronomic behaviour of pepper (Capsicum annuum L.), an open field experiment was carried out to determine growth, yield and fruit quality of long type pepper hybrid cultivar ('Efil'). As a scion plant material was used 'Efil F1' and rootstock 'Guclu F1'. 'Efil/Efil' ('Scion/Scion'), 'Efil/Guclu' ('Scion/Rootstock') and non-grafted 'Efil' ('Sicon') were used as the grafted combination. According to experiment, grafted plants were taller than control (non-grafted). Total yield, fruit number, fruit flesh firmness, fruit weight and stem diameter were influenced by rootstock and grafting. Grafted pepper produced 16% more yield than control plants for 'Efil/Guclu'. A similar trend was also observed on 'Efil/Efil'. The lowest yield recorded on 'Efil' (non-grafted).

***Key words**: grafting vegetable, Capsicum annuum, scion, rootstock.*

INTRODUCTION

Pepper (*Capsicum annuum* L.) is a crop of high economic importance in Turkey. The area of pepper grown in Turkey is 1.141.216 da with 3.414.852 million tons of pepper production (TUIK, 2016). Pepper growing is getting more difficult day by day, because of crop damage due to the specific pathogens, *Phytophthora capsici*, *Verticillium dahliae* and *Meloidogyne* spp. in soil (Morra and Bilotto, 2006; Myung et al., 2006).

One of the major goals in pepper breeding is the development of a cultivar completely resistant to soil-borne diseases. However, that is very difficult to achieve and requires much time and effort.

For the alleviation of soil-borne diseases, cultural practices such as crop rotation and sanitation are recommended, but pesticide is generally applied to control the diseases (Kim et al., 2010; Semi et al., 2010; Tran and Kim, 2010; Yeon et al., 2008). Grafting is an environment-friendly alternative method for disease control (Oka et al., 2004; Rivard and Louws, 2008). Grafting scions onto resistant rootstocks makes it possible to control soil-borne diseases and increase yield of the susceptible cultivar (Lee and Oda, 2003). Recently, the cultivated area of grafted *Solanaceae* and *Cucurbitaceae* have increased tremendously (Lee et al., 2010). At present, grafting is mainly used in order to reduce infections by soil-borne pathogens and to enhance the tolerance against abiotic stresses (King et al., 2008; Louws et al., 2010; Rivero et al., 2003).

One way of avoiding or reducing losses in production caused by pathogens in high-yielding genotypes would be to graft them onto rootstocks capable of reducing soil-borne diseases and increasing yield and fruit quality (Lee, 1994). In order to prevent soil-borne diseases in continuous cropping, peppers are generally grafted onto the rootstocks that are of the same species as scions (*C. annuum* L.) that have resistance to *Phytophthora blight* (King et al., 2010). It was reported that grafting of peppers also improved tolerance to high salt conditions (Chung and Choi, 2002) and low temperature (Jang et al., 2008).

The aim of this study was to investigate and evaluate the agronomic performance of hybrid pepper (scion) under open field conditions following grafting on pepper rootstocks, in comparison with un-grafted and scion self-grafted (scion/scion) plants.

MATERIALS AND METHODS

The F1 hybrid, long type 'Efil' (Asgen, Turkey) was grafted on commercial rootstocks,

‘Guclu’ (Graines Voltz, Türkiye). Un-grafted ‘Efil’cultivar and itself grafting ‘Efil/Efil’ were also used as control.
The cleft grafting was realized when rootstocks and grafts showed six and two true leaves, respectively. Grafted and un-grafted pepper plants were transplanted on 10 April 2016 in open field condition on the Experimental Farm of Suleyman Demirel University.
The experimental soil was loamy (Bouyoucos, 1962) having pH 7.9 (1:2.5 soil to water ratio), 9.5 % $CaCO_3$, 1.1% organic matter (Jackson, 1962), 15.9 mg kg^{-1} $NaHCO_3$ extractable P (Olsen et al., 1954), 125, 266, 375 mg kg^{-1} 1 N NH_4OAC exchangeable K and Ca and Mg (Knudsen et al., 1982). DTPA extractable Fe, Cu, Zn and Mn concentrations (Lindsay and Norwell, 1978) were 2.9, 0.55, 0.89 and 11.9 mg kg^{-1}, respectively.
Treatments were arranged in a randomized complete-block design with three replications, each consisting of 30 plants. Plants were grown in single rows (1.0 m × 0.50 m) at a plant density of 2.5 plants m^{-2}.
Irrigation was applied by drip-irrigation and was scheduled using tension meters to ensure that water was non-limiting (the high and low tension set points were –30 kPa and –1 kPa, respectively).
The irrigation frequency was arranged every morning. The Following nutrient content; (mg/L): N: 100; K: 50; P: 60; Mg: 30; Ca: 30; Fe: 3.0, Mn: 2.0; Zn: 0.25; B: 0.70; Mo: 0.05 was used during the experiment.
During the experiment, pH 6-7 and EC 1.2-1.8 were set.
Plants were kept free from weeds, insects, and diseases using standard growing management. The experiment was terminated after 120 days from transplanting, plant height was recorded on eight plants per plot. Mature green fruits were harvested regularly every week.
Fresh weight of marketable fruits, fruit number, length, and diameter were recorded on 20 plants per plot. Fruits that were deformed or badly misshapen were considered unmarketable. Fruit shape index (SI), defined as the ratio between width and length was also calculated. Three representative marketable fruits of each plot were analyzed for fruit quality parameters.
All data were statistically analyzed by ANOVA using the MINITAB software package.

RESULTS AND DISCUSSIONS

Plant height was not significantly influenced by grafting combination while plant diameter affected significantly by grafting (Table 1). Grafted plants were 9 and 15% thinner scion diameter than control for ‘Efil/Efil’ and ‘Efil/Guclu’, respectively.
Among the combination, the greatest plant diameter was recorded on non-grafted plant ‘Efil’. The plant height was slightly influenced by grafted (Table 1).

Table 1. Effect of grafting combination on plant diameter (mm) and plant height (cm)

	Plant diameter (mm)			Plant height (cm)		
Efil	12.83 A	±	0.14	58.55	±	0.82
Efil/Efil	11.65 B	±	0.15	60.82	±	0.77
Efil/Güçlü	10.87 C	±	0.20	59.23	±	0.97

There was no differences determinate plant fresh and dry weight between grafted and non - grafted plants (Table 2).

Table 2. Effect of grafting combination on plant fresh and dry weight (g)

	Plant fresh weight (g)			Plant dry weight (g)		
Efil	190.7	±	6.86	40.59	±	1.39
Efil/Efil	190.6	±	5.75	40.58	±	1.70
Efil/Güçlü	179.2	±	6.66	36.23	±	1.22

Generally, it has been reported that grafting promotes vegetative growth at different levels dependent on rootstock (Colla et al., 2008). Promoted vegetative growth (plant height) was explained by the vigorous root system of rootstocks, which are often capable of absorbing water and plant nutrients more efficiently than scion roots and serve as a good supplier of endogenous hormones (Kato and Lou, 1989).
But, in this study, we could not determinate highly differenceson vegetative grown such as plant height and fresh weight etc., and between grafted and non-grafted plants.

This situation can be explained by the fact that there is no good combination between the scion and the rootstock.

Table 3. Effect of grafting combination on fruit length (cm) and fruit stem length (cm)

	Fruit length (cm)			Fruit stem length (cm)		
Efil	19.12 A	±	0.19	2.117	±	0.05
Efil/Efil	18.38 B	±	0.17	2.183	±	0.05
Efil/Güçlü	17.58C	±	0.24	2.075	±	0.04

Fruit length was significantly influenced by rootstock; whereas no significant difference was observed on fruit stem length, fruit length (Table 3) fruit diameter and fruit flesh diameter (Table 4).

Table 4. Effect of grafting combination on fruit diameter (mm) and dry fruit flesh diameter (g)

	Fruit diameter (mm)			Fruit flesh diameter (mm)		
Efil	23.475	±	0.33	2.457	±	0.04
Efil/Efil	23.168	±	0.38	2.462	±	0.04
Efil/Güçlü	22.339	±	0.48	2.426	±	0.06

Total yield was influenced by rootstock, whereas fruit weight was not affected by grafting. The highest yield was obtained by the combination 'Efil/Guclu', while the lowest value was recorded on the control (non-grafted) and 'Efil/Efil' (grafted itself) (Table 5).
Grafted rootstock ('Efil/Guclu') produced around 12% more yield than control plant (Table 5).

Table 5. Effect of grafting combination on fruit weight (g) and total yield (kg/plant)

	Fruit weight (g)			Total Yield (kg/plant)		
Efil	32.98	±	0.70	0.66	±	0.09
Efil/Efil	33.22	±	0.70	0.66	±	0.04
Efil/Güçlü	31.12	±	1.18	0.75	±	0.10

It was demonstrated that grafting per se directly affects plant yield (Nielsen and Kappel, 1996). Its influence can be exerted by the interaction of some or all of the following processes: increase of water and nutrient uptake due to the rootstocks vigorous root system (Lee, 1994), enhanced production of endogenous-hormones (Zijlstra et al., 1994), and enhancement of scion vigor (Leoni et al., 1990).
The joint action of some or all of these processes could explain the higher yield in pepper from grafted plants. There are some reports that certain rootstocks may cause deterioration in fruit quality (Lee, 1994).

CONCLUSIONS

In the present study, some of qualities such as fruit length, fruit stem length, fruit diameter, fruit flesh diameter were not affected by grafted combination. Therefore, the use of grafted pepper plants under open field conditions would represent a potential strategy for an increase in total yield and some of the soil diseases without having remarkable deterioration in the taste of the peppers.

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