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BIOMASS NUTRIENT CONCENTRATION AND UPTAKE OF GRAFTED AND NON-GRAFTED PEPPER PLANTS

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Abstract

Study was conducted to compare nutrient concentrations and nutrient uptakes of grafted and non-grafted pepper. The F1 hybrid, long type 'Efil' (Asgen, Turkey) was grafted on commercial rootstocks, 'Guclu' (GrainesVoltz, Türkiye). Un-grafted 'Efil'cultivar and itself grafting 'Efil/Efil' were also used as control. The experiment was conducted until the harvest. Plants were fertigated during the growth periods containing Hoagland nutrient solution. After the harvest, ten plants were cut above ground the soil randomly. Each plant was cleaned, dried, weighted and analyzed for mineral element. Results showed that plant dry weight did not vary depending on the grafting. Plant P and Ca concentrations obtained from the grafted and non-grafted peppers significantly varied each other; however, other nutrient concentrations did not vary significantly. Although, plants P, Ca and Cu uptakes showed variation between grafted and non-grafted peppers, other nutrient uptakes were not affected from the grafting.

Key words*: grafting, growth, tomato, nutrient concentration.*

INTRODUCTION

In order to meet increasing food demands of growing population in the world, some attempts are being provided in horticulture as in other agricultural production systems. Decreasing of fertile agricultural soils, non-favorable soil, environmental and climatic conditions, increasing costs of agricultural inputs, etc. force the agriculturists to develop new ways. Vegetable grafting is one of the ways to obtain high quality fruit yield. Although, basic reason of grafting was to prevent the plants from soil pathogens in the past (Lee, 1994), some other benefits were realized over the years. While, some researchers used the grafts to increase resistances against low and high temperatures (Rivero et al., 2003; Venema et al., 2008), some researchers used to increase plant nutrient uptake (Ruiz et al., 1997a; Colla et al., 2008), synthesis of endogenous hormones (Dong et al., 2008). Rouphael et al. (2008) indicated the improvement in efficient water use in grafted plants. Also, plants become resistant to soil pollutants (Otani and Seike, 2006), some element toxicity (Edelstein et al., 2005; Rouphael et al., 2008; Arao et al., 2008) and salt and flooding injury with grafting (Fernández-García et al., 2004; Martinez-Rodriguez et al., 2008).

There are some different reports conducted on the examinethe effectiveness of rootstock and scion effects on mineral nutrient concentrations of a variety. According to the findings of some researchers indicates that rootstock and scion has an important role on foliar nutrient concentrations and nutrient uptakes of fruits (Poling and Oberly,1979; Tagliavini et al., 1992; Kucukyumuk and Erdal, 2009; Kucukyumuk and Erdal, 2011). Results of the Ruiz et al. (1997b) show that there was a little changes in leaf nutrient concentrations between different rootstocks. They also indicated the strong relationship between the variations in foliar concentrations of N and Na and yield differences in grafted plants. According to the results of Khah et al. (2006), fruit Ca concentration in grafted tomato was greater than in the fruits of un-grafted tomato cv. Similarly, Tsouvaltzis et al. (2004) indicated that fruit mineral concentration increased, when tomato cv. was grafted. Rouphael et al. (2008) showed that grafted watermelon plants had

similar fruit P and Ca concentrations, where as K and Mg concentrations were significantly improved by both irrigation rate and grafting combination. But there are also many studies indicating the ineffectiveness of grafting. Chaplin and Westwood (1980), working with grafted fruit trees, found no evidence that the different rootstocks used caused variability in leaf nutrients. Proietti et al. (2008) reported no difference in the nitrate concentrations between grafted and un-grafted watermelon pulps. Similarly, Colla et al. (2010) indicated that the nitrate concentration of melon fruits did not vary with grafting. Fernandez- García et al. (2004) were detected no significant differences in nitrate concentration of tomato fruits in both grafted and un-grafted plants.

The aim of the present work was to investigate the differences of biomass nutrient concentrations and nutrient uptakes between grafted and non-grafted pepper plants under field conditions feed by nutrient solution.

MATERIALS AND METHODS

The F1 hybrid, long type 'Efil' (Asgen, Turkey) was grafted on commercial rootstocks, 'Guclu' (GrainesVoltz, 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 05 April 2016 in open field condition on the Experimental Farm of Suleyman Demirel University.

Study was planned according to the randomized parcels with 10 replicates under field condition and plants were fertigated with Hoagland solution during the growth period. At the end of the harvest, plants were pulled up from the soil and bought the laboratory.

Then, plants were cleaned with top water; roots were omitted and above ground biomass were washed with dilute acid and pure water to remove surface residuals. After, plants were dried at 70°C until the stable weight was reached.

Finally, dried plant materials were weighted, grounded and wet digested with microwave oven for nutrient analysis. Phosphorus concentrations of samples were determined with a spectrophotometer (Shimadzu UV-1208) at 430 nm according to the vanadomolybdo phosphoric acid method.

Potassium, Ca, Mg, Fe, Cu, Zn, and Mn concentrations were determined using atomic absorption spectrophotometer (Varian AA240 FS).

The experimental soil was loamy (Bouyoucos, 1951) 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} NaHCO3 extractable P (Olsen et al., 1954), 125, 266, 375 mg kg^{-1} 1N 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.

All data were submitted for statistical analyses using MSTAT program for one-way analysis of variance applied to determine any significant difference at 0.05%.

RESULTS AND DISCUSSIONS

Dry weight

Plant dry weights and nutrient concentrations

Plant dry weight varied between 43.7 g and 49.8 g but these variations did not make any statistical sense. Plant nutrient variations were between 0.12%-0.14% for P, 3.58%-3.72% for K and 0.51%-0.55% for Mg.

As could be seen from these values, there were small differences between grafted and non-grafted peppers but, these differences also were not significant. Only Ca concentrations showed significant differences and the highest Ca was determined with the grafting of cv. 'Efil' on its own rootstock. Grafting of cv. 'Guclu' on the rootstock-'Efil', gave the lowest Ca amount. There was not significant variation between grafted and non-grafted 'Efil' varieties as well (Table 1).

Biomass micronutrient concentrations were given in Table 2. As could be seen from there, only Cu concentrations were significantly affected from the grafting.

While non-grafted 'Efil' cultivar has the highest Cu value (9.8 mg kg^{-1}), other grafted materials have lower Cu value and they took place in the same statistical group.

Table 1. Dry weight and macro nutrient concentrations of grafted and non-grafted pepper plants

Variety	DWg	Nutrient concentrations, %			
		P	K	Ca	Mg
Efil	49.8	0.12	3.72	0.37 AB*	0.51
Efil/Efil	45.5	0.13	3.68	0.41 A	0.55
Efil/Guclu	43.7	0.14	3.58	0.33 B	0.51

*shows the differences between grafted and non-grafted plants($P<0.05$); there is not a significant differences between the values shearing the same letters.

Table 2. Micro nutrient concentrations of grafted and non-grafted pepper plants

Variety	Nutrient concentrations, mg kg^{-1}			
	Fe	Zn	Mn	Cu
Efil	194	184	149	9.8 A*
Efil/Efil	206	180	144	8.5 B
Efil/Guclu	215	177	154	8.0 B

*shows the differences between grafted and non-grafted plants ($P<0.05$); there is not a significant differences between the values shearing the same letters.

Biomass nutrient uptake

Plant nutrient removal by above ground biomass of pepper plants was given in Table 3. As could be seen from there, most of the nutrients removed by upper part of plant such as P, K, Mg, Fe, Zn and Mn, did not vary with grafting. Only, Ca and Cu removal of pepper plants by above ground biomass changed with grafted and non-grafted plants.

Looking at the results it can be said that there were not significant differences betweeen grafted and non-grafted 'Efil' pepper cultivar in terms of growth, most nutrient concentrations and uptakes. These results might seem not to be in the accordance with the most studies conducted on rootstock and scion. But there might be several reasons of this. The first reason in this study might be the fertilization type. As indicated before, plants were fed with the nutrient solution during the growth period. So, plants received nutrients easily from the media without needing rootstock or scion root's performance. The other reason of these results may be due to the similarities in the root systems between rootstocks (Ioannou et al., 2002; Kacjan-Marsic and Osvald, 2004). As known, root system of the plants affects vegetative growth, yield, water and nutrient uptakes. Some of the researchers explain the importance of harmony between the rootstock and scion on vegetables growth and nutrition (Leonardi and Giuffrida, 2006). As mentioned by Romano and Paratore (2001), vegetable grafting does not improve the yield when the selection of the rootstock is not suitable.

CONCLUSIONS

As conclusion, there were no differences between grafted and non-grafted pepper variety used in this study in terms of plant growth, nutrient concentration and nutrient uptake.

Table 3. Nutrient uptake of grafted and non-grafted pepper

Variety	Nutrient uptake							
	g $plant^{-1}$				mg $plant^{-1}$			
	P	K	Ca	Mg	Fe	Zn	Mn	Cu
Efil	0.060	1.85	0.18 AB*	0.25	9.66	9.16	74	0.49 A
Efil/Efil	0.059	1.67	0.19 A	0.25	9.37	8.19	66	0.39 B
Efil/Guclu	0.061	1.56	0.14 B	0.22	9.40	7.73	67	0.35 B

*shows the differences between grafted and non-grafted plants ($P<0.05$); there is not a significant differences between the values shearing the same letters.

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