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EVALUATION OF HYBRID STOCKS ON VIGOR, YIELD AND QUALITY OF WATERMELON

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Abstract

In this study, the influence of two hybrid rootstocks with different scions on watermelon plant vigor, fruit yield and quality were studied. Also, grafted plants were compared with non-grafted ones. The present research was conducted in Odemis, Izmir, in western Turkey. The trials were set up in randomised complete block design with four replications. The watermelon cultivars Crisby and Crimstar were grafted onto Ferro and RS 841, commercial hybrids of *Cucurbita. maxima x Cucurbita moschata*. Grafted plants increased root length (80-95%), main stem length (36-67%) and number of lateral vine (36-42%). It was determined that grafted plants had 115 % more yield and 27 % more fruit weight than control. There was a difference among hybrid rootstock-scion combinations, grafting Crimstar onto Ferro produced the highest main stem length and yield. There were not detected any significant effect of grafting and rootstock-scion combinations on fruit index, rind thickness and total soluble solids. It can be concluded that grafting, in watermelon plants positively affected plant growth and yield without quality losses. These effects were changed by rootstock-scion combinations being used. Therefore rootstock-scion combinations should be carefully selected for specific climatic and geographic conditions. Appropriate selection can help increase yield and improve plant vigor in commercial watermelon fields.

Keywords: *Grafting, rootstock-scion combinaton, yield, quality*

Introduction

Watermelon is an important vegetable with a global production of 103.0 Mt and it’s being cultivated in wide areas thorough the world with an area of 3.50 M ha^{-1}. Turkey is one of the main producers of watermelon along with China, Iran, Brazil, Egypt and United States (FAO, 2011).

One of the problems related to intensive watermelon yield is the increase of soil-borne diseases. There are different ways to prevent soil-borne diseases such crop rotation, breeding programs, soil fumigant (methyl bromide). These management practices have some disadvantages. The grafting technique seems to be an effective solution when genetic and chemical approaches for disease management are not available (Oda, 2002a,b). Except controlling soil-borne diseases, grafting may enhance tolerance to abiotic stresses, increase yield and result in more efficient water and nutrient use; extend harvest periods, and improve fruit yield and quality (Shimada and Moritani, 1977; Romero et al., 1997; Oda 2002a,b; Trionfetti-Nissini et al., 2002; Lee and Oda, 2003; Rivero et al., 2003; Hang et al., 2005). For

these purposes, watermelons are grafted on *C. maxima, C. moschata, C. pepo, B. hispida, L. siceraria,* squash interspecific hybrids and *Sicyos angulatus* species (Davis et al., 2008a). The effects of rootstocks can show great differences with different scion cultivars. Martinez-Ballesta et al. (2010) reported that graft incompatibility usually occurs at early stages, when vascular connections are forming, but it can appear as late as the fruiting stage, when the

plant has high demand for water and nutrients. Graft incompatibility and decrease in the fruit yield and quality may appear depending on the combination of scion and rootstock. The scion variety obviously affects final size, yield and quality, but rootstocks effects drastically alter these characteristics (Tamada, 1989; Lee, 1994; Edelstein, 1999; Lee and Oda, 2003; Hagihara, 2004).

The objective of this study was to evaluate the influence of two hybrid rootstocks with different scions on watermelon plant vigor, fruit yield and quality.

Materials and methods

The study was carried out in the experimental fields of Odemis Vocational Training School, Ege University, Izmir (38°16 ′N; 27°59 ′E; 123 m above sea level) during 2007. Climatic conditions during the experiment were given in Figure 1. The experiments were conducted in the plastic greenhouse (Experiment 1) and in the field (Experiment 2). The watermelon cultivars (Crispy and Crimstar) which are widely grown in the area, were grafted onto 'Ferro' and 'RS-841', commercial hybrids of *C. maxima x C. moschata*. Non-grafted plants were used as control in both experiments. The soil was neutral in reaction, without problems of total salt, loamy sand in structure, and low in lime and organic material.

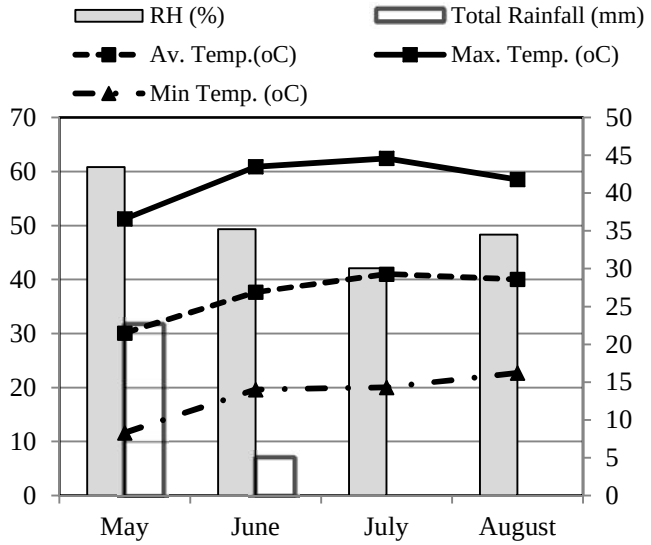

Figure 1. Climatic conditions during 2007.

In experiment 1, the grafted and non-grafted seedlings were planted to the 8 l plastic bags under plastic greenhouse on 15 May. These plants were used for plant growth measurements. A randomized complete block design was followed by three replicates, each consisting of 10 plants. Three plants representing each replicate were rooted for 30 days after planting as recommended by Yetişir and Sarı (2004). Root length (cm), main stem length (cm) and number of lateral vine were determined.

In experiment 2, the grafted and non-grafted seedlings were planted to the soil on 18 May under open field conditions. Plants were spaced at 2 m between plants and 2 m between rows, with a density of 2500 plants/ha. Plants were fertilized with equivalent to 150 kg N, 120 kg P_2O_5, 200 kg K_2O and 150 kg $Ca(NO_3)_2$ per hectare during growing season. The furrow irrigation was applied as needed and other cultivation practices were conducted. The experimental design was a randomized complete blocks. Each treatment was replicated four times, with 15 plants in each replicate. Ten fruits from each replicate were chosen to determine the yield and quality measurements. Harvests were performed 3 times from the end of the July to the end of the August. Marketable fruits were collected at ripening and the

following measurements were recorded: fruit yield (t/ha^{-1}), fruit weight (kg/fruit), fruit index (fruit length/fruit diameter), thickness of rind (mm) and total soluble solids concentration (^{o}Brix). The soluble solids content of the juice obtained from the central endocarp was determinated with the use of a refractometer.
Analysis of variance was performed using SAS statistical program (SAS, 1996) and significant differences between applications were compared using orthogonal statistical design.

Results and Discussion

The vigor, yield and quality performances of grafted and non-grafted plants are given in Table 1. The results showed that growth performance of grafted plants was significantly influenced by grafting and main stem length affected by rootstock-scion combinations. Control plants had the shortest root length with 20.7 cm when compared to the grafted plants. No differences were found between rootstock-scion combinations for root length. Main stem length significantly affected grafting and also Ferro/Crimstar at 312 cm produced the highest main stem length. Number of lateral vine was significantly influenced by grafting and rootstock-scion combinations had similar number of lateral vine. Grafted plants produced more lateral vine (5 lateral vine/plant) than non-grafted control plants (3 lateral vine/plant).
Yield characteristics of grafted and control watermelon plants are presented in Table 1. Yield affected by grafting and rootstock-scion combinations. Control plants had the lowest yield with 15.82 t/ha^{-1} when compared to the grafted plants. Yield of Crimstar on to Ferro at 36.05 t/ha^{-1} was significantly higher than other grafted plants. The mean fruit weight was also significantly affected by grafting but non-significant differences in fruit weight were found between rootstock-scion combinations (Table 1). The highest fruit weight was obtained from the grafted plants with a weight of 4.8/4.9 kg, whereas fruit from the control plants weighed 3.8 kg. The results of the effect of grafting and rootstock-scion combinations on watermelon plants represented that grafting enhanced vigorous root system resulting in growth promotion and yield. Many authors stated that grafting affected growth and yield (Chouka and Jebari, 1999; Salam et al., 2002; Yetişir et al., 2003; Yetişir and Sarı, 2004; Miguel et al., 2004; Alan et al., 2007). These increases can be explained advantages of grafting plants; tolerance of low temperature, tolerance of salinity, enhanced water and inorganic nutritient uptake (Rivero et al., 2003). On the other hand, these positive effects of grafting influenced by rootstock-scion combinations. Present results supported that Crimstar on to Ferro had the highest main stem and yield. Most reports on grafting suggest that changes in the scion are controlled by the rootstock through controlled uptake, synthesis and translocation of water, minerals and plant hormones (Davis et al., 2008a). On the other hand, plant hormones are important endogenous factors which regulate aspects of plant vegetative and reproductive development and thus are believed to be important player in root-shoot communication. Hormonal factors affecting rootstock contribution to the scion performance and rootstock-scion interactions under abiotic stresses (Aloni et al., 2010).
Fruit quality characteristics such as fruit index, rind thickness and soluble solids were not significantly affected by grafting and rootstock-scion combinations (Table 1). There were significant differences between cultivars for rind thickness. Rind thickness of Crisby at 14.0 mm was significantly higher than Crimstar (12.3 mm). There are many conflicting reports on changes in fruit quality resulting from grafting. It has been reported that grafting may have adverse effects on fruit quality, especially depend on rootstocks (Lee, 1994; Nissini et al.,
Table 1. The vigor, yield and quality characteristics of grafted and non-grafted watermelon plants.

Root length (cm)				**Main stem length (cm)**		
Treatments	Crisby	Crimstar	Mean	Crisby	Crimstar	Mean
Control	21.2	20.2	20.7	194	148	171
Ferro	36.8	43.8	40.3	258	312	285
RS 841	39.6	34.8	37.2	230	234	232
Mean	32.5	32.9		227	231	
T:p<0.01	C:n.s	T*C:n.s.		T:p<0.01	C:n.s.	T*C:p<0.05
No. of. lateral vine				**Yield (t/ha^{-1})**		
Control	3.2	3.4	3.3	17.22	14.41	15.82
Ferro	4.4	5.0	4.7	32.69	36.05	34.37
RS 841	4.5	4.4	4.5	33.90	33.62	33.76
Mean	4.0	4.3		27.94	28.03	
T:p<0.01	C:n.s	T*C:n.s		T:p<0.01	C:n.s.	T*C:p<0.01
Fruit weight (kg/fruit)				**Fruit index**		
Control	3.6	3.9	3.8	1.10	1.11	1.11
Ferro	4.5	5.0	4.8	1.13	1.17	1.15
RS 841	4.9	4.8	4.9	1.16	1.13	1.15
Mean	4.3	4.6		1.13	1.14	
T:p<0.01	C:n.s.	T C:n.s.		T:n.s.	C:n.s.	T*C:n.s.
Rind thickness (mm)				**TSS (%)**		
Control	13.3	11.3	12.3	8.7	8.8	8.7
Ferro	13.3	12.7	13.0	8.2	8.7	8.5
RS 841	15.3	13.0	14.2	9.0	8.7	8.9
Mean	14.0	12.3		8.6	8.7	
T:n.s.	C:p<0.05	T*C:n.s		T:n.s.	C:n.s.	T*C:n.s.
T: Treatments C:Cultivar n.s: Non significant				T*C:Treatments*Cultivar		

2002; Traka-Mavrona et al., 2000; Davis et al., 2008b) but in our experiments, we could not determinate any detrimental effect of grafting and rootstock-scion combinations on fruit quality. Similar results were also reported by Yetişir et al. (2003) and Miguel et al. (2004). The differences in reported results may be attributable in part to different production environments, type of rootstock-scion combination used and harvest date. It was suggested that this discrepancy in the literature demonsrated the importance of optimizing rootstock-scion combinations for each cropping environment (Ruiz et al., 1997).

Conclusion

It can be concluded that grafting, in watermelon plants positively affected plant growth and yield without quality losses. These effects were changed by rootstock-scion combinations being used. Therefore rootstock-scion combinations should be carefully selected for specific climatic and geographic conditions. Appropriate selection can help increase yield and improve plant vigor in commercial watermelon fields.

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