ISSN : 1812-5379 (Print)
ISSN : 1812-5417 (Online)
http://ansijournals.com/ja

JOURNAL OF AGRONOMY

ANSInet
Asian Network for Scientific Information
308 Lasani Town, Sargodha Road, Faisalabad - Pakistan

Journal of Agronomy 6 (2): 362-365, 2007
ISSN 1812-5379

Effect of Grafting on Watermelon Plant Growth, Yield and Quality

Özlem Alan, Nilay Özdemir and Yasemin Günen
Ege University, Ödemiş Vocational Training School, 35760, Izmir, Turkey

Abstract: In this study, the effect of different rootstocks on watermelon plant growth, fruit yield and quality were studied by comparing grafted plants with non-grafted ones under low tunnels for early production and later open field growing conditions. The watermelon (*Citrullus lanatus* (Thunb.) *Matsum and Nakai*) cultivar Crispy was grafted onto TZ-148 and RS-841, commercial hybrids of *C. maxima x C. moschata* and an experimental rootstock (*Lagenaria siceraria*) cv. 64-18. Non-grafted plants were used as control. Grafting significantly affected plant growth. Control plants had short main stem, less number of lateral vine and low root dry weight. Fruit yield was positively influenced by grafting when compered with the control under two growing conditions. There was a difference among grafted plants, 64-18 was significantly poor for yield characteristics than the other rootstocks. Detrimental effects were not determinated in fruit quality such as fruit index, rind thickness and soluble solid contents on grafted plants. These results showed that the use of grafting can be an advantageous alternative in watermelon production. Grafted plants improved plant growth and yield without any harmful effects on fruit quality. The positive effects of grafting can change according to the rootstock being used.

Key words: Watermelon, grafting, plant growth, yield, quality

INTRODUCTION

Watermelon is an important vegetable and it's being cultivated in wide areas thorough the world. Soil-borne diseases may cause a decrease in cultivated area of this important crop. Yield and quality may heavily affected in infested soils either early cultivation under low plastic tunnel or later field production conditions. There are different ways to prevent soil-borne diseases such as crop rotation, breeding programs, soil fumigant (methyl bromide) (Yetişir and Sarı, 2004; Rivero *et al*., 2003). These management practices have some disadvantages. Thus, the selection of resistant rootstocks to soil pathogens seems to be an effective solution.

According to Lee (2003), grafting is an important technique for vegetable production and has become a common practice in many parts of the world, especially Korea, Japan, and some other Asian and European countries where sustainable production is performed. In Turkey, vegetable grafting has recently increased, primarily for tomatoes and watermelons. The use of grafted watermelon has increased about 3, 8 times in the last three years (Atasayar, 2006).

Except controlling soil-borne diseases, grafted plants which have stronger root systems can be used to increase low temperature tolerance and yield and reduce fertilizer and agrochemical application (Yetişir *et al*., 2003; Rivero *et al*., 2003). For these purposes, watermelons are grafted on *C. maxima*, *C. moschata*, Benincasa hispida and *Lagenaria siceraria* species as rootstocks. The rootstocks can influence plant growth, yield and fruit quality. The effects of rootstocks can show great differences with different scion cultivars. Graft incompatibility and decrease in the fruit quality may appear depending on the combination of scion and rootstock (Lee, 1994; Edelstein, 1999; Lee and Oda, 2003).

In the present study, the influence of grafting on different rootstocks of watermelon plants growth, fruit yield and quality under low plastic tunnel for early production and later open field conditions.

MATERIALS AND METHODS

The experiments were conducted in the plastic greenhouse (Experiment 1) and in the field (Experiment 2) during 2006 at the Ege University, Ödemiş Vocational Training School in Turkey. The watermelon (*Citrullus lanatus* (Thunb.) *Matsum* and *Nakai*) cultivar Crispy was grafted onto TZ-148 and RS-841, commercial hybrids of *C. maxima x C. moschata* and an experimental rootstock (*Lagenaria siceraria*) cv. 64-18. Non-grafted plants were used as control in both experiments. The soil was sandy loam (69% sand; 24% loam with 1.6% organic matter and pH 7.3.

Corresponding Author: Özlem ALAN, Ege University, Ödemis Vocational Training School, 35760, Izmir, Turkey
Tel: +90 232 5453272 Fax: +90 232 5444356

Table 1: Plant growth characteristic of grafted and non-grafted watermelon plants (Experiment 1, C: Crispy)

Treatment	Root length (cm)	Main stem length (cm)	No. of lateral vine	Root dry weight (g)
C (control)	63.00b	112.00b	4b	13.57b
C/64-18	69.00b	188.33a	9a	16.88b
C/TZ-148	67.33b	195.00a	9a	21.30a
C/RS-841	76.33a	205.33a	9a	24.33a
LSD 5 (%)	6.69	48.10	1.29	4.36

Within each column, same letter indicates the absence of significant differences at $p = 0.05$

Table 2: Yield characteristic of grafted and non-grafted watermelon plants (Experiment 2, C: Crispy)

	Fruit yield (kg/plant)		Number (fruits/plant)		Fruit weight (kg/fruit)	
Treatment	Low tunnel	Open field	Low tunnel	Open field	Low tunnel	Open field
C (control)	7.25b	8.98c	1.78b	1.48c	4.08c	6.45
C/64-18	10.95b	14.20b	2.28b	2.35b	4.60b	6.28
C/TZ-148	17.70a	18.95a	3.60a	3.38a	4.93b	6.15
C/RS-841	20.13a	17.95a	3.70a	3.75a	5.43a	6.35
LSD 5 (%)	4.48	2.76	0.84	0.66	0.41	NS

Within each column, same letter indicates the absence of significant differences at $p = 0.05$; NS: Non significant

In experiment 1, the grafted and non-grafted seedlings were planted to the 8 L plastic bags under plastic greenhouse on 5 April. These plants were used for plant growth measurements. A randomized complete block design was followed by three replicates, each consisting of 5 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), number of lateral vine and root dry weight (g) were determined. Roots were weighed for fresh weight and placed in drying oven with circulating air at 65°C for 48 h than weighed for dry weight.

In experiment 2, the grafted and non-grafted seedlings were planted to the soil on 5 April under low plastic tunnel and on 16 June open field conditions. Plants were spaced at 2 m between plants and 2 m between rows, with a density of 2500 plants/ha. The tunnels were removed when the temperature was suitable (20-25°C) for watermelon. 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 average maximum and minimum temperatures during the whole growing season were 40 and 16°C. The experimental design was a randomized complete blocks. Each treatment was replicated four times, with 10 plants in each replicate. Ten fruits from each replicate were chosen to determine the yield and quality measurements. Harvests were performed 3 times in both conditions and from middle of June to mid-July under low plastic tunnel production and from the end of the August to mid-October under open field conditions. Marketable fruits were collected at ripening and the following measurements were recorded: fruit yield (kg/plant), fruit weight (kg/fruit), number of fruits per plant, fruit index (fruit length/fruit diameter), thickness of rind (mm) and total soluble solids concentration (°Brix). The soluble solids content of the juice obtained from the central endocarp was determined with the use of a refractometer.

Analysis of variance was performed using SAS statistical program (SAS, 1996) and mean differences were determinated by LSD test.

RESULTS AND DISCUSSION

The growth performance of grafted plants were compered to non-grafted control plants. The results showed that root length, main stem length, number of lateral vine and root dry weight were significantly influenced by grafting (Table 1). Root length of C/RS-148 at 76.33 cm was significantly higher than other grafted and control plants. The main stem length was also affected by grafting. Control plants had the shortest main stem with 112 cm when compared to the grafted plants. Number of lateral vine gave similar results as main stem length. Grafted plants produced more lateral vine (9 lateral vine/plant) than non-grafted control plants (4 lateral vine/plant). Root dry weight was significantly affected and C/RS-841 and C/TZ-148 produced the highest root dry weight while C/64-18 and control had the lowest dry weight. The effect of the grafting on watermelon growth characteristics indicated that grafting affected root and vegetative development of watermelon plants but there is difference between rootstocks in root dry weight. TZ-148 and RS-841 commercial rootstocks produced stronger root systems than an experimental rootstock 64-18.

Yield characteristics of grafted and non-grafted watermelon plants are presented in Table 2. Under both growing conditions, fruit yield affected by grafting. C/TZ-148 and C/RS-841 produced higher yields than the control

Table 3: Quality characteristic of grafted and non-grafted watermelon fruits (Experiment 2, C: Crispy)

	Fruit Index		Rind Thickness (mm)		TSS (%)	
Treatment	Low tunnel	Open field	Low tunnel	Open field	Low tunnel	Open field
C (control)	1.03	1.16	11	11.25	9.70	11.13a
C/64-18	1.03	1.20	12	14.00	9.78	9.75b
C/TZ-148	1.03	1.21	12	13.25	9.68	9.08b
C/RS-841	1.03	1.22	12	12.75	9.28	10.20ab
LSD 5 (%)	NS	NS	NS	NS	NS	1.32

Within each column, same letter indicates the absence of significant differences at p = 0.05; NS: Non significant

and C/64-18. Control plants with 7.25 kg under low tunnels and 8.98 kg open field conditions had the lowest fruit yield. Significant differences were found in the fruit number per plant between controls and grafted plants under low tunnel and open field conditions (Table 2). Grafted plants produced the highest number of fruits per plant except C/64-18 which was significantly lower than the other rootstocks. The mean fruit weight was also significantly affected by grafting under low plastic tunnel conditions but growing in open field conditions, non-significant differences in fruit weight were found (Table 2). The highest fruit weight was obtained from the C/RS-841 with a weight of 5.43 kg, whereas fruit from the control plants weighed 4.08 kg under low plastic tunnel growing conditions.

The results of the effect of grafting on watermelon plants represented that this technique enhanced vigorous root system resulting in growth promotion and yield increases in both growing conditions. 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). 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 different rootstocks. TZ-148 and RS-841 commercial hyrid rootstocks provided vigorous plant and an increase in the yield but an experimental rootstock 64-18 caused weaker plant growth and lower yield. As its known plant vigour was closely related to root systems which supply enough water and plant nutrients to the scion. Root dry weight is one of the indexes that measures root vigour. Present results supported that 64-18 had poorer root system (Table 1). Although other yield characteristics were not affected by growing conditions, fruit weight affected. Under low plastic tunnel conditions where low temperature monitored, grafting affected fruit weight but in open field conditions where temperature is suitable for watermelon cropping, there was no difference between control and grafted plants. Watermelon crop is highly sensitive to low temperatures that is one of the major factor reducing vegetative development and reproduction. Some rootstocks are more resistant to low temperatures (Rivero *et al*., 2003).

Fruit quality characteristics of grafted and non-grafted plants are presented in Table 3. Fruit index and rind thickness were not significantly affected by grafting under both growing conditions. The effect of grafting on the soluble solids of fruits was different according to growing conditions. There were significant differences between control and grafted plants in open field conditions while no differences were found under low plastic tunnels growing conditions. Non-grafted control plants (11.13%) and grafted C/RS-841 plants (10.20%) had similar soluble solids, C/TZ-148 and C/64-18 had lower solid contents than the others.

It has been reported that grafting may have adverse effects on fruit quality, especially depend on rootstocks (Lee, 1994; Nissini *et al*., 2002; Traka-Mavrona *et al*., 2000) but in our experiments, we could not determinate any detrimental effect of grafting on fruit quality. Similar results were also reported by Yetişir *et al.* (2003) and Miguel *et al.* (2004). The soluble solid contents were changed through the growing conditions. The environmental conditions or harvest time may cause variation in soluble solid contents.

CONCLUSIONS

It can be concluded that grafting, in watermelon plants positively affected plant growth and yield without quality losses. These effects were changed by the rootstocks being used.

ACKNOWLEDGMENTS

This research was supported by Ege University Science and Technology Center, Izmir, Turkey (Project No 2006/ÖMYO/001).

REFERENCES

Atasayar, A., 2006. The usage of grafted watermelon seedling in Turkey. Hasad Horticulture Magazine, 252: 87-91.

Chouka, A.S. and H. Jebari, 1999. Effect of grafting on watermelon on vegetative and root development, production and fruit quality. Acta Hortic., 492: 85-93.

Edelstein, M.R., Cohen, Y. Burger and S. Shriber, 1999. Integrated management of sudden wilt in melons, caused by *Monosporascus cannonballus*, using grafting and reduced rates of methybromide. Plant Dis., 83: 1442-1445.

Lee, J.M., 1994. Cultivation of grafted plants, I. Current status, grafting methods and benefits. Hortic. Sci., 29: 235-239.

Lee, J.M., 2003. Advances in Vegetable Grafting, Chronica Horticulturae. Publ. Int. Soc. Hortic. Sci., 43: 13-19.

Lee, J.M. and M. Oda, 2003. Grafting of herbaceous vegetable and ornamental crops. Hortic. Rev., 28: 127-134.

Miguel, A., J.V. Maroto, A. San, C. Bautista, V. Baixauli, B. Cebolla, S. Pascual, Lopez and J.L. Guardiola, 2004. The grafting of triploid watermelon is an advantageous alternative to soil fumigation by methyl bromide for control of *Fusarium* wilt. Scientia Hortic., 103: 9-17.

Rivero, M., J., M. Ruiz and L. Romero, 2003. Role of grafting in horticultural palnts under stress conditions. Food. Agric., Environ., 1: 70-74.

Salam, M.A., A.S.M.H. Masum, S.S. Chowdhury, Monoranjan Dhar, M.A. Saddeque and M.R. Islam, 2002. Growth and Yield of Watermelon as Influenced By Grafting, Online J. Biol. Sci., 2: 298-299.

SAS., 1996. Statical Analysis System. Institute Inc SAS Version. 6.12. Cary NC, (Computer program).

Traka-Mavrona, E., M. Koutsika-Sotiriou and T. Piritsa, 2000. Response of squash (*Cucurbita* sp.) as rootstock for melon (*Cucumis melo* L.), Scientia Hortic., 83: 353-362.

T-Nissini, P., G. Colla, E. Granati, O. Temperini, P. Crino and F. Saccardo, 2002. Rootstock resistance to fusarium wilt and effect on fruit yield and quality of two muskmelon cultivars. Sci. Hortic., 93: 281-288.

Yetişir, H., N. Sari and S. Yücel, 2003. Rootstock resistance to Fusarium wilt and effect on watermelon fruit yield and quality. Phytoparasitica, 31: 163-169.

Yetişir, H. and N. Sari, 2004. Effect of Hypocotyl Morphology on Survival Rate and Growth of Watermelon Seed lings Grafted on Rootstocks with Different Emergence Performance at arious Temperatures. Turk. J. Agric. For. (TÜBITAK), 28: 231-237.