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Effect of three cucurbits rootstocks on vegetative and yield of 'Charleston Gray' watermelon

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Abstract

Watermelon [*Citrullus lanatus* (thumb.) Matsum and Nakai] cv. Charleston gray was grafted onto three rootstocks: *Cucurbita pepo*, *Lagenaria siceraria* and (*Cucurbita maxima* x *C. moshata*). The non grafted watermelon plant was used as control. In this experiment efficiency of two kinds of grafting methods: Tube grafting and Hole insertion grafting and it was found that, Hole insertion grafting gave better survival rate than the other type. The grafted and non grafted plants were transplanted to the filed. The experiment was conducted as a complete randomized block design with four replications, each consisting of ten plants. The results revealed that grafted plants had better vegetative growth than none grafted, control ones. Furthermore, stem length, number of lateral branches, number of internodes and fresh and dry weights of stem and leaves were improved, but grafting had no significant effect on fruit quality and yield. In conclusion it is recommended that grafting procedure in some crops such as watermelons should be done only after assuring the benefits and risks of grafted seedlings.

Keywords: Rootstock; Scion; Hole insertion grafting; Splice grafting; *Lagenaria siceraria*; *Cucurbita moschata*; *C. maxima x C. moshata.*

Introduction

Grafting is widely used for the production of fruit bearing vegetables in Japan, Korea and some other Asian and European countries where intensive and continuous cropping is performed. Grafting vegetables was first performed in Korea and Japan in the late 1920s by grafting watermelons onto gourd rootstocks. Consequently, the cultivation of grafted plants increased gradually in these countries, and currently most watermelons, cucumbers and various Solanaceous crops are grafted before transplantation (Lee, 1994). Grafting vegetables onto compatible rootstocks offers a number of advantages like resistance to soil pathogens, in particular *Verticillium* and *Fusarium* (Bletsos et al., 2003). Improved yield, particularly in infested soils (Bletsos et al., 2003) and greater tolerance to thermal and salt stresses (Ahn et al., 1999; Rivero et al., 2003).

The cultivated area and species of grafted vegetables have been consistently increased. Currently, watermelon is one of the vegetables in which grafting is performed intensively in the world (Yetisir and Sari, 2003). For these purposes, watermelons are grafted onto *C. moschata*, *C. maxima*, *Benincasa hispida* and *Lagenaria siceraria* species as rootstock (Lee, 1994). Resistant watermelon cultivars could be introduced from combined breeding programs designed to prevent the occurrence of soil-borne diseases. However developing new cultivars resistant to diseases is time consuming and enhance appearance of the new races of pathogens. As main objective, grafting susceptible cultivars onto resistant rootstocks may enable the control of soilborne diseases (Lee, 1994; Oda, 1995).

Though grafting needs time, space and materials but attention to grafting has recently increased by researchers and industry, because of outlawing methylbromide.

Various grafting methods are adopted for different species, even within the same species. They differ in terms of required time, type of fixing method and survival percentage (Lee et al., 1998; Oda, 1999). The choice of grafting type within certain species could also be related to climatic conditions and to rootstock vigor. Generally, the survival ratio is related to different aspects concerning plant growth phase, size and cut characteristics (Leonardi and Romano, 2004). Adopting the same grafting method, the survival ratio may be differ in relation to both rootstock and scion (Traka-Mavrona et al., 2000). On the whole, the mechanisms involved in the biont response are related to growth rate before grafting, tissue age, climatic conditions, rootstock leaf area, wetness of cut area, cut surface in the contact, pressure between cut area and number of vascular bundle in contact (Oda et al., 1993; Oda et al., 2000).

The aim of present study was to determine the compatibility rate of watermelon cv. Gharleston gray with different rootstocks, and ascertain the effects of different rootstocks on vegetative growth, yield and quality.

Materials and Methods

This study was conducted in department of Horticulture, University college of Agriculture and Natural resource, university of Tehran in 2006. The watermelon [*Citrullus lanatus* (thumb.) Matsum and Nakai] cultivar Charleston gray was grafted onto three different rootstocks. For obtaining the same stem diameter of scion and rootstocks, watermelon seeds were planted five days earlier than rootstocks seeds, and non-grafted watermelon plants were used as control. The hole-insertion grafting and tube grafting technique were used. However, it is well known that, for tube grafting method, the scion/stock diameter is very critical and according to Oda et al. (1993) the survival rate of grafted seedling being inversely proportional to the difference between scion and rootstock diameter. Moreover, the hole insertion grafting would be convenient for watermelon because of their small seedling size compared to the size of stock seedling, such as gourd and squash (Lee, 1994). Seedlings were grown in an unheated greenhouse under tunnels. After eighteen days of stocks planting, grafting carried out in a shady place. During acclimatization, the light level was kept about 3 to 5 Klux, air temperature around 24-27 ºC and relative air humidity 95% for three days. Gradually, the relative humidity was then lowered and the light intensity increased. After grafting, the seedlings were moved into the nursery. During this phase plants were fertilized with N-P-K (20-20-20). The seedlings were then transplanted in the fields fifteen days after grafting. The experiment design was a completely randomized block design. Each treatment was replicated four times with ten plants in each replicate. Plants were grown with 2.0×0.75 m spacing.

Live grafted plants were counted 20 days after grafting and survival rate was expressed as a percentage of the total number of plants grafted.

Harvest time was determined based on several indicators of maturity and accordingly ripen fruits were harvested. These included the withering of the first tendril located next to the fruit on the branch and yellowing of the bottom part of the fruit in contact with the soil as already proposed by Robinson (1997). The fruits were weighed and the soluble solids content of the juice (extracted from the central endocarp) was determined with the use of hand refractometer. Number of fruit per plant was determined by dividing the total number of plants in each replicate.

From each replicate, 3 plants were collected for sampling and stem length, number of lateral branches, number of internodes, fresh/ dry weight of stem and leaves were noted.

In every experiment, the significance of the effects was ascertained by SAS software and the survival ratios were analyzed by means of the test comparison of proportion.

Results and Discussion

The highest survival rate was observed in hole insertion grafting method, graft-rootstock combination of (watermelon-*Lagenaria*) and lowest survival rate in the tube grafting method was recorded. The survival rate of grafted watermelon onto *Cucurbita pepo*, Ferro and *Lagenaria* were: 70-85-90 percent (Figure 2). The lower survival rate in the tube grafting compared to the hole insertion grafting may be caused by the lower cut surface in contact and more transpiration. On the whole, the mechanisms involved in these different responses are related to growth rate before grafting, tissue age, climatic conditions, rootstock leaf area, wetness of cut area, cut surface in contact area, pressure between cut area and number of vascular bundles in the same area (Oda et al., 1993; Oda et al., 2000).

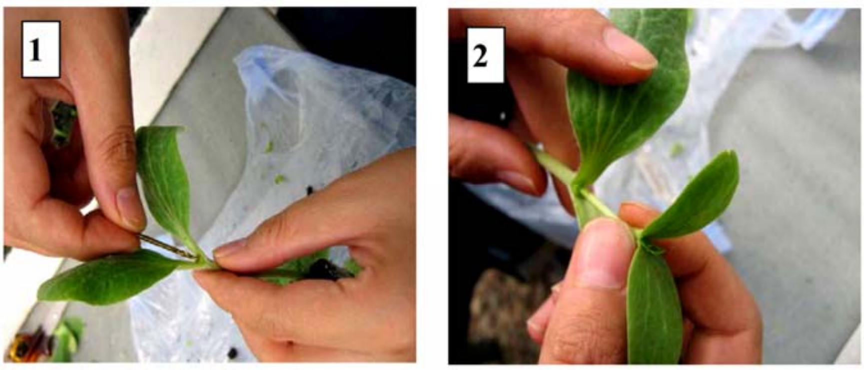

Figure 1. Hole insertion grafting method. (1. Making hole, 2. Scion insertion).

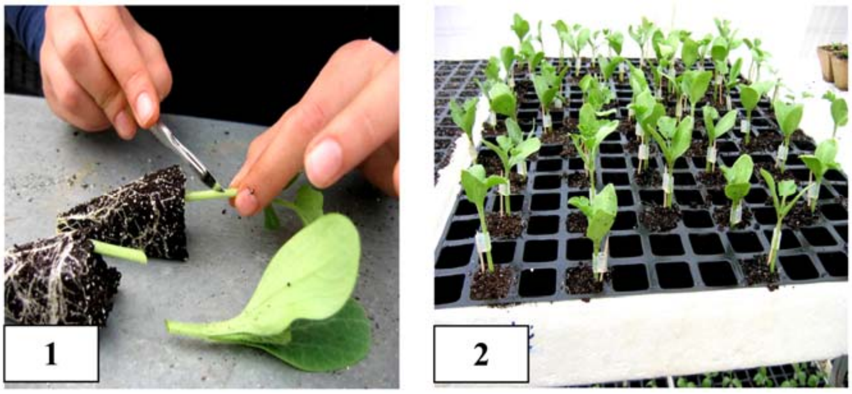

Figure 2. Practicing tube grafting of watermelon on its respective cucurbit rootstocks.

Stem length, number of lateral branches, number of internodes, fresh weight and dry weight, were recorded among grafted and control plants (Table 1). Owing to using genetically different rootstocks all the characteristics were significantly affected by type of rootstock used for grafting. It has been reported that grafting promotes vegetative growth at different levels depending on rootstock characteristics. Promoted vigor and vegetative growth could be explained by existing resistance to soil borne diseases (Lee, 1994) increased water and plant nutrition uptake (Rivero et al., 2003) augmented endogenous hormone production (Zijlstra et al., 1994), tolerance to low soil temperature (Den Nijs, 1987) and salinity tolerance in the rootstocks (Rivero et al., 2003).

In addition, grafting had no significant effect on total soluble solid, length and weight of fruit. It has been already stated that grafting on *cucurbita* rootstocks may have adverse effects on watermelon fruit quality (Salam, 2002). In our experiments, we could not detect any significant negative effect on watermelon fruit quality. Moreover, grafting decreased total yield of grafted watermelon onto *Cucurbita pepo*. However, total yield did not vary by rootstock type (Table 2).

Table 1. Vegetative characteristics of grafted and control plants.

	Stem length (m)	Laterals	Internodes	Fresh weight (g)	Dry weight (g)
Control	3.40[c]	8.42[c]	46.17[b]	698.1[b]	209.12[b]
Ferro	4.98[a]	10.07[ab]	59.83[a]	889.8[b]	246.26[b]
Lagenaria	3.57[b]	8.77[bc]	54.33[ab]	759.1[b]	255.31[b]
C. pepo	5.1[a]	10.96[a]	62.58[a]	1872.1[a]	447.5[a]

Means followed by the same letters within a column do not differ at P≤0.05.

Table 2. Total soluble solid, length and weight of fruit and total yield of watermelon grafted onto different rootstocks.

	TSS (%)	Fruit length (cm)	Fruit weight (Kg)	Total fruit yield (Kg/h)
Control	10.4[a]	39.04[a]	7.39[a]	28439[a]
Ferro	9.92[a]	39.33[a]	7.02[a]	27496[a]
Lagenaria	10.2[a]	37.45[a]	5.95[a]	25979[a]
C. pepo	9.9[a]	36.58[a]	7.13[a]	14535[b]

TSS= Total soluble solids.
Means followed by the same letters within a column do not differ at P≤0.0.

Conclusions

Even though there are many problems as associated with cultivating grafted vegetables, the need for successfully grafted seedlings is growing rapidly. Breeding programs for production of multipurpose rootstocks, developing efficient grafting machines and improved grafting techniques will undoubtedly encourage use of grafted seedlings all over the world. Moreover, growing grafted watermelon plant is an efficient alternative to soil fumigation.

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