Comparison of Soil and Soilless Cultivation of Carnation in Isparta Province

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Abstract

This study was carried out to compare crop yield and produce quality in soil and soilless culture of carnation conducted in Isparta Province, where summer season carnation has been cultivated in Turkey since 2000. Standard carnation varieties ('Turbo' and 'Oasis') were grown on beds containing pumice and the production of flowers and their quality characteristics (vase life, stem length, flower diameter and weight) were determined. Flower yield of 'Turbo' and 'Oasis' varieties grown in pumice was 22% and 19%, respectively, higher than in soil. Moreover, stem length was much longer in plants grown on soilless culture ('Turbo' and 'Oasis'; 96.11 cm and 73.87, respectively) than in soil ('Turbo' and 'Oasis'; 80.54 and 68.92 cm, respectively).

INTRODUCTION

Carnation accounts for approximately 43% (513 ha) of the cut flower production areas in Turkey (1199 ha) and 89% of this production is exported (Anonymous, 2007). In Turkey, most of carnation production, if not all, derives from soil culture. However, the use of soilless culture for the cultivation of mother plants for cutting increased recently. One of the most important problems encountered under protected cultivation is soil-borne diseases, pests and weeds. Methyl bromide (MeBr) is a soil fumigant that till the recent past has been used to eliminate soil-borne diseases, pests and weeds. However, the use of MeBr has been banned by the Montreal Protocol, soil disinfection by vapor requires special arrangements and its cost is high, the long application period is required for solarization (Kinvo, 2000; Pizano, 2002a,b). Therefore, soilless culture remains an effective tool to control soil-borne diseases and indeed substrate culture is increasingly used in the world (Gul et al., 2005).

Soilless culture is an artificial growing technique which provides plants with support and a reservoir for nutrients and water. Choosing a right material for substrate use is important. There are many different substrates used in soilless culture. Selection of a particular substrate depends on its cost, availability, and local experience on its use (Klougart, 1983; Verdonck et al., 1983). Pumice may be a satisfactory growing media due to having adequate porosity and aeration with enough water holding capacity; moreover, pumice is cheap and available in many regions in Turkey (Kirikoglu, 1990; Paksoy, 1995; Demirer et al., 1998), which has rich deposits with a total reserve estimated to be about 1.743.000.000 tons (Kirikoglu, 1990).

This study was carried out to compare crop yield and produce quality in soil and soilless culture of carnation conducted in Isparta Province (Turkey), where carnation is generally has been cultivated during summer season since 2000.

MATERIALS AND METHODS

This research was carried out in plastic greenhouses at the Experimental Station of Suleyman Demirel University, Faculty of Agriculture, Department of Horticulture

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(Isparta) in 2006. Two standard carnation cultivars ('Turbo' and 'Oasis') of *Dianthus caryophyllus* L. were grown in beds with pumice as well as in soil according to the traditional growing method in the region.

The dimensions of the beds were 3 m in length, 80 cm in width, 20 cm in depth and 3 mm in wall thickness. Carnation seedlings were planted in 5 rows spaced 16 x 15 cm apart between and within row in both soilless culture and soil on 26 April 2006.

Pumice of different sizes (0-3, 3-11 and 11-16 mm), as supplied by ISBAS in Isparta, were used: 11-16 mm pumice was placed with a thickness of 5 cm at the base of beds, 3-11 mm pumice was used for 10 cm high layer in the middle, then smaller-size material was used for the top layer of 3 cm. Plants were drip-irrigated (dripper capacity was 2 L h^{-1}) according to a schedule that produced a drain fraction of 20-40% (Maloupa and Gerasopoulos, 1999). The carnations grown in pumice medium were given the nutrient elements, diluting the stock nutrient solutions prepared in 3 tanks (A, B and C) of 1 m^3 by irrigation water at a certain ratio (1:200) by means of a computer control unit.

The composition (mg L^{-1}) of the nutrient solution fed to the soilless plants was the following: N-$NO3^-$ 161, N-NH_4^+, 3.5; P, 46; K; 244; Ca, 140; Mg, 18; Fe, 1.95; Mn, 0.41; Zn, 0.19, Cu: 0.03, B, 0.21; Mo, 0.05 (Sonneveld and Bik, 1983). The electrical conductivity (EC) of the nutrient solution was 1.7 mmhos cm^{-1} and the pH was maintained at 5.5 by nitric acid.

Single pinch method was applied to the plants and the shoot apexes were topped by hand above the fifth leaf pair from the bottom. Harvesting was done above the second node from the base, when flowers were fully open. The experiment last till 6 November 2006.

The following parameters were examined in the study: the time from planting to first harvest; flower stem length, diameter, fresh weight; flower diameter; vase life; crop yield (flower number per plant and per unit area). Flower vase life was evaluated under laboratory conditions (20-22^{o}C, 60-70% RH, 12 h daylight and 12 h darkness).

The experiment was designed with three replicates according to split-plot layout with randomized blocks and 900 plants in each replicate. Growing media factor was placed in main plots and cultivar factor was placed in subplots. The Duncan's multiple range test was employed to determine the differences among the group averages.

RESULTS AND DISCUSSION

Time from Planting to Harvest

As shown in Table 1, the effect of growing media and cultivars were statistically significant ($p< 0.01$). The harvest of carnations grown in pumice occurred about 96 days after planting against 106 days in soil culture (Table 1). Moreover, 'Turbo' cultivar flowered approximately four days earlier than 'Oasis' cultivar.

Flower Quality

The data on stem length being one of the important quality parameters in carnations are presented in Table 1. It was determined that the interaction between growing media and cultivars was statistically significant with regard to flower stem length ($p<0.01$). The differences between 'Turbo' and 'Oasis' cultivars grown in pumice are statistically significant ($p<0.05$). The 'Turbo' cultivar with an average stem length of 96.11 cm grown in pumice medium has longer stem length than the 'Oasis' cultivar (73.87 cm). The 'Turbo' cultivar with an average stem length of 80.74 cm grown in soil is also longer than the 'Oasis' cultivar (68.87 cm). Whereas the stem length average of 'Turbo' cultivar grown in pumice medium was 96.11 cm, it was determined to be 80.74 cm in soil. Similarly, the 'Oasis' cultivar grown in pumice had 96.11 cm stem length and the stem length in soil was 68.87 cm. It was determined that pumice media had higher values in both cultivars separately and was statistically significant ($p<0.05$).

Effects of growing media ($p<0.05$) and cultivars ($p<0.01$) on stem diameter were statistically significant. The stem diameter (4.57 mm) of carnations grown in soil was

thicker compared to the stem diameter (4.26 mm.) of carnations grown in pumice and that the stem diameter (4.86 mm) of 'Turbo' cultivar was thicker than the 'Oasis' cultivar (3.97 mm).

The data related to the stem weight obtained based on growing media and cultivars. It was determined that there was not a statistically significant difference between growing media in terms of stem weight and that the stem weights were measured to be 37.81 g and 37.56 g in pumice and soil, respectively. The cultivars had statistically significant difference with respect to stem weight ($p<0.01$) and that the 'Turbo' cultivar (43.14 g) had greater value compared to the 'Oasis' cultivar (32.22 g) with respect to stem weight.

One of the important parameters in carnations is flower diameter. The variation of flower diameters with respect to growing media and cultivars is shown in Table 2. The difference between flower diameter averages of cultivars is statistically significant ($p<0.05$). 'Turbo' cultivar (71.14 mm) had greater flower diameter than that of 'Oasis' cultivar (68.77 mm). There was no statistically significant difference between growing media.

Flower Vase Life

The data on vase life being one of the most important criteria in growing carnations are presented in Table 2. It was determined that whereas the effect of growing media was not statistically significant on vase life, the difference between the cultivars was statistically significant ($p<0.01$) with respect to vase life and that the 'Oasis' cultivar (11.67 days) had longer vase life than the 'Turbo' cultivar (10.33 days).

Crop Yield

Yield values obtained for cultivars and growing media are shown in Table 2. The difference between growing media in terms of yield values per plant was statistically significant ($p<0.01$). It was observed that the yield value per plant for carnations grown in pumice medium (5.34 stems/ plant) had been higher by 20.78 % than the carnations grown in soil (4.23 stems/ plant). As yield averages per plant for cultivars are compared, it was determined that the difference between them was not statistically significant.

The difference between growing media with respect to yield per square-meter was statistically significant ($p<0.01$). Yield values per square-meter for carnations grown in pumice and soil were determined to be 222.36 and 176.32 flowers, respectively. The difference between cultivar averages with respect to yield scores per square-meter was not found statistically significant.

In the study, it was observed that the carnations grown in pumice medium yielded better results in terms of both yield and some quality parameters as compared to the carnations grown in soil. These findings are in agreement with those published by Pivert, 1996. Similarly, it was found that that the use of pumice provided better results in terms of both yield and flower quality when compared to other growing media such as pumice, volcanic ash and 1:1 (v:v) peat: sand (Boztok et al., 1995). Boertje (1995) also stated that pumice could be used as substrate for both vegetables and cut flowers.

Moreover, compared to the soil, the carnations grown in soilless culture produced more flowers per plant and then per unit area (+21%, roughly), flowered earlier and their flower stems were longer. As far as cultivars are concerned, 'Turbo' plants had longer stems and larger flowers than 'Oasis' plants both in pumice and in soil; however, 'Oasis' plants gave higher flower yield.

CONCLUSION

In conclusion; firstly based on this study soilless culture may be a good alternative production method to conventional soil culture in Isparta Province. Secondly pumice can be a good growing media which is cheap and locally available. Thirdly flower yield and quality parameters not only depend on growing media but also variety and climatical conditions of greenhouse.

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Tables

Table 1. Effects of growing system on the duration of cultivation and plant growth in two cultivars of carnation grown under greenhouse in Isparta Province (Turkey) (*).

Growing Media	Cultivars		Mean
	'Turbo'	'Oasis'	
	Time from planting to harvest (days)		
Pumice	94.3 ± 0.3	98.3 ± 0.7	96.3 ± 0.9 B
Soil	103.7 ± 0.7	109.0 ± 0.6	106.3 ±1 .3 A
Mean	99.0 ± 2.1 b	103.7 ± 2.4 a	
	Flower stem length (cm)		
Pumice	96.1 ± 0.6 aA	73.9 ± 0.5 bA	845 ± 5.0
Soil	80.7 ± 0.7 aB	68.9 ± 0.8 bB	74.8 ± 2.7
Mean	88.4 ± 3.5	71.4 ± 1.2	
	Stem diameter (mm)		
Pumice	4.7 ± 0.1	3.9 ± 0.1	4.3 ± 0.2 B
Soil	5.1 ± 0.2	4.1 ± 0.1	4.6 ± 0.2 A
Mean	4.9 ± 0.1 a	4.0 ± 0.1 b	
	Fresh stem weight (g)		
Pumice	43.6 ± 0.4	32.0 ± 0.6	37.8 ± 2.6
Soil	42.7 ± 1.0	32.4 ± 1.7	37.6 ± 2.5
Mean	43.1 ± 0.5 A	32.2 ± 0.8 B	

*: Mean values followed by different letter are statistically different (P = 0.01, capital letter; P = 0.05, small letter).

Table 2. Effects of growing media and cultivar on yield and some quality parameters (*).

Growing Media	Cultivars		Mean
	'Turbo'	'Oasis'	
	Flower diameter (mm)		
Pumice	70.2 ± 0.6	68.3 ± 0.7	69.3 ± 0.6
Soil	72.0 ± 0.8	69.2 ± 0.5	70.6 ± 0.8
Mean	71.1 ± 0.6 A	68.8 ± 0.4 B	
	Vase life (day)		
Pumice	10.3 ± 0.3	11.7 ± 0.33	11.0 ± 0.4
Soil	10.3 ± 0.3	11.7 ± 0.33	11.0 ± 0.4
Mean	10.3 ± 0.2 B	11.7 ± 0.21 A	
	Yield per plant (stems/plant)		
Pumice	5.3 ± 0.1	5.4 ± 0.1	5.3 ± 0.1 A
Soil	4.1 ± 0.1	4.3 ± 0.1	4.2 ±0 .1 B
Mean	4.7 ± 0.3	4.9 ± 0.2	
	Yield per square-meter (stems/m^2)		
Pumice	221.1 ± 1.0	223.6 ± 1.0	222.4± 1.0 A
Soil	171.7 ± 2.4	181.0 ± 3.6	176.3 ± 2.8 B
Mean	196.4 ± 11.1	202.3 ± 9.7	

*: Mean values followed by different letter are statistically different (P = 0.01, capital letter; P = 0.05, small letter).