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Effect of Treated Saline Water on Flower Yield and Quality of Roses *Rosa hybrida* and Carnation *Dianthus caryophyllus*

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ABSTRACT: The effect of three irrigation frequencies of treated saline water (salinity range 2.5-3.0 dS/m) was investigated on flower yield and quality of the First Red rose cultivar grown on three rootstocks (*Rosa indica*, *Rosa canina*, and Natal Briar) and three carnation cultivars Voyore, Diana, and Chad, in two planting media, soil and volcanic rock (tuff). Water regimes for soil experiments were irrigation to the field capacity (every two days, every three days and every four days). Tuff experiments were irrigated daily at 120%, 100%, and 80% of the evaporation readings.

Significantly larger rose flower size, longer and thicker flower stems, higher number of nodes, longer internodes, and fewer blind shoots were produced by First Red rose cultivar when grown on Natal Briar rootstock combined with the three irrigation levels.

The three carnation cultivars performed similarly in regard to flower yields when planted in both planting media. Generally, better flower and flower stem quality (larger flower size, length and diameter, longer and thicker flower stalk, higher number of nodes, longer internodes) were produced by the three cultivars grown in soil than in tuff using this saline water.

It is recommended to grow these cut flower plants in soil rather than in tuff medium when this type of saline water is available for irrigation. However, more research is strongly recommended in the field of using low quality water for cut flower production.

KEYWORDS: Rose; Carnation, Yield; Quality; Treated; Saline Water.

INTRODUCTION

In Jordan, the challenge for agriculture is represented by the extreme difficulty to sustain the high water consumption levels currently required by growers, particularly due to limited water resources (Jordan Ministry of Water and Irrigation, 2002 year report).

The rapidly expanding population has generated an ever-increasing volume of saline wastewater, which raised a question as to how this water type should be managed and recycled for society benefits. The treated saline wastewater was applied mainly to field crops[1]. Each reuse opportunity has had its place as a water supply option[2]. Treated saline wastewater was used to irrigate citrus trees in Florida[3] and highway landscapes in Egypt[4]. So, these experiments were set to explore potential alternative crops for beneficial reuse of this low quality water.

To reserve fresh water for other higher-value uses (drinking, industry, and tourism) we proposed the low quality water be used to grow two cut flower crops, roses *Rosa hybrida* and carnation *Dianthus caryophyllus*. In commercial plantings, the yield and flower quality of the First red cultivar roses have been reported to be highly affected by rootstock type[5,6]. Roses were classified as salt tolerant up to 3-4 dS/m level of salinity[7], or as salt sensitive[8] or highly salt sensitive[9] with EC levels less than 0.8-1.0 dS/m. In contrast, it was reported that roses can resist up to 6 dS/m without affecting yield and quality[8]. Carnations were reported to be slightly salt sensitive at salinity concentrations of 1.5 – 2.3 dS/m[9] and moderately tolerant of salinity concentrations of 2 – 3 dS/m[7].

This study was conducted to study effect of recycled treated saline water on performance (Yield and Quality) of First Red cultivar rose[5] grafted onto three rootstocks *Rosa indica*, *Rosa canina* and Natal Briar, and three carnation cultivars (Voyore, Diana, and Chad) in two planting media, soil and volcanic rock tuff, under plastic house conditions.

Materials and Methods

This study was carried out during 2003 using mini-plants of First Red cultivar cut rose flowers grafted onto three rootstocks: *Rosa indica, Rosa canina,* and *Rosa hybrida,* Natal Briar; and three carnation cultivars, Voyore, Diana, and Chad purchased from Amman flower auction agent.

Each plant type was grown in a plastic house of 360 m^2 area with pad and fan system in Ramtha area 60 Km north of Amman. Two planting media were used in two separate experiments in each plastic house. Experimental plots for roses were 0.6 x 1 m areas with 8 plants in two rows spaced 25 x 40 cm in each plot. Each carnation plot comprised 32 plants grown in a 1 x 1 m area, for both culture media. Soilless media was placed on 700 *u* black polyethylene mulch sloped to 1.5 cm% for excess water drainage. Plants were irrigated at three different frequencies with saline water. The saline water was the outlet of the Ramtha wastewater treatment station with a salinity range of 2.5-3.0 dS/m. Daily irrigation occurred to 120%, 100%, and 80% of the evaporation pan readings for the soilless system, and to the field capacity every two days, every three days, and every four days for soil experiments. Sand, screen, and disc filtered water, with no fertilizer was applied through out the experiments.

Rose plants on the different rootstocks and carnation cultivars were treated as sub-plots, while water regimes were the main plots, arranged in a randomized complete block design (RCBD) with four replications. One experiment was conducted in soil and the other in tuff for each plant species in each plastic house. Uniform plastic house shading was used in summer. Plant disease and insect control was done when needed during the experiments.

To assess the production and quality characteristics, data on the following parameters were collected:

1. Total production (number of harvested flowers).
2. Flower length and diameter.
3. Flower stalks length and diameter.
4. Number of nodes and internode length per flower stalk.
5. Number of blind (non-productive) shoots/ plant for roses.

The results were statistically analyzed and mean comparison was performed according to the Least Significant Difference (LSD) at the 5% level of significance.

Results

Roses

The least flower yield was obtained from the combination of *R. indica* rootstock with the highest irrigation frequency in both planting media (Fig. 1). However, no significant differences were observed between flower yields of the three rootstocks when combined with the two lower frequency irrigation regimes (every three days and every four days) in soil medium (Fig. 1 A). Rose flower yields for the tuff medium were highest from *R. canina* rootstock under the highest water level (120%) and *R. indica* with the second water level (100%) (Fig. 1B). Significantly larger rose size, longer and thicker flower stalk, higher number of nodes, longer internodes and less number of blind shoots were produced by First Red cultivar roses grown on the Natal Briar rootstock when irrigated with the three levels of this treated saline wastewater for both planting media (Table 1).

First red cultivar roses irrigated with the highest levels (every two day and 120% of EP) for both planting media gave larger flower sizes, longer and thicker flower stalks and longer internodes compared to the other

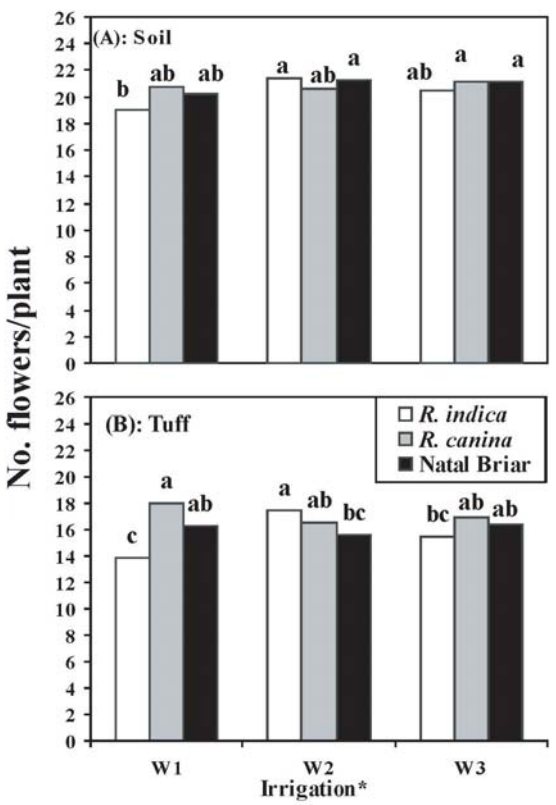

Fig 1. Yield response of First Red cultivar roses grown on three rose rootstocks and irrigated by three levels of treated, saline water, planted in soil (A) and tuff (B) for the season 2003. (*):Irrigation frequency for soil to the field capacity; W1=(Every other day); W2= (Every two days); W3= (Every three days). For tuff W1= (120%); W2= (100%); and W3= (80%) of EP.

Table 1. Interactive effect of three rose rootstocks and three frequencies of treated saline water irrigation on flower and stalk quality and number of blind shoots of First Red cultivar roses, planted in soil and tuff for the season 2003.

WF(1)	Roostock(2)	Flower length (cm)		Flower diameter (cm)		Flower stalk length (cm)		Flower stalk diameter (cm)		No. nodes /Stalk		Internode length (cm)		Blind shoots /Plant	
		Soil	Tuff	Soil	Tuff	Soil	Tuff	Soil	Tuff	Soil	Tuff	Soil	Tuff	Soil	Tuff
1	R. indica	3.8 cd(3)	3.6 ab	3.0 bc	2.7 b	35.0 bc	35.5 cd	0.65 cd	0.62 cde	7.0 f	6.7 f	5.0 ab	5.4 a	9.2 ab	6.0 b
	R. canina	3.9 cd	37. a	3.3 ab	2.8 b	35.7 bc	36.5 c	0.72 bc	0.66 bc	7.5 ef	7.5 f	4.9 ab	4.8 ab	8.7 ab	5.6 b
	Natal Briar	4.7 b	3.8 a	3.7 a	3.3 a	47.0 a	48.0 a	0.85 a	0.76 a	9.5 cd	10.2 c	5.1 a	4.6 abc	6.1 b	2.7 d
2	R. indica	3.7 d	3.4 ab	2.5 cd	2.6 b	34.0 c	30.5 ef	0.63 d	0.58 def	8.0 def	8.2 e	4.2 abc	3.7 cde	8.4 ab	6.7 b
	R. canina	4.1 c	3.2 b	3.0 bc	2.8 b	34.5 bc	31.7 de	0.64 cd	0.65 bc	9.0 def	8.2e	3.8 c	3.5 def	11.1 a	6.3 b
	Natal Briar	5.0 ab	3.7 a	3.1 b	3.2 a	48.2 a	42.7 b	0.75 b	0.72 ab	11.7 b	10.7 b	4.0 bc	3.9 bcd	5.7 b	3.7 cd
3	R. indica	3.6 d	2.9 cd	2.5 d	2.4 b	28.2 d	27.2 f	0.63 d	0.54 f	8.7 def	9.2 d	3.2 cd	2.9 efg	9.2 ab	8.3 a
	R. canina	4.1 c	2.7 d	2.8 bcd	2.6 b	28.5 d	30.2 ef	0.61 d	0.57 ef	10.7 bc	12.0 a	2.6 d	2.6 g	9.2 ab	8.4 a
	Natal Briar	5.2 a	3.4 ab	2.9 bcd	2.8 b	38.7 b	37.0 c	0.64 cd	0.64 cd	14.0 a	13.2 a	2.7 d	2.7 fg	5.0 b	4.1 c
	LSD	0.44	0.40	0.52	0.37	4.69	4.36	0.08	0.06	1.88	1.24	1.05	0.93	4.50	1.38

(1): Watering frequency: For soil to the field capacity: 1=(Every other day); 2= (Every two days); 3= (Every three days); for tuff 1= (120%); 2= (100%); and 3= (80%) of EP.
(2): First Red cultivar budded on each.
(3): Different letters indicate significant mean separations for each factor within columns by LSD test, 5% level.

two water levels, every three days and every four days for soil, and 100 and 80% of EP for tuff (Table 1).

Carnations

Regardless of saline water level, the three carnation cultivars gave similar flower yields when planted in natural soil and in the tuff medium (Fig. 2). The least flower yield was produced by the combination of Chad in the soil with irrigation level every three days and Voyore and Chad cultivars with the lowest water level in both planting media. The highest yield was shown by Diana when irrigated every three days in soil (Fig. 2 A) and 100% ofthe evaporation reading for tuff medium (Fig. 2 B).

Generally flowers with larger size, (length and diameter), longer and thicker flower stalks, higher number of nodes, and longer internodes were produced by the three cultivars grown in soil than in tuff using this treated saline water (Table 2).

There were no significant differences between combinations of cultivars and irrigation levels in flower length in tuff medium, stalk diameter in both media and

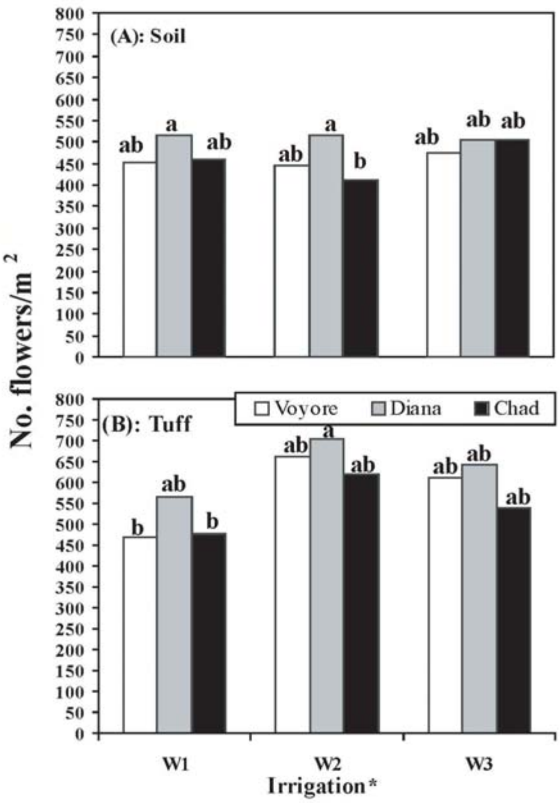

Fig 2. Yield response of three carnation cultivars irrigated by three levels of treated saline water planted in soil (A) and tuff (B) for the 2003 season. *Irrigation frequency for soil (to the field capacity); W1 = Every other day; W2 = Every two days; W3 = Every three days. For tuff W1= 120% of EP, W2 = 100% and W3 = 80%.

number of nodes per stem in soil (Table 2). However, slight differences were noticed in the other parameters, flower diameter, stem length, and internode length in both media (Table 2). Additionally, the three irrigation levels similarly affected flower quality parameters in both media.

Table 2. Interactive effect of the three cultivars and three frequencies of treated saline water irrigation on flower and stem quality of carnations planted in soil and tuff for the 2003 season.

WF(1)	Cultivar(2)	Flower length (cm)		Flower diameter (cm)		Flower stalk length (cm)		Flower stalk diameter (cm)		No. nodes /Stalk		Internode length (cm)	
		Soil	Tuff	Soil	Tuff	Soil	Tuff	Soil	Tuff	Soil	Tuff	Soil	Tuff
1	Voyore	4.6 ab(3)	4.0 a	2.2 abc	1.7 ab	54.8 ab	47.9 abc	0.42 a	0.37 a	8.2 a	6.7 c	7.2 ab	7.0 bc
	Diana	4.5 ab	3.7 a	1.9 bc	1.9 a	48.3 b	54.8 ab	0.33 a	0.31 a	7.2 a	5.9 d	6.6 ab	9.5 a
	Chad	4.7 ab	3.8 a	2.3 ab	1.9 a	56.8 ab	45.8 bc	0.38 a	0.34 a	8.1 a	6.5 cd	7.1 ab	7.0 bc2
	Voyore	4.7 ab	3.7 a	2.0 bc	1.8 ab	65.7 ab	52.6 abc	0.45 a	0.41 a	8.7 a	6.3 cd	7.7 ab	8.2 ab
	Diana	4.2 b	3.7 a	1.9 bc	1.9 a	51.9 ab	51.5 abc	0.41 a	0.39 a	9.5 a	6.3 cd	5.4 b	8.1 ab
	Chad	4.7 ab	3.5 a	2.1 bc	1.9 a	56.1 ab	40.8 c	0.39 a	0.38 a	9.3 a	5.9 d	7.1 ab	6.8 bc3
	Voyore	4.8 a	3.6 a	2.6 a	1.6 b	65.3 ab	58.2 a	0.47 a	0.38 a	10.4 a	9.4 b	6.4 ab	6.2 cd
	Diana	4.3 ab	4.1 a	1.8 bc	1.7 ab	51.9 ab	51.6 abc	0.42 a	0.39 a	9.3 a	10.6 a	5.5 b	4.8 d
	Chad	4.6 ab	3.9 a	1.8 bc	1.8 ab	70.1 a	51.9 abc	0.32 a	0.36 a	8.0 a	9.9 ab	8.5 a	5.2 cd
	LSD	0.54	ns	0.49	0.28	20.84	12.33	ns	ns	ns	0.75	2.85	1.86

(1): Watering frequency, for soil (to the field capacity): 1 = Every other day, 2 = Every two days and 3 = Every three days. For tuff 1 = (120%), 2 = (100%) and 3 = (80%).
(2): Flower color: Voyore = red; Diana = yellow; Chad = netted yellow-red.
(3): Mean separation for each factor within columns by LSD test, 5% level.

Discussion

Flower yield and quality of First Red roses grown on the three rootstocks were better in soil medium than in the tuff when irrigated with saline water (2.5-3.0 dS/m). Although rose tolerance to the salinity level in both media was within the range limit reported by Kotuby (3-4 dS/m)[7], rose salinity tolerance highly exceeded the low limits reported by the Department of Agriculture of Western Australia (0.8-1.0 dS/m)[9]. Roses have been reported to resist salinity levels up to 6 dS/m without adverse effect on the yield and flower quality produced[8].

In natural soil planting, there was no significant difference in rose yield under water levels 2 and 3 (every three days and four days), regardless of rootstock. However, the yield was greater than the highest watering level (every other day) (Fig. 1A). For tuff planting, good rose yield needed more water application and specific rootstock (120% with *R. canina* and 100% with *R. indica*) (Fig. 1B).

Carnations are reported as slightly salt sensitive at salinity concentrations of 1.5 – 2.3 dS/m[9]and moderately tolerant of salinity concentrations of 2 – 3 dS/m[7]. Our results clearly indicate higher carnation yield was obtained from the tuff experiment (Fig. 2B). The three cultivars tolerated saline water (2.5-3.0 dS/m) better in soil medium than in the tuff in regard to high flower quality parameters (Table 2).

Conclusions

Cut flower crops (First Red rose plant combinations and the three carnation cultivars) used in this study, can tolerate saline water in soil better than in soilless culture, irrespective of the watering level used. Soil planting gave better yields and fewer blind shoots for roses and better flower quality produced for carnations than tuff planting. Thus, it is recommended to grow these cut flower plants in soil rather than in tuff medium when this type of saline water is available for irrigation. However, more research is strongly recommended in the field evaluating use of low quality water for cut flower production.

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