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The Influence of Foliar Application of Potassium on Yield and Quality of Carrot (*Daucus carota* L.) Plants Grown under Sandy Soil Conditions

[1]El-Tohamy, W.A., [1]H.M. El-Abagy, [2]M.A. Badr, S.D. [1]Abou-Hussein and [1]Y. I. Helmy

[1]Vegetable Research Department, National Research Center, Dokki, Cairo, Egypt
[2]Soil Science Department, National Research Center, Dokki, Cairo, Egypt

Abstract: The experiments were conducted under sandy soil conditions in Nubaria (west delta region) to study the response of carrot plants to foliar application of potassium. Different levels of foliar potassium fertilizer (0.5, 1, 1.5 and 2ml/L) were applied. Plant growth, productivity, root quality and chemical analysis of leaves (N, P and K) were recorded in response to the application of these treatments. The results showed that carrot plants responded positively to all K levels. Vegetative growth parameters (including plant height, number of leaves and fresh and dry weight of leaves) were significantly enhanced by the levels of K especially at the higher levels while control plants obtained the lowest values. The level 1.5 ml/L seems to be optimal for carrot plants as increasing the K level more than this level did not give significant increment. Similar results were observed concerning root length, diameter, fresh and dry weight of roots and total soluble solids (T.S.S.) in roots. Results concerning the chemical analysis of carrot leaves are discussed. The results indicated that foliar application of K under sandy soil conditions improved root quality as well.

Key words: Carrot, pottassium fertilizer, quality, yield, sandy soil

INTRODUCTION

Sandy soils (such as in Nubaria, west delta region) is characterized by poor fertility and low availability of nutrients especially the macronutrients including potassium. Under such conditions plants will certainly suffer from nutrient deficiency. Potassium application is very important for carrot plants. Hochmuth *et al.* (2006) indicated that potassium (K) is required for successful carrot (*Daucus carota*) production in sandy soils. Moreover, several studies revealed the importance of potassium to achieve high carrot yield (Pekarskas and Bartaseviciene, 2007; Anjaiah and Padmaja, 2006; Balooch *et al.*, 1993) and quality of roots (Sharangi and Paria, 1995; Balooch *et al.*, 1995; Selvi *et al.*, 2005; Lyngdoh, 2001; Sharangi and Paria, 1997). Also, Ivanov (2001) discussed the role of potassium in maintaining soil fertility and emphasized the necessity of continuous use of potassium fertilizer for carrot production. Foliar application of potassium increased the yield of carrot plants (Subrahmanyam and Raju, 2000).

According to Kadar (2008), carrot is a potassium-demanding plant. Therefore, under sandy soil conditions, additional foliar application of potassium could be beneficial for improving carrot productivity. The aim of the present study was to examine the effectiveness of foliar application of potassium on carrot growth, yield and quality of roots under sandy soil conditions.

MATERIAL AND METHODS

Seeds of carrot (*Daucus carota* L.), cv. Chantenay were sown in the two winter season of 2007 and 2008 at the experimental research station of the National Research Center in Nubaria region. Table 1 shows the physical and chemical characteristics of the soil. When plants reached 20 days old they were sprayed twice (14 days interval) with foliar potassium fertilizer (Green: containing 35% of K as K_2O) at concentrations of 0.5, 1, 1.5 and 2 ml/L while control plants were only sprayed with water. All agricultural practices required for carrot production were followed as commonly used in the region.

Corresponding Author: El-Tohamy, W.A., Vegetable Research Department, National Research Center, Dokki, Cairo, Egypt

Table 1: Physical and chemical properties of the experimental soil.

Physical properties							
Sand	Clay	Silt	Texture	F.C. %	W.P. %		
90.08	9.26	0.66	Sandy	16.57	5.25		
Chemical analysis							
E.C. M/moh.	P.H.	Meq./L.					
		Ca	Mg	Na	K	HCO_3	Cl
1.7	8.2	7.02	0.527	0.982	0.31	1.3	0.566

The following measurements were recorded:

1. Plant growth and yield measurements: plant height, number of leaves, plant fresh and dry weight, fresh and dry weight of roots, root length and root diameter were recorded.
2. Total soluble solids (T.S.S.) of roots: measured by refractometer.
3. Chemical measurements: Total nitrogen was measured by the modified -Kjeldahl method (Bremner and Mulvaney,1982).Potassium and phoshorus was determined according to the standered method described by (Jackson,1973).

Statistical analysis:

The experiments were established as complete randomized block design with 4 replicates and analysis of variance was calculated according to Snedecor and Cochran (1967). Least significant difference (L.S.D.) at 5% was used to compare between means.

RESULTS AND DISCUSSION

Generally, foliar application of K at all concentrations significantly improved carrot growth (expressed as plant height, number of leaves and fresh and dry weight of leaves), yield (fresh and dry weight of roots) and (root length and diameter) compared to control plants. Higher concentrations of K gave the highest effects at both seasons (Table 2). Subrahmanyam and Raju (2000) found that foliar application of potassium increased the yield of carrot plants.

It is worth mentioning that increasing the concentration of foliar application of potassium significantly improved root characters and root quality as the total soluble solids of roots increased by the application of potassium (Table 2). Generally, the application of K significantly improved carrot growth, productivity and quality of roots. Bartaseviciene and Pekarskas (2007) indicated that potassium fertilizers increased the total and marketable harvest of carrots. The K fertilizers significantly influenced the sugar content of the carrots and decreased the quantity of the nitrates. Foliar application of K significantly improved carrot growth, photosynthetic rate, transpiration rate, yield and even other characters related to seed production (seed yield, 1000-seed weight and germination vigour) as found by Zhang *et al*. (2006). Moreover, potassium application has great effects on carrot productivity and quality and different studies focused on the effects of K either individually or in combination with other nutrients such as nitrogen or phosphorus. For example, the increased application of NPK fertilizer increased the contents of dry matter, ash, protein, calcium and copper (Zdravkovic *et al*., 2007. Also, Anjaiah and Padmaja (2006) found that root yield and quality parameters (total carotenes, total soluble solids and total sugars) increased with increasing levels of potassium. These findings are in agreement with Lyngdoh (2001) who stated that K played a key role in increasing the root TSS value. Increasing K level improved carrot root weight and shelf life as indicated by decreased post-harvest moisture loss (Shibairo *et al*., 1998). Potassium and N application rates were found to influence markedly thae quality and the carotene content of carrot roots (Sharangi and Paria ,1995). The results revealed that foliar application of K significantly improved the quality of roots as indicated by increased root length, diameter, TSS and fresh and dry weight of roots (Table 2). Sharangi and Paria (1996) found that the application of higher levels of K produced the longer, wider and heavier roots than the lower levels. Similar trend was observed by Hassan *et al*. (1992) who found that average root weight, root length, total plant FW and yield increased with increasing potassium, nitrogen and phosphorus fertilizer application.

The results reveal that the level of 1.5 ml/L of foliar K seems to be optimal for carrot plants as increasing the level of K more than this level did not significantly improve any of the above mentioned parameters.

Table 2: Effects of foliar potassium application on carrot growth characters, yield and quality of roots.

Treatment	Plant height (cm)	Number of leaves	Root length cm	Root diameter cm	Fresh weight of roots (g)	Leaves fresh weight (g)	Leaves dry weight (g)	Root dry weight (g)	T.S.S. in roots
			1st season						
(Control)	55.50	10.25	13.00	2.08	49.70	28.58	1.91	4.65	2.65
0.5 ml/L of foliar K	60.75	15.75	14.38	2.40	68.90	32.83	3.33	5.60	3.05
1 ml/L of foliar K	66.00	18.75	15.25	3.20	70.40	36.50	4.03	7.10	3.36
1.5 ml/L of foliar K	67.50	20.25	16.50	3.85	77.30	50.35	6.58	8.85	3.91
2 ml/L of foliar K	69.30	21.50	17.13	4.23	81.25	50.75	6.70	9.51	4.11
L.S.D. at 5%	2.30	1.69	0.86	0.45	5.58	1.21	0.16	0.84	0.22
			2nd season						
(Control)	51.00	9.50	10.50	2.00	45.70	26.33	1.84	4.285	2.36
0.5 ml/L of foliar K	57.25	12.50	14.13	2.23	68.40	31.33	3.08	5.1	3.00
1 ml/L of foliar K	60.50	17.00	14.75	2.80	69.00	33.70	3.73	6.35	3.21
1.5 ml/L of foliar K	65.50	18.25	15.75	3.43	77.30	49.05	6.10	8.555	3.51
2 ml/L of foliar K	68.81	20.00	16.50	3.92	80.40	51.50	6.57	8.87	3.65
L.S.D. at 5%	4.83	2.41	1.10	0.55	6.94	4.91	0.56	1.58	0.41

Table 3: Effects of foliar potassium application on N, P and K contents of leaves.

Treatment	N content in leaves%	P content in leaves%	K content in leaves%
	1st season		
(Control)	2.27	0.28	2.00
0.5 ml/L of foliar K	2.28	0.27	2.60
1 ml/L of foliar K	2.27	0.28	3.00
1.5 ml/L of foliar K	2.31	0.27	3.35
2 ml/L of foliar K	2.30	0.29	3.55
L.S.D. at 5%	N.S.	N.S.	0.211
	2nd season		
(Control)	2.24	0.29	1.55
0.5 ml/L of foliar K	2.25	0.31	2.38
1 ml/L of foliar K	2.27	0.32	2.83
1.5 ml/L of foliar K	2.28	0.28	2.73
2 ml/L of foliar K	2.27	0.33	2.93
L.S.D. at 5%	N.S.	N.S.	0.740

Chemical analysis of leaves is shown in Table (3). The results showed that foliar application of potassium significantly increased the K content of leaves at both seasons although the effects were not significant concerning N and P contents. Sanderson and Sanderson (2006) indicated that increasing rates of applied K linearly increased the K content of carrot petioles. Also, Kadar (2008) found that potassium uptake was improved by potassium fertilizer application.

Our results suggest the possibility to improve carrot productivity and quality by using foliar application of potassium under sandy soil conditions. The level of 1.5 ml/L of foliar K fertilizer seems to be optimal for improving carrot yield and quality of roots. However, increasing the level more than 1.5 ml/L will not give significant changes.

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