Response of Costata Persimmon Trees to Different Rootstocks and NK Fertilization
1. Growth, Yield and Leaf Mineral Content

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ABSTRACT

This investigation was carried out in 2000 and 2001 to study the effect of two rootstocks (seedling and Trabols), different rates of nitrogen and potassium fertilizers and their interactions on shoot length, fruit set, fruit retention, yield and leaf mineral content of Costata persimmon trees. The results are summarized as follow:

1. Regardless of potassium fertilization and rootstock, nitrogen fertilization increased shoot length, fruit set, in 2001. Fruit retention, yield and leaf N and Mg were increased in both seasons. On the other hand, leaf K, Fe and Zn in both seasons and P in the second season were decreased. However, leaf Ca and Mn were not affected by nitrogen fertilizer.

2. Regardless of nitrogen fertilization and rootstock, potassium fertilization increased fruit set, fruit retention, yield and leaf K, Zn and Mn, whereas leaf Ca, in both seasons, and Mg, in 2001, were decreased. Shoot length and leaf N, P and Fe, in both seasons, and Mg, in 2001, were not affected by the addition of potassium sulphate.

3. Regarding the effect of rootstock, irrespective of N and K fertilization, the Costata persimmon trees on seedling rootstock had higher shoot length, fruit set, fruit retention, yield and leaf N, K and Ca as compared with Trabols rootstock. Leaf P, Zn and Mn on seedling rootstock were higher, whereas leaf Fe, in both seasons, and Mg, in 2001, were not affected by rootstock.

INTRODUCTION

Costata persimmon represents the main persimmon variety grown in Egypt. Recently, the Egyptian consumer paid an increasing attention in eating persimmon fruit, though the area planted with persimmon is progressively increasing. In addition, researches and studies play an important role in improving persimmon productivity and quality. Growth, yield and nutritional status of the trees were found to be affected by the rootstock and cultivar (Drake *et al.*, 1988 and 1991; Omarov, 1988 and Omarov and Erokhina, 1989). Rootstocks have a profound effect on flowering and fruiting of apple trees (Hirst and Ferree, 1995). This might be due to the differences among rootstocks in phosphorus uptake and differences in the distribution of phosphorus within the tree. Bukovac *et al.*(1958) reported that uptake of phosphorus by roots was influenced by rootstock and was positively related to rootstock vigor. However, further work revealed that the increase of phosphorus uptake by vigorous rootstocks was not entirely due to the presence of a larger root system. The other nutrients were found to influence apple flowering. Flowering of apple trees was increased by nitrogen application (Gao *et al.*, 1992). Similarly, potassium has been associated with flower and fruit production (Campbell and Bould, 1970). The nitrogen and potassium fertilization may affect the growth, yield and leaf mineral content of persimmon trees (Abd El-Megeed, 1992).

The objective of the present study was to study the effect of rootstock and NK fertilization and their interactions on the growth, yield and leaf mineral content of Costata persimmon trees.

MATERIALS AND METHODS

The present work was carried out during 2000 and 2001 seasons on Costata persimmon trees (*Diospyrus kaki*, L.) grown in a private orchard at El-Tarh region, El-Beheira Governorate. The soil of the orchard was clay well drained with water table depth of 100-120 cm and pH of 7.8-7.9. Physical and chemical characteristics of the soil are presented in Table (1). Fifteen years old trees, budded on Trabols and seedling rootstocks and planted at 5 meters apart, were irrigated with Nile water every 15 days during each experimental season. Forty-eight trees, as uniform as possible, were chosen for each rootstock. Trees were fertilized with organic manure at a rate of 25 m^3 per feddan in November of each season. Also, calcium superphosphate was added at a rate of 150 kg per feddan in mid February in both seasons.

Nitrogen and potassium fertilizers were applied at different rates, either alone or in combinations with each other, as follow: nitrogen fertilizer as ammonium nitrate (33.5% N) was applied at four different rates; i.e., 0.0 (N_0), 600 g (N_1), 1200 g (N_2) and 1800 g (N_3) per tree. Potassium fertilizer as potassium sulphate (48% K_2O) was applied at three different rates; i.e., 0.0 (K_0), 600 g (K_1) and 1200 g (K_2) per tree. Nitrogen and potassium fertilizers were added at three equal doses; at early (for N fertilizer) and late (for K fertilizer) March, May and August of both seasons. Twenty-four fertilization treatments, representing all the possible combinations of the four levels of nitrogen fertilizer, three levels of potassium fertilizer and two rootstocks, were used in this investigation (4x3x2 = 24 treatments). Fertilizers were broadcasted on the soil surface 1.5-2.0 m apart from the tree trunk and trees were immediately irrigated. Each fertilization treatment was repeated for each rootstock in both seasons. Treatments were arranged in a randomized complete block design with four replicates for each treatment and one tree as a single replicate (24 treatments x 4 replicates = 96 trees).

Table 1. Physical and chemical properties of the experimental orchard soil samples at different soil depths.

Properties		Soil depth (cm)		
		0 - 30	30 - 60	60 - 90
Physical properties:				
$CaCO_3$	%	14.65	12.48	14.75
EC	mmhos/cm	0.9	1.1	2.6
Texture		clay	clay	clay
Chemical properties:				
Macro-elements				
N	%	0.17	0.10	0.11
P	ppm	55	26	42
K	ppm	0.1	0.6	1.1
Ca^{++}	meq/L	6.0	5.6	12.0
Mg^{++}	meq/L	2.8	2.6	5.8
Na^{+}	meq/L	2.4	2.8	7.2
Micro-elements				
Fe	ppm	22.7	19.6	20
Cu	ppm	14.3	8.9	10.6
Zn	ppm	13.2	7.3	12.8
Mn	ppm	54	31	47
Anions, meq/L				
$CO_3^{=}$		0.0	0.0	0.0
HCO_3^{-}		6	5.2	4.6
Cl^{-}		1.8	2.6	10.0
$SO_4^{=}$		3.6	3.9	11.8

For investigating the effect of the different fertilization treatments and rootstocks on the growth, fruit set, fruit retention and yield, four main branches/tree were selected and tagged in March 2000 and 2001 and their average spring shoot length was measured in July of both seasons. Also, the number of flowers at full bloom on each branch was recorded. Moreover, the number of fruits on each branch was counted and recorded at fruit set after June drop and at harvest date. The percentages of fruit set and fruit retention after June drop and at harvest date were calculated. Tree yield as kg and number of fruits/tree was recorded at harvest date in mid October of each season.

In order to study the leaf mineral content, a leaf sample of 20 leaves was collected from each experimental tree in mid-July of both seasons. The samples were taken from the middle part of non-bearing shoots. Samples were washed with tap water, rinsed two times with distilled water and oven dried at 65-70°C to a constant weight. The dried leaf tissues were grounded and digested with sulphuric acid and hydrogen peroxide, as outlined by Evenhuis and Dewaard (1980). Suitable aliquots were taken for the determination of leaf mineral content. N and P were determined colorimetrically according to Evenhuis (1976) and Murphy and Riley (1962), respectively. Potassium was determined by a flame photometer. Ca, Mg, Fe, Mn and Zn were measured by Perkin Elmer Atomic Absorption Spectrophotometer.

Data were statistically analyzed according to Little and Hills (1978).

RESULTS AND DISCUSSION

Shoot length

Regardless of potassium and rootstock, the data in Table (2) showed that average shoot length significantly increased in response to the nitrogen fertilizer application. Trees received N_2 and N_3 in the first season and N_1, N_2 and N_3 in the second season gave the greatest increase in shoot length as compared with the control. Similar results were obtained by Smith *et al.*(1985), Bussi and Amiot (1998), Saayman and Lambrechts (1998) and Abd El-Megeed (1992). They reported that nitrogen fertilizer had a significant effect on average shoot length.

With regard to potassium fertilizer, average shoot length was not affected (Table 2). However, interaction between nitrogen and potassium increased average shoot length during both seasons. These results agreed with those obtained by Bussi and Amiot (1998). They found that potassium fertilizers did not affect vegetative growth, whereas an interaction between nitrogen and potassium increased vegetative growth.

Regardless of nitrogen and potassium fertilization treatments, data in Table (2) showed that average shoot length was affected by rootstocks, being largest on seedling rootstock, while smallest on Trabols. These results are, generally, in line with those of Omarov and Erokhina (1989). They reported that trees on *Diospyros lotus* were larger and had a markedly more vigorous root systems than trees on *Diospyros virginiana.* In the meantime, Omarov (1988) found that the trees on *Diospyros lotus* had a better branched skeletal with more active fibrous roots than trees on *Diospyrus virginiana*.

Fruit set percentage

The results in Table (2) showed that, regardless of potassium fertilizer and rootstock, the percentage of fruit set tended to increase by increasing the rate of nitrogen fertilizer. In the first season, however, this increase was not statistically significant. The increase of fruit set percentage due to N fertilization was also reported by Abd El-Megeed (1992) on persimmon trees.

An increase in fruit set percentage with regard to potassium fertilization was recorded in both seasons (Table 2). Application of 1200 g, in the first

Table 2. Effect of NK fertilization rates and rootstocks on growth, percentages of fruit set and retention after June drop or at harvest date and yield of Costata persimmon trees during 2000 and 2001 seasons.

Factors		2000 season						2001 season					
		Shoot length (cm)	Fruit set (%)	Fruit retention (%)		Yield/tree		Shoot length (cm)	Fruit set (%)	Fruit retention (%)		Yield/tree	
				I	II	No. of fruits	Fruits weight (kg)			I	II	No. of fruits	Fruits weight (kg)
Nitrogen levels (N)	0	30.25	60.36	28.96	26.86	153	25.08	28.43	54.67	26.73	23.61	138	18.86
	1	32.62	64.64	30.02	29.01	175	29.03	34.65	61.82	29.62	30.05	162	26.72
	2	37.65	69.83	32.82	30.07	183	32.36	38.73	66.72	36.25	35.10	183	31.54
	3	38.74	68.93	36.71	34.92	188	32.45	39.86	70.36	35.12	34.00	186	31.85
L.S.D $_{0.05}$		3.25	NS	2.48	1.87	17	3.72	5.12	7.52	3.82	4.64	9	6.02
Potassium levels (K)	0	33.67	60.55	29.72	27.86	167	27.53	34.69	50.26	27.92	26.85	158	23.02
	1	35.42	66.56	31.35	30.81	170	29.62	35.62	63.50	32.73	31.46	168	28.88
	2	35.38	70.72	35.32	31.98	187	32.04	35.95	76.46	35.16	33.77	176	29.83
L.S.D $_{0.05}$		NS	8.51	2.16	1.63	15	3.24	NS	6.54	3.32	4.64	8	5.23
Rootstocks (RT)	S	37.53	69.83	33.72	31.81	183	32.32	37.83	70.22	35.64	34.10	172	29.48
	T	32.13	62.07	30.55	28.64	167	27.15	33.01	56.57	28.23	27.29	163	25.00
L.S.D $_{0.05}$		2.32	6.97	1.77	1.33	12	2.65	3.65	5.36	2.73	3.31	6	4.28
N x K		*	*	*	*	*	*	*	*	*	*	*	*
N x RT		*	*	NS	*	*	*	*	*	*	*	*	*
K x RT		NS	*	*	*	*	*	NS	*	*	*	*	*
N x K x RT		*	*	NS	*	*	*	*	*	NS	*	*	*

I = Fruit retention at June drop. II = Fruit retention at harvest date.
S = Seedling rootstock. T = Trabols rootstock.
* = Significant. N.S = Not significant.

season, and either 600 or 1200 g K_2SO_4/tree, in the second season, significantly increased fruit set as compared with the control (Table 2). These results are in agreement with those of Attala (1997), who found that the fruit set was significantly increased by application of K_2SO_4 at 1.5 or 2.0 kg/tree.

Moreover, the percentage of fruit set of trees on seedling rootstock was higher than that of trees on Trabols rootstock, in both seasons.

Percentage of fruit retention

Data in Table (2) showed that the application of nitrogen increased the percentage of fruit retention, either after June drop or at harvest date, in both seasons. Trees received 1200 or 1800 g ammonium nitrate gave the greatest increase in fruit retention after June drop, whereas at harvest date fruit retention was increased by applying 600, 1200 or 1800 g ammonium nitrate per tree, in both seasons. These results are in agreement with those obtained by Ahlawat and Yamdagni (1988) and Abd El-Megeed (1992).

Regardless of rootstock and nitrogen fertilizer, the data in Table (2) showed that the percentage of fruit retention after June drop or at harvest date was significantly increased by the application of potassium sulphate, in both seasons. Attala (1997) reported that the fruit drop was reduced by the application of potassium sulphate.

With regard to rootstock, the percentage of fruit retention after June drop and at harvest date on seedling rootstock was significantly higher than that of Trabols rootstock. Omarov (1989) and Engel (1990) reported that the average yield of the trees varied with rootstocks.

Yield

The three levels of nitrogen fertilizer (N_1, N_2 and N_3) significantly increased the yield (weight of fruits/tree) as compared with the control (N_0), in both seasons (Table 2). However, no differences were found among the three levels. In addition, the yield as number of fruits/tree was significantly higher by application of N_3 level than that of control (N_0), in both seasons. However, the N_2 and N_3 levels gave the highest number of fruits per tree followed by N_1 in the second season only. These results are, generally, in line with those reported by Bussi and Amiot (1998), Monga *et al.*(1990) and Abd El-Megeed (1992).

Regardless of nitrogen fertilizer and rootstock, the data in Table (2) showed that, in both seasons, the yield either as weight or number of fruits per tree tended to increase by the application of potassium sulphate at the rate of 1200, in the first season, or 600 and 1200 g/tree in the second season. These results agreed with those found by Smith *et al.*(1985), Abd El-Megeed (1992) and Attala (1997). They reported that potassium fertilization increased yield.

With regard to rootstock, the data in Table (2) showed that the yield either as weight or number of fruits per tree of persimmon trees on seedling rootstock was higher than that on Trabols, in both seasons. The differences between both rootstocks was present regardless of nitrogen and potassium fertilization. Omarov and Erokhina (1989) found that the average fruit yield on *D. lotus* persimmon was greater than on *D. virginiana*.

Leaf mineral content

Data in Table (3) represent leaf mineral contents as affected by the different fertilizers and rootstocks. Regardless of potassium fertilizer and rootstock, it was found that the application of nitrogen fertilizer increased leaf nitrogen and magnesium contents as compared with control, in both seasons. The addition of 1200 and 1800, in 2000, and 600, 1200 and 1800 g ammonium nitrate per tree in 2001 caused a marked increase in leaf nitrogen and magnesium contents. These results coincided with those reported by Abd El-Megeed (1992) on persimmon and El-Morshedy (1997) on apple trees. They found that the nitrogen fertilizer increased leaf nitrogen and magnesium contents. Moreover, Kumar and Bhutani (1996) and Jia *et al.*(1999) found that the leaf nitrogen content was higher in trees treated with higher level of nitrogen fertilizer, whereas magnesium content was not affected. On the other hand, the addition of either 1200 or 1800 g ammonium nitrate per tree decreased leaf potassium content in both seasons, and leaf iron and zinc contents in the second season. In contrast, adding 1800 g /tree decreased leaf iron and zinc contents in the first season, and leaf phosphorus content in the second season. However, the leaf calcium and manganese content were not affected by nitrogen fertilizer, in both seasons. These results are, generally, in line with those reported by Kumar and Bhutani (1996) on Santa Rosa plum trees, El-Morshedy (1997) on apple trees and Jia *et al.*(1999) on Hakuho peach trees. Abd El-Megeed (1992), working on Costata persimmon trees, found that the nitrogen fertilization decreased leaf phosphorus, potassium, iron and zinc contents, but increased leaf calcium and manganese contents.

With regard to potassium fertilization only, the data in Table (3) showed that potassium application did not significantly affect leaf nitrogen, phosphorus and iron contents in both seasons, and leaf magnesium content in the first season. However, leaf potassium, zinc and manganese contents were significantly increased by adding 600 g potassium sulphate per tree, in the first season, and 600 or 1200 g per tree, in the second season. Potassium application at 1200 potassium sulphate g/tree decreased leaf calcium content, in the first season, and leaf magnesium content, in the second season. Both 600 and 1200 g potassium sulphate per tree decreased leaf calcium content, in the second season only. These results agreed with those reported by Kassem (1991) and El-Morshedy (1997) on apple trees and Abd El-Megeed (1992) and

Table 3. Effect of NK fertilization rates and rootstocks on leaf mineral content of Costata persimmon trees during 2000 and 2001 seasons.

Factors		2000 season								2001 season							
		%					ppm			%					ppm		
		N	P	K	Ca	Mg	Fe	Zn	Mn	N	P	K	Ca	Mg	Fe	Zn	Mn
Nitrogen levels (N)	0	1.87	0.25	1.64	1.76	0.36	170	36	48	1.64	0.27	1.60	1.89	0.33	178	37	50
	1	2.00	0.27	1.56	1.94	0.40	150	35	50	2.18	0.25	1.50	1.77	0.39	166	33	45
	2	2.19	0.24	1.46	1.82	0.49	153	33	45	2.30	0.22	1.35	1.79	0.41	156	30	47
	3	2.36	0.25	1.43	1.77	0.47	133	28	46	2.58	0.20	1.36	1.82	0.43	149	27	46
$L.S.D_{0.05}$		0.17	NS	0.14	NS	0.06	21	6	NS	0.36	0.06	0.20	NS	0.04	19	5	NS
Potassium levels (K)	0	2.06	0.25	1.42	1.92	0.45	160	31	44	2.16	0.25	1.30	1.97	0.42	170	28	43
	1	2.12	0.25	1.50	1.87	0.43	149	31	47	2.07	0.22	1.52	1.78	0.40	159	32	50
	2	2.14	0.26	1.65	1.69	0.42	145	38	50	2.30	0.24	1.55	1.71	0.36	158	36	49
$L.S.D_{0.05}$		NS	NS	0.12	0.17	NS	NS	5	5	NS	NS	0.17	0.13	0.03	NS	4	5
Rootstocks (RT)	S	2.30	0.23	1.62	1.96	0.42	158	31	43	2.32	0.20	1.56	1.89	0.38	167	30	42
	T	1.92	0.27	1.44	1.69	0.44	144	35	51	2.03	0.27	1.35	1.75	0.41	157	34	52
$L.S.D_{0.05}$		0.12	0.03	0.10	0.14	NS	NS	3	4	0.26	0.04	0.14	0.11	0.02	NS	3	4
N x K		*	*	*	NS	*	*	*	*	*	*	*	NS	*	*	*	*
N x RT		*	NS	*	*	*	*	*	*	*	*	*	*	*	*	*	*
K x RT		*	*	*	*	NS	NS	NS	*	*	*	*	*	NS	NS	NS	NS
N x K x RT		*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*

S = Seedling rootstock. T = Trabols rootstock.
* = Significant. N.S = Not significant.

Attala (1995) on persimmon trees. They reported that potassium fertilizer increased leaf K and Mn and decreased leaf N, P, Ca and Mg contents, while leaf Fe and Zn contents were not affected.

With regard to rootstock alone, leaf nitrogen, potassium and calcium contents of trees budded on seedling rootstock were highest, whereas leaf phosphorus, zinc and manganese contents were lowest, in both seasons. In addition, no significant differences were found in leaf iron content, in both seasons, and magnesium content, in the first season only (Table 3). Similar results were found by Kassem (1996).

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الملخص العربى

استجابة أشجار الكاكى صنف كوستاتا لنوع الأصل المستخدم والتسميد بالنتروجين والبوتاسيوم

١- النمو والمحصول والتركيب المعدنى للأوراق

حسن على قاسم

قسم الفاكهة - كلية الزراعة - جامعة الأسكندرية

أجريت هذه الدراسة خلال عامى ٢٠٠٠، ٢٠٠١ على أشجار كاكى صنف كوستاتا بغرض دراسة تأثير نوع الأصل المستخدم (أصل بذرى وطرابلس) وكذلك التسميد بمعدلات مختلفة من النتروجين والبوتاسيوم والتداخلات الممكنة بينهم على كل من النمو الخضرى ونسبة عقد الثمار والنسبة المئوية للثمار المتبقية على الأشجار والمحصول (وزن وعدد الثمار/شجرة) وكذلك محتوى الأوراق من المعادن. وقد أوضحت النتائج المتحصل عليها الآتى:

١- أدى التسميد بالنتروجين بغض النظر عن التسميد البوتاسى ونوع الأصل المستخدم إلى زيادة فى النمو الخضرى ونسبة عقد الثمار فى الموسم الثانى والنسبة المئوية للثمار المتبقية سواء بعد تساقط يونيو أو عند مرحلة الجمع والمحصول (وزن وعدد الثمار/شجرة). التسميد بالنتروجين سبب زيادة فى محتوى أوراق أشجار الكاكى من كل من النتروجين والمغنيسيوم ونقص فى كل من البوتاسيوم والحديد والزنك فى عامى الدراسة والفوسفور فى العام الثانى بينما لم يتأثر كل من الكالسيوم والمنجنيز.

٢- بغض النظر عن النتروجين ونوع الأصل المستخدم سبب التسميد بمعدلات مختلفة من البوتاسيوم زيادة فى نسبة عقد الثمار والنسبة المئوية للثمار المتبقية بعد تساقط يونيو أو عند الجمع والمحصول (وزن وعدد الثمار/شجرة) وأيضا سبب زيادة فى محتوى أوراق الكاكى من البوتاسيوم أو الزنك والمنجنيز ونقص فى الكالسيوم فى عامى الدراسة والمغنيسيوم فى الموسم الثانى ولم يتأثر كل من النمو الخضرى والنتروجين والفوسفور والحديد فى عامى الدراسة والمغنيسيوم فى الموسم الأول.

٣- بالنسبة لتأثير نوع الأصل المستخدم بغض النظر عن التسميد بالنتروجين والبوتاسيوم فإن أشجار الكاكى المطعمة على أصل بذرى حدث بها زيادة فى النمو الخضرى ونسبة عقد الثمار والنسبة المئوية للثمار المتبقية بعد تساقط يونيو أو عند الجمع والمحصول (وزن وعدد الثمار/شجرة) بالمقارنة بالأشجار المطعمة على أصل طرابلس. أما محتوى أوراق الكاكى المطعم على الأصل البذرى فكانت عالية فى كل من النتروجين والبوتاسيوم والكالسيوم ومنخفضة فى الفوسفور والزنك والمنجنيز. ولم يكن هناك تأثير لنوع الأصل على كل من الحديد فى عامى الدراسة والمغنيسيوم فى الموسم الأول.