Response of Florda Prince Peach Trees to Soil and Foliar Applications of Potassium

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ABSTRACT

This investigation was carried out in 2000 and 2001 growing seasons to study the leaf mineral content, yield and fruit quality of Florda Prince peach trees as affected by four levels of potassium sulphate (0,250,500 and 750 g/tree) by soil or foliar application. Regardless of application method, potassium sulphate increased leaf potassium and decreased leaf calcium and magnesium content during both seasons, and leaf manganese and phosphorus in the second season only. In addition, yield, fruit weight, TSS, acidity had increased during both seasons with potassium application. No differences were found between the four potassium levels in their effect on leaf nitrogen, zinc and iron content and fruit firmness during both seasons. Foliar application resulted in the highest leaf phosphorus, potassium and fruit TSS during both seasons. On the other hand, the soil application resulted in the highest leaf iron during both seasons, and magnesium and manganese in the second season only. However, no differences between the two methods of application (soil or foliar) were observed in leaf nitrogen, calcium and zinc contents, yield, fruit quality; fruit firmness and acidity during both seasons.

INTRODUCTION

Potassium deficiency of peaches has been a serious problem dating back many years (Evans *et al.*, 1977). Potassium deficiency symptoms appear as pale chlorotic leaves in early to midsummer, subsequent leaf scorching, shoot dieback and sunburned fruit. The soils in most of these potassium deficient areas are fine textured, readily "fixing" potassium fertilizer applied to the soil. Thus, the most common method used to correct the deficiency has been to apply massive doses of potassium sulphate drilled 15-20 cm deep in several bands along the tree rows (Uriu *et al.*, 1980). Even that treatment, however, does not always correct the deficiency. There is a continuing need for better ways of fertilizing with potassium. The present work was carried out to determine the leaf mineral content, yield and fruit quality of Florda Prince peach trees as affected by four levels of potassium sulphate and two application methods.

MATERIALS AND METHODS

The present study was carried out during 2000 and 2001 growing seasons on six-year-old Florda Prince peach trees *(Prunus persica*, B) grown in a private orchard at El Tarh region, El Behera Governorate. The trees were budded on Nemagard rootstock, grown in clay soil with pH =7.5 and EC = 0.3 m mohs/cm^2, spaced at 4x5 meters and irrigated with Nile water at 20-25 days intervals. The trees were annually fertilized with organic manure at a rate of 20 cubic meters per feddan in November, ammonium sulphate at a rate of 2.5 kg per tree, in two equal doses in mid February and mid April and calcium super phosphate at a rate of 1.0 kg per tree in mid February. Water table was at about 100 cm from soil surface.

Thirty two trees, as uniform as possible, were chosen for the present study and treated with potassium sulphate (48% K_2O) at rates of 0, 250,500, 750 g/tree either as foliar spray or as soil application at three equal doses in the first week of February, March and April. Foliar spray treatments were applied during the period from early February to mid April and each tree was subjected to 10 sprays during this period. Spray treatments were 0.000, 0.500,1.000 and 1.500 % potassium sulphate, which represent 0, 250, 500, 750 gm K_2SO_4, respectively.Each tree received five liter of solution per spray. Control trees were sprayed with water only. The experimental treatments were arranged in a randomized complete block design and the treatment was replicated four times with one tree in each replicate, i.e. 4 potassium sulphate levels x 2 application methods x 4 replicates = 32 trees

In early May, a leaf sample of 30 leaves was collected from each experimental tree from the middle part of the outer shoots and washed with tap water, distilled water and oven dried at 70 ^{0}C to a constant weight. The dried leaves were ground and digested with sulphuric acid and hydrogen peroxide according to Evenhuis and De Waard (1980). Suitable aliquots were taken for the determination of mineral elements. N and P were determined colorimetrically according to Evenhuis (1976) and Murphy and Riley (1962), respectively, K was determined by flamephotometer, while Ca, Mg, Fe, Mn, Zn and Cu by Perken Elemer Atomic Absorption Spectrophotometer.

At harvest time, i.e. early May, the yield was recorded as fruits weight per tree. From the yield of each experimental tree, 40 fruits were taken at random for the determination of fruit quality. In each fruit sample, fruit weight was recorded and firmness was determined by Magness and Taylor (1925) pressure tester. In fruit juice, TSS were determined by a hand refractometer and acidity as malic acid by titration with 0.1 N sodium hydroxide.

The data obtained throughout the course of this study were statistically analyzed using the analysis of variance as illustrated by Snedecor and Cochran (1972).

RESULTS AND DISCUSSION

1.Leaf mineral content.

The data concerning the effect of different potassium fertilization rates on the leaf mineral composition of Florda Prince peach are presented in Tables 1 and 2.

a. Nitrogen

The data of the present investigation indicated that during both seasons the leaf nitrogen concentration was not greatly affected by potassium fertilization. These findings might support those obtained by Smith *et al.*, (1985), Plisek (1987), Ahmedullah *et al.*, (1987), Kassem (1991) and Abd el Al *et al.*, (1994) who reported that potassium fertilization had little or no effect on the leaf nitrogen content. On the other hand, Awada and Long (1980) and spires (1984) concluded that the application of high potassium rates caused a linear reduction in the leaf nitrogen content.

b. Phosphorus

As for the effect of potassium fertilization on the phosphorus concentration of peach leaves, the data of the first experimental season, 2000, indicated that the addition of potassium to peach trees did not affect the leaf phosphorus content. In 2001, however, the potassium fertilization at a rate of 750 g potassium sulphate /tree caused a significant decrease in leaf phosphorus content as compared with 500 g and the control. Significant difference was also found between 250 g and control treatment. Forsyth and Webster (1971), Spiers (1984), Smith *et al.*, (1985) and Abd El Al *et al.*, (1994), reported that the potassium fertilization did not affect the leaf phosphorus. Nevertheless, Ludders *et al.*, (1974) and Awada and Long (1980) found that potassium fertilization tended to decrease the leaf phosphorus content.

c. Potassium

This data revealed that applying potassium to peach trees increased their leaf potassium during both seasons (Table 1). In the first season, 750 g potassium sulphate treatment significantly increased leaf potassium content than the control. In the second season, the experimental trees treated with 250 or 750 g potassium sulphate per tree had significantly higher leaf potassium than the other treatments. These findings supported those previously reported by numerous investigators. For example, Keleg *et al.*,(1977) on almond, Cline and Bradt (1980) on grape ,Ahmedullah *et al.*,(1987) on grape, Kassem (1991) and Abd El Al (1994) on mango found that fertilizing fruit trees with potassium increased their leaf potassium content. Meanwhile, Plisek (1987) reported that there was essentially no difference in potassium content between leaf sampled from tree that had or had not received potassium fertilizers.

d. Calcium and Magnesium

The data tabulated in Table (1) showed that applying potassium fertilizers to Florda Prince peach trees appreciably decreased the leaf calcium and magnesium content during both seasons. The influence of potassium in depressing calcium and magnesium absorption by fruit trees had been pointed out by previous numerous investigators such as; Forsyth and Webster (1971), Ludders *et al.*, (1974), Awada and Long (1980), Basso *et al.*, (1983), Hiroce *et al.*, (1984) and Kassem (1991), they all found that potassium fertilization aggravated or induced calcium and magnesium deficiency. Furthermore, Cain (1953) concluded that translocation and redistribution factors are responsible for the antagonistic effects observed in the leaves, and if there is a real antagonistic action between potassium and magnesium it appears to be in the transport regulatory mechanism. Moreover, Oberly and Bognton (1966) stated that, there seem to be evidence that factors enhancing potassium absorption might decrease that of calcium in apple trees.

e. Iron, Zinc and Manganese

As for the leaf micronutrients, it was noticed that regardless of potassium application method, the data of the present study indicated that the concentration of iron and zinc in leaf tissues was not greatly affected by potassium fertilization during both seasons (Table 2). The leaf manganese content decreased by the potassium fertilization in the second season, whereas in the first season no significant differences were found between the peach that had or had not received potassium fertilizers. These results seemed to be in agreement with those reported by Sadawski *et al.*, (1978), Spiers (1984), Smith *et al.*, (1985) and Kassem (1991) who reported that potassium fertilization did not affect leaf iron, zinc or manganese content.

The data representing the effect of the two potassium application methods (soil or foliar) on the leaf mineral content of Florda Prince peach trees are presented in Tables 1 and 2. The results generally indicated that the soil application resulted in the highest leaf iron, during both seasons, magnesium and manganese in the second one and the lowest leaf potassium and phosphorus during both seasons. The data also indicated that the leaf nitrogen, calcium and zinc were not affected with different potassium application methods during both seasons.

Keleg *et al.*, (1977) working on almond trees found that the potassium foliar sprays increased leaf potassium content. Khamis *et al.*, (1994) on pear and peach found that the soil application increased leaf nitrogen content, whereas foliar application increased leaf phosphorus and potassium and decreased leaf calcium contents in both species. Abd el Al (1994) on mango found that the soil application had no clear effect on the leaf nitrogen, potassium and phosphorus content.

2.Fruit Quality:

a. Yield

Regardless the methods of application, the present results listed in Table (3) showed that, in both seasons, the average fruit yield was significantly higher in trees received either 500 or 750 g potassium sulphate per tree than that of the control. These results are ,generally, in line with those reported by Bruchholz and Fiedler (1979) on apple trees, Awada and Long (1980) on papaya plants and Smith *et al.* (1985) on pecan. They all found that potassium fertilization showed a great effect on the yield of the trees. On the other hand, Cummings (1965) on peaches, Keleg *et al.*, (1977) on almond and Ahmedullah *et al.*, (1987) on grapes. They all reported that the addition of potassium fertilizer did not increase the yield.

Data also revealed that, during both seasons, no significant differences were found between the peach trees applied with potassium either to the soil or as foliage sprays in their tree yield. This seemed to agree with results obtained by Keleg *et al.*, (1977) on almond trees. They found that neither soil nor foliar application of potassium sulphate had any appreciable effect on the yield of trees.

b. Fruit Weight

Regardless of methods of application, the data in Table (3) showed that the potassium fertilization tended to increase the fruit weight during both seasons. The addition of 750 g potassium sulphate per tree significantly increased average fruit weight than the other treatments in year 2000, whereas in year 2001, 500 g and 750 g significantly increased the fruit weight than the control. These results were in agreement with those obtained by Ahmedullah *et al.*, (1987) on grapes and Kassem (1991) on apple who found that the potassium fertilization increased the fruit weight or size. Beattie (1954) pointed out that the effect of potassium upon fruit size would probably be related to the role of potassium in carbohydrate translocation.

The data concerning the effect of methods of application on the average fruit weight, presented in Table (3), revealed that during both seasons, no differences were found between the soil and the foliar application in their fruit weight. Abd el Al *et al.*, (1994) found that the methods of application (soil or foliage) had no significant effect on fruit weight.

c. Fruit Firmness

Regardless of methods of application, the data in Table (3) showed that the fruit firmness at harvest time was not significantly affected in both seasons with potassium fertilization.These findings completely agreed with those previously found by Forsyth and Webster (1971), Bramlage *et al.*, (1985) and Kassem (1991).

The data on methods of application showed that fruit firmness was not affected during both seasons, (Table 3)

d. Total Soluble Solids:

The data of the present investigation indicated that, in both seasons, regardless of application methods, the potassium fertilization tended to increase the fruit total soluble solids (Table 3). The addition of 500 and 750 g potassium sulphate per tree in 2000 and 2001 seasons significantly increased the fruit total soluble solids than the control. The fruits harvested from trees treated with 750 g potassium sulphate per tree had significantly higher total soluble solids content than those received 250 g per tree. Similarly, Cline and Brandt (1980) on grape and Abd el Al (1994) on mango reported that the potassium fertilizer increased fruit total soluble solids. On the other hand, Keleg *et al.*, (1981) and Kassem (1991) found that the potassium fertilizer did not affect the total soluble solids of the fruits.

As for the effect of application methods, the data in Table (3) revealed that, regardless of potassium rates, the foliar application significantly raised total soluble solids than the soil addition during both seasons. The same findings were also reported by Abd El Al *et al.*, (1994) working on mango fruits.

e. Fruit Acidity:

The data concerning the effect of potassium sulphate on the acidity of Florda Prince peach fruit are listed in Table (3). The data indicated that all potassium fertilization rates (250, 500 or 750 g K_2SO_4 /tree), regardless of application methods, significantly increased the fruit acidity content during both seasons. Similar results were found by Cummings and Reeves (1971), Meheriak and Lau (1979), Fallahi *et al.*, (1985) and Kassem (1991). For example, Cummings and Reeves (1971), working on peaches, reported that acidity was positively related to potassium. They added that the lower hydrogen ion concentration with the concomitant positive correlation between potassium supply and total organic acids as potassium was increased.

Data also revealed that, during both seasons, the fruit acidity of Florda Prince peach was not affected by the methods of application (either by soil or foliar application). These results agreed with previous findings of Abd EL Al *et al.*, (1994) on mango, found that the methods of application had no significant effect on fruit acidity

Table 1. Effect of potassium soil and foliar applications on leaf macro elements content (%on dry weight basis) of Florda Prince peach trees in 2000 and 2001.

Treatments K_2SO_4/tree (g)	Nitrogen %			Phosphorus %			Potassium %			Calcium %			Magnesium %		
	Soil Application	Foliar Application	Mean	Soil Application	Foliar Application	Mean	Soil Application	Foliar Application	Mean	Soil Application	Foliar Application	Mean	Soil Application	Foliar Application	Mean
2000															
0	1.94	2.10	2.02	0.22	0.24	0.23	1.88	1.68	1.66	1.98	2.05	2.02	0.46	0.42	0.44
250	1.97	1.96	1.97	0.22	0.24	0.23	1.66	1.73	1.67	1.96	2.00	1.98	0.36	0.35	0.36
500	2.22	2.24	2.23	0.20	0.26	0.23	1.63	1.80	1.72	2.10	1.86	1.98	0.38	0.36	0.37
750	2.02	2.46	2.24	0.19	0.25	0.22	1.89	1.96	1.93	1.90	1.96	1.93	0.39	0.38	0.38
Means	2.04	2.19	-	0.21	0.25	-	1.69	1.79	-	1.99	1.97	-	0.40	0.38	-
L.S.D 0.05	Treatment	Methods	TxM	Treatment	Methods	TxM	Treatment	Methods	TxM	Treatment	Methods	TxM	Treatment	Methods	TxM
	NS	NS	NS	NS	0.02	0.04	0.11	0.08	0.16	0.7	NS	0.10	0.01	NS	0.06
2001															
0	2.12	2.18	2.15	0.30	0.35	0.33	1.97	1.88	1.93	2.26	2.15	2.21	0.44	0.40	0.42
250	2.28	2.12	2.20	0.26	0.30	0.28	2.00	2.45	2.23	2.14	2.00	2.07	0.38	0.36	0.37
500	2.32	2.38	2.35	0.27	0.33	0.30	1.89	2.41	2.15	2.03	2.18	2.11	0.42	0.38	0.40
750	2.20	2.36	2.28	0.22	0.27	0.25	2.22	2.32	2.27	1.98	1.96	1.97	0.38	0.40	0.39
Means	2.23	2.26	-	0.26	0.31	-	2.02	2.27	-	2.10	2.07	-	0.41	0.39	-
L.S.D 0.05	Treatment	Methods	TxM	Treatment	Methods	TxM	Treatment	Methods	TxM	Treatment	Methods	TxM	Treatment	Methods	TxM
	NS	NS	NS	0.04	0.03	0.06	0.23	0.16	0.32	0.20	NS	0.28	0.02	0.01	0.03

Table 2. Effect of potassium soil and foliar applications on leaf micro elements content (ppm on dry weight basis) of Florda Prince peach trees in 2000 and 2001.

Treatments K_2SO_4/tree (g)	Iron ppm			Zinc ppm			Manganese ppm		
	Soil Application	Foliar Application	Mean	Soil Application	Foliar Application	Mean	Soil Application	Foliar Application	Mean
2000									
0	100	96	98	36	32	34	54	58	56
250	110	100	105	38	40	38	60	55	58
500	106	98	102	38	40	39	60	60	60
750	110	100	105	36	38	37	56	50	53
Means	107	99	-	37	38	-	58	56	-
L.S.D at 0.05	Treatment	Methods	TxM	Treatment	Methods	TxM	Treatment	Methods	TxM
	NS	6	12	NS	NS	NS	NS	NS	NS
2001									
0	106	96	101	42	38	40	60	58	59
250	112	100	106	40	38	39	57	58	58
500	106	99	103	40	40	40	66	60	63
750	114	100	107	36	38	37	50	45	48
Means	110	99	-	40	39	-	58	55	-
L.S.D at 0.05	Treatment	Methods	TxM	Treatment	Methods	TxM	Treatment	Methods	TxM
	NS	5.0	10.0	NS	NS	NS	4	3	6

Table 3. Effect of potassium soil and foliar applications on yield and fruit quality of Florda Prince peach trees in 2000 and 2001.

Treatments K_2SO_4 /tree	Fruit Yield kg/tree			Fruit weight /g			Firmness lb/inch^2			TSS %			Acidity %		
	Soil Application	Foliar Application	Mean	Soil Application	Foliar Application	Mean	Soil Application	Foliar Application	Mean	Soil Application	Foliar Application	Mean	Soil Application	Foliar Application	Mean
2000															
0	12.80	13.60	13.20	136.20	137.50	136.85	8.60	8.20	8.40	8.00	9.10	8.55	0.75	0.83	0.79
250	16.30	16.00	16.15	136.20	130.90	133.55	8.00	7.60	7.80	8.70	9.30	9.50	0.87	1.01	0.94
500	17.70	18.60	18.15	136.90	132.20	138.55	9.20	8.60	8.90	9.30	10.20	9.75	0.95	0.97	0.96
750	18.20	17.80	18.00	154.80	150.70	148.25	8.70	7.60	8.15	10.40	10.60	10.50	0.93	0.95	0.92
Means	16.25	16.50	-	136.78	137.83	-	8.63	8.00	-	9.10	9.80	-	0.88	0.94	-
L.S.D at 0.05	Treatment	Methods	TxM	Treatment	Methods	TxM	Treatment	Methods	TxM	Treatment	Methods	TxM	Treatment	Methods	TxM
	4.20	NS	NS	6.23	NS	8.81	NS	NS	NS	0.88	0.62	1.24	0.11	NS	0.16
2001															
0	14.60	16.50	15.55	123.40	120.20	121.60	8.20	8.80	8.50	9.30	9.00	9.15	0.85	0.82	0.84
250	17.20	18.20	17.70	122.70	127.30	125.00	8.90	8.60	8.75	9.01	9.80	9.40	0.86	0.97	0.92
500	17.80	18.90	18.35	130.70	129.50	130.10	10.00	9.20	9.60	9.20	10.30	9.75	0.93	0.98	0.96
750	20.20	19.30	19.75	135.60	130.60	133.10	9.20	8.90	9.05	10.0	10.80	10.40	1.02	0.97	1.00
Means	17.45	18.23	-	128.10	120.90	-	9.08	8.88	-	9.38	9.98	-	0.92	0.94	-
L.S.D at 0.05	Treatment	Methods	TxM	Treatment	Methods	TxM	Treatment	Methods	TxM	Treatment	Methods	TxM	Treatment	Methods	TxM
	2.22	NS	3.14	7.20	NS	10.18	NS	NS	NS	0.36	0.25	0.51	0.07	NS	0.10

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الملخص العربي

استجابة أشجار الخوخ فلوردا برنس للإضافة الأرضية و الورقية بسماد البوتاسيوم

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أجريت هذه الدراسة في عامي ٢٠٠٠ و ٢٠٠١ لدراسة تأثير إضافة أربع مستويات من كبريتات البوتاسيوم (صفر - ٢٥٠ - ٥٠٠ - ٧٥٠ جرام / شجرة) مضافة عن طريق التربة أو بالرش على الأشجار و ذلك لدراسة تأثيرها على المحتوى المعدني للأوراق و كمية المحصول و جودة ثمار الخوخ فلوردا برنس و كانت النتائج كالآتي :- أدت إضافة كبريتات البوتاسيوم بغض النظر عن طريقة الإضافة إلى زيادة محتوى أوراق الأشجار من عنصر البوتاسيوم و قلل محتواها من الكالسيوم و المغنيسيوم في سنتي الدراسة و قلل من المنجنيز و الفسفور في الموسم الثاني فقط . أدت إضافة كبريتات البوتاسيوم (عن طريق التربة أو الرش) إلى زيادة المحصول ووزن الثمرة و المواد الصلبة الذائبة و الحموضة خلال عامي الدراسة . بينما لم يوجد فرق بين المستويات الأربعة المضافة من كبريتات البوتاسيوم على عناصر النيتروجين و الزنك و الحديد و

أيضا صلابة الثمار في عامي الدراسة . أما بالنسبة لتأثير طريقة الإضافة فقد أدى الرش إلى زيادة عنصـــري البوتاسيوم و الفسفور و المواد الصلبة الذائبة في عامي الدراسة بينما أدت الإضافة الأرضية إلى زيادة الحديد في السنتين و إلى زيادة المغنيسيوم و المنجنيز في السنة الثانية فقط و لم يكن هناك فرق بين طريقتــي الإضافــة (الرش أو الأرض) بالنسبة للمحصول و جودة الثمار - الصلابة - الحموضة - و عنصـــر النـــتروجين و الكالســـــــيوم و الزنـــــــــك .