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EFFECT OF POTASSIUM FERTILIZATION ON ANNA APPLE TREES GROWN IN SANDY SOILS OF EGYPT

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Abstract

The effect of applying different doses from 0 to 2 kg of potassium sulphate/tree, divided in four applications, was investigated on Anna apple trees on M.M. 106 stock grown at newly reclaimed sandy soils under a drip irrigation system. No significant effect in leaf N and P content occurred in response to fertilizer addition, yet, K, Fe. Zn and Mg contents increased by application of 1.5 or 2.0 K of K_2 SO_4 .Likewise, obvious increases in leaf total soluble and non soluble carbohydrates were evident. Significant increase in fruit set and decrease in fruit drop were also noticed. Fruit weight, volume, flesh firmness and T.S.S. values increased by 1.5 and 2.0 Kg rate of fertilizer resulting into higher values of T.S.S. /acidity that caused earlier fruit ripening. However, acid content was not affected. Yield was highly increased by the high rates of potassium sulphate additions.

INTRODUCTION

Production of low chilling apple cultivars has spread extensively in the newly reclaimed sandy soils in Egypt during the last decades. Many difficulties including nutritional problems, have been met by the growers. Optimum rates and time of application of major elements are not exactly determined. However, it has been mentioned that the optimum concentration of major mineral elements in mature apple leaves were around: N 1.8-2.4%, P 0.08-0.30, K 1.3-1.8%, Ca 1.0-1.3%, Mg 0.35 -0.50%, S 2%, Zn 35-50 p.p.m, Mn 35-50 p.p.m, Cu 7.5 -20 p.p.m, Fe 50 p.p.m, B 35-50 p.p.m (Swietlikand Miklos, 1984).

It has been reported that increasing potassium application resulted in only slight variation in vegetative and reproductive development of Gravensteiner apples (Schumacher Stadler, 1991).

The highest average yield of Goldenspur apples was obtained from plots receiving N, P and K (as potassium chloride) each at 60 kg/ha (Zhigarevich and Treglzova, 1991). However, it has been determined that 540 kg k_2o kg/ha was the optimum fertilization rate. The best results in terms of growth, yield and fruit stability of Goldenspur apple were produced when 60 kg N + 60 kg P + 60 kg k/ha were applied (Treglazova and Fataliev, 1994).

In an experiment carried out on young Anna apple trees growing in newly reclaimed sandy soil at El-Nubaria, Egypt, soil application of 450 or 900g $K_2 SO_4$/ tree in 3 equal split doses: March 10th, May 1st and June 1st resulted in significant increase of yield, fruit weight, fruit size and fruit firmness (Kilany and Kilany, 1991).

Effect of potassium application on mineral leaf content of apples was reviewed by Hansen (1975) and citrus by Resse and Koo (1975). The aim of this work is to determine the optimum K requirements for young Anna apple trees grown in newly reclaimed sandy soil.

MATERIALS AND METHODS

This investigation was carried out during the two successive seasons, 1994 and 1995 on young Anna apple trees on M.M. 106 stock of seven and eight years-old, planted 5m x 5m apart (168 trees/Feddan). Trees are grown in sandy soil of El-Kasassen experimental orchard. Drip irrigation, using 3000 M^3 of water/feddan/ year, is practiced. Analyses of soil and water before and after treatments are presented in Table 1.

The trees were equally subjected to the same cultural and fertilization practices (except for k). Fifteen M^3/fed of cow manure + 200 kg super phosphate (15.5% P_2O_5) were applied/feddan in shallow trenches dug 50 cm away from the trunks. Nitrogen fertilization was carried out by adding 210 units in December of Nitrogen as Ammonium nitrate (33.5%) per feddan.

The experiment included four treatments of potassiun fertilization by adding 0.0,0.75,1.5 and 2.0 Kg of potassium sulphate/tree (48-52 K_2O) divided into 4

split doses (March, April, May and June) and added to the soil surface under the irrigation drippers. Each treatment comprised 4 replicates each of 3 individual trees. Guard rows of untreated trees surrounded each replicate. Samples of leaves were taken from medium portion of current season growth in July according to the method described by Westwood (1978). Leaves were dried at 70°C for 72 h. Total nitrogen, phosphorus and potassium were determined according to the method described by Koch and Meekin (1924), Troug and Meyer, (1939), and Brown and Lilleiand (1946). Fe, Zn and Mn were determined using the atomic absorption apparatus model (Thermo Jarrell Ash smith-Hieftje 1000) (Barrows and Simpson, 1962). Total carbohydrates were analysed by the method of Smith and Dubois (1956). Percentage of fruit set and shedding was calculated. Samples were taken from various replicates when control fruits attained maturity (Abd El-Aziz *et al.*, 1985).

Table 1. Soil and irrigation water analysis.

Sample	PH	soluble salts p.p.m	NO3 (%)	P (%)	K (%)	Na (%)	Cl- (%)	SO4- (%)	Hco- (%)
Before Application	7.98	1664	1.29	0.08	1.62	12.2	12.3	14.33	3.93
After Application									
Control 0.0 kg/tree	7.72	1671	1.28	0.09	1.60	12.0	12.9	14.9	3.59
0.75 Kg/tree	7.70	1680	1.26	0.08	1.71	12.1	13.03	14.2	3.41
1.5 Kg/tree	7.63	1690	1.29	0.08	1.73	11.92	12.9	14.9	3.39
2.0 Kg/tree	7.69	1681	1.29	0.09	1.72	12.21	13.1	14.3	3.51
Irrigation Water	7.60	1088	0.93	0.07	1.67	11.4	8.47	6.2	3.28

Individual fruit weight and diameter, firmness (Lb/cm2) using penetrometer (fruit tester) trade mark effegi with plunger of 5/16 inch. T.S.S. was determined using a hand refractometer (ATAGO No1 Brix 0 32%) made in Japan.

The starch content was estimated by the method of Lane and Eynon (1960) and Whelan (1955). Total number of fruits and yield/tree were estimated. Data were subjected to analysis of variance using the complete randomized design and averages were compared by L.S.D. (05) (Snedecor and Cochran, 1967).

RESULTS AND DISCUSSION

Vegetative Growth :

Mineral content of mature leaves on dry weight bases are presented in Table 2. It is evident that neither nitrogen nor phoshorous in the leaves were affected by potassium application in both seasons. However, potassium percentage increased by 1.5 and 2.0 Kg soil application. Concerming Fe, Zn and Mn, they were increased by potassium application especially at 1.5, 2.0 kg rates. Dry weight of leaves was not affected by any of the potassium treatments. Leaves total soluble and non soluble carbohydrates increased with the high concentrations of postassium especially at 2.0 Kg.

Table 2. Effect of potassium application on Anna apple Leaves nutrients and carbohydrates.

	Leaf elements concentrations							Carbohydrate		
K_2O/tree (kg)	N (%)	P (%)	K (%)	Fe (%)	Zn (%)	Mn (%)	Dry weigh (%)	Soluble (%)	Non Soluble (%)	Total (%)
Season 1994										
Control	1.90	0.11	0.49	69	35	82	41.31	3.20	5.75	8.95
0.75	1.93	0.12	0.79	72	52	120	41.91	6.95	1.70	8.65
1.50	1.92	0.12	1.16	80	80	179	41.82	6.75	1.95	8.70
2.00	1.99	0.14	1.26	83	90	191	41.73	6.20	3.70	9.90
L.S.D 0.5	N.S.	N.S.	0.35	4.5.	6.0	5.0	N.S.	1.2	2.0	0.5
Season 1995										
Control	1.82	0.12	0.60	75	38	89	41.29	4.20	4.40	8.60
0.75	1.99	0.13	0.89	96	62	190	41.70	5.40	3.50	8.90
1.50	1.92	0.14	1.09	99	93	183	41.62	5.55	3.50	9.05
2.00	1.99	0.13	1.13	98	100	200	41.50	6.55	2.40	8.95
L.S.D 0.5	N.S	N.S	0.30	5.0	7.1	5.2	N.S	0.8	1.8	0.22

The effect of potasium fertilization on leaf mineral content has been previously discussed. In the absence of K, leaf K content declined to 0.9% in bearing apple trees (Klein, 1992). Leaf content of "Cox's orange pippin" potassium was increased by soil application of potassium (Hansen, 1975). The effect of potassium application on leaf mineral content has been extensively studied in many citrus cultivars. Many reports

emphasized a significant increase (Koo and Reese, 1973; Reese and Koo, 1976; Fahmy and Hassaballa, 1977; Badra and Yousif, 1978; Bakr *et al.*, 1980 and Sarooshi *et al.*, 1991). Concerning nitrogen content, some reports pointed out that it was reduced by K application (Takidze, 1971), increased (Badra and Yousif, 1978) or had no effect (Jones *et al.*, 1973). No effect had been attributed to K fertilization on P leaf content (Takidze, 1971; and Bazeleth, 1980). Ca became lower in leaves by K application (Takidze, 1971 Fahmy and Hassablla, 1977). Less Mg content in leaves has been reported by Reese and Koo (1976) and Badra and Youssif (1978). However, Cu and Zn have been increased (Badra and Yousif, 1978) while Fe and Mn decreased (Kazak and Khalidy, 1974) by potassium application.

Fruit Set and Drop :

It is apparent that K application resulted in considerable increase in fruit set (Table 3).

Table 3. Effect.of potassium application on physical apple fruit characteristics and yield.

Treatment K2O/tree (kgs)	Fruit Set (%)	Fruit drop (%)	Fruit No./tree (g) (g)	Yield tree (Kg)
		Season 1994		
Control	9.01	26.2	189	15.69
0.75	23.7	14.2	290	29.96
1.50	34.1	10.2	289	34.42
2.00	36.2	8.3	291	34.92
L.S.D 0.5	2.1	4.5	9.1	1.8
		Season 1995		
Control	8.01	24.3	182	16.63
0.75	18.0	13.2	299	33.79
1.50	36.1	11.4	295	36.29
2.00	38.2	8.0	290	35.38
L.S.D 0.5	3.4	5.9	8.3	1.5

In the two seasons of the investigation, both 1.5 and 2 kg of K_2o were superior in this respect. Fruit drop was also decreased by Potassium application. Differ-

ences were not constant between the 3 concentrations. Potassium application enhanced fruit set (Wang *et al.*, 1994). However no signifficant variation in reproductive development of apple trees could be related to K fertilization (Schumacher and Stadler, 1991).

Mature fruits quality :

Fruit characters were compared when reached maturity (Abd El-Aziz *et al.*, 1985). Both fruit weight and volume increased by Potassium application (Table 4). The increase was more evident with the high concentrations of Potassium.

Table 4. Effect of potassium application on Anna apple fruit characteristics.

Treatment K_2O/tree (kgs)	Fruit Weight (g)	Fruit Volume (cm)3	Fruit dimension		Firmness (16/cm_2)
			Length cm	Width cm	
		Season 1994			
Control	83.0	99	6.3	5.7	12.3
0.75	103.3	121	7.4	6.8	12.5
1.50	119.1	183	7.9	6.8	12.4
2.00	120.0	200	8.1	7.2	13.1
L.S.D 0.5	7.1	5.1	1.2	1.1	0.2
		Season 1995			
Control	93	101	6.7	5.9	11.5
0.75	113	162	6.9	6.8	12.0
1.50	123	220	7.5	7.1	12.2
2.00	122	210	7.9	7.0	12.8
L.S.D 0.5	6.8	6.2	0.5	1.2	0.4

Fruit dimensions were enlarged except those of the equatorial diameter in the second season. Potassium application resulted in firmer fruits. This was more evident with the higher concentrations of potassium in the first year of study. T.S.S. in the Juice was increased by Potassium application at the rates of 1.5 and 2.0 kg KNO_3 in the first season and only at the rate of 2 kg in the second one (Table 5).

Acidity was not changed significantly by any of the treatments in the two seasons. (Table 5).

Table 5. Effect of potassium application on some Anna fruit chemical components.

K_2O/tree (kgs)	T.S.S. (%)	Acidity (%)	T.S.S. acid ratio	Ascorbic acid (mg/100g)	Starch (%)	Total sugars (mg/g D.W.)
			Season 1994			
Control	11.3	0.90	12.56	13.0	3.5	175
0.75	12.0	0.80	15.00	13.7	3.1	200
1.50	12.9	0.80	16.13	13.9	3.1	210
2.00	14.2	0.79	17.97	14.5	3.0	225
L.S.D. 0.5	1.20	N.S	1.50	1.5	0.2	4.5
			Season 1995			
Control	11.9	0.80	14.88	12.0	3.4	180
0.75	12.5	0.81	15.43	13.2	3.3	205
1.50	13.8	0.73	18.90	13.9	3.2	221
2.00	15.0	0.62	24.19	14.2	3.1	232
L.S.D. 0.5	2.0	N.S	1.8	2.0	0.2	4.9

T.S.S/ acid ratio increased by potassium application especially with 1.5 and 2.0 kg from K_2SO_4 as compared with the control. Such increament has enhanced fruit maturity dramatically. Nevertheless, the rate of 750 kg did not result in any apparent effect in the second season.

Ascorbic acid and starch contents increased by potassium fertilization especially at the rate of 2.0 kg. However, this rate was more effective than the other rates in the second season. Soluble total sugar content also increased by potassium application.

This was more apparent at the two kg rate of application in both seasons and in the 1.5 kgs in the second only.

Previous studies confirmed that significant increase of fruit weight, size and

firmness were induced by 450 or 900 gm K_2SO_4, (Kilany and Kilany, 1991). Fruit quality, however, was improved by K application (Wang *et al.*, 1994).

Yield :

Number of mature fruits per tree was not changed by potassium application in the first season, however, it increased significantly in the second (Table 3). Total yield increased by potassium in the two years of the experiment. Differences attributed to different rates of applications were not apparent. Previous studies confirmed that significant increase of yield was induced by 450 or 900 K_2SO_4/tree (Kilany and Kilany, 1991) .

Other investigations reported increase in the yield of apple fruits by K application (Zhigarevich and Treglazova, 1991; Klein, 1992; Solv'Eva *et al.*, 1992; Tregelazova and Fataliev, 1994).

Conclusion :

The present results indicate that adding K_2SO_4 at the rates of 1.5 or 2.0 Kg to young Anna apple trees under drip irrigation has its positive impact on yield and fruit quality allowing apple growers having similar conditions to adjust their fertilizer rates and frequencies more properly.

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تأثير التسميد البوتاسى على اشجار التفاح صنف أنا النامية فى الأراضى الرملية فى مصر

إيمان صبحى عطا الله

معهد بحوث البساتين مركز البحوث الزراعية - الجيزة .

تمت دراسة تأثير إضافة معدلات مختلفة من كبريتات البوتاسيوم من صفر الى ٢ كجم/ شجرة مقسمة على أربع دفعات على اشجار التفاح صنف الأنا المطعومة على أصل م.م ١٠٦ والنامية فى الاراضى الرملية الحديثة الإستصلاح والتى تروى بنظام الرى بالتنقيط .لم تكن هناك تأثيرات معنوية على محتوى الأوراق من عنصرى النيتروجين والفوسفور نتيجة لإضافة السماد فقد زاد المحتوى من عناصر البوتاسيوم والحديد والزنك والمغنسيوم عند إضافة ١,٥ أو ٢ كجم من السماد للشجرة. وبالمثل كانت هناك زيادات واضحة فى الكربوهيدرات الكلية الذائبة والغير ذائبة كما كانت هناك زيادة معنوية فى عقد الثمار ونقص فى تساقطها، أدت إضافة ١,٥ كجم أو ٢ كجم من السماد الى حدوث زيادة فى وزن وحجم الثمار وصلابة اللحم ومحتواه من المواد الصلبة الذائبة الكلية ولقد أدي ذلك إلى زيادة نسبة المواد الصلبة الذائبة الى الحموضة مما سبب تبكير نضج الثمار لكن المحتوى من الحموضة لم يتغير .

أدت إضافة المعدلات العالية من كبريتات البوتاسيوم إلى حدوث زيادة معنوية فى المحصول.