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EFFECT OF DIFFERENT LEVELS OF POTASSIUM ON FRUIT SET, YIELD AND FRUIT QUALITY OF PERSIMMON.

BY

Soaad A. Mohamed and Ibrahim, M.A.
Hort. Res. Institute, Agric. Research Centre

ABSTRACT

This experiment was conducted during 2005, 2006 and 2007 seasons to study the effect of different doses of potassium sulphate (K_2SO_4) at 300, 600, 900 and 1200g/tree divided in four soil applications (20% at starting of bud brust, 20% after fruit set, 40% one month after fruit set and 20% three months after fruit set) on "Costata" mature persimmon trees grown in a clay loamy soil under flood irrigation.

The obtained results could be summarized as follow:

Leaf area, leaf N, P and K contents, recorded significant increments over the control nearly with all K_2SO_4 levels during the three seasons of the study. All potassium sulphate applications significantly increased fruit set % and yield (kg/tree) while 1200g was the superior in all studied seasons if comparing to the control.

Fruit weight, volume, fruit length and diameter recorded the highest significant values with all K_2SO_4 levels in all seasons in compared to the control especially with 900 or 1200g which sometimes had no significant differences. As for firmness, it was significantly increased at 600, 900 and 1200g K_2SO_4 if compared to the control through the three seasons.

Moreover, TSS, TSS/acid ratio content in fruits significantly increased with all K_2SO_4 levels, also, vitamin C significantly increased at 600, 900 and 1200g K_2SO_4 compared to the control during the seasons under study. On the other hand, fruit acid content significantly decreased at 900 or 1200g K_2SO_4 and it was not significantly affected at 300 and 600g compared to check trees. In addition, tannins fruit content significantly decreased with all K_2SO_4 levels in comparing with the control during the three studied seasons.

Key words: Persimmon, kaki, potassium, clay loamy soil, fertilization, yield, fruit quality.

INTRODUCTION

Persimmon trees are deciduous and growing well with good production under native temperature and subtropical areas. Diospyrous kaki which is known as the Japanese persimmon is most important specie containing at least thousand horticultural varieties (Baily, 1960 and Hulme 1970) . Persimmon cultivated in Egypt, belongs to Japanese group and includes a few cultivars like "Costata", "Hachya' and "Tozuru gaki", its acreage is 7000 feddans. Most of area is concentrates in Dakahlia and Nubaria region, El-Behira Governorate according to statistics of Ministry of Agriculture, Egypt (2006).

Costata persimmon trees have been introduced to Egypt in 1911 by Ministry of Agriculture (Baghdady and Minasey, 1963) and successfully grown under the Egyptian environmental conditions. That was due to its low chilling requirements (George *et al.*, 1994).

Fruit quality when was properly ripened is considered very fine (Wali,1998).

However, one of the important factors which plays an important role in the productivity of persimmon trees is fertilization with some macro-elements. Moreover, the applied rate, the date and method of application are so important factors which reflected on increasing the productivity and improving the fruit quality of persimmon trees. One of these main macro-elements is potassium (K).

Potassium is the most important cation, not only is regard to its content in plant tissues but also, with respect of its physiological and biochemical function (Ansari and Bowling, 1972). The main function of potassium in biochemistry is the activation of various enzymatic systems (Evans and Sorger, 1966).

Potassium soil application in the form potassium sulphate at the rate of 450 or 900g/tree in three equal split doses: March 10th, May 1st and June 1st resulted in significant increase in leaf area (cm^2) of "Anna" apple trees and 900g/tree significantly increased yield/tree, fruit weight, size and firmness and decreased acidity (Kilany and Kilany 1991). Also, Attala (1998) reported that applying different doses from 0-2 kg of K_2SO_4/tree divided to four applications on Anna apple trees on MM.106 stock in sandy soil didn't affect leaf N, P content but increased K leaf content with 1.5 or 2.0 kg of K_2SO_4. There was significant increase in fruit set or yield but a decrease in fruit drop was noticed with the high level of K_2SO_4 application (2.0 kg/tree). On the other hand, fruit weight, volume, fruit firmness, total soluble solids and TSS/acid ratio values were increased by all tested treatments. Higher values of TSS/acid ratio led to earlier fruit ripening.

Moreover, EL-Sherif *et al.* (2008) studied the effect of four potassium fertilizer sources to spray on Golden Japanese plum trees at bud burst, after fruit set and at month after fruit set. They found that all treatments significantly increased fruit set, yield, fruit weight and dimensions while decreased firmness. Also, TSS increased while acidity decreased. Treatments enhanced leaf N, P and K contents.

Recommendations of potassium fertilization must be reconsidered due to the fact that most of the farmers did not apply enough amounts as they believe that the soil is rich in potassium, which was really depleted before decades after the Nile river mud supply has been stopped.

The main objective of this study was to determine the optimum soil application of potassium for "Costata" persimmon trees grown in a clay loamy soil.

MATERIALS AND METHODS

This experiment was carried out through the three consecutive seasons 2005, 2006 and 2007 on" Costata" persimmon trees (*Diospyrous kaki* L.), full bearing at sixteen years old budded on (Diospyrous lotus) rootstock, planted at 5mx5m apart in clay loamy soil and growing under flood irrigation system in Horticulture Experiment Station, Qalyoubia Governorate, Egypt.

The trees were chosen healthy and uniform as possible in vigor and shape and equally subjected to the same cultural as well as fruit maturing with warm water and fertilization practices.

Mechanical and chemical analyses of the experimental soil at 30,60 and 90 cm. depth are shown in Table (1). These standard methods described by Piper (1950). Available nitrogen was determined according to Allam (1951).

This investigation included four treatments of potassium fertilization beside the control. Potassium added at 1- 300g, 2- 600g, 3- 900g 4- 1200g of potassium sulphate/ tree. (48% K) divided into four doses along the season:-

Table (1): Mechanical and chemical analyses of the experimental soil.

Characters	Depth (cm.)		
	0 - 30	30 - 60	60 – 90
Sand %	18.95	19.00	17.90
Silt %	25.85	24.65	25.50
Clay %	52.20	54.00	54.80
Texture class	Clay loam	Clay loam	Clay loam
Ca CO_3 %	3.00	2.80	2.35
pH (1: 2.5) ds/m	7.90	7.92	7.95
Ec meq/100g	38.90	37.60	36.00
Soluble cation (meq/ l00g soil)			
Ca^{++}	3.85	3.57	2.80
Mg^{++}	2.00	1.30	1.35
Na^{+}	4.48	3.38	3.40
K^{+}	1.40	1.00	0.20
Soluble Anions (meq/l00g. Soil)			
CL^{-}	4.38	3.70	3.50
HCO_3-	4.33	3.85	3.75
CO_3-	-	-	-
SO_4-	3.02	1.70	0.50

1- 20% from the dose at starting of bud brust (last of March or first April).
2- 20% after fruit set (20 April).
3- 40% added at month after setting (20 may).
4- 20% at three months after set (20 July).

Potassium treatments added on the soil surface around the trees under canopy and irrigated.

These treatments were applied in addition to the common Kaki grower fertilization practices (200gm K_2SO_4) resembling the control.

Each treatment included four replicates, each of 2 individual trees. Guard rows of untreated trees surrounded each replicate.

Following characteristics were determined:

1- Vegetative growth:

a- Average leaf area (cm^2):

At the growing season four brunches per tree in different directions has laballed. Four shoots (one shoot per branch) were sampled and all leaves were measured by using the Planometer to determining leaf area.

b- Leaf dry weight (gm) and leaf minerals content:

From medium portion of current season growth on mid August of all seasons, samples of twenty mature leaves were carefully collected from the previously labeled shoots according to the method described by Westwood (1978), washed with tap water three times followed by distilled and oven dried at 70°c for 72 hours till constant weight, then leaf dry weight was recorded. Dry leaves ground, digested with sulphoric acid and hydrogen peroxide to determine total nitrogen by modified Micro-Kjeldahl method as described by Pregl (1945), phosphorus was determined via colormetric method according to Jackson (1958) and potassium was determined by atomic absorption spectrophotometer (Perkin-Elemer Model 3300) according to Brandifeld and Spincer (1965). Nitrogen, phosphorus and potassium were expressed as a percent from the total leaves dry weight.

2- Fruiting parameters:

a- Percentage of fruit set was calculated.
b- Total weight (kg) of harvested fruit (yield) for tree was measured each year at commercial maturity.

3- Fruit characters:

a- Physical characters:

Samples of ten fruits from each replicate were taken when control fruits attained maturity for physical measurements, i. e. fruit weight (g), volume (cm^3), dimensions [Length (cm), Diameter (cm) and L/D ratio] and flesh firmness with 5/16 Inch plunger.

b- Chemical characteristics (In fruit juice):

1- Total soluble solids (TSS) using a hand refractometer.
2- Total titratable acidity percent as malic acid.
3- Tannins % and vitamin C ($mg/100cm^3$ Juice) according to the A.O.A.C (1995) method.

Data of the present study subjected to analysis of variance using the complete randomized blocks design according to Snedecor and Cochran (1990) and mean were compared using the New L.S.D values of 5% level.

RESULTS

1- Leaf area and leaf dry weight:

According to Table (2) it was noticed that both leaf area and dry weight of leaves significantly increased under all soil application of potassium levels comparing with the control treatment.

Soil application of K_2SO_4 at 1200g recorded the highest significant value compared to other treatments and the control. Since, it recorded (62.92, 65.52 and 70.08cm^2) while the control gave (37.60, 38.83 and 40.70cm^2) of leaf area, also, recorded (5.4, 5.3 and 5.46g) of leaf dry weight compared to the lowest values related to the control (4.00, 3.80 and 4.10g) in the three studied seasons, respectively. Levels at 300 and 600g K_2SO_4 application gave the same significance in the third season of leaves dry weight character.

2- Mineral composition of the leaves:

From data presented in Table (3), it could be noticed that nitrogen percentage increased by potassium level increasing if comparing to the control especially at 900g (2.43, 2.42, 2.66) and 1200g K_2SO_4 (2.53, 2.55 2.78) while the control was (2.21, 2.20 and 2.30) in the three studied seasons, respectively. However, 300g K_2SO_4 served as control in the first and third seasons.

Phosphorus content was significantly affected with potassium application at all levels comparing to untreated one. K_2SO_4 at 1200g recorded the highest significant content over the other levels (0.35, 0.33 and 0.35) followed by 900g whereas check plants recorded the lowest values (0.25, 0.22 and 0.24) in all studied seasons. However, In the third season levels 2, 3 and 4 were significantly similar effect in this respect.

Potassium leaf content had significantly increased at all soil potassium concentrations compared to the control. The highest values (1.92, 2.08 and 1.87) were gained with the highest concentration (1200g of K_2SO_4) comparing to the control (1.28, 1.25 and 1.26).

3- Fruiting parameters.

Fruit set % percentage and yield (kg) in Table (4) revealed that all tested potassium application levels significantly increased fruit set percent and yield in gradual significant increments comparing with the untreated trees. These results were similar in the three studied seasons. The highest significant fruit set (70.56, 74.70, and 76.20%) and yield values (40.72, 38.54, 35.74kg) were accompanied with the highest level of K_2SO_4 fertilization. The lowest values were connection with the control of fruit set (43.50, 39.80, and 40.31%) and the control of yield (21.30, 22.00, 19.50kg) in the three studied seasons.

4- Fruit physical characteristics:

4-a- fruit weight and size:

Both fruit weight and size were positively affected by potassium soil applications compared to the control (Table 5). The increase was more evident with the maximum concentration of potassium application at the three studied seasons as it recorded (122.7, 127.6 and 129.4g) for weight compared with

the control (84.5, 91.4 and 86.2g). Where, it recorded (130.6, 131.5 and 137.5cm^3) for volume while the least values connected with the check trees (87.6, 94.1 and 90.4cm^3). However, insignificant difference was noticed between level 900 & 1200 of K_2SO_4 applications on fruit weight or fruit volume in values in the second and first seasons, respectively.

Table (2): Effect of different levels of potassium on leaf area and dry weight of leaves in "Costata" persimmon during 2005, 2006 and 2007 seasons.

Treatments	Leaf area (cm^2)			Dry Weight of leaves(g)		
	1StSeason	2ndSeason	3rdSeason	1StSeason	2ndSeason	3rdSeason
Control	37.60E	38.83E	40.70E	4.00E	3.80E	4.10D
K1 [300g (K_2SO_4)]	41.04D	45.40D	48.10D	4.41D	4.10D	4.44C
K2 [600g (K_2SO_4)]	45.50C	51.70C	56.15C	4.70C	4.43C	4.73C
K3 [900g (K_2SO_4)]	55.52B	58.11B	63.33B	5.00B	4.83B	5.13B
K4 [1200g (K_2SO_4)]	62.92A	65.52A	70.08A	5.40A	5.30A	5.46A
New L.S.D at 5%	3.06	3.32	4.65	0.09	0.22	0.32

Table (3): Effect of different levels of potassium on N, P and K leaf content in "Costata" persimmon during 2005, 2006 and 2007 seasons.

Treatments	N% in leaves		
	1StSeason	2ndSeason	3rdSeason
Control	2.12D	2.20D	2.30C
K1 [300g (K_2SO_4)]	2.20CD	2.38BC	2.43C
K2 [600g (K_2SO_4)]	2.31BC	2.34C	2.58B
K3 [900g (K_2SO_4)]	2.43AB	2.42B	2.66AB
K4 [1200g (K_2SO_4)]	2.53A	2.55A	2.78A
New L.S.D at 5%	0.12	0.08	0.13
	P% in leaves		
Control	0.25E	0.22D	0.24C
K1 [300g (K_2SO_4)]	0.28D	0.27C	0.28BC
K2 [600g (K_2SO_4)]	0.30C	0.27C	0.31AB
K3 [900g (K_2SO_4)]	0.32B	0.31B	0.30AB
K4 [1200g (K_2SO_4)]	0.35A	0.33A	0.35A
New L.S.D at 5%	0.02	0.02	0.05
	K% in Leaves		
Control	1.28E	1.25E	1.26D
K1 [300g (K_2SO_4)]	1.42D	1.41D	1.45C
K2 [600g (K_2SO_4)]	1.58C	1.61C	1.67B
K3 [900g (K_2SO_4)]	1.78B	1.83B	1.70B
K4 [1200g (K_2SO_4)]	1.92A	2.08A	1.87A
New L.S.D at 5%	0.08	0.08	0.08

Table (4): Effect of different levels of potassium on fruit set and yield in "Costata" persimmon during 2005, 2006 and 2007 seasons.

Treatments	Fruit set %			Yield (kg/tree)		
	1st Season	2nd Season	3rd Season	1st Season	2nd Season	3rd Season
Control	43.50E	39.80E	40.31E	21.30E	22.00E	19.50E
K1 [300g (K_2SO_4)]	55.50D	52.76D	51.32D	26.70D	26.00D	24.057D
K2 [600g (K_2SO_4)]	63.07C	61.04C	59.50C	30.80C	31.40C	28.33C
K3 [900g (K_2SO_4)]	71.50B	68.25B	67.40B	33.70B	35.43B	32.017B
K4[1200g(K_2SO_4)]	77.56A	74.70A	76.20A	40.72A	38.54A	35.74A
New L.S.D at 5%	3.84	3.44	3.97	1.45	2.23	1.17

Table (5): Effect of different levels of potassium on fruit weight and fruit volume in "Costata" persimmon during 2005, 2006 and 2007 seasons.

Treatments	Fruit Weight (gm)			Fruit volume (cm^3)		
	1st Season	2nd Season	3rd Season	1st Season	2nd Season	3rd Season
Control	84.50D	91.40E	86.20E	87.60E	94.1C	90.40D
K1 [300g (K_2SO_4)]	94.05C	100.1D	94.50D	98.20D	104.9BC	101.4C
K2 [600g (K_2SO_4)]	103.20B	111.1C	104.6C	108.0C	113.2B	111.6C
K3 [900g (K_2SO_4)]	115.1A	119.2B	116.3B	121.5B	124.4A	124.2B
K4 [1200g (K_2SO_4)]	122.7A	127.6A	129.4A	130.6A	131.5A	137.5A
New L.S.D at 5%	8.96	3.64	6.09	7.78	11.07	10.33

4-b- Fruit length, fruit diameter, (L/D) and firmness:

Table (6) cleared that potassium concentrations induced significant increase in fruit length and diameter values compared to the control. Generally, the high level of potassium recorded the highest values in both characters. There were insignificant difference between potassium 900g & 1200g in the second season for the fruit length and in the first season for the fruit diameter. In addition,, there were insignificant differences between all treatments in all studied seasons in respect to fruit shape index (L/D).

Considering the effect of different levels of potassium sulphate on flesh firmness of persimmon fruits, it was cleared that the highest significant values of firmness were noticed with 1200g application (19.21, 19.22, 18.90 Ib/Inch^2) followed by 900g (18.23, 18.80 17.80 Ib/Inch^2) when compared with the control which recorded (16.20, 17.00, 15.60 Ib/Inch^2) values. Generally, potassium application resulted in firmness fruits.

5- Fruit chemical characteristics

5-a- TSS% and acidity:

Data presented in Table (7) achieved that TSS in the juice was gradually significantly increased as the potassium concentration arise in soil applications compared to control. This was more evident with the higher concentrations of potassium at the three studied seasons as 1200g K_2SO_4 recorded (25.1, 24.1 and 24.0) while values of check trees were (20.2, 20.0 and 19.6), respectively.

Furthermore, it was noticed that all levels of K reduced acid fruit content in the juice. The lowest significant value of fruit acidity was observed with potassium sulphate application at 1200g followed by 900g comparing with check plants.

TSS/acid ratio significantly increased by potassium applications in comparing with the control especially with 1200g and 900 of K_2SO_4 in all seasons.

Table (6): Effect of different levels of potassium on fruit length, diameter, shape index and fruit firmness in "Costata" persimmon during 2005, 2006 and 2007 seasons.

Treatments	Fruit length (cm)		
	1st Season	2nd Season	3rd Season
Control	5.20E	5.40D	5.25E
K1 [300g (K_2SO_4)]	5.56D	5.75C	5.50D
K2 [600g (K_2SO_4)]	5.88C	6.01B	5.85C
K3 [900g (K_2SO_4)]	6.15B	6.35A	6.17B
K4 [1200g (K_2SO_4)]	6.55A	6.50A	6.50A
New L.S.D at 5%	0.19	0.15	0.09
	Fruit Diameter (cm)		
Control	5.40D	5.20D	5.00E
K1 [300g (K_2SO_4)]	5.74C	5.47C	5.25D
K2 [600g (K_2SO_4)]	5.99B	5.80B	5.55C
K3 [900g (K_2SO_4)]	6.40A	5.94B	5.95B
K4 [1200g (K_2SO_4)]	6.59A	6.28A	6.25A
New L.S.D at 5%	0.22	0.26	0.14
	Fruit shape index (L/D)		
Control	0.96A	1.04A	1.05A
K1 [300g (K_2SO_4)]	0.97A	1.05A	1.05A
K2 [600g (K_2SO_4)]	0.98A	1.04A	1.05A
K3 [900g (K_2SO_4)]	0.96A	1.07A	1.04A
K4 [1200g (K_2SO_4)]	0.99A	1.04A	1.04A
New L.S.D at 5%	0.05	0.08	0.02
	Fruit firmness (Ib/Inch^2)		
Control	16.20D	17.00D	15.60D
K1 [300g (K_2SO_4)]	16.52CD	17.70CD	16.20D
K2 [600g (K_2SO_4)]	17.50BC	18.10BC	16.90C
K3 [900g (K_2SO_4)]	18.23AB	18.80AB	17.80B
K4 [1200g (K_2SO_4)]	19.21A	19.22A	18.90A
New L.S.D at 5%	1.09	0.95	0.69

5-b-Tannins% and Vitamin C:

It was evident from the data in Table (8) that fruit juice total tannins content significantly decreased with all potassium concentrations (with significant differences between them) if compared to control. The lowest significant value of tannins was obtained with the highest level of K.

Data in the same Table (8) illustrated that fruit juice content of vitamin C percentage gradually increased as potassium levels increased especially at 1200g K_2SO_4 which gave the highest significant values compared to the control other concentrations (73.7, 74.9 and 67.4%), while the control was the lowest values (58.4, 62.6 and 55.3%). However, 300g of K2SO4 served as control in the three tested seasons.

DISCUSSIONS

The previous results which cleared that soil application of potassium increased fruit set, yield and improved physical and chemical fruit characters as well as enhanced leaf content of N, P and K was in agreement with Hansen, (1975) who found that leaf K content of "Cox's orange pippin" apple was increased by soil application of potassium. Also, Stiles (1994) and Zayen *et al.*, (1994a and b) on apple who cleared that there was a significant positive relationship between total amount of K applied and leaf area (cm^2) and

leaf K content regardless the source of potassium, also, significant positive relationship were found between fruit set, yield, average fruit weight and percent leaf potassium. In addition, they found that increasing K level in NPK fertilization gave the highest percentage in fruit set; yield and fruit quality as fruit weight and size as well as TSS was the highest.

On the same line, Awasthi *et al.* (1999) studied the effect of rate and method of potassium application on yield, fruit quality and nutrient status of New Castle apricot during 1993 and 1994 seasons. They found that yield was significantly increased with the increase of K level. Also, soil application of K significantly increased leaf K content.

Also, (Neilsen *et al.* 2004) worked on "Fuji", "Fiesta" and "Spartan" apple cultivars budded on M.9 rootstock found that potassium fertigation generally increased leaf K concentration, fruit size, yield and fruit titratable acidity while decreased fruit firmness and leaf N concentration for "Fuji" apple only. Fruit soluble solids content was the only parameter unaffected by K fertigation.

In addition, a slight increase was noticed by Mansour *et al.* (1986) concerning fruit weight, size and yield of "Mit-Chamr" Peach as a result of adding K_2SO_4/tree. Also, in other work it has been reported that increasing potassium application resulted in only slight variation in vegetative and reproductive development of "Gravensteiner" apples (Schumacher and Stadler, 1991).

On the other hand, some reports pointed out that N content was reduced by K application (Takidze, 1971) or had no effect (Jones *et al.*, 1973). In addition, Mansour *et al.*, (1986) stated that there was no significant differences in leaf content of nutrient elements (N, P and K) when compared with the control. Also, P did not affected (Zayan *et al.*, 1994a), firmness decreased while acidity increased (Neilsen *et al.*, 2004). TSS was not affected (Kilany and Kilany 1991). Acidity was not affected (Attala, 1998).

Generally, there are important positive effects of K as follow:

Potassium is very mobile in the plant since, it transported directly towards the meristemeatic tissue (Greenway and Pitman, 1965). Both K and Ca have reported a vital structural role in providing firmness and mechanical strength to cell wall (Poovaiah *et al.*, 1988). In general, increasing fruit weight, fruit size as a result of potassium application as previous data could be due to K as it involved in the translocation of carbohydrates from leaves to fruits (Roy and Goldschmidt, 1996).

In addition, some of the fruit quality parameters such as fruit size and V. C. content, improved with potassium application (Wei *et al.*, 2001).

Overall, it could be concluded that mineral nutrition for trees play an important role for synthesis endogenous phytohormones (inducing gibberellins) and affect plant growth directly rather than through increased mineral uptake due to increased plant growth which increased dry weight (Abd El-Dayem, 2001). Moreover, Abd El Dayem (2001) observed that K supply caused alteration of the endogenous hormones balance in plant which led to a balance of the nutrients in the leaves.

Also, a deficiency in potassium affects some processes such as respiration, photosynthesis, chlorophyll development and water content of leaves. The best known function of potassium is its role in stomatal opening and closing. The highest concentrations of potassium are found in the meristemeatic regions of the plant vegetative growth. It is essential as an activator for enzymes involved in the synthesis of certain peptide. In addition of its role as an activator in protein and carbohydrate metabolism. The symptoms of potassium deficiency include chlorosis followed by necrotic areas at the tip and margin of the leaf, these symptoms appear first on the more mature leaves, leaf tip curves downward. Generally, a plant deficient in potassium is stunted in growth with a pronounced shortening of the internodes (Plant Physiology Book 1986).

As for the essential previous functions of potassium being there, which may be reflected on nutritional status of the trees, yield and fruit quality in the current study.

Table (7): Effect of different levels of potassium on total soluble solids, acidity and TSS/acid ratio in "Costata" persimmon during 2005, 2006 and 2007 seasons.

Treatments	TSS%		
	1st Season	2nd Season	3rd Season
Control	20.20 E	20.00E	19.60E
K1 [300g (K_2SO_4)]	21.40D	21.00D	21.00D
K2 [600g (K_2SO_4)]	22.70C	22.20C	22.10C
K3 [900g (K_2SO_4)]	24.10B	23.30B	23.00B
K4 [1200g (K_2SO_4)]	25.10A	24.10A	24.00A
New L.S.D at 5%	0.17	0.39	0.56
	Acidity %		
Control	0.60A	0.54A	0.62A
K1 [300g (K_2SO_4)]	0.57AB	0.52B	0.60AB
K2 [600g (K_2SO_4)]	0.55ABC	0.49C	0.58AB
K3 [900g (K_2SO_4)]	0.52BC	0.46D	0.55BC
K4 [1200g (K_2SO_4)]	0.51C	0.43E	0.51C
New L.S.D at 5%	0.06	0.02	0.06
	TSS/acid ratio		
Control	33.67C	37.11E	31.63D
K1 [300g (K_2SO_4)]	37.58B	40.39D	35.08CD
K2 [600g (K_2SO_4)]	41.37B	45.00C	38.22BC
K3 [900g (K_2SO_4)]	46.37A	50.73B	42.03B
K4 [1200g (K_2SO_4)]	49.36A	56.06A	47.10A
New L.S.D at 5%	3.83	2.39	4.92

Table (8): Effect of different levels of potassium on tannins and vitamin (C) in "Costata" persimmon during 2005, 2006 and 2007 seasons.

Treatments	Tannins%			Vitamin C (mg/100cm^{3}juice)		
	1st Season	2nd Season	3rd Season	1st Season	2nd Season	3rd Season
Control	0.85A	0.78A	0.68A	58.40D	62.60C	55.30D
K1 [300g (K_2SO_4)]	0.70B	0.71B	0.62B	63.00CD	65.20C	58.30CD
K2 [600g (K_2SO_4)]	0.63C	0.61C	0.55C	66.50BC	69.30B	60.80BC
K3 [900g (K_2SO_4)]	0.55D	0.55D	0.47D	70.50AB	71.50AB	64.00AB
K4 [1200g (K_2SO_4)]	0.45E	0.50D	0.41E	73.70A	74.90A	67.40A
New L.S.D at 5%	0.06	0.06	0.06	4.98	4.07	3.85

CONCLUSION

The current study indicated that soil application of K_2SO_4 at 600, 900 and 1200g to "Costata" persimmon trees under flood irrigation system had positive effects on fruit set, yield and fruit quality as well as leaf area and leaf minerals content. Overall, it could be concluded that the best recommended treatment according to previous data, was adding 1200g K_2SO_4/tree/season (20% from the dose at starting of bud burst, 20% after fruit set, 40% added at month after setting and 20% at three months after set) as it achieved the utmost results comparing to the other application under study.

REFERENCES

Abd El- Dayem, H.M.M. (2001): Interactions between phytohormones and mineral nutritions (A review article) Agric. Botany Department, Faculty of Agric. Moshtohor, Zagazig Univ. February, pp 5-10.

A.O.A.C. (1995): Association of Official Agriculture Chemists. Official Methods of Analysis. Published by the A. O. A. C. Box 540, Washington.

Allam, F. (1951): The koering method for the determination of available soil nitrogen. Analytical Agric. Chem. Part 1. Cairo (Arabic Text).

Ansari, A.Q. and Bowling, D.J.F. (1972): Measurements of the transport electrical potential of plant grown in soil. New phaytol., 71: 111- 17.

Attala, E.S. (1998): Effect of potassium fertilization on "Anna" apple trees grown in sand soils of Egypt. Egypt J. Res., 76 (2): 709-720.

Awasthi, R.P.; Bhutani, V-P. and Kaith, N-S (1999): Influence of rate and method of potassium application on yield. Fruit quality and nutrient status of "New Castle" apricot progressive-Horticulture 31 (1/2): 1-8.

Baghdady, H. A. and Minasey, F. (1963): The Fruit Production. Text Book, Dar El-Maarif, Egypt. P. 563 (in Arabic).

Bailey. LH. (1960): Manual of cultivated Plants. The Macmillan Company, New York, pp. 792- 793.

Brandifeld, E.G. and Spincer (1965): Determination of magnesium, zink, iron and copper by Atomic Absorption Spectroscopy. J. Sci. Food Agric., 16: 33-8.

El-Sherif, H.M.; Taha, N.M. and El-Fakharany, E.M. (2008): Effect of potassium fertilizer source on tree fruiting, fruit quality and storability of Golden Japanese plum. J. Agric. Sci. Mansoura Univ., 33 (4): 2743.56.

Evans, H.J. and Sorger, G. J. (1966): Role of mineral elements with emphasis on the univalent cations. Ann. Rev. Plant Physiol., 17: 47-77.

George, A. P.; Callins, R. J. and Rasmussen, T. S. (1994): Phenological of non-astringent persimmon in subtropical. Australia. J. Hort. Sci., 39(5): 934-946.

Greenway, H. and Pitman, M.G. (1965): Potassium retranslocation seedling of Hordeum vulgare. Aust. J. boil. Sci.., 18: 235-247.

Hansen, P. (1975): Effect of potasstum and magnesium on "Cox Orange Pippen" on a sandy loam. Tidsskrift for plantearl 79 (2): 259-265. Soils and fertilizers, No.(38): 5262.

Hulme, A.C. (1970): The biochemistry of fruits and their products 1st Ed. Vol. (1): 352- 359, 387- 390, 521- 533. Academic Press, London and New York.

Jackson, M.L. (1958): Soil Chemical analysis. Constable Ltd. Co., London, P. 498.

Jones, W.W.; Embleton, T. W.; Foot, H.J. and Platt, G.R. (1973): response of young lemon trees to potassium and zink application, yield and fruit quality. Soils and Fertilizers, No. 37: 367.

Kilany, A.E. and Kilany, O.E. (1991) Effect of potassium and Boron nutrients on growth, yield and fruit quality of "Anna" apple trees. Bull. Fac of Agric. Univ. of Cairo, Vol. 42, No. 2: 415-428.

Mansour, N.M.; El-Gebeely, M. and Shaltout; A. (1986): Effect of Potassium Sulphate on fruit characters of peach trees. Egypt. J. Hort., Vol. 13 (1): 35-42.

Neilsen, G. H.; Neilsen; D.; Herbert; L. C. and Hogue; E.J. (2004): Response apple trees to fertigation of N and K under conditions susceptible to the development of potassium deficiency. J. Amer. Hort. Sci., 129 (1): 26-31

Piper, C. S. (1950): Soil and Plant Analysis. Enter Sci: Publishers, New York, 213- 217.

Plant Physiology Book (1998): Delvin, R. M. and Witham F. H. (1983): Univ., of Massachusetts and The Pennsylvania State Univ. Fourth Edition, 1986, pp: 141, 142.

Poovaiah, B.W.; Glenn, G.M. and Reddy, A.S.N. (1988): Calcium and fruit softening physiology and biochemistry. Hort. Rev., 10: 107-143.

Pregl, F. (1945): Quantitative organic Micro-analysis. 4th Ed. J. and A. Churchill Ltd., London, P. 126-9.

Roy, P.S. and Goldschmidt, E.E. (1996): Mineral nutrition (Use of mineral nutrients by citrus) Book biology of citrus page141.

Samra, N.R. (1989): Effect of foliar fertilization with potassium sulphate on Guava fruit trees. J. Agric. Sci. Mansoura Univ., 14 (2): 1183-89.

Schumacher, R. and Stadler, W. (1991): Nitrogen and Potassium trial with Gravensteiner Stickstaff-Und Kaliumversuch bei Gravensteiner. Schweizerisch Zeitschrift fur obst-und weinbau 127 (12) 307-310.

Snedecor, G. W. and Cochran, W. G. (1990): "Statistical Methods", 7 th Ed., Iowa State Univ., Press, Ames Iowa, U S A. 593p.

Stiles, W. C. (1994): Alternative sources for foliar application of potassium to apple trees. 91st Annual Meeting of the Amer. Soc. for Hort. Sci., 7-10 August No. 261 {HortScience, Vol. 29 No. 5}.

Takidze, R. (1971): The diagnosis of Mandrian potassium nutrition subtropicheske. Kul Juvy, (6): 52-56. (Hort. Abst., Vol. 42: 8349).

Wali, A. (1995): Persimmon. Technical Bulletin No, 8/98, Ministry of Agriculture, Egypt.

Wei L.J.; Fang, C.; Fan, W.Y.; Bi, LD.; Bing, Y.C.; Yiaoqun, W.; Faan, S.; Huan, W. Y. and Hardter, R. (2001): Effect of application of potassium on the yield and quality of Navel orange. Journal of Fruit Science, Vol.18 (5), pp.272-275, 3 ref.

Westwood, M.N. (1978): Temperate-Zone pomology. W. H. Freeman Company San Fransisco. USA. pp. 428.

Zayan, M.; Zeerban, S.; EL-Sayed Morsy and Mikhael, G.B. (1994a): Effect of NPK fertilization treatments on "Anna": apple trees grown in calcareous soil. 1- Effect on vegetative growth and leaf mineral contents. J. Agric. Res. Tanta Univ., 20 (4): 740-51.

Zayan, M.; Zeerban, S.; EL-Sayed Morsy and Mikhael, G.B. (1994b): Effect of NPK fertilization treatments on (Anna) apple trees grown in calcareous soil. 11- Effect on yield and fruit quality. J. Agric. Res. Tanta Univ., 20 (4): 752-65.

تأثير مستويات مختلفة من البوتاسيوم على عقد الثمار والمحصول وجودة ثمار الكاكى

سعاد عبدالرحيم محمد ، مجدى عبد الفتاح ابراهيم
معهد بحوث البساتين – مركز البحوث الزراعية

أجريت هذه التجربة خلال ثلاثة مواسم متتالية ٢٠٠٥ و ٢٠٠٦ و ٢٠٠٧ لدراسة تأثير إضافة جرعات مختلفة من سلفات البوتاسيوم: ٣٠٠، ٦٠٠ ، ٩٠٠ و ١٢٠٠جم / شجرة/سنة تم تقسيمها إلي أربعة إضافات للتربة (٢٠% عند بداية تفتح البراعم ، ٢٠% بعدعقد الثمار ، ٤٠% بعد شهر من العقد و٢٠% بعد ثلاثة شهور من العقد) علي أشجار الكاكي البالغة صنف "كوستاتا" النامية في أراضي طميية طينية وتروى بالغمر. ويمكن تلخيص أهم النتائج التى تم الحصول عليها فيما يلي:-

زادت مساحة الورقة و محتوي الأوراق من عناصر النيتروجين و الفوسفور و البوتاسيوم معنوياً مع كل تركيزات البوتاسيوم تقريباً مقارنة بالكنترول خلال مواسم الدراسة الثلاثة. أدت كل تركيزات سلفات البوتاسيوم إلي زيادة معنويه في النسبة المئوية لعقد الثمار والمحصول (كجم / شجرة) بينما كان تركيز ١٢٠٠جم هو الأفضل في كل مواسم الدراسة مقارنة بأشجار الكنترول .

سجل الوزن ، الحجم ، الطول و القطر للثمار معنويا أعلي قيم مع كل مستويات البوتاسيوم في كل المواسم خاصة مع مستوي ٩٠٠، ١٢٠٠ جم اللذين تشابها معنويا أحيانا. بالنسبة للصلابة قد زادت معنويا عند ٦٠٠، ٩٠٠ و ١٢٠٠ جم من سلفات البوتاسيوم عندما قورنت بالكنترول خلال الثلاثة مواسم .

فوق ذلك، أعطت المواد الصلبة الذائبة ، نسبة المواد الصلبة الذائبة إلى الحموضة أعلى قيم معنويا مع كل مستويات البوتاسيوم، أيضاً زاد فيتامين ج معنويا مع٦٠٠، ٩٠٠ و ١٢٠٠ جم من سلفات البوتاسيوم مقارنة بالكنترول خلال المواسم تحت الدراسة. من ناحية أخرى تناقص معنوياً محتوي الثمار من الحامض عند ٩٠٠ و ١٢٠٠جم من سلفات البوتاسيوم فى حين لم تتأثر معنوياً عند مستوي ٣٠٠ و ٦٠٠جم بالنسبة لأشجار المقارنة. بالإضافة إلى ذلك تناقص أيضا محتوي الثمار من التأنينات معنوياً مع كل مستويات سلفات البوتاسيوم مقارنة مع الكنترول خلال مواسم الدراسة الثلاثة.