# Response of "Canino" Apricot Trees to Different Irrigation and Potassium Treatments

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## ABSTRACT

This study was conducted during 2004 and 2005 growing seasons at a private farm at EL-Nubaria, Behira Governorate, Egypt. The objective of this study was to investigate the response of " Canino" apricot trees to three amounts of irrigation water using drip irrigation system [$I_1$: 2771.6 $m^3$/fed/year(control), $I_2$: 2355.86 $m^3$/fed/year $I_3$:1940.12 $m^3$/fed/year] , the three potassium fertilization levels[$K_1$: 80 Kg $K_2O$/fed/year (control), $K_2$: 100 Kg $K_2O$/fed/year and $K_3$ : 120 Kg $K_2O$/fed/year] and their combination on the vegetative growth, the leaf chemical composition, yield and fruit quality of " Canino" apricot trees. The trees were 6 years old, budded on apricot rootstock, planted at 4.5 x 5.5 m apart in sandy soil. The results revealed that ($I_2$) treatment was superior for vegetative growth characters ;trunk cross sectional area(TCA), leaf area and the new number of shoots/branch. Also, leaf N, P and K contents as well as leaf chlorophyll reading, yield and fruit weight as compared to the other treatments in the second season. On the other hand, ($I_3$) treatment gave the highest significant value of leaf free proline content ,fruit firmness , starch %and carotene for " Canino" apricot fruits in both seasons. While, the highest values of the chemical properties i.e. percentage of TSS, total sugar and acidity were gained from ($I_1$) treatment in both seasons.

Concerning the effects of potassium fertilization levels, the results, indicated that $K_3$ treatment had increased the vegetative growth characters (trunk cross-sectional area (TCA), leaf area and number of shoot/branch), the highest leaf values of N and K contents and leaf chlorophyll reading in both seasons. Meanwhile , leaf P content did not reflect any significant response due to using different rates of potassium fertilization in both season. On the contrary the $K_3$ treatment gave the lowest value for leaf free proline content in both seasons. Moreover the application of 120 Kg $K_2O$/fed/year ($K_3$) gave the highest yield /tree, fruit weight and quality in both seasons but the only exception was for starch % which was reduced.

The interaction effects between the different irrigation amount and the potassium fertilization levels, the results revealed that $I_2$ x$K_2$ or $I_2$ x $K_3$ gave the highest significant mean values of (TCA) in the second season. Meanwhile, $I_1$ x $K_3$ gave the highest significant mean values of leaf N content and leaf chlorophyll reading in both seasons. Furthermore $I_2$ x $K_3$ gave the best results for leaf N content in the second season and for leaf K content in the two studied seasons. The maximum value of leaf free proline was obtained from $I_3$ x $K_1$ in the second season only. The highest yield kg/tree and fruit weight were found in the tree under $I_1$ x $K_3$ and $I_2$ x $K_3$ in the first and second seasons, respectively. As for leaf P content and fruit quality ,the results did not show any significant .

It could be recommended from this study that irrigation of "Canino" apricot trees planted in Egyptian sandy soil using 2355.86 $m^3$ water /fed/year and 120 kg $K_2O$/fed/year is suitable for obtaining good vegetative growth, increasing tree yield and improving fruit quality. In addition, advantage of preserving large amount of water in the irrigation process.

## INTRODUCTION

"Canino" apricot cultivar is considered one of the important deciduous fruits which succeeded in our local environmental conditions. It has many advantages as low chilling requirements, early bearing, a high yield with good quality for fresh consumption and processing. Apricot trees widely spread in Nubaria region which is considered a new reclaimed area. Most of this soil is considered sandy loam. This type of soil has its own problems as low capacity of water rotation and poverty in nutrient contents. In addition, it is well known that " *Canino*" apricot trees, are highly sensitive to soil humidity as the deficiency in water irrigation is often the most limiting factor for crop production. Also, the requirements of nutrition are high.Therefore, apricot growers abuse the drip irrigation systems by applying much of water irrigation to increase yield without knowing the true requirement of apricot trees. Many investigators illustrated that the application of irrigation levels such as Assaf *et al.*, (1975) observed that the highest yield, the largest fruit size and most vigorous trunk growth were observed when a high water regime (40 and 80% available water in the 0-600 mm and 0-1200 mm layers, respectively) was maintained during the shoot growth and fruit development stages. However at the rest of the seasons, irrigation was applied when the 0-600 mm layer was at wilting point and the 600-1200 mm layer at 60% available soil water. Black (1976) and Levin *et al.*, (1979) pointed out that the drip irrigation enables a restricted volume of welted soil to be maintained with small fluctuations in water tension and with the development of a dense root system with minimum loss of water and fertilizers by leaching. Also many authors documented favorable effects of using the drip irrigation system on vegetative growth

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and yield of apple (Cripps 1971, Pacholak 1986, Erf and Proctor 1989).Under the Egyptian conditions, many investigators indicated that the use of optimum rate of drip irrigation system improved the vegetative growth, yield and fruit quality on several crops. (EL-Morshedy *et al.*, 1997 on pear, Khalil *et al.*, 2000 on apple, El-Wazzan *et al.*,2000 on orange). Similar conclusion was obtained by Abd EL-Messeih and El-Gendy (2004a &b) on "Canino" apricot trees planted in sandy soil in Nubaria area under the drip irrigation system. Irrigation interval 100 to 200 m bar as soil moisture suction was to improve vegetative growth, leaf mineral content, yield and fruit quality.

Concerning applying potassium fertilization in sandy soil is very important because the trees which suffer from potassium deficiency is more liable to "Water Thirst Phenomenon". In addition it is well known that apricot trees need excess amount of potassium fertilization. The role of potassium element is essential to increase the fruit size as it preserves the water contents of cells. It is a cofactor in chlorophyll, production photosynthesis process and improving the peel colour of fruits. Many workers indicated that the application of potassium fertilization improved vegetate growth increased the yield and improved fruit quality. Mansour *et al*, (1986) reported that the potassium sulphate gave the best results for fruit weight,size and colouration in peach. Furthermore, Attala, (1997) on apple and El –Sabrout and Kassem (2002) on orange mentioned that, the application of potassium fertilization through the drip irrigation improved vegetative growth, yield and fruit quality.

Thus, this work aimed to evaluate the different levels of drip irrigation and potassium fertilization on vegetative growth, leaf chemical composition, yield and fruit quality of "Canino" apricot trees grown in sandy soil conditions.

## MATERIALS AND METHODS

The present study was carried out during the two successive seasons of 2004 and 2005 at a private orchard at EL-Nubaria region, Behira Governorate. Fifty-four trees, 6 years old of the " Canino" apricot (*Prunus armeniaca* L.) as uniform as possible were selected for this study. These trees were grafted on apricot rootstock and planted at 4.5 x 5.5 m apart (169 trees/fed.)The same trees were used in the two experimental seasons. The trees received the same horticultural practices as usually done in this orchard. The usual fertilization program was about 20 $m^3$ organic manure/fed/year mixed with 200 kg calcium superphosphate in granules form, ( 15.5 %$P_2O_5$) were added in round trenches (20cm depth) close to the root system around the tree canopy. In addition macro nutrients were applied as fertigation twice a week from February till September. Nitrogen fertilization was carried out by adding 100 Kg N/fed/year as ammonium nitrate (33.5%) and potassium by 80 kg $K_2O$/fed/year as potassium sulphate while phosphorus fertilization by 40 L/fed as orthophosphoric acid. Moreover, micro nutrients were added as foliar sprays of a mixture of chelated Fe, Zn and Mn in April and May, while foliar Ca chelate was added separately after the end of bloom period. Leaf analysis for the N,P and K contents were taken at last June 2003 before the experiment. The results are shown in Table 1.

**Table 1. leaf N,P and K contents before starting the experiment.**

| N (%) | P (%) | K (%) |
|---|---|---|
| 1.75 | 1.55 | 1.27 |

The physical and the chemical properties of the sandy soil of the experimental site had been analyzed according to Chapman and Pratt (1961). The results are shown in Table 2.

The drip irrigation system was used in this orchard by four drippers per tree (each, one of 8L/h discharge ) are set on two lateral lines for each row of the tree on the two opposite sides, situated within 50 cm each side of the trunk. All drippers were left for 2.30 hours daily, so the tree will be irrigated with 80 L/day, which was done every 6 days weekly from March to September, as for the rest of months, the irrigation program was conducted as follows in Table 3.

The chemical characteristics of the irrigation water used in this study were analyzed according to Chapman and Pratt (1961) and the results are shown in Table 4.

**Table 2. The physical and the chemical characters of the experimental site.**

| Soil depth (cm) | Texture | pH | EC. (ds/m) | Soluble cations Meq/L | | | | Soluble anions Meq/L | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | $Na^{++}$ | $Ca^{++}$ | $Mg^{+}$ | $K^{+}$ | $HCO^{-3}$ | $Cl^{-}$ | $SO_4^{-}$ |
| 0-30 | Sandy loam | 7.7 | 5.85 | 29.4 | 16.0 | 11.0 | 1.6 | 2.8 | 26.7 | 28.5 |
| 30-60 | Sandy loam | 7.6 | 3.16 | 9.0 | 16.2 | 3.1 | 1.3 | 2.5 | 9.50 | 17.6 |

**Table 3. The quantity and the number of irrigation water applied per month in each irrigation treatment during 2004 and 2005.**

| Irrigation treatments | Jan. | Feb. | Mar. | April | May | June | July | Aug. | Sep. | Oct. | Nov. | Dec. | Total l/tree/year |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| I1 control | 160 | 960 | 1920 | 1920 | 1920 | 1920 | 1920 | 1920 | 1920 | 960 | 640 | 240 | 16400 |
| I2 | 136 | 816 | 1632 | 1632 | 1632 | 1632 | 1632 | 1632 | 1632 | 816 | 544 | 204 | 13940 |
| I3 | 112 | 672 | 1344 | 1344 | 1344 | 1344 | 1344 | 1344 | 1344 | 672 | 448 | 168 | 11480 |
| The number of irrigations | 2 | 12 | 24 | 24 | 24 | 24 | 24 | 24 | 24 | 12 | 8 | 3 | 205 |

The same rate was applied in two exprimental seasons

**Table4: Water characters of the experimental site.**

| pH | EC | TDS | Cations meq/L | | | | Anions meq/L | | |
|---|---|---|---|---|---|---|---|---|---|
| | ds/m | ppm | $Na^{++}$ | $Ca^{++}$ | $Mg^{+}$ | $K^{+}$ | $HCO_3$ | $Cl^{-}$ | $SO_4^{-}$ |
| 7.4 | 0.94 | 410 | 3.3 | 2.1 | 1.1 | 0.1 | 1.6 | 4.2 | 0.8 |

The tested treatments of the experiment were based on two major factors (a): three levels of irrigation water /fed/year which resulted from decreasing the time of irrigation as follows:

$I_1$= 2771.6 $m^3$/fed/year (control).

$I_2$= 2355.86 $m^3$/fed/year

$I_3$= 1940.12 $m^3$/fed/year

(b): three levels of potassium fertilization as follows:

$K_1$= 80 kg/fed /year (control).

$K_2$= 100 kg/fed /year

$K_3$= 120 kg/fed /year

The trees received the normal cultural practice usually adapted for this farm except potassium fertilization which was in granular form of potassium sulphate (48% $K_2O$). The amount of fertilizers per tree were dissolved in one liter of water and applied in a circle around the trunk of the tree under the irrigation drippers. The total amount of potassium fertilization levels were divided in three portions as follows:

1- Quarter the amount was added from mid February to the end of March.

2- Half the amount was added from April to June

3- And the remaining quarter was added from July to September.

The above portions were added twice a week for 60 irrigations,

The amount of water in every irrigation and the rates of potassium fertilization are shown in Table 5.

The experiment included 9 treatments which represented the combination of three irrigation rates and the three potassium fertilization levels. The experiment layout was split- plot system in a randomized complete blocks design. Irrigation rates were randomly distributed in the main plots, whereas, fertilization treatments were in the sub-plots. Each sub-plot contained two trees and replicated three times.

**Data Recorded:**

**1-Vegetative growth measurements:**

Four main branches ,as uniform as possible, were chosen from each experimented tree, tagged and the average of the new shoot number/ selected branch was counted, in late October. To estimate the increase of the trunk cross-sectional area (TCA) in $cm^2$ according to the formula : circumference = 2 Л and cross sectional area = $Л^2$ where Л= 3.14 and r = 1/2 the diameter (Westwood, (1988)). The diameter of every studied tree was determined at 10 cm over the union at late February and late October of every experimental year. To determine the leaf area, samples of 10 mature leaves were collected at random from each studied tree on mid August, washed with tap water and dried with cotton. The determination of leaf area was carried out using leaf area meter Model (1-203, CID, Inc, USA).

**2 -Determination of leaf chemical contents:**

**a- Determination of leaf reading chlorophyll content:**

leaf chlorophyll reading was recorded using MINOLTA CHLOROPHYLL METER SPAD-502 (Minolta camera. Co., LTD Japan) at the field in mid

**Table 5. The time and amount of applied irrigation water ($m^3$/fed) and K fertilization levels for every irrigation treatment during the growing season of "Canino" apricot trees.**

| Treatments | | | Number of irrigations /year | Time of irrigation period/day | | Water quantity (L/tree/day) |
|---|---|---|---|---|---|---|
| Water quantity† | | Potassium rate kg $K_2O$/fed/year | | h. | Min. | |
| $m^3$/tree/year | $m^3$/fed/year | | | | | |
| $I_1$ 16.400†† | 2771.6†† | $K_1$ 80†† | 205 | 2 | 30 | 80 |
| | | $K_2$ 100 | | | | |
| | | $K_3$ 120 | | | | |
| $I_2$ 13.940 | 2355.86 | $K_1$ 80 | 205 | 2 | 12 | 68 |
| | | $K_2$ 100 | | | | |
| | | $K_3$ 120 | | | | |
| $I_3$ 11.480 | 1940.12 | $K_1$ 80 | 205 | 1 | 45 | 56 |
| | | $K_2$ 100 | | | | |
| | | $K_3$ 120 | | | | |

† water quantity for 169 trees /fed. †† Either water or potassium = control.

June. The average of ten readings was taken on the middle of leaves from all over the tree circumference.

b- Determination of leaf free proline content

On the first of August in both studied seasons, leaf samples were taken to determine free proline contentaccording to Singh *et al.*, (1973) by using 0.5 gm of dried mature leaf sample which were homogenized in 10 ml 3.5% sulphosaliclic acid and centrifuged for 5 minutes at 300 rpm and decanted, then filtered through Whatman No.2 filter paper. The supernatant diluted and injected in Beckman Amino Acid Analyzer 119 CL. The proline concentration was determined from standard curve and calculated on dry weight basis.

c- Determination of leaf mineral composition:

To estimate the effect of different irrigation and fertilizer treatments on the leaf mineral composition, samples consisted of twenty mature leaves that were collected at midshoot of current, at late of June, in both seasons. The leaves were washed several times with tap water, rinsed three times in distilled water, and then dried at 70-80 $^0$C in an electric air-drying oven to a constant weight. The dried leaves of each sample were ground in porcelain mortar to avoid contamination with any minerals, 0.3 gm from the ground dried material of each sample was digested with $H_2O_2$ and $H_2SO_4$ according to Evenhuis and De Waard (1980). Suitable aliquots were taken for the determination of mineral elements. Total nitrogen and phosphorus were determined colorimetrically according to Evenhuis (1976), and Murphy and Riley (1962), respectively. Potassium was determined against a standard curve by flame photometer (Chapman and Pratt, 1961). The concentrations of macro elements were expressed as percent (%)on dry weight basis,

**3- Yield and fruit quality measurements:**

The total yield of each studied tree was determined on weight basis (kg) at harvest time at the first half of June of both studied years. twenty mature fruits from each studied tree were taken at random to determine fruit quality. In each sample, fruit weight was recorded as (gm) firmness was determined according to Magness and Taylor (1925) pressure tester using a 5/16 plunger. Total soluble solids (TSS%) in the juice were determined using a hand refractometer and the acidity percentage was determined according to AOAC (1980), the starch % was according to Woodman (1941) and carotene pigments in fruit skin tissues was determined at harvest time and calculated as mg/100g fresh weight according Wettstein (1957).

All obtained data were, statistically analyzed according to Steel and Torrie (1980) and the Duncan's test was used to compare the differences between treatments means.

## RESULTS AND DISCUSSION

### 1-Vegetative growth characters:

The results presented in Table 6, generally, indicated in the first season increasing irrigation water amount increased the trunk cross-sectional area (TCA), leaf area and number of new shoot/branch. Regarding to (TCA), and leaf area the differences between $I_1$ and $I_2$ were not significant enough to be mentioned. In the second season $I_2$ had significant effect on (TCA), leaf area and number of new shoot/branch. Those results were true in both growing seasons and matched well with those reported by Lötter *et al.*, (1985), Erf and Proctor (1989) and Neilsen *et al.* (1995),on apple. Recent studies on "Anna" apple and "Canino" apricot trees by Khalil *et al.*, (2000) and Abd EL-Messeih and EL-Gendy (2004-a) respectively, proved that there was a positive trend between the optimum amount of water applied to trees and the trunk cross sectional area (TCA), leaf area and average shoot number /selected branch.

Concerning the effects of potassium fertilization levels on vegetative growth characters of "Canino" apricot trees, the results in Table 6 showed that TCA, leaf area and average number of new shoot/branch, increased as the potassium fertilization levels increased. The application of 120 Kg $K_2O$/fed/year stands favorably and responsible for the statistically increments for the studied vegetative parameters over the two fertilization treatments, in both seasons. The only exception was observed in TCA, where, potassium fertilization at the rate of 100 kg $K_2O$/fed gave similar trend compared to those applied with 120 kg $K_2O$/fed, in the first season. Meanwhile in the second season there is no different occurs between $K_1$ and $K_2$ .The enhancement of vegetative growth by the application of potassium fertilization may be due to its vital contribution in several metabolic processes in plants, and its role on assimilating the photosynthetic reaction (Marschner, 1994). Those results are in line with Kassem (1991), Kilany and Kilany (1991) and Attala (1997) on apple trees and El Morshedy (1997) on peach who concluded that, increasing the supply of mineral-K progressively and significantly, increased vegetative growth characters.

As for the effect of interaction between the application of various water irrigation amount and potassium fertilizer rates on the vegetative growth parameters of "Canino" apricot trees, the results in Table 6 did not show any significant combination, indicating the absence of such an interaction on TCA, leaf area and average number of new shoots/branch in

**Table 6. Effect of different levels of irrigation water and potassium treatments on vegetative growth characters of "Canino" apricot trees in 2004 and 2005 seasons.**

| Treatments | | 2004 | | | 2005 | | |
|---|---|---|---|---|---|---|---|
| Irrigation rates $m^3$/fed | Potassium rates $K_2O$/fed | TCA $cm^2$ | Leaf area $cm^2$ | N. of new shoots/ branche | TCA $cm^2$ | Leaf area $cm^2$ | N. of new shoots/ branche |
| $I_1$ 2771.6 | | 68.07 a | 24.88 a | 11.67 a | 69.15 b | 26.9 b | 13.33 b |
| $I_2$ 2355.86 | | 67.80 a | 24.77 a | 11.30 b | 69.76 a | 27.31 a | 14.33 a |
| $I_3$ 1940.12 | | 67.33 b | 21.55 b | 8.60 c | 67.46 c | 21.03 c | 8.63 c |
| | $K_1$ 80 | 67.13 b | 22.97 c | 9.57 c | 68.02 b | 23.95 c | 10.53 c |
| | $K_2$ 100 | 68.04 a | 23.38 b | 10.73 b | 69.08 b | 25.19 b | 12.43 b |
| | $K_3$ 120 | 68.02 a | 24.85 a | 11.27 a | 69.27 a | 26.11 a | 13.33 a |
| $I_1$ 2771.6 | $K_1$ 80 | 67.20 | 24.10 | 10.60 | 68.20 D | 25.82 | 11.60 |
| | $K_2$ 100 | 68.40 | 24.33 | 11.80 | 69.45 C | 27.24 | 13.60 |
| | $K_3$ 120 | 68.60 | 26.20 | 12.60 | 69.8 B | 27.64 | 14.80 |
| $I_1$ 2355.86 | $K_1$ 80 | 67.10 | 24.00 | 10.50 | 68.47 D | 25.88 | 12.60 |
| | $K_2$ 100 | 68.20 | 24.20 | 11.60 | 70.40 A | 27.48 | 14.80 |
| | $K_3$ 120 | 68.10 | 26.10 | 11.80 | 70.4 0A | 28.57 | 15.60 |
| $I_3$ 1940.12 | $K_1$ 80 | 67.10 | 20.80 | 7.60 | 67.4 0E | 20.14 | 7.40 |
| | $K_2$ 100 | 67.53 | 21.60 | 8.80 | 67.4 0E | 20.85 | 8.90 |
| | $K_3$ 120 | 67.35 | 22.24 | 9.40 | 67.60 E | 22.11 | 9.60 |
| significant of interaction | | NS | NS | NS | ** | NS | NS |

TCA= trunk cross sectional area

values followed by the same letter (s), through a particular column of means, are not significantly different, using Duncan's multiple range test at 0.05.

both years. The exception was found in the second season, as the treatment combination of applying ($I_2$)2355.86 $m^3$ water /fed /year and receiving 100 or 120 kg $K_2O$/fed/year gave the highest mean values for TCA. Those results are in the same direction with Khalidy and Nayyal (1976) on lemon and EL-Sisy (2001) on guava who noticed that using the high level of the amount of water applied plus the higher dose of potassium fertilizer improved the vegetative growth.

**2-Leaf chemical composition:**

**a- Leaf mineral content:**

Results presented in Table 7, indicated that, nitrogen percent of "Canino" apricot leaves, significantly increased with ($I_1$) level compared with those other treatments in the first season. While in the second season the difference between ($I_1$) and ($I_2$) was insignificant. In both season, leaf potassium content, significantly increased with ($I_2$) rate as compared to other rates. On the other side, leaf P content did not reflect any significant response due to using different rates of irrigation in the first season. While ($I_2$) rate, significantly increased leaf P content in the second season. These results may be due to leaching of mineral elements by more irrigation. Moreover, the results are in general accordance to that reported by Pacholak (1986), who mentioned that the optimum irrigation tended to increase apple total leaf N,P and K content . Also apple, trees protected from rainfall by tent-like covers of polyethylene had less foliar N,P and K based on either concentration or amount per unit leaf area than unprotected ones (Erf and Proctor, 1989). Moreover in Egypt those results are in partial agreement with those found by Abd EL-Samed, (1995) and Mohamed ( 2003) on olive, Abd EL Messeih (2000) on apple and Abd EL Messeih and EL-Gendy (2004-b) on apricot trees.They concluded that, leaf N,P and K content gradually and significantly increased as a result of optimum irrigation rate applied. On the other side, EL-Morshedy *et al.*, (1997), reported that deficit irrigation throughout the growth season, significantly, increased leaf N,P and K content of Le Conte pear trees.

Concerning the effect of potassium fertilization on leaf N,P and K% of "Canino" apricot leaves, the results presented in Table 7 showed that, in both seasons, the experimental trees received $K_3$ (120 Kg $K_2O$/fed/year) potassium sulphate had significantly higher leaf N and K contents as compared with those of other treatments. On the other side, leaf P content did not reflect any significant response due to using different rates of potassium fertilization in both seasons. These results agree with those obtained by Attala, (1997) on apple EL-Seginy and Khalil, (2000) on Le Conte pear Kassem and EL-Seginy (2002) on peach, EL Sabrout and Kassem (2002) on orange and Mohamed (2003) on olive. They concluded that, leaf N and K content increased by increasing potassium application rates, while; leaf P content was not significantly affected.

**Table 7. Effect of different levels of irrigation water and potassium treatments on N,P and K of "Canino" apricot leaves in 2004 and 2005 seasons**

| Treatments | | 2004 | | | 2005 | | |
|---|---|---|---|---|---|---|---|
| Irrigation rates $m^3$/fed | Potassium rates $K_2O$/fed | N (%) | P (%) | K (%) | N (%) | P (%) | K (%) |
| $I_1$ 2771.6 | | 2.10 a | 0.226 a | 1.48 b | 2.03 a | 0.160 b | 1.49 b |
| $I_2$ 2355.86 | | 2.03 b | 0.157 a | 1.55 a | 2.04 a | 0.167 a | 1.65 a |
| $I_3$ 1940.12 | | 1.83 c | 0.137 a | 1.38 c | 1.70 b | 0.127 c | 1.37 c |
| | $K_1$ 80 | 1.77 c | 0.160 a | 1.30 c | 1.77 c | 0.157 a | 1.30 c |
| | $K_2$ 100 | 2.07 b | 0.157 a | 1.40 b | 1.94 b | 0.153 a | 1.46 b |
| | $K_3$ 120 | 2.13 a | 0.202 a | 1.71 a | 2.07 a | 0.150 a | 1.75 a |
| $I_1$ 2771.6 | $K_1$ 80 | 1.80 E | 0.180 | 1.30 F | 1.80 E | 0.170 | 1.20 H |
| | $K_2$ 100 | 2.20 B | 0.170 | 1.40 D | 2.10 B | 0.160 | 1.53 E |
| | $K_3$ 120 | 2.30 A | 0.327 | 1.73 B | 2.20 A | 0.157 | 1.75 B |
| $I_1$ 2355.86 | $K_1$ 80 | 1.80 E | 0.160 | 1.40 E | 1.90 D | 0.170 | 1.50 F |
| | $K_2$ 100 | 2.10 C | 0.160 | 1.50 D | 2.03 C | 0.170 | 1.58 D |
| | $K_3$ 120 | 2.20 B | 0.150 | 1.75 A | 2.20 A | 0.167 | 1.88 A |
| $I_3$ 1940.12 | $K_1$ 80 | 1.70 F | 0.140 | 1.20 G | 1.60 G | 0.130 | 1.20 H |
| | $K_2$ 100 | 1.90 D | 0.140 | 1.30 F | 1.70 F | 0.130 | 1.28 G |
| | $K_3$ 120 | 1.90 D | 0.130 | 1.65 C | 1.80 E | 0.127 | 1.62 C |
| significant of interaction | | ** | NS | ** | ** | NS | ** |

values followed by the same letter (s), through a particular column of means, are not significantly different, using Duncan's multiple range test at 0.05.

Results of the interaction effects among the various irrigation levels and different potassium fertilization treatments on leaf N, P and K content of "Canino" apricot trees listed in Table 7, clarified that the inadequate influence of irrigation amount, irrespective of N was found to be remarkably increased as a results of fertilization with 120 Kg potassium sulphate/fed/year with ($I_1$) 2771.6 $m^3$/fed/year or ($I_2$) 2355.86 $m^3$/fed/year irrigation rate in the first and second season, respectively as well as in $I_2 \times K_3$ for leaf K content in the both seasons.

**b- Leaf chlorophyll reading and free proline content:**

It is evident from Table 8 that the leaf chlorophyll reading was significantly higher in the "Canino" apricot trees grown under high irrigation rates (control) than $I_2$ and $I_3$ treatments in the first season. However, in the second season $I_2$ (2355.86 $m^3$/fed/year) significantly gave the highest chlorophyll reading compared to those of the other treatments. On the contrary the free proline contents of leaves were significantly increased in the case of the trees grown at the deficit irrigation ($I_3$) and decreased in ($I_2$) and ($I_1$), respectively in two experimental seasons. This means that deficit irrigation stimulate the biosynthesis and accumulation of this amino acid in leaves and in the same time reduced leaves total chlorophyll values. The accumulation of leaf free proline content in tree under water stress may be due to its inability to synthesize more chlorophyll and protein (proline is an essential factor in biosynthesis of chlorophyll, (Hussein 1998). Similar results are in a good line with Abd EL Messeih (2000) on apple trees and Abd EL-Messeih and EL -Gendy (2004-b) on apricot trees. They stated that under water stress condition, leaf chlorophyll reading reduced and free proline increased as consequence of deficit irrigation. On the other side, EL-Mansi *et al.*, (1999) mentioned that, increasing the amounts of applied water up to 1000 $m^3$/fed. significantly decreased the chlorophyll and the proline contents in pea leaves.

Regarding the effect of different levels of potassium on leaf chlorophyll reading and free proline contents of "Canino" apricot trees, the results in Table 8 showed that in both seasons the highest leaf chlorophyll reading was associated with high level of potassium fertilization (120 Kg $K_2O$/fed/year). Meanwhile the lowest value was found in the tree treated with of 80 Kg $K_2O$/fed/year (control). The above mentioned results concerning leaf chlorophyll content are in line with those previously obtained by Bakr *et al.*, (1980) and El Sabrout and Kassem (2002) on orange. On the contrary El Morshedy (1997) on peach mentioned that the chlorophyll values were depressed as potassium dose increased. The leaf free proline value was significantly decreased in leaves of trees fertilized by 120 Kg $K_2O$/fed/year while the highest value was found in the trees fertilized by 80 Kg $K_2O$/fed/year.

Data of Table 8 showed that the comparison among the mean values of various treatment combinations

**Table 8. Effect of different levels of irrigation water and potassium treatments onleaf chlorophyll reading and free proline of " Canino" apricot leaves in 2004 and 2005 seasons**

| Treatments | | 2004 | | 2005 | |
|---|---|---|---|---|---|
| Irrigation rates m³/fed | Potassium rates $K_2O$/fed | leaf chlorophyll reading (SPAD) | Leaf free proline mg/100 gm dry weight | leaf chlorophyll reading (SPAD) | Leaf free proline mg/100 gm dry weight |
| $I_1$ 2771.6 | | 31.3 0a | 5.78 c | 31.73 b | 5.80 c |
| $I_2$ 2355.86 | | 31.0 0b | 5.83 b | 31.97 a | 5.81 b |
| $I_3$ 1940.12 | | 22.4 0c | 7.24 a | 21.77 c | 8.16 a |
| | $K_1$ 80 | 27.43 c | 6.30 a | 27.30 c | 6.62 a |
| | $K_2$ 100 | 28.23 b | 6.27 b | 28.73 b | 6.59 b |
| | $K_3$ 120 | 29.03 a | 6.25 c | 29.40 a | 6.56 c |
| $I_1$ 2771.6 | $K_1$ 80 | 30.10 E | 5.81 | 30.20 E | 5.82 E |
| | $K_2$ 100 | 31.20 C | 5.76 | 31.80 D | 5.80 G |
| | $K_3$ 120 | 32.40 A | 5.70 | 33.20 A | 5.78 I |
| $I_1$ 2355.86 | $K_1$ 80 | 30.00 F | 5.82 | 30.20 E | 5.84 D |
| | $K_2$ 100 | 31.10D | 5.83 | 32.60 C | 5.81 F |
| | $K_3$ 120 | 31.90 B | 5.85 | 33.10 B | 5.79 H |
| $I_3$ 1940.12 | $K_1$ 80 | 22.20 I | 7.28 | 21.60 H | 8.21 A |
| | $K_2$ 100 | 22.40H | 7.23 | 21.80 G | 8.16 B |
| | $K_3$ 120 | 22.60 G | 7.22 | 21.90 F | 8.11 C |
| Significant of interaction | | ** | NS | ** | ** |

values followed by the same letter (s), through a particular column of means, are not significantly different, using Duncan's multiple range test at 0.05.

exhibited that application of $I_1$ (2771.6 $m^3$/fed/year) + $K_3$ (120 kg $K_2O$/fed/year) for leaf chlorophyll reading in both seasons and $I_3$ (11480 $m^3$/fed/year) with $K_1$ (80 kg $K_2O$/fed/year) for free proline content, in the second season that gave the higher values.

**3-Yield and fruit quality**

**a-Yield and physical properties:**

Analysis of variance in Table 9 showed that the maximum yield in kg/tree and fruit weight was gained by treatment ($I_1$) and ($I_2$) in the first and second seasons, respectively. However, the lowest yield and fruit weight were recorded from treatment ($I_3$) which received the least water amount in both seasons. These results may be attributed to the greater amount of synthesized metabolites which can be considered as a final result of improving all physiological processes including nutrient uptake. (Khalil, 1991). These results agreed with those reported by Pacholak (1986), Ali *et al.*, (1998) and Khalil *et al.*,(2000) who concluded that adequate water supply for apple trees is an important factor for maximizing its production. On the other hand, the results in Table 9 clearly showed that, fruit firmness markedly increased with decreasing water applied rates compared with the control in both seasons. These findings were more pronounced with water irrigation at 11480 $m^3$ /fed/year ($I_3$) when added in both seasons. Such results may prove that the amount of applied water affects firmness. These results are in full agreement with those reported by El Morshedy and Haggag (1997)on peach,Ali *et al.*, (1998), Abd EL- Messeih (2000) and Khalil *et al.*, (2000)on apple who concluded that fruits produced under dry conditions were higher in the firmness value.

As for the effect of the different potassium levels on yield Kg/tree, fruit weight and firmness of "Canino" apricot trees the data in Table 9 indicated that the trees grown at the high potassium level ($K_3$) gave significantly the highest yield kg/ tree and fruit weight and firmness followed by $K_2$ while the least significant values were detected in $K_1$ treatment in both seasons. Similar trend was found by Mansour *et al*,(1986),Kassem and EL-Seginy (2002) and Mohamed (2003) on peach and olive respectively, who reported that potassium sulphate increased yield and improve fruit quality.

Concerning the effect of the interaction between the irrigation treatments and the potassium fertilization levels on yield Kg/tree, fruit weight and fruit firmness, the data in Table 9 indicated that " Canino" apricot trees at $K_3$ levels with the control and $I_2$ treatments gave the

**Table 9. Effect of different levels of irrigation water and potassium treatments on yield /tree. fruit weight and firmness of " Canino" apricot trees in 2004 and 2005 seasons**

| Treatments | | 2004 | | | 2005 | | |
|---|---|---|---|---|---|---|---|
| Irrigation rates $m^3$/fed | Potassium rates $K_2O$/fed | yield/tree (kg) | fruit weight (gm) | fruit firmness ($lb/in^2$) | yield/tree (kg) | fruit weight (gm) | fruit firmness ($lb/in^2$) |
| $I_1$ 2771.6 | | 49.37 a | 32.91 a | 5.71 c | 54.71 b | 35.03 b | 5.93 c |
| $I_2$ 2355.86 | | 47.90 b | 31.73 b | 6.03 b | 56.40 a | 36.67 a | 6.50 b |
| $I_3$ 1940.12 | | 41.47 c | 25.60 c | 6.16 a | 42.70 c | 26.03 c | 6.87 a |
| | $K_1$ 80 | 44.07 c | 26.54 c | 5.47 c | 46.72 c | 29.20 c | 5.85 c |
| | $K_2$ 100 | 45.90 b | 30.37 b | 5.97 c | 52.03 b | 32.87 b | 6.47 b |
| | $K_3$ 120 | 48.77 a | 33.33 a | 6.47 a | 55.00 a | 35.67 a | 7.00 a |
| $I_1$ 2771.6 | $K_1$ 80 | 46.80 E | 28.60 E | 5.20 | 48.70 F | 31.40 F | 5.40 C |
| | $K_2$ 100 | 48.70 C | 33.40 C | 5.80 | 55.60 D | 35.30 D | 6.10 BC |
| | $K_3$ 120 | 52.60 A | 36.80 A | 6.10 | 59.80 B | 38.40 B | 6.30 ABC |
| $I_1$ 2355.86 | $K_1$ 80 | 45.20 F | 27.50 F | 5.60 | 50.40 E | 32.40 E | 5.90 BC |
| | $K_2$ 100 | 47.60 D | 32.30 D | 5.90 | 58.20 C | 37.40 C | 6.40 ABC |
| | $K_3$ 120 | 50.90 B | 35.40 B | 6.60 | 60.60 A | 40.20 A | 7.20 AB |
| $I_3$ 1940.12 | $K_1$ 80 | 40.20 I | 23.60 H | 5.60 | 41.20 I | 23.80 I | 6.20 ABC |
| | $K_2$ 100 | 41.40 H | 25.40 G | 6.20 | 42.30 H | 25.90 H | 6.90 AB |
| | $K_3$ 120 | 42.8 G | 27.80 F | 6.70 | 44.60 G | 28.40 G | 7.50 A |
| significant of interaction | | *** | *** | NS | *** | *** | ** |

values followed by the same letter (s), through a particular column ofmeans, are not significantly different, using Duncan's multiple range test at 0.05.

highest mean values for yield and fruit weight in the first and second seasons, respectively. On the other hand, in the second season, $I_3$ x $K_3$ gave the highest mean value of fruit firmness.

**b- Chemical properties:**

Data in Table 10 indicated that TSS%, total sugars % and acidity % in the fruit juice were significantly increased in the control $I_1$ followed by $I_2$ and $I_3$, in both seasons. Only exception as for TSS% the difference between $I_1$ and $I_2$ was not enough to be significant in both seasons. On the contrary the starch % and carotene significantly increased in $I_3$ treatment followed by $I_2$ and $I_1$ treatments, in the two experimental seasons.

These results indicated that fruit quality of "Canino" apricot trees was found to be better using a lot of water supply than water deficit conditions. These results agreed with those reported by Khalil *et al.*, (2000) Mohamed (2003) and Abd-EL-Messeih and El-Gendy (2004a).

Concerning the effects of potassium fertilization rates on chemical properties (percentage of TSS, total sugars, acidity ,starch and carotene) of "Canino" apricot fruit, the results in Table 10 showed that TSS %, total sugars % and acidity % were increased as a result of increasing potassium fertilization rates. Application of 120 kg $K_2O$/fed/year was superior for all results in the studied chemical properties compared to other treatments in both seasons. As for TSS%, the results indicated that the differences among three levels of potassium fertilization were not enough to be significant in two experimental seasons. These results are in line with Cummings and Reeves (1971), Attala (1997), Kassem and EL-Seginy (2002) and EL-Sabrout and Kassem (2002) working on several crops, they reported that TSS %, acidity % and total sugars % were positively related to potassium applied. They added that the lower hydrogen ion concentration with the concomitant positive correlation between potassium supply and total organic acids as potassium was increased. On the other hand, the starch % was significantly increased at $K_1$ in comparison with other treatments in both seasons. The exception was found in

**Table 10. Effect of different levels of irrigation water and potassium treatments on chemical characters of " Canino" apricot fruits in 2004 and 2005 seasons**

| Treatments | | 2004 | | | | | 2005 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Irrigation rates $m^3$/fed | Potassium rates $K_2O$/fed | TSS % | Total sugars % | Acidity % | Starch % | carotene mg/100 g f.w. | TSS % | Total sugars % | Acidity % | Starch % | carotene mg/100 g f.w. |
| $I_1$ 2771.6 | | 13.15a | 49.63a | 0.53a | 32.99c | 35.73c | 13.18a | 49.83a | 0.54a | 32.79c | 34.85c |
| $I_2$ 2355.86 | | 13.07a | 49.13b | 0.51b | 33.43b | 36.60b | 13.15a | 49.22b | 0.53b | 33.29b | 35.37b |
| $I_3$ 1940.12 | | 11.85b | 44.43c | 0.48c | 36.97a | 37.30a | 11.72b | 44.10c | 0.47c | 37.09a | 36.40a |
| | $K_1$ 80 | 12.62a | 47.33c | 0.50b | 34.71a | 35.23c | 12.62a | 47.37c | 0.50c | 34.73a | 34.42c |
| | $K_2$ 100 | 12.69a | 47.70b | 0.50b | 34.48ab | 36.40b | 12.68a | 47.73b | 0.52b | 34.23b | 35.27b |
| | $K_3$ 120 | 12.75a | 48.17a | 0.52a | 34.20b | 38.00a | 12.76a | 48.11a | 0.53a | 34.21b | 36.93a |
| $I_1$ 2771.6 | $K_1$ 80 | 13.12 | 49.20 | 0.52 | 33.36 | 34.20 | 13.14 | 49.40 | 0.53 | 33.34 | 33.25 |
| | $K_2$ 100 | 13.15 | 49.60 | 0.53 | 32.96 | 35.50 | 13.17 | 49.90 | 0.55 | 32.66 | 34.80 |
| | $K_3$ 120 | 13.19 | 50.10 | 0.56 | 32.46 | 37.50 | 13.22 | 50.20 | 0.56 | 32.36 | 36.50 |
| $I_1$ 2355.86 | $K_1$ 80 | 12.95 | 48.60 | 0.51 | 33.96 | 35.20 | 13.11 | 48.20 | 0.51 | 33.86 | 34.40 |
| | $K_2$ 100 | 13.11 | 49.10 | 0.51 | 33.46 | 36.80 | 13.14 | 49.20 | 0.53 | 33.36 | 35.20 |
| | $K_3$ 120 | 13.14 | 49.70 | 0.53 | 32.86 | 37.80 | 13.20 | 49.90 | 0.55 | 32.66 | 36.50 |
| $I_3$ 1940.12 | $K_1$ 80 | 11.8 | 44.20 | 0.48 | 36.80 | 36.30 | 11.60 | 44.00 | 0.47 | 37.00 | 35.60 |
| | $K_2$ 100 | 11.84 | 44.40 | 0.48 | 37.00 | 36.90 | 11.72 | 44.10 | 0.48 | 37.30 | 35.80 |
| | $K_3$ 120 | 11.92 | 44.70 | 0.49 | 37.10 | 38.70 | 11.85 | 44.20 | 0.48 | 37.60 | 37.80 |
| significant of interaction | | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS |

TSS= Total soluble solids

values followed by the same letter (s), through a particular column of means, are not significantly different, using Duncan's multiple range test at 0.05.

the first season, the potassium fertilization at the rate 80 Kg $K_2O$/fed gave similar trend compared to those applied at 100Kg $K_2O$/fed.

No significant differences were observed for interaction effects between varying irrigation levels and potassium treatments on chemical properties of "Canino" apricot fruits (Table 10).

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# الملخص العربي

## استجابة أشجار المشمش " كانينو" لمعاملات مختلفة من الري والتسميد البوتاسى

آمال محمود السجينى

أجريت هذه الدراسة خلال عامي ٢٠٠٤و ٢٠٠٥ في مزرعة خاصة بمنطقة النوبارية – بحيرة – مصر بهدف دراسة استجابة أشجار المشمش " كانينو" لثلاث مستويات من الماء تحت نظام الرى بالتنقيط ( ري١ =٢٧٧١,٦ م٣/فدان/سنة (المقارنة) - ري٢= ٢٣٥٥,٨٦ م٣/فدان/سنة - ري٣=١٩٤٠,١٢ م٣/فدان/سنة) مع ثلاث معاملات التسميد البوتاسى ( بو١ - ٨٠ كيلو للفدان فى السنة " الكنترول"- بو٢ - ١٠٠ كيلو للفدان فى السنة- بو٣ - ١٢٠ كيلو للفدان فى السنة)والتوافيق بينهما ودراسة تأثير ذلك على المجموع الخضرى والمحتوى الكيماوى للأوراق والمحصول وجودة الثمار والاشجار عمرها ٦ سنوات ومطعومة على اصل المشمش البذرى ومزرعة على مسافة ٤,٥× ٥,٥ فى تربة رملية وأوضحت النتائج ما يلى:-

تفوقت معاملة الرى الثانية ( ري٢ ) فى زيادة المجموع الخضرى معبرا عنه فى مساحة مقطع الجذع ومساحة الورقة وعدد النموات الحديثة لكل فرع وايضا محتوى الأوراق من النتروجين والفوسفور والبوتاسيوم والكلوروفيل والمحصول مقارنة بالمعاملات الأخرى فى السنة الثانية للدراسة. وقد أعطت المعاملة ري٢ اعلى القيم معنويا لمحتوى الأوراق من النيتروجين الحر و صلابة الثمار ونسبة النشا والكاروتين , فى ثمار مشمش الكانينو وذلك بالمقارنة بالمعاملات الأخرى خلال عامى الدراسة. وأظهرت النتائج ان معاملة الرى الأولى تفوقت فى صفات جودة الثمار معبرا عنها بنسبة المواد الصلبة الذائبة والسكريات الكلية ونسبة الحموضة خلال عامي الدراسة.

وقد أظهرت النتائج تأثير مستويات التسميد البوتاسى ان بو٢ أدى إلى زيادة معنوية فى مساحة مقطع الجذع ومساحة الورقة وعدد النموات الحديثة فى كل فرع ومحتوى الأوراق من النيتروجين والبوتاسيوم والكلوروفيل خلال سنتى الدراسة. و لم تظهر اى فروق بين معاملات التسميد البوتاسى على محتوى الورقة من الفسفور. وعلى عكس ما سبق فأعطى معدل التسميد البوتاسى بو٢ اقل قيم لمحتوى الورقة من البرولين الحر فى سنتى الدراسة. وأدى التسميد البوتاسى إلى زيادة المحصول وتحسين جودة الثمار ( نسبة السكريات الكلية ونسبة الحموضة والصلابة و الكاروتين) وكان ١٢٠ كيلو سلفات بوتاسيوم للفدان فى السنة أفضل من المعاملات الأخرى. و لم تظهر نسبة المواد الصلبة الذائبة أى فروق للمعاملات التسميد البوتاسى المختلفة.

وعن تأثير التداخل بين معاملات المياه ومستويات التسميد البوتاسى فقد أظهرت النتائج ان معاملة ري٢ × معاملة التسميد بو٢ أو ري٢ × معاملة التسميد بو٣ أعطت أفضل القيم لمتوسطات مساحة مقطع الجزع فى السنة الثانية. وان معاملة ري١ × معاملة التسميد بو٣ أعطت أفضل القيم فى محتوى الأوراق من النتروجين والكلوروفيل و الكاروتين فى الثمار فى سنتى الدراسة. ومعاملة الرى٢ والتسميد بو٣ كانت الأفضل بالنسبة لمحتوى النيتروجين بالأوراق وذلك فى السنة الثانية أما محتوى البوتاسيوم بالأوراق فى سنتى الدراسة. أما معاملة الرى المنخفضة ري٣ × التسميد البوتاسى المنخفض بو١ أعطى اعلى القيم للبرولين الحر فى الورقة فى السنة الثانية فقط. بينما أفضل محصول كان بمعاملة الرى الأولى مع التسميد البوتاسى مع المستوى الثالث وأيضا معاملة الرى الثانية مع نفس مستوى التسميد. وذلك فى السنة الأولى ثم الثانية من الدراسة على التوالى و لم يتواجد تأثير للتداخل بين معاملات المياه ومستويات التسميد البوتاسى على محتوى الأوراق من الفوسفور و صفات جودة الثمار.

ويمكن التوصية تحت ظروف هذه الدراسة أن أشجار المشمش الكانينو المزرعة فى الأراضى الرملية المصرية تستخدم كمية من المياه = ٢٣٥٥,٨٦ م٣/للفدان فى السنة وإضافة ١٢٠ كيلو سلفات بوتاسيوم للفدان فى السنة للحصول على أشجار ذات مجموع خضرى جيد وزيادة فى المحصول وتحسين جودة الثمار بالإضافة إلى توفير كمية كبيرة من مياه الرى.