Annals of Agric. Sci., Moshtohor **ISSN 1110 -0419**
Vol. 50(1) (2012), 31– 42 **http://annagricmoshj.com**

Effect of Zinc and Urea Foliar Spray on Growth, Yield and Fruit Quality of" Canino" Apricot Trees Grown In Sandy Soils

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Abstract

The present investigation was performed during the two successive seasons of 2010 and 2011 on "Canino" apricot (*prunus armeniaca*) trees of ten year old grown in new reclaimed sandy soil. Trees were sprayed by two Zinc forms i.e, sulphate and chelated at 0.1 and 0.2% alone or combined with urea at 0.5% at full bloom, fruit set and two months later. Spraying chelate zinc at 0.2% + 0.5% urea treatment recorded significantly the highest shoot length, leaf area, fruit set, and yield and improved significantly fruit quality as compared with the lowest values of the unsprayed trees (control). The highest fruit flesh firmness, T.S.S, carotene and sugars content as well as leaf mineral composition were resulted by the same foliar spray treatment (chelate zinc at 0.2% + 0.5% urea) as compared to the control.

Key words: :" Canino" apricot - zinc sulphate –chelate zinc- fruit set- yield - fruit quality- leaf mineral composition

Introduction

Apricot *(Prunus armeniaca)* is a deciduous fruit tree belonging to family *Rosaceae*, subfamily *Prunoideae*, which produces stone fruits (Drupe). Apricot total planted area in Egypt a mounted 18559 Feddans and fruiting area reached 15278 in 2008 and the total production recorded 101139 ton (Ministry of Agriculture Statistics, 2008).

There is strong evidence that zinc is an essential minor element for fungi and higher plants; but, it is found as traces. The low zinc supplies to plants in water cultures prevent moderate growth. Zinc plays an important role in several plant metabolic processes; it activates enzymes and is involved in protein synthesis and carbohydrate, nucleic acid and lipid metabolism (Pahlsson, 1989).

In addition, Mahrous and. El-Fakhrani (2000) mentioned that zinc sulphate increased significantly fruit set, fruit weight, diameter, firmness and T.S.S. of apricot, meanwhile it decreased fruit acidity when compared with other treatments and the control. According to, Orphanos (2000) apple zinc foliar application during the growing season increased the Zn content of the sprayed leaves even if they were just beginning to grow at the time of spraying. He added that spraying Zn-EDTA when the apical bud was bursting did not increase Zn in leaves produced from the lateral buds. In addition, Stoyanova and Doncheva (2002) found that an increase in Zn supply resulted in a decrease in the concentrations of Ca, Mg, P in the roots and an increase of Ca and N levels in the stems and leaves. The amount of Zn in the roots stems and leaves increased with greater Zn rates.

Moreover, Almaliotis et al (2006) studied the Leaf nutrient levels in relation to apricot yield and found that multiple regression analysis revealed that yield (ranging from 5 to 20 t/ha) was highly related to leaf mineral content of N, P, K, Ca, Mg, B, Mn, Zn, Fe and Cu. Recently, Persian walnut (Juglans regia) pollen germination, fruit set, vegetative growth, nut weight, kernel percent, nut and kernel length, and chlorophyll index were the highest when boron (B) and zinc (Zn) were applied simultaneously at 174 and 1050 mg/L concentrations, respectively(Keshavarz1, et al. 2011).

Zeevart and Creelman(1988) cleared that the role of urea spraying may change the balance between ABA and other hormones (cytokinins, gibberellins and indole acetic acid). Physiological role of urea have been clarified, hence transfer of nitrogen from leaves to bud and other parts of plant, which help to increase and promote phytohormones as cytokinins, gibberellins and IAA (Rashad and Stino, 2003). Albrigo and Syvertsen (2006) stated that the urea foliar sprayed orange trees produced significantly less fruit than the soil N treatment in only 1 of 3 years, but the yields were numerically less every year. They noticed that foliar urea application alone was more costly and less productive than a soil N program.

Urea nitrogen (N) applications on 'Fuyu' persimmon later than August significantly decreased the number of flower buds the following year, the difference being up to 5-fold between the August- and the September-N sprayed trees. Severe cold injury occurred in 54.2% of the shoots in the October-N sprayed trees, indicating that the N applied late in the season had rendered the trees to be highly susceptible to cold injury in Korea (Choi, et al. 2009).

Recently, Ouzounis and Lang (2011) found that fall foliar applications of urea on sweet cherry (Prunus avium L.) Increased storage N levels in flowering spurs (up to 40%), shoot tips (up to 20%), and bark (up to 29%). Premature defoliation decreased storage N in these tissues by up to 30%. Spur leaf size in the spring was associated with storage N levels; fall foliar urea treatments increased spur leaf area by up to 24%. Foliar urea applications increased flower spur N levels most when applied in late summer to early fall. They added that such applications also affected the development of cold acclimation in cherry shoots positively during fall; those treated with urea were up to 4.25 °C more cold-hardy than those on untreated trees.

Moreover, Fernandez-Escobar, et al. (2011) had studied the mobilization of nitrogen in the olive bearing shoots after foliar application of urea and found that the rapid translocation of nitrogen from the younger leaves to other storage organs of the tree could explain the insensitivity of leaf analysis to detect excess nitrogen, since mature leaves from current-season shoots must be sampled to determine the nutritional status of the tree. The failure of leaf analysis to detect excess nitrogen may be a cause of nitrogen over-fertilization in olive orchards.

The aim of the present study was to study the effect of increasing zinc concentrations in the nutrient medium on plant growth, Zn, N, P, K, Fe and Mn uptake and their distribution, fruit set, fruit quality and the effect of adding exogenous urea on the increment of zinc effect.

Materials and methods

The present work was conducted during the two growing successive seasons of 2010 and 2011 on "Canino" apricot (prunus armeniaca) trees grown in new reclaimed sandy soil in private orchard at El-Nubaria, Behira Governorate. Trees were ten year old, grafted on Balady apricot seedlings and planted at 5x5 meters apart, nearly similar in growth vigor and fruiting, free from any visual disease symptoms and receiving regularly the recommended orchard management.

Two sources of zinc (zinc sulphate and chelate Zn) and urea fertilizer were applied as a foliar sprays three times a year i.e at full bloom, fruit set and two months later. The treatments were arranged in randomized complete block design; each treatment was represented by three replicates (trees). The applied treatments were as follows:

- Control (sprayed with tap water).
- Urea at5 g/ liter (0.5%).
- Zinc sulphate at 1 g/ liter (0.1%).
- Zinc sulphate at 2 g/ liter (0.2%).
- Chelate zinc at 1 g/ liter (0.1%).
- Chelate zinc at 2 g/ liter (0.2%).
- Zinc sulphate at 1 g liter (0.1%) + urea at 5 g/ liter (0.5%).
- Zinc sulphate at 2 g/ liter (0.2%) + urea at 5 g/ liter (0.5%).
- Chelate zinc at 1 g/ liter (0.1%) + urea at 5 g/ liter (0.5%).
- Chelate zinc at 2 g/ liter (0.2%) + urea at 5 g/ liter (0.5%).

All trees were sprayed until run off during the two seasons.

Furthermore to evaluate the efficiency of the tested treatments on tree growth, fruiting and fruit quality, the following measurements were carried out:-

1- Vegetative Growth Measurements:-

Four main branches similar as possible were chosen at the four cardinal of each treated tree, tagged and the average of the current shoot length was measured with(cm) on October, in both seasons. Ten mature leaves were collected at random from each studied tree to determine leaf area by using Leaf Area meter model (1203, CID, Inc, USA).

2- Flowering and Fruiting:

Four branches, in the different sides of each tree were tagged for determining the fruit set percentage. Fruit set was calculated in relation to the total number of flowers and then the percentages were calculated as follow:

$$\text{Fruit set (\%)} = \frac{\text{No. of developing fruit lets}}{\text{Total No. of flowers}} \times 100$$

3-Yield and Fruit Quality:-

3-1 Fruits were collected at maturity stage late of June from each tree of various replicates and yield weight (kg/tree) was estimated by multiplying the number of fruits with average fruit weight

3-2 Fruit physical properties:-

Twenty fruits from each tree under study were chosen for determining the following:-

- Average weight of fruit (gm).
- Average fruit volume (ml).
- Average fruit length (cm).
- Average fruit diameter (cm).
- Fruit flesh thickness (mm) was determined.
- Fruit firmness was estimated as Ib/inch^2 using the Magness and Taylor (1925) pressure tester of 5/16 inch plunger.

3-3 Chemical properties:-

- Total soluble solids (T.S.S)was determined by a hand refractometer,
- Acidity of fruit juice was determined (as malic acid) by titration with 0.1 normal sodium hydroxide with phenolphthalein as an indicator, according to A.O.A.C(1992)
- Total sugars %content were determined according to Malik and Singh (1980),total carotene in fruit pulp was determined according to the procedure outlined by Wenstein(1957) and expressed as mg/100g fresh weight was determined according to method of Rabino et al.(1977).

4-Determination of leaf mineral composition:-

Leaf minerals contents were determined in August of both seasons. Samples of 30 leaves /tree were taken at random from the previously tagged shoots of each tree. Leaf samples were washed with tap water and distilled water twice, dried at 70 ^{o}C to a constant weight and then ground. The ground samples were digested with sulphoric acid and hydrogen peroxide according to Evenhuis and Dewaard (1980). Total nitrogen and Phosphorus were determined calorimetrically according to Evenhuis (1978), and Murphy and Riley (1962), respectively. Potassium was determined by a flame Photometer model E.E/L. (Jackson, 1967) . Fe, Zn and Mn were determined by perking –Elmer atomic absorption spectrophotometer model 2380 Al, according to Jackson and Ulrich (1959) and Yoahida et al. (1972).

Data were statistically analyzed in factorial design according to the method of Sendecor and Cochran (1990), L.S.D at 5% level was used for comparison between means of each treatment.

Results and discussions

1. Vegetative growth measurements:-

a) Shoot length:**-**

Data obtained during both 2010 and 2011 experimental seasons regarding the specific effect of zinc (chelate& sulphate forms each at 1 and 2 g/L) and urea (0.5%) foliar spray treatments, as well as their combinations (interaction effects) are presented in Table (1).As for the specific effect of zinc application, it is quite evident that all investigated treatments increased significantly average shoot length as compared to the control (0.0 Zn) during both seasons.

However, zinc foliar sprayed at higher rate (2g/L) was relatively more effective regardless of zinc source, but differences were so slight and did not reach level of significance as four zinc spray treatments were compared each other during two seasons of study. With regard to specific effect of urea spray, Table(1) shows that the average shoot length of "Canino" apricot trees was significantly increased for the urea sprayed trees as compared to those of unsprayed ones(control)during both seasons of study.

Concerning the interaction effect of zinc x urea treatments, it is quite clear that specific effect of each investigated factor was directly reflected on their combinations herein, the shortest shoots length were significantly coupled with those "Canino" apricot trees received neither zinc nor urea treatments. In other words all combinations between urea (0.5%) and two zinc sources (at either 1 or 2 g/L) resulted significantly in the tallest shoots. However, the combination of urea and zinc at 2g/L was more effective regardless of source.

b) Leaf area:**-**

Referring to the specific effect of zinc foliar spray treatments, it was quite evident as shown from table(1) that the leaf area followed to great extent the same trend previously detected with the shoot length. Herein, all zinc spray treatments increased significantly leaf area compared with control during both seasons. However, the highest zinc solution i.e 0.2% was more effective from one hand and chelate form tended to surpassed the mineral form particularly during the first experimental season.

On the other hand the specific effect of urea spray(0.5%)was so pronounced and resulted significantly in wider greater leaf area than the control (unsprayed trees with urea) during both seasons.

With regard to the interaction effect of two investigated factors (zinc x urea spray), Table (1) displays that the specific effect of each factor was directly reflected on their different combinations. Herein, the greatest leaf area was clearly in closed relationship to the Canino apricot trees sprayed with urea (0.5%) and higher zinc solution(0.2%of either chelate or sulphate forms). The contrary was found with the control (neither zn nor urea applied trees), however trees subjected to other investigated urea& zinc combinations were statistically in between the aforesaid two extremes.

The present results are in agreement with those of Pahlsson (1989) who reported that zinc plays an important role in several plant metabolic processes where it activates enzymes and is involved in protein synthesis and carbohydrates, nucleic acid and lipid metabolism and with those of Rashad and Stino (2003) using urea on "Le-Conte" pear and with those of Almaliotis, et al. (2006) who studied the relation between leaf mineral contents and plant growth and yield. Moreover, growth was improved by spraying zinc on the foliage Persian walnut (Keshavarzi, et al., 2011).

2- Fruit Set Percentage:-

Data obtained during both seasons regarding the response of fruit set % in Canino apricot trees to specific and interaction effect of zinc spray (chelate &sulphate forms each at 0.1 and0.2%) and urea (0.5%)spray treatments as well as their combinations are presented in Table (2).

Concerning the specific effect of zinc foliar spray treatments it is quite clear that all investigated zinc spray treatments increased significantly fruit set% over control (no zinc sprayed trees) during both experimental seasons. Zinc spray treatments at the higher concentration (0.2%) surpassed significantly those at the lower concentration (0.1%) particularly during 1st season. On the other hand difference between two zinc sources was not so pronounced and didn't reach level of significance when two zinc sources at either lower (0.1%) or higher (0.2%) concentration were separately compared each other during both seasons.

As for the specific effect of urea spray, Table (2) displays its beneficial influence in this concern, especially during 1st season where difference was significant.

Referring the interaction effect of zinc and urea spray combinations, Table (2) reveals obviously the considerable variations in fruit set %.herein, the highest fruit set% was always in concomitant to foliar sprayed. Canino apricot trees with urea 0.5%plus zinc solution at 0.2%(regardless of its form) in spite of the chelate form was slightly effective than the mineral (sulphate source).on the contrary, the least fruit set %was always coupled with the control (neither zn nor urea spray treatment).In addition, other combinations were in between the aforesaid two extremes .The present results are in harmony with those obtained by Mahrous and El-Fakharani (2000) who stated that zinc sulphate spraying increased fruit set; and Keshavarzi et al. (2011) who found that spraying Persian walnut by boron and zinc increased fruit set.

3-Yield and fruit quality:-

3-1 Yield per tree:-

Table (2)displays clearly that productivity of Canino tree (yield expressed as harvested fruits in Kg/tree) influenced significantly by either the specific effect of two investigated factors (urea 0.5% spray &zinc spray with its two forms at 0.1or0.2%) and interaction effect of their combinations. Herein, all zinc spray solutions increased significantly canino tree yield as compared to the control (no zn spray) during both 2010&2011 experimental seasons.

However, spraying both zinc forms at the highest concentration (0.2%) resulted significantly in the highest yield increment during both seasons. On the other hand, it was so worthy to be noticed that chelate zinc was more effective than sulphate form especially during 2nd season. However, difference between two zinc forms applied at the lower concentration (0.1%) was not significant and could be neglected from the statistic point of view during both seasons. With regard the specific effect of urea (0.5%), Table (2) reveals obviously a considerable increase during both seasons, whereas differences were significant as compared to control (unsprayed trees with urea).

Referring the interaction effect, it could be generally noticed that specific effect of each factor (zinc& urea) was reflected on their combinations. Anyhow, it could be safely concluded that foliar sprayed canino apricot trees with urea (0.5%) combined with chelate zinc at 0.2% followed by urea (0.5%) plus zinc sulphate (0.2) yielded significantly the highest yield (49.39&49.26) and (52.20&50.73) Kg/tree during 2010 and 2011 experimental seasons, respectively.

On the contrary, the lightest significant yield was usually coupled with control trees (received neither urea nor zinc). In addition, other combinations were in between the aforesaid two extremes, however both combinations between 0.5%urea spray and zinc spray of either sulphate or chelate zinc tended significantly to be more effective to increase yield as compared to the other combination members of such intermediate category during both experimental seasons.

Table 1. Effect of zinc and urea spraying on shoot length and leaf area of “Canino” apricot trees during 2010 and 2011 seasons

Treatments	Shoot length (cm.)			Leaf area $(cm)^2$		
Urea	0.0	0.5%	Mean*	0.0	0.5%	Mean*
Zinc	Season 2010					
No zinc	39.90	49.47	44.46	23.40	25.95	24.68
ZnSO4 1g/L	49.10	51.48	50.29	25.03	26.45	25.74
ZnSO4 2g/L	49.25	53.33	51.29	25.50	26.99	26.25
Zn-EDTA 1g/L	48.82	51.14	49.92	25.52	26.98	26.25
Zn-EDTA 2g/L	48.69	51.90	50.30	26.01	27.55	26.78
Mean**	45.79	51.10		24.82	26.65	
Season 2011						
No zinc	40.16	50.05	45.10	24.13	26.29	25.21
ZnSO4 1g/L	48.77	51.04	49.91	26.11	26.73	26.42
ZnSO4 2g/L	49.28	53.64	51.46	26.15	27.80	26.98
Zn-EDTA 1g/L	49.39	50.71	50.05	26.24	26.70	26.46
Zn-EDTA 2g/L	49.42	51.88	50.65	25.53	27.59	26.56
Mean**	46.20	51.22		25.38	27.59	
L.S.D at 0.5% for		Season 2010	Season 2011		Season 2010	Season 2011
Zinc		4.44	1.67		0.33	0.20
Urea		4.44	1.67		0.33	0.20
Zinc X Urea		6.29	2.36		0.47	0.28

*&**refer to specific effect of Zn and urea application treatments, respectively.

Table 2. Effect of zinc and urea spraying on fruit set (%) and fruit yield (Kg./tree) of "Canino" apricot trees during 2010 and 2011 seasons.

Treatments	Fruit set (%)			fruit yield (Kg/tree)		
Urea	0.0	0.5	Mean*	0.0	0.5%	Mean*
Zinc	Season 2010					
No zinc	16.13	20.16	18.14	40.00	46.53	43.27
ZnSO4 1g/L	20.65	21.95	21.30	45.25	47.53	46.39
ZnSO4 2g/L	22.10	23.76	22.93	46.29	49.26	47.77
Zn-EDTA 1g/L	20.94	22.12	21.53	45.44	47.61	46.53
Zn-EDTA 2g/L	23.57	23.94	23.76	46.30	49.39	47.84
Mean**	20.68	22.39		44.66	48.06	
	Season 2011					
No zinc	40.16	50.05	45.10	42.20	47.57	44.88
ZnSO4 1g/L	48.77	51.04	49.91	48.10	49.28	48.72
ZnSO4 2g/L	49.28	53.64	51.46	46.83	50.73	48.78
Zn-EDTA 1g/L	49.39	50.71	50.05	47.43	49.60	48.51
Zn-EDTA 2g/L	49.42	51.88	50.65	47.91	52.20	50.06
Mean**	46.20	51.22		46.49	49.28	
L.S.D at 0.5% for	Season 2010	Season 2011			Season 2010	Season 2011
Zinc	0.40	3.13			0.46	0.49
Urea	0.40	3.13			0.46	0.49
Zinc X Urea	0.56	4.43			0.65	0.70

*&**refer to specific effect of Zn and urea application treatments, respectively

The previous results of Mahrous and El-Fakharani (2000) on apricot and of Keshavarzi et al. (2011) on Persian walnut are in line with the present result as regard to yield increment as a result of spraying zinc sulphate.

3-2 Fruit Physical Properties:-

In this regard frit weight (g), size (ml),dimensions (equatorial &polar diameters in cm) and flesh (thickness &firmness) were the investigated fruit physical properties in response to specific and interaction effects of urea, zinc spray treatments and their combinations. Data obtained during both 2010&2011 experimental seasons are presented in Tables (3),(4)and(5).

a-Average fruit weight and size:-

Table (3) displays obviously that both fruit weight and size followed typically the same trend as the specific effect of each investigated factor (zinc&urea spray) was concerned. Herein, all investigated zinc solutions (chelate &sulphate forms each at 0.1 and 0.2%) increased significantly two fruit physical parameters as compared to control (no zinc spray).However, the higher zinc concentration (0.2%) of both chelate and sulphate was more effective from one hand and former form surpassed also sulphate form from the other during both seasons. On the contrary, the lightest and smallest fruits statistically were always in concomitant to the no zinc sprayed trees at the lower concentration (0.1%) came in between.

Referring the specific effect of urea (0.5%) foliar spray, it is quite evident that both weight and size of Canino apricot cv. responded significantly (positively) to the urea application. Besides Table (3) reveals also that the specific effect of two investigated factors (zinc &urea sprays) was directly reflected on their combinations (interaction effect). Anyhow, the heaviest and largest fruits were significantly coupled with Canino apricot trees subjected to, urea (0.5%) and chelate zinc 0.2)sprays ,descending followed by those of urea (0.5) plus zinc sulphate (0.2)and/or urea (0.5%)plus chelated zinc (0.1)during both seasons. The reverse was true with fruit of neither zinc nor urea spray (control).

In addition, other combinations were in between with a relative tendency of variance as compared each other for experimental seasons. The present results are in harmony with those of Mahrous and El-Fakharani (2000) on apricot and of Keshavarzi et al. (2011) on Persian walnut who stated that spraying zinc increased fruit weight and size.

b -Fruit dimensions (equatorial & polar diameters):-

The response of equatorial and polar diameters (width &height) of Canino apricot fruit to the specific and interaction effects of zinc the (sulphate &chelate) forms each at either 0.1 or 0.2% concentrations) and urea (0.5%) sprays, as well as their combinations (interaction)was shown in Table (4). It is quite clear to be noticed that the same trends of response previously detected with fruit weight and size were also detected. However, the rate of response was relatively less pronounced with two fruit dimensions. Anyhow, urea spray increased significantly fruit dimensions of Canino apricot cv.

Moreover, all zinc spray solutions increased significantly also both fruit width and height over control, but differences between different zinc spray treatments were less pronounced and in most case did not reach level of significance particularly as two zinc sources were compared each other during two seasons of study. Consequently, differences among means of different zinc and urea combinations in most cases were not significant as compared each other except as compared to the neither urea nor zinc treated trees.

The present results are in harmony with those of Mahrous and El-Fakharani (2000) on apricot and of Keshavarzi et al. (2011) on Persian walnut who stated that spraying zinc increased fruit weight and size.

Table 3. Effect of zinc and urea spraying on fruit weight and size of "Canino" apricot trees during 2010 and 2011 seasons.

Treatments	Fruit weight(g)			Fruit size (ml)		
Urea	0.0	0.5%	Mean*	0.0	0.5%	Mean*
Zinc			Season 2010			
No zinc	33.00	37.03	35.02	31.60	35.05	33.32
ZnSO4 0.1g/L	37.77	41.52	39.65	35.27	39.01	37.14
ZnSO4 0.2g/L	38.98	43.13	41.06	36.27	40.52	38.39
Zn-EDTA0.1g/L	38.34	41.70	40.02	35.74	40.87	38.31
Zn-EDTA0.2g/L	39.59	45.07	42.31	37.31	41.39	39.35
Mean**	37.53	41.69		35.24	39.31	
			Season 2011			
No zinc	33.65	36.34	35.00	31.68	34.10	32.89
ZnSO4 0.1g/L	37.17	39.30	38.24	35.01	37.91	36.46
ZnSO4 0.2g/L	38.14	40.70	39.42	35.45	38.31	36.68
Zn-EDTA0.1g/L	37.70	41.70	39.70	34.53	40.04	37.29
Zn-EDTA0.2g/L	38.74	44.93	41.84	36.19	41.22	38.70
Mean**	37.08	40.59		34.57	38.32	
L.S.D at 0.5% for		Season2010	Season 2011		Season 2010	Season 2011
Zinc						
Urea		0.68	0.47		0.50	0.48
Zinc X Urea		0.68	0.47		0.50	0.48
		1.21	0.66		0.70	0.68

*&**refer to specific effect of Zn and urea application treatments, respectively.

Table 4. Effect of zinc and urea spraying on fruit dimensions of "Canino" apricot trees during 2010 and 2011 seasons.

Treatments	Fruit equatorial diameter (width cm)			Fruit polar diameter (cm)		
Urea	0.0	0.5%	Mean*	0.0	0.5%	Mean*
Zinc			Season 2010			
No zinc	3.39	3.51	3.45	3.23	3.51	3.37
ZnSO4 0.1g/L	3.61	4.09	3.85	3.58	4.03	3.81
ZnSO4 0.2g/L	4.06	4.12	4.09	3.87	4.08	3.98
Zn-EDTA0.1g/L	3.89	4.09	3.99	3.73	4.04	3.88
Zn-EDTA0.2g/L	3.92	4.15	4.03	3.88	4.09	3.99
Mean**	3.77	3.99				
			Season 2011			
No zinc	3.41	3.50	3.46	3.36	3.51	3.44
ZnSO4 0.1g/L	3.56	4.03	3.80	3.54	4.02	3.78
ZnSO4 0.2g/L	3.62	4.06	3.84	3.59	4.04	3.82
Zn-EDTA0.1g/L	3.59	4.08	3.84	3.57	4.04	3.81
Zn-EDTA0.2g/L	3.69	4.17	3.93	3.66	4.14	3.90
Mean**	3.57	3.97		3.54	3.95	
L.S.D at 0.5% for		Season 2010	Season 2011		Season 2010	Season 2011
Zinc		0.10	0.02		0.07	0.02
Urea		0.10	0.02		0.07	0.02
Zinc X Urea		0.14	0.03		0.10	0.03

*&**refer to specific effect of Zn and urea application treatments, respectively

c- Flesh thickness:-

With regard to the specific effect of zinc spray solutions (zinc sulphate &chelate) each at 0.1 and 0.2%, Table (5) reveals that all investigated zn spray treatments slightly increased fruit flesh thickness during the two experimental seasons. Differences were significant with comparison to the control (no zinc applied) during both seasons. Moreover variance between two Zn concentrations and its form, varied from one seasons to another. Herein, two conflicted trends were detected during two seasons as two zinc sources were compared, whereas chelate form was more effective than sulphate during 1st season, but the reverse was true in 2nd season.

In addition, higher concentration (0.2%) significantly surpassed lower one (0.1%) in 1st season but both concentrations of either sulphate or chelate form were equally the same during 2nd season.

As for the specific effect of urea (0.5%) spray, Table (5) displays that the differences in fruit flesh thickness were not so pronounced, however urea application increased it significantly. Anyhow, the relatively slight effect of specific effect of two investigated factors (Zn and urea spray) resulted obviously in the absent of significance between the different investigated Zn x urea combination during both experimental seasons. The unique exception in this concern was so clear to be distinguished with comparison the neither Zn nor urea sprayed Canino apricot trees to the various Zn x urea combinations.

The unparalleled rates of response between the fruit flesh thickness from one hand and the whole fruit (weight & size) from the other may be attributed to such fact that different fruit tissues (seed, flesh)each followed its own trend in this concern from one hand and flesh thickness is an inherent stable characteristic.

Table 5. Effect of zinc and urea spraying on flesh thickness and fruit firmness of “Canino” apricot trees during 2010 and 2011 seasons.

Treatments	Flesh thickness (mm)			Fruit firmness (lb/inch2)		
Urea / Zinc	0.0	0.5%	Mean*	0.0	0.5%	Mean*
	Season 2010					
No zinc	12.4	13.1	12.8	9.42	10.50	9.96
ZnSO4 0.1g/L	13.0	12.9	12.9	10.30	10.26	10.28
ZnSO4 0.2g/L	13.0	13.0	13.0	10.30	10.20	10.25
Zn-EDTA0.1g/L	13.1	12.9	13.0	10.42	10.47	10.45
Zn-EDTA0.2g/L	1.32	13.1	13.1	10.38	10.53	10.46
Mean**	12.9	13.0		10.16	10.39	
	Season 2011					
No zinc	12.5	13.0	12.7	9.67	11.04	10.36
ZnSO4 0.1g/L	12.9	12.9	12.9	10.99	10.94	10.97
ZnSO4 0.2g/L	12.9	12.9	12.9	10.95	11.00	10.98
Zn-EDTA0.1g/L	12.7	12.9	12.8	10.95	10.44	10.70
Zn-EDTA0.2g/L	12.8	12.8	12.8	11.39	11.05	11.22
Mean**	12.8	12.9		10.79	10.89	
L.S.D at 0.5% for		Season	Season		Season	Season
Zinc		2010	2011		2010	2011
Urea		1.0	1.0		0.11	0.06
Zinc X Urea		1.0	1.0		0.11	0.06
		2.0	1.0		0.15	0.09

*&**refer to specific effect of Zn and urea application treatments, respectively.

D-Fruit firmness:-

Concerning the specific effect of zinc spray treatments, Table (5) displays that fruit firmness was increased significantly by all Zn spray solutions as compared to control (no Zn applied) during two seasons. Anyhow, chelate zinc sprays at 0.2% was statistically the superior either data of season or an average of two seasons were concerned. Moreover, chelated zinc solution was more effective than sulphate from regardless of concentration except in 2nd season with 0.1% chelate zn spray. On the other hand, the specific effect of urea (0.5%) slightly increased fruit firmness.

As for the interaction effect, Table (5) clears that the unsprayed Canino apricot trees with neither urea nor zinc induced significantly the softest fruits. While the reverse was found with the chelate zinc sprayed trees at 0.2% particularly those of urea treated trees. In addition, other combinations were in between with a noticeable tendency of variance during two seasons.

3-3 Fruit chemical properties:-

Fruit juice total soluble solids (TSS),acidity, total sugars and carotenoids compounds percentage were the investigated fruit chemical properties in response to the specific and interaction effects of two investigated factors (zinc &urea sprays) and their combinations. Data obtained during both 2010&2011 experimental seasons are presented in Tables (6) and (7).

A-Fruit juice TSS and acidity percentage:-

With regard to the specific effect of zinc spray treatments, Table (6) displays obviously that two conflicted trends were detected as the response of two fruit juice chemical properties was concerned. Herein, fruit juice TSS% was significantly increased by all investigated zinc spray treatments, while the reverse was true with fruit juice total acidity.

Moreover, the efficiency of zinc source for increasing TSS or decreasing acidity than control was more pronounced with chelate zinc than sulphate for former juice component while the opposite was found with later one.

Referring the specific effect of urea spray, it is quite evident that both fruit juice TSS and total acidity increased in fruits of urea sprayed trees. However, the increase in TSS was more pronounced and reached level of significance .however, the increase in total acidity was slight and didn't reach level of significance. As for the interaction effect of two investigated factors, it could be noticed that the highest significant juice TSS% was coupled by the urea (0.5%) plus chelate Zn (regardless of its concentration) sprayed trees.

However the least TSS% was exhibited by the control neither urea nor Zn applied). On the other trend of response took other way around with fruit juice total acidity , whereas control trees (without urea and zinc)induced the richest fruits in their total acidity content, while those of Zn sulphate sprayed trees particularly when urea was absent were the poorest fruits in their acidity content.
According to, Mahrous and. El-Fakhrani (2000) mentioned that zinc sulphate increased significantly T.S.S. of apricot; meanwhile it decreased fruit acidity when compared with other treatments and the control.

Table 6. Effect of zinc and urea spraying on fruit T.S.S. and acidity of "Canino" apricot trees during 2010 and 2011 seasons.

Treatments	T.S.S. (%)			Acidity (%)		
Urea	0.0	0.5%	Mean	0.0	0.5%	Mean
Zinc				Season 2010		
No zinc	11.33	12.87	12.10	0.68	0.58	0.63
ZnSO4 0.1g/L	12.98	12.90	12.94	0.56	0.59	0.58
ZnSO4 0.2g/L	13.10	13.03	13.06	0.58	0.60	0.59
Zn-EDTA0.1g/L	13.20	13.23	13.22	0.58	0.61	0.60
Zn-EDTA0.2g/L	13.20	13.37	13.28	0.59	0.62	0.61
Mean**	12.76	13.08		0.58	0.60	
			Season 2011			
No zinc	11.50	12.46	11.98	0.60	0.52	0.56
ZnSO4 0.1g/L	12.71	12.60	12.66	0.50	0.51	0.51
ZnSO4 0.2g/L	12.75	12.70	12.72	0.49	0.51	0.50
Zn-EDTA0.1g/L	12.77	12.77	12.77	0.53	0.54	o.53
Zn-EDTA0.2g/L	12.91	12.91	12.91	0.54	0.54	0.54
Mean**	12.53	12.72		0.53	0.52	
L.S.D at 0.5% for		Season	Season		Season	Season
Zinc		2010	2011		2010	2011
Urea		0.16	0.12		0.03	0.01
Zinc X Urea		0.16	0.12		0.03	0.01
		0.22	0.17		0.05	0.01

*&**refer to specific effect of Zn and urea application treatments, respectively.

B-Fruit juice total sugars and carotene contents:-

Data obtained regarding the response of two fruit juice chemical properties of Canino apricot trees to specific and interaction effect of zinc(sulphate &chelate forms each at 0.1&0.2% conc.) and urea (0.5%) sprays, as well as their combinations (interaction) was concerned in Table(7). It is quite clear to be noticed that all investigated treatments increased significantly the average total sugar as compared to the control (no zinc &urea) during both seasons.

However, zinc foliar sprayed at(0.1 &0.2%conc.)in sulphate forms was relatively effective regardless of zinc source, during the both experimental seasons. On the other hand the specific effect of urea spray (0.5%) was so pronounced and resulted significantly increase in total sugar than control (unsprayed trees with urea) during seasons 2010&2011.

While, the interaction effect of two investigated factor (zinc x urea spray) was shown that the specific effect of each factor didn't reflect on their different combinations. Herein, the mineral form (0.1&0.2%) combined with urea (0.5%) gave the best results in both seasons under study.

Moreover, the efficiency of zinc source for increasing carotene% than control was more pronounced with chelate zinc than sulphate for former juice component while the greatest was found with chelate form. Also, the specific effect of urea spray (0.5%) was so pronounced and resulted in significant increase in carotene (%) than control (unsprayed trees with urea) during seasons 2010&2011.

Besides, Table (7) reveals also that the specific effect of two investigated factor (zinc &urea sprays) was not directly reflected on their combinations (interaction) Herein, the chelate form (0.1&0.2%) combined with urea (0.5%) gave the best results in both seasons under study. However the least total sugars and carotene % were exhibited by the control (neither urea nor zn applied).

Table 7. Effect of zinc and urea spraying on fruit total sugar content (%) and carotene (%) of "Canino" apricot trees during 2010 and 2011 seasons.

Treatments	Total sugars (%)			Carotene (%)		
Urea	0.0	0.5%	Mean*	0.0	0.5%	Mean*
Zinc	Season 2010					
No zinc	7.19	7.54	7.37	2.45	2.86	2.66
ZnSO4 0.1g/L	7.55	7.50	7.53	2.85	2.85	2.85
ZnSO4 0.2g/L	7.60	7.49	7.55	2.91	2.91	2.88
Zn-EDTA0.1g/L	7.52	7.50	7.51	2.98	2.95	2.97
Zn-EDTA0.2g/L	7.45	7.45	7.45	3.19	3.00	3.09
Mean**	7.46	7.50		2.88	2.90	
	Season 2011					
No zinc	7.07	7.48	7.28	2.59	2.68	2.64
ZnSO4 0.1g/L	7.51	7.49	7.50	2.87	2.86	2.86
ZnSO4 0.2g/L	7.52	7.47	7.50	2.91	2.89	2.90
Zn-EDTA0.1g/L	7.46	7.46	7.46	3.01	2.91	2.96
Zn-EDTA0.2g/L	7.45	7.43	7.44	3.10	3.04	3.07
Mean**	7.40	7.47		2.90	2.88	
L.S.D at 0.5% for		Season 2010	Season 2011		Season 2010	Season 2011
Zinc		0.07	0.15		0.01	0.10
Urea		0.07	0.15		0.01	0.10
Zinc X Urea		0.10	0.21		0.01	0.14

*&**refer to specific effect of Zn and urea application treatments, respectively.

4-Leaf mineral content:-

a- Leaf macro elements content :-

(N %),(P %) and (k %) were the investigated leaves mineral composition in response to the specific and interaction effects of two investigated factors (zinc &urea sprays) and their combinations. Data obtained during both 2010&2011 experimental seasons are presented in Tables (8).

Data indicated that zinc sprayed (sulphate &chelate)at 0.1and 0.2%increased the content of macro elements(N,P and k)in both seasons (2010&2011) under study compared with the unsprayed trees.

Spraying urea at o.5% alone increased significantly N content in the leaves but was not effective on P and K contents as compared with the unsprayed trees (control).

Referring the interaction effect, it could be generally noticed that specific effect of each factor (zinc& urea) was reflected on their combinations. , however both combinations between 0.5%urea spray and zinc spray of either sulphate or chelate zinc tended significantly to be more effective to increase (N,P and K) as compared to the other combination members of such intermediate category during both experimental seasons.

The present results are in agreement of those instead of Almaliotis et al.(2006) working on apricot and by Ouzounis and Lang (2011) working on cherry (*Prunus avium L*.). Ouzounis and Lang (2011) found that fall foliar applications of urea on sweet cherry (*Prunus avium* L.).

b-Leaf micro elements content:-

Leaf micro elements content (Fe),(Zn) and (Mn) were the investigated leaves mineral composition in response to the specific and interaction effects of two investigated factors (zinc &urea sprays) and their combinations. Data obtained during both 2010&2011 experimental seasons are presented in Tables (9).

Referring, the specific effect of zinc foliar spray treatments, it is quite clear that all investigated zinc spray (sulphate &chelate) at 0.1and 0.2%increased significantly the content of micro elements (Fe,Zn and Mn) over control (no zinc sprayed trees)in both seasons (2010&2011) under study. While, chelated form (0.1&0.2%) was more effective than the mineral form particularly during the two experimental seasons.

Also, using urea alone at 0.5% treatment recorded significant increment in Fe, Zn and Mn leaf content compared with unsprayed trees (control).

With regard to the interaction effect of two investigated factors (zinc x urea spray) Table (9) displays that the specific effect of each factor was directly reflected on their different combinations. Herein, the highest significant values of Fe, Zn and Mn resulted from spraying zinc chelated at 0.2% + urea at 0.5% as compared with the lowest values of the unsprayed trees.

According to, Orphanos (2000) apple zinc foliar application during the growing season increased the Zn content of the sprayed leaves even if they were just beginning to grow at the time of spraying. He added that spraying Zn-EDTA when the apical bud was bursting did not increase Zn in leaves produced from the lateral buds.

Finally, Zn-EDTE 2g/L with urea 0.5%foliar application is more practical and has positive effect on yield and fruit quality.

Table 8. Effect of zinc and urea spraying on N, P and K percentages in leaves of "Canino" apricot trees during 2010 and 2011 seasons.

Treatments	N (%)			P (%)			K (%)		
Urea	0.0	0.5%	Mean*	0.0	0.5%	Mean*	0.0	0.5%	Mean*
Zinc					Season 2010				
No zinc	1.73	1.85	1.79	0.32	0.33	0.32	1.71	1.74	1.73
ZnSO4 0.1g/L	1.82	1.88	1.85	0.34	0.35	0.34	1.74	1.76	1.75
ZnSO4 0.2g/L	1.82	1.88	1.85	0.34	0.36	0.35	1.75	1.80	1.73
ZnEDTA0.1g/L	1.81	1.86	1.83	0.36	0.37	0.37	1.75	1.82	1.79
ZnEDTA0.2g/L	1.79	1.87	1.83	0.37	0.38	0.37	1.76	1.84	1.80
Mean**	1.79	1.87		0.35	0.36		1.74	1.79	
					Season 2011				
No zinc		1.86	1.82	0.31	0.31	0.31	1.72	1.74	1.73
ZnSO4 0.1g/L		1.85	1.85	0.32	0.35	0.34	1.76	1.81	1.79
ZnSO4 0.2g/L		1.86	1.84	0.33	0.34	0.34	1.76	1.81	1.79
ZnEDTA0.1g/L		1.87	1.85	0.34	0.35	0.35	1.78	1.83	1.81
ZnEDTA0.2g/L		1.87	1.85	0.35	0.36	0.36	1.79	1.84	1.82
Mean**		1.86		0.33	0.34		1.79	1.81	
L.S.D at 0.5% for	Zinc	Season	Season		Season	Season		Season	Season
Urea		2010	2011		2010	2011		2010	2011
Zinc X Urea		0.02	0.01		0.01	0.01		0.01	0.01
		0.02	0.01		0.01	0.01		0.01	0.01
		0.03	0.02		0.01	0.01		0.01	0.01

*&**refer to specific effect of Zn and urea application treatments, respectively.

Table 9. Effect of zinc and urea spraying on Fe, Zn and Mn contents in leaves of "Canino" apricot trees during 2010 and 2011 seasons.

Treatments	Fe (ppm)			Zn (ppm)			Mn (ppm)		
Urea	0.0	0.5%	Mean*	0.0	0.5%	Mean*	0.0	0.5%	Mean*
Zinc					Season 2010				
No zinc	73.00	74.67	73.83	30.33	33.00	31.67	56.00	58.00	57.00
ZnSO4 0.1g/L	76.33	82.67	79.50	36.00	37.67	36.83	59.00	66.00	62.50
ZnSO4 0.2g/L	79.00	84.67	81.83	37.67	38.00	37.83	62.33	68.00	65.17
ZnEDTA0.1g/L	80.00	87.00	83.50	38.33	41.33	39.83	64.33	64.00	65.67
ZnEDTA0.2g/L	81.67	88.00	84.83	40.00	43.67	41.83	65.00	68.33	66.67
Mean**	78	83.40		36.47	38.73		61.33	64.87	
				Season 2011					
No zinc	74.67	81.00	77.83	31.67	32.00	31.83	57.33	58.00	57.67
ZnSO4 0.1g/L	82.33	85.00	83.67	35.00	41.00	38.00	60.00	61.33	60.67
ZnSO4 0.2g/L	84.33	85.00	84.67	36.67	43.33	40.00	61.33	62.00	61.67
ZnEDTA0.1g/L	82.33	87.33	84.83	38.33	45.00	41.67	61.00	63.00	62.00
ZnEDTA0.2g/L	86.33	87.33	86.83	38.67	46.00	42.33	63.00	66.67	64.83
Mean**	82.00	85.13		36.07	41.47		60.53	62.20	
L.S.D at 0.5% for		Season	Season		Season	Season		Season	Season
Zinc		2010	2011		2010	2011		2010	2011
Urea		0.90	0.67		0.87	0.87		0.77	0.93
Zinc X Urea		0.90	1.67		0.87	0.87		0.77	0.93
		1.28	2.37		1.23	1.34		1.09	1.32

*&**refer to specific effect of Zn and urea application treatments, respectively

Referring to the present results, it could be concluded that “Canino” apricot trees grown on sand soils must be supplied with zinc in EDTA or sulphate as a foliar application especially at full bloom, fruit set and two months after fruit set to enhance tree yield and fruit quality.

Our results also proved that, foliar application of zinc in EDTA 2g/Lwith urea 0.5% concentration is efficient to give a great effect on yield and fruit quality at picking time enhancing fruit marketability of "Canino" apricot fruits.

Acknowledgment:-

We are deeply grateful to prof. Dr.Mohamed Sharaf. Horticulture Department, in Faculty of Agr.Moshtohor, Banha University for his supervision and kind help.

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تأثير الرش الورقى بالزنك واليوريا على النمو وعقد الثمار والمحصول وصفات الثمار لأشجار المشمش صنف "كانينو"المنزرعة فى أراضى رملية

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الملخص العربى
تم إجراء هذا البحث خلال موسمين متتالين 2010 و 2011 على أشجار مشمش صنف "كانينو" عمر 10 سنوات منزرعة تحت ظروف تربة رملية مسـتصلحة. وقد تم رش الأشجار بسلفات الزنك أو الزنك المخلبي بتركيز 0.1 و 0.2% منفردين أو مخلوطين باليوريا بتركيز 0.5% عند تمام التزهير والعقد وبعد شهرين من تاريخ العقد. وقد سجلت معاملة الزنك المخلبي عند تركيز 0.2% + يوريا بتركيز 0.5% أعلى زيادة فى طول ا لفرع وأكبر حجم للورقة وأعلى نسبةعقد للثمار وأكبر محصول للشجرة وأحسن صفات جودة للثمار عند مقارنتها بالأشجار غير المرشوشة (المقارنة) التي سـجلت أقل القيم. وقد سجلت نفس المعاملة أعلى صلابة للثمار وأعلى كاروتين وسكريات كلية للثمار وأعلى محتوى من العناصر فى الأوراق عند مقارنتها بالأشجار غير المرشوشة.