Effect of Foliar Applications of Gibberellic Acid and Micronutrients on Leaf Mineral Content, Fruit Set, Yield and Fruit Quality of Sultani Fig Trees

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ABSTRACT

This investigation was carried out during 2001 and 2002 growing seasons on Sultani fig trees, grown in a calcareous sandy loam soil in Burg El.Arab region (about 60 Kilometers west of Alexandria), aiming to study the effect of foliar sprays with Gibberellin and a mixture of chelated (Fe, Zn and Mn) alone or in combination on fruit set, leaf mineral content, yield and fruit quality. Results revealed that, Gibberellin alone or with a mixture of chelated (Fe, Zn and Mn) treatments increased significantly fruit set. Yield as weight or number of fruits/tree, as well as fruit quality (average fruit weight, fruit diameter, fruit length, TSS, acidity, V.C. and total sugars) were, generally, improved under all treatments as compared with the control. Gibberellin alone or with a mixture of chelated (Fe, Zn and Mn) when applied to foliage caused a pronounced increase in leaf N, Fe, Zn and Mn content, while leaf content of P and K decreased in both experimental seasons. Application mixture of (Fe + Zn + Mn) at 0.05% + GA_3 at 10 ppm was more effective compared to other treatments in both seasons.

INTRODUCTION

The figs, *Ficus carica*, L. is considered one of the important commercial fruit trees which grow successfully in Egypt and their fruits are from the most popular for local consumption. The total area of fig orchards increased to 75621 feddans and the total annual production was about 194631 tons of fresh fruit in Egypt in 2002 (according to the statistics of Ministry of Agriculture and Land Reclamation in 2002). More than 80 % of the new established fig orchards was along the north western cost of Egypt and it considered the main area of fig production (New cultivated area) where the "Sultani" variety is the most widely grown and it is main crop ripens from early July to November (Rokba *et al.*,1985). At these new cultivated regions, Sultani cultivar suffers from several factors, which affect its production. The first consideration is calcareous soil conditions and high PH value that causes a precipitation of Fe, Zn and Mn in an unavailable form for plants. Thus, foliar application seems to be valuable in correcting the widespread occurrence of certain micronutrient deficiency symptoms (Marschner, 1995 and Taiz and Zeiger, 1998). The second point, to note is that maturation of fig fruits begins in some areas later than the others. This

problem decreases the profitability of fig during early season. Experiments showed an increase in fruit set and yield when gibberellic acid was applied to flower clusters (Crane and Grossi, 1960). Therefore the growers try to spray some growth regulators such as Gibberellin (GA_3 i.e. Berelex) which is the most isomer widely used, as others are more expensive and less stable.

Many investigators have been carried out in Egypt concerning the effect of microelements spray on deciduous fruits Warner and Proebsting (1958) and keleg et al. (1981) on fig, El-Gazzar et al. (1979) and El-Shobaky *et al.* (2001)on grapes, Keleg *et al.* (1979) on almond, Awad and Atawia (1995a&b) and Kabeel *et al.* (1998) on pears, El-Shazly (1999) and El-Seginy et al. (2003) on apples.

As for the effect of growth regulator spray, many investigation on some fruit crops were accepted from Crane and Grossi (1960), Crane *et al.* (1970) and Rabie (1991) on figs, Makarem and Mokhtar (1996), El-Seginy et al. (2003) on apples, Mokhtar and Khalil (1998) on plums and El-Seginy and Khalil (2000) on pears.

Therefore, the present study was carried out to evaluate the effect of foliar spray of chelated Fe, Zn and Mn and/or Gibberellin (GA_3 i.e. Berelex) on fruit set, yield, fruit quality and leaf mineral content of Sultani fig trees grown in a calcareous soil.

MATERIALS AND METHODS

The present study was carried out during 2001 and 2002 growing seasons, on 16 years old Sultani fig trees, grown in a calcareous sandy loam soil in Burg El Arab region, about 60 kilometers west of Alex. and spaced at 5×5 meters apart. Soil characters are listed in Table(1).

All trees in this orchard were annually fertilized with 20 m^3 / feddan of organic manure in December, 1.5 kg/tree ammonium sulfate (20.5% N) in two equal doses in March and April, 1 kg/tree calcium super phosphate (15.5 % P_2O_5) in March and 0.5 kg/tree potassium sulphate (48 % K_2O) in three doses in March, April and June. All trees received the same normal cultural practices commonly adopted in this orchard.

The selected trees were nearly similar in vigor and free from any pathogens. The trees sprayed with different treatments in the two seasons, as follows:

T_1: Foliar spray with water only (control).

T_2: Foliar spray with a mixture of chelated (Fe*+ Zn**+ Mn***) at 0.025 %.

T_3: Foliar spray with a mixture of chelated (Fe + Zn + Mn) at 0.05 %.

T_4: Foliar spray with GA_3 at 10 ppm.

T_5: Foliar spray with mixture of chelated (Fe + Zn +Mn) at 0.025 % + GA_3 at 10 ppm.

T_6: Foliar spray with a mixture of chelated (Fe + Zn + Mn) at 0.05 % + GA_3 at 10 ppm.

*Fe- EDDHA (6% Fe), **Zn- EDTA (14 % Zn) and ***Mn- EDTA (12 % Mn).

Trees were sprayed with the above treatments, three times, at full bloom, after fruit set (fruit diameter 2 cm) and after one month of fruit set. Foliar sprays were applied using a hand pressure sprayer. Triton B emulsifier at rate of 0.2 % was used as a surfactant. Each tree received 5 liters spraying solution.

Twenty four trees, as uniform as possible, were selected for the present study. The treatments were applied and arranged in a randomized complete block design. Each treatment included four replicates with one tree for each replicate. The following parameters were determined in the two successive seasons:

1- **Fruit set:** Two main branches from the two directions (east and west) on each tree were chosen and tagged in the first of April of the two experimental seasons. The number of the flowers was recorded and then set fruits on the selected branches were counted to calculate the percentage of fruit set.
2- **Leaf mineral content**: At the beginning of August of both seasons, samples of 5 leaves per tree were taken at random from the previously tagged branches of each tree. Leaf samples were washed with tap water, rinsed with distilled water and oven dried at 70°c to constant weight and then ground. The ground samples were digested with sulfuric acid and hydrogen peroxide according to Evenhuis and DeWaard (1980). N and P leaf contents were colorimetrically determined according to Evenhuis (1976), and Murphy and Riley (1962), respectively. K content was determined against a standard by Flame Photometer. Fe, Zn and Mn leaf contents were measured by Atomic Absorption Spectrophotometer.
3- **Yield and fruit quality:** The total yield of each tree was calculated using the average fruit weight in Kg and the total number of fruits per

tree. The number of fruits per each experimental tree was counted on 8 July in both seasons.

At harvesting time, on mid July, of both seasons, eight fruits were taken at random from each tree to determine fruit quality (average fruit weight (gm), diameter and length). In fruit juice of each fruit sample, total soluble solids (TSS) percentage was determined by a hand refractometer, the percentage of acidity was measured according to A.O.A.C (1980). Vitamin C was determined by titration with 2,6- dichlorophenol indophenol blue dye and expressed as mg vitamin C/100ml juice. Total sugars in the fruit pulp tissues, were determined by phenol sulfuric method according to (Dubois et al., 1956).

Data were statistically analyzed according to Snedecor and Cochran (1990), and L.S.D. test at 0.05 levels was used for comparison between treatments.

RESULTS AND DISCUSSION

Fruit set and yield:

Data concerning the effect of treatments on fruit set and yield during the two experimental seasons are showed in Table (2).

The tabulated data indicated that, in the first season, fruit set percentage was increased significantly only in all treatments containing GA_3. In the second season, however, this percentage was significantly increased as response to both chelated mixtures whether alone or in combination with GA_3 when compared with the control.

These results may be due to the effect of plant hormones, i.e. GA_3 which could lead to an increase in fruit set for deciduous trees (Crane and Rene, 1949) on figs and (Makarem and Mokhtar, 1996) on apples. In addition, micronutrients deficiency causes a great disturbance in the physiological and metabolic processes in the plant (EL-Gazzar *et al.*, 1977). Therefore, spraying Sultani fig trees by GA_3 and micronutrient elements gave relatively the best results. In general these results are in line with those reported by Keleg *et al.* (1981) on figs, EL-Gazzar *et al.* (1979) on grapes, Awad and Atawia (1995b), Makarem and Mokhtar (1996), Kabeel *et al.*, (1998), El-Seginy and Khalil (2000), El-Seginy *et al.* (2003) who worked on pears and apples.

Results as shown in Table (2) revealed that, GA_3 treatments, whether alone or in combination with chelated mixtures, increased yield,

expressed as number or weight of fruits per tree and the differences were significant when compared with the control, on the other hand, spraying chelated mixtures alone, gave no clear effect. GA_3 plays a major role in enlarging fruit size (Wiltank and Krezdorn, 1969). Moreover, chelated Fe, Zn and Mn has an important function in enzymatic systems and chlorophyll formation which is responsible for photosynthesis (Mengel and Kirkby, 1987). Also, the improvement of yield as results of Zn sprays may be explained by the fact that Zn plays a role in tryptophan synthesis which is the precursor of endogenous natural hormone (IAA) which is necessary for all plants metabolic processes (Price, 1970). Also, (Jyung *et al.*, 1975) stated that Zn has a possible role in plant metabolism involved in starch formation.

In general these results are in harmony with those obtained by Keleg *et al.* (1981) on fig, Sourour (1992) and El-Seginy *et al.*, (2003) on apples, Bacha *et al.*, (1995) on grapes and Awad and Atawia (1995a) on pears. They stated that foliar spray of Fe, Zn and Mn increased the total yield of studied fruit trees. Also, Rabie (1991), Makarem and Mokhtar (1996) and El-Seginy and Khalil (2000) and El-Seginy *et al.* (2003) reported that foliar spray of GA_3 increased the fruit set, fruit weight and therefore increased the yield.

Leaf and mineral content:

It is clear from the data in table (3) that leaf N content was increased while leaf K was decreased as a result of spraying with GA_3 whether alone on in combination with different chelated mixtures when compared with the control. Phosphorus concentration, however, decreased significantly due to all treatments applied. As for microelements concentration, the data revealed that the concentration of Zn, Fe and Mn was increased in all spraying treatments. These results may be due to that GA_3 may intensifies an organ ability to function as a nutrient sink (Addicott and Addicott, 1982). In addition the effect on plant nutrient status resulted from spraying different solutions might be attributed to quick absorption via leaves and the limited loss of the nutrients when they were sprayed (Marschner, 1995). As for the reduction in leaf P content might be attributed to the antagonism between Fe and P (Nawar 1991). These results agreed to some extent with Keleg *et al.* (1981), Rabie (1991), Sourour (1992), Awad and Atawia (1995a), Kabeel *et al.*, (1998), El-Shazly (1999), El Seginy and Khalil (2000), El-Shobaky *et al.*, (2001) and El-Seginy *et al.* (2003) who worked on deciduous fruit trees.

Fruit quality:

The results in Table (4) showed that, fruit weight, diameter, length, vitamin C, TSS and total sugars were increased by GA_3 alone or combined with two concentrations of microelements compared to the control in both seasons. Acidity, however, showed an opposite trend. These results agreed with those obtained by Crane and Grossi (1960), Hirai *et al.* (1966), El- Kassas (1976), Phad *et al.* (1980), Amin (1987) and Rabie (1991) on fig fruits. They found, in general, that all the properties of fruit quality were improved when sprayed with GA_3 as compared with the control. The results also indicated that chelated mixture at 0.05 % had a positive effect on fruit acidity in both seasons and on fruit TSS in the second season only. These results were in line with Warner and Proebsting (1958) and Keleg *et al.* (1981). In general, the highest significant value of fruit quality was from trees treated with (Fe, Zn, Mn) at 0.05 % + GA_3 10 ppm in both seasons. However, spraying experimental trees with a separate mixture of (Fe, Zn, Mn) at 0.025 % is lower value. These findings agreed with those found by El-seginy and Khalil (2000) on pears and El-Seginy *et al.*, (2003) on apples.

CONCLUSION

The obtained results in the present research strongly suggest that foliar application of Sultani fig trees with GA_3 and/or chelated (Fe, Zn and Mn) is recommended to increase fruit set , yield quantity and fruit quality of trees grown in calcareous soil. Therefore; it may be recommended inserted these nutrients and plant hormone in the fertilization program of Sultani fig.

Table(1): Soil analysis of the experimental orchard.

Soil depth (cm)	Texture	PH	EC Ds/m	Total $CaCo_3$	O.M. %	Soluble cations and anions meq/100g soil							DTPA-extractable mg/kg		
						Na^+	K^+	Ca^+	Mg^{++}	Cl^-	Co_3^-	HCo_3^-	Fe	Zn	Mn
0-30	Sandy Loam	8.04	3.02	50.2	0.52	2.87	0.157	12.7	0.35	1.10	0.41	12.7	0.38	0.29	0.46
30-60		7.92	2.56	57.3	0.54	3.35	0.063	13.3	0.90	1.55	0.34	52.8	0.37	0.28	0.44
60-90		8.02	2.45	59.2	0.55	2.87	0.094	13.3	0.50	0.90	0.82	13.2	0.33	0.28	0.41

Table(2): Effect of foliar applications of micronutrients and/ or GA_3 on fruit set and yield of Sultani fig trees during 2001 and 2002 seasons.

Treatments	Fruit set %		Yield /tree			
			No. of fruit/tree		Kg/tree	
	2001	2002	2001	2002	2001	2002
T_1: Control	11.72	13.00	226	229	15.11	16.44
T_2: (Fe + Zn + Mn) at 0.025 %	12.28	15.55	228	230	15.33	16.56
T_3: (Fe + Zn + Mn) at 0.05 %	12.55	15.85	229	231	15.45	16.67
T_4: GA_3 at 10ppm	16.74	17.11	245	246	17.22	18.55
T_5: (Fe + Zn + Mn) at 0.025 % + GA_3 at 10ppm	17.00	18.00	252	254	18.00	19.22
T_6: (Fe + Zn + Mn) at 0.05 % + GA_3 at 10ppm	18.82	19.00	261	263	19.00	20.32
L.S.D. at 0.05	2.31	2.32	14	13	1.64	0.74

Table(3): Effect of foliar applications of micronutrients and/ or GA_3 on leaf mineral contents of Sultani fig trees during 2001 and 2002 seasons.

Treatments	N(%)		P(%)		K(%)		Fe (ppm)		Zn(ppm)		Mn(ppm)	
	2001	2002	2001	2002	2001	2002	2001	2002	2001	2002	2001	2002
T_1 : Control	1.48	1.51	0.18	0.19	1.09	1.15	85	90	22	23	19	20
T_2 : (Fe + Zn + Mn) at 0.025 %	1.56	1.66	0.15	0.16	1.08	1.14	100	102	28	28	23	24
T_3 : (Fe + Zn + Mn) at 0.05 %	1.61	1.75	0.17	0.17	1.07	1.12	104	105	32	33	25	27
T_4 : GA_3 at 10ppm	1.82	2.06	0.14	0.15	0.95	1.00	102	104	29	30	24	26
T_5 : (Fe + Zn + Mn) at 0.025 % + GA_3 at 10ppm	2.11	2.32	0.15	0.16	0.98	1.01	107	109	30	32	27	28
T_6 : (Fe + Zn + Mn) at 0.05 % + GA_3 at 10ppm	2.20	2.41	0.16	0.16	1.00	1.03	108	110	31	33	28	31
L.S.D. at 0.05	0.14	0.15	0.01	0.02	0.05	0.08	5.00	5.00	4.00	4	3	2

Table(4): Effect of foliar applications of micronutrients and/ or GA_3 on the fruit quality of Sultani fig trees during 2001 and 2002 seasons.

Treatments	Fruit weight (g)		Fruit Diameter (cm)		Fruit Length (cm)		Vitamin c (mg/100ml)		Acidity (%)		TSS (%)		Total Sugar (%)	
	2001	2002	2001	2002	2001	2002	2001	2002	2001	2002	2001	2002	2001	2002
T_1 : Control	42.51	44.20	3.35	3.51	3.15	3.55	1.10	1.40	0.28	0.27	10.11	11.55	40.97	41.51
T_2 : (Fe + Zn + Mn) at 0.025 %	43.31	45.05	3.95	4.00	3.20	3.63	1.30	1.50	0.27	0.27	11.15	12.69	41.88	42.39
T_3 : (Fe + Zn + Mn) at 0.05 %	44.02	45.58	4.22	4.13	3.54	4.00	1.40	1.50	0.26	0.25	11.40	13.02	41.92	42.41
T_4 : GA_3 at 10ppm	45.66	47.35	4.46	4.82	4.77	4.85	2.00	2.10	0.25	0.22	12.95	13.85	43.88	44.72
T_5 : (Fe + Zn + Mn) at 0.025 % + GA_3 at 10ppm	47.15	47.88	5.98	5.95	5.00	5.17	2.30	2.40	0.24	0.20	13.22	14.00	45.54	47.55
T_6 : (Fe + Zn + Mn) at 0.05 % + GA_3 at 10ppm	48.00	48.96	6.66	6.70	5.50	5.67	2.50	2.60	0.22	0.19	13.77	14.60	46.50	48.00
L.S.D. at 0.05	2.24	1.40	0.98	0.64	0.94	0.91	0.33	0.29	0.02	0.02	1.37	1.46	2.18	1.07

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الملخص العربى

تأثير الرش بالجبريلين و بعض المغذيات الصغرى على المحتوى المعدنى للأوراق و نسبة العقد و المحصول و صفات جودة الثمار لأشجار التين السلطانى

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*محطة بحوث البساتين بالصبحية- الأسكندرية ** الحديقة النباتية بالمعمورة-الأسكندرية

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أجرى هذا البحث عامى ٢٠٠١-٢٠٠٢ على أشجار التين صنف سلطانى عمرها ١٦ سنة المنزرعة فى أرض جيرية بمنطقة برج العرب (حوالى ٦٠ كم غرب الأسكندرية) لدراسة تأثير الرش بالجبريلين و المخلوط المخلبى من الحديد و الزنك و المنجنيز كلا بمفرده أو مخلوطين معا على المحتوى المعدنى للأوراق و نسبة العقد و المحصول و صفات جودة الثمار. أظهرت النتائج أن الرش بالجبريلين منفردا أو مع مخلوط الحديد و الزنك و المنجنيز أدى إلى زيادة نسبة العقد و زيادة المحصول و تحسين جودة الثمار من حيث متوسط وزن الثمرة و المواد الصلبة الذائبة و أنخفاض نسبة الحموضة و أرتفاع نسبة السكريات الكلية. كذلك كان محتوى الأوراق من النيتروجين و الحديد و الزنك و المنجنيز مرتفعا بينما أنخفض الفوسفور و البوتاسيوم خلال عامى الدراسة. أيضا حققت المعاملة (الجبريلين بتركيز ١٠ جزء فى المليون + المخلوط المخلبى بتركيز ٠,٠٥ %) أفضل النتائج خلال عامى الدراسة.