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Effect of Soil Fertilization on Vegetative Growth, Yield and Leaf Nutrient Composition of Sultani Fig Trees

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ABSTRACT. Field experiment was conducted during 1985 and 1986 using sultani fig trees grown in Sidi Krare orchard (about 30 km west of Alexandria, Egypt). Eight fertilization treatments were as follows:

1. Control (without fertilization).
2. 1 kg super phosphate (15% P_2O_5) + 1 kg potassium sulphate (48-50% K_2O)/tree.
3. 1 kg super phosphate + 1 kg potassium sulphate + 0.5 kg N/tree (from commercial urea 46.5% N).
4. 1 kg super phosphate + 1 kg potassium sulphate + 0.5 kg N/tree (from urea forte 46.5% N + micro nutrients).
5. 1 kg super phosphate + 1 kg potassium sulphate + 0.5 kg N/tree (from ammonium sulphate 21% N).
6. 1 kg super phosphate + 1 kg potassium sulphate + 1.5 kg N/tree (from commercial urea).
7. 1 kg super phosphate + 1 kg potassium sulphate + 1.5 kg N/tree (from urea forte).
8. 1 kg super phosphate + 1 kg potassium sulphate + 1.5 kg N/tree (from ammonium sulphate).

Applying 1.5 kg N from commercial urea to fig trees significantly increased the yield per tree than those of 1st, 4th, 5th and 8th treatments in 1985 and 1986.

The higher level of nitrogen (1.5 kg) from different sources of fertilizers and lower level (0.5 kg) from ammonium sulphate significantly decreased TSS as compared with other treatments in 1985, whereas in 1986 the higher values were obtained from adding 0.5 kg and 1.5 kg N from urea forte (4th and 7th treatments). In general, nitrogen fertilization from different sources increased acidity as compared with those of 1st and 2nd treatments.

In 1986, the concentrations of magnesium and manganese were increased under the effect of nitrogen treatments, and the higher level of nitrogen from urea forte and ammonium sulphate increased sodium as compared with control treatment.

In general, nitrogen applications increased leaf zinc in both seasons and nitrogen, iron and copper in 1985, while copper was decreased in 1986 as compared with the control. In 1985, the higher level of nitrogen from urea forte and ammonium sulphate increased phosphorus and potassium, respectively, while both treatments increased calcium as compared with the control. In 1986, applying nitrogen fertilizers decreased leaf calcium when compared with that of untreated trees.

The average yield per tree was correlated negatively with leaf chloride in 1986, while vegetative growth was correlated negatively with zinc in both seasons of study and with copper in 1985 only. The percentages of total soluble solids (TSS) were correlated positively with the concentrations of magnesium, iron, manganese and zinc in the leaves, while it had a negative correlation with copper in 1986. The correlation coefficient between TSS and acidity was negative in 1985 and positive in 1986. Also, correlations, in general, were found among nutrient elements in the leaves in both seasons of study.

Accordingly to 1987 statistics (C.A.P.M.S., 1988, Egypt), the total area grown with fig trees in Egypt was about 21000 feddans (8750 Hectare). More than 90% of the total area is located along the North-West Coast of Egypt. The low productivity of fig trees in this region might be due to many factors such as, in adequate fertilization, irrigation, pruning and pest control (El-Adawy 1987 and Taha *et al.* 1989a,b). The average amount of rainfall was about 202 mms per year.

Therefore, the present investigation was carried out to study the effect of soil fertilization with P and K, and different N sources and amount on vegetative growth, yield, leaf nutrient elements and fruit quality of Sultani fig trees.

Materials and Methods

The field experiment was performed during 1985 and 1986 using Sultani fig trees (*Ficus carica*, Risso) grown in Sidi Krare orchard (about 30 kg west of Alexandria, Egypt). The trees were 25 years old and were planted in sandy soil at 7 m apart. The experimental trees were irrigated with well water.

Thirty two uniform trees were selected for these trials and eight fertilization treatents were carried out and each one was replicated four times (4 trees) with one tree for each replicate. The treatments were as follows:

1. Control (without fertilization).
2. 1 kg super phosphate (15% P_2O_5) + 1 kg potassium sulphate (48-50% K_2O)/tree.
3. 1 kg super phosphate + 1 kg potassium sulphate + 0.5 kg N/tree (from commercial urea 46.5% N).
4. 1 kg super phosphate + 1 kg potassium sulphate + 0.5 kg N/tree (from urea forte 46.5% N + micro nutrients).
5. 1 kg super phosphate + 1 kg potassium sulphate + 0.5 kg N/tree (from ammonium sulphate 21% N).
6. 1 kg super phosphate + 1 kg potassium sulphate + 1.5 kg N/tree (from commercial urea).
7. 1 kg super phosphate + 1 kg potassium sulphate + 1.5 kg N/tree (from urea forte).
8. 1 kg super phosphate + 1 kg potassium sulphate + 1.5 kg N/tree (from ammonium sulphate).

The P and K fertilization were added once during the first week of April, while the N fertilization was divided into two equal doses, the first was applied with the P and K detilizers, and the second dose was applied one month later. Fertilizer was spread, by hand, over an area of about 0.6 m^2 around each tree. After applying the different fertilizers, all the treated trees, including the control, were immediately irrigated with water taken from wells, and the amount of water given for each tree was about 80-90 1. The treated trees were also irrigated monthly from May to August.

The length of five shoots, as well as the total number of shoots on each tree, were recorded at the end of each growing season to calculate the total shoot length per tree (m).

Leaf samples (five mature leaves) were collected from each experimental tree in mid August for both seasons of study. The leaves were washed with tap water, distilled water and oven dried at 70°C to constant weight. The dried materials were digested according to Chapman and Pratt (1961).

Ca, Mg, Fe, Mn, Zn and Cu were determined using a Perkin Elmer Atomic Absorption Spectro Photometer (Model 305 B). K and Na were estimated by Flame Photometer. P was determined colorametrically according to Chapman and Pratt (1961), Cl using the silver nitrate method according to Jackson and Brown (1955) and N by a Microkjeldahl method as in A.O.A.C. (1970).

To determine the yield per tree, the fruits of each tree were counted before they reached full size (maturity stage). On August 15th, samples of 10 mature fruits were collected from each tree to determine the average fruit weight to estimate the total yield using the total number of fruits per tree. Total soluble solids, in the juice of ten fruits, was determined by a hand refractometer and acidity by titration with 0.1 N sodium and expressed as percent of citric acid (A.O.A.C., 1970).

Soil and irrigation water samples were analyzed before starting the experiment and the data are presented in Table 1. The data were statistically analyzed according to Snedecor and Cochran (1972).

Results and Discussion

Vegetative growth, yield and fruit quality

The data in Table 2 revealed that, in 1985, the total shoot length per tree in the 1st treatment (control) was significantly higher in the 2nd (P+K only) and 6th (1.5 kg N from commercial urea) treatments. In 1986, the total shoot length per tree was significantly higher in the 6th treatment than that in the 5th (0.5 kg N from ammonium sulphate) treatment.

As for the average total number of fruits per tree, the present results of 1985 and 1986 indicated that the 3rd (0.5 kg N from commercial urea), 6th (1.5 kg N from commercial urea) and 7th (1.5 kg N from urea forte) treatments significantly increased the total number of fruits per tree as compared with that of the 5th (0.5

Table 1. Analysis of soil and water samples from the experimental orchard

Soil analysis				Water analysis		
	A*	B*	C*			
pH	7.85	7.76	7.75	pH		7.65
Ec (mmhos/cm)	0.39	2.40	1.78	Ec	(mmhos/cm)	2.62
Na^+ (meq/L)	0.90	5.70	4.31	Na^+	(meq/L)	12.71
K^+ (meq/L)	0.40	2.80	2.25	K^+	(meq/L)	0.72
Ca^{++} (meq/L)	1.70	11.75	9.50	Ca^{++}	(meq/L)	3.60
Mg^{++} (meq/L)	1.10	2.25	2.12	Mg^{++}	(meq/L)	2.32
Cl^- (meq/L)	1.00	12.90	10.40	Cl^-	(meq/L)	24.00
$CaCO_3$ (Percent)	89	78	84	B^-	(mg/L)	1.38

* A = depth of 0-30 cm, B = depth of 30-60 cm and C = depth of 60-90 cm.

kg N from ammonium sulphate) treatment. In 1985, the 6th (1.5 kg N from commercial urea) increased the total number of fruits than in the control and 4th (0.5 kg N from urea forte) treatments, while the 3rd (0.5 kg N from commercial urea) increased it when compared with that of the 4th (0.5 kg N from urea forte) treatment and the differences were significant. In 1986, the 6th treatment significantly increased the total number of fruits as compared with those of the 4th and 8th (1.5 kg N from ammonium sulphate), while the 2nd treatment significantly increased it when compared with that of the 5th treatment (Table 2).

The average fruit weight, in 1985, was significantly lower in the 5th treatment as compared with those of the 2nd, 3rd, 4th and 6th ones, whereas in 1986 the differences among all treatments were not significant (Table 2).

Table 2. Effect of soil fertilization treatments on total shoot length, total number of fruits, yield per tree, average fruit weight, T.S.S. and acidity of Sultani fig trees in 1985 and 1986

Treatments*	Total shoot length/tree (m)	Average total number of fruit/tree	Average yield tree (kg)	Average fruit weight (gm)	TSS %	Acidity %
			1985			
1	23.67	494	16.00	32.25	17.2	0.14
2	16.26	524	19.55	37.35	16.7	0.15
3	17.63	771	28.45	36.84	16.4	0.18
4	21.07	484	18.26	37.95	15.9	0.22
5	17.38	319	7.96	26.10	12.2	0.24
6	16.99	802	31.27	38.01	13.5	0.24
7	17.43	721	21.11	28.48	13.9	0.20
8	18.31	582	16.96	30.20	13.1	0.20
L.S.D. 0.05	6.62	286	12.28	10.03	1.6	0.03
			1986			
1	22.77	523	15.60	29.36	14.2	0.15
2	18.29	581	20.77	36.98	16.0	0.18
3	18.90	652	21.35	32.41	16.3	0.19
4	16.08	465	14.24	30.73	17.6	0.23
5	11.18	287	9.12	29.41	17.5	0.24
6	23.95	782	29.17	35.92	16.5	0.26
7	16.60	626	23.09	36.27	17.6	0.22
8	17.99	464	14.61	31.44	16.4	0.19
L.S.D. 0.05	11.74	288	10.24	9.74	3.4	0.06

* The treatment are listed in details in the material and methods.

Concerning the yield per tree, the data of 1985 and 1986 seasons indicated that adding 1.5 kg N from commercial urea (6th treatment) significantly increased the yield per tree than those of the 1st, 4th, 5th and 8th treatments. The 3rd (0.5 kg N from commercial urea) and 7th (1.5 kg N from urea forte) treatments significantly increased the yield as compared with that of the 5th treatment in 1985 and 1986 seasons. In 1986, the 2nd treatment increased the yield as compared with that of the 5th treatment and the difference was significant (Table 2). The effect of nitrogen fertilizers on vegetative growth and yield of fig trees in the present results are in agreement with that reported by Proebesting and Warner (1954), El Adawy (1987), Taha *et al.* (1989a) and El-Sehrawy (1990) on fig trees.

The above mentioned for the effect of commercial urea on yield may be attributed to relatively higher solutibility of urea in comparison with ammonium sulphate. The solubility of the fertilizer play an important role, especially under the limited amount of irrigation water under such condition. These results are in the line with Proebsting and Warner (1954) on fig trees and Struklec (1970) on pears. They mentioned that the applying of commercial urea to the trees gave the higher yield when compared with the other sources of nitrogen.

The total soluble solids (TTS) in the fruits was significantly higher in 1st, 2nd, and 4th treatments than in the other treatments, in 1985, whereas in 1986 it was significantly lower in the 1st treatment than those in the 4th and 7th ones. The acidity percent in 1985 was significantly lower in the 1st and 2nd treatments than in those of the other treatments. On the contrary, fruit acidity in the 5th and 6th treatments was significantly higher than those of 3rd, 7th and 8th ones. In 1986, a higher acidity percentages were observed in the 5th and 6th treatments, while the lowest values occurred in the 1st and 2nd ones and the differences were significant between the two extreems. The remaining treatments were in between (Table 2). Generally, nitrogen application decreased TSS and increased acidity of fig fruits. These results are in agreement with those of El-Adawy (1987), Taha *et al.* (1989a) and El-Sehrawy (1990) on fig trees.

Leaf nutrient content

The present data show that leaf nutrient elements differed from one season to the other and according to treatments, growth, yield, chemical composition of the soil, relationships among leaf nutrients and many other factors.

Data presented in Table 3 indicated that, in 1986, the nitrogen applications significantly increased magnesium and manganese as compared with those in the control. Also, adding 1.5 kg N from urea forte (7th) and ammonium sulphate (8th) increased leaf sodium as compared with that of the control and the differences were significant. The 1st treatment (control) gave the lowest contents of zinc and copper in 1985, while in 1986 it gave lowest nitrogen, iron, zinc and higher copper as compared with other treatments. The differences were significant in most cases.

In 1985, the 7th (1.5 kg N from urea forte) treatment significantly increased leaf phosphorus, and the 8th (1.5 kg N from ammonium sulphate) treatment increased potassium, while 7th and 8th treatments increased leaf calcium as compared with the control and the differences were significant. On the contrary, leaf calcium of untreated trees was significantly higher than those of nitrogen fertilization treatments in 1986 (Table 3). These findings were also found by many investigators such as El Adawy (1987), Taha *et al.* (1989a), El-Sehray (1990) on fig

Table 3. Effect of different soil fertilization treatments on leaf nutrient contents of Sultani fig trees in 1985 and 1986 (on dry weight basis)

Treatments*	per dent						P.P.m				
	N	P	K	Ca	Mg	Na	Cl	Fe	Mn	Zn	Cu
	1985										
1	2.19	0.15	0.71	3.68	0.73	0.25	1.30	258	23	28	21
2	2.36	0.17	0.71	3.05	0.71	0.24	1.65	182	22	35	40
3	2.40	0.15	0.69	3.05	0.67	0.27	1.89	242	21	38	40
4	1.88	0.15	0.64	2.68	0.72	0.26	1.53	305	26	32	35
5	2.03	0.15	0.72	3.63	0.74	0.26	1.97	225	24	33	40
6	1.65	0.15	0.76	3.68	0.71	0.26	1.18	273	26	33	38
7	1.85	0.19	0.73	5.03	0.72	0.25	1.60	285	22	33	36
8	1.66	0.18	1.03	5.38	0.69	0.25	1.42	311	25	35	41
L.S.D. 0.05	0.58	0.04	0.15	1.07	0.13	0.04	0.68	89	9	10	9
	1986										
1	0.89	0.067	1.21	2.28	0.25	0.09	1.85	77	14	32	37
2	2.23	0.056	1.09	1.22	2.25	0.12	1.48	127	21	38	14
3	1.53	0.073	1.01	1.46	0.31	0.12	1.79	143	27	38	14
4	2.28	0.072	1.40	1.46	0.30	0.14	1.85	182	28	45	13
5	1.58	0.058	1.16	1.46	0.31	0.12	2.10	158	31	44	12
6	2.91	0.062	1.67	1.68	0.31	0.10	1.42	133	39	38	14
7	1.51	0.070	1.24	1.59	0.35	0.17	1.61	141	38	39	14
8	1.81	0.075	0.92	1.74	0.30	0.15	1.61	104	32	35	9
L.S.D. 0.05	0.37	0.017	0.35	0.24	0.04	0.04	0.72	23	7	6	5

* Treatments are listed in details in the material and methods.

trees, Guha and Mitchell (1966) on some deciduous trees and Labanauska *et al.* (1963) on valencia oranges.

Relationships of leaf nutrients to vegetative growth, yield and fruit quality

Correlation analysis indicated that the concentrations of leaf zinc (r = −0.75 and r = −0.72) in both seasons and copper (r = −0.72) in 1985 were negatively correlated with the total shoot length (m) per tree, while leaf chloride (r = −0.82) was negatively correlated with the average yield (kg) per tree in 1986 only and these correlations were significant at level of 0.05.

The correlation coefficient between leaf magnesium (r = 0.77), iron (r = 0.87), mangenese (r = 0.75) and zinc (r = 0.85) and TSS were significantly positive, while it was significantly negative correlation between copper (r = −0.81) and TSS in 1986. Also, negative correlation was found between TSS and Acidity in 1985 (r = −0.80), while it was positive in 1986 (r = 0.77).

From the correlations analysis, it was show that the correlations coefficient, in 1985, between iron and both nitrogen (r = −0.76) and sodium (r = −0.74), manganese and nitrogen (r = −0.78) and zinc and magnesium (r = −0.79) were significantly negative, while it was positive between ca and both phosphorus (r = 0.76) and potassium (r = 0.78) and between zinc and copper (r = 0.86). In 1986, negative correlation was found between leaf calcium and iron (r = −0.73), while positive correlations were found between manganese and magnesium (r = 0.87) and between zinc and iron (r = 0.96). These relationships were partially agreed with those reported by El-Sehrawy (1990).

From the present results, it was concluded that the applying of 1.5 kg N from commercial urea (6th treatment) to fig trees generally gave the higher yield as compared with the other sources of nitrogen and control in both seasons of study.

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تأثير التسميد الأرضي على النمو الخضري والمحصول والمحتوى المعدني للأوراق في أشجار التين السلطاني

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بريده ـ ص. ب: ١٤٨٢ ـ المملكة العربية السعودية

أجري هذا البحث خلال عامي ١٩٨٥ ، ١٩٨٦ على أشجار تين سلطاني مثمر عمرها ٢٥ سنة ونامية بمزرعة سيدي كرير (تقع على بعد ٣٠ كم غرب مدينة الأسكندرية) ومنزرعة على مسافة ٧ متر في أرض رملية وذلك لدراسة تأثير التسميد الأرضي بمصادر النيتروجين والفوسفور والبوتاسيوم على النمو الخضري والمحصول وجودة الثمار والمحتوى المعدني للأوراق.

وعوملت الاشجار بمعاملات التسميد التالية :

١ ـ مقارنة (بدون تسميد).
٢ ـ ١ كجم سوبر فوسفات (١٥ ٪ P_2O_5) + ١ كجم كبريتات بوتاسيوم (٤٨ ـ ٥٠ ٪ 4_2O) / شجرة.
٢ ـ ١ كجم سوبر فوسفات (١٥ ٪ P_2O_5) + ١ كجم كبريتات بوتاسيوم (٤٨ ـ ٥٠ ٪ K_2O) / شجرة.
٣ ـ ١ كجم سوبر فوسفات + ١ كجم كبريتات بوتاسيوم + ٠,٥ كجم نتروجين/ شجرة من اليوريا (٤٦,٥ ٪ نتروجين).

٥ ـ ١ كجم سوبر فوسفات + ١ كجم كبريتات بوتاسيوم + ٠,٥ كجم نتروجين / شجرة من كبريتات الأمونيوم (٢١ ٪ نتروجين).

٦ ـ ١ كجم سوبر فوسفات + ١ كجم كبريتات البوتاسيوم + ١,٥ كجم نتروجين / شجرة من اليوريا.

٧ ـ ١ كجم سوبر فوسفات + ١ كجم كبريتات بوتاسيوم + ١,٥ كجم نتروجين / شجرة من يوريا فورت.

٨ ـ ١ كجم سوبر فوسفات + ١ كجم كبريتات بوتاسيوم + ١,٥ كجم نتروجين/ شجرة من كبريتات الأمونيوم.

وأضيف سمادي سوبر فوسفات وكبريتات البوتاسيوم دفعة واحدة خلال الأسبوع الأول من شهر أبريل ١٩٨٥ ، ١٩٨٦ ، بينما أضيف السماد النتروجيني على دفعتين متساويتين خلال شهري أبريل ومايو من عامي الدراسة ـ وأحتوت كل معاملة على ٤ مكررات وكل مكررة عبارة عن شجرة واحدة.

ولقد أوضحت النتائج أن أشجار التين المعاملة ب ١,٥ كجم نتروجين من اليوريا أعطت أعلى محصول ـ خلال عامي الدراسة بالمقارنة بمصادر النتروجين الأخرى وأشجار المقارنة. بينما سبب التسميد النتروجيني ـ بصفة عامة ـ إلى نقص محتوى الثمار من المواد الصلبة الذائبة وزيادة الحموضة.

كما بينت النتائج ـ في عام ١٩٨٥ ـ أن محتوى الأوراق من المغنسيوم والصوديوم والمنجنيز لم يتأثر بمعاملات التسميد المختلفة بينما سببت المعاملات في عام ١٩٨٦ زيادة تركيز المغنسيوم والمنجنيز بالأوراق، كما أدت المعاملة بالمستوى العالي من النتروجين (١,٥ كجم) من اليوريا فورت وكبريتات الأمونيوم إلى زيادة الصوديوم في الأوراق عنه في أشجار المقارنة. وزاد محتوى الأوراق من الزنك نتيجة معاملات التسميد خلال موسمي الدراسة، والنتروجين والحديد والنحاس في عام ١٩٨٥ وقل تركيز النحاس في عام ١٩٨٦ عنه في أشجار المقارنة.

أدت المعاملة بالمستوى العالي من النتروجين من اليوريا فورت وكبريتات الأمونيوم إلى زيادة تركيز الفوسفور والبوتاسيوم على التوالي في عام ١٩٨٥، بينما سببت نفس المعاملتين إلى زيادة تركيز الكالسيوم، وفي عام ١٩٨٥ سببت معاملات التسميد النتروجيني إلى نقص تركيز الكالسيوم عنه في أشجار المقارنة.

وجد أن هناك تلازم معنوي سالب خلال عامي الدراسة بين محتوى الأوراق من الزنك والنحاس والنمو الخضري للأشجار، وكان التلازم سالباً بين الكلوريد في الأوراق والمحصول في عام ١٩٨٦ فقط.

في عام ١٩٨٦ - إرتبطت النسبة المئوية للمواد الصلبة الذائبة ومحتوى الأوراق من المغنيسيوم والحديد والمنجنيز والزنك بتلازم معنوي موجب وتلازم معنوي سالب مع النحاس. وكان التلازم سالباً بين النسبة المئوية للمواد الصلبة الذائبة والحموضة في عام ١٩٨٥ وموجباً في عام ١٩٨٦. بصفة عامة - وجدت علاقات تلازم بين العناصر الغذائية في الأوراق خلال عامي الدراسة.