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MICRONUTRIENT CHANGES AND CHEMICAL PROPERTIES IN SAMANY DATE PALM CULTIVAR AS AFFECTED BY NITROGEN AND POTASSIUM APPLICATION

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ABSTRACT

The present investigation was carried out during 2004 and 2005 seasons on Samany date palm cv. Samany grown in El-Kanater El-Khairia, El-Kaliobia Governorate, Egypt, to study the effect of nitrogen (ammonium nitrate) and potassium (potassium sulphate) fertilization on date palm micronutrient status, fruit chemical properties, and effect of sampling time, leaflets position (basal, middle and terminal) on leaf and fruit micronutrient contents and interaction between them, in order to obtain information to be used as a basis to proper fertilizer programs. Applying (1.5+1.5) kg/palm/yearly caused the highest values of TSS in the two seasons and total sugars and reducing sugars in the first season. (1.75+1.50) kg/palm/yearly gave the lowest total acidity and highest non-reducing sugars in the first season. (2.00+1.50) kg/palm/yearly gave the highest moisture content in the first season.

The results showed that Mn, Zn Cu leaf contents were below standard. There were decreases in iron and zinc and increases in Mn and Cu concentrations of leaflets and date fruit with increasing rates of nitrogen and potassium fertilizers in both seasons. Iron was the predominant micronutrient in Samany dates. The contents of micronutrients in Samany date palm varied in both sampling time and leaflets position along the mature leaf.

The leaf micronutrients Fe, Mn, Zn and Cu concentrations increased with leaf age from May till August then decreased in September. Fe, Mn, Zn and Cu in fruits tended to be more at the beginning of fruit growth then decreased with fruit development.

The micronutrient levels in Samany date palm leaflets were significantly affected by leaflets position (basal, middle and terminal). Fe, Mn, Zn and Cu concentration of leaflets increase from the basal third toward the terminal third of the leaflets.

Keyword: date palm (*Phoenix dactylifera* L.), micronutrients, nitrogen, potassium

INTRODUCTION

Date palm (Phoenix dactylifera, L.) is among the most important fruit trees in Egypt. Research on fertilization of date palm is limited. Due to insufficient or incorrect fertilization, the trees exhibit certain nutritional disorders. The fruit growers are using some mineral fertilizers such as nitrogen, potassium and phosphorus. Information regarding micronutrient elements of date palm is limited. Micronutrients is perhaps the most widespread and serious of all disorders in Egypt palms. Fertilization efficiency can be noted through foliar and fruit analyses. The balance between macro and micronutrients has received much less attention. El-Fouly and Fawzi (1994), reported about the effect of balanced fertilizers use on improvement yield with less environmental pollution. Some investigators have studied the effect of nitrogen and potassium fertilization on fruit chemical properties, and studied the seasonal changes in leaf and fruit mineral contents of different date palm cultivars: Hussein & Hussein (1992), Montasser *et al.* (1994), Al-Jubari (1996), Helail & Eissa (1997), Kassem *et al.* (1997), El-Kholey (1999), Melouk *et al.* (1999 a & b), Attalla *et al.* (2001&2003), Soliman & Osman (2003) and Shahein *et al.* (2003). The objective of this work was to evaluate the micronutrient changes and chemical properties of Samany date palm fruits as affected by different rates of nitrogen and potassium fertilization at different times and its concentrations in leaflets position which might be helpful in determining guidelines for further fertilization programs.

MATERIAL AND METHODS

This study was conducted at the Ministry of Agriculture experiment stations at El-Kanater El-Khairia, El-Kaliobia Governorate, Egypt for two successive seasons, 2004 and 2005 on Samany date palm, of about 30 years old grown on clay soil and moderate pruning (10: 1 leaf/bunch ratio, Hussein *et al.* , 1998). The experimental palms were healthy, as they were uniform in growth, vigor, height and fruiting capacity in the preceding year. Only eight bunches were left on each experimental tree. Phosphorus was applied in November at the level of 1.5 Kg calcium super phosphates (15.5 % P_2O_5/ palm. All other cultural practices were carried out according to the traditional schedule for experimental palms. Prior to any practices, a composite soil sample was taken from the soil depth (0-60 cm) of the experimental site, air-dried, sieved by 2mm sieve. Soil and water used for irrigation were analyzed (Table 1). Nitrogen and potassium fertilizer, at different rates were added to the experimental trees in combination with each other. Nitrogen fertilizer in the form of ammonium nitrate (33.5% N) and potash fertilizer in the form of potassium sulphate (48% K_20), were applied to the trees. The study comprised five levels of nitrogen and potassium, namely zero (control), 1.50+1.50, 1.75+1.50, 2.00+1.50 and 2.0+2.0 kg per palm per year.

Nitrogen and potassium fertilizers were divided into three equal doses and added to trees at middle of February, May and July in both seasons. Fertilizer treatments were added through broadcasting, on the soil surface, 1.5 meters from the palm trunk. The five experimental treatments were arranged in a randomized complete block design with three replications (one palm for each replication = 15 palms). The yield of the palms was harvested at the first week of October and the second half of September in the first and second seasons, respectively; and the following data were record:

1- Total soluble solids content (TSS%) was determined in juice fruit according to A.O.A.C. (1995).
2- Fruit acidity (%) was determined according to A.O.A.C. (1995) and the titrable acidity was calculated as citric acid (Ranganns, 1978 and Mawlood, 1980).
3- Total soluble sugars (%): It was determined according to Smith *et al.* (1956) in the methanol extract using the phenol sulphuric acid method and concentration was calculated as g/100g dry weight percentage.

4- Reducing soluble sugars (%): It was determined in the methanol extract according to Nelson and Somogy (1944) and A.O.A.C. (1995) and the percentage was calculated as g/100g dry weight percentage.
5- Non-reducing sugars (%): It was determined by difference between total soluble sugars and reducing sugars.
6- Crude fiber of the fruit: Crude fiber content was determined according to the procedure described by the A.O.A.C. (1995).
7- Leaf and fruit mineral analysis.

Table (1) Analysis of soil and irrigation water of the experimental orchard (asaverage of two years).

Soil analysis		**Water analysis**	
Character	Value	Character	Value
Sand %	22.20	EC (dS/m)	0.67
Silt %	42.15	pH	7.38
Clay %	35.65	**Cations (meq.l)**	
Texture	Silty clay loam	Ca^{++}	2.30
pH	8.01	Mg^{++}	1.50
EC (dS/m)	0.83	N^{+}	2.95
O.M %	1.20	K^{+}	0.02
Total $CaCO_3$ %	3.65	**Anions (meq/l)**	
Soluble cations (meq. /1)		CO_3-	1.00
Ca^{++}	3.80	HCO_3-	1.75
Mg^{++}	2.80	SO_4	1.81
N^{+}	1.58	Cl^{-}	3.22
K^{+}	0.12		
Microelements (ppm)			
Fe	2.90		
Mn	3.61		
Zn	0.91		
Cu	0.95		

Texture hydrometer method (Bouyoucos, 1954)
pH and E.C.: in 1:2.5 soil/water suspension (Jackson, 1973)
O.M.:Black method (Walkley and Black, 1934)
CaCO3: Collin's calcimeter (Alison and Moodle, 1965)
P: $NaHCO_3$ extract, at pH 8.5 (Olsen *et al.* , 1954).
K, Ca and Mg: NH_4-Aoc extract at pH 7.0 (Jackson, 1973).
Micronutrients:DTPA extract, at pH 7.3 (Lindsay and Norvell, 1978)

For leaf mineral analysis, newly emerged leaf was selected from each palm and composted for three palms of Sammany cultivar. Pinnate samples were taken at monthly intervals during growth season (After pollination and fruit set) until harvesting. Pinnate divided into three parts, terminal, middle and basal leaflets. Fruit samples were taken at monthly intervals during growth season (After pollination and fruit set) until harvesting. Pinnate and fruit samples were washed with tap water and then distilled water to remove the dust and any chemical spray residues. After washing, they were dried in an electric oven at 60-70ºC until a constant weight. The dried material was ground in an electric mill. One gram of the ground material was digested using a mixture of 8:1:1 by volume conc. nitric, perchloric and sulphoric acids, respectively (Chapman and Pratt, 1978). Clear digest was quantitatively transferred to 100 ml volumetric flask, to determine nutrients. Nutrient concentrations in the soil and leaf extractants were measured using atomic absorption spectrophotometer. The results were subjected to statistical analysis according to Snedecor and Cochran (1980). Treatment means were compared using the Duncan least significant range (LSR) at 5 percent level of significance in both seasons of experimentation.

RESULTS AND DISCUSSION

1. Soil and water characteristics:

In both seasons, the data in Table (1) show that the experimental silty clay loam was of high pH, medium $CaCO_3$ and low organic matter content and high EC. Available nutrient contents were low for Fe, Mn, Zn and Cu (Ankerman and Large, 1974). Also, the data in Table (1) show that the irrigation water was of low EC.

2. Effect of nitrogen and potassium fertilization on leaf and fruit micronutrient concentrations:

Data in Tables (2,3) showed the effect of different fertilization treatments on leaf and fruit micronutrient concentrations (Fe, Mn, Zn and Cu) for Samany cultivar in 2004 and 2005 seasons. There was decrease in pinnae and fruit iron and zinc concentrations in both seasons with increasing the rates of nitrogen and potassium fertilizers. The decreasing of Fe and Zn in the pinnae and fruit might be attributed to the dilution effect resulting from date palm growth. As for the effect of different fertilization treatments on leaf and fruit Mn and Cu concentrations, there was an increase compared with control. Although, increasing in Mn and Cu concentrations, its values and Zn were below standard that proposed by Lacoeuilhe *et al.* (1968), and Marchal, (1969). These could be as a reason of low availability of these nutrients from soil, might be due to high pH and poorly aerated soils, Broschat, (2000). In these connection, El-Fouly and Fawzi, (1982) and Hagen & Tucker, (1982) mentioned that insufficient supply of micronutrients to fruit trees is considered to be one of the most limiting nutritional problems.

These results confirm that the increase of N and K fertilizers led to increase of demand of Fe and Zn by the date palm trees. The nutrient disorders could have been a combined deficiency of Mn, Zn and Cu. A high soil pH value, and consequently decreased the availability of nutrients in soil, may be the cause of deficiency. Micronutrients deficiency can be mostly controlled by foliar application. Faissal & Gamal (1991) found that the highest yield with good fruit quality obtained due to spraying Bent Eisha palms three times with Zn+Fe each at 0.5% in chelated form. Meerow & Brochat (1996) Mentioned that micronutrients can be applied as a foliar spray, even chelated forms are best applied to the root zone for maximum efficiency of uptake and foliar applications of micronutrients should not be performed more than once per month. It is worth noting that foliar application of micronutrients can be very efficient when its uptake from the soil is restricted. It must be used side by side with macronutrient fertilizers.

Table (2): Effect of nitrogen and potassium fertilization on some micronutrient concentrations (ppm) in Samany date palm leaves during 2004 and 2005 seasons.

Amm.N+Pot.Sulphate	Season (2004)				Season (2005)			
	Fe	Mn	Zn	Cu	Fe	Mn	Zn	Cu
Zero (Control)	456.9a	25.2e	16.6a	3.7a	461.2a	22.4e	15.0a	4.8e
1.50 + 1.50 Kg	416.3b	31.7d	13.9b	4.6a	420.8b	28.4d	12.6b	5.4d
1.75 + 1.50 Kg	392.2c	36.0c	12.8c	5.2a	395.7c	32.9c	11.6c	6.1c
2.00 + 1.50 Kg	366.6d	41.9b	11.5d	5.7a	366.4d	38.4b	10.2d	6.8b
2.00 + 2.00 Kg	285.6e	49.9a	9.1e	6.7a	286.1e	47.0a	7.6e	8.0a

Table (3): Effect of nitrogen and potassium fertilization on some micronutrient concentrations (ppm) in Samany date palm fruits during 2004 and 2005 seasons.

Amm.N+Pot.Sulphate	Season (2004)				Season (2005)			
	Fe	Mn	Zn	Cu	Fe	Mn	Zn	Cu
Zero (Control)	201.3a	6.5e	17.1a	5.6e	213.5a	6.6e	19.1a	6.0e
1.50 + 1.50 Kg	167.5b	7.5d	12.8b	6.4d	173.1b	8.1d	15.6b	6.8d
1.75 + 1.50 Kg	137.0c	8.8c	11.0bc	7.1c	142.5c	9.4c	12.9c	7.5c
2.00 + 1.50 Kg	110.7d	10.1b	9.5c	8.0b	116.3d	11.3b	10.2d	8.4b
2.00 + 2.00 Kg	74.9e	12.4a	7.4d	10.0a	81.9e	14.3a	7.6e	10.7a

3-Effect of nitrogen and potassium fertilization treatments on the chemical properties of Samany Date Palm Fruits

The results concerning the chemical properties in the two seasons are presented in Table (4).

3.1. Moisture content (%)

Regarding the effect of nitrogen and potassium fertilization on moisture content percentage, results showed that there was a significant effect between fertilization treatments in the first season only. Treatment (2.0 +1.5) kg/palm/year gave the highest moisture content followed by treatment (1.75 +1.50) kg/palm/year than the control and other fertilization treatments. These results are generally in agreement with those found by Soliman & Osman (2003)

3.2. Total soluble solids (%)

Significant effect was found on total soluble solids percentage (TSS) of Samany fruit due to the nitrogen and potassium fertilization in both seasons.

Treatment (1.5+1.5) Kg/palm/year followed by treatment (2.0+2.0) Kg/palm/year gave higher values of TSS as compared with control and other fertilization treatments in both seasons of study.

These results are in agreement with those reported by El-Hammady *et al.* (1987 &1994), Kassem *et al.* (1997) and Soliman & Osman (2003).

3.3.Total acidity (%)

Concerning the total acidity percentage, the results obtained indicated that, there were significant differences between fertilization treatments in both seasons. Treatment (1.75+1.50) Kg/palm/year and treatment (2.0+1.5) Kg/palm/year gave the lowest total acidity as compared with the control and other treatments in the first and second season, respectively. The findings of

Kassem *et al.* (1997) and Soliman & Osman (2003) are in agreement with these results.

3.4. Total sugars (%)

Regarding the effect of nitrogen and potassium fertilization on total sugars percentage, the results indicated that treatment (1.5 +1.5) Kg/palm/year followed by treatment (2.0 +2.0) Kg/palm/year gave the highest total sugars percentage as compared with the control and other treatments in the first season. Treatment (1.5 +1.5) followed by treatment (1.75 +1.50) Kg/palm/year gave the highest total sugar percentage than the control and other fertilization treatments in the second season. The results of Hussein (1972), Aly (1993), Kassem *et al.* (1997) and Soliman & Osman (2003) are in agreement with our results.

3.5. Reducing sugars (%)

Regarding the effect of nitrogen and potassium fertilization treatments on dates reducing sugars percentage during the present study. It is noticed from the obtained results that during in both seasons, the reducing sugars exhibited similar trend as the total sugars percentage.

3.6. Non-reducing sugars (%)

The obtained results indicated that, the non-reducing sugars percentage was significantly affected by nitrogen and potassium fertilization. Treatment (1.75 +1.50), followed by treatment (2.0 +2.0) Kg/palm/year and treatment (1.5 +1.5) followed by treatment (2.0 +1.5) Kg/palm/year gave the highest non-reducing sugars as compared with the control in the first and second seasons, respectively. These results are in partial agreement with those reported by Soliman and Osman (2003).

Table (4): Effect of N and K fertilization on some fruit chemical properties of Samany date palm during 2004 and 2005 seasons.

Characteristics / Treatments	Moisture content (%)	Total soluble solids (%)	Total acidity (%)	Total sugars (%)	Reducing sugars (%)	Non-reducing sugars (%)
Amm.N+Pot.Sulphate	Season (2004)					
Zero (Control)	70.82bc	21.03d	0.0167a	42.57d	40.43c	2.14c
1.50 + 1.50 Kg	69.13c	26.95a	0.0147ab	62.50a	58.42a	4.08ab
1.75 + 1.50 Kg	74.28ab	24.57c	0.0117b	50.83bc	46.10bc	4.73ae
2.00 + 1.50 Kg	76.40a	25.49b	0.0123b	45.62cd	41.70bc	3.92b
2.00 + 2.00 Kg	72.38bc	26.19ab	0.0130b	52.34b	46.90b	5.45a
Amm.N+Pot.Sulphate	Season (2005)					
Zero (Control)	68.63a	19.80d	0.0143b	46.66c	43.24b	3.43b
1.50 + 1.50 Kg	73.54a	25.71a	0.0170a	56.34a	52.36a	3.98b
1.75 + 1.50 Kg	77.74a	24.09b	00147b	53.92ab	51.14a	2.77b
2.00 + 1.50 Kg	69.61a	22.98c	0.0120c	44.08c	38.66c	5.42a
2.00 + 2.00 Kg	76.01a	25.16a	0.0147b	52.71b	50.06a	2.64b

4. Effect of sampling time:

Changes of nutrients during growth season help us to give the trees their requirements, of nutrients in suitable time. The micronutrient levels in Samany date palm leaf and fruit were significantly affected by time of sampling. For all sampling dates, the range of leaf and fruit Fe concentrations was wider than that found in other micronutrients. Data in

Tables (5 & 6) showed that average ranges for micronutrients in Samany date palm leaves were 244.6 – 616.7 ppm (Fe), 21.9 – 47.4 ppm (Mn), 9.3 – 19.5 ppm (Zn), 3.8 –7.8 ppm (Cu). While the ranges for micronutrients in Samany palm fruits were 47.2 – 208.7 ppm (Fe), 5 –18.1 ppm (Mn), 6.3 – 21.2 ppm (Zn), 5.1 – 11.6 ppm (Cu). It was found that leaf micronutrients (Fe, Mn, Zn and Cu) concentrations increased with leaf age from May till August, while in September showed decrease of leaf Fe, Mn, Zn and Cu concentrations. Beside the leaf analysis, fruit analysis could reflect the requirement of nutrients better. It can be seen from Table (5) that the concentration of Fe, Mn, Zn and Cu in fruits were tend to be more at the beginning of May and June, then decreased, with fruit development. Similar results were shown by Sawaya *et al.* (1983), who found that minerals (Fe, Cu and Zn) decreased as fruit progressed in maturity and Houba *et al.* , (1996) who mentioned that nutrient contents change during plant growth.

Fe, Mn, Zn and Cu increased with leaf age, whenever, fruits increased in size, these nutrients decreased in fruits, so that a part of micronutrient fertilizers requirement could be applied during the development stage of fruits.

The results showed also, that Fe content in Samany dates predominated over the other micronutrients, these results in agreement with Sawaya *et al.* (1983), and Yousif *et al.* (1982), they mentioned that dates could be considered a good source of Fe.

Table (5): Micronutrient concentrations (ppm) of Samany date palm leaves at successive time during 2004 and 2005 seasons.

Sampling time	Season (2004)				Season (2005)			
	Fe	Mn	Zn	Cu	Fe	Mn	Zn	Cu
May.	244.6e	21.9d	10.6d	4.6a	249.1e	33.4d	9.3d	5.2e
Jun.	319.2c	27.5c	11.4c	5.6a	324.1c	23.0d	10.0c	6.2c
Jul.	447.3b	43.5b	12.1b	5.2a	447.1b	38.0c	10.8b	6.5b
Aug.	616.7a	47.4a	19.5a	6.5a	616.0a	43.1a	17.9a	7.8a
Sep.	289.8d	44.4b	10.2d	3.8a	293.9d	41.6b	8.9e	5.4d

Table (6): Micronutrient concentrations (ppm) during fruit development of Samany date palm at successive time in 2004 and 2005 seasons.

Sampling time	Season (2004)				Season (2005)			
	Fe	Mn	Zn	Cu	Fe	Mn	Zn	Cu
May.	158.7b	9.9b	13.9b	5.1d	167.8b	10.6b	15.3b	5.3e
Jun.	203.7a	15.5a	20.9a	11.6a	208.7a	18.1a	21.2a	11.5a
Jul.	166.2b	8.1c	8.5c	6.0c	176.1b	7.3c	10.9c	5.8d
Aug.	47.2d	6.9d	8.2cd	8.5b	52.9d	7.7c	9.3c	9.1b
Sep.	111.6c	5.0e	6.3d	5.9c	121.7c	6.0d	8.8c	7.7c

5. Effect of leaflets position.

The micronutrient levels in Samany date palm leaflets were significantly affected by the position (basal, middle and terminal).

From Table (7) the average ranges for different micronutrient concentrations were as follows: 374.0-398.0 ppm (Fe), 30.3-42.7 ppm (Mn), 11.5-13.2 ppm (Zn), 4.9-6.4 ppm (Cu), In both seasons Fe, Mn, Zn and Cu concentrations gradually increased from the basal to the terminal leaflets.

In this connection, Labanauskas & Nixon (1962) found large difference in nutrient concentration in leaflets distribution along the length of the rachis. Also, Houba *et al.* , (1996) mentioned that nutrient contents differ between the different plant parts.

Table (7): Effect of the leaflets position on micronutrient concentrations (ppm) in Samany leaves during 2004 and 2005 seasons.

Leaflets position	Season (2004)				Season (2005)			
	Fe	Mn	Zn	Cu	Fe	Mn	Zn	Cu
Basal	374.4b	33.7b	12.9a	4.9b	377.4b	30.3c	11.5a	6.0c
Middle	381.6b	34.5b	12.3b	5.0b	382.2b	31.3b	11.0b	6.2b
Terminal	394.6a	42.7a	13.2a	5.5a	398.5a	39.8a	11.7a	6.4a

6. Interaction between N & K treatments and sampling time:

Table (8) showed that at August, treatments T_1, T_2, T_3 and T_4, respectively gave highest Fe and Zn leaf concentrations, while gave highest Mn and Cu leaf concentrations with T_5.With regards to the fruit concentrations, Fe and Zn were higher in June with T_1, also, Mn and Cu concentrations were found highest in June with T_5, Table (9).

Table (8): Mean effect of the interaction between sampling time and N & K treatments on leaf micronutrient concentrations of Samany date palm during 2004/2005 seasons.

	Season (2004)				Season (2005)			
	Fe	Mn	Zn	Cu	Fe	Mn	Zn	Cu
P_1xT_1	255.4 mo	12.6 l	13.8ef	2.4 o	261.9 kn	14.3 j	12.2 fg	3.3 o
P_1xT_2	252.1 mo	16.9 k	12.2 gi	3.7 n	255.3 kn	18.3 i	10.9 hi	4.3 m
P_1xT_3	248.9 no	21.0 ij	10.8 jl	4.9 ik	249.3 ln	22.8 h	10.2 ij	5.4 k
P_1xT_4	238.3 o	26.2 h	09.7 lm	5.6 fh	242.4 mn	26.8 g	8.5 k	6.0 ij
P_1xT_5	228.3 op	32.8 fg	06.6 o	6.3 d	236.6 no	35.0 f	4.7 m	6.9 fg
P_2xT_1	401.9 gi	18.2 jk	14.9 e	4.0 mn	406.6 fg	13.7 j	12.8 ef	4.9 l
P_2xT_2	362.2 ij	23.6 hi	12.4 gi	4.6 kl	367.7 gh	18.4 i	10.8 hi	5.4 kl
P_2xT_3	331.3 jk	25.9 h	11.4 ik	4.9 ik	336.7 hi	21.4 h	10.2 ij	5.6 jk
P_2xT_4	286.8 ln	31.2 g	10.3 kl	6.1 de	291.4 jl	26.8 g	8.9 k	6.8 fg
P_2xT_5	213.9 op	38.7 e	07.8 n	8.3 a	218.2 no	34.5 f	7.4 l	8.2 bc
P_3xT_1	483.1 e	31.7 g	14.9 e	4.1 mn	486.6 e	28.3 g	13.3 e	5.3 k
P_3xT_2	470.0 ef	30.0 e	12.6 fi	4.9 jk	474.8 e	32.7 f	11.4 gh	5.9 ij
P_3xT_3	455.8 ef	43.0 d	11.9 hi	5.4 gi	460.2 e	37.7 e	10.6 hi	6.5 gh
P_3xT_4	440.0 fg	46.1 cd	11.4 ik	5.7 eg	444.7 ef	41.3 cd	10.3 ij	7.0 ef
P_3xT_5	387.3 hi	57.9 a	09.8 lm	6.2 d	369.1 gh	50.1 b	8.4 k	8.0 bc
P_4xT_1	776.2 a	32.9 fg	25.9 a	5.7 eg	779.6 a	27.8 g	24.3 a	6.5 fh
P_4xT_2	680.4 b	42.9 d	21.5 b	6.0 df	684.4 b	38.4 e	20.3 b	6.9 fg
P_4xT_3	633.6 c	47.5 c	20.0 c	6.5 cd	637.0 c	43.3 c	18.4 c	7.8 cd
P_4xT_4	587.6 d	53.5 b	17.4 d	6.9 c	569.3 d	48.7 b	16.0 d	8.3 b
P_4xT_5	405.7 gh	60.5 a	12.9 fh	7.6 b	409.4 fg	57.3 a	10.4 hi	9.7 a
P_5xT_1	367.7 hj	30.6 g	13.3 fg	2.2 o	371.6 gh	28.1 g	12.1 fg	3.9 n
P_5xT_2	316.4 kl	35.9 ef	10.6 kl	3.6 n	321.6 ij	34.1 f	9.4 jk	4.4 m
P_5xT_3	291.4 lm	42.8 d	09.9 lm	4.0 mn	295.3 ik	39.3 de	8.6 k	5.3 kl
P_5xT_4	280.6 ln	52.9 b	08.8 mn	4.3 lm	284.1 jm	48.3 b	7.2 l	6.2 hi
P_5xT_5	192.8 p	59.8 a	08.2 n	5.1 hj	197.0 o	58.0 a	7.2 l	7.4 de

P_1 = May **P_2 = June** **P_3 = July**
P_4 = August **P_5 = September** **T_1-T_5 = Treatments**

Table (9): Mean effect of the interaction between sampling time and N & K treatments on fruit micronutrient concentrations of Samany date palm during 2004/2005 seasons.

	Season (2004)				Season (2005)			
	Fe	Mn	Zn	Cu	Fe	Mn	Zn	Cu
P_1xT_1	234.0 b	7.3 gh	22.0 b	3.2q	240.3 b	7.9 ik	20.7 c	2.5 q
P_1xT_2	167.0 cd	8.7 fg	15.7 cd	4.4p	173.0 cd	9.1 fh	18.3 ce	4.6 no
P_1xT_3	148.7 de	9.7 ef	13.0 de	4.9op	154.7 de	10.2 f	15.0 dg	5.2 mn
P_1xT_4	136.3 df	10.6 e	10.0 eg	5.7ln	140.3 df	11.5 e	12.3 fi	6.0 km
P_1xT_5	107.3 eh	13.2 d	9.0 eh	7.2j	130.7 ef	14.4 d	10.0 fk	8.5 gh
P_2xT_1	279.7 a	10.8 e	32.0 a	8.7e	285.0 a	11.7 e	37.0 a	8.7 fg
P_2xT_2	275.3 a	12.2 d	21.8 b	9.5d	280.3 a	14.0 d	25.7 b	9.7 df
P_2xT_3	196.3 c	14.7 c	20.0 bc	11.2c	201.0 c	17.0 c	20.0 cd	11.0 c
P_2xT_4	147.3 de	17.4 b	18.7 bc	13.2b	152.3 de	21.0 b	13.0 eh	12.3 b
P_2xT_5	120.0 eg	22.5 a	12.0 df	15.3 a	125.0 ef	26.7 a	10.3 fj	15.7 a
P_3xT_1	246.3 ab	5.7 ij	12.0 df	4.3pq	286.0 a	4.7 o	15.3 cf	3.5 p
P_3xT_2	192.0 c	6.7 hi	9.7 eg	5.2no	197.7 c	5.7 no	12.3 fi	4.2 op
P_3xT_3	172.7 cd	8.0 gh	8.0 eh	6.1km	178.3 cd	6.7 ln	10.7 fj	5.5 ln
P_3xT_4	136.0 df	9.7 ef	7.2 fh	6.2kl	140.7 df	8.0 oh	9.3 gk	6.7 jk
P_3xT_5	84.0 gj	10.5 e	5.7 gh	8.5fg	77.7 df	11.7 e	7.0 ik	9.0 eg
P_4xT_1	73.3 hk	5.2 jk	10.2 eg	7.3ij	78.0 gh	5.7 no	11.7 fj	10.0 de
P_4xT_2	63.7 ik	5.8 ij	8.7 eh	7.7hi	69.0 gh	6.3 mn	10.3 fj	9.3 dg
P_4xT_3	46.3 jl	7.3 gh	8.3 eh	8.0gi	51.0 hi	7.7 jl	9.3 gk	8.3 gi
P_4xT_4	34.7 kl	7.7 gh	7.4 fh	8.6ef	43.0 hi	9.0 gi	8.7 hk	7.7 hi
P_4xT_5	18.0 l	8.3 g	6.5 gh	10.8cd	23.3 i	9.7 fg	6.3 jk	10.0 df
P_5xT_1	173.0 cd	3.3 l	9.2 eh	4.3pq	178.3 cd	3.3 p	11.0 fj	5.2 mn
P_5xT_2	139.3 df	4.2 kl	8.3 eh	5.2no	145.3 df	5.2 o	11.3 fk	6.3 kl
P_5xT_3	121.0 eg	4.5 jl	5.5 gh	5.3mn	127.3 ef	5.7 no	9.7 fk	7.4 ij
P_5xT_4	99.3 fi	5.5 ik	4.3 h	6.5k	105.0 fg	6.8 km	7.7 hk	9.3 eg
P_5xT_5	45.3 jl	7.5 gh	4.0 h	8.3gh	52.7 hi	9.0 gi	4.3 k	10.3 cd

P_1 = May P_2 = June P_3 = July P_4 = August P_5= September T_1-T_5 = Treatments

7. Interaction between N & K treatments and leaflets position

In both seasons, with T_1 (control), Fe concentrations were the highest in the terminal followed by basal and Middle leaflets, respectively. Also, with T_1 (control), Zn was nearly in the same trend. As for Mn and Cu concentrations, terminal leaflets were the highest with T_5, (Table 10).

Table (10): Mean effect of the interaction between leaflet position and N & K treatments on leaf micronutrient concentrations of Samany date palm during 2004/2005 seasons.

	Season (2004)				Season (2005)			
	Fe	Mn	Zn	Cu	Fe	Mn	Zn	Cu
T_1xB	460.1a	23.6 k	17.0 a	3.7 f	464.7a	21.8 j	15.6 a	4.5a
T_1xM	447.2a	22.0 k	15.3 b	3.8 f	451.9a	19.8 k	14.0 b	4.8a
T_1xT	463.3a	29.1 ij	17.4 a	3.5 f	467.0a	25.8 hi	15.3 a	5.0a
T_2xB	420.5a	27.9 j	14.0 cd	4.5 e	425.0a	24.4 i	12.8 c	5.2a
T_2xM	409.3a	30.7 hi	13.2 de	4.6 e	413.9a	27.2 gh	12.2 cd	5.4a
T_2xT	419.3a	36.4 ef	14.4 c	4.6 e	423.4a	33.5 f	12.7 c	5.5a
T_3xB	386.2a	32.8 gh	12.9 ef	5.1 d	389.7a	28.0 g	12.0 d	6.0a
T_3xM	392.8a	35.0 fg	12.3 fg	5.1 d	396.3a	32.5 f	11.0 e	6.3a
T_3xT	397.6a	40.3 d	13.2 de	5.3 cd	401.1a	38.1 d	11.9 d	6.0a
T_4xB	349.8a	37.9 de	11.3 h	5.3 cd	353.9a	33.5 f	09.8 f	6.6a
T_4xM	372.3a	39.5 d	11.6 gh	5.6 c	363.5a	36.0 e	10.3 ef	6.7a
T_4xT	377.8a	48.3 b	11.7 gh	6.2 b	381.7a	45.6 b	10.5 e	7.1a
T_5xB	255.3a	46.3 bc	09.3 i	6.2 b	253.4a	43.8 b	07.3 h	7.7a
T_5xM	286.3a	44.2 c	08.8 i	6.2 b	285.3a	41.2 c	07.4 h	7.8a
T_5xT	315.2a	59.3 a	09.1 i	7.8 a	319.5a	55.9 a	08.2 g	8.5a

T_1-T_5 = Treatments B = Leaflets basal M = Leaflets middle T = Leaflets terminal

8. Interaction between sampling time and leaflets position.

Table (11) showed that during August, concentrations of Fe and Cu were high in middle, followed by basal and terminal leaflets, respectively, while Zn was high in terminal followed by the basal and middle leaflets, respectively. As for Mn the terminal leaflets were the highest in September.

Table (11): Mean effect of the interaction between leaflets position and sampling time on leaf micronutrient concentrations of Samany date palm 2004/2005.

	Season (2004)				Season (2005)			
	Fe	**Mn**	**Zn**	**Cu**	**Fe**	**Mn**	**Zn**	**Cu**
Basal x May	253.5 g	17.5 h	10.9a	4.1 jg	257.7 h	19.5 gh	09.7a	4.6 h
Middle x May	236.7 g	19.9 h	10.0a	4.3 j	242.1 h	21.5 g	08.9a	4.8 h
Terminal x May	243.7 g	28.2 j	10.9a	5.4 cd	247.5 h	29.4 j	09.3a	6.2 de
Basal x Jun.	294.8 j	23.1 j	11.9a	5.0 e	300.1 jg	18.6 h	10.4a	5.9 j
Middle x Jun.	309.3 ej	24.9 g	10.6a	5.2 de	314.3 jg	20.3 gh	09.5a	5.9 ej
Terminal x Jun.	353.5 d	34.6 e	11.6a	6.6 a	357.9 e	30.1 j	10.2a	6.7 c
Basal x Jul.	430.9 c	39.4 d	12.0a	5.1 de	428.6 d	33.9 e	10.7a	6.4 d
Middle x Jul.	450.7 c	41.8 d	11.9a	5.0 e	448.4 cd	36.4 d	10.7a	6.3 d
Terminal x Jul.	460.3 c	49.6 b	12.5a	5.6 c	464.2 c	43.7 b	11.1a	6.9 bc
Basal x Aug.	602.0 b	48.7 bc	19.9a	6.8 a	605.6 b	43.9 b	18.1a	8.1 a
Middle x Aug.	660.7 a	46.3 c	18.8a	6.9 a	650.7 a	41.3 c	17.2a	8.3 a
Terminal x Aug.	587.4 b	47.2 bc	19.9a	6.0 b	591.5 b	44.0 b	18.5a	7.2 b
Basal x Sep.	290.7 j	39.9 d	09.8a	3.8 g	294.8 g	35.6 de	08.5a	5.2 g
Middle x Sep.	250.5 g	39.5 d	09.9a	3.9 jg	255.4 h	27.3 d	08.6a	5.9 j
Terminal x Sep.	328.2 de	53.8 a	10.9a	3.8 g	331.5 ej	51.8 a	09.6a	5.2 g

Conclusion

From the overall data of this investigation, it could be concluded that the micronutrient disorders could have been a combined deficiency of Mn, Zn and Cu. the values of Mn, Zn and Cu in Samany date palm leaves were below standard. A high soil pH value, and poorly aerated soils, consequently decreased the availability of micronutrients in soil may cause a deficiency. The results confirm that the increase of N and K fertilizers led to increase of demand of Fe and Zn by the date palm trees. It is recommended that application of micronutrients must be used side by side with macronutrient fertilizers. Micronutrients can be mostly controlled by foliar application. Fe, Mn, Zn, and Cu concentrations increased from the basal to the terminal leaflets and with leaf age from May till August. Applying the rates of N & K (1.5+1.5) kg/palm/yearly caused the highest values of TSS in the two seasons and total sugars and reducing sugars in the first season. (1.75+1.50) kg/palm/yearly gave the lowest total acidity and highest non-reducing sugars in the first season, while (2.00+1.50) kg/palm/yearly gave the highest moisture content in the first season. ACKNOWLEDGMENT

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التغييرات في العناصر الصغرى والصفات الكيميائية لنخيل البلح السمانى وتأثرها بالتسميد النتروجينى والبوتاسي

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أجريت هذه الدراسة خلال موسمي ٢٠٠٤،٢٠٠٥ على نخيل البلح السمانى النامي في منطقة القناطر الخيرية وذلك لدراسة تأثير التسميد النيتروجيني في صورة (نترات الأمونيوم) والتسميد البوتاسى في صورة (كبريتات البوتاسيوم) على حالة العناصر المغذية الصغرى للأوراق والصفات الكيميائية للثمار ومحتواها من العناصر المغذية الصغرى وكذلك دراسة تأثير ميعاد أخذ العينة وموقع الوريقات على طول الورقة (القاعدي ، الأوسط ، الطرفي) والتفاعل بينهم على محتوى العناصر الصغرى في الأوراق والثمار وذلك بغرض الحصول على معلومات تساعد في وضع برامج سمادية مناسبة لأشجار النخيل تحت هذه الظروف والمناطق المشابهة لها

هذا وقد أوضحت النتائج المتحصل عليها الآتي:-

- أشجار النخيل المسمدة ب ٥.١ كجم نترات أمونيوم + ٥.١ كجم سلفات بوتاسيوم شجرة/سنة أعطت أعلى نسب للمواد الكلية الذائبة (TSS) خلال موسمي الدراسة وللسكر الكلى وللسكر المختزل خلال الموسم الأول.
- أشجار النخيل المسمدة ب ٧٥.١ كجم نترات أمونيوم + ٥٠.١ كجم سلفات بوتاسيوم شجرة/سنة أعطت اقل حموضة كلية وأعلى نسبة للسكر غير المختزل خلال الموسم الأول.
- أشجار النخيل المسمدة ب ٠٠.٢ كجم نترات أمونيوم + ٥٠.١ كجم سلفات بوتاسيوم شجرة/سنة أعطت أعلى محتوى رطوبى خلال الموسم الأول.
- تركيزات عناصر المنجنيز والزنك والنحاس في أوراق نخيل البلح السمانى أقل من الكافي
- بزيادة جرعة التسميد النيتروجيني والبوتاسى أدى إلى نقص تركيز كل من عنصري الحديد والزنك وزاد تركيز كل من عنصري المنجنيز والنحاس في الأوراق والثمار في كلا الموسمين.
- العنصر السائد على بقية العناصر الصغرى في ثمار البلح السمانى هو عنصر الحديد.
- محتوى العناصر الصغرى في وريقات أشجار نخيل البلح السمانى اختلف تبعا لوقت أخذ العينة (مايو إلى سبتمبر) وموقع الوريقات (قاعدي-وسطى-طرفي) على طول الورقة.
- محتوى العناصر الصغرى في وريقات أشجار نخيل البلح السمانى زاد مع زيادة عمر الورقة من مايو حتى اغسطس ثم نقص في سبتمبر.
- محتوى العناصر الصغرى في ثمار نخيل البلح أعلى نسبياً في بداية نمو الثمار ثم يقل المحتوى تدريجياً أثناء فترة نمو الثمار.
- محتوى العناصر الصغرى في وريقات أشجار نخيل البلح السمانى يزيد من الثلث القاعدي في اتجاه الثلث الطرفي للورقة.

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