Nutritional Evaluation of Some Date Palm (*Phoenix Dactylifera* L.) Cultivars Grown Under Egyptian Conditions

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Abstract: A field study was carried out during two consecutive years (2010-2011) at private orchard located in El-Minia governorate (Upper Egypt) on 22 years old Zaghloul, Samany, Hayany date palm (*Phoenix dactylifera* L.) cultivars to investigate soil and leaf nutritional status and their reflection on yield quantity. Soil test showed that the soil was deficient in Zn and Cu, while leaf analysis showed that the trees suffering from K and Mn deficiency in the first season (2010); K, Ca, Mg, Mn and Zn deficiency in the second season (2011). Consequently, the yield of the first season was higher than the yield of the second season. However, Samany cultivar gave the highest yields along the two seasons which indicate its higher tolerance to the soil unfavorable conditions than Zaghloul and Hayany cultivars. More studies should be done to design fertilizer programs depend upon soil test and leaf analysis for different date palm cultivars grown under different environmental conditions.

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Key words: Date palm (*Phoenix dactylifera* L.), var. Zaghloul, Samany, Hayany, Nutrient status.

1. Introduction

The date palm (*Phoenix dactylifera* L.) is one of the oldest cultivated trees in the world. According to **FAO (2010).**, Egypt is considered among the top ten date producers, Zaghloul, Samany, Hayany are the most economically important dare palm cultivars grown in Egypt. Date fruits constitute a substantial part of the diet of the Egyptian people, especially in the month Ramadan. Dates fruits contain substantial amounts of sugars, minerals and vitamins. According to **Robinson (1972),** 15 dates fruits would provide more than 80% of daily body requirement of magnesium, 70% of sulfur, 25% of potassium, 20% of calcium, and a substantial amount of the body requirements from iron, manganese, copper and zinc **(Underwood, 1977).** To meet the increased demand on date palm fruits, there is a need to maximize its production. One of the important factors affecting fruit quality and productivity of date palm is fertilization. A research done on the date palm showed that proper application of macro and micro nutrient fertilizers is necessary to increase quantitative, qualitative and economical output of date production in palm groves.

Fertilizer trials has been made on different date palm cultivars to increase yielding ability besides improving fruit quality (**Minessy *et al.,* 1974; Shawky and Mougheth 1974; El-Hassanin, *et al*, 1994; Kassem *et al.*, 1997; Shawky *et al.*, 1999; Atalla *et al.,* 1988, 2001 and 2003; Soliman and Osman 2003; Shaaban, *et al.*, 2006; Soliman, and Shaaban 2006; Shaaban and Soliman. 2007).**

The objective of the present study was to study the nutritional status of some Egyptian date palm trees and its reflection on yield.

2. Materials and Methods

The present investigation was carried out on about 22 years old Zaghloul, Samany and Hayany date palm cultivars grown at a private orchard under conditions of El-Minia governorate (Upper Egypt) during the two successive seasons of 2010 and 2011 to study the effect of the nutritional status under farm conditions on trees yield. Soil texture of the orchard was loamy and the trees were cultivated at a density of 240 tree/ha., and surface irrigated with Nile River water.

Fertilization:

Farm manure was added once every year during winter in the rate of 25 Kg/tree. Nitrogen was added in the rate of 280gN/tree as ammonium sulphate (20.6%N) at three equal doses in March, May and July Phosphorus was added in the rate of 155g P_2O_5/tree as calcium superphosphate (15.5% P_2O_5) as one dose in December and 480g K_2O/tree as potassium sulphate (50% K_20) were added at two equal doses in March and May. Zinc sulphate was added as a rate of 150g/tree in the end of January, only in the first season. The fertilizers were broadcasted on soil surface 1.5 m apart from the palm trunk. The yield of experimental palms was harvested at the first half of August in the two seasons

Sampling:

Soil samples were taken from 0-60cm depth of equal distances and depths from the trunk of the tree in Oct-Nov. (before fertilizer application). Leaf samples were collected, under natural growth conditions from adult trees at September. Leaf samples were picked up randomly as described by **Shawky and Mougheth (1974)** from the pinnae of the young leaves (less than one year old) at a constant height around the trees from the middle portion of the leaf above fruiting zone.

Analysis:

Soil:

Soil samples were analyzed for texture, pH and electrical conductivity (EC) using water extract (1:2.5) method, for total calcium carbonate ($CaCO_3$%): calcimeter method and for organic matter (O.M%) using potassium dichromate **(Chapman and Pratt, 1978).**

Phosphorus was extracted using sodium bicarbonate **(Olsen *et al.*, 1954).** Potassium (K), calcium (Ca) and Magnesium (Mg) and sodium (Na) were extracted using ammonium acetate **(Jackson, 1973).** Iron (Fe), Manganese (Mn), Zinc (Zn) and Copper (Cu) were extracted using DPTA (**Lindsay and Norvell, 1978).**

Leaves:

Samples were washed with tap water, 0.001 M HCl, distilled water and dried in a ventilated oven at 70^{o} C for 48 hrs. Dried samples were ground in a stainless steel mill with 0.5 mm sieve.

Nutrients measurements:

Plant material was digested using an acid mixture consisting of nitric, perchloric and sulfuric acids in the ratio of 8:1:1 (v/v), respectively **(Chapman and Pratt, 1978**). Total N was determined in the dry plant material using the boric acid modification described by **Ma and Zuazage (1942),** and distillation was done using a Buechi 320-N2-distillation unit. Phosphorus was measured using spectrophotometer (Perkin-Elmer, LKB ultrospec:II) using the molybdate vanadate method according to **Jackson (1973).** Potassium, calcium and sodium were measured using Flame photometer (Jenway, PFP 7). Iron, Mn, Zn, Cu and Mg were measured using atomic absorption spectrophotometer (Perkin Elemer, 1100 B).

Evaluation of the nutrient status:

Soil data were evaluated according to **Ankerman and Large (1974)** and **Silvertooth, (2001)** whereas data of leaf analysis were evaluated according to **Van der Vorm (1992)** for macronutrients, **Lacoeuihe *et al.*, (1968), Marchal (1969)** for micronutrients. Data were subjected to statistical analyzed using, Costate Statistical package, in order to calculate means, standard deviations (SD), **(Anonymous, 1989).**

3. Results and Discussion

Soil nutrient status

According to the tentative values of the soil characteristics and available nutrient concentration by **Ankerman and Large (1974), Silvertooth (2001)** data presented in Table (1) indicate that the soil was loamy in texture, contains lower amounts of salts and having medium contents of organic matter and calcium carbonate. Data also, show that the orchard's soil suffers from very high pH and low Zn and Cu. On the other hand calcium was in the high range in both soils of the two varieties. A high availability of a nutrient in the soil does not necessarily mean that the plant can extract enough of that nutrient to meet its need. This means that the nutrients in the soil are imbalanced. Moreover, due to the very high pH, micronutrients and phosphorus should be present in forms that are less available to be taken by the trees roots **(Marschner, 1995).** Thus, micronutrients and phosphorus deficiency act as limiting factors for growth and yield production. Because it has a big root system, there is a general believed between farmers that date palm tree does not need fertilizer addition. This may was true before high dam construction, where huge amounts of sediments were brought up by the river water adding substantial amounts of mineral nutrients yearly to the soil where palm trees are grown. Field experiments on date palm showed the necessity of fertilizers to growth and fruits production**. Munir *et al.*, (1992)** reported that maximum yield of Dhakki date palm cultivar was obtained by adding 460g of nitrogen, 500g of P_2O_5 and 500g of K_2O per tree. The amount of nutrients yearly removed by one palm tree var. Taboni through fruits and leaf pruning was 472 g N, 47.7g P, 422.6 g K, 218.9g Ca, 36.4 g Na, 5.8 g Fe, 1.2 g Mn, and 1.3g Zn. This estimate assumed a total fresh weight of 100 Kg of dates from 10 bunches **(EI-Shurafa, 1984).** Also, **Shaaban, *et al*., (2006)** found that the total nutrients removed annually by one palm tree var. Samany under moderate pruning were: 776g N; 166g P; 1218g K; 335g Ca; 222g Mg; 31g Na; 19g Fe; 1.4g Mn; 1.1g Zn and 0.7g Cu (average of two seasons). Such huge nutrients removed from soil, must compensate to obtain high yield and good quality.

Leaf nutrient status

As reflection of soil conditions, the trees were suffering from K and Mn deficiency in the first season (2010), K, Ca, Mg, Mn and Zn deficiency in the second season (2011) (Table 2). Direct causes for the deficiency of these nutrients are high pH values and lack of micronutrients fertilization. Potassium is an important nutrient for date palm growth and productivity. Potassium is necessary for the formation of sugars, synthesis of proteins, cell division and growth, fruit formation and improvement of fruit size, flavor and colour **(Abbas and Fares, 2008).** Potassium has also been shown to promote plant disease reduction **(Holzmueller *et al.,* 2007).** Manganese acting as an activator of the dehydrogenases, transferases, hydroxylases, and decarboxylases involved in respiration, amino acid, lignin and hormone synthesis **(Graham, 1983, Burnell, 1988)**

Even so, the trees received organic manure and NPK chemical fertilizers in the experimental growth seasons; they still suffer from nutrient deficiency. This declared that the applied fertilizer program was not suitable for trees nutrient requirements. Balance of cations in the root zone is very important to realize good nutrient absorption and nutrient balance in the shoot tissues. **Baker and Amacher (1981)** defined normal values for the exchangeable cations in the soil solution as 60-80% for Ca, 10-20% for Mg, and 2-5% for K.

Table 1. Soil analysis of the experimental orchard (average of two years).

Analysis \ Variety	Zaghloul	Samany	Hayany
Sand%	22	22	22
Silt%	42	42	42
Clay%	36	36	36
Texture	Loamy	Loamy	Loamy
pH (1:2.5)	8.66 VH	8.87 VH	8.84 VH
EC. dS/m (1-2.5)	0.24 VL	0.14 VL	0.15 VL
O.M %	2.41 M	2.34 M	2.61 M
$CaCO_3$%	2.40 M	3.20 M	3.20 M
Macroelements (mg/100g)			
P	1.56 M	1.82 M	1.69 M
K	28 M	24 M	32 H
Ca	600 VH	300 H	300 H
Mg	148 M	164 M	160 M
Na	30 M	20 L	24 L
Microelements (ppm)			
Fe	16 M	20 H	18 H
Mn	11 M	15 H	13 H
Zn	0.9 L	0.9 L	0.9 L
Cu	0.5 L	0.3 L	0.4 L

VL= very low, L= Low, M= medium, H= high, VH= very high

Table 2.Range, mean±SD of date palm leaf nutrient contents in El-Minia Governorate

Nutrient \ Variety	Zaghloul		Samany		Hayany	
	Range	Mean±SD	Range	Mean±SD	Range	Mean±SD
%	Season 2010					
N	1.02 – 1.59	1.33±0.26 H	0.83 – 1.63	1.21±0.33 H	0.92 – 1.44	1.25±0.23 H
P	0.12 – 0.14	0.13±0.01 H	0.09 – 0.11	0.10 ±0.01 M	0.09 – 0.15	0.11±0.03 M
K	1.78 – 1.91	1.86±0.06 L	1.84 – 1.98	1.93±0.06 L	1.80 – 1.95	1.89±0.07 L
Ca	0.30 – 0.35	0.33±0.02M	0.31 – 0.36	0.33±0.02M	0.35 – 0.39	0.37±0.02M
Mg	0.45 – 0.54	0.50±0.04 H	0.45 – 0.62	0.52±0.07 H	0.33 – 0.39	0.36±0.03 M
Na	0.05 – 0.08	0.07±0.01 L	0.05 – 0.10	0.07±0.02 L	0.04 – 0.11	0.07±0.03 L
ppm						
Fe	233 – 305	269±30 M	121–304	250±87M	175 – 302	241±52M
Mn	34 – 40	36±3 L	26– 31	27±3 L	23– 30	28±3 L
Zn	41– 49	44±4 M	48– 72	55±11 M	50– 61	55±5 M
Cu	6– 9	7.5±1.3 M	7– 9	8.0±1.0 M	8– 9	8.5±0.6 M
%	Season 2011					
N	1.35 – 1.87	1.69±0.30 H	0.72 – 1.44	1.05±0.36 H	1.10 – 1.27	1.18±0.09 H
P	0.15 – 0.21	0.17±0.03H	0.10 – 0.12	0.11±0.01 M	0.13 – 0.14	0.14±0.01 H
K	1.56 – 1.63	1.58±0.04L	1.63 – 1.87	1.75±0.12 L	1.49 – 1.58	1.54±0.05 L
Ca	0.10 – 0.19	0.16±0.05L	0.18 – 0.19	0.19±0.002L	0.18 – 0.19	0.19±0.003L
Mg	0.13 – 0.15	0.14±0.01 L	0.10 – 0.13	0.11±0.02 L	0.13 – 0.18	0.15±0.03 L
Na	0.02 – 0.03	0.02±0.006L	0.01 – 0.03	0.02±0.01 L	0.01 – 0.03	0.02±0.01 L
ppm						
Fe	160 – 334	234±90 M	117 – 236	167±62 M	175 – 232	209±30 M
Mn	44 – 58	50±7 L	24 – 31	28±4 L	26 – 52	38±13 L
Zn	17 – 18	18±1 L	18 – 22	19±2 L	18 – 28	21±6 L
Cu	5 – 7	6±1 L	6 –7	7±1 M	6 – 9	8±2 M

L= low, M= medium, H= high, VH= very high

Yield analysis

The unsuitable fertilizer program was reflected as low fruit yields of the three cultivars Zaghloul, Samany and Hayany (Table 3). For example, Zaghloul cultivar yield is about 85% of that achieved by **Marzouk and Kassem (2011)** for the same cultivar. On the other hand there was a reduction in the trees production in the second year (2011) by 13.9%, 20.5% and 20% for Zaghloul, Samany and Hayany, respectively compared to the first year (2010). This may because in the second year Ca, Mg and Zn deficiency were appeared rather than K and Mn. Calcium deficiency can reduce cell wall

strength. The cell wall contained it. **(Bakshi *et al*.**, 2005). Excess vegetative vigour, may results in a dilution of the calcium contents.

Magnesium is a component of the chlorophyll molecule, acts as a cofactor for many enzymatic processes associated with phosphorylation, dephosphorylation, and the hydrolysis of various compounds, and acts as a structural stabilizer for various nucleotides. Studies indicate that 15 to 30% of the total magnesium in plants is associated with the chlorophyll molecule **(Marschner, 1995).** Zinc is an integral component of enzyme structures and has catalytic, coactive and structural functions in the plants **(Vallee and Auld, 1990, Vallee and Falchuk, 1993).** Potassium, calcium, magnesium and micronutrients deficiency can correct by applying foliar sprays or application fertilizers containing them.

However, the highest production under such conditions was achieved by Samany cultivar followed by Zaghloul and the lowest yield was produced by Hayany cultivar. This means that samany cultivar is the most resistant to the soil unfavorable conditions than the other two cultivars.

Table 3. Date palm production (Kg/tree) under the trial condition

Variety	Season 2010	Season 2011
	Yield (kg/tree)	
Zaghloul	180	155
Samany	220	175
Hayany	175	140

Conclusions

From the present study, it can be concluded that:

- Date palm trees grown under farm conditions suffer from nutrient deficiency and soil unfavorable conditions.
- Sammany cultivar is more resistant to soil and climate unfavorable conditions than Zaghloul and Hayany.
- More studies should be done to stabilize fertilizer programs depend upon soil test and leaf analysis for different date palm cultivars to achieve better growth and higher yields

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