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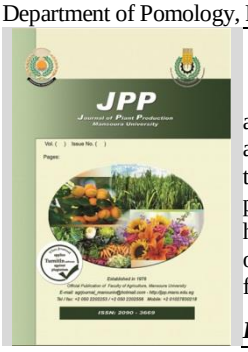
Developing Yield and Fruit Quality of Date Palms Cv. Zaghloul by Drenching the Soil with Micronutrients Compound and Amino Acids

Ameer M. Shalan*

Department of Pomology, Faculty of Agriculture, Mansoura University, 35516, Mansoura, Egypt



ABSTRACT

A field trial was carried out during two successive seasons 2018 and 2019 in sandy soil by drenching soil around Zaghloul date palm trees (One meter away from the trunk) with micronutrients compound and amino acids at different levels for evaluating their effect on the productivity and fruits quality of Zaghloul date palm trees. The palms supplied with 120 g micronutrients + 150 ml amino acids/palm/year (T9) showed the more pronounced effect above all estimated parameters compared to other treatments or the control during this study; hence, it enhanced percentages of fruit set, retained fruit, chlorophyll in leaflets and nutrient uptake which reflect on increasing bunch weight and yield per palm. Likewise, it improved fruit quality and retained its properties well for 3 days during shelf life after harvest.

Keywords: Micronutrients – Amino acids – Date - Palms – Zaghloul – dactylifera.

INTRODUCTION

Date palm cv Zaghloul (*Phoenix dactylifera*, L.) is the most favorable cultivar in Egypt at the Bisir stage. It is a diploid (2n = 36), perennial, and monocotyledonous plant of the Arecaceae (Palmaceae) family (Nixon and Carpenter, 1978 and Dransfield *et al.*, 2008) and widely cultivated in newly reclaimed areas of the Middle East and North Africa (Al-Khayri and Al-Bahrany, 2001).

Most of the newly reclaimed areas in Egypt are sandy and loamy sand soils with a high $CaCo_3$ level. These soils have an extremely low cation capacity and a tendency to leach or fix nutrient (Tisdale and Nelson, 1978 and Youssef and Awad, 2008); furthermore, it is characterized by several environmental stress which causes significant crop losses, its include high salinity, temperature extremes, mineral nutrient deficiency and topography (Youssef and Awad, 2008).

Date palm cv Zaghloul is one of the fruit crops that can grow in such soils due to its capability to tolerate drought and stress. Production levels of the crop in these areas are generally small due to poor soil fertility. Accordingly, it seems that Date palm cv Zaghloul needs additional mineral nutrients but most date producers have adopted the practice of producing acceptable yield by the improper quantity of macronutrients (N, P, and K) without application of micronutrients. This level of production can be improved greatly by fertilizer addition, which also improves the quality of fruits (Khayyat *et al.*, 2007 and Osman, 2010); hence, a fully productive date palm tree can support up to 30 clusters, which can carry more than 300 kg of fruits (Jain *et al.*, 2011).

Therefore, it is important to involve micronutrients in fertilization program of date palm cv Zaghloul because they help in improving fruit set, fruit retention, and development as well as total yield and fruit quality (Sarrwy *et al.*, 2012). It is preferable to use in chelated forms; hence, micronutrients like iron, copper, zinc, molybdenum, magnesium, and manganese if applied directly as inorganic salts, become insoluble forms, so their absorption by the plant decreases. The chelating agent protects the metal ions from undesirable chemical reactions such as precipitation and hence increases the availability of these metal ions to plants (Datir, 2012). Besides, it is important to use amino acids in fertilization program of Date palm cv Zaghloul to face environmental stress in newly reclaimed areas; hence; amino acids might have contributed in the absorption of micronutrients and also served as a source of nitrogen to the additional increase in growth contributing characters (Datir, 2012); moreover, amino acids are considered as precursors and constituents of proteins (Rai, 2002), which are important for stimulation of cell growth. They contain both acid and basic groups and act as buffers, which help to maintain favorable pH value within the plant cell (Davies, 1982).

Many researchers recommended giving micronutrients to date palm trees by trunk injection or foliar application (Gholamreza and Mohammad, 2010 and Hashem and Jamal, 2018) to avoid losing these elements through soil fertilization by leaching or soil fixation under sandy soil conditions. But this hypothesis is not logical according to the morphological structure of date palm tree; hence, it is a monocotyledonous plant that has highly developed fibrous roots and lignified trunk that lacks cambium, hence it cannot be grafted or getting elements by injection. Furthermore, it has large leaves at the apex, reaching the height of over 20 m, having a crown radius of about 7-8 m and the leaves are 4-5 m long (Jain *et al.*, 2011) which reduces the efficiency of the foliar process in date palm trees.

Therefore, this field experiment aims to enhance micronutrients uptake in the fertilization program of Date palm cv Zaghloul by examining the effect of various combination levels of compound micronutrients and amino acids on its productivity in the newly reclaimed soil for achieving better growth and higher yield.

* **Corresponding author.**
E-mail address: amir_shalan@yahoo.com
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MATERIALS AND METHODS

1. Plant materials and experimental implementation

This trail was consummated during 2018 and 2019 seasons on Zaghloul Date palm in a sandy region at Kalabsho city, Mansoura Governorate, Egypt for appraising its fruit set and retention percentage, yield, leaflet mineral content, chlorophyll percentage, physiochemical fruit characteristics and shelf life under different levels of compound micronutrients with amino acids. Before the start of the trial, the soil properties were predestined (Table 1)as stated by Jones (2001).

It has been found that the soil has a sandy texture and is slightly saline. Soil pH is basic (about 8.1). In general, the nutritional status of the soil is low (Table 1). The level of soil organic matter content (OM) is low in the surface and subsurface layers (about 0.89%), due to the climatic condition of the studied area, which favors its rapid decomposition. The N, P and K contents are also low. Levels of available micronutrients are very low. In general, the soil of the study area requires NPK and micronutrients to achieve a nutrient balance for better plant growth.

Before the start of the trial, the palms were fertilized with chicken manure in the rate of 25 Kg/palm and Phosphorus in the rate of 5 Kg/palm as calcium superphosphate (15.5% P2O5) once every year during December. During the growing season, Nitrogen was added in the rate of 5 Kg/palm as ammonium sulfate (20.6%N) at three equal doses in March, May, and July. Potassium was added in the rate of 2 Kg/palm as potassium sulfate (50% K20) at two equal doses in March and May. The fertilizers were broadcasted on soil surface 1 m apart from the palm trunk but received no micronutrient fertilizer.

The trial was designed as a randomized complete block design with three replicates (one palm/replicate) by using 30 Zaghloul date female palms which were 22-year-old, nearly similar in growth vigor and spacing at 7 m apart.

Table 1. Physical and chemical analysis of the experimental soil.

Soil characters		0-30 cm	30-60 cm	60-90 cm
Mechanical analysis (%)	Coarse sand	6.92	5.9	4.37
	Fine sand	73.15	71.92	70.33
	Silt	12.35	14.33	16.18
	Clay	7.58	8.66	9.12
	Texture class	Sandy	Sandy	Sandy
pH (1:2.5)		7.93	8.07	8.18
E.C. $dS.m^{-1}$(1:5)		1.18	1.10	1.03
O.M. %		0.89	0.72	0.64
Total $CaCO_3$ %		6.08	5.81	5.16
Water soluble ions meq/100g soil	Ca^{++}	1.18	1.07	0.98
	Mg^{++}	0.79	0.64	0.61
	Na^{+}	3.79	3.75	3.54
	K^{+}	0.28	0.17	0.14
	CO_3^{--}	-	-	-
	HCO_3^{-}	1.32	1.19	1.12
	Cl^{-}	2.98	3.42	3.38
	SO_4^{--}	1.74	1.02	0.77
Available (ppm)	N	43.2	39.6	35.4
	P	4.61	4.09	3.87
	K	109.2	66.3	54.6
Extractable DTPA (ppm)	Fe	2.98	2.05	1.72
	Zn	1.03	0.87	0.69
	Mn	1.44	1.12	1.02
	Cu	0.37	0.43	0.51
	B	0.93	0.82	0.71
	Mo	0.072	0.079	0.083

They received surface irrigation from the groundwater and were hand-pollinated from one male palm in 1st and 2nd seasons. The bunch thinning (8 leaves:1 bunch) was adjusted after a month from pollination during both seasons. Zaghloul date female palms were subjected to ten treatments as follows:

T_1	60 g micronutrients + 50 ml amino acids / palm / year	T_6	80 g micronutrients + 150 ml amino acids / palm / year
T_2	60 g micronutrients + 100 ml amino acids / palm / year	T_7	120 g micronutrients + 50 ml amino acids / palm / year
T_3	60 g micronutrients + 150 ml amino acids / palm / year	T_8	120 g micronutrients + 100 ml amino acids / palm / year
T_4	80 g micronutrients + 50 ml amino acids / palm / year	T_9	120 g micronutrients + 150 ml amino acids / palm / year
T_5	80 g micronutrients + 100 ml amino acids / palm / year	T_{10}	Control

The mentioned levels in every treatment were divided into three equal doses which added at the beginning of February, May, and July during both seasons.

The micronutrients which used in this trial is a compound micronutrients made by Eden Modern-Spain (Disper Complex GS®) composed of 5% chelated Iron (Fe) with EDDHSA, 0.6% Boron (B), 0.2% Molybdenum (Mo) and 4% Manganese (Mn), 2% Magnesium (MgO), 0.5% Zinc (Zn), 0.4% Copper (Cu) chelated with EDTA. And the amino acid complex is made by Green Universe Agriculture, S.L, Madrid-Spain (Universe Rich®) composed of 10% Nitrogen and 14.67% amino acids at L-α form which suitable for up taking by the plant.

All applications were implemented by drenching the soil around the palm trunk (at a distance of one meter from the trunk) and were inserted into the top 30 cm layer of soil by mixing with 10 L irrigation water.

2. Fruit set percentage

The number of nodes and set fruits in twenty-five strands per palm was recorded after 1 week of last addition (beginning of July). The fruit set percentage was estimated using the following formula:

$$\text{The percentage of fruit set} = \frac{\text{Total number of set fruit per strand}}{\text{Total number of nods per strand}} \times 100$$

3. Retained fruit percentage

The retained fruit percentage was calculated at the harvest time according to the following formula:

$$\text{The retained fruit percentage} = \frac{\text{Total number of retained fruits per bunch}}{\text{Total number of the nodes per bunch}} \times 100$$

4. Yield (kg/palm):

In both seasons, bunches were harvested during the second week of October at the bisir stage when fruits became crunchy and red. Then the bunch weight was estimated in kilograms and its number per palm was registered to calculate the yield per palm in kilograms.

5. Chlorophyll and pinnae (leaflets) mineral content

A leaf sample of four fully expanded leaves which endure the fruit bunches in their axis around the head of each palm (about two years old) was collected haphazardly from each palm at mid of July in 1st and 2nd seasons to determine

leaflets mineral content (Zn, Fe, Mn, Cu, B, N, P, K, Ca and Mg) and chlorophyll. Leaflets samples (30 leaflets/replicate) were collected randomly from the middle leaves portion to measure chlorophyll by using CCM-200 plus Chlorophyll Content Meter and determining the mentioned minerals as outlined by Jones (2001).

6. Fruit quality and shelf life

Eighty fruits at Bisir stage were randomly collected from each replicate, 50 fruits to determine fruit quality and 30 fruits for shelf life. The dimensions (length and diameter) were measured in (cm) using a digital caliper. Fruit weight was measured in (g) using a digital balance. Fruit firmness was estimated as ($Ib.in^{-2}$) by a hand Effegi-Penetrometers provided with plunger 3 mm diameter according to Ameer and El-Boray (2019). An identical sample was established from 25 fruits per replicate for estimating soluble solids content (SCC) as Brix % by a digital refractometer and titratable acidity percentage of malic acid in fruit juice (AOAC, 1995). SSC/acid ratio was expressed by the ratio between them. The residual fruit characteristics i.e. total anthocyanin (mg/100g), dry matter (%), total sugar (%), tannins (%), calcium content (mg/100) were measured to determine fruit quality according to Mazumdar and Majumder (2003); finally, fruit No_3-N content was estimated as ppm (Jones, 2001).

The fruits which were set aside for shelf life were weighted and held for two days after harvest then several parameters were determined i.g. loss in weight (%), rutab (%), total sugar (%), tannins (%), SSC (%), Titratable acidity (%), SSC/acid ratio, Fruit dry matter (%) according to Mazumdar and Majumder (2003); hence, loss in weight was calculated as percentage referring to the following equation:

$$\text{Weight loss \%} = \frac{\text{Initial weight} - \text{weight at sampling date}}{\text{Initial fruit weight}} \times 100$$

While, rutab fruits is that displayed visible alteration in 20% of its surface color to dark brown and its percentage was calculated referring to the following equation:

$$\text{Rutab \%} = \frac{\text{Weight of rutab fruits}}{\text{Initial weight}} \times 100$$

7. Experimental Design and Statistical Analysis: The experiment was designed in a complete randomized model with three replicates per treatment. One way ANOVA was run using the SAS program according to Snedecor and Cochran (1994). Means were compared using the least significant differences (LSD) at 5% level of probability (Waller and Duncan, 1969).

RESULTS AND DISCUSSION

The obtained results indicated that micronutrients with amino acids worked in harmony to improve the behavior and productivity of Zaghloul date palm trees as follow:

1. Percentage of set and retained fruit, bunch weight and yield per palm:

Data presented in Table 2, indicate that fertilizing Zaghloul date palm with micronutrients and amino acids increased fruit set (%), retained fruit (%), the weight of bunch (Kg) and yield per palm (Kg) as compared to untreated palms in the 1st and 2nd seasons. Palms drenched by 120 g micronutrients + 150 ml amino acids/palm/year gave the highest percentage of fruit set (89.83 & 91.03 %), retained fruit (44.92 & 45.52 %), and the heaviest bunch weight (16.20 & 18.70 kg) and yield/palm (220.15 & 256.30 kg) in the first and second seasons, consecutively. The lowest percentage of fruit set (71.59 & 72.79 %), fruit retention (35.80 & 36.40 %), bunch weight (7.10 & 9.60 kg) and yield per palm (92.30 & 94.80 kg) were obtained from control in the first and second seasons, consecutively.

This might be due to that micronutrients contain some elements that have the main role in increasing the percentage of a set and retained fruit such as boron and zinc (Etman *et al.*, 2007; Hansch and Mendel, 2009). These increment in fruit set percentage due to boron may be attributed to its role in maintaining high pollen survival, germination, and pollen tube elongation (Zia *et al.*, 2006; Harhash and Abdl-Nasser, 2010) and for fruit retention percentage, it has a role in cell wall metabolism in higher plants (Blevins and Lukaszewski, 1998), growth and development of fruit (Goldbach, 1997 and Marschner, 2012) formation of borate cross-links of pectin in presence of Ca^{++} to produced more cemented cell wall (Blevins and Lukaszewski, 1998), especially in abscission zone during fruit development which results in improving fruiting rate (Tsukahara *et al.*, 2013).

Table 2. Effect of micronutrients and amino acids at different concentrations on fruit set (%), retained fruit (%), bunch weight (kg) and yield per palm (Kg) of Zaghloul date palm trees during the 2018 and 2019 seasons.

Treatments	Fruit set (%)		Retained fruit (%)		Bunch weight (kg)		Yield / palm (Kg)	
	2018	2019	2018	2019	2018	2019	2018	2019
60 g micronutrients + 50 ml amino acids / palm / year	72.79	73.99	36.40	37.00	9.30	11.80	101.67	104.17
60 g micronutrients + 100 ml amino acids / palm / year	79.22	80.42	39.61	40.21	10.17	12.67	109.50	160.00
60 g micronutrients + 150 ml amino acids / palm / year	84.91	86.11	42.46	43.06	10.95	13.45	112.00	157.50
80 g micronutrients + 50 ml amino acids / palm / year	85.31	86.51	42.66	43.26	11.25	13.75	204.60	207.10
80 g micronutrients + 100 ml amino acids / palm / year	85.95	87.15	42.98	43.58	12.15	14.65	206.55	209.05
80 g micronutrients + 150 ml amino acids / palm / year	86.76	87.96	43.38	43.98	12.95	15.45	210.60	213.10
120 g micronutrients + 50 ml amino acids / palm / year	87.35	88.55	43.68	44.28	13.45	15.95	215.20	217.70
120 g micronutrients + 100 ml amino acids / palm / year	88.90	90.10	44.45	45.05	14.10	16.60	222.65	253.80
120 g micronutrients + 150 ml amino acids / palm / year	89.83	91.03	44.92	45.52	16.20	18.70	220.15	256.30
Control	71.59	72.79	35.80	36.40	7.10	9.60	92.30	94.80
LSD at 5%	1.32	1.32	0.66	0.66	0.12	0.11	1.53	1.52

Moreover, zinc increases fruit removal force due to its involvement in many enzymatic reactions that regulate protein and carbohydrate metabolism necessary for growth and development (Harhash and Abdl-Nasser, 2010; Sarrwy *et al.*, 2012) and can be enumerated as promotion of the metabolism of auxin and pollen formation (Marschner, 2012). It could be explained that the presence of boron and zinc together at the same time fortified the positive effect on

fruit set. This may be due to the improved effect of these elements on the nutritional status of the palm, which reflected on enhancing fruit set, retention, and development.

In this regard, the increase in weight of bunch and yield per palm of Zaghloul date palm tree due to micronutrients and amino acids applications attributed mainly to their effect on increasing fruit retention (Davarpanah *et al.*, 2016); also, due to the role of magnesium on increasing leaf total chlorophyll content and hence photosynthesis level was increased (Bybordi and Shabanov, 2010) and consequently increasing fruit weight; also, presence of sufficient amounts of available Fe causes an increase in photosynthesis and carbohydrate motion in the plant which makes more production yield (Gholamreza and Mohammad, 2010).

Furthermore, amino acids increasing total yield under salinity stress by decreasing soil pH which improving nutrient availability especially microelements in calcareous soils. Also, they increase the activities of antioxidant enzymes and decreasing lipid peroxidation which reducing salt-induced oxidative damage (Abd El-Razek and Saleh, 2012). These results are in the same direction as that of Sarrwy *et al.* (2012); Omer *et al.* (2014) and Mostafa (2015) who mentioned that micro-nutrients improves fruit set, fruit retention, and development as well as yield and fruit quality.

2. leaflet mineral content:

Micronutrients and amino acids applications increased the leaflet content of micronutrients (Zn, Fe, Mn, Cu and B) compared to the control (Table 3). Fertilization with 120 g micronutrients + 150 ml amino acids followed by 120 g micronutrients + 100 ml amino acids/palm/year had the most pronounced effect on percentages of micronutrients and macronutrients during first and second seasons compared to untreated palms which presented the lowest values in this respect. Moreover, results for the leaflet macronutrients content (nitrogen, phosphorus, potassium, calcium, and magnesium) has adopted the same approach to the results of the micronutrients during both seasons; therefore, trees drenched with 120 g micronutrients + 150 ml amino acids/palm/year presented the highest significant effect in this respect compared with the other treatments; conversely, control trees gave the lowest leaflet content of macronutrients during 1st and 2nd seasons of study (Table 4).

Table 3. Effect of micronutrients and amino acids at different concentrations on leaflet micronutrient content (Zn, Fe, Mn, Cu and B) (ppm) of Zaghloul date palm trees during the 2018 and 2019 seasons.

Treatments	Zn (ppm)		Fe (ppm)		Mn (ppm)		Cu (ppm)		B (ppm)	
	2018	2019	2018	2019	2018	2019	2018	2019	2018	2019
60 g micronutrients + 50 ml amino acids / palm / year	1.46	1.59	15.61	15.74	4.97	5.10	2.93	3.06	14.07	14.20
60 g micronutrients + 100 ml amino acids / palm / year	1.72	1.85	16.03	16.16	5.15	5.28	3.10	3.23	14.28	14.69
60 g micronutrients + 150 ml amino acids / palm / year	1.95	2.08	16.36	16.49	5.31	5.44	3.26	3.39	14.56	14.93
80 g micronutrients + 50 ml amino acids / palm / year	2.17	2.30	16.67	16.80	5.47	5.60	3.45	3.58	14.82	14.95
80 g micronutrients + 100 ml amino acids / palm / year	2.38	2.51	16.98	17.11	5.60	5.73	3.61	3.74	15.06	15.19
80 g micronutrients + 150 ml amino acids / palm / year	2.57	2.70	17.25	17.38	5.73	5.86	3.74	3.87	15.30	15.43
120 g micronutrients + 50 ml amino acids / palm / year	2.74	2.87	17.53	17.66	5.86	5.99	3.90	4.03	15.57	15.70
120 g micronutrients + 100 ml amino acids / palm / year	2.91	3.04	17.83	17.96	6.01	6.14	4.04	4.17	15.83	15.96
120 g micronutrients + 150 ml amino acids / palm / year	3.08	3.21	18.09	18.22	6.14	6.27	4.18	4.31	16.04	16.17
Control	1.24	1.37	15.35	15.48	4.76	4.89	2.97	3.10	10.72	11.80
LSD at 5%	0.017	0.02	0.056	0.057	0.02	0.017	0.02	0.017	3.43	3.34

Such increase in the micro- and macro-nutrient in leaflets (Tables 3 and 4) might be due to an effect caused by increasing nutrient uptake; as a result, drenching soil around Zaghloul date palm trees with 120 g micronutrients + 150 ml amino acids/palm/year lead to an increase in nutrient availability and that coincides with facts reported by Yruela (2005) and Abdel Ghany and Pilon (2008) who mentioned that copper protein like Plastocyanin, being the most abundant copper protein promotes electron transport in the thylakoid lumen of chloroplasts.

Table 4. Effect of micronutrients and amino acids at different concentrations on leaflet macronutrient content (nitrogen, phosphorus, potassium, calcium and magnesium) (%) of Zaghloul date palm trees during the 2018 and 2019 seasons.

Treatments	N (%)		P (%)		K (%)		Ca (%)		Mg (%)	
	2018	2019	2018	2019	2018	2019	2018	2019	2018	2019
60 g micronutrients + 50 ml amino acids / palm / year	1.00	1.13	0.29	0.42	1.48	1.61	0.30	0.43	0.34	0.47
60 g micronutrients + 100 ml amino acids / palm / year	1.22	1.35	0.30	0.43	1.64	1.77	0.42	0.55	0.45	0.58
60 g micronutrients + 150 ml amino acids / palm / year	1.34	1.47	0.31	0.44	1.82	1.95	0.53	0.66	0.56	0.69
80 g micronutrients + 50 ml amino acids / palm / year	1.46	1.96	0.33	0.46	1.98	2.11	0.62	0.75	0.67	0.80
80 g micronutrients + 100 ml amino acids / palm / year	1.59	1.72	0.34	0.47	2.12	2.25	0.71	0.84	0.75	0.88
80 g micronutrients + 150 ml amino acids / palm / year	1.71	1.84	0.35	0.48	2.21	2.34	0.79	0.92	0.84	0.97
120 g micronutrients + 50 ml amino acids / palm / year	1.83	1.09	0.36	0.49	2.33	2.46	0.83	0.93	0.91	1.04
120 g micronutrients + 100 ml amino acids / palm / year	1.94	2.07	0.36	0.49	2.46	2.59	0.88	1.01	0.98	1.11
120 g micronutrients + 150 ml amino acids / palm / year	2.03	2.16	0.37	0.50	2.54	2.67	0.94	1.07	1.03	1.16
Control	0.96	1.59	0.27	0.40	1.32	1.45	0.18	0.31	0.22	0.35
LSD at 5%	0.056	0.057	0.002	0.003	0.017	0.02	0.02	0.04	0.017	0.02

Furthermore, amino acids act as a signaling component, i.e., increases antioxidant enzyme activity and causes efficient nutrient uptake (Calvo *et al.*, 2014; Persson *et al.*, 2003; Gioseffi *et al.*, 2012). Likewise, L-methionine which is considered one of the amino acids acts as a growth regulator of cytokinin, brassinosteroids, and auxin, increasing the initiation of roots; helps with the absorption of more nutrients by the plant (Davies, 2004; El-Awadi *et*

al., 2011), which may stimulate endogenous hormone homeostasis (Colla *et al.*, 2017; Rouphael *et al.,* 2017) and is required for the development of hairy roots (Davies, 2004) at optimum levels. Eventually, improve nutrient availability, and enhance plant quality (Rouphael and Colla, 2018; Rouphael *et al.*, 2018).

3. Leaflet chlorophyll percentage and fruit weight, length and diameter:

The highest leaflet chlorophyll percentage was (96.57 & 97.69 % in the two seasons, respectively) observed by drenching soil with 120 g micronutrients + 150 ml amino acids/palm/year; on the contrary, the lowest leaflet Chlorophyll percentage was (20.63 & 43.44 % in the two seasons, respectively) occurred with control (Table 5). That might be due to Zaghloul date palm trees supply its requirements from Mg, Fe and amino acids which support chlorophyll formation; hence, magnesium is an essential element for chlorophyll molecule structure that regulates photosynthesis process (Salama *et al.*, 2014); iron is essential for photosynthesis and chlorophyll biosynthesis (Jeong and Connolly 2009; Adamski *et al.,* 2012) and amino acids like L-methionine influence phytohormones which ultimately increases the chlorophyll content and chloroplast development or cytokinins (Bahari *et al.*, 2013; Anne and Thomas, 2015).

Referring to fruit weight, length, and diameter, data of Table (5) show that soil drenched with 120 g micronutrients + 150 ml amino acids/palm/year, presented the highest significant effect in this respect; hence, it resulted in 28.50 & 30.21 g for fruit weight, 5.88 &7.68 cm for fruit length and 2.54 & 3.31 cm for fruit diameter in the two seasons, respectively. Reversely, the untreated palms gave the lowest leaflet chlorophyll percentage and fruit weight, length and diameter during both seasons. That might be due to the role of micronutrients (zinc, iron, copper, and manganese) in increasing the activity of photosynthesis enzymes and increase the concentration of chlorophyll (Jain, 2008) which leads to a greater accumulation of food such as sugars, proteins, acids and water in the expanding cells. Additionally, amino acids are considered as precursors and constituents of proteins (Rai, 2002), which are important for stimulation of cell growth, thus reflecting in increasing the weight, the length and the diameter of the fruit (Altemimy *et al*., 2019).

Table 5. Effect of micronutrients and amino acids at different concentrations on leaflet Chlorophyll (%) and fruit weight (g), length (cm) and diameter (cm) of Zaghloul date palm trees during the 2018 and 2019 seasons.

Treatments	Fruit weight (g)		Fruit length (cm)		Fruit diameter (cm)		Chlorophyll (%)	
	2018	2019	2018	2019	2018	2019	2018	2019
60 g micronutrients + 50 ml amino acids / palm / year	19.76	21.47	4.99	6.81	2.21	2.98	31.88	51.48
60 g micronutrients + 100 ml amino acids / palm / year	20.21	21.91	5.01	6.81	2.24	3.01	42.19	58.84
60 g micronutrients + 150 ml amino acids / palm / year	20.64	22.35	5.01	6.82	2.27	3.04	52.51	66.21
80 g micronutrients + 50 ml amino acids / palm / year	20.84	22.54	5.02	6.87	2.30	3.07	62.82	73.58
80 g micronutrients + 100 ml amino acids / palm / year	21.46	23.17	5.07	6.79	2.32	3.09	70.32	78.93
80 g micronutrients + 150 ml amino acids / palm / year	21.56	23.26	5.11	6.91	2.36	3.13	78.76	84.96
120 g micronutrients + 50 ml amino acids / palm / year	21.67	23.37	5.12	6.92	2.37	3.14	85.32	89.65
120 g micronutrients + 100 ml amino acids / palm / year	22.03	23.73	5.23	7.03	2.43	3.20	91.89	94.34
120 g micronutrients + 150 ml amino acids / palm / year	28.50	30.21	5.88	7.68	2.54	3.31	96.57	97.69
Control	18.57	20.27	4.79	6.59	2.15	2.92	20.63	43.44
LSD at 5%	2.15	2.15	0.33	0.33	0.14	0.13	1.59	1.14

4. Firmness and Chemical fruit characteristics:

The response of firmness and chemical fruit characteristics to different concentrations of micronutrients with amino acids is shown in Tables 6 and 7. Either firmness or chemical fruit characteristics showed a positive relationship with different concentrations of micronutrients and amino acids unless titratable acidity (%), tannins (%), and fruit No_3-N content (ppm) which were decreased as the concentrations of micronutrients with amino acids increased. In particular, the treatment with 120 g micronutrients + 150 ml amino acids/palm/year significantly increased fruit firmness (Ib/inch^2), SSC (%), SSC/acid ratio, total anthocyanin (mg/100g), fruit dry matter (%), total sugar (%), and fruit content of calcium (mg/100) but control showed a preference in titratable acidity (%), tannins (%), and fruit No_3-N content (ppm) which introduced the highest significant effect for these characteristics.

Table 6. Effect of micronutrients and amino acids at different concentrations on fruit Firmness (Ib/inch^2), SSC (%), titratable acidity (%), SSC/acid ratio and total anthocyanin (mg/100g) of Zaghloul palm trees during the 2018 and 2019 seasons.

Treatments	Fruit Firmness (Ib/inch^2)		SSC (%)		Titratable acidity (%)		SSC/acid ratio		Total anthocyanin (mg/100g)	
	2018	2019	2018	2019	2018	2019	2018	2019	2018	2019
60 g micronutrients + 50 ml amino acids / palm / year	11.33	12.60	27.30	26.85	0.35	0.39	78	68.8	55.79	57.14
60 g micronutrients + 100 ml amino acids / palm / year	11.67	13.99	27.50	26.86	0.33	0.38	83.3	70.7	59.44	60.79
60 g micronutrients + 150 ml amino acids / palm / year	13.07	12.26	27.53	27.89	0.32	0.37	86.0	75.4	59.9	61.25
80 g micronutrients + 50 ml amino acids / palm / year	13.10	14.03	28.67	29.02	0.31	0.35	92.5	82.9	64.25	65.59
80 g micronutrients + 100 ml amino acids / palm / year	13.33	14.26	28.69	29.03	0.30	0.33	95.6	87.9	64.47	65.78
80 g micronutrients + 150 ml amino acids / palm / year	13.57	14.49	29.50	29.85	0.29	0.31	101.7	96.3	65.38	66.73
120 g micronutrients + 50 ml amino acids / palm / year	13.63	14.93	30.00	30.35	0.28	0.29	107.1	104.7	65.94	67.29
120 g micronutrients + 100 ml amino acids / palm / year	14.00	14.56	30.17	30.52	0.27	0.28	111.7	109	66.60	67.95
120 g micronutrients + 150 ml amino acids / palm / year	14.43	15.36	30.19	30.53	0.23	0.25	131.3	122.1	66.91	68.26
Control	11.33	12.26	27.27	25.52	0.36	0.41	75.8	62.2	54.61	55.95
LSD at 5%	3.18	3.17	1.74	1.73	0.015	0.014	7.34	5.82	1.59	1.60

Table 7. Effect of micronutrients and amino acids at different concentrations on fruit dry matter (%), total sugar (%), tannins (%), and fruit content of calcium (mg/100) and No_3-N (ppm) of Zaghloul palm trees during the 2018 and 2019 seasons.

Treatments	Fruit dry matter (%)		Total sugar (%)		Tannins (%)		Fruit calcium content (mg/100)		Fruit No_3-N content (ppm)	
	2018	2019	2018	2019	2018	2019	2018	2019	2018	2019
60 g micronutrients + 50 ml amino acids / palm / year	69.75	70.25	16.45	16.80	0.47	0.35	128.1	129.5	71.4	69.95
60 g micronutrients + 100 ml amino acids / palm / year	69.93	70.43	16.64	16.99	0.45	0.33	143.5	144.9	69.5	68.05
60 g micronutrients + 150 ml amino acids / palm / year	71.24	71.74	16.83	17.18	0.41	0.29	157.2	158.6	67.8	66.35
80 g micronutrients + 50 ml amino acids / palm / year	72.23	72.73	17.02	17.37	0.39	0.27	171.9	173.2	65.2	63.75
80 g micronutrients + 100 ml amino acids / palm / year	72.57	73.07	17.21	17.56	0.37	0.25	186.7	188.1	62.6	61.15
80 g micronutrients + 150 ml amino acids / palm / year	73.10	73.59	17.41	17.76	0.35	0.23	201.4	202.8	60.0	58.58
120 g micronutrients + 50 ml amino acids / palm / year	73.14	73.64	17.49	17.84	0.33	0.21	217.3	218.7	54.5	53.05
120 g micronutrients + 100 ml amino acids / palm / year	74.25	75.43	17.82	18.17	0.31	0.19	232.8	234.2	51.2	49.75
120 g micronutrients + 150 ml amino acids / palm / year	74.93	74.75	18.03	18.38	0.29	0.17	247.7	249.1	47.7	46.25
Control	64.88	65.38	16.24	16.59	0.48	0.36	113.3	114.7	73.1	71.65
LSD at 5%	4.15	4.14	0.008	0.008	0.001	0.002	0.16	0.16	0.16	0.16

These enhancements in fruit firmness and chemical characteristics may be due to the role of micronutrient in stimulating the process of photosynthesis and starch metabolism to sugars and the movement of carbohydrates from the locations of composition in the leaves to fruits and increase the proportion of soluble solid content (SSC) and rapid breathing and thus increase the maturity (Al-Ali, 2006) and this explains the increment of SSC (%), SSC/acid ratio, total anthocyanin (mg/100g), fruit dry matter (%), total sugar (%) and lower acidity and tannins ratio; hence, boron is involved in many processes such as protein synthesis, transport of sugars and carbohydrate metabolism (Hansch and Mendel, 2009). Moreover, Zinc has also an important role in starch metabolism in plants. It is well known that zinc acts a cofactor of many enzymes and affects many biological processes such as photosynthesis reactions, nucleic acids metabolism, protein and carbohydrate biosynthesis (Marschner, 2012); most of all, the important role of magnesium on chlorophyll molecule structure, carbohydrate metabolism, many enzymes involved in carbohydrate metabolism and protein synthesis (Cakmak and Yazici, 2010). So, the enhancement effect on chlorophyll was reflected in improving vegetative growth which leads to more carbohydrates production through photosynthesis process and consequently improved total soluble solids, total sugar content and finally fruit quality.

Fruit firmness affected significantly by micronutrient with amino acids which increase the calcium content of Zaghloul palms leaflets and fruits (Tables 4 and 7); moreover, B form borate ester by reacting with apiose residues of two rhamnogalacturonan II (RGII) molecules and the resulting RGII borate dimers further shows the cross-linking with pectins of the cell wall thereby initiating the formation of the three-dimensional pectic network and thus, maintaining the structural integrity of the cell wall (Kobayashi *et al.*, 1996; Camacho-Cristo ´bal *et al.*, 2008; Beato *et al.*, 2011). Also, Cu enhances cell wall formation and lignification in several tissues (Burkhead *et al.*, 2009).

The increment in fruit dry matter percentage may be due to the effect of amino acids on the stimulation of root growth of treated Zaghloul palm trees, which may improve water and nutrient uptake capability, leading to yield productivity (Colla *et al.*, 2017; Rouphael *et al.*, 2017), as well as enhanced cell formation and increased fresh and dry matter (Fawzy *et al.*, 2012). Meanwhile, fruit No_3-N content was diminished as the application levels increase and this may be due to iron plays a crucial role in processes in plants that require electron transfer reactions, including photosynthesis and nitrogen assimilation (Marschner, 2012) and the bioavailability of boron is also necessary for nitrogen fixation and nitrate assimilation (Reguera *et al.*, 2010; Beato *et al.*, 2010). Additionally, Cu plays an important part in nitrogen assimilation (Durgesh *et al.*, 2015) and Mo is directly involved in redox reactions of nitrate; furthermore, Mn has a role in nitrate reductase activity (Marschner, 2012).

5. Fruit shelf life after harvest:

Data presented in Table 8 clearly show that all micronutrients with amino acids treatments had a significant effect on maintaining the characteristics of Zaghloul date palm fruits for 3 days during shelf life after harvest compared to the control treatment. Hence, the soil around trees which drenched by 120 g micronutrients + 150 ml amino acids/palm/year had the most pronounced effect on this respect compared to other treatments during both seasons; Hence, it presented the lowest percentages for loss in weight (14.35 & 13.05 %) and rutab (15.14 & 13.84 %) while the highest values for these parameters were obtained by the control (20.31 & 19.01 % for loss weight and 54.33 & 53.03 % for rutab) during both seasons, respectively. This might be due to that Zaghloul date palm fruits contain the sufficient quantity of micronutrients that helped in reducing the stress caused by increasing the respiration rate of the fruits after harvest; hence, some copper proteins act as the most effective scavenger of reactive oxygen species (Yamasaki *et al.*, 2008; Montes *et al.*, 2014) and the savior role of Zn against oxidative stress by being involved in multiple anti-oxidative enzymes such as ABX and glutathione reductase (Alscher *et al.*, 1997; Cakmak, 2000).

Finally, for all these discussed results it can be concluded the importance of supplying the fertilization program of Zaghloul date palms orchards with 120 g micronutrients + 150 ml amino acids/palm/year as a soil application for enhancing its productivity and fruits shelf life of Zaghloul date palm trees.

Table 8. Effect of micronutrients and amino acids at different concentrations on fruit quality 3 Days during shelf life after harvest of Zaghloul date palm trees during the 2018 and 2019 seasons.

Treatments	3 Days during shelf life after harvest							
	Loss weight (%)		Rutab (%)		Total sugar (%)		Tannins (%)	
	2018	2019	2018	2019	2018	2019	2018	2019
60 g micronutrients + 50 ml amino acids / palm / year	19.25	17.95	46.59	45.29	20.48	20.83	0.42	0.30
60 g micronutrients + 100 ml amino acids / palm / year	17.35	16.05	42.53	41.23	21.07	21.42	0.40	0.28
60 g micronutrients + 150 ml amino acids / palm / year	17.33	16.03	34.60	33.30	21.65	22.00	0.36	0.24
80 g micronutrients + 50 ml amino acids / palm / year	17.10	15.80	33.88	32.58	22.24	22.59	0.34	0.22
80 g micronutrients + 100 ml amino acids / palm / year	16.91	15.61	33.08	31.78	22.83	23.18	0.32	0.20
80 g micronutrients + 150 ml amino acids / palm / year	16.57	15.27	32.14	30.84	23.36	23.71	0.30	0.18
120 g micronutrients + 50 ml amino acids / palm / year	16.27	14.97	27.90	26.60	23.97	24.32	0.28	0.16
120 g micronutrients + 100 ml amino acids / palm / year	15.85	14.55	19.00	17.70	24.55	24.90	0.26	0.14
120 g micronutrients + 150 ml amino acids / palm / year	14.35	13.05	15.14	13.84	25.23	25.58	0.24	0.12
Control	20.31	19.01	54.33	53.03	19.86	20.21	0.43	0.31
LSD at 5%	4.16	4.17	1.48	1.48	0.017	0.017	0.002	0.002
Treatments	SSC (%)		Titratable acidity (%)		SSC/acid ratio		Fruit dry matter (%)	
	2018	2019	2018	2019	2018	2019	2018	2019
60 g micronutrients + 50 ml amino acids / palm / year	24.74	28.08	0.24	0.29	103.1	96.8	27.72	25.96
60 g micronutrients + 100 ml amino acids / palm / year	25.07	28.08	0.22	0.27	113.9	104.0	28.18	26.42
60 g micronutrients + 150 ml amino acids / palm / year	25.35	29.08	0.21	0.26	120.7	111.9	28.69	26.93
80 g micronutrients + 50 ml amino acids / palm / year	25.67	30.25	0.21	0.26	122.2	116.4	29.20	27.44
80 g micronutrients + 100 ml amino acids / palm / year	26.01	30.25	0.21	0.26	123.9	116.4	29.68	27.92
80 g micronutrients + 150 ml amino acids / palm / year	26.33	31.08	0.21	0.26	125.4	119.5	30.19	28.43
120 g micronutrients + 50 ml amino acids / palm / year	26.61	31.58	0.20	0.25	133.1	126.3	30.75	28.99
120 g micronutrients + 100 ml amino acids / palm / year	26.90	31.75	0.17	0.22	158.2	144.3	31.44	29.68
120 g micronutrients + 150 ml amino acids / palm / year	27.15	31.75	0.12	0.17	226.3	186.8	31.93	30.17
Control	24.46	26.75	0.25	0.30	97.8	89.2	27.11	25.35
LSD at 5%	0.017	1.74	0.015	0.015	17.75	11.53	0.017	0.017

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تطوير محصول وجودة ثمار نخيل البلح صنف الزغلول عن طريق غمر التربة بمخلوط المغذيات الصغرى والأحماض الأمينية

أمير محمد شعلان

قسم الفاكهة – كلية الزراعة – جامعة المنصورة – المنصورة – مصر – ٣٥٥١٦

تم إجراء تجربة حقلية خلال موسمين ناجحين ٢٠١٨ و ٢٠١٩ في التربة الرملية عن طريق غمر التربة حول أشجار نخيل البلح الزغلول (متر واحد من الجذع) بمركب المغذيات الصغرى والأحماض الأمينية بتركيزات مختلفة لتقييم تأثيرها على الإنتاجية وجودة ثمار نخيل البلح الزغلول. أظهرت أشجار النخيل المزودة بـ ١٢٠ جم من المغذيات الصغرى + ١٥٠ مل من الأحماض الأمينية / النخلة / السنة (المعاملة ٩) تأثيرًا أكثر وضوحًا على مستوى جميع القياسات المقدرة مقارنة بالمعاملات الأخرى أو الكنترول خلال هذه الدراسة ؛ حيث زودت النسب المئوية لعقد الثمار ، والثمار المحتفظ بها ، والكلوروفيل في الرويشات وامتصاص المغذيات والذى إنعكس على زيادة وزن السباطة والمحصول لكل نخلة. وكذلك ، فقد تحسنت جودة الثمار واحتفظت بخصائصها جيدًا لمدة ٣ أيام خلال فترة التخزين بعد الحصاد.