

# Analysis of mineral in date palm fruit under different nitrogen fertilization

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Received: July 1994  
Accepted: May 1995

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**ABSTRACT**  
Four nitrogen levels, from 0 to 900 g/year, were used as ammonium nitrate (33.5% N) four or six times a year during two growing seasons. Fruit mineral content of date palm Khasab cultivar was studied at different stages of fruit development. The nitrogen application increased significantly fruit N concentration compared with control during the second studied growing season, but had no effect on P, K and Zn. Furthermore, fruit Mn and Fe concentrations increased significantly with application of 600 g N/tree/year at the first stage of fruit development through the first season. P, K, Mn and Fe levels of Khasab fruit significantly decreased with age. Nitrogen and zinc levels had the same behaviour in the first season, but in the second growing season these N and Zn concentrations evolved differently.

**KEYWORDS**  
Dates, varieties, nitrogen fertilizers, mineral contents, fruits, developmental stages.

## Effet de la fertilisation azotée sur le contenu des dattes en éléments minéraux.

**RÉSUMÉ**  
Quatre niveaux d'azote, de 0 à 900 g/an, ont été utilisés sous forme de nitrate d'ammonium (33,5% N), répartis en quatre ou six applications par an pendant deux cycles de production. La composition en éléments minéraux de dattes Khasab a alors été étudiée à différents stades du développement du fruit. Par rapport à un témoin non fertilisé, l'apport d'azote a augmenté significativement la teneur du fruit en N pendant la deuxième saison de production étudiée, mais il n'a eu aucun effet sur d'autres éléments tels que P, K et Zn. De plus, lors de la première saison de production, l'apport de 600 g N/arbre/an a augmenté significativement la teneur des fruits en Mn et Fe, lors du premier stade de leur développement. Par ailleurs, les taux en P, K, Mn et Fe de la date Khasab ont diminué avec l'âge. Les taux en N et Zn ont eu le même comportement lors de la première période de production, mais lors de la seconde, ces éléments ont évolué différemment.

**MOTS CLÉS**  
Datte, variété, engrais azoté, teneur en éléments minéraux, fruit, stade de développement.

## Efecto de la fertilización nitrogenada sobre el contenido de los dátiles en elementos minerales.

**RESUMEN**  
Cuatro niveles de nitrógeno, de 0 a 900 g/año, fueron utilizados con forma de nitrato de amonio (33,5% N), repartidos en cuatro o seis aplicaciones por año durante dos ciclos de producción. La composición en elementos minerales de dátiles Khasab fue entonces estudiada en diferentes fases del desarrollo del fruto. Respecto a una muestra sin fertilizar, la aportación de nitrógeno aumentó significativamente la cantidad de N en el fruto durante la segunda temporada de producción estudiada, pero no tuvo ningún efecto sobre otros elementos tales como P, K y Zn. Además, durante la primera temporada de producción, la aportación de 600 g N/árbol/año aumentó significativamente la cantidad de Mn y Fe en los frutos, en la primera fase de su desarrollo. Por otra parte, las proporciones de P, K, Mn y Fe del dátil Khasab disminuyeron con la edad. Las proporciones de N y Zn tuvieron el mismo comportamiento durante el primer período de producción, pero durante el segundo, estos elementos evolucionaron diferentemente.

**PALABRAS CLAVES**  
Dátiles, variedades, abonos nitrogenados, contenido mineral, fruto, etapas de desarrollo.

## ● introduction

Date palm trees (*Phoenix dactylifera* L.) are among the most horticultural crops in the United Arab Emirates. The number of cultivated date palm trees in the country are estimated at about 18 million (Ministry of Agriculture and Fisheries, 1993). The soil is characterized as sandy and very low in mineral content. Accordingly, it is essential to supply it with chemical fertilization to obtain good fruit quality and quantity. The effect of nitrogen fertilization on growth and productivity of date palm trees was reported (FURR and ARMSTRONG, 1958, 1959; ALJUBURI *et al.*, 1991; ALJUBURI, 1993; HUSSEIN and HUSSEIN, 1983; HUSSEIN *et al.*, 1993; EL-HAMADY *et al.*, 1993). Soil applications of N, P, K and organic manure did not show a significant effect in mineral contents, especially N, P, K, Ca and Mg of the date palm fruit (BACCHA and ABO-HASSAN, 1983), whereas, application of nitrogen fertilization to date palm trees increased the levels of N, P and K in fruit (HUSSEIN *et al.*, 1977) and decreased the Na levels in the leaves (MONTASSER and EL-HAMADY, 1988). NIELSEN *et al.* (1993) mentioned that leaf and fruit N and P concentration declined over time as apple trees began fruiting despite the annual application of N and P via fertirrigation. CLARK and SMITH (1990) found that the concentration of B, K, N, Mg, Mn, Zn, Cu, Fe and P elements in whole persimmon fruit declined during fruit growth. SAWAYA *et al.* (1982) noted that the nutritionally essential minerals N, P, K, Mn, Ca, Na, Mg, Fe, Cu and Zn (and ALJUBURI *et al.*, 1994, N, P, K, Zn, Mn, Fe and Cu) were high at the early stages of date palm fruit development and decreased during maturation. The objective of this research was to study the effect of different nitrogen concentrations on fruit elements of date palm (cultivar Khasab), at different stages of fruit growth and development.

## ● materials and methods

A study was conducted at Al-Kuwaytate Experiment and Research Station, Department of Agriculture and Animal Production, Al-Ain,

United Arab Emirates. Four nitrogen levels (0, 300, 600 and 900 g/tree/year) were applied in the form of ammonium nitrate (33.5% N) either in four or six equal applications from late October through April during two growing seasons 1988/1989 and 1989/1990.

The trees were planted in sandy soil at 10 m apart. Twenty-one mature date palm trees of Khasab cultivars were chosen. All the trees were of similar ages (20 years old), uniform in growth, free from insect damage and diseases and were subjected to the same management and cultural practices. Treatments were arranged in a complete randomized block design with each treatment consisting of three mature trees. Nitrogen fertilizers were added into a trench 15 cm wide and 15 cm deep dug around and below the drip of the date palm tree, then buried with the dugout soil and irrigated with approximately 500 liters for 1 hour. Date palm trees were pollinated on 5-15 March 1989 and 1990 by placing eight fresh male strands on a female spadix centre. A collection of fruit sample started 45 (first stage), 90 (second stage), 135 (third stage) and 225 (fourth stage) days after the pollination date for both seasons (1989 and 1990) (ALJUBURI *et al.*, 1991). Eight bunches on each tree were chosen for sampling. Each sample consisted of 100 fruit, which were picked randomly from different strands on each bunch. Fruit samples were thoroughly wiped with tap water then with distilled water. Seeds and calyxes were removed and the flesh of each date was cut into small parts and dried in a vacuum oven at 70°C until a consistent weight was achieved (ALJUBURI *et al.*, 1994). The dried samples were ground, and 2 g of fruit powder were dissolved in 5 ml 20% HCl according to CHAPMAN and PRATT (1961). Z, Mn and Fe were determined using an Atomic Absorption Spectrophotometer (Model 400), Varian Techtron Pty Ltd, Springvale, Australia. Potassium was determined with a Flame Spectrophotometer (Model 400), Corning Science Products, Corning Limited, Halstead, Essex, England, while phosphorus was determined by using an Auto Analyzer (Model 100), Scientific Instruments, USA, and nitrogen was determined by micro-Kjeldahl. The data were subjected to Duncan's multiple range test using MASTAT programme analysis.

## ● results

Applications of N did not show significant differences in nitrogen contents of Khasab fruit among various treatments during the first and second growing seasons except that at the fourth stage in the second growing season, where fruit nitrogen levels increased significantly for all treatments as compared with control. Nitrogen levels in date palm fruit decreased significantly with age for all treatments in the first growing season, whereas fruit N levels decreased significantly in the second and third stages and increased only slightly in the fourth stage. Application of nitrogen fertilizers for two successive growing seasons did not show a significant effect on the Khasab fruit P concentration. The means of fruit P concentration at the first stage for all treatments were significantly higher as compared with the second and third stages of development during the first growing season and second, third and fourth stages of development during the second growing season (table I). Khasab fruit K at all four stages of development did not respond to the various

concentrations of nitrogen applications of either four or six equal doses a year compared with fruit of untreated date palm trees during the first and second growing seasons. The mean of fruit K level tended to be significantly high in the first stage of development, then progressively and significantly decreased with fruit age throughout the two successive seasons. Application of 600 g nitrogen/tree/year in four equal doses registered significantly the highest levels of Khasab fruit Mn at the first stage of development as compared with control, whereas application of 300 or 600 g N/tree/year in four or six equal doses, respectively, reduced significantly fruit Mn level as compared with control during the first growing season. Fruit Mn of date palm trees did not respond to application of various concentrations of nitrogen fertilizers during the second growing season (table II). Application of different concentrations of nitrogen fertilizers in four or six equal doses/year/tree did not show a significant increase of Zn levels in Khasab fruit, whereas fruit Zn levels reduced significantly and progressively with fruit age for all treatments during the first growing season.

**Table I**  
Influence of nitrogen fertilization on N and P levels of Khasab date palm fruit at 45, 90, 135 and 225 days after pollination<sup>1,2</sup>.

Treatment g/tree/year in 4 or 6 doses	Fruit N concentration (% dry wt) Days after pollination								Fruit P concentration (% dry wt) Days after pollination							
	First season (1989)				Second season (1990)				First season (1989)				Second season (1990)			
	45	90	135	225	45	90	135	225	45	90	135	225	45	90	135	225
Control	1.60 abcd	1.08 efgh	0.82 ghijkl	0.79 ghijkl	0.78 bc	0.57 e	0.54 e	0.58 e	0.16 a	0.12 a	0.12 a	0.18 a	0.16 a	0.11 a	0.12 a	0.12 a
300 g in 4 doses	2.03 a	1.25 bcdefg	0.98 fghij	0.50 jkl	0.76 cd	0.54 e	0.56 e	0.98 a	0.17 a	0.11 a	0.10 a	0.14 a	0.16 a	0.11 a	0.12 a	0.11 a
300 g in 6 doses	1.66 abc	1.12 defgh	0.85 ghijkl	0.43 kl	0.77 cd	0.59 e	0.59 de	0.85 abc	0.16 a	0.13 a	0.11 a	0.13 a	0.15 a	0.12 a	0.12 a	0.11 a
600 g in 4 doses	1.97 a	1.18 bcdefg	0.97 fghij	0.44 kl	0.85 abc	0.59 e	0.58 de	0.97 a	0.16 a	0.12 a	0.11 a	0.15 a	0.16 a	0.12 a	0.12 a	0.12 a
600 g in 6 doses	1.67 ab	1.16 cdefg	0.83 ghijkl	0.56 ijkl	0.76 bcd	0.50 e	0.58 de	0.98 a	0.17 a	0.12 a	0.11 a	0.14 a	0.16 a	0.11 a	0.12 a	0.11 a
900 g in 4 doses	1.45 bcdef	1.22 bcdefg	0.63 hijkl	0.45 kl	0.76 bcd	0.48 e	0.50 de	0.94 ab	0.16 a	0.12 a	0.11 a	0.14 a	0.16 a	0.11 a	0.13 a	0.12 a
900 g in 6 doses	1.58 abcde	0.94 fghijk	1.30 fghi	0.42 l	0.79 bc	0.55 e	0.59 de	0.97 a	0.17 a	0.12 a	0.11 a	0.16 a	0.16 a	0.11 a	0.13 a	0.11 a
Mean	1.7 a	1.09 b	0.87 c	0.55 d	0.78 a	0.55 b	0.57 b	0.90 a	0.16 a	0.12 b	0.11 b	0.15 a	0.16 a	0.11 c	0.12 bc	0.11 c

<sup>1</sup> Values are means of three replications (each replication represents 100 fruits);

<sup>2</sup> means within columns or rows followed by same letter do not differ significantly ( $P = 5\%$ ): Duncan's multiple range test.

**Table II**  
Influence of nitrogen fertilization on K and Mn levels of Khasab date palm fruit at 45, 90, 135 and 225 days after pollination<sup>1,2</sup>.

Treatment g/tree/year in 4 or 6 doses	Fruit K concentration (% dry wt) Days after pollination								Fruit Mn concentration (% dry wt) Days after pollination							
	First season (1989)				Second season (1990)				First season (1989)				Second season (1990)			
	45	90	135	225	45	90	135	225	45	90	135	225	45	90	135	225
Control	1.51 a	0.94 bcd	0.89 bcde	0.80 cde	1.40 ab	1.06 bcde	0.67 fg	0.59 g	48.3 b	14.00 efgh	10.33 hij	6.67 jkl	31.67 a	25.67 abcdef	17.67 bcdef	14.38 de
300 g in 4 doses	1.50 a	1.04 bc	0.87 cde	0.81 cde	1.48 a	1.12 bc	0.76 defg	0.52 g	41.67 d	13.67 efghi	10.33 hij	3.67 l	28.00 abc	20.33 abcdef	15.67 cdef	16.33 cdef
300 g in 6 doses	1.48 a	0.95 bcd	0.85 cde	0.69 de	1.49 a	1.05 bcde	0.71 efg	0.59 g	46.67 bc	13.00 efghi	9.67 ijk	3.67 l	29.67 ab	23.33 abcdef	13.33 f	14.33 def
600 g in 4 doses	1.48 a	0.96 bcd	0.85 cde	0.87 cde	1.55 a	0.97 cdef	0.79 cdefg	0.64 fg	53.00 a	15.00 ef	11.00 fghi	6.00 kl	31.67 a	21.33 abcdef	13.67 ef	14.77 def
600 g in 6 doses	1.50 a	0.95 bcd	0.80 cde	0.63 e	1.48 a	1.07 bcd	0.66 fg	0.66 fg	43.33 cd	16.00 e	11.33 fghi	4.67 l	30.67 ab	21.67 abcdef	13.67 ef	13.33 f
900 g in 4 doses	1.47 a	1.03 bc	0.78 cde	0.86 cde	1.36 ab	1.09 bcd	0.63 fg	0.65 fg	49.33 b	14.67 cfg	10.67 ghij	3.67 l	26.33 abcdef	21.67 abcdef	14.33 def	13.33 f
900 g in 6 doses	1.53 a	1.00 bc	0.85 cde	0.75 cde	1.48 a	0.77 cdefg	0.72 efg	0.67 fg	49.00 b	15.67 e	12.33 efghi	4.67 l	27.00 abcd	26.67 abcde	14.33 def	13.33 f
Mean	1.5 a	0.98 b	0.85 c	0.78 c	1.46 a	1.02 b	0.70 c	0.62 c	47.33a	14.50b	10.80c	4.72d	29.58a	23.29b	17.04c	14.25c

<sup>1</sup> Values are means of three replications (each replication represents 100 fruits);

<sup>2</sup> means within columns or rows followed by same letter do not differ significantly ( $P = 5\%$ ): Duncan's multiple range test.

Application of nitrogen fertilizer did not affect Zn levels in fruit at the second and third stages of fruit development during the second growing season, whereas the Zn element in fruit was significantly higher during the fourth stage of development than in control for 300 g N/tree/year either in four or six equal doses, and 900 g N/tree/year in six equal doses, but there were no significant differences of other treatments relative to control (table III). Zinc element concentration in fruit tended to be higher in all treatments at the first stage of fruit development as compared to the second and third stages of fruit development, whereas in the fourth stage of fruit development, the Zn level increased again until it reached an approximate value as in the first stage of fruit development. Applications of nitrogen fertilizer to Khasab trees did not show a significant effect on fruit Fe in all stages of fruit development as compared with control during the first and second growing season; however, applying 600 g N/tree/year in either four or six equal doses increased fruit Fe level significantly as compared with control and other experimental treatments at the first stage of development during the first growing season.

The results also indicate that Fe contents during the first stage of fruit development was highly significant, whereas fruit Fe level decreased significantly in the second stage, then increased gradually but not significantly in the third and fourth stages of fruit development during the first and second growing seasons (table III).

## ● discussion and conclusion

The results conclude that nitrogen levels of Khasab fruit progressively decreased with fruit age in the first season, whereas fruit N concentrations in the second season decreased significantly in the second and third stages of fruit development. The first part of the results was in agreement with SAWAYA *et al* (1982) and ALJUBURI *et al* (1994), who found that ten nutritionally essential minerals were high at the early stages of fruit development and then decreased during maturation.

Application of nitrogen fertilizers either in four or six equal doses a year for two successive growing seasons did not show a significant effect on the Khasab fruit P concentration (table I). The fruit at the first stage of development for

Table III  
Influence of nitrogen fertilization on Zn and Fe levels of Khasab date palm fruit at 45, 90, 135 and 225 days after pollination<sup>1,2</sup>.

Treatment g/tree/year in 4 or 6 doses	Fruit Zn concentration (% dry wt) Days after pollination								Fruit Fe concentration (% dry wt) Days after pollination							
	First season (1989)				Second season (1990)				First season (1989)				Second season (1990)			
	45	90	135	225	45	90	135	225	45	90	135	225	45	90	135	225
Control	45.00 a	12.67 c	11.00 c	7.67 c	73.33 b	48.33 e	51.33 de	45.33 e	101.33 bc	27.67 de	32.33 de	37.33 de	244 abc	150.00 abc	173.00 abc	225.33 abc
300 g in 4 doses	43.00 a	13.00 c	10.67 c	5.33 c	72.33 bc	47.67 e	52.67 cde	70.33 bcd	102.33 bc	23.33 e	40.67 de	43.00 de	318.33 ab	270.33 abc	171.67 abc	221.00 abc
300 g in 6 doses	46.33 a	14.33 c	11.00 c	5.33 c	60.33 bcde	49.00 e	53.67 bcde	73.67 b	99.35 bc	29.67 de	35.33 de	40.67 de	377.00 a	66.00 abc	235.33 abc	204.33 abc
600 g in 4 doses	52.00 a	13.00 c	10.33 c	8.00 c	60.00 bcde	49.00 e	52.67 cde	62.33 bcde	181.33 a	29.00 de	34.33 de	67.00 cd	177.00 abc	65.00 c	198.67 abc	226.33 abc
600 g in 6 doses	45.00 a	13.00 c	12.00 c	5.33 c	70.67 bcd	48.00 e	52.00 cde	56.67 bcde	137.33 a	25.00 de	39.67 de	30.67 de	248.00 abc	92.00 bc	245.33 abc	242.33 abc
900 g in 4 doses	49.67 a	11.33 c	9.00 c	4.00 c	60.00 cde	45.67 e	54.00 bcde	62.33 bcde	98.67 bc	26.67 de	34.33 de	44.67 de	229.67 abc	70.33 c	199.67 abc	205.33 abc
900 g in 6 doses	48.00 a	11.67 c	11.00 c	3.67 c	61.67 bcde	47.33 e	52.67 cde	95.67 a	135.00 b	32.33 de	32.33 de	33.33 de	272.67 abc	93.67 bc	277.00 abc	225.67 abc
Mean	47.00 a	12.71 b	10.71 b	5.62 c	65.48 a	47.86 c	52.71 b	64.08 a	122.19 a	27.67 c	35.57 bc	42.38 b	266.67 a	129.62 b	14.38 a	221.47 a

<sup>1</sup> Values are means of three replications (each replication represents 100 fruits);

<sup>2</sup> means within columns or rows followed by same letter do not differ significantly ( $P = 5\%$ ): Duncan's multiple range test.

all treatments were significantly higher in fruit P levels compared with the second and third stages of development during the first growing season and second, third and fourth stages of development during the second growing season. The results are in agreement with SAWAYA *et al* (1982) and ALJUBURI *et al* (1994), who reported that ten nutritionally essential minerals showed that all were highest at the early stages of development and decreased during maturation, and with CLARK and SMITH (1990), who found that the concentration of P, N, K, Mn, Zn, Cu, Fe, B and Mg in persimmon fruit declined during fruit growth. In addition, the application nitrogen fertilizer in either four or six equal doses per year during two growing seasons had no effect on fruit K levels (table II). Similar results were obtained by BACHA and ABO-HASSAN (1983) while HUSSEIN *et al* (1977) found that K levels in fruits of Khuneizi and Sukkari date palm cultivars increased with an increasing amount of nitrogen application to the trees. The data also suggest that the fruit K levels progressively decreased with fruit age during two successive growing seasons.

These results confirm those of SAWAYA *et al* (1982) and ALJUBURI *et al* (1994), who reported that ten nutritionally essential minerals of Khudari and Sullaj or Khasab date palm cultivars showed that all were high at the early stages of development and decreased during maturation. Similar results were obtained by CLARK and SMITH (1990) on persimmon fruits. Fruit Mn concentration increased significantly with application of 600 g N/tree/year equally split over four doses at the first stage of fruit development during the first season. The results also revealed that fruit Mn and Zn were significantly higher at the first stage of fruit development as compared with the other stages.

Application of 600 g N either in four or six equal doses/year/tree increased significantly the Fe level at the first stage of fruit development during the first growing season compared with control and other experimental units (table III). These results also established that Fe in Khasab fruits was higher in the second season than in the first growing season, and the Fe level in fruit was significantly higher at the first fruit stage of development as compared with the other stages for both seasons.

## acknowledgments

*The author wishes to express his thanks to Mr ALMASRY, Mr AL-KASAB, Mr AZAB and Mr FARIS for their encouragement during the course of this work. Research was funded by the UAE University-Date Palm Development Project.*

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