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STUDIES ON THE AMOUNT OF MINERALS ANNUALLY LOST BY WAY OF FRUIT HARVEST AND LEAF PRUNINGS OF DATE PALM TREE*

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ABSTRACT

Sodium and eight nutrient elements (N, P, K, Ca, Fe, Mn, Zn and Cu) were determined in the different parts of the date palm tree (flesh, seed, fruit strands, bunch, stalk, pinnae and rachis) in an attempt to obtain an estimate of the amount of minerals lost by way of fruit harvest and leaf prunings. The lowest and highest values of mineral content observed (based on dry-matter) were as follows: N 0.185% for rachis and 1.160% for pinnae; P. 0.024% for rachis and 0.125% for seed; K 0.071% for pinnae and 1.1089% for stalk; Ca 0.125% for seed and 0.533% for pinnae; Na 0.0034% for seed and 0.142% for rachis; Fe 18.9 ppm for seed and 255 ppm for pinnae; Mn 1.6 ppm for stalk and 44ppm for pinnae; Zn 3.6 ppm for flesh and 32.6 ppm for pinnae Ash contents ranged from 2.47% for flesh to 9.34% for stalk. It was estimated that each palm lost about 82.4 kg of dry matter annually by way of fruit harvest and leaf pruning. This was calculated to contain 472.4 g N, 47.7 g P, 422.6 g K, 218.9 g Ca, 36.4 g Na, 5.8 g Fe, 1.2 g Mn and 1.3 g Zn Whole Fruits (flesh and seed) drew the greatest amount of N (272 g), P (30.8 g) and K 310.8 g from the soil, whereas leaf prunings (pinnae and rachises) drew the greatest amount of Na (29.7 g), Ca (138.7 g), Fe (4.0g), Mn (0.85 g) and Zn (0.32 g).

★ This work was carried out in Libya Department of Horticulture, Faculty of Agriculture, University of Al-Fateh, Tripoli.

دراسات على كميات العناصر الغذائية التي تفقد سنوياً من نخلة التمر عن طريق جمع المحصول وتقليم الاوراق

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الخلاصة

تم تقدير الصوديوم وثمانية عناصر غذائية وهي (نتروجين، فوسفور، بوتاسيوم، كالسيوم، منجنيز، حديد، زنك، نحاس) في كل من لحم الثمار والبذور والشماريخ وعنق العذق وكذلك في الوريقات والعرق الوسطى للأوراق التي في عمر التقليم بغرض تقدير ومقارنة التركيب المعدني للاجزاء المختلفة لنخلة التمر وكذلك حساب كميات العناصر التي تفقد سنوياً نتيجة لجمع المحصول وتقليم الاوراق، هذا وقد جمعت العينات من أشجار نخيل مثمرة من صنف « طابوني » تقع في عدة مزارع في منطقة الخمس في شمال ليبيا .

تبين من التحليل الكيماوي أن هناك تفاوتاً كبيراً في المحتوى المعدني للاجزاء المختلفة وفيما يلي أقل وأعلى تركيز للعناصر المقدرة:

نتروجين	0.185٪	في العرق الوسطى	1.160٪	في الوريقات
فوسفور	0.024٪	في العرق الوسطى	0.125٪	في البذور
بوتاسيوم	0.071٪	في الوريقات	1.108٪	في عنق العذق
كالسيوم	0.125٪	في البذور	0.533%	في الوريقات
صوديوم	0.0034٪	في البذور	0.142٪	في العرق الوسطى
منجنيز	1.6	جزء في المليون في عنق العذق	44	جزء في المليون في الوريقات
حديد	18.9	جزء في المليون في البذرة	255	جزء في المليون في الوريقات

زنك	3.6٪	جزء في المليون	32.6	جزء في المليون	
		في لحم الثمار		في الوريقات	
الرماد	2.47٪	في الثمار	%0.34	في عنق الغذق .	

وقد قدرت كمية المادة الجافة التي تفقدها النخلة الواحدة سنوياً نتيجة لجمع المحصول وتقليم الاوراق بحوالي 82.4 كغم وذلك بافتراض أن النخلة تنتج سنوياً 100 كغم ثمار خلال ورطب، 10 عذوق، c. ورقة وهذه الكمية من المادة الجافة تحتوي على 472.4 نتروجين، 47.7 غم فوسفور، 422.6 غم بوتاسيوم 218.9 غم كالسيوم، 36.4 غم صوديوم، 5.8 غم حديد، 1.2 غم منجنيز، 1.3 غم زنك .

تبين من النتائج أن الثمار وحدها (اللحم والبذور) أدت الى فقد معظم كميات النتروجين 272 غم، والفوسفور 30.8 غم، والبوتاسيوم 310.8 غم، بينما أدى تقليم الاوراق الى فقد معظم كميات الصوديوم 29.7 غم، والكالسيوم 138.7 غم، الحديد 4.01 غم، المنجنيز 0.4 غم، والزنك 0.32 غم .

هذه الكميات من العناصر التي تفقد سنوياً يجب تعويضها عن طريق اضافة الاسمدة حتى يمكن المحافظة على انتاجية الأشجار، بعد أن يؤخذ في الاعتبار كميات العناصر التي تستنفذ أو تفقد نتيجة للعوامل الأخرى مثل الصرف وعمليات تثبيت العناصر في التربة ووجود زراعات بينية وغيرها .

INTRODUCTION

A significant part of the nutrient elements taken up by date palm tree are annually lost by way of fruit harvest and leaf prunings. An assay of the mineral content of the different parts of fruit bunch including seed, flesh, fruit strands and bunch stalk and also pinnae and rachis of leaf prunings can provide a quantitative appraisal of the amount of minerals annually removed by these parts away from the plantation. These data give a clear picture on the amount of minerals annually absorbed by the whole palm under our experimental and environmental conditions.

Many studies have been reported on the mineral content of flesh (4, 5, 8, 9, 11, 12, 16, 21) Seed (6, 8, 11, 12, 13) fruit stalk (7) pinnae (4, 7, 8, 10, 12, 14, 15, 18, 19, 20) and rachis (7, 20), however, few attempts have been made to estimate the total quantities of minerals annually drawn or removed by fruit bunches, leaf prunings or by the whole palm. Embleton and Cook (7) calculated that a moderate annual prunings of leaf and fruit bunches of one date palm consists of approximately 44kg. of dry matter. This contains 213g N, 16g. P. and 611g K. Bliss and Hass (1) estimated that the flesh of the fruit of a palm yielding 9000 fruit would contain about 239 gN, 41 g. P and 587 g K. In coconut palm, according to the study of Pillal and Davis (17) each palm annually removes 549 g N, 115 g. P, 635 g K, 497 g. Ca and 196 g. Mg.

The object of the present study was to determine and compare the mineral content of flesh, seed, strands, stalk, pinnae and rachis in an attempt to establish an estimate of the amount of minerals annually removed by the individual parts and whole palm. This can help to provide a precise scientific basis for planning fertilizer program for date palm orchards.

MATERIAL AND METHODS

Date palm *(Phoenix dactylifera* L.) cultivar, Tabuuni was used in this study. It is one of the commonly grown cultivars in the coastal region of Libya. This region is characterized by high relative humidity (60 – 75%) and insufficient effective heat units (1100°C – 1400°C)*. The fruit in most cases is, therefore, harvested at khalaal and rutab stages (3).

Sampling, measurements and analysis: Samples were collected in the last week of October , 1981 from three different orchards in Khomis district (130Km. east of Tripoli). Two mature palms – more than 10 years old and in full production-were chosen from each orchard and used for the determination of fresh and dry weights and mineral contents of flesh, seed, strand, stalk, pinnae and rachis. Nearly two kg. of fruit at khalal and rutab stages were harvested separately from individual palm. From this a sample of 50 fruits was drawn at randon and used for measurements and

★ Maximum temp + Minimum temp.
– 18

analysis of flesh and seed. Strands and stalk samples were taken from two separate bunches per selected tree. To make a representative sample of stalk, small segments of stalk were taken from various position and then composited. Two pruning age leaves, located below the fruiting zone, were detached from each palm and 18 pinnae were excised from each leaf. Six near the tip of the rachis, six from the middle blade and six near the base. The 18 pinnae were composited. Representative samples of rachis were obtained by sectioning out material near the base, middle and tip. The fresh weight of flesh and seed per fruit, strands and stalk per bunch and pinnae and rachis per leaf were also recorded. All the samples were dried in draft oven at 70°C to constant weight. These were then ground for mineral determination. Two grams of the ground material were digested with Hcl (dry ashing). Analysis of K, Ca, Na was done by flame photometer (Corning 400) Fe, Zn, Mn, Cu by atomic absorption, (Perkin-Elmer 500), P by spectrophotometry and N by Micro-Kjeldahle method (2). A partial analysis of soil characteristics was carried out on duplicate samples of each orchard according to Chapman and Pratt (2). The values were as follows: Sand 54.2%, Silt 23.1%, Clay 22.6%, pH 7.7, Ece. 91mmhos/c. Ca^{++3} meg/L, Hco_3 1.9 meg/L and cl^{-}2.46 meg/L. No systematic fertilization programme was ever followed for these orchards except that was added for the intercropped plants.

Computations: Mineral assay were based on dry weight and results were expressed as percent for N, P , K, Ca, Na and ash and as ppm for Fe, Mn, Zn, and Cu. Concentration of minerals of whole fruit, whole bunch (stalk and strands) and whole leaf were derived by calculation from those for seed and flesh, strand and stalk, and pinnae and rachis respectively.

Similarly, to establish uniform perspective for the different variables, the computations of the amount of minerals annually removed per palm or per part were based upon the assumption that each palm tree, on the average; produce 100 kg of fruits (at Khalal or rutab stage) 10 bunches and 20 leaves yearly. Differences in mineral content among the different parts were subjected to statistical analysis using analysis of variable.

RESULTS AND DISCUSSIONS

Dry weight: The quantitative data on fresh and dry weights of flesh and seed per fruit, stalk and strands per bunch and pinnae and rachis per leaf are given in Table 1. To draw a more practical picture these data were used to compute the dry matter produced by each individual part per palm per year . Each palm would supply approximately 82 . 4 kg . of dry matter annually of which 47.3% was accumulated in the flesh of fruit. Of the remainder 12.1% goes to seed, 2.6% to fruit strands; 4.6% to bunch stalk; 16.5% to pinnae, and 16.8% to rachis (Table 1).

Mineral composition: Data on chemical analysis of the different parts of date palm tree are presented in Table 2. With regards to the mineral contents no great variations were found between flesh or seeds at Khalal and rutab stages except for K where it was significantly higher at Khalal stage. Studies on fruit flesh of the world's most popular date cultivars showed a wide variation in their mineral content. Ranges reported were as follows: N.0.4 – 1.0%; PO.041 – 0.31%; K 0.57 – 1.04%; Ca 0.054 – 0.219%, Na 0.005 – 0.39%; Fe 5 – 103 ppm; Mn 2-75 ppm; Zn 7-76 ppm, and Cu 4-29 ppm (4, 5, 8, 9, 11, 12, 16, 21). Evedently, these variations are attributable to differences between cultivars, stages of maturity and agroclimatic factors. However, the concentration of all minerals in fruit flesh, determined in the present study were generally within these ranges.

Comparing the different parts of date palm tree with respect to mineral contents, the data showed that, total N was the highest in pinnae (1.16%) and seed (1.001%) and lowest in the rachis (0.185%) and bunch stalk (0.260%).

This tends to suggest that rachis and stalk primarily comprise of the conducting system and do not store N. The phosphorus content was greater in seed (0.125%) than in any other part of date palm tree. It contained two or more times as much P as the flesh or strands and over 4 times as much as the rachis or stalk. The potassium content was highest in the bunch stalk i.e. 1.108% of the dry weight. The value in flesh at Khalal stage was slightly lower, whereas the pinnae showed the lowest value (.071%) (Table 2). Embleton and Cook (7) noted exceptionally high value

(4.33%) for K content of "Deglet Noor" fruit stalk. The calcium and Sodium contents in the felsh and seeds and ash in the flesh were significantly lower than those of strands, stalk, pinnae and rachis. The differences were much greater in the case of Na (Table 2). Pinnae contained higher amounts of Fe (255 ppm), Mn (44 ppm) and Zn (32.6 ppm) as compared to other parts. The differences were more pronounced in the case of iron. Amounts of Fe in pinnae were over 6 times of rachis and stalk and over 9 times that of seed and flesh (Table 2). Chemical analysis of pinnae of the more important cultivars showed a wide difference in the mineral content of pinnae (4, 7, 8, 10, 12, 14, 15, 18, 19, 20). The following ranges were reported: N 1.33 – 2.55%; P 0.085 – 0.32%; K.47 – 1.64%; Ca 0.27 – .79%. Na 0.007 – 0.159%; Fe 60 – 373 ppm, Mn 24 – 192 ppm; and Zn 6 – 16 ppm. These differences might be due to leaf age or the varity, agroclimatic conditions and cultivar behaviour. The observed values of N, P and K in the present data are relatively low as compared to the previously published reports. Possibly this difference is due to the age of leaves used (4 years old), since many studies on the seasonal changes of N, P and K showed that N and K content decreased greatly with age (4, 15, 18, 20). Situation about P; however is controversial it has been shown to decrease as the leaf become older (4, 15), or that leaf age had minor influence in P content (18, 20). Ruther (18) assumes this decline is due to the migration of these elements out of leaf to younger tissues or/and to accumulation of other material such as cellulose and Silica which possibly can have some diluting effect on N, P and K.

Estimated amounts of minerals annually removed by the different parts of date palm tree. Estimated amount of minerals annually removed or drawn from the soil by flesh, seeds, strands, stalks, pinnae and rachis are illustrated in Fig. 1., it is clear that in comparison with other parts the fruit-flesh removed the highest amount of N (172.0 g.), P (18.3 g.) and K (294. g.). Pinnae removed the greatest amount of Fe (3.5 g.) Mn (.59 g.), Zn (.32 g) and Ca (72.3 g.), whereas rachis removed the highest amount of Na (19.7 g.). A notable point is that the fruit-flesh, rachis and pinnae accumulated approximately the same amounts of ash (Fig. 1).

The total amount of minerals, per palm per year, lost by way of fruit

harvest and leaf pruning, are illustrated in Fig. 2. It was calculated that each palm annually removes 472. g. N; 422.6 g. K; 219 g. Ca; 48 G. P; 36.4 g. Na; 5.8 g. Fe; 1.2 g. Mn; 1.3 g. Zn and 3.389 kg ash from the soil. To remain productive these amounts should be made up by replenishing the tree with fertilizers.

It is envisaged that, these data will be valuable in planning a precise fertilization program for date palm orchards. In doing so, however, the amounts of nutrients absorbed by intercropped plants, lost in soil drainage or deficient to the date palm due to the formation of insoluble compounds in the soil must also be taken into account.

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Table 1

Fresh and dry weights of flesh and seed per fruit, strands and stalk per bunch and pinnae and rachis per leaf, and amounts of dry matter produced per palm per year.

	FRUIT						Strands and Stalk			LEAF			Total Palm Year
	Khalal Stage			Rutab Stage									
	Flesh	Seed	Total	Flesh	Seed	Total	Strands	Stalk	Total	Pinnae	Rachis	Total	
Fresh Weight (g).	7.2	1.5	8.6	7.6	1.3	8.9	507	1186	1693	1295	1876	3171	
Dry Weight (g).	2.9	1.1	4.0	3.9	1.0	4.9	222	378	600	678	693	1371	
Dry matter (%)	40.1	65	46.5	51.8	73.8	55.3	44	30.2	35.4	51.8	36.9	43.2	
Dry matter/Palm/year* kg	29	11.0	40	39.0	10.0	49.0	2.2	3.8	6.00	13.6	13.9	27.4	82.4
Percent of total	—	—	—	47.3	12.1	59.4	2.6	4.6	7.3	16.5	16.8	33.3	100

★ Values reported are rounded numbers.

Table 2

Mineral composition of the different parts of Tabuuni date palm (on dry weight basis).

Element	Fruits						Strands and Stalk of bunch			Leaf		
	Khalaal Stage			Rutab Stage								
	Flesh	Seed	Whole fruit	Flesh	Seed	Whole fruit	Strands	Stalk	Whole strands and stalk	Pinnae	Rachis	Whole leaf
						PERCENT						
Nitrogen	0.435^{c}	0.940^{b}	0.568	0.441^{c}	1.001^{b}	0.550	0.353^{cd}	0.260^{de}	0.290	1.160^{a}	0.185^{de}	0.670
Phosphorus	0.051^{cd}	0.121^{a}	0.069	0.047^{d}	0.125^{a}	0.063	0.062^{c}	0.027^{e}	0.039	0.082^{b}	0.024^{e}	0.059
Potassium	1.040^{a}	0.196^{de}	0.817	0.754^{b}	0.169^{dc}	0.646	0.430^{c}	1.108^{a}	0.857	0.071^{c}	0.366^{cd}	0.220
Calcium	1.63^{cd}	0.145^{d}	0.162	0.130^{d}	0.125^{d}	0.129	0.333^{b}	0.253^{bc}	0.283	0.533^{a}	0.479^{a}	0.506
Sodium	0.0046^{d}	0.0034^{d}	0.0043	0.0043^{d}	0.0037^{d}	0.0045	0.0827^{b}	0.075^{b}	0.078	0.074^{b}	1.42^{b}	0.108
Ash	3.39^{c}	—	3.39	2.47^{c}	—	2.47	7.75^{b}	9.34^{a}	8.75	6.51^{b}	7.35^{b}	6.93
						PPM						
Iron	21.1^{c}	18.9^{c}	20.5	26.9^{c}	22.8^{c}	26.1	165.9^{a}	38.5^{c}	85.6	255^{a}	41.2^{c}	146.4
Manganese	5.7^{c}	9.7^{c}	6.8	5.1^{c}	9.6^{c}	6.0	6.7^{c}	1.6^{c}	3.5	44^{a}	18.9^{b}	31.3
Zinc	3.6^{d}	22.2^{bc}	8.5	3.8^{d}	24.6^{b}	7.9	19.4^{bc}	15.7^{c}	17.1	32.6^{a}	23.3^{b}	27.9
Copper	3.3	5.1	3.9	3.7	6.1	4.2	—	—	—			—

Means in each row followed by the same letter are not significantly different at $P = 0.05$ according to Duncan's multiple range test.

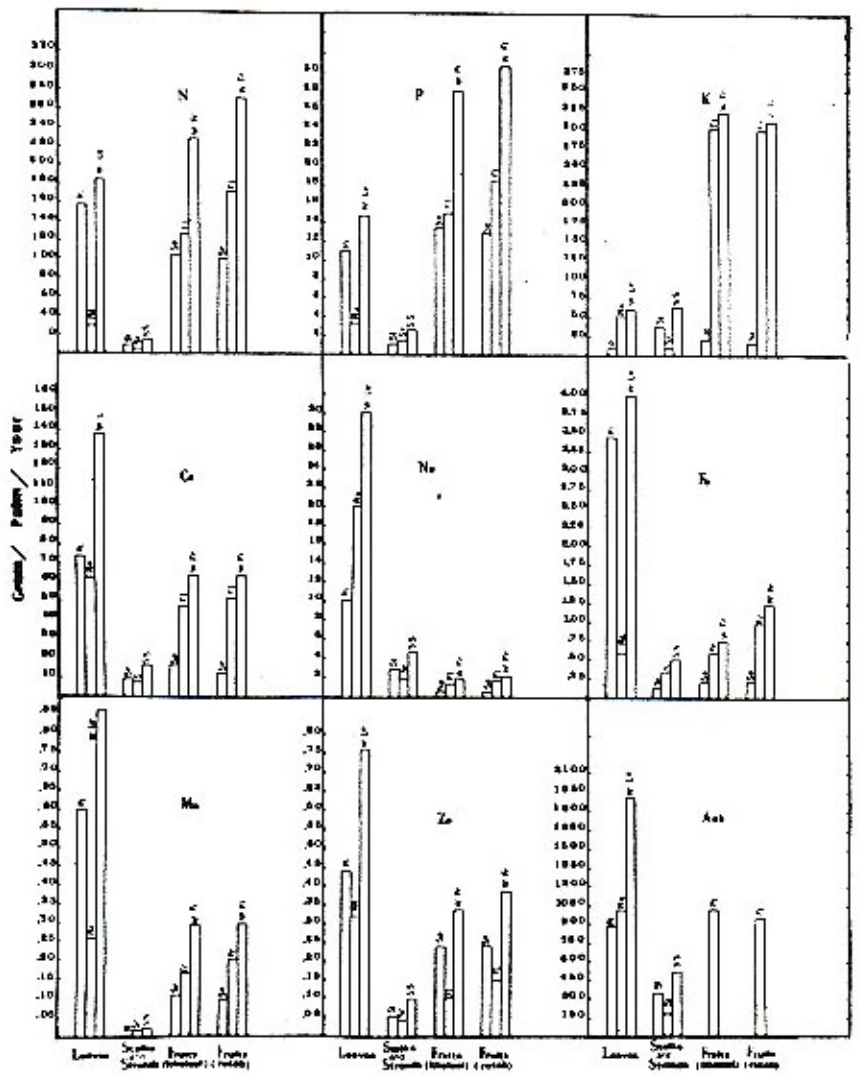

Figure 1: Estimated amounts of minerals, per palm, per year, removed by the different parts of fruit bunch and leaf prunings of date palm tree (F = Flesh; Se = Seed; WF = whole fruit; Sr = Strands; St = Stalk; P = Pinnae; R = Rachis; WL = whole leaf).

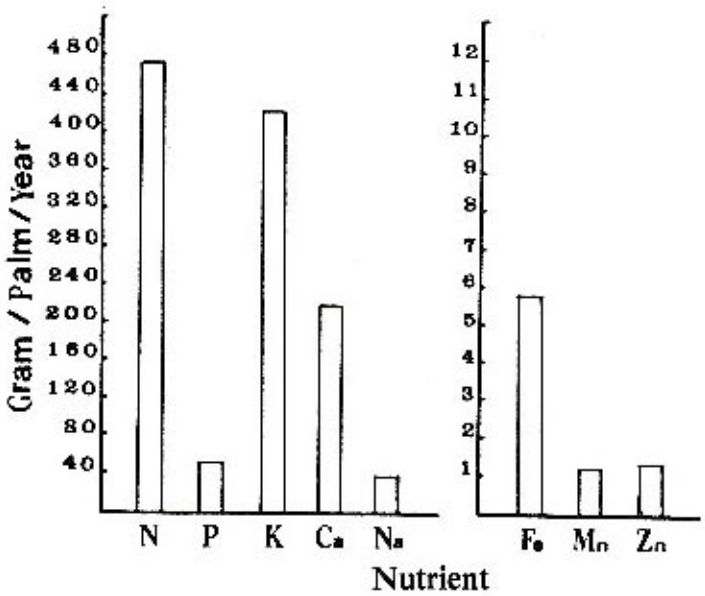

Figure 2: Total amounts of minerals annually lost in fruit harvest and leaf prunings of one date palm tree.