

Improving Yield, Fruit Quality and Leaf Mineral Content of Hayany Date Palm By the Application of Olive Pomace and Mineral Fertilization

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ABSTRACT

The present investigation was carried out during 2010 and 2011 seasons on Hayany date palm cultivar grown at El-Arish, North Sinai Governorate, Egypt, and depended on rainfall for irrigation, to study the effect of using olive pomace alone (as organic fertilizer) or in combination with nitrogen, phosphorus and potassium fertilizers on yield, fruit quality and some minerals content in leaves. The results could be summarized as follows. Fertilizing with 25 Kg olive pomace combined with N or NP or NK per palm tended to increase N content in pinnae as compared with other treatments. K content affected with the fertilization treatments, NK, 25 Kg olive pomace + NK and control treatments gave the highest of values leaf K content in both seasons. Moreover, P, Mg and Na content in pinnae were not significantly affected by different fertilization treatments including the control in both seasons. However Fe, Zn and Mn percentages were increased by adding olive pomace either alone or combined with mineral nutrients compared to other treatments. Concerning Ca content, no consistent trend was found between different treatments including the control. Moreover, adding olive pomace combined with NP and NK increased total chlorophyll in pinnae. As for the fruit chemical characteristics, no significant differences in TSS content in fruits were detected between different treatments including the control except treatment N which gave the lowest value. Regarding fruit total sugars content the application of olive pomace alone or combined with the minerals increased fruit total sugars content, as compared to mineral fertilization. Fruit tannins were significantly higher when palms were fertilized with olive pomace alone as compared to other treatments. Adding olive pomace combined with minerals (N, NP and NK) significantly increased yield / palm than that of the control. Fertilizing with 25 Kg olive pomace combined with NK significantly increased the average fruit and pulp weight, fruit length and diameter as compared with the control. No significant differences were found between different treatments in seed weight. According to the conditions of this experiment, it is recommended to fertilize Hayany date palm with 25 Kg olive pomace combined with NK which gave a reasonable yield with high fruit quality.

Key words: Date palm, organic fertilizer, olive pomace, leaf mineral content.

INTRODUCTION

Date palm (*Phoenix dactylifera L.*) tolerates the hard environmental conditions compared to other fruit trees. However, it needs fertilization with nutrient elements as other fruit trees. Nevertheless, experiments on date palm fertilization require more attention. Huge reductions in soil minerals content must be compensated annually by good fertilization programs in order to maintain the high yield and good quality of dates. However, the continuous use of chemical fertilization leads to deterioration of soil characteristics and fertility as well as it might lead to the accumulation of heavy metals in plant tissues which contribute to fruit nutrition value and edible quality (Shimbo *et al.*, 2001). The second source of nutrients is organic manure which is derived from animal or plant sources. It is an excellent source of organic matter and macro- and micro-minerals. In addition to providing nutrients for crop growth, manure has several beneficial effects on soil properties. Application of organic fertilizers was found to improve structural stability and lowered bulk density of the soil. It improved moisture retention, water infiltration rate and the hydraulic conductivity of soil (Tisdale and Nelson 1987) and (Young, 1997). However, organic manure may be beneficial to crop and soil on the long term (Tirol-Padre *et al.*, 2007). Similarly, soil fertility can be managed using organic fertilizers, crop rotation and association along with composting and recycling of the organic matter (Kenny and Hassan, 2006).

The primary use of ammonium sulfate was as a fertilizer for alkaline soils. In the soil the ammonium ion is released and forms a small amount of acid, lowering the pH balance of the soil, while contributing essential nitrogen for plant growth. The main disadvantage to the use of ammonium sulfate is its low nitrogen content relative to ammonium nitrate, (Karl-Heinz, 2012)

El-Arish is the capital and largest city of the Egyptian governorate of North Sinai, lying on the Mediterranean coast of the Sinai peninsula, 344 kilometers northeast of Cairo. The purpose here in nutrient management is to keep mineral nutrient levels in the tree with in the

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desired range to have the growth and development effects and fruiting of trees as desired by the grower.

The present investigation was carried out to study the effect of using olive pomace alone (as organic fertilizer) or in combination with nitrogen, phosphorus and potassium fertilizers on yield, fruit quality and mineral content in leaves of Hayany date palm cultivar.

MATERIALS AND METHODS

The present investigation was conducted during 2010 and 2011 seasons on mature palm trees (20 years-old) of Hayany date palm cultivars grown at El-Arish, North Sinai, Egypt. Selected palms in full production stage were chosen and subjected to the normal cultural practices, and depended on rainfall for irrigation. The average of rainfall rate was tabulated in Table (1) according to Willy Weather El Arish, QLD 4855.

Chemical analysis of olive pomace in both seasons was analyzed before used and presented in (Table 2).

Eight fertilization treatments were applied as shown in Table (3) each treatment was replicated four times with two palms for each replicate in a randomized complete block design (Snedecor and Cochran, 1990).

N-as ammonium sulphate (20.6% N) was added at rate of 2 kg/palm but with olive pomace 1 kg only. P-as calcium super phosphate (15.5% P₂O₅) was added at

rate of 1.5 kg/palm. Potassium as potassium sulphate (48% K₂O) was added at rate of 1 kg/palm.

All fertilization treatments were applied once yearly at late of January in two holes with 75 cm diameter and 75 cm depth at a distance of 100 cm from the palm trunk on two sides in the first season and on the opposite sides in the second season.

The effect of different fertilization treatments on leaf mineral content, yield and fruit quality was determined as follows:

1. Leaf mineral contents:

Twenty pinnae (as a sample) from each experimental palm were collected at mid November in both seasons from the medium part of the five consecutive leaves which less were than one year old and located just over the fruiting zone as described by Rizk (1987).

1.1. Total nitrogen and phosphorus were determined calorimetrically according to Evenhuis (1976) and Murphy and Riley (1962), respectively.

1.2. Potassium was determined by Pertracourt PEP1 Flame Photometer (On dry weight basis) according to Brown and Lilleland (1946).

1.3. Calcium, magnesium, manganese, zinc and iron contents were determined using Perkin –Elmer Atomic Absorption Spectro-photometer Model 305 B.

Table 1. Average of rainfall rate (mm) for 2010 and 2011 seasons

Month	2010		2011	
	Daily Average	Total amount	Daily Average	Total amount
Jan	22.8	681.0	17.1	529
Feb	13.0	365.2	35.0	980
Mar	19.5	605.0	34.0	1054.6
Apr	23.5	708.2	15.4	462.4
May	5.5	169.2	2.8	87.8
June	3.1	93.6	4.9	147.8
July	5.8	181.0	1.7	54.0
Aug	6.0	185.0	2.3	70.8
Sept	4.8	143.6	3.9	115.6
Oct	16.3	506.0	10.0	309.6
Nov	13.3	398.2	7.2	214.8
Dec	18.9	586.6	10.0	309.4
Average	12.70	334.8	12..0	361.3

Table 2. Chemical analysis of olive pomace used in fertilizing 2010 and 2011 seasons

Moisture %	Ash %	Organic matter %	N %	P %	K %	Ca %	Na %	Fe ppm	Mn ppm	Cu ppm
2010										
23.45	5.3	41.21	3.12	0.09	0.45	0.47	0.35	1184	107	9
2011										
24.98	5.1	40.74	3.07	0.09	0.47	0.47	0.36	1413	110	11

Table 3. The layout of fertilization treatments during 2010 and 2011 seasons

Treatments	Dosage/palm/year		
	N (gm)/palm	P ₂ O ₅ (gm)/palm	K ₂ O (gm)/palm
2010			
NPK (control)	412	232.5	480
N	412	0	0
NP	412	232.5	0
NK	412	0	480
25 Kg olive pomace	780	22.5	112.5
25 Kg olive pomace + N	986	22.5	112.5
25 Kg olive pomace + NP	986	255	112.5
25 Kg olive pomace + NK	986	22.5	592.5
2011			
NPK (control)	412	232.5	480
N	412	0	0
NP	412	232.5	0
NK	412	0	480
25 Kg olive pomace	767.5	22.5	117.5
25 Kg olive pomace + N	973.5	22.5	117.5
25 Kg olive pomace + NP	973.5	457.5	117.5
25 Kg olive pomace + NK	973.5	22.5	597.5

2. Total chlorophyll:

Total chlorophyll was measured in pinnae by Minlota chlorophyll meter SPAD reading according to (A.O.A.C. 1995).

3. Yield:

The yield per palm in Kg was recorded at the end of October at the peak of fruitful color stage.

4. Fruit quality:

The fruit fresh weight of each treated palm was determined through collected sample of 20 fruits. Fruit quality was determined at harvest date, fruit weight, fruit length and diameter as physical properties. The

percentage of total soluble solids (TSS %) was determined in fruit juice by hand refractometer. While chemical properties as total sugars and soluble tannins were determined (% on fresh weight basis) according to Dubios *et al.* (1956) and Swain and Hillis (1959), respectively.

Soil samples were taken at 0-30 cm, 30-60 cm and 60-90 cm from soil surface orchard for chemical analysis and mechanical analysis of experiments and the data are shown in (Table 4).

Table 4. Soil analysis of the experimental orchard

Parameters	(1) Chemical analysis							
	pH	E.C. (dS m ⁻¹)	Organic matter (%)	S.P. (%)				
Soil Depth								
0-30 Cm	7.87	1.4	0.12	10				
30-60 Cm	7.91	0.9	0.12	10				
60-90 Cm	7.90	1.2	0.11	10				
Soluble ions soil paste extract (meq/L)								
	Ca ⁺⁺	Mg ⁺⁺	Na ⁺	K ⁺	Co ₃ ⁻	HCO ₃ ⁻	Cl ⁻	HSO ₄ ⁻
	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L	meq/L
0-30 Cm	2.79	1.9	7.10	1.3	0.27	4.3	5.47	3.05
30-60 Cm	2.50	1.8	5.96	1.2	0.26	4.5	5.20	2.50
60-90 Cm	2.62	1.9	7.90	1.5	0.27	4.1	5.90	3.65
(2) Mechanical analysis								
	Clay %	Silt %	Fine Sand %	Coarse sand %	Texture grade			
Soil sample	3	2	74.8	20.2	Sandy			

RESULTS AND DISCUSSION

1. Effect of olive pomace and mineral fertilization treatments on pinnae minerals content of Hayany date palms:

As for the effect of different fertilization treatments on pinnae minerals content, the data in Table (5) showed that nitrogen content was affected with different fertilization treatments in both experimental seasons. Treatments, 25 Kg olive pomace combined with N or NP or NK per palm significantly increase N content in pinnae as comparing with other treatments. This was true in both seasons.

Concerning phosphorus content in pinnae, no significant differences were found between different treatments including the control in both seasons except treatment N alone in the second season which gave the lowest value.

Regarding to K content, the results of both seasons Table (5) revealed that leaf K content was affected with the fertilization treatments, NK, 25 Kg olive pomace combined with NK and control treatments gave the highest value comparing with N and NP treatments which gave the lowest values.

Generally no significant differences were found between different treatments in Mg and Na content, in pinnae including the control in both seasons, however Fe, Zn and Mn percentage were increased by adding olive pomace either alone or combined with mineral nutrients compared to remaining other treatments.

Concerning Ca content, the obtained data show that there is no consistent trend in calcium content between different treatments including the control in both seasons. Organic manures enhanced soil properties and soil fertility (Mathew and Karikari, 1995) and (Kaurch *et al.*, 2005) and might lead to the increase of available nutrients and their uptake (Kanal and Kuldkepp, 1993). The addition of organic manure might have provided supplemental exchangeable actions such as potassium, calcium, magnesium and ammonium as well as increasing the available phosphorous (Magdoff, 1998 and Ofosu-Anim *et al.*, 2006). In this respect, the overall increase in leaf mineral contents, as a result of applying organic manure or organic fertilization in combinations with mineral fertilizer, in the present study might be explained in the light of results of previous studies.

Table 5. Effect of fertilization treatments on leaf minerals content (on dry weight basis) for Hayany date palm cultivar during 2010 and 2011 season

Treatments	N	P	K	Ca	Mg	Na	Fe	Zn	Mn
	%				ppm				
2010									
NPK (control)	1.61c	0.154a	0.94ab	1.13bc	0.20ab	0.085a	144.0b	55.43c	58.70b
N	1.62c	0.152a	0.70c	1.13bc	0.20ab	0.083a	144.7b	55.40c	60.15b
NP	1.60c	0.154a	0.71c	1.08cd1.	0.20ab	0.083a	146.7b	5350c	65.40b
NK	1.62c	0.157a	0.93ab	05d	0.19b	0.085a	148.2b	66.50b	60.47b
25 Kg olive pomace	1.69b	0.156a	0.90b	1.19ab	0.21a	0.088a	167.8a	71.48a	82.50a
25 Kg olive pomace + N	1.75a	0.154a	0.94a	1.20a	0.21a	0.085a	173.8a	71.60a	84.40a
25 Kg olive pomace + NP	1.74a	0.160a	0.95a	1.15abc	0.21a	0.088a	171.6a	71.82a	84.50a
25 Kg olive pomace + NK	1.72a	0.157a	0.97a	1.12bc	0.21a	0.088a	174.3a	72.12a	83.80a
2011									
NPK (control)	1.86b	0.156ab	0.66ab	1.14v	0.20a	0.088a	147.2c	65.75b	69.74cd
N	1.84b	0.144b	0.55d	1.15c	0.20a	0.083a	148.1c	55.83c	69.90cd
NP	1.78c	0.148ab	0.54d	1.14c	0.20a	0.085a	147.6c	55.52c	67.28d
NK	1.77c	0.1464b	0.65ab	1.14c	0.20a	0.085a	149.4c	69.50b	65.87d
25 Kg olive pomace	1.68d	0.156ab	0.64bc	1.18b	0.21a	0.085a	166.9b	75.00a	73.37a
25 Kg olive pomace + N	2.605a	0.156ab	0.64bc	1.18b	0.21a	0.088a	169.2ab	73.28a	73.10ab
25 Kg olive pomace + NP	2.035a	0.161a	0.62c	1.20b	0.21a	0.085a	172.7a	76.71a	73.08ab
25 Kg olive pomace + NK	2.010a	0.153ab	0.66a	1.22a	0.21a	0.083a	173.1a	75.02a	73.39a

Means separation in each column by Duncan's Multiple Range Test, 5% level

2. Effect of olive pomace and minerals fertilization treatments on pinnae chlorophyll content of Hayany date palms:

Concerning the total chlorophyll in pinnae the data in Table (6) indicated that olive pomace combined with NP and NK in the first season and combined with N, NP and NK in the second season gave the highest value and the differences were statistically significant among these treatments and most of the other treatments. These different levels of chlorophyll concentration would seem to be correlated with the differences in nitrogen availability between the treatments. These results coincided with those obtained by Hoda, Aly *et al.*, (2009) on Zaghlou and Samany date palm cultivars.

3. Effect of olive pomace and minerals fertilization treatments on some fruit chemical properties of Hayany date palms:

Results presented in Table (6) indicated that there are no significant differences in TSS content in fruits between different treatments including the control except N treatment which gave the lowest value in both seasons.

Regarding fruit total sugars content, the data revealed that application of olive pomace alone or combined with the minerals in the second season increased fruit total sugars content as compared to mineral fertilization except NPK treatment but in the first season olive pomace combined with NK resulted higher significant value as compared with NPK, N, NP and olive pomace + N.

Fruit tannins were significantly higher when fertilized with olive pomace alone as compared to fertilization with all other treatments in both seasons. Similar findings were reported by those found by El-Deeb *et al.*, (2000) and Hoda Aly, (2003) the latest found that the palm trees fertilized by town refuse plus urea had a significant higher percentage of total sugars as compared with that fertilized with town refuse alone. Sharawy (2005) stated that the combined application of mineral nitrogen and compost, was effective in improving fruit quality of lime trees in comparison to application of each source alone. The general increase in fruit quality characteristics by the application of organic fertilizer or organic matter plus minerals NPK might be due to the increase in the availability N, P and K in the soil due to the application of organic fertilizers (Magdoff, 1998) these essential nutrients may have a direct impact on photosynthesis and accumulation of dry matter and total soluble solids.

4. Effect of olive pomace and minerals fertilization treatments on yield and some fruit physical properties and yield of Hayany date palms:

Data of both seasons presented in Table 7, showed that fruit yield (kg/palm) was significantly higher in all olive pomace combined with minerals (N, NP and NK) treatments and the differences were statistically significant among them and all remaining treatments except olive pomace alone in the first season. Increasing yield due to using of olive pomace compared with control or other inorganic fertilizer may be due to the effect of organic materials in improving soil properties (Abdel-Nasser, and Harhash 2000), increasing nutrients content also may be explained on the basis that the organic materials increased the soil water holding capacity which encourage the solubility and consequently the available nutrients (Zaid and Kriem, 1992; El-Kassas *et al.* 1997, Nassar, 1998, Kastens *et al.*, and Marzouk and Kassem 2010).

The results remaining the effect of different fertilizers treatments on the various physical fruit characteristics are presented in Table (7). Fruit weight and pulp weight were increased in both seasons by applying olive pomace in combination with NP or NK and the differences were statistically significant in compared with all mineral treatments. No significant differences in seed weight were found between different treatments in both seasons except treatment 25 Kg olive pomace + NK and control which gave the lowest value in the first season.

In regard to fruit dimensions, data of Tables (7) revealed a nearly similar trend as discussed for fruit weight, olive pomace in combination with NK significantly increased both fruit length and diameter as compared with all mineral treatments. in both seasons.

These findings are in harmony with those found by Hussein *et al.* (1992), Sourour *et al.* (1998), El-Deeb *et al.*, (2000), Khan *et al.*, (2008) and Marzouk and Kassem (2010). The above results indicated an enhancement in fruit quality characteristics especially fruit weight with the application of organic fertilizer or its supplementation with mineral NPK compared to mineral fertilization alone. Similar findings were reported by Shahein *et al.* (2003) working on Samany date. Also, Sharawy (2005) stated that the combined application of nitrogen, through mineral and compost, was effective in improving fruit quality of lime trees in comparison to application of each source alone. The general increase in fruit quality characteristics by the application of organic manure or organic manure plus mineral NPK compared to mineral NPK and N might be

due to the increase in the available N, P and K in the soil due to the application of organic fertilizers.

Conclusively, the obtained results give basis to conclude that adding olive pomace as organic fertilizer or organic matter in combination with minerals NPK for "Hayany" date palm under El-Arish, North Sinai,

conditions (Egypt) is considered one of the most important practices to obtain reasonable yield/ palm with high fruit quality. The most beneficial treatment in this concern is application of olive pomace in combination with NK, which gave a reasonable yield and high fruit quality and could be considered as a recommended treatment under the conditions of this experiment.

Table 6. Effect of fertilization treatments on some fruit chemical properties and pinnae total chlorophyll (on fresh weight basis) for Hayany date palm cultivar during 2010 and 2011 seasons

Treatment	TSS %	Total sugar %	Soluble tannin %	Total chlorophyll SPAD reading
2010				
NPK (control)	33.53abc	36.92cd	3.82b	66.25b
N	32.85c	36.59d	3.82b	63.75c
NP	33.97abc ³	37.32bc	3.93b	67.40ab
NK	3.30abc	37.43abc	3.72bc	66.28b
25 Kg olive pomace	34.06ab	37.96ab	4.46a	65.22bc
25 Kg olive pomace + N	34.05ab	36.56d	3.48c	66.25b
25 Kg olive pomace + NP	34.30a	37.37abc	3.92b	68.41a
25 Kg olive pomace + NK	34.38a	38.05a	4.02b	67.52a
2011				
NPK (control)	35.51abc	24.31ab	3.51cd	65.40abc
N	34.20bc	22.58b	3.39d	64.10c
NP	36.75ab	23.19b	4.12b	66.30abc
NK	35.48abc	23.33b	3.46cd	65.87b
25 Kg olive pomace	35.57abc	26.42a	4.64a	67.82ab
25 Kg olive pomace + N	37.85a	27.12a	4.20b	68.13a
25 Kg olive pomace + NP	37.57a	27.57a	3.54c	68.10a
25 Kg olive pomace + NK	36.82ab	27.81a	3.50c	68.28a

Means separation in each column by Duncan's Multiple Range Test, 5% level

Table7. Effect of different fertilization treatments on some fruit physical properties and yield for Hayany cultivar during 2010 and 2011 seasons

Treatment	Fruit weight (gm)	Pulp weight (gm)	Seed weight (gm)	Fruit length (cm)	Fruit diameter (cm)	Yield (kg/palm)
	2010					
NPK (control)	22.77d	20.49d	2.29b	5.52b	2.60e	84.78c
N	21.95e	19.28e	2.68a	5.27c	2.72bc	100.6b
NP	23.01d	20.45d	2.56ab	5.62ab	2.72bc	90.59bc
NK	21.86e	19.37e	2.50ab	5.31c	2.69cd	85.80c
25 Kg olive pomace	25.99c	23.37c	2.62ab	5.36c	2.67d	109.1ab
25 Kg olive pomace + N	27.35b	24.87b	2.47ab	5.65a	2.76ab	112.4a
25 Kg olive pomace + NP	27.77a	25.33ab	2.44ab	5.71a	2.72bc	115.7a
25 Kg olive pomace + NK	27.95a	25.65a	2.30b	5.70a	2.80a	118.2a
2011						
NPK (control)	24.25cd	21.50c	2.55a	5.54cd	2.68c	79.33d
N	23.87d	21.39c	2.48a	5.49d	2.71c	70.56cd
NP	24.53c	22.10c	2.44a	5.51cd	2.63d	82.12c
NK	24.31cd	21.59c	2.57a	5.52cd	2.70c	81.80c
25 Kg olive pomace	25.01c	22.48ab	2.53a	5.59bc	2.68c	108.00bc
25 Kg olive pomace + N	26.69b	24.15b	2.54a	5.69a	2.76b	125.50a
25 Kg olive pomace + NP	26.95ab	24.44ab	2.51a	5.69a	2.73bc	129.91a
25 Kg olive pomace + NK	27.39a	24.90a	2.49a	5.70a	2.82a	133.43a

Means separation in each column by Duncan's Multiple Range Test, 5% level

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الملخص العربي

تحسين المحصول وجودة الثمار بإضافة مخلفات عصر الزيتون والتسميد المعدني للنخيل صنف الحياني

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كذلك فإن مخلفات عصر الزيتون محتله بـ NP أو NK تزيد من محتوى الكلوروفيل في الوريقات. أما بالنسبة للخصائص الكيماوية في الثمار فقد أظهرت النتائج أنه لا يوجد فروق معنوية بين المعاملات ماعدا معاملة النيتروجين منفردا التي أعطت أقل محتوى من المواد الصلبة الذائبة. أما بالنسبة للسكريات الكلية فقد أظهرت النتائج أن إضافة مخلفات عصر الزيتون أما منفردة أو مخلوطة بالتسميد المعدني أعطت زيادة في محتوى الثمار من السكريات الكلية بالمقارنة بالتسميد المعدني منفردا. وظهرت أعلى زيادة معنوية للتانينات عند إضافة مخلفات عصر الزيتون منفردا بالمقارنة بباقي المعاملات. إضافة مخلفات عصر الزيتون مخلوطة بالعناصر المعدنية مثل N, NP و NK أعطت زيادة معنوية لمحصول النخلة عن معاملة الكنترول. التسميد بـ 25 كجم من مخلفات عصر الزيتون مخلوطة بـ NK سببت زيادة معنوية من متوسط وزن ولب وطول وقطر الثمرة بالمقارنة بالكنترول. لا يوجد فروق معنوية عند التسميد بالمعاملات المختلفة على وزن البذرة طبقا لما سبق فقد أظهرت التوصيات لهذا البحث أن تسميد الحياني بـ 25 كجم من مخلفات الزيتون مخلوطة بـ NK أعطت أعلى تأثير على المحصول وأفضل صفات جودة للثمار.

أجريت تجربته خلال موسمى 2011/2012 على نخيل البلح صنف الحياني المزروع بالعريش، محافظة شمال سيناء، مصر تحت ظروف الري بمياه الأمطار. وذلك لدراسة تأثير استخدام مخلفات عصر الزيتون منفردا كمصدر عضوى أو مخلوطا بالنيتروجين أو الفوسفور أو البوتاسيوم أو التسميد المعدني منفردا على المحصول وجودة الثمار وبعض العناصر المعدنية بالأوراق. وكانت النتائج كالتالى: التسميد بـ 25 كجم من مخلفات عصر الزيتون مخلوطة بالعناصر المعدنية الأخرى N أو NP أو NK أعطت أعلى محتوى من النيتروجين بالوريقات بالمقارنة بباقي المعاملات الأخرى. أما محتوى البوتاسيوم فقد تأثر وأعطى أعلى محتوى مع NK أو مخلفات عصر الزيتون مخلوطة بـ NK والكنترول (المقارنة) وذلك في كلا الموسمين بينما محتوى الفوسفور والمغنسيوم والصدويوم لم يتأثر معنويا بكل المعاملات بما فيها الكنترول في كلا الموسمين. وقد زاد محتوى الحديد والزنك والمنجنيز في الوريقات بإضافة مخلفات عصر الزيتون إما منفردا أو مخلوطة بالأسمدة المعدنية بالمقارنة بباقي المعاملات. أما محتوى الكالسيوم فلم يظهر أى اتجاه واضح في كلا الموسمين.