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EFFECT OF ORGANIC FERTILIZATION ON GROWTH, YIELD AND FRUIT QUALITY OF ZAGHLOUL DATE PALM GROWN IN SANDY SOIL

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Abstract: The beneficial effects of organic fertilization either alone or combined with inorganic nitrogen fertilizer on growth, nutrient status and fruiting of Zaghloul date palms grown in sandy soil were investigated during 2006 and 2007 seasons. Organic manure was applied at 0.0, 20, 40, 60, 80 and 100% combined with inorganic-N at 100, 80, 60, 40, 20 and 0.0% of the recommended dose of nitrogen fertilization of 1200 g/palm/year.

The obtained results indicated that application of organic nitrogen either alone or combined with inorganic nitrogen form significantly improved vegetative growth traits and palm nutrient status as well as increased yield and improved the dates quality as compared to application of mineral nitrogen alone. Fertilizing by organic manure either at 60 to 80% plus 40to 20% inorganic nitrogen form gained the highest score recording comparing with other fertilization tested treatments.

The results also revealed that replacing 60-80% of nitrogen requirements for Zaghloul date palms grown in sandy soil by organic manure added once at winter season improved the growth and nutritional status of palms as well as yield and dates quality, in addition, saving nitrogen fertilization cost and reducing the environmental pollution problems.

Key word: Organic fertilization – growth and yield of date palm in sandy soils.

Introduction

Egypt is one of the major producing countries of date palm which has an important position in the fruit economic production. In addition, the date palm is a source of nutrition and shelter against harsh conditions. In many desert areas, dates have been used as a staple food for hundreds of years (Nixon and Carpenter, 1978).

Fertilization, especially nitrogen is one of the important tools for increasing crop yield. The efficiency of nitrogen fertilizer under field conditions and surface irrigated soils, rarely exceeds 50% and is usually ranging between 30 and 40% (Sahrawat, 1979). Such low efficiency may be due to losses of N from soils as nitrate and nitrite by leaching or as nitrogen gases through nitrate reduction

by volatilization (Goring, 1962) causing many problems such as nitrate pollution of ground water and environment. In addition, they can alter the composition of fruits, vegetables and root crops and decrease their contents of vitamins, minerals and other useful compounds. Apparently, harmful residues that remain in food pose threats to health (Bogatyre, 2000).

In the last few decades organic fertilization for fruit crops became a good alternative to chemical fertilization to avoid pollution of the environment and to produce a safe and nutritious food that is good for health (Blake, 1990). Growers apply organic N amendments for perceived or real improvement, in soil physical, chemical and biological properties but the main benefit appears to be the increase in nutrient availability (Yagodin, 1984; Lindemann and Cardenas, 1984; Darwish *et al*., 1995, El-Salhy *et al*., 2002, Diab, 2006 and Almadini and Al-Gosaibi, 2007). The use of organic materials as N source has been considered as a best management because organic N is released to the trees more gradually than water soluble inorganic N fertilizers. Thus improving the efficiency of nutrient chemical and biological properties (Nijjar, 1985).

Application of farmyard manure with a mineral N source was accompanied with an obvious promotion on growth, yield and quality of date palm fruits (Ghafoor and Gopang, 1988; Hussein *et al*., 1992; El-Morshedy, 1997; Shahein *et al*., 2003; Abdel-Hameed and Ragab, 2004; Mansour *et al*., 2004; Mohamed and Gobara, 2004; El-Assar, 2005; Abou Sayed-Ahmed *et al*., 2005; Diab, 2006 and Almadini and Al-Gosaibi, 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 main objective of this study was to evaluate the effect of organic manures alone or combined with inorganic N on growth, yield and fruit quality of Zaghloul date palm grown in sandy soil. In addition, selecting the optimum rate of them was also investigated.

Materials and Methods

The present study was carried out during the two successive seasons of 2006 and 2007 at the Experimental Orchard of Qena, Agriculture Faculty, South Valley University, Egypt. Eighteen Zaghloul date palms of uniform vigour 11 years old, healthy with no visual nutrient deficiency planted in sandy loam soil and water table depth at not less than three meters were chosen. Analysis of the soil was

done according to Wilde *et al*. (1985) and are shown in Table (1).

The experiment included six treatments representing various levels of nitrogen fertilization (inorganic and organic). Each treatment had under the same recommended N level of 1200 g N/palm/year as shown in Table (2).

Inorganic nitrogen source was applied in the form of ammonium nitrate (33.5% N) and added at three equal batches at the first week of March, May and July of each season. Meanwhile, organic-N was applied as chicken manure (2.5% N), Table (1) and added once at the first week of January in both seasons. The experiment was arranged in a randomized complete block design with three replications, one palm per each. Calcium superphosphate (15.5% P_2O_5) and potassium sulphate (48% K_2O) were added at one kg/plant. Other horticultural management such as irrigation, pruning, artificial pollination and pest control were used as usual.

Average number of newly growing leaves was counted at the end of growth season. In addition, four mature leaves (fronds) around fruiting zone (each embracing a bunch) were chosen on each palm to determine leaf length (m), number of pinnae, number of spines, proportion (%) of pinnae and spines area to rachis length. Four pinnae were taken from the middle part of each leaf to determine pinna area according to Shabana and Antoun (1980) using the following equation:

Pinna area (cm^2) = length x maximum width x 0.84

Table(1): Some physical and chemical characteristic of experimental soil and chicken manure used.

Soil property	Value	Chicken manure characters	Value
Sand (%)	77.2	Organic matter (%)	34.34
Silt (%)	18.8	pH value	7.56
Clay (%)	4.0	Total N (%)	2.50
Texture grade	Sandy loam	Total P (%)	0.39
pH (1:2.5)	8.08	Total K (%)	1.90
$CaCO_3$ (%)	7.47	Fe (ppm)	3310
Organic matter (%)	0.97	Zn (ppm)	654
Total nitrogen (%)	0.19	Mn (ppm)	190
Available P (ppm)	2.7		
Na (mg/100 g)	1.01		
K (mg/100 g)	0.74		
DTPA-Extractable Fe (ppm)	7.50		
DTPA-Extractable Mn (ppm)	5.20		
DTPA-Extractable Zn (ppm)	1.70		

Table(2): The amount of nitrogen in inorganic and organic sources used in the studied treatments.

Fertilization treatment		The amount of fertilization				Total N/palm (g)
		Mineral fertilizer		Organic fertilizer		
		Amount/ palm (kg)	Net N/palm (g)	Amount/ palm (kg)	Net N/palm (g)	
100% mineral-N control	T_1	3.582	1200	0.0	0.0	1200
80% min. + 20% organic-N	T_2	2.866	960	9.6	240	1200
60% min. + 40% organic-N	T_3	2.149	720	19.2	480	1200
40% min. + 60% organic-N	T_4	1.433	480	28.8	720	1200
20% min. + 80% organic-N	T_5	0.716	240	38.4	960	1200
100% organic	T_6	0.0	0.0	48.0	1200	1200

The whole leaf area (m^2) was obtained from multiplying the pinna area by the number of pinnae/leaf.

Percentage of N, P and K in the dried pinnae were determined according to procedures outlined by Wild *et al*. (1985).

All bunches were harvested when reached the commercially derived color. The yield of each palm was recorded in terms of weight (kg) and number of bunches/palm. Fifty dates were taken randomly from each palm to determine the physical and chemical fruit properties as outlined in A.O.A.C. method (1985).

To general evaluation of tested fertilization treatments effects, hundred unit were shared between following ten main characteristics, number of new leaves/palm, leaf length, leaf area and pinnae zone length percentage. In addition, number of bunches/palm, bunch weight and yield/palm as well as fruit weight, flesh percentage and total soluble solids (10 units for each). Within each of these parameters, the treatment that recorded the upper most values received all the units specified for it. The following equation was used to determine these characters.

$$\text{Characters} = \sum \frac{B}{A} \times 10$$

Where: A = the highest value recorded for studied character among all treatments.

B = value recorded for the specific character for considered treatment.

The proper statistical analysis was carried out according to the methods outlined by Gomez and Gomez (1984) using L.S.D. test for distinguishing treatment means.

Results and Discussion

1- Effects of fertilization treatments on vegetative growth and pinnae N, P and K content:

The effects of organic fertilization levels on some vegetative growth traits and pinnae N, P and K contents of Zaghloul date palms during 2006 and 2007

seasons are shown in Tables 3 and 4. Data in previous tables show that increasing organic-N levels was followed by a gradual significant promotion in area of pinnae and leaves as well as pinnae zone leaf length percentage and leaf content of N, P and K. The maximum values of pinnae area and whole of leaf and its content of N and K were obtained on palm that supplied by 20-40% inorganic-N plus 60-80% organic-N form (T_4 & T_5). However, the application of all N amounts as ammonium nitrate recorded the minimum values of these traits. Contrarily, the new leaf and leaf length were significantly decreased due to amending the palm with organic-N source only. The best results with vegetative growth and leaf nutrient composition of Zaghloul date palm were obtained due to fertilizing with 60 to 80% of whole nitrogen dose/palm at organic form.

Such findings in response to using organic-N fertilizer may be mainly attributed to its positive action on increasing the activity of microflora, water holding capacity, soil structure aggregation soil, the soil acidity, soil humus content and the availability of most nutrients. In addition, organic manures are considered important sources of macro and micro-nutrients. They contain considerable amounts of N, P, K, Fe, Mn and Zn (Table 3). Moreover, they can provide most nutrients to palms along the whole growth season. Such improving and stimulation lead to enhancing the biosynthesis of organic foods and cell division (Nijjar, 1985).

These results are in agreement with those obtained by Ghafoor and Gopan (1988), Abdel-Hameed and Ragab (2004), Mohamed and Gobara (2004), Mansour *et al*. (2004) and Diab (2006) who reported positive vegetative growth and leaf nutrient composition responses of various date palm cultivars to the annual application of organic fertilizers.

2 – Effect of fertilization treatments on yield and bunch traits:

A significant promotion on yield (kg)/palm and bunch weight occurred with increasing organic N levels from 40 to 100% of whole nitrogen dose/palm compared to application all amounts of N in an inorganic from (see Table 5). Number of bunches was not alter in the first season as a result of treatments. Moreover, in the second season the maximum number of bunches was obtained from the palms received 80% organic-N plus 20% inorganic-N. However, the minimum number occurred on the palms that were supplied with the inorganic N only.

Also, supplying Zaghloul date palms with 200 or 400 g inorganic N plus 800 or 600 g organic-N/palm gave the heaviest bunch weight and consequently the yield/palm was significantly increased. Whereas, the minimum

values of bunch weight and yield/palm were related with palms that supplied by inorganic-N only comparing using the organic N form either alone or combined with inorganic form. No significant differences in bunch weight and yield/palm were observed due to raising the organic-N fertilizer level from 60 to 100% of the recommended dose.

The increase in yield/palm could be due to organic manure effects in increasing the bunch weight during two the studied seasons. In addition, the improving effect of organic manure on number of bunch/palm could be attributed to their vital role in improving palm growth and nutritional status can encourage the cell division and the development of meristematic tissues (Miller *et al*., 1990) consequently improving the number of inflorescences borne.

These results are in harmony with those obtained by Hussein *et al*. (1992), Shahein *et al*. (2003) and El-Assar (2005) who found that the yield of Zaghloul and Samany date palms lend to be higher as a results of fertilizing with organic-N source either alone or combined the artificial nitrogen sources. In addition heavy bunch weight was related to application the organic-N fertilization only, whereas, the lowest bunch weight related to application nitrogen fertilization at a completely via inorganic source. Also, Abdel-Hameed and Ragab (2004), Mansour *et al*. (2004), Mohamed and Gobara (2004), Abou-Sayed-Ahmed *et al*. (2005) and Diab (2006) who reported that an increase in bunch weight and yield of various date palm cultivars in response to increase percentage of organic fertilizer from 12.5 to 75% of recommended nitrogen dose.

3 – Effect of fertilization treatments on fruit quality:

Using organic-N either alone or in combination with an inorganic-N source was significantly effective in improving quality of Zaghloul dates in terms of increasing weight, length, flesh percentage and pulp thickness of fruits, total soluble solids %, sugar contents and decreasing the total acidity % compared to using the inorganic-N alone (Table 6 and 7). The observed improving effect on the quality of the fruits was associated with increasing the applied level of organic-N and with decreasing the amount of inorganic-N. There were no significant differences in such traits due to raising the organic-N source from 60 to 100% of recommended dose. Such finding might be owing to the effect of organic manures in enhancing the availability of nutrient and accelerating the biosynthesis of organic and enhancing cell enlargement could improve the fruit weight and length. In addition, organic-N sources either alone or combined with mineral-N

sources could be ascribed a good balance between growth and fruiting could be result in accumulation more carbohydrates and makes them very available for enhancing ripening of fruits.

The best results with regard to yield and dates quality were obtained by fertilizing the palms with organic source either 60 or 80% plus 40 and 20% inorganic source of whole nitrogen dose/palm. These results are in accordance with those obtained by Shahein *et al*. (2003), Abdel-Hameed and Ragab (2004), Mohamed and Gobara (2004), Mansour *et al*. (2004), El-Assar (2005) and Diab (2006) who reported that increasing the organic-N level substantially from 12.5 to 75% of recommended nitrogen rate was followed by a gradual improving the fruit quality.

4 – General evaluation of organic-N levels:

As a general evaluation of the studied organic-N level fertilization, average of the two studied seasons, according to vegetative growth, yield components and fruits quality. Data in Table (8) emphasize the prementioned trends. Fertilization by either combined 80% organic-N plus 20% inorganic-N form (T_5) or 60% organic-N plus 40% inorganic-N (T_4) recorded the highest score (98.4 and 97.2 units, respectively). Both treatments recorded approximately similar effect on vegetative growth (38.2 & 38.8 units) and yield component (29.9 & 29.6 units), whereas (T_5) surpassed (T_4) in fruit quality (30.0 units) against 29.1 units, respectively. Whereas, the least total scores was recorded to apply the inorganic-N form only (T_1) (91.5 units). It could be arranged these scores in adescendingly order as follow (98.4, 97.2, 96.6, 96.4, 93.3 and 91.5 units due to use T_5, T_4, T_6, T_3, T_2 and T_1, respectively.

These results may be attributed to the effect of organic-N form on improving the vegetative growth that induce a positive improvement on yield components and fruit quality. Such positive improvement was previously explanated.

In general, one can be conclude that best forming practices of the fertilization for Zaghloul date palms grown in sandy loam soil is using 1200 g N/palm at either 60-80% at organic-N form added as one dose at the first of January, plus 20-40% at inorganic-N form applied at three equal batches in March, May and July. Under such promising treatment growth and palm nutritional status as well as yield and fruit quality were greatly improved. In addition, improved soil properties and reduced the environmental pollution problems.

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تأثير التسميد العضوى على نمو ومحصول وخصائص ثمار نخيل البلح الزغلول النامية بالأراضى الرملية

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أجرى هذا البحث خلال موسمى ٢٠٠٦ ، ٢٠٠٧ بغرض دراسة تأثير التسميد العضوى على النمو الخضرى والحالة الغذائية والمحصول وخصائص ثمار نخيل البلح الزغلول النامية فى الأراضى الرملية حيث كانت المعاملات هى إضافة التسميد العضوى بمعدل صفر ، ٢٠ ، ٤٠ ، ٦٠ ، ٨٠ ، ١٠٠% مع إضافة الباقى (١٠٠ ، ٨٠ ، ٦٠ ، ٤٠ ، ٢٠ ، صفر) من الجرعة الموصى بها على صورة نيتروجين معدنى (١٢٠٠ جم/نخلة/سنة) . وقد أوضحت النتائج ما يلى :

– أدى استخدام النيتروجين العضوى مع النيتروجين المعدنى إلى تحسين النمو حيث أدى إلى زيادة مساحة الوريقات والورقة بينما حدث نقص فى طول الأوراق وعدد الأوراق الجديدة/نخلة/ سنة .

– سبب استخدام التسميد بالنيتروجين العضوى فى صورة فردية أو خليطاً مع النيتروجين المعدنى إلى زيادة مؤكدة فى نسبة النيتروجين والبوتاسيوم والفوسفور بالوريقات وبالتالى حدث تحسين للحالة الغذائية مقارنة بإضافة الجرعة كاملة فى الصورة المعدنية .

– أدى استخدام التسميد العضوى فردياً أو خليطاً مع الأسمدة المعدنية إلى تحسين وزن السباطة وعدد السباطات والمحصول / نخلة مقارنة بإضافة الجرعة كلية فى الصورة المعدنية .

– أدى استخدام التسميد العضوى فردياً أو خليطاً مع الأسمدة المعدنية إلى زيادة مؤكدة فى وزن الثمرة ونسبة اللحم ونسبة المواد الصلبة الذائبة الكلية ومحتوى السكريات بالثمار مقارنة بإضافة الجرعة كاملة فى الصورة المعدنية .

– أعطت معاملتى التسميد بمعدل (٨٠% عضوى + ٢٠% معدنى) أو (٦٠% عضوى + ٤٠% معدنى) أحسن النتائج طبقاً للنمو الخضرى والحالة الغذائية للأشجار والمحصول وخصائص الثمار .

من نتائج هذه الدراسة يمكن التوصية بإحلال ٦٠–٨٠% من كمية الاحتياج من النيتروجين لأشجار نخيل البلح الزغلول النامية بالأراضى الرملية بالأسمدة العضوية حيث يؤدى ذلك إلى تحسين نمو الأشجار وزيادة المحصول وتحسين جودته بالإضافة إلى تقليل تكلفة السماد المعدنى وكذلك تقلل مشاكل تلوث البيئة .