RESPONSE OF DATE PALM (PHOENIX DACTYLIFERA) TO COMBINATIONS OF ORGANIC AND INORGANIC FERTILIZERS UNDER DIFFERENT IRRIGATION SYSTEMS IN THE NEW VALLEY TRANSPLANTS

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ABSTRACT

This trial was conducted under commercial field conditions in Dakhla Oasis, New Valley Governorate- Egypt, in order to investigate the influence of two irrigation systems (flood and drip irrigation), combinations of organic and inorganic fertilizers and different date palm (Phoenix dactylifera) cultivars (i.e. Barhi, Sagae. Khadry and Majdool) in sandy soil during the study season (2013 - 2014). Four different combinations of organic and mineral fertilizers were evaluated as compared to the control (i.e. 100% mineral). The treatments include (1)100% mineral; (2) 100% cattle manure; (3) 100% chicken manure; (4) 50% mineral plus 50% cattle and (5) 50% mineral plus 50% chicken manure. . All treatments were arranged in a split-split plot design with three replicates; irrigation systems were arranged in the main plot while the combination of organic and inorganic fertilizers were arranged in sub plot, and date palm cultivars were arrange in sub-sub plot. Vegetative growth parameters (Plant length and number of leaves) were measured as well as physical and chemical characteristics of soil before and after application were analyzed.

The results showed that application of different organic manures to the sandy soil improved its physical properties including soil field capacity, wilting point conductivity as well as available water compared to the soil without organic manures (control). The chemical analysis of soil indicated that, flood irrigation led to decrease soil pH; the 100% of manure fertilizer decreased soil pH more than other fertilizers combinations. The cation exchange capacity (CEC) showed similar trend as that of pH. In contrast, the

soil EC had different trend; the 100% mineral fertilizers gave the lowest EC values followed by 50% mineral plus 50% organic fertilizers; the highest soil EC was obtained by 100% cattle or chicken manure. The pH, CEC and EC of soil were higher under drip irrigation as compared to flood irrigation system.

Date palm plant growth was influenced by increasing organic manure under irrigation system. Plant length and number of leaves per plant were increased by 50% mineral and 50% cattle under drip irrigation as compared to other treatments. The highest plant growth parameter was obtained by 50% mineral and 50% cattle combined with drip irrigation system for Majdool cultivar during the experimental season.

Key words: Organic manure, Cattle manure, Chicken manure, Sandy soil, Irrigation, Date palm.

INTRODUCTION

Date palm (Phoenix dactylifera) is an important tree crop of the semi and arid regions where it grows in unplanted and cultivated groves with little rains and high evapotranspiration. The date palm (Phoenix dactylifera L.) is the most important tree grown in arid and semi-arid regions. The date palm is one of the main causes for sustainability of human life in many of the arid parts of the old world (Sawaya, 2000). As a general rule in date palm fertilization, 2 to 3 kg N per date palm tree per year for fully grown palm is recommended (Arar, 1975). This amount could be applied in two to three applications in sandy soils. In the Middle-east and North Africa, the better date palm gardens use organic manures which are often buried in deep circular trenches around the palms. These manures are usually dung of animals and are used at rates of 1 - 37 Ton/ ha (Arar, 1975). In long term studies, organic manures have been shown to largely improve soil physical conditions such as moisture retention capacity and aggregate soil stability, crop water use efficiency (Hati *et al.*, 2006), improve soil fertility, crop performance and yield (Kaur *et al*., 2005;

Sarkar *et al.,* 2003; Bokhtiar and Sakurai, 2005; Hossain and Ishimine, 2007; Tirol-Padre *et al.,* 2007). In Egypt cultivation of date palm goes back to thousands of years. Nowadays ,date palms are spread all over Egypt, wherever water is available (Riad, 1996) and date industry supports over one million people (Bazza, 2008). Recently, there are about 14 million trees, occupying 30,934 ha, which represent 6.32% of the fruit cultivated area in Egypt. Date productions of Egypt represent about 20% of the total world production (FAOSTAT 2009). While organic manure may be beneficial to crops on the long term, their efficiency in enhancing crop growth and yield in the short term have, in most cases, been enhanced with combination of inorganic fertilizers. Kaur *et al*., (2005) showed that palm tree were enhanced when inorganic fertilizer was combined with organic manures.

The date palm like any other fruits need to adoption of a proper fertilization program (including adequate rates, appropriate sources, and efficient application methods and timing) is an important strategy for obtaining better fruit yield and quality. On the other hand, organic wastes are critically needed to be applied as soil amendments for improving soil properties at the same time as slow release fertilizers. This study was conducted to investigate the impact of soil conditioner on soil properties as well as irrigation requirements of date palm. The main aim of this study was to investigate the response of palm trees to different irrigation systems as well as to determine the efficient combination of organic and inorganic fertilizers.

MATERIALS AND METHODS

Study location: The present study was conducted to investigate the protocol for date palm production in Dakhla Oasis, New Valley Governorate, Egypt (25° 26′ 18″ N, 30° 33′ 30″ E) during the study seasons of 2013/ 2014.

Plant materials: One year old seedlings (Fasilah) were planted in sandy soil at October 5th 2013. The space between each two rows was eight meters, and the space between the two plants inside the same row was eight meters. Four new imported date palm cultivars were used in this investigation i.e. Barhi, Segae, Khodry and Majdool, each cultivar was presented by 60 seedlings (Fasilah). Total of 240 tissue culture date palm seedlings (Fasilah) were acclimated for one year under net-house conditions until the seedlings attained 2 -3 leaves.

Study treatments: The study includes the effect of three factors combinations of organic and inorganic fertilizers, irrigation system and date palm cultivars.

Organic manure: Four different combinations of organic and mineral fertilizers were tested compared to the control (100% mineral): the applications were (1)100% mineral fertilization (Mineral fertilization was added to the mixture according to, the recommendation of the Ministry of Agriculture and Land Reclamation); (2) 100% cattle manure; (3) 100% chicken manure; (4) 50% mineral plus 50% cattle and (5) 50% mineral plus 50% chicken manure. Each treatment contained 24 seedlings (six seedlings of each cultivar).

Irrigation system: two irrigation system (flood irrigation and drip irrigation) water requirement calculated by Penman-Monteith equation (Allen *et al.*, 1998). The drip irrigation system was applied by one polyethylene hose (lateral) for each row; bubblers were installed for each date palm tree (120 liters per hour). Flood irrigation was applied by basin system. Each basin was contained four date palm trees. Each irrigation treatment contained 120 date palm seedlings (30 seedlings of each tested cultivars).

Date palm cultivars: Four new imported cultivars (i.e. Barhi, Segae. Khodry and Majdool) were cultivated in sandy soil.

Experimental design: All treatments were arranged in split-split plot design with three replicates; irrigation systems were arranged in the main plot and combination of organic and mineral fertilizers were arranged in sub main plot. However, the date palm cultivars were arranged in the sub-sub plot.

Measurements: Vegetative growth parameters (Plant length and number of leaves) were measured at the age of 12 months, physical and chemical characteristics of soils were analyzed before and after application of fertilizer treatments.

Soil analysis: Soil samples analyses of 30 cm depth for the experimental site were performed, before planting (Table 1 & 2). Physical and chemical properties of soil were described by Piper (1950), Jackson (1967) and Black (1969).

Table (1): Physical and chemical characteristics of soils.

Sand	Clay	Silt	pH	Cl^-	$HCO3^-$	$CO3^{--}$	Na	K	Ca	Mg	CEC	field capacity	Base Saturation
%				Milliequivlent / Liter							Meq/ 100g	%	
94.5	2	3.5	7.4	1.4	2.1	0.0	1.5	0.26	1	1	4.1	10.5	26.0

Table (2): Organic manure analysis

	O.M%	C%	K%	N%
Cattel Manure	55.72	16.86	1.05	1.57
Chicken Manure	47. 67	28.86	1.26	2.09

RESULTS AND DISCUSSION

1. Effect of different organic manures and irrigation system on soil chemical properties.

1.1 Soil Ph: The data in Table (3) represent the pH of the investigated treatments after application of fertilizer and irrigation treatments. The results indicated that flood irrigation system was effective in decreasing soil pH compared to drip irrigation system. Soil pH decreased in treated sandy soil with the application of organic fertilizers. However, the decreasing in soil pH among different treatments was relatively small. Also, the results showed that 100% chicken manure was more effective in decreasing soil pH as compared to the other treatments.

Regarding the interaction effect between the two irrigation systems and fertilization treatments, there was significant effect among treatments during the experimental seasons. The highest pH was obtained by 50% mineral plus

50% chicken combined with drip irrigation followed by 100% mineral fertilization combined with drip irrigation system. In addition, flood irrigation system combined with 100% chicken manure recorded the lowest pH value.

The changes were remarkable and acceptable due to the low buffering capacity of the sandy soil and could be attributed to production of organic and inorganic acids from organic manure through decomposition processes by soil microbes (Adel, 1980).

1.2 Cation Exchange Capacity (CEC): Cation exchange capacity is important to soil nutrient availability in relation to the nutrient saturation of soil colloids and the type of soil colloids. Soil CEC almost had the same trend of the observed data of soil pH. The pH can indicate the amount of acidity present in soils with identical cation-exchange properties (Westerman, 1990).

Data presented in Table (3) showed that the CEC values significantly increased in all treatments particularly that contained 50% mineral plus 50% cattle followed by 50% mineral plus 50% chicken. The lowest CEC values were obtained by 100% mineral fertilizers. This may be due to that the improving conditions and acceleration of decomposition process lead to produce more organic acids.

Regarding the interaction effect between different irrigation systems and organic fertilization, there was significant effect among treatments during the experimental seasons. The highest CEC values were obtained by 50% mineral plus 50% cattle manure combined with drip irrigation followed by 50% mineral plus 50% chicken manure combined with drip irrigation. In addition, flood irrigation system combined with 100% mineral fertilizers recorded the lowest CEC value.

The CEC is related to accumulation of humic substance (Dayegamlye, *et. al*. 1997). In addition, the value of CEC increases also by increasing the pH due to the important role of humus material in increasing the availability of nutrients in soils, (Knonova, 1966).

1.3 Electrical conductivity (EC): Data presented in Table (3) indicated that flood irrigation was more effective on decreasing the EC values than drip irrigation system. The highest EC values are recorded with application of 100% chicken manure followed by 100% cattle manure; the lowest EC was obtained by 100% mineral fertilizer.

Regarding the interaction effect between different irrigation system and fertilization treatments, there was significant effect among treatments during the experimental seasons. The highest EC values were obtained by 100% chicken manure combined with drip irrigation followed by 100% cattle manure combined with drip irrigation. In addition, flood irrigation system combined with 100% mineral fertilizer recorded the lowest EC value.

Regarding the electric conductivity of sandy soil, it increased by more than 5 folds due to treating soil with organic manure. This may be due to the high soluble salts content in the organic manure. This finding coincided with those of (Adel, 1980) who mentioned that the rate of organic manure amendment increased, EC of soil increased too. Abdel El- Naim *et. al* (1975) showed that addition of organic wastes such as farmyard manure to soil led to increase the total soluble salts after six months of the experimental duration then decreased after ten months. Other possibility may be due to the relatively high ammonium content in the manures (Lila, 2001).

2. Effect of organic matter applications on field capacity, wilting point and available water after organic manure addition.

Date in Table (4) show the field capacity and wilting percentage as well as available water in soil after the application of different organic and mineral fertilizers. The highest field capacity was obtained by 100% cattle manure application followed by 100% chicken manure; while the lowest field capacity was obtained by 100% mineral fertilizer treatment. The wilting point had almost the same trend, 100% of organic fertilizer led to increase wilting point. Using 100% chicken manure gave the highest wilting point followed by 100% cattle manure. The lowest wilting point was obtained by 100% mineral fertilizer. Finally, available water showed similar trend as field capacity with 100% cattle manure; while the 100% mineral fertilizer gave the lowest available water percentage.

3. Effect of different organic manure and irrigation system on the vegetative growth of date palm cultivars.

Irrigation system had positive effect on the number of leaves per plant and plant length (Tables 5 & 6). The highest mean values were obtained with the drip, and the lowest values were recorded for the flood irrigation system. The superiority of drip over flood irrigation may be attributed to the fact that bubblers can provide the palm with adequate water requirement and keep proper moisture in the plant root pattern. These results are in conformity with those obtained by Amiri *et al.* (2007) and Al- Subaiee *et al.* (2013).

Using of 50% cattle manure plus 50% mineral fertilizer gave the highest vegetative growth followed by 50% chicken manure plus 50% mineral fertilizer.

Majdool cultivar gave the highest vegetative growth followed by Segae cultivar; while Barhi cultivar gave the lowest vegetative growth.

The vegetative growth parameters were significantly affected by the interaction between the irrigation system and different combination of fertilizers (Table 5& 6). The highest values were obtained by 50% mineral plus 50% cattle combined with drip irrigation system followed by 50% mineral plus 50% chicken combined with drip irrigation system. This may be due to fact that water applied of 50% mineral plus 50% cattle under drip irrigation adequately meets the palm water and fertilizers requirements, while the other amounts did not. This result is in agreement with the findings of Hussein and Hussein (1983) and Wahba *et al.* (1990).

Regarding the interaction between irrigation system and date palm cultivars, data showed that the highest vegetative growth was obtained by the plants under the drip irrigation combined with Majdool treatment followed by drip irrigation combined with Segae treatment; while the lowest vegetate growth was gained by the flood irrigation combined with Barhi cultivar.

Regarding the interaction between organic fertilizer and cultivars, data showed that the highest vegetative growth was recorded with 50% mineral plus 50% cattle combined with Majdool treatment followed by the plants fertilized by 50% mineral plus 50% cattle combined with Segae cultivar. The lowest vegetative growth obtained by 100% chicken manure combined with Barhi. The differences among all treatments were significant.

According to the interaction effect between the different irrigation method, organic fertilizer and palm cultivar, data showed that, there were significant differences resulted due to the interaction between the treatments. The highest plant length and number of leaves was observed under drip irrigation combined with 50% mineral plus 50% cattle treatment and Majdool cultivar, followed by drip irrigation combined with 50% mineral plus 50% cattle and Segae cultivar. While, the lowest plant length and number of leaves was recorded by flood irrigation combined with 100% chicken manure and Barhi.

CONCLUSION

It could be concluded that application of organic fertilizer with drip irrigation, is optimal for good date palm growth and fasilah quality (length and number of leaves). Also, application of organic fertilizer at 50% mineral plus 50% cattle proved to be superior in terms of characteristics under study with drip irrigation.

Table (3): Effect of interaction between organic manure and irrigation level on pH, CEC and electrical conductivity of sandy soil.

Treatment	Flood Irrigation	Drip Irrigation	Mean (B)	Surface Flood Irrigation	Drip Irrigation	Mean (B)	Surface Flood Irrigation	Flood Irrigation	Mean (B)
	pH			CEC			Ec		
100% mineral fertilization (control)	7.5	7.57	7.54	7.87	8.32	8.10	2.02	2.21	2.12
50% mineral + 50% cattle	7.44	7.54	7.49	9.17	9.29	9.23	2.25	2.33	2.29
50% mineral + 50% chicken	7.48	7.62	7.55	9.12	9.21	9.17	2.31	2.4	2.36
100% cattle manure	6.68	7.4	7.04	8.86	9.11	8.99	2.35	2.5	2.43
100% chicken manure	6.31	6.92	6.62	8.82	8.52	8.67	2.39	2.51	2.45
Mean (A)	7.08	7.41		8.77	8.89		2.26	2.39	
LSD (A) Irrigation	0.124			0.114			0.108		
LSD (B) Fertilizer	0.051			0.748			0.025		
LSD (A * B) Interaction	0.031			0.045			0.024		

Table (4): Effect of organic matter applications on field capacity, wilting point and available water after organic manure addition (%).

Treatment	Field capacity	Wilting point	Available water
100% mineral fertilization (control)	10.82	3.84	6.98
50% mineral + 50% cattle	12.65	4.62	8.03
50% mineral + 50% chicken	11.54	4.22	7.32
100% cattle manure	13.36	5.22	8.13
100% chicken manure	13.16	5.62	7.54

Table (5): Effect of interaction between organic manure and irrigation method on plant height (cm/plant) (12 months)

irrigation.(A)	Fertilizer (B)	Barhi	Segae	Khodry	Majdool	Mean(B)
Drip	100% mineral fertilization (control)	78.00	102.67	97.33	113.00	**97.75**
	50% mineral + 50% cattle	93.67	123.00	116.67	135.67	**117.25**
	50% mineral + 50% chicken	82.33	108.67	103.33	120.00	**103.58**
	100% cattle manure	70.67	82.13	86.27	94.67	**83.44**
	100% chicken manure	78.00	86.67	94.67	104.33	**90.92**
Mean		**80.53**	**100.63**	**99.65**	**113.53**	**98.59**
Flood	100% mineral fertilization (control)	66.33	86.00	86.00	97.33	**83.92**
	50% mineral + 50% cattle	79.67	103.33	103.00	117.00	**100.75**
	50% mineral + 50% chicken	70.67	91.33	91.00	103.00	**89.00**
	100% cattle manure	67.00	75.67	75.33	84.00	**75.50**
	100% chicken manure	63.00	81.67	82.00	92.67	**79.84**
Mean		**69.33**	**87.60**	**87.47**	**98.80**	**85.80**
interaction	100% mineral fertilization (control)	**72.17**	**94.34**	**91.67**	**105.17**	**90.83**
	50% mineral + 50% cattle	**86.67**	**113.17**	**109.84**	**126.34**	**109.00**
	50% mineral + 50% chicken	**76.50**	**100.00**	**97.17**	**111.50**	**96.29**
	100% cattle manure	**68.84**	**78.90**	**80.80**	**89.34**	**79.47**
	100% chicken manure	**70.50**	**84.17**	**88.34**	**98.50**	**85.38**
Mean (C)		**74.93**	**94.11**	**93.56**	**106.17**	
LSD Irrigation Type					6.39	
LSD Different Fertilization					3.69	
LSD Different Cultivars					5.21	
LSD Irrigation Type * Different Fertilization					2.32	
LSD Irrigation Type Different Cultivars					3.16	
LSD Different Fertilization * Different Cultivars					1.51	

Table (6): Effect of interaction between organic manure and irrigation method on the number of leaves/plant (12 months)

irrigation.(A)	Fertilizer (B)	Barhi	Segae	Khodry	Majdool	Mean(B)
Drip	100% mineral fertilization (control)	5.33	6.33	5.00	8.00	**6.17**
	50% mineral + 50% cattle	6.33	6.00	5.33	8.00	**6.42**
	50% mineral + 50% chicken	5.33	6.33	5.00	8.33	**6.25**
	100% cattle manure	5.33	5.67	5.00	6.67	**5.67**
	100% chicken manure	5.67	5.67	5.00	6.67	**5.75**
Mean		**5.60**	**6.00**	**5.07**	**7.53**	6.05
Flood	100% mineral fertilization (control)	5.33	6.00	5.67	7.00	**6.00**
	50% mineral + 50% cattle	5.33	6.00	5.67	7.00	**6.00**
	50% mineral + 50% chicken	5.33	6.00	5.67	7.00	**6.00**
	100% cattle manure	5.00	5.67	5. 3333	6.67	**5.78**
	100% chicken manure	5.33	6.00	5.67	6.67	**5.92**
Mean		**5.27**	**5.93**	**5.67**	**6.87**	5.95
interaction	100% mineral fertilization (control)	**5.33**	**6.17**	**5.33**	**7.50**	**6.08**
	50% mineral + 50% cattle	**5.83**	**6.00**	**5.50**	**7.50**	**6.21**
	50% mineral + 50% chicken	**5.33**	**6.17**	**5.33**	**7.67**	**6.12**
	100% cattle manure	**5.17**	**5.67**	**5.00**	**6.67**	**5.63**
	100% chicken manure	**5.50**	**5.83**	**5.33**	**6.67**	**5.83**
Mean		**5.43**	**5.97**	**5.30**	**7.20**	
LSD Irrigation Type			0.05			
LSD Different Fertilization			0.07			
LSD Different Cultivars			0.32			
LSD Irrigation Type * Different Fertilization			0.04			
LSD Irrigation Type Different Cultivars			0.18			
LSD Different Fertilization * Different Cultivars			0.10			
LSD Irrigation Type* Different Fertilization* Different Cultivars			0.04			

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استجابة نخيل البلح إلى التسميد العضوي وغير العضوي تحت نظم الري المختلفة في الوادي الجديد

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المستخلص

أجريت هذه التجربة في مركز الداخلة بمحافظة الوادي الجديد – مصر لدراسة تأثير نظم الري وخليط من الأسمدة العضوية وغير العضوية على أصناف النخيل المختلفة خلال موسم ٢٠١٣/٢٠١٤. وكان الهدف من الدرسة هو دراسة تأثير مجموعة مختلفة من الأسمدة العضوية وغير العضوية تحت نظامين ري (الري بالغمر والري بالتنقيط) على خصائص التربة وكذلك أربعة أصناف من نخيل التمر (برحي، سقعي، خضري ومجدول) في التربة الرملية. وكان تصميم التجربة قطع منشقة مرتين مع ثلاثة مكررات، تم ترتيب نظم الري في القطع الرئيسية وتم ترتيب معاملات الأسمدة العضوية وغير العضوية في القطع الفرعية وكانت أصناف النخيل القطع تحت الفرعية. تم

أخذ قياسات النمو الخضري (طول النخلة وعدد الأوراق) وكذلك تقدير الخواص الفيزيائية والكيميائية للتربة قبل وبعد إجراء المعاملات.

وأظهرت النتائج أن استخدام التسميد العضوي في التربة الرملية يؤدي إلى تحسين الخواص الفيزيائية، وتبين من القياسات أنه في حالة إستخدام التسميد العضوي أدى إلى تحسن في كلٍ من السعة الحقلية ونقطة الذبول ونسبة الماء الميسر في التربة مقارنة بمعاملات التسميد المعدني (الكنترول). وأشار التحليل الكيميائي للتربة إلى أن الري بالغمر أدى إلى إنخفاض درجة حموضة التربة (pH). وبالنسبة لمعاملات التسميد فإن نسبة ١٠٠٪ من سماد الدواجن أدت إلى انخفاض درجة حموضة التربة مقارنة بباقي المعاملات. أما بالنسبة للسعة التبادلية الكتيونية (CEC) كانت أعلى قيم لمعامله التسميد ٥٠٪ معدني مع ٥٠٪ عضوي، وأما بالنسبة لقياسات ملوحة التربة (EC) فقد حققت الأسمدة المعدنية ١٠٠٪ إنخفاض في ملوحة التربة يليها معاملة التسميد ٥٠٪ تسميد معدني مع ٥٠٪ تسميد عضوي.

تأثر النمو الخضري لنخيل التمر بالتسميد العضوي تحت نظام الري بالتنقيط، حيث زاد طول النبات وعدد الأوراق لكل نخلة مع معاملة التسميد (٥٠٪ من تسميد معدني و ٥٠٪ من سماد الماشية) وذلك تحت نظام الري بالتنقيط. بالنسبة لمعاملات الأصناف فقد أثبتت التجربة أن صنف مجدول أعطى أعلى نمو مقارنة بباقي الأصناف.