Zagazig J. Agric. Res., Vol. 36 No. (4) 2009 753-770

EFFECT OF IRRIGATION REGIMES AND PHOSPHORUS FERTILIZATION ON YIELD, WATER – RELATIONS OF SESAME CROP

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Accepted 10 /8 /2009

ABSTRACT: Tow field experiments were conducted at Ismailia Agricultural Research Station in successive season namely 2005 and 2006 to study the effect of different rates of phosphorus (15.5, 31.0 and 46.5 Kg P_2O_5/ fed.) under five scheduling irrigation intervals by using pan coefficients i.e. 1.5, 1.25.1.00, 0.75 and 0.5 on some water relations, yield, water & phosphorus use efficiency and Some chemical analyses for sesame crop.

The main results can be summarized as follows:

1. Seasonal water use by sesame ranged between 474.31 to 1046.98 mm depending on irrigation intervals. Phosphorus fertilizer had a slight effect on water use by sesame.
2. Significant effect of both irrigation and phosphorus application on sesame seed yield, stalk yield/fed and water & phosphorus use efficiency. Results also indicated that increasing irrigation intervals and phosphorus fertilizer led to a decrease in seed oil percentage and increasing concentration of phosphorus in seeds.
3. One coefficient of pan evaporation and 31.0 P_2O_5/fed. is preferable for consuming water and phosphorus use efficiency.

Key words: Sesame, irrigation, phosphorus, seed yield, seed oil percentage.

INTRODUCTION

Sesame (*Sesmum indicum,L*) is considered as one of the most important oil crop in Egypt. It is a summer crop grown on a wide range of soils especially sandy soils for oil production. Intensive research work is needed to increase the yield output of the newly selected varieties through irrigation management and fertilization.

In sandy soils with a low water holding capacity and high permeability, water management is a very important factor influencing crop yield. Metwally *et al.* (1984). and Ibrahim *et al.*(1987).found that sesame consumptive water use was positively affected by the available soil moisture in the root zone. Rao (1992) and Rao *et al.* (1993). showed that applied P to sesame increased seed and straw P concentrations but did not generally affect N and K. Tiwari *et al.* (1994) showed that sesame seed yields were highest (0.53 t/ha) with the application of 60 kg N + 30 kg P + 20 kg K. Ashri (1995) reported that the total amount of water required to grow a sesame crop ranged from 600 to 1000 mm, depending on the cultivar and the climatic conditions. Awad *et al.* (1997) revealed that sesame seed and oil yields were highest with 45 kg N + 45kg P_2O_5/faddan. Elemery *et al.* (1997) and Attia *et* al. (1999) revealed that sesame seed yield and water use efficiency (WUE) were improved by increasing the number of irrigations. Anton and El-Rais (2000) showed that seasonal water consumptive use by sesame ranged between 358.51 and 632.96 mm depending on the available soil moisture. Ahmad *et al.* (2001) and Attia (2001) revealed that increasing levels of phosphorus fertilization significantly increased all studied sesame plant parameter compared with unfertilized plants. Nath *et al.* (2001) stated that the amount and distribution of rainfall and differences in temperature and soil conditions are the major factors affecting seed yield and some yield components of sesame in arid and semi-arid regions. In the study of Sepaskhah and Andam (2001) found that the ET value for sesame was found to be 915.6 mm under semiarid conditions. El-Sayed (2003) concluded that irrigation of sesame of 4 days intervals in sandy soil during growing season of study gave the highest seed yield, water use efficiency and seed oil percentage. Kenan *et al.* (2007) indicated that sesame seasonal evapotranspiration ranged from (598.0 mm to 1019.0 mm) in 2004. El-Tantawy and El-Samanody (2007) indicated that using Penman Monteith coefficients from 0.8 to 1.2 caused a significant increase in all sesame parameters of study.

The present investigation aimed to study the effect of irrigation intervals by using pan evaporation and phosphorus fertilization on some water relation, yield, water& phosphorus use efficiency and chemical analysis of sesame.

MATERIALS AND METHODS

The present investigations were carried out at the farm of Ismailia Agricultural Research station, to study the effect of irrigation in combination with different rates of phosphorus on some water relations, yield, water and phosphorus use efficiency and chemical analysis of sesame (variety Shandaweel3). A split plot design was used with three replicates. The main plots were assigned as irrigation regimes, while the sub plots were the rates of phosphorus fertilized. The details of the treatments are as follows:

1-Main plots (Irrigation treatments: 1.5, 1.25, 1.00, 0.75 and 0.5 pan evaporation coefficients)

2-Sub-plots (phosphorus fertilizer rates: 15.5, 31 and 46.5 Kg P_2O_5/ fed.)

Planting dates of sesame crop were 30/5/2005 and 5/6/2006 for the first and second year, respectively. All cultural practices were the same as recommended for sesame crop except irrigation regimes and phosphorus fertilization. Dates of harvesting for sesame were 11/9/2005 and 18/9/2006. Irrigation was practiced according to the daily records of the evaporations pan and the crops i.e., sesame was irrigated when the water balance reached zero, theoretically. These means, when daily evaporations pan reading x evaporation coefficient equal total available soil moisture.

Sub -plot area was 10.5 m^2 (3x3.5 m) with five rows. The chemical and mechanical analysis of the investigated soil were determined according to Jackson (1973) and the results are presented in Tables (1and 2).

Irrigation System

The experiment was irrigated by a solid set sprinkler system. The laterals were spaced 12m apart. The sprinklers were spaced 10 meters lateral in each and had a control valve to adjust the quantity of applied water.

The rate of water application was 45.5 m^3/fed./hr (sprinkle discharge 1.3 m^3/hr at 2.5 bar). The quantity of applied water was exactly controlled with excellent uniform distribution of water. The sprinkler irrigation triangle system was used. Irrigation water was measured from the relation between sprinkler discharge and time of application. The number of sprinklers per faddan were 35. The application rate (A)

$$A = K \frac{Q_S}{LS}$$

Where:

A= Application rate [mm/hr],

Q_s=Discharge of sprinklers [L/min],

L= The distance between sprinklers on laterals, [m],

S= The distance between laterals [m],

K = Fraction equal 60

The Studies Characters

Water relations

The consumptive use (Cu) or actual evapotranspiration (ET_a)

The consumptive use (Cu) of water estimated according to the equation given by Israelsen and Hansen 1962 as follow:

$$Cu = \frac{Dad(e_2 - e_1)}{100}$$

Where:

Cu= The depth of consumptive use [mm],

D = Soil depth [mm],

Ad = Soil bulk density [gm/cm^3],

e_1= Soil moisture content before irrigation, [w/w],

e_2 = soil moisture content after irrigation, [w/w].

Crop coefficient (Kc)

Crop coefficient Kc was determined during the growing season of both crops as follows:

$$\text{Crop coefficient Kc} = \frac{\text{Actual evapotranspiration (mm/day)}}{\text{Potential evapotranspiration (mm/day)}}$$

Potential evapotranspiration (ETp)

Potential evapotranspiration (ET_P) was determined by three methods:

Pan evaporation method:

The pan evaporation is related to the reference evapotranspiration described by Doorenbos and Pruitt (1977) as foolows:

$$ET_o = K_p E_{pan}$$

Where:

ET_o: reference evapotranspiration [mm/day],

K_p : Pan Coefficient [-],

E_p: Pan evaporation [mm/day].

Seed and Straw Yield kg/fed

Water use efficiency

Water use efficiency (WUE) in kg/m^3 was calculated for the deferent treatments, using the following formula of Vites (1965):

$$W.U.E = \frac{\text{Seed yield in kg / fed}}{\text{Actual evapotranspiration in m}^3\text{/fed}}$$

Fertilizer Use Efficiency

Fertilizer use efficiency (F.U.E) in kg of grain yield divided into weight of applied fertilizer, kg according to the formula of Huggins and pan (1993):

$$F.U.E = \frac{\text{Economic yield kg / fed}}{\text{Applied fertilizer in Kg/fed}}$$

Percentage of seed oil content% and chemical analysis for sesame seed and stalk

All the data collected for the yield, its components and chemical composition were subjected to the statistical analysis according to Snedecor and Cochran (1967), and the mean values were compared by LSD.

Table 1. Soil physical properties of the investigated soil

Soil depth cm	Mechanical composition				Texture	Pb g/cm^3	$\Theta_{F.C}$ %	$\Theta_{w.p}$ %	Θ_{ASW}	
	Coarse sand %	Fine sand %	Silt %	Clay %					%	mm
0-15	68.00	25.75	3.82	2.43	Sandy	1.60	7.63	1.40	6.23	14.95
15-30	72.32	23.07	3.11	1.50	Sandy	1.64	6.66	1.21	5.45	13.49
30-45	75.20	20.97	3.00	0.83	Sandy	1.66	6.18	1.52	4.66	11.60
45-60	87.44	8.46	3.65	0.45	Sandy	1.67	4.77	1.56	3.21	8.04

Table 2. Chemical analysis of the investigated soil

Soil depth		Properties															
		pH (in 1: 2.5 Susp.)	EC dSm^{-1}	Soluble Cations in soil paste extract, meq/L				Soluble Anions in soil paste extract, meq/L				Available-N (ppm)	Available -P (ppm)	Available-K (ppm)	CEC (meq/100g soil)	O.M %	$CaCO_3$
				Ca^{++}	Mg^{++}	Na^{+}	K^{+}	$CO_3^{=}$	HCO_3^{-}	Cl^{-}	$SO_4^{=}$						
Before planting sesam 2005	0-30	7.33	0.25	0.37	0.23	1.21	0.53	---	0.33	1.36	0.65	22.63	3.91	42.17	14.73	0.14	0.45
	0-60	7.82	0.12	0.19	0.11	0.72	0.14	---	0.14	0.96	0.06	17.32	2.55	47.09	12.26	0.09	0.05
2006	0-30	7.88	0.30	0.48	0.36	1.61	0.53	---	0.50	1.84	0.64	25.10	4.00	50.12	21.00	0.23	0.5
	0-60	7.90	0.13	0.31	0.25	0.50	0.27	---	0.18	0.78	0.37	18.23	3.10	43.20	11.62	0.11	0.06

RESULTS AND DISCUSSION

Water Relations of Sesame Crop

Seasonal actual evapotranspiration (ETa)

Evapotranspiration is the combination of two processes, evaporation and transpiration. Evaporation is the direct vaporization of water from the soil surface and / or from plant surface. Transpiration is the flow of water vapor from the interior of plant to the atmosphere, Jones *et al.* (1984).

Seasonal actual evapotranspiration as affected by irrigation regimes and phosphorus fertilization during the growing seasons 2005 and 2006 is presented in Tables 3 and 4. Results of 2005 season indicate that seasonal actual evapotranspiration (ETa) values were 981.63, 938.63, 753.39, 595.68 and 515.63 mm resulted from 1.5, 1.25, 1.0, 0.75 and 0.50 accumulative pan evaporation treatments respectively. Whereas, the corresponding values for the second season were 1025.60, 958.44, 882.69, 694.19 and 475.73 mm for the same respective irrigation regimes. In general, results in both seasons indicate that the highest actual evapotranspiration was recorded under 1.5 accumulative pan evaporation treatment, while the lowest one was recorded under 0.5 irrigation regime. From these results, it could be concluded that the quantity of water use depends on the frequent irrigation intervals. When soil was kept wet by short irrigation intervals, higher seasonal consumptive use was obtained. Similar results were obtained by Metwally *et al.* (1984), Ashri (1995), Sepaskah and Andam (2001), El-sayed (2003)and Kenan *et al.*(2007).

Regarding to the effect of phosphorus rates as presented in Table 5, data showed that averages values of actual evapotranspiration in the first season were 751.21, 755.95 and 763.30 mm for 15, 31 and 46 kg P_2O_5/fed., respectively. While in the second season, results indicate that values were 794.62, 806.80 and 820.56 mm for the same respective phosphorus treatments. Adding 46 and 15 kg P2O5/fed., respectively recorded the highest and lowest values. These results may be attributed to the enhanced transpiration by increasing plant growth. Increased by increasing phosphorus levels. The highest values of 763.30 and 820.56 mm were resulted by adding 46.5 kg P2O5/fed in the first season and the second season respectively. The lowest values of 751.21 and 794.62 mm were obtained by 15.5 kg P2O5/fed for the same respective seasons.

Sesame crop coefficient (Kc)

The factors affecting the value of crop coefficient (Kc) are mainly the climatic conditions, crop characteristics, sowing date, rate of crop development and length of growing season. The crop coefficient (Kc) values which determined for sesame during growth season are shown in Table 6. The obtained values clearly show that the values are largest than the reference Kc values, given by Doorenbos and Kassam (1979).

Table 3. The meteorological data of Ismailia during the two years of studying. (Summer season, 2005 and 2006)

Parameter / Month	Temp. Max. C°	Temp. Min. C°	Temp. Mean	R.H Max %	R.H Min %	R.H mean %	W.S m/sec.	Sunshine %	Ra. $MJm^{-2}day^{-1}$
				Summer season 2005					
May	31.6	16.9	24.3	83.0	23.0	53.0	1.7	77.0	40.0
June	33.7	20.6	27.1	83.0	27.1	55.0	1.4	85.0	41.23
July	36.0	22.4	29.2	84.0	28.0	56.0	1.7	84.0	40.62
August	36.9	23.2	30.0	84.0	32.0	58.0	1.6	85.0	37.98
September	35.7	19.4	27.5	83.0	30.0	56.0	1.4	85.0	33.30
				Summer season 2006					
May	30.0	16.5	23.3	82.0	23.0	52.0	1.7	77.0	40.00
June	32.8	20.3	26.6	83.0	27.0	55.0	1.4	85.0	41.23
July	36.0	23.7	29.9	83.0	27.0	55.0	1.7	84.0	40.62
August	35.9	22.9	29.4	84.0	28.0	56.0	1.6	85.0	37.98
September	34.1	21.6	27.9	84.5	29.0	57.0	1.4	85.0	33.30

Table 4. Daily and monthly actual evapotranspiration (ETa, mm) as affected by different values of pan Coefficient and phosphorus fertilization in summer season 2005 for sesame crop

Irrigation treatment	Months / Fert. Traet.	May*		June		July		Aug.		Sept. **		Total	
		Daily mm	Monthly mm	Daily mm	Monthly mm	Daily mm	Monthly mm	Daily mm	Monthly mm	Daily mm	Monthly mm	mm	m^3/ fad
1.5 Pan	15.5 kg P_2O_5 /fed	5.10	10.2	5.94	178.26	12.72	394.19	10.74	333.09	4.91	54.03	969.77	4073.03
Coefficient	31 kg P_2O_5 /fed	5.10	10.2	6.05	181.55	12.80	396.88	10.84	336.0	4.92	54.13	978.76	4110.79
	46.5 kg P_2O_5 /fed	5.10	10.2	6.24	187.09	13.08	405.37	10.94	339.29	4.95	54.42	996.37	4184.75
1.25 Pan	15.5 kg P_2O_5 /fed	5.10	10.2	5.55	166.36	11.97	371.16	10.49	325.04	5.06	55.63	928.39	3899.24
Coefficient	31 kg P_2O_5 /fed	5.10	10.2	5.59	167.80	12.12	375.73	10.55	327.00	5.08	55.84	936.57	3933.59
	46.5 kg P_2O_5 /fed	5.10	10.2	5.93	177.94	12.20	378.20	10.60	328.55	5.09	55.94	950.83	399.344
1.0 Pan	15.5 kg P_2O_5 /fed	5.10	10.2	5.56	166.78	7.79	241.44	8.82	273.27	5.05	55.51	747.2	3138.24
Coefficient	31 kg P_2O_5 /fed	5.10	10.2	5.59	167.58	7.84	243.13	8.83	273.8	5.06	55.64	750.35	3151.47
	46.5 kg P_2O_5 /fed	5.10	10.2	5.71	171.36	8.06	249.81	8.84	274.15	5.16	56.71	762.23	3206.37
0.75 Pan	15.5 kg P_2O_5 /fed	5.10	10.2	5.30	158.87	5.66	175.46	6.20	192.28	5.04	55.49	592.30	2487.66
Coefficient	31 kg P_2O_5 /fed	5.10	10.2	5.27	158.11	5.76	178.56	6.24	193.56	5.06	55.67	596.10	2503.62
	46.5 kg P_2O_5 /fed	5.10	10.2	5.27	158.05	5.83	180.59	6.25	193.68	5.10	56.11	598.63	2514.25
0.5 Pan	15.5 kg P_2O_5 /fed	5.10	10.2	4.59	137.57	5.70	176.57	4.58	141.99	4.74	52.11	518.44	2177.45
Coefficient	31 kg P_2O_5 /fed	5.10	10.2	4.60	137.88	5.70	176.66	4.59	142.37	4.62	50.86	517.97	2175.47
	46.5 kg P_2O_5 /fed	5.10	10.2	4.60	137.97	5.45	168.97	4.62	143.27	4.55	50.06	516.47	2143.97

* planting date: 30/5/2005 ** Harvest date: 11/9/2005

Table 5. Daily and monthly evapotranspiration (ETa, mm) affected by different values of pan Coefficient and phosphorus fertilization in summer season 2006 for sesame crop

Irrigation Treat.	Months / fert.treat,	June		July		Aug.		Sept. **		Total	
		Daily mm	Monthly mm	Daily mm	Monthly mm	Daily mm	Monthly mm	Daily mm	Monthly mm	mm	m^3/ fad
1.5 Pan Coefficient	15.5 kg P_2O_5 /fed	9.53	238.36	10.96	339.83	11.02	341.71	3.57	64.31	984.21	4133.68
	31 kg P_2O_5 /fed	9.71	242.87	12.07	374.17	11.17	346.19	3.58	64.39	1027.62	4316.00
	46.5 kg P_2O_5 /fed	10.12	252.90	12.85	398.49	11.24	348.4	3.62	65.19	1064.98	4472.92
1.25 Pan Coefficient	15.5 kg P_2O_5 /fed	8.73	218.24	10.65	330.05	10.76	333.53	3.61	64.92	946.72	3976.22
	31 kg P_2O_5 /fed	8.95	223.85	10.73	332.65	10.8	334.72	3.64	65.50	956.72	4018.22
	46.5 kg P_2O_5 /fed	9.17	229.24	10.85	336.35	10.98	340.45	3.66	65.84	971.88	4081.90
1.0 Pan Coefficient	15.5 kg P_2O_5 /fed	7.31	182.86	10.69	331.48	9.68	300.00	3.54	63.80	878.14	3688.19
	31 kg P_2O_5 /fed	7.32	182.89	10.74	332.98	9.69	300.35	3.58	64.39	880.61	3698.56
	46.5 kg P_2O_5 /fed	7.41	185.37	10.85	336.41	9.71	301.03	3.69	66.47	889.28	3734.98
0.75 Pan Coefficient	15.5 kg P_2O_5 /fed	6.78	169.59	7.46	231.16	7.16	221.96	3.55	63.83	686.54	2883.47
	31 kg P_2O_5 /fed	6.82	170.56	7.49	232.19	7.38	228.83	3.45	62.08	693.66	2913.37
	46.5 kg P_2O_5 /fed	6.92	172.99	7.62	236.08	7.47	231.56	3.43	61.70	702.33	2949.79
0.5 Pan Coefficient	15.5 kg P_2O_5 /fed	5.58	139.55	5.28	163.66	3.66	113.50	3.37	60.73	477.44	2005.25
	31 kg P_2O_5 /fed	5.55	138.75	5.27	163.25	3.65	113.13	3.35	60.29	475.42	1996.76
	46.5 kg P_2O_5 /fed	5.53	138.30	5.26	163.00	3.65	113.07	3.33	59.94	474.31	1992.10

* Planting date: 5/6/2006 ** Harvest date: 18/9/2006

Table 6. Crop coefficient (Kc) for sesame variety Shandweel-3 under 1 accumulative pan evaporation treatment in 2005 and 2006 seasons using pan evaporation formula

Season	Summer season 2005			Summer season 2006			Average
	ETo mm/day	ETa mm/day	Kc	ETo mm/day	ETa m/day	Kc	Kc
May	6.04	5.10	0.84	----	----	---	---
June	6.56	5.62	0.86	7.17	7.35	1.03	0.95
July	6.71	7.90	1.18	6.81	10.76	1.58	1.38
August	6.14	8.83	1.44	6.50	9.69	1.49	1.47
September	5.77	5.09	0.88	5.23	3.61	0.69	0.79
Seasonal Kc			1.04			1.19	1.14

Sesame Yield

Seed and sticks yields of sesame as influenced by various treatments i.e. irrigation scheduling and phosphorus levels are presented in Table 7. Statistical analysis of the variance demonstrated that irrigation scheduling and phosphorus rates had a significant effect upon the productivity of sesame in both seasons, but insignificant effect on sticks yield at the second season 2006. The high-frequency schedule (1.5 pan coefficient) yielded the maximum seed and sticks yield followed by the others irrigation treatments. The differences in seed and sticks yields of sesame between the irrigation treatments, i.e. 1.5, 1.25 and 1.0 pan coefficients were found to be insignificant, on other hand were found to be significant between the previous irrigation pan coefficient treatments and the other i.e. 0.75 and 0.5. Although, the differences between results gained from the 0.75 and 0.5 pan coefficient were found to be insignificant. Such results prove that maintaining soil moisture at a high level by increasing frequency of irrigation water maximized seed sesame production. Decreasing soil moisture beyond such level decreased yield production of sesame in sandy soils. This trend may be due to the multiple effects of water stress on plant growth, which in turn reflected on seed yield. These results are in harmony with those reported by Metwally *et al.* (1984), Ibrahim *et al.* (1987), ELemery *et al.* (1997), and Kenan *et al.* (2007).

Regarding the role of phosphorus fertilizer on yield of sesame, results in Table 7 revealed that increasing phosphorus rate resulted in a significant increase in sesame yield, except insignificant for sticks sesame yield at summer 2006. These findings could be attributed to importance of phosphorus as an essential macro-nutrient especially in sandy soil which suffer from great deficiency in such element. These results are in agreement with those reported by Rao (1992), Rao *et al.* (1993), Awad *et al.* (1997), and Ahmad *et al.*(2001).

The interaction between irrigation regimes and phosphorus fertilizer was found to be insignificant in the first season, whereas, in the second season was significantly. The maximum yield 638.40 Kg/fad was recorded from treatment-received irrigation at 1.5 pan coefficient and fertilized with 46.5 P_2O_5. While the minimum seed yield 108.17 Kg/fad. was gained for the same respective treatments.

Effect of Irrigation Treatment and Phosphorus Fertilization on Sesame Water Use Efficiency and Sesame Phosphorus Use Efficiency

Sesame water use efficiency and sesame phosphorus use efficiency were influenced by irrigation intervals and rates of phosphorus application. The obtained data are presented in Table (7).

All variables significantly affected sesame water use efficiency and phosphorus use efficiency in two seasons. The results showed that 1.5 pan coefficient treatment produced the maximum water use efficiency and phosphorus use efficiency followed by the others treatments. The lowest W.U.E and P.U.E were obtained from the 0.5 pan coefficient and 46.5 Kg P_2O_5. The differences between the three-pan coefficient (i.e. 1.5, 1.25, 1.0) for the two parameters (W.U.E and P.U.E) insignificant in both seasons except for P.U.E at the second season. But the differences between the previous pan coefficient and the others (i.e. 0.75 and 0.5) were significant. The previous result are in full agreement with those reported by Metwally *et al.* (1984), Attia *et al.* (1999), Anton and EL-Rais (2000) and EL-Sayed (2003).

Table 7. Seed yield, Stalk yield, WUE. PUE, % P per seed &stalk and oil content affected by different values of pan Coefficient and phosphorus fertilization in summer seasons 2005 and 2006 for sesame crop

Irrigation Treat.	Parameters fert.treat,	Seed yield kg/fed.		Stalk yield ton/fed.		WUE		PUE		% P of seed		% P of stalk		Oil content %	
		2005	2006	2005	2006	2005	2006	2005	2006	2005	2006	2005	2006	2005	2006
1.5 Pan	15.5 kg P_2O_5/fad	528.0	462.93	1.31	1.28	0.13	0.11	30.86	35.2	1.46	1.48	0.20	0.18	60.5	60.5
Coefficient	31 kg P_2O_5/fad	706.7	655.15	1.75	1.59	0.17	0.15	21.17	23.55	1.58	1.55	0.25	0.26	60.8	60.6
	46.5 kg P_2O_5/fad	723.5	638.4	1.79	1.51	0.17	0.14	14.19	16.07	1.62	1.58	0.28	0.28	60.9	61.1
1.25 Pan	15.5 kg P_2O_5/fad	492.0	403.2	1.30	1.26	0.13	0.10	26.88	32.80	1.51	1.51	0.20	0.20	59.4	59.3
Coefficient	31 kg P_2O_5/fad	661.3	611.6	1.43	1.47	0.17	0.15	20.39	22.04	1.54	1.60	0.26	0.27	60.1	59.4
	46.5 kg P_2O_5/fad	629.4	623.7	1.78	1.5	0.16	0.15	13.86	13.99	1.72	1.63	0.30	0.29	60.2	59.5
1.0 Pan	15.5 kg P_2O_5/fad	321.3	394.3	1.00	1.11	0.10	0.11	26.29	21.42	1.54	1.60	0.21	0.22	58.0	57.8
Coefficient	31 kg P_2O_5/fad	504.0	600.0	1.92	1.38	0.16	0.16	20.00	16.80	1.57	1.64	0.32	0.31	58.1	58.1
	46.5 kg P_2O_5/fad	510.4	607.13	1.75	1.45	0.16	0.16	13.49	11.34	1.89	1.71	0.32	0.31	58.2	58.2
0.75 Pan	15.5 kg P_2O_5/fad	172.0	250.6	0.91	0.91	0.07	0.09	16.71	11.47	1.70	1.71	0.25	0.29	54.5	55.3
Coefficient	31 kg P_2O_5/fad	222.7	252.0	0.85	0.91	0.09	0.09	8.40	7.42	1.94	1.92	0.33	0.35	56.0	56.0
	46.5 kg P_2O_5/fad	233.3	279.4	0.80	0.98	0.09	0.09	8.21	5.17	2.13	1.96	0.30	0.29	56.3	56.2
0.5 Pan	15.5 kg P_2O_5/fad	92.0	109.7	0.49	0.59	0.04	0.05	7.31	6.13	1.9	1.94	0.27	0.33	56.4	55.0
Coefficient	31 kg P_2O_5/fad	154.3	110.7	0.67	0.41	0.07	0.06	3.69	5.14	1.96	2.07	0.33	0.35	54.7	55.4
	46.5 kg P_2O_5/fad	154.7	108.2	0.63	0.40	0.07	0.05	2.47	3.44	1.85	1.82	0.23	0.29	55.2	55.5
	I	227.7	53.10	0.16	0.16	0.04	0.02	2.21	2.05	0.16	0.17	0.01	0.05	0.39	0.47
LSD at 0.05	F	148.4	40.81	0.21	n.s	0.02	0.01	1.53	1.49	0.09	n.s	0.03	0.41	0.29	n.s
	I x F	n.s	90.98	n.s	n.s	0.05	n.s	3.03	2.99	n.s	n.s	0.04	0.05	0.52	n.s

Regarding to the effect of phosphorus fertilization on phosphorus use efficiency. The differences between phosphorus fertilization rates on PUE were significant. The best response to phosphorus fertilization on WUE is the application of 31.0 Kg P2O5/fad., but the best response to phosphorus fertilization on PUE is the application of 15.5 KgP2O5/fad.. This results are in good line with those obtained by, Rao *et al.*(1993), Tiwari *et al.* (1994), Awad *et al.*(1997) and Ahamed *et al.*(2001).

The effect of interaction between the irrigation regimes and the applied rates of phosphorus were significant for both seasons except of WUE was insignificant in the second season.

Percentage of Seed Oil and Phosphorus Content% of Sesame Crop

Oil seed percentage and phosphorus concentration percentage of sesame yield as affected by irrigation regimes and phosphorus fertilization are recorded in Table 7. Results indicated that seed oil was increased under decrease irrigation interval but, phosphorus concentration percentage of sesame yield behavior inverse. This trend reveals that oil accumulation in sesame seeds is enhanced by wet conditions rather than dry. In this respect, Rao (1992), Rao *et al.* (1993), Anton and El-Rais (2000) and El-Sayed (2003) reached to the same results.

As for the effect of phosphorus fertilizer on the content of sesame seed oil percentage and phosphorus concentration of sesame yield, results of Table 7 showed that both oil and phosphorus concentration percentage increased by increasing the applied phosphorus up to46.5 Kg P_2O_5/ fed. These results are in agreement with those reported by Awad *et al.* (1997).

Conclusion

Sesame yield, water & phosphorus use efficiency and chemical analysis of sesame responded greatly by either irrigation regimes and the rate of applied phosphorus. Irrigation sesame at 1.5 pan coefficient increased sesame yield as well as seed oil content. However, the 1.0 pan coefficient seemed to be more economic from the stand point of water & phosphorus use efficiency. Phosphorus fertilizer increased sesame production. The rate of

31.0 Kg P_2O_5/ fed. can be recommended in poor sandy soils of Ismailia for sesame crop.

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تأثير الرى والتسميد الفوسفاتى على العلاقات المائية والمحصول لمحصول السمسم

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أقيمت تجربتان حقليتان بمحطة البحوث الزراعية بالإسماعيلية خلال موسمي ٢٠٠٥/٢٠٠٦ لدراسة أثر جدولة ري محصول السمسم (صنف شندويل ٣) ومعدلات التسميد الفوسفاتي على العلاقات المائية، المحصول وكذا التحليل الكيماوي لمحصول السمسم تحت نظام الري بالرش.

وقد أوضحت النتائج الأتي:

- تراوح الاستهلاك المائي لمحصل السمسم بين ٤٧٤,٣١ – ١٠٤٩,٩٨ مم.
- أدى الري والتسميد الفوسفاتي إلى تأثير معنوي على كل من المحصول و نسبة الزيت وكذلك محتوى البذور والقش من الفوسفور فى كلا موسمي الدراسة.
- أشارت النتائج أيضا إلى التأثير المعنوي لكل من الري والتسميد الفوسفاتي على كفاءة استخدام المياه و كفاءة الأستعمالية للسماد.
- حققت معاملة الري عند (١,٠) معامل وعاء البخر أعلى كفاءة فى استخدام المياه بينما حقق التسميد الفوسفاتي بمعدل ١٥,٥ كجم/فدان أعلى كفاءة إستعمالية للسماد.