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Effect of Drip Irrigation and Phosphorus Fertilization on the Growth of Peanut Plants Grown on Sandy Calcareous Soils

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FIELD experiments were carried out at the Experimental Farm of Arab El- Awammer Research Station, Agriculture Research Center, Assuit, Egypt, during the two successive growth summer seasons of 2010 and 2011, to study the effect of two levels of phosphorus fertigation (23 and 31 kg P_2O_5/ fed) divided into different doses (3, 6 and 9 doses) under different irrigation regimes (80 and 100% from pan evaporation). Water consumptive use, irrigation water use efficiency (IWUE), peanut yield and yield components were evaluated. The obtained results could be summarized as follows:

The seasonal average quantity of irrigation water applied to peanut plants was 754.8 and 943.5 mm which equals 80 and 100% of pan evaporation, respectively. The crop evapotranspiration of peanut was 858.8 and 783.6 mm in the first and second seasons, respectively, as calculated by Penman Monteith equations.

Peanut yield and yield traits were significantly increased with increasing the levels and doses of phosphorus fertilization. The highest values of WUE and IWUE were obtained from the highest level of phosphorus fertilization under irrigation with 80% of pan evaporation.

Keywords: Peanut, Fertigation, Drip irrigation, Sandy calcareous soil, Phosphorus fertilization.

The demands on agricultural products and water resources were increased steeply every where at the same time. Water is a limiting factor in any agricultural expansion depending on its quantity, quality and methods of water application**.** Growing of a fallow crop as peanut could be a good choice because of its high economic value and the benefit of legumes in the maintenance of soil organic N. Peanut is grown in many arid and semiarid regions during dry seasons therefore; it needs to be irrigated to produce economic yields. The application of fertilizers through the irrigation system (fertigation) became a common practice in modern agriculture. Increased yields, improvement in quality of the product, water and nutrient expense efficiencies and protection of the environment are some of the main characteristics of this method.

Doorenbos *et al*. (1979) reported that, water requirements for peanut depending on climate, range from 2100 to 2940 m^3 / fed. for growth season. Tayel and Wahba (1989) found that the peanut was planted in a sandy soil, irrigated by center pivot irrigation system in El-Sharkia governorate, the recorded maximum seasonal evapotranspiration (ETm) and the actual one (ETa) were 3326.4 and 2389.8 m^3 / fed., respectively. Water deficit, occurred especially during flowering and the early part of yield formation periods led to 21% reduction in yield. Using the 2389.8 m^3 / fed and avoiding the deficits during flowering and early part of yield formation stages increased the yield. El-Koliey *et al*. (2001) estimated the seasonal water requirements for peanut crop grown under surface, sprinkler and drip irrigation systems in Assuit region, were 5622, 3748 and 3307, m^3 / fed., respectively. Mohamed and Usman (2007) found that the seasonal actual applied amounts of irrigation water were 980, 1960, 2940 and 3920 m^3/fed. while, the seasonal measured depleted water was 960.83, 1718.92, 2113.10 and 2414.88 m^3 /fed. when irrigated with 15, 30, 45 and 60 min every 2 days, respectively. El-Boraie *et al.* (2009) found that the maximum water depletion values were found at the develop and mid stages of plant growth. The superior effect on pod yield (1824 kg/fed.) was obtained with applying 983.73mm of irrigation water calculated by Penman-Monteith equation and applied with drip irrigation every day under inoculation of the seeds by *Rhizobium* + *Azotobacter chroococcum* + *Bacillus megaterium*. Hefzy (2009) found that, the seasonal irrigation water applied under surface irrigation was higher than those under sprinkler irrigation. Values were 1321.2, 1195.2 and 912.5 mm, under surface irrigation while they were 852.5, 791.4 and 594.7 mm under sprinkler irrigation system, for peanut plants irrigated at the depletion of 25, 50 and 75 % of available soil moisture, respectively.

El- Adel (2001) indicated that the highest seed yield of peanut (1190 kg / fed.) was achieved by irrigation every day using 100 % of ETc and traditional fertilization. The effects of irrigation systems on pods and fodder yields and oil yield were insignificant, in both seasons. However, the pods and fodder yields, were increased significantly with increasing available soil moisture, in both seasons, while, protein percentage was decreased (Hefzy, 2009).

Phosphorus is the most important nutrient which affects the yield and quality of leguminous crops including groundnut. Phosphorus plays a beneficial role in legume growth promoting extensive root development and thereby ensuring a good yield. Phosphorus fertilization was investigated by several workers and they recommended varied doses of P_2O_5 kg ha-1 for increasing the yield and its attributes (Patel *et al.*, 1990 and Sharma & Yadav, 1997). Agasimani and Babalad (1991) reported that response to P could be obtained when the available P status in the soil was less than 15 kg P_2O_5 /fed. Singh and Chaudhari (1996) reported that phosphorus application brought about significant increase in biological yield in calcareous soils. Increasing phosphorus levels increased leaves and stem weight/plant, number of pods and seeds/plant, weight of pods and seeds/ plant, 100-seed weight, seed and oil yields, oil percentage, seed protein content as well as NPK contents (Mehta & Ram Mohan Rao, 1996; Nasr-Alla *et al.*, 1998; Tran Thi Thu Ha 2003; El-Habbasha *et al.*, 2005;

Mirvat *et al.,* 2006 and Ibrahim & Mona, 2008). The aim of this study was to find the best irrigation and phosphorus application managements for peanut grown on sandy calcareous soils.

Material and Methods

Field experiments were carried-out at the Experimental Farm of Arab El-Awammer Research Station, ARC, Assuit, Egypt (which, lies between latitude 27°, 11′ N and longitude 31°, 06′ E and the altitude of the area is 71 m) during two successive growing season 2010 and 2011 to study the effect of two levels of phosphorus fertigation in the form of phosphoric acid (23 kg P_2O_5/ fed (P_1) and 31 kg P_2O_5/ fed. (P_2)) applied in different doses (D_1 (3 doses), D_2 (6 doses) and D_3 (9 doses)) under different irrigation regimes namely 80% (I_1) and 100% (I_2) from pan evaporation. Irrigation water use efficiency (IWUE), phosphate fertilizer use efficiency, peanut yield and yield components were estimated. The average monthly meteorological data of Assuit weather station during the growth seasons are presented in Table 1. The experiment included 12 treatments with three replicates; all treatments were arranged in spilt, spilt plots design. Peanut seeds (Gize 5, variety) were planted in the 1st of June and 12th of June in the first and second summer seasons on 2010 and 2011, respectively. The peanut plants were harvested on October 20 and 31 in first and second seasons, respectively. Soil physical and chemical properties were measured and recorded in Table 2. CROPWAT model was used to calculate reference evapotranspiration with Penman Monteith (Smith, 1991).

Crop evapotranspiration (ETc). (Allen et al., 1998)

$$ET_c = ET_0 \times Kc$$

where:

ETc = Crop evapotranspiration.
ET_0 = Reference evapotranspiration.
Kc = Crop coefficient

TABLE 1. Average monthly meteorological data of Assuit weather station during the two growth seasons of 2010 and 2011.

	Temperature (ċ)		Relative humidity %	Epan mm/day	Wind speed m/sec	Solar radiation Col/Cm^2/day	Sunshine hours
	Max	Min					
Summer season 2010							
June	34.3	16.9	46.7	6.3	4.2	639	12.3
July	37.8	17.9	42.4	6.7	2.8	631	12.2
August	35.0	20.8	52.2	7.1	4.9	608	11.9
September	37.0	20.9	54.0	5.0	4.2	538	10.8
October	34.9	18.4	54.4	4.6	4.3	454	10.0
Summer season 2011							
June	37.2	21.8	31.6	6.3	2.4	639	12.3
July	39.1	23.0	34.0	7.2	1.9	631	12.2
August	37.1	21.3	41.0	7.1	1.6	608	11.9
September	35.0	19.3	46.4	5.6	1.1	538	10.8
October	31.6	16.4	45.5	3.6	1.6	454	10.0

TABLE 2. Physical and chemical characteristics of representative composite soil sample from the field experimental site.

Chemical properties									
pH (1 : 1)	EC dS/ m (1 : 1)	Soluble cations (meq / L)				Soluble anions (meq / L		Available Phosphorus (ppm	Total nitrogen (%)
		Ca^{++}	Mg^{++}	Na^{+}	K^{+}	CO_3^{--} $+HCO_3^{-}$	Cl^{-}		
8.37	0.33	1.43	1.16	0.19	0.75	1.68	1.47	8.31	0.003
Physical properties									
Particle size distribution (%)			Texture class	Moisture content (Volumetric %)			O.M (%)	$CaCO_3$ (%)	bulk density
Sand	Silt	Clay		S. P.	F.C.	W.P.			
89.9	7.1	3.0	sandy	23.3	10.9	4.5	0.19	30.9	1.63

Irrigation water use efficiency (IWUE)

The irrigation water use efficiency (IWUE) values were calculated as follows:

$$IWUE = \frac{Grain\ or\ Seed\ yield\ (Kg\ /\ fed.)}{Irrigation\ water\ requirements\ (m^3\ /\ fed.)}$$

Phosphorus fertilizer use efficiency (PUE)

Phosphorus fertilizer use efficiency (PUE) was calculated to express the amount of yield (kg) produced by an input of 1 unit (kg) of fertilizer. The following equation was used:

$$PUE = \frac{Yield\,(Kg\ /\ fed.)}{Total\ phosphorus\ fertilizer\ added\,(Kg\ /\ fed)}$$

Statistical analysis

All obtained data were subjected to statistical analysis of variance and treatment means were compared for significant differences using the LSD at $p = 0.05$.. The MSTAT-C (version 2.10) computer program was used to perform all the analysis of variance in agreement with the procedure outlined by Steel and Torrie (1982).

Results and Discussion

Irrigation water applied

The data in Table 3 and in Fig. 1 indicate that the irrigation water applied vary from growth stage to another through the two growth seasons. These variations are low at the beginning of the growing season, because peanut canopy has not established yet so the loss of moisture is mostly by evaporation from soil surface. As the plant developed, a gradual increase is observed in water consumption. The irrigation water applied reaches its peak in the medium growth stage. This may be due to the high air temperature which prevailing through this period and the growth status of plant. After reaching the peak of vegetation development, the rate of irrigation water applied pronouncedly decreases during the late season of plants. The seasonal irrigation water applied was mostly influenced by irrigation treatments. The increase in irrigation water applied under I_1 treatment may be attributed to the increase in direct evaporation. Therefore, the seasonal irrigation water applied is higher under I_1 followed by I_2 for peanut during the two growth seasons. These results are in the same line with those reported by Doorenbos *et al.* (1979); Tayel & and Wahba (1989); Plaut & Ben-Hur (2005); Mohamed & Usman (2007) and Hefzy (2009).

TABLE 3. Irrigation water applied (mm) as affected by irrigation regime at different peanut growth stages during summer seasons of 2010 and 2011.

Growth stages	2010		2011		Average of two seasons	
	I_1	I_2	I_1	I_2	I_1	I_2
Initial stage	61.4	49.1	63.1	50.4	62.2	49.8
Development stage	198.5	158.8	212.1	169.7	205.3	164.2
Mid- season stage	456.4	365.1	460.0	368.0	458.2	366.6
Late-season stage	150.7	120.6	146.4	117.1	148.6	118.8
Harvest stage	87.4	69.9	51.1	40.9	69.3	55.4
Total	**954.4**	**763.5**	**932.6**	**746.1**	**943.5**	**754.8**

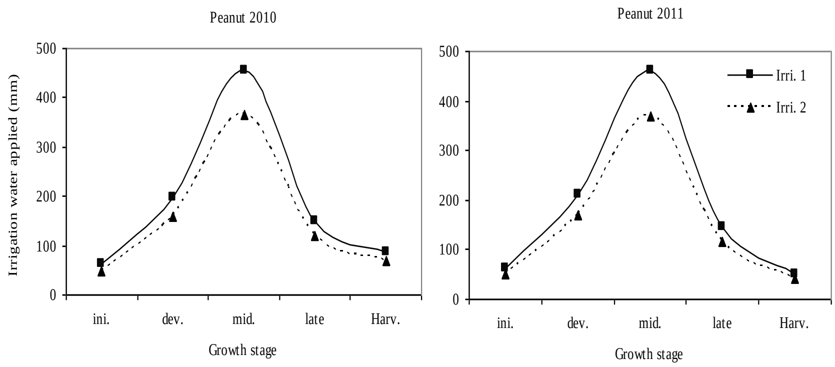

Fig. 1. Irrigation water applied (mm) at different growth stages of peanut grown under different irrigation regimes during the seasons of 2010 & 2011.

Crop evapotranspiration (ETc)

Data in Table 4 which illustrated in Figure 2 show the values of the crop evapotranspiration (ETc) calculated according to Penman Monteith equations for peanut crop during the two successive growth seasons. The results show that the total values of ETc for peanut crop were 858.8mm in the first growth season and 783.6 mm in the second growth season according to Penman Monteith equations**.** The results also, indicated that the total ETc values in the first season were higher than the values of the second season. El – Koliey *et al.* (2001) calculated the seasonal ETc for peanut crop at Assuit Governorate and found it to be 676.13, 764 and 584.5 mm as calculated from, Modified Penman, Penman Monteith and Doorenbos& Pruitt, respectively. Hefzy (2009) calculated seasonal ET_c for peanut crop at Assuit Governorate and found it to be 826.6 and 872.0mm as calculated from Penman Monteith during seasons 2005 and 2006, respectively.

TABLE 4. Crop evapotranspiration ETc (mm) during growth stages of peanut calculated according to Penman Monteith equations.

Growth stages	2010	2011	Average of two seasons
Initial stage	64.2	63.6	63.9
Development stage	188.9	192.0	190.4
Mid- season stage	388.0	346.3	367.1
Late-season stage	143.0	121.1	132.1
Harvest stage	74.8	60.6	67.7
Total	**858.8**	**783.6**	**821.2**

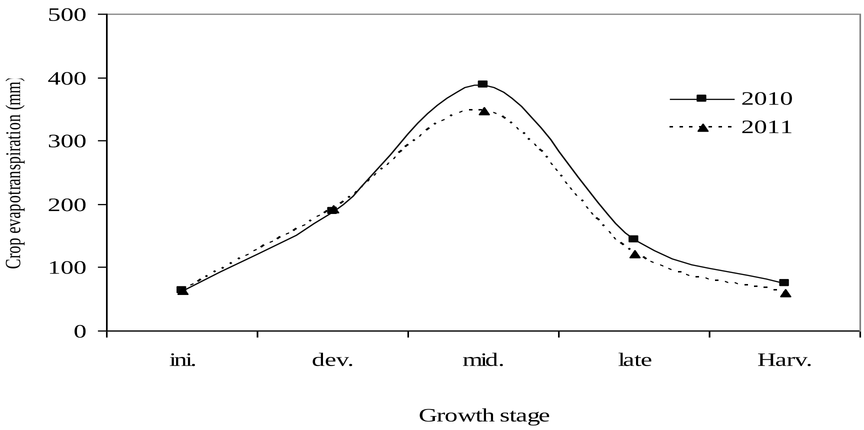

Fig. 2. Crop evapotranspiration (mm) for peanut during the growth stages through the growth seasons of 2010 and 2011.

Yield of peanut and its components

Effect of irrigation regimes, P rates and number of fertigation doses on yield and its components of peanut.

Irrigation regimes significantly ($p \leq 0.05$) affect pods and fodder yields of peanut (Tables 5 and 6). First irrigation treatment (I_1) resulted in significantly ($p \leq 0.05$) higher pod and fodder yields compared to second irrigation treatment (I_2). Increasing amount of irrigation from I_1 to I_2 led to an increase of 21.70 and 15.55% in the pods yield and 21.66 and 15.55% in fodder yield in 2010 and 2011 seasons, respectively.

Meanwhile, irrigation treatments hadn't significant effects on 100-pod weight and 100-seed weight (Tables 7 and 8). The highest values of 100-pod and 100-seed weights were obtained with irrigation at I_1. Irrigating peanut plants under I_1 increased the available soil moisture in the root zone which enhances the peanut plants to absorb sufficient water and consequently increase the photosynthesis activity. This in turn increases the cell division and stem elongation and diameter. Also, increasing the available soil moisture may increase the rate of leaf appearance and leaf growth which resulted in increasing the other growth parameters. The availability of water in the soil root zone environment and increasing of net assimilation rate resulted in the increase in dry matter accumulation in the reproductive organs of plants. However, plants that suffered from water deficit in the root zone have limited root system and weak shoot growth, which in turn reduced both vegetative growth and yield of peanut crop. Similar results were obtained by some authors (Hefzy, 2009).

Results presented in Tables 5-10 show clearly that there were significant differences between phosphorus rates influence on the studied characters in 2010 and 2011 seasons. Application of fertigated phosphorus at the rate of 31 kg P_2O_5 fed^{-1} gave the highest values of pod and fodder yields; 100-pod and 100-seed weights as compared with a rate of 23 kg P_2O_5 fed^{-1} in both seasons. Increasing in the previous parameters may be due to the increase of phosphorus rate which is known to help developing a more extensive root system and thus enabling plants to extract water and nutrients, from more soil depths. This in turn could enhance the plants to produce more assimilates which was reflected in higher biomass. Furthermore, the increases in yield due to phosphorus fertilizer may be attributed to the activation of metabolic processes, where its role in building phospholipids and nucleic acid is known. Moreover, phosphorus is an important nutrient for all the crops in general and legumes in particular, it is a key constituent of ATP and plays, significant role in energy transformation in plant and also in various roles in seed formation. Phosphorus application increases groundnut yield and yield contributing characters. Dry matter can also be increased with increasing P levels up to a certain limit (Sanker *et al.*, 1984; Marschner, 1986; Savani *et al.*, 1995 and Gobarah, Mirvat *et al.*, 2006). A long time reaction of soluble P with soil leads to its reaction with solid phase of soil and with calcium carbonate and the formation of relatively insoluble reaction products with Ca, Fe and Al leading to P fixation. All these processes leading to fixation are delayed when we apply fertilizer through fertigation as plants absorbs this nutrient quickly and directly from solution applied through fertigation. In addition, the positive effect of fertigation may also be due to optimum moisture in the soil at appropriate time along with fertilization, which facilitates maximum utilization of applied P by plant. Gajbhiye *et al.* (1990) reported that availability of more water for plant absorption and better metabolic activity resulted in higher dry matter yield. Similar results have been also reported by Iqbal *et al.* (2003).

TABLE 5. Pods yield (kg/ fed.) of peanut as influenced by irrigation regimes, P rates and number of fertigation doses under drip irrigation.

Treatments		**2010**				**2011**			
		D_1	**D_2**	**D_3**	**Mean**	**D_1**	**D_2**	**D_3**	**Mean**
I_1	P_2	1301.3	1490.2	1727.7	1506.4	1491.4	1652.3	1854.6	1666.1
	P_1	1179.7	1251.9	1359.2	1263.6	1387.8	1449.4	1540.7	1459.3
Mean			1371.1	1543.5	**1385.0**	1439.6	1550.9	1697.7	**1562.7**
I_2	P_2	1046.3	1182.6	1444.7	1224.5	1274.2	1390.3	1613.5	1426.0
	P_1	980.7	1025.7	1148.4	1051.6	1218.3	1256.6	1361.2	1278.7
Mean		1013.5	1104.1	1296.5	**1138.1**	1246.3	1323.5	1487.4	**1352.4**
Split mean		**1127.0**	**1237.6**	**1420.0**		**1342.9**	**1437.2**	**1592.5**	
Phosph x Split	P_2	1173.8	1336.4	1586.2	**1365.5**	1382.8	1521.3	1734.1	**1546.1**
	P_1	1080.2	1138.8	1253.8	**1157.6**	1303.1	1353.0	1451.0	**1369.0**
L.S.D 0.05 for I		88.1				75.0			
L.S.D 0.05 for P		136.5				116.2			
L.S.D 0.05 for IxP		n.s				n.s			
L.S.D 0.05 for D		99.9				85.1			
L.S.D 0.05 for IxD		n.s				n.s			
L.S.D 0.05 for PxD		n.s				n.s			
L.S.D 0.05 for IxPxD		n.s				n.s			

TABLE 6. Fodder yield (kg/ fed.) of peanut as influenced by irrigation regimes, P rates and number of fertigation doses under drip irrigation.

Treatments		2010				2011			
		D_1	**D_2**	**D_3**	**Mean**	**D_1**	**D_2**	**D_3**	**Mean**
I_1	P_2	2281.7	2612.6	3028.4	2640.9	2618.8	2901.5	3256.7	2925.7
	P_1	2068.8	2195.3	2383.1	2215.8	2437.0	2545.1	2705.5	2562.5
Mean			2403.9	2705.8	**2428.3**	2527.9	2723.3	2981.1	**2744.1**
I_2	P_2	1835.2	2073.9	2532.8	2147.3	2237.5	2441.3	2833.3	2504.0
	P_1	1720.4	1799.2	2014.1	1844.5	2139.4	2206.7	2390.2	2245.4
Mean		1777.8	1936.5	2273.4	**1995.9**	2188.4	2324.0	2611.8	**2374.7**
Split mean		**1976.5**	**2170.2**	**2489.6**		**2358.2**	**2523.6**	**2796.5**	
Phosph x Split	P_2	2058.4	2343.2	2780.6	**2394.1**	2428.1	2671.4	3045.0	**2714.9**
	P_1	1894.6	1997.2	2198.6	**2030.1**	2288.2	2375.9	2547.9	**2404.0**
L.S.D 0.05 for I					154.2				131.7
L.S.D 0.05 for P					238.9				204.1
L.S.D 0.05 for IxP					n.s				n.s
L.S.D 0.05 for D					174.9				149.4
L.S.D 0.05 for IxD					n.s				n.s
L.S.D 0.05 for PxD					n.s				n.s
L.S.D 0.05 for IxPxD					n.s				n.s

TABLE 7. Weight of 100-pod (g) of peanut as influenced by irrigation regimes, P rates and number of fertigation doses under drip irrigation.

Treatments		2010				2011			
		D_1	**D_2**	**D_3**	**Mean**	**D_1**	**D_2**	**D_3**	**Mean**
I_1	P_2	231.7	235.3	239.9	235.6	201.5	204.6	208.6	204.9
	P_1	216.9	226.4	231.6	225.0	188.7	196.9	201.3	195.6
Mean			230.8	235.7	**230.3**	195.1	200.7	205.0	**200.3**
I_2	P_2	213.8	222.1	233.4	223.1	185.9	193.1	202.9	194.0
	P_1	210.8	221.0	226.6	219.5	183.3	192.2	197.1	190.8
Mean		212.3	221.6	230.0	**221.3**	184.6	192.7	200.0	**192.4**
Split mean		**218.3**	**226.2**	**232.9**		**189.8**	**196.7**	**202.5**	
Phosph x Split	P_2	222.7	228.7	236.6	**229.4**	193.7	198.9	205.7	**199.4**
	P_1	213.9	223.7	229.1	**222.2**	186.0	194.5	199.2	**193.2**
L.S.D 0.05 for I					n.s				n.s
L.S.D 0.05 for P					3.9				3.4
L.S.D 0.05 for IxP					n.s				n.s
L.S.D 0.05 for D					2.7				2.4
L.S.D 0.05 for IxD					n.s				n.s
L.S.D 0.05 for PxD					n.s				n.s
L.S.D 0.05 for IxPxD					n.s				n.s

TABLE 8. Weight of 100-seed (g) of peanut as influenced by irrigation regimes, P rates and number of fertigation doses under drip irrigation.

Treatments		2010				2011			
		D_1	**D_2**	**D_3**	**Mean**	**D_1**	**D_2**	**D_3**	**Mean**
I_1	P_2	84.9	86.2	88.0	86.4	71.0	72.1	73.5	72.2
	P_1	79.3	82.9	84.8	82.4	66.3	69.3	70.9	68.8
Mean			84.6	86.4	**84.4**	68.6	70.7	72.2	**70.5**
I_2	P_2	78.2	81.3	85.5	81.6	65.3	67.9	71.5	68.3
	P_1	77.0	80.9	83.0	80.3	64.4	67.6	69.4	67.1
Mean		77.6	81.1	84.2	**81.0**	64.8	67.8	70.4	**67.7**
Split mean		**79.8**	**82.8**	**85.3**		**66.7**	**69.2**	**71.3**	
Phosph x Split	P_2	81.5	83.8	86.7	**84.0**	68.1	70.0	72.5	**70.2**
	P_1	78.2	81.9	83.9	**81.3**	65.3	68.4	70.1	**68.0**
L.S.D 0.05 for I					n.s				n.s
L.S.D 0.05 for P					1.5				1.2
L.S.D 0.05 for IxP					n.s				n.s
L.S.D 0.05 for D					1.0				0.9
L.S.D 0.05 for IxD					n.s				n.s
L.S.D 0.05 for PxD					n.s				n.s
L.S.D 0.05 for IxPxD					n.s				n.s

TABLE 9. Irrigation water use efficiency (Kg/m^3) of peanut as influenced by irrigation regimes, P rates and number of fertigation doses under drip irrigation.

Treatments		2010				2011			
		D_1	**D_2**	**D_3**	**Mean**	**D_1**	**D_2**	**D_3**	**Mean**
I_1	P_2	0.32	0.37	0.43	0.38	0.38	0.42	0.47	0.43
	P_1	0.29	0.31	0.34	0.31	0.36	0.37	0.39	0.37
Mean			0.34	0.38	**0.34**	0.37	0.40	0.43	**0.40**
I_2	P_2	0.33	0.37	0.45	0.38	0.41	0.44	0.51	0.45
	P_1	0.31	0.32	0.36	0.33	0.39	0.40	0.44	0.41
Mean		0.32	0.35	0.40	**0.36**	0.40	0.42	0.48	**0.43**
Split mean		**0.31**	**0.34**	**0.39**		**0.38**	**0.41**	**0.45**	
Phosph x Split	P_2	0.33	0.37	0.44	**0.38**	0.40	0.43	0.49	**0.44**
	P_1	0.30	0.32	0.35	**0.32**	0.37	0.39	0.41	**0.39**
L.S.D 0.05 for I					0.02				0.02
L.S.D 0.05 for P					0.04				0.03
L.S.D 0.05 for IxP					n.s				n.s
L.S.D 0.05 for D					0.03				0.02
L.S.D 0.05 for IxD					n.s				n.s
L.S.D 0.05 for PxD					n.s				n.s
L.S.D 0.05 for IxPxD					n.s				n.s

TABLE 10. Phosphorus use efficiency (kg/ units) of peanut as influenced by irrigation regimes, P rates and number of fertigation doses under drip irrigation.

Treatments		2010				2011			
		D_1	**D_2**	**D_3**	**Mean**	**D_1**	**D_2**	**D_3**	**Mean**
I_1	P_2	56.6	64.8	75.1	65.5	64.8	71.8	80.6	72.4
	P_1	38.1	40.4	43.8	40.8	44.8	46.8	49.7	47.1
Mean		47.3	52.6	59.5	**53.1**	54.8	59.3	65.2	**59.8**
I_2	P_2	45.5	51.4	62.8	53.2	55.4	60.5	70.2	62.0
	P_1	31.6	33.1	37.0	33.9	39.3	40.5	43.9	41.3
Mean		38.6	42.3	49.9	**43.6**	47.4	50.5	57.0	**51.6**
Split mean		**42.9**	**47.4**	**54.7**		**51.1**	**54.9**	**61.1**	
Phosph x Split	P_2	51.0	58.1	69.0	**59.4**	60.1	66.1	75.4	**67.2**
	P_1	34.8	36.7	40.4	**37.3**	42.0	43.6	46.8	**44.2**
L.S.D 0.05 for I		2.9				2.5			
L.S.D 0.05 for P		4.8				4.1			
L.S.D 0.05 for IxP		n.s				n.s			
L.S.D 0.05 for D		3.3				2.8			
L.S.D 0.05 for IxD		n.s				n.s			
L.S.D 0.05 for PxD		4.7				4.0			
L.S.D 0.05 for IxPxD		n.s				n.s			

The relationship between water and phosphorus use efficiency

Regression analysis was used to study the relationships between water and phosphorus use efficiency under different fertigation doses (Fig. 3). Data show that, there was a positive linear relationship between WUE and PUE with significant correlation coefficients of 0.486^{**} and 0.583^{**} when applied fertigated-P at six and nine doses, respectively, meanwhile application of fertigated-P at three doses gave insignificant correlation coefficient ($0.311^{n.s}$). This means that increasing fertigation increased WUE and PUE. Any increase in WUE is followed by significant increase in PUE. So, any saving in irrigation water increases WUE, PUE and farmer profit. In addition, decreasing fertilizers consumption, consequently decreases pollution of both soil and water. These results are agreeable with those obtained by Tayel *et al.* (2006) and (2010).

Conclusion

Irrigated peanut plants with quantity of water equals to 100 % from pan evaporation and application of 31 P_2O_5 kg/fed. on 9 doses gave the highest values of peanut yield on sandy calcareous soils.

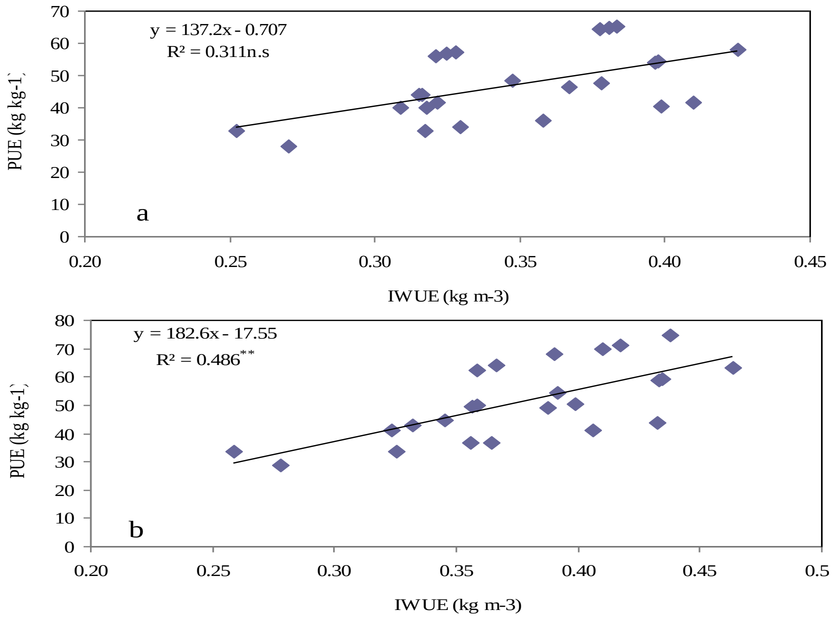

Fig. 3. The relationship between water and phosphorus use efficiency through the growing seasons of 2010 and 2011.

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تأثير الرى بالتنقيط والتسميد الفوسفورى على نمو نباتات الفول السودانى بالأراضى الرملية الجيرية

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أجريت تجربة حقلية بالمزرعة التجريبية لمحطة بحوث عرب العوامر بأسيوط / مركز البحوث الزراعية / مصر خلال موسمى نمو صيفيين متتابعين عامى 2010 و 2011 م لدراسة أثر معدلى فوسفات 23 و 31 كجم فو$_2$ أ$_5$ / فدان مع مياه الرى على 3 أو 6 أو 9 دفعات تحت نظام رى ترشيدى 80 أو 100 % من البخر الطبقى (طبقة نمو الجذور) ، وقد قيم الاستهلاك المائى وكفاءة استعمال مياه الرى ومحصول الفول السودانى ومكونات هذا المحصول .

وأمكن تلخيص النتائج المتحصل عليها فيما يلى :

المتوسط الفصلى لكمية الماء المستعمل لنباتات الفول السودانى كانت 754,8 ، 943,5 مم معادلة 80 و 100% من البخر الطبقى على الترتيب ، وبلغ نتح نباتات الفول السودانى 585,8 و 783,6 مم فى الموسمين الأول والثانى على الترتيب محسوبا بمعادلة بنمان مونتيث .

هذا وقد ازداد محصول الفول السودانى وتحسنت صفاته بزيادة معدل ودفعات التسميد الفوسفورى ، وكانت أعلى كفاءة لاستعمال المياه وأعلى كفاءة نظام رى هما المتحصلتان من أعلى معدل تسميد فوسفورى تحت رى 80% من البخر الطبقى .