

EFFECT OF IRRIGATION INTERVALS AND PK FERTILIZER LEVELS ON PEANUT (*Arachis hypogaea*, L.) UNDER SANDY SOIL CONDITIONS

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ABSTRACT

The influences of irrigation at three intervals (every 4, 6 and 8 days), potassium at three rates (24, 48 and 72 kg K₂O/fad) and phosphorus at three rates (15, 30 and 45 kg P₂O₅/fad) on yield, yield components and seed quality of peanut cultivar Giza 5 were studied in a private farm at El-Salhya region, Sharkia Governorate during summer seasons of 2006 and 2007.

Results show that either irrigation or fertilization treatments affected significantly all studied characters. Decreasing irrigation intervals from 8 to 6 and then to 4 days, increasing K fertilizer levels from 24 to 48 and then to 72 kg K₂O/ fad and increasing P fertilizer levels from 15 to 30 and then to 45 kg P₂O₅/fad increased significantly plant height, number of branches/plant, number of pods/plant, seed yield/plant, 100-pod weight, shelling percentage, pod, seed and foliage yields/fad. However, oil and protein percentages significantly increased by any increase of K or P fertilizer, but with respect to irrigation treatments, the highest oil percentage was attained when the irrigation intervals were at 4 or 8 days with no significant effect on protein percentage.

The interaction effect between irrigation intervals and K fertilizer levels on 100-pod weight and seed yield/fad as well as the interaction effect between irrigation intervals and P fertilizer levels on 100-pod weight and foliage yield/fad were significant. Irrigation every 4 days under 72 kg K₂O/fad or 45 kg P₂O₅/fad gave the heaviest 100- pod weight and highest seed yield/fad. Foliage yield/fad were the highest with 4 days irrigation interval when 30 or 45 kg P₂O₅/fad were applied.

Significant and positive correlation coefficients were detected between seed yield/fad and all studied characters, while

Key words: Irrigation intervals, pk fertilizer levels, peanut (*arachis hypogaea*, L.), sandy soil.

INTRODUCTION

Peanut (*Arachis hypogaea*, L.) is one of the most important oil crops grown successfully in Egypt not only for oil production, but also for fresh human consumption or for export. The increase of peanut production requires an effective production plan, and the cultural practices must be effectively integrated into the total peanut production plan to increase yield and quality of peanut.

Irrigation (amount and timing) is still the key to a successful peanut crop under reclaimed sandy soil conditions and appeared to be a considerable factor affecting peanut economic production. Sakr *et al.* (1996) reported that increasing irrigation interval decreased significantly plant height, number of branches/plant, number of pods/plant, 100-pod weight, 100-seed weight, shelling percentage and oil and protein contents. Also, they found that the 5 days interval may be the optimum for peanut production, Amir *et al.* (2005) stated that peanut plants with adequate water irrigation not only has given more kernels, but also highest levels of total protein. Also, they found that oil content increased as the amount of water increased. Plout and Ben-Hur (2005) studied three irrigation frequency treatments i.e. every 3, 7 and 10 days during flowering and pod-filling stages and found that the differences in peanut pod yield due to irrigation were not significant.

Regarding to K fertilizer application, Anton and Bassiem, (1998); Dahdouh, (1999) and Darwich *et al.* (2002) found that adding 48 kg K₂O/fad significantly increased each of plant height, number of pods/plant, weight of pods and seeds/plant, 100-seed weight, yield of pods and seeds/fad. Moreover, El-Far and Ramadan (2000) observed that application of 36 kg K₂O/fad significantly increased each of pod weight/plant, 100-seed weight, shelling percentage and pod yield/fad. Also, Ali and Mowafy (2003), showed that K fertilizer significantly increased each of plant height, number of pods/plant, weight of pods and seeds/plant, 100-seed weight, pod and seed yields/fad, shelling percentage and fodder yield/fad. Asmaa Khameis (2003) observed a significant increase in each of plant height, pod and seed weight/plant and yields/fad of peanut due to adding 50 kg

K₂O/fad. Finally, Maha Abd Alla (2004) reported that increasing K fertilizer from 24 to 48 and 72 kg k₂o/fad tended to increase the yield and yield attributes of peanut. Similar results were recorded by Nasr-Alla *et al.* (1998), Migawer-Ekram and Mona Soliman (2001) and Saleh *et al.* (2003).

With respect to phosphorus fertilization, Attia (2004) showed that peanut pod and seed yields/fad as well as yield attributes significantly increased with increasing P levels up to 45 kg P₂O₅/ fad. Moreover, Nasr-Alla *et al.* (1998) and Migawer-Ekram and Mona Soliman (2001) with peanut grown in newly reclaimed loamy sandy soil, found that increasing P rates up to 30 kg P₂O₅/fad significantly increased pod and seed yields /fad and their attributes and resulted in acceptable oil and protein contents. However, Mirvat *et al.* (2006) mentioned that adding P fertilizer up to 60 kg P₂O₅/fad significantly increased yield and its components as well as protein content of peanut, while oil percentage insignificantly affected by P fertilizer rates. Similar results were obtained by El-Far and Ramadan (2000), El-Shahat (2001), Darwish *et al.* (2002), Ali and Mowafy (2003), Yasein (2005) and Ash-Shormillesy-Salwa and Abd El-Hameed (2006).

Therefore, the aim of this work was to study the effect of irrigation intervals, phosphorus and potassium fertilization on yield and its attributes of peanut under sandy soil conditions.

MATERIALS AND METHODS

Two field experiments were carried out at El-Salhya region, Fakous District, Sharkia Governorate, Egypt during two successive summer seasons of 2006 and 2007. The objective of this work was to investigate the effect of irrigation interval, potassium and phosphorus fertilization levels on yield, yield attributes and quality of Giza 5 peanut cultivar under cultivated sandy soil conditions.

A split- split plot design with four replicates was followed, three irrigation intervals (8, 6 and 4 days) were assigned to the main plots. The sub-plots were allotted by three potassium fertilization levels (24, 48 and 72 kg K₂O/fad in the form of potassium sulphate (48 % K₂O). The sub-subplots were occupied by three phosphorus fertilization levels (15, 30 and 45 kg P₂O₅/fad in the form of calcium super phosphate (15.5% P₂O₅). K and P fertilizers were added just before sowing which was undertaken on May 21st and 25th in the 1st and 2nd seasons, respectively. The sub-subplot area was 16m² (4×4 m) included eight rows 50 cm apart, one plant /hill and 20 cm distance between hills. The preceding crop was wheat in the two seasons.

The soil of experimental site is sandy in texture, it had an average pH of 8.8 and organic matter content of 0.27%. The available N, P and K contents were 36.41, 5.27 and 190.15 ppm, respectively (average over the two seasons for the upper 30 cm of soil depth). A basal dose of gypsum (500 kg/fad) was applied during soil preparation, in addition to 30 kg N in the form of ammonium sulphate (20.5 % N) applied in equal three doses at sowing, after 24 and 48 days from sowing. All cultural practices, except those under study, were kept the same as usually practiced in peanut fields.

At harvest, the following characters were estimated on ten guarded plants taken randomly from the third row of each plot in both seasons. 1- Plant height (cm), 2- Number of branches/plant, 3- Number of pods/plant, 4- Seed yield (gm/plant), 5-100-pod weight (g) and 6- Shelling (%). In addition, the middle two rows were harvested from each plot to estimate 1- Pod yield (kg/fad), 2- Seed yield (kg/fad) and 3- Foliage yield (t/fad).

Dried mature seeds were ground into very fine powder to determine oil percentage using Soxhelt method with diethyl ether as a solvent, while crude protein percentage was determined as a total nitrogen by Micro-kjeldahl method. Chemical analysis procedures used were followed as described by A.O.A.C. (1980).

Analysis of variance and combined analysis for the two seasons were carried out as described by Snedecor and Cochran (1982). The differences among treatments were compared using Duncan's multiple range test (Duncan, 1955), where means had the different letters were statistically significant, while those followed by the same letters were statistically insignificant. In the interaction Tables, capital and small letters were used to compare means in rows and columns, respectively. The combined analysis of variance of the two seasons was used to calculate the simple correlation coefficients as described by Svab (1973).

RESULTS AND DISCUSSION

1- Plant height and number of branches/plant:

Data presented in Table (1) show that prolonging irrigation interval from 4 to 6 or to 8 days caused a continuous and significant decrease in both plant height and number of branches/peanut plant. This was valid in the two growing seasons and the combined analysis, except the first season, where the decrease in plant height not reached the 5 (%) level of significance by prolonging irrigation from 4 to 6 days. Similar results were obtained by Sakr *et al.* (1996), Amir *et al.* (2005) and Plout and Ben-Hur (2005).

Increasing of K fertilizer levels from 24 to 48 and up to 72 kg K₂O/fad and P fertilizer rate from 15 to 30 and to 45 kg P₂O₅/fad was followed by a positive and significant increase in both plant height and number of branches /plant. This was true in both seasons and their combined. Similar results were reported by El-Far and Ramadan (2000), Ali and Mowafy (2003) and Maha Abd Alla (2004).

2- Number of pods and seed weight (g) per plant:

Data in Table (2) show that decreasing irrigation interval from 8 to 6 and down to 4 days caused a continuous and significant increases in both number of pods and seed weight/peanut plant. This was true in both seasons and their combined. In this respect, Shinde and Pawar (1982 and 1984) reported that, maximum values in number of pods and seed yield per plant were obtained under sandy soil conditions by irrigation every 4 days.

Regarding the response of pods number and seed weight per plant to K and P fertilization it is interesting to note that any increment of K and P fertilizer was followed by a significant increase in each of pods number and seed weight/peanut plant. This was true in both seasons and their combined. These data are in harmony with those reported in the literature on K fertilizer by Saleh *et al.* (2003) and Maha Abd Alla (2004) and on P fertilizer by El-Far and Ramadan, (2000) and Ali and Mowafy (2003).

3- 100- pod weight (g) and shelling percentage:

Each decrease in irrigation interval from 8 to 6 and from 6 to 4 days was followed by a significant increase in both 100-pod weight and shelling percentage (Table 3). This was true in both seasons and their combined. These data clearly indicate that exposing peanut plants to drought caused a reduction in yield components. These results are supported by finding of Azab *et al.* (2004). They noted that irrigate peanut plant at 50% depletion from field capacity gave the highest values of 100-pod weight and shelling percentage. Also, Sakr *et al.* (1996) obtained similar findings.

Increasing of K fertilizer from 24 to 48 and up to 72 kg K₂O/ fad and P fertilizer rate from 15 to 30 and to 45 kg P₂O₅/fad resulted in a significant increase in both 100- pod weight and shelling percentage. This was true in both seasons and their combined. Similar results were obtained on K fertilizer by Dahdouh (1999) and Asmaa Khameis (2003) and P fertilizer by Anton and Bassiem (1998) and Ali and Mowafy (2003).

The interaction effect between irrigation intervals and K fertilization levels on 100-pod weight was highly significant (Table 3). The heaviest 100-pod

weight was recorded by irrigation every four days and application of 72 kg K₂O/ fad as shown in Table 3a.

Also, the interaction effect between irrigation intervals and P fertilizer level on 100-pod weight was highly significant. The heaviest 100 pod weight was found by irrigation every four days and adding of 45 kg P₂O₅/fad as shown in Table 3b.

Table 3-a : Effect of interaction between irrigation intervals and K-fertilization levels on peanut 100-pod weight (g).

K-fertilizer levels		K ₁	K ₂	K ₃
Irrigation interval				
I ₁		C 140.17c	B 155.97c	A 165.09c
I ₂		C 151.66b	B 170.15b	A 182.20b
I ₃		C 155.98a	B 184.30a	A 188.88a

Table 3-b : Effect of interaction between irrigation intervals and P-fertilization levels on peanut 100-pod weight (g).

P-fertilizer levels		P ₁	P ₂	P ₃
Irrigation interval				
I ₁		B 149.02b	A 155.28c	A 156.93c
I ₂		C 158.40b	B 166.92b	A 176.44b
I ₃		C 167.53a	B 175.37a	A 186.26a

4- Pod, seed and foliage yields per faddan:

As shown in Table (4) pod, seed and foliage yields were significantly increased by irrigation every four days. This was true in both seasons and their combined. Similar results were obtained by Reddy *et al.* (1982) and Desai *et al.* (1992). Also, Shinde and Pawar (1982) reported that exposing peanut plants to moisture stress caused a reduction in seed yield

and its components. Maximum values were obtained by irrigation every 4 days.

Increasing K-level up to 72 kg K_2O_2 / fad increased significantly pod, seed and foliage yields per fad. This was always true in both seasons and their combined. Similar findings were obtained by El-Far and Ramadan (2000) and Asmaa Khameis (2003). Response of pod, seed and foliage of peanut yields to K fertilization may be due to its role on nature of peanut growth and pegging has to be grown in light textural soil. This type of soil is characterized by being poor fertile soil. Also, potassium being a very mobile element and its content in sandy soil is poor, has to be applied too.

A clear cut effect of P fertilizer application was observed on pod, seed and foliage yields /fad. This is expected since similar effect on all the aforementioned characters in both seasons and their pooled data. The responses of the three yields were positive and significant by raising of P level from 15 to 30 and up to 45 kg P_2O_5 /fad. These responses are in a good line with those reported by Sakr *et al.* (1996), and Maha Abd Alla (2004).

Concerning the interaction effect of irrigation interval and K fertilization levels on seed yield /fad. The results in Table (4a) showed that shortening irrigation interval from 8 to 6 and to 4 days increased significantly seed yield /fad. This was always true under studied any K fertilizer level. Also, under all irrigation intervals studied, any increase in K fertilizer level was followed by a significant respective increase in seed yield /fad.

Table 4-a: Effect of interaction between irrigation intervals and K-fertilization levels on peanut seed yield (kg/fad).

Irrigation interval	K-fertilizer levels		
	K ₁	K ₂	K ₃
I ₁	C 376.17c	B 450.33c	A 503.62c
I ₂	C 463.43b	B 536.12b	A 590.05b
I ₃	C 545.48a	B 663.93a	A 728.03a

The interaction effect of both irrigation and phosphorous factors Table (4b) on foliage yield was significant, but no further information more than those got from the main effects of irrigation interval and P fertilization levels could be obtained.

Table 4-b: Effect of interaction between irrigation intervals and P-fertilization levels on peanut foliage yield (t/fad).

Irrigation interval	P-fertilizer levels		
	P ₁	P ₂	P ₃
I ₁	C 3.98b	B 4.71b	A 4.98b
I ₂	B 4.67a	A 4.92b	A 5.21b
I ₃	B 4.90a	A 5.40a	A 5.65a

5- Seed quality:

Being an important in oil crop, both oil % (for oil) and protein % (for cake) are important criteria in seed quality.

The results in Table (5) showed that, irrigation every 6 days caused a significant decrease in seed oil percentage. This was true in the second season and the combined. Shortening irrigation interval from 8 days decreased significantly protein percentage in the first season whereas, in the second season there is no significant effect. Similar findings were noted by Sakr *et al.* (1996).

Concerning K fertilization effect on seed oil percentage, it could be noted that, any increment of k fertilizer above 24 kg K₂O/fad was followed by a significant increase in seed oil percentage. This was true in both seasons and their combined. Similar results were obtained by Ali and Mowafy (2003) and Maha Abd Alla (2004).

The highest protein percentage in peanut seeds was recorded by applying of 72 kg K₂O/fad. Similar findings were reported by Nasr-Alla *et al.* (1998) and Saleh *et al.* (2003). Meanwhile, there is no significant difference in protein percentage when plants were received 24 and 48 kg K₂O/fad in the second season and combined data.

The effect of phosphorus fertilizer was also significant in this respect. Favourable and significant effect of P application on both oil and protein contents of peanut seeds was recorded. The response was significant by application of 45 kg P₂O₅/fad in the first season and combined. Similar results were obtained by Ali and Mowafy (2003) and Maha Abd Alla (2004).

6- Correlation studies:

Data of simple correlation coefficients between seed yield of peanut and its contributing characters are presented in Table 6. Seed yield appeared

positive and significant correlation coefficients with all studied characters, except protein percentage had a positive and insignificant correlation coefficient with seed yield/ fad. Ali and Mowafy (2003) and Maha Abd Alla (2004) found that peanut seed yield/fad appeared positive and significant correlation coefficients with each of plant height, number of branches/plant, number of pods/plant, seed yield/plant, 100-seed weight, shelling percentage and pod and foliage yields/fad. Also, all correlation coefficients among the studied yield attributes were positive and significant, except that of number of pods/plant with foliage yield/fad, shelling percentage with oil percentage and protein percentage with each of plant height, number of branches/plant, 100-pod weight, shelling percentage and pod yield/fad, whereas coefficients did not reach the 5% level of significance.

Conclusively, from this study it could be concluded that peanut grown on sandy soil must be irrigate every four days and fertilized by at least K and P fertilizers. Previous analysis of soil shows that K and P contents of the experimental soil fall far below adequacy. Though peanut is a legume yet it needed 72 kg K₂O and 45 kg P₂O₅/fad under the same conditions.

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تأثير فترات الري ومعدلات التسميد الفوسفاتي والبوتاسي على الفول السوداني تحت ظروف الأراضي الرملية

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تمت دراسة تأثير الري كل ٤ ، ٦ ، و ٨ أيام والتسميد البوتاسي بمعدل ٢٤ ، ٤٨ ، ٧٢ كجم بوب/أفدان وكذلك التسميد الفوسفاتي بمعدل ١٥ ، ٣٠ ، و ٤٥ كجم فوب/أه/ فدان على المحصول ومساهماته وجودة البذور لصنف الفول السوداني جيزة ٥ بمزرعة خاصة بمنطقة الصالحية - محافظة الشرقية خلال صيف عامي ٢٠٠٦ ، ٢٠٠٧ .

توضح النتائج أن تقليل الفترة بين الريات من ٨ إلى ٦ ثم إلى ٤ أيام وزيادة معدلات التسميد البوتاسي من ٢٤ إلى ٤٨ ثم إلى ٧٢ كجم بوب/أفدان وكذلك زيادة معدلات التسميد الفوسفاتي من ١٥ إلى ٣٠ ثم إلى ٤٥ كجم فوب/أه/ فدان أدى إلى زيادة معنوية فى ارتفاع النبات، عدد الأفرع/ نبات، عدد القرون/ نبات، محصول البذور/ نبات، وزن الـ ١٠٠ قرن، نسبة التصافي ومحصول البذور والقرون والعرش/ فدان. أما بالنسبة لنسبة الزيت والبروتين بالبذور فقد زاد معنوياً بزيادة معدلات التسميد البوتاسي والفوسفاتي إلى المعدلات القصوى ولكن بالنسبة للفترة بين الريات فقد تحققت أعلى نسبة زيت عند الري كل ٤ أو ٨ أيام ولم يكن لمعاملات الري تأثير معنوي على نسبة البروتين.

كان لتداخل الفعل بين فترات الري والتسميد البوتاسي تأثيراً معنوياً على وزن الـ ١٠٠ قرن وكذلك محصول البذور/فدان. علاوة على أن تداخل الفعل بين فترات الري والتسميد الفوسفاتي كله له تأثيراً معنوياً على وزن الـ ١٠٠ قرن، محصول العرش/فدان. كانت أعلى قيم تم الحصول عليها لوزن الـ ١٠٠ قرن ومحصول البذور/فدان قد سجلت عند الري كل ٤ أيام وباستخدام أعلى معدلات من التسميد البوتاسي أو الفوسفاتي. كان أعلى محصول عرش/ فدان ثم الحصول عليه عند إجراء الري كل ٤ أيام والتسميد الفوسفاتي بمعدلات ٣٠ أو ٤٥ كجم فوب/أه/ فدان. كان معامل الارتباط بين محصول البذور /فدان وكل الصفات المدروسة موجباً ومعنوياً ماعدا نسبة البروتين والتي ارتبطت بمحصول البذور/ فدان ارتباطاً موجباً وغير معنوياً.

توصى الدراسة من خلال النتائج المتحصل عليها برى الفول السوداني كل ٤ أيام تحت ظروف الأراضي الرملية. ولأن الفول السوداني محصول بقولي والأراضي الرملية كما يشير تحليل التربة فقيرة في محتواها من المغذيات فهو يحتاج لإضافة ٧٢ كجم بوب/أه و ٤٥ كجم فوب/أه/فدان.