International Journal of Plant & Soil Science
3(6): 523-537, 2014; Article no. IJPSS.2014.6.002

SCIENCEDOMAIN *international*
www.sciencedomain.org

Response of Some Peanut (*Arachis hypogaea* L.) Cultivars Grown in Sandy Soil to Soil and Foliar Feeding with the Different Sources of Phosphorus

A. M. El-Saady[1], A. A. El-Sayed[1], W. M. A. K. Teilep[2*] and M. F. El-Dahshouri[1]

[1]Fertilization Technology Department, National Research Centre (NRC), Dokki-Cairo, Egypt.
[2]Oil Crops Research Section, Field Crops Research, Institute, Agriculture, Research Centre. Giza, Egypt.

Authors' contributions

This work was carried out in collaboration between all authors. All authors read and approved the final manuscript.

Conference Proceeding Full Paper

Received 27th November 2013
Accepted 22nd February 2014
Published 19th March 2014

ABSTRACT

Peanut (*Arachis hypogaea* L.) is one of most important leguminous crops for animal and human nutrition. Therefore, the objective of the present study was to improve the growth, yield and yield components as well as nutrient status of peanut cultivars grown on sandy soil by applying different sources of phosphorus as a soil and foliar feeding. Summer field experiment was carried out in Ismailia Experimental Station, Agriculture Research Center, during the growing seasons 2010 and 2011 to study the influence of soil (at recommended doses) and foliar application of phosphorus (at 0.5% P_2O_5) using different sources of phosphorus fertilizer on leaves uptake of some nutrients, growth, yield and yield components of three peanut (*Arachis hypogaea* L.) cultivars, (Giza-6, R92 and Gregory). The experimental design was split plot with four replicates. The three peanut cultivars were occupied in Main plot and ten treatments of phosphorus fertilizer (soil and foliar application) were allocated at random in sub-plots. Result showed significant differences among peanut cultivars in all studied parameters in the two of study seasons. Superiority of dry weight of leaves, nutrient uptake by leaves, plant height, pods yield and

---

**Corresponding author: E-mail: karim_m_683@Hotmail.com;*
Note: Full paper submitted at the First International Conference on "Food and Agriculture: New Approaches" held in the National Research Centre, Cairo, Egypt from December 2 to 4, 2013.

yield components and shelling percentage were recorded by Giza-6 and R92 cultivars. The obtained results indicated that the Applying UP and MKP to soil improved all growth and yield components and resulted improving nutrients uptake in peanut leaves which induced significant increase in pods yield as compared to other treatments. There was significant effect of the interaction between peanut cultivars and phosphorus fertilizer of different sources on all parameters studied. Giza-6 cultivar gave the highest values for plant height, weight of pods/plant, 100-pod weight, weight of seeds/plant and dry weight of leaves/plant, when fertilizer with SSP as foliar, UP, MAP and MKP application to the soil, respectively. Based on two years results, it could be concluded that application of MKP to soil might be the best for crop nutrients status, pods yield and its components under sandy soil condition, at Ismailia.

Keywords: Peanut (Arachis hypogaea L.); phosphorus fertilizer; soil and foliar feeding; yield and sandy soil.

1. INTRODUCTION

Peanut (*Arachis hypogaea* L.) is one of most important exported summer oil seed crop in Egypt, it contains about 50% oil, 25-30% protein, 20% carbohydrate and 5% fiber and ash, which make a substantial contribution to human nutrition [1].

Recently this crop has been given great attention from Government as well as from the scientific institutes due to its suitability to cultivate in the new reclaimed sandy soils in Egypt, which located in Ismailia, Sharkia, Minia, and Giza as well as South Tahrir Province, Al-Tahady Sector, Beheira Governorate. These sandy-textured soils were long believed to be too droughty for economic groundnut production. Now under recent irrigation system (sprinkler irrigation), these soils are proving to be most economically feasible soils for peanut cultivation. Sandy soils represent the most desert area in Egypt, and they are usually deficient in organic matter and plant nutrients [2].

Phosphorus is very important nutrient for legumes in particular [3]. It is a key constituent of adenosine triphosphate (ATP) in plants [4] and also plays various roles in seed formation. Absorption and reduction of nitrate is an energy consuming process and the energy is supplied by ATP. Although leguminous crop can fix their own nitrogen, they often need phosphorus and potassium for good seed formation [5]. Phosphorus also promotes root growth, enhances nutrient and water use efficiency and increases yield. The requirement of phosphorus in nodulating legumes is higher compared to non-nodulating crops [6]. Due to the important roles played by phosphorus in the physiological processes of plants, application of phosphorus to soils deficient in the nutrient tends to increase groundnut yield.

There are several kinds of synthetically phosphorus fertilizers manufactured in different grades. Among of such inorganic phosphatic fertilizers; single super phosphate (SSP), mono-ammonium phosphate (MAP), mono-potassium phosphate (MKP), di-ammonium phosphate (DAP) and urea phosphate (UP), which used in Egypt.

Several investigators emphasized response of peanut to P. [7,8,9,10,11,12] reported that increasing phosphorus levels increased each of number of pods and seeds/plant, weight of pods and seeds/plant, 100-seed weight as well as seed and oil yields.

Foliar feeding is often the most effective and economical way to correct plant nutrient deficiencies. During the last decades, foliar feeding of nutrients has become an established procedure in crop production to increase yield and improve the quality of crop products [13].

This procedure can also improve nutrient utilization and lower environmental pollution through reducing the amounts of fertilizers must add to soil in order to obtain the highest crops yield [14]. Furthermore, foliar feeding of any nutrient improves the physiological performance of plants and consequently promotes nutrient absorption and uptake of the same nutrient or other nutrients through improving root growth [15].

Therefore, the objective of the present study was to improve the growth, yield and yield components as well as nutrient status of some peanut cultivars grown on newly reclaimed sandy soil by use soil and foliar feeding of phosphorus fertilizer.

2. MATERIALS AND METHODS

Two field experiments were carried out in Ismailia Experimental Farm, Agricultural Research Center, Ismailia governorate, during the 2010 and 2011 growing seasons to study the response to soil and foliar feeding with phosphorus fertilizer and their influence on leaves nutrients uptake of elements, growth, yield and yield components of the three peanut cultivars (*Arachis hypogaea* L.) i.e. Giza-6, R92 and Gregory to soil and foliar feeding.

The experimental design was split plot with four replicates. The three peanut cultivars were occupied in main plot and ten treatments of phosphorus fertilizer were allocated at random in sub-plots as follow:

1. Single Superphosphate (15.5 P_2O_5) as soil application at 30 unit P_2O_5/fed. (SSPs)
2. Urea phosphate (43.5 % P_2O_5: 17 % N) as soil application at 30 unit P_2O_5/fed. (UPs)
3. Mono-ammonium phosphate (61% P_2O_5: 12 % N) as soil application at 30 unit P_2O_5/fed (MAPs)
4. Mono-potassium phosphate (52 % P_2O_5: 34 % K_2O) as soil application at 30 unit P_2O /fed. (MKPs)
5. Di-ammonium phosphate (53 % P_2O_5: 21 % N) as soil application at 30 unit P_2O_5/fed. (DAPs)
6. Single Superphosphate (15.5% P_2O_5) as foliar application at 0.5 % P_2O_5 (SSPf)
7. Urea phosphate (43.5% P_2O_5: 17% N) as foliar application at 0.5 % P_2O_5 (UPf)
8. Mono-ammonium phosphate (61% P_2O_5: 12% N) as foliar application at 0.5 % P_2O_5 (MAPf)
9. Mono-potassium phosphate (52% P_2O_5: 34 %K_2O) as foliar application at 0.5 % P_2O_5 (MKPf)
10. Di-ammonium phosphate (523% P_2O_5 : 21% N) as foliar application at 0.5 % P_2O_5 (DAPf)

Peanut plants were sprayed with the aforementioned fertilizers two times 35 and 50 days after sowing. The sprayed solution volume was 250 and 300 L/fed. in the first and second spray, respectively. While, the soil application of phosphorus fertilizers was added in two equal splits (at planting and 30 days after sowing) in both seasons.

Soil was ploughed using a chisel plough and divided into experimental units, 2.0 m long and 3.0 m width. Every plot contained 5 rows each of 60 cm width. Peanut seeds were sown on

May 7th and 9th in 2010 and 2011 seasons; respectively at the rate of 50 kg/feddan by hand drilling in rows.

Soil Analysis: Representative soil samples were taken after soil preparation and before fertilization from the experimental sites (0-50 cm depth) for determining physico-chemical characteristics (Table 1).

Table 1. Soil Physico, Physico-chemical and chemical properties characteristics (0 – 50 cm) in 2010 and 2011 seasons

Characteristics	2010	11
Physical Properties		
Sand (%)	91.0	90.0
Silt (%)	3.4	3.2
Clay (%)	5.6	6.8
Texture	Sand	Sand
E.C (dS/m)	0.30VL	0.35VL
pH	8.83VH	8.65 VH
Chemical Properties		
$CaCO_3$ %	1.27 VL	1.55 VL
Organic Matter %	0.21 VL	0.26 VL
Available macronutrients (mg / 100 g soil)		
P	0.47 VL	0.52 VL
K	8.4 VL	7.6 VL
Na	12.0 VL	14.2 VL
Ca	110 VL	122 VL
Mg	7.0 VL	6.6 VL
Available micronutrients (mg/kg soil)		
Fe	2.01 VL	1.24 VL
Mn	3.81 VL	2.91 VL
Zn	0.19 VL	0.24 VL
Cu	0.15 VL	0.19 VL

VL= Very low, L = Low, M = Medium, H = High, VH = Very high; Evaluation based on [16]

Nitrogen and potassium were added at rate of 80 kg N/fed, and 24 kg K_2O/fed. respectively. Nitrogen was applied as ammonium sulfate (20.6% N) in three equal splits (before sowing, 30 and 50 days after sowing) in both seasons. Potassium was applied as potassium sulphate (50% K_2O) at 30 days after sowing. The whole experimental plots were also sprayed with mixed iron, manganese and zinc in EDTA form two times (40 and 55 days after sowing) at rate of 0.5 g/L. from each nutrient. Plants were irrigated at 6 days interval using sprinkler system and weeds were controlled by hoeing.

Plant samples were taken to determine dry weight of leaves and macro- and micronutrient contents. Leaves were washed in sequence with tap water, 0.01 N HCl- acidified distilled water and distilled water, and then dried in a ventilated oven at 70ºC till constant weight was obtained.

2.1 Recorded Data

A sample of five plants /treatment was randomly taken at 90 days after sowing to determine dry weight of leaves per plant, macro and micronutrients uptake by leaves. Yield and its components: At maturity, i.e. 150 days after sowing the plants were harvested, then samples were taken to determine the following characteristics: Plant height (cm), branches number/plant, number of pods per plant, pod weight/plant, seed weight/plant, 100- pod weight (g), 100- seed weight (g) and shelling percentage. Pod yield Ardab /Feddan, (one Ardab = 75 kg)] and. Pod yield was determined in plot (2.0 m long and 3.0 m wide) then, converted to Feddan (Feddan (Fed.) = 4200m^2).

Nitrogen was determined using Micro – Kjelahl method, using boric acid modification, and distillation was done using Gerhardt apparatus. Phosphorus was photometrical determined using Spectrometer (Perkin-Elmer Lambda-2). Potassium, sodium and calcium were measured using Dr. Lang -M8D Flame-photometer. Magnesium, Fe, Mn, Zn and Cu were determined using the Atomic Absorption Spectrophotometer (Perkin-Elmer 1100 B). Protein calculated as (N %) × 6.25. Carbohydrate percentage in grains was determined according to the method adapted by [17].

Statistical analysis: Collected data were subjected to the proper statistical analysis with the methods described by [18]. Since the data in both seasons took similar trends and variances were some extents homogeneous according to Bartllets test. LSD test was applied at 5 % level for comparing the numerical averages according to [19].

3. RESULTS AND DISCUSSION

3.1 Effect of Varietal Differences

Dry weight of leaves: Significant differences in dry weight of leaves were recoded between different peanut varieties only in the second season (Table 2). And R92 cv. was the superior one in productivity heavier leaves compared to the other varieties, followed by Giza-6 cv. in both seasons, while the lowest value of this criterion was observed in Gregory cv. in 2010 and 2011 seasons. This means that R92 cv. is more efficient in producing metabolites, which reflected on producing heavier leaves. This reflected increasing in the production of more sizeable organs among which the increment of plant height and number of branches (Table 3). Similar trend was obtained by [20], who found significant differences between two peanut cultivars in dry weight of their shoots

3.2 Nutrients Uptake of Leaves

Data in Table 2 included the macro- and micronutrients uptake in leaves of different peanut varieties (average of two seasons). This data show differences in N, K, P, Mg, Fe, Mn and Zn uptake of leaves. The highest uptake of N, Mg, Mn and Zn were obtained by Giza-6 cv., while the highest uptakes of P, K and Fe were obtained by R92 cv. The differential benefits of the three cultivars from available nutrients in soil, might be attributive to the variation in their root system volume as well as their root exudations. In this respect [21,22] came to the same conclusion.

3.3 Yield and its Components

Data presented in Table 3 show significant differences among Giza-6, R92 and Gregory in the yield and yield attributes except, number of branches per plant in both seasons and shelling percentage in first season. Whereas, Giza-6 cv. was superior to other cultivars in the obvious parameters, followed by R92 cv. and then by Gregory cv. in the first season. These superiorities for Giza-6 cultivar were by 12.8 and 16.3% for pods number /plant, 40.5 and 44.1% for pods weight/plant, 25.2 and 20.5% for 100-pod weight, 33.7 and 53.8% for seed weight/plant, 11.9 and 12.7% for 100-seed weight and 29.3 and 55.5% for pods yield (Ardab/fed.) as compared with R92 and Gregory cultivars, respectively. Similar trend was found in the second season with R92 cv. as compared with Giza-6 and Gregory cultivars. Moreover, R92 cv. was superior to other cultivars in the plant height (cm) in both 2010 and 2011 seasons, followed by Giza-6 cv. and then by Gregory cv. However, Gregory cv. was superior to other cultivars in the 100 - pod weight parameter, followed by Giza-6 cv. and then by R92 cv. in the second season. Such differences may be due to genetical make up of the three cultivars. The superiority of Giza-6 and R92 cultivars may be referring to its high ability to grow under Ismailia condition. These results are supported by the findings of [21,22].

3.4 Effect of Phosphorus Fertilizer from Different Sources

3.4.1 Dry weight of leaves

Soil and foliar application of different phosphorus fertilizer had a significant effect among of them on dry weight of leaves/plant in both seasons (Table 4). The highest dry weight of leaves per plant were recorded in treatments; UPs and MKPs in both growing seasons, while significantly lowering in the dry weight of leaves per plant were by the treatment UPf and MAPf in 2010 and 2011 growing seasons. However, were found that application of phosphorus fertilizer generally increased dry weight in both seasons. Such increases in dry weight due to phosphorus application may be due to the fact that phosphorus is known to help in the developing the root system growth [23,11] and thus enables plants to absorb more water and nutrients from a certain depth of the soil. This in turn could enhance the plant's ability to produce more assimilates which were conducted on reflected in the high biomass, as in the case of leaves dry weight in study. Similar results have been reported in previous studies on peanut either in Egypt, [9,10,11] or over seasons; plant [24,25].

3.4.2 Nutrients uptake by leaves

In the average of two seasons, results in Table (4) indicated that, phosphorus fertilizer treatments significantly affected uptake of N, P, K, Mg, Fe, Mn and Zn by leaves of peanut plants. It is obviously noticed that soil application of UP and MAP gave the highest nutrients uptake by peanut leaves from P, K, Mg, Fe, Mn and Zn compared with the other treatments. While, the highest values for N uptake by peanut leaves was obtained by the treatment of MKP as foliar application. On the other hand, the lowest N uptake by peanut leaves were recorded in treatments DAP, SSP and MAP; as soil application. The lowest P uptake by leaves was recorded when SSP was added to the soil, while soil applied DAP gave the lowest values for K uptake by leaves. This mean that the uptake of the studied nutrients by leaves of peanut plants showed more increment when phosphorus fertilizers were applied to the soil compared to foliar application. The reason for that might be used phosphorus fertilizer such UP and MAP are acidic fertilizer; their acidic effects of soil makes P more available to plants compare to DAP and SSP. This is in agreement with [25].

3.4.3 Yield and its components

The data in Table 5 revealed that different yield attributing characteristics of peanut like plant height (cm), number of branches/plant, number of pods /plant, weight of pods and seeds /plant, 100-pod and -seed weight and shelling percentage were significantly influenced by different sources of phosphorus. The results are true for the two growing seasons 2010 and 2011 except, plant height, number of branches /plant and number of pods/plant in the first growing season. Maximum plant heights (25.8 and 25.7 cm) were recorded from the treatments SSP as a foliar and DAP as a soil followed by MKP as foliar and SSP as a soil (24.8 and 24.2 cm) and the lowest (22.0cm) from MAP as a foliar application. The highest number of branches/plant (5.5) was obtained by Up as a soil, while the treatment MKP as a foliar gave the lowest value (4.7). Maximum weight of pods/plant (70.3 and 44.8 g), weight of seeds /plant (46.6 and 30.3 g), 100-pod weight (200.9 and 189.8 g) and 100 -seed weight (92.7 and 83.0 g) were obtained from the treatment MKP as a soil in two growing seasons, respectively. Better growth and development of crop plants due to phosphorus supply and nitrogen uptake might have increased the supply of assimilates to seed, which ultimately gained more weight. Similar achievements on hundred seed weight with phosphorus are reported by [9,10,11].

The effect of different sources of phosphorus on peanut pods yield was found to be significant in both seasons. Maximum pods yield (25.2 and 25.6 Ardab/fed.) was obtained from MKP treatment as soil application in both 2010 and 2011 seasons, respectively. Several investigators [7,8,10,12], reported that respond to P. by increasing phosphorus levels led to increased each of number of pods and seeds/plant, weight of pods and seeds/plant as well as 100-seed weight. This might be due to the cumulative favorable effect of higher number of pods /plant and higher hundred pods and seed weight (Table 5). The better performance of MKP compared to other sources might be attributed to readily available phosphorus resulting in better absorption and utilization of phosphorus by plant and presence of other important plant nutrients i.e. potassium. Potassium is a multifunctional versatile nutrient indispensable for plants. In plants, the function of K has several roles, such as enzyme activation, stimulation of assimilation and transport of assimilate, anion/cation balance as well as water regulation through control of stomata against fungal diseases [26]. In this context [27] found that potassium hydrogen phosphate activating the plants resistance to fungal diseases by increasing the accumulation of phenolic compounds. This might be also due to the efficiency of mono-potassium phosphate (MKP) in inducing local and systemic protection from the fungal disease powdery mildew, as mentioned by [28] who also reported that MKP product can increase crop vigor and improve crop quality since MKP comprise the essential P and K nutrient elements.

3.5 Effect of Interaction between Cultivars and Phosphorus Fertilizers

3.5.1 Dry weight of leaves

The interaction effects between the different sources of phosphorus fertilizer and peanut cultivars seemed to be significant for dry weight of peanut leaves/plant of grown for the two successive seasons 2010 and 2011 (Table 6). The highest values of the dry weight of leaves/plant (19.2 and 18.7 g) were obtained by using MKP as soil application with Giza-6 cultivar in both seasons, respectively. While, the lowest values ones (7.9 and 8.7 g) were attained by spraying the peanut cultivars Gregory and R92 with UP and MAP in first and second seasons, respectively. These increases may be attributed to the source of phosphorus fertilizer (MPK) which content on K, the function of K has several roles, such as enzyme activation, stimulation of assimilation and transport of assimilate anion/cation balance as well as to the reliable role of P for encouraging the metabolic processes and consequently increasing dry matter. These results agreement with those obtained by [4,29,30].

3.5.2 Nutrients uptake of leaves

In the average of two growing seasons 2010 and 2011, results in Table 6 indicated that, interaction between phosphorus fertilizer treatments and peanut cultivars significantly affected on uptake of N, P, K, Mg, Fe, Mn and Zn by leaves. The highest value of the N uptake of leaves/plant (740.8 mg/plant) was obtained by using MKP as a foliar with Giza-6 cultivar, while the lowest value ones (215.96 mg/plant) was attained by Gregory vultivar sprayed with DAP, as a soil application with R92 cultivar. Maximum P (58.6 mg/plant), Mg (124.9 mg/plant), Fe (1314.1 µg /plant), Mn (956.7 µg /plant) and Zn (655.5 µg /plant) uptake of leaves were recorded from the treatments MKP as a soil with Giza-6 cultivar, while the lowest values (395.4 and 151.7) for Fe and Zn uptake of leaves were obtained by applying MAP as a foliar with R92 cultivar, respectively. However, the maximum uptake of leaves for K was obtained by adding MAP as a soil application with Gregory cultivar, while applying DAP as a foliar on plants of Gregory peanut cultivar gave the lowest value for P and K uptake of leaves. It could be concluded that MKP as a soil application with Giza-6 cultivar gave the highest dry weight of leaves/plant and the most nutrients uptake of leaves at 90 days after sowing. The better performance of MKP compared to other sources might be attributed to readily available phosphorus resulting in better absorption and utilization of phosphorus by plant and presence of other important plant nutrients i.e. potassium. Potassium is a multifunctional versatile nutrient indispensable for plants. In plants, the function of K has several roles, such as enzyme activation, stimulation of assimilation and transport of assimilate anion/cation balance as well as water regulation through control of stomata beside the role of MKP increasing the immunity performance of peanut plants against some fungal disease [26]. And the differences among three cultivars may be due to genetical make up of the three cultivars. These results are supported by the findings of [21,22].

3.5.3 Yield and its components

Data presented in Table 7 illustrated the effect of interaction between cultivars and different sources of phosphorus fertilizers on yield and yield attributes. No significant differences were observed between treatments except, number of pods/plant and weight of pods and seeds/plant in growing seasons and plant height, 100-pod weight and pods yield/feddan in first season. Giza-6 cultivar recorded the highest value of plant height, weight of pods/plant, 100-pod weight and weight of seeds/plant with MKP as foliar spray, UP, MAP and MKP as foliar application, respectively. While, R92 cultivar recorded the highest number of pods/plant in the first season, weight of pods/plant in second season and pods yield/feddan in second season with SSP and MKP as a soil application, respectively. These results are in harmony with those obtained by [21,22].

Table 2. Dry weight and nutrients uptake (average two seasons) of leaves in three peanut varieties at 90 day from sowing as affected by varietal differences at 2010 and 2011 seasons (n=40)

Parameters	DW of leaves (g/plant)		N	P	K	Mg	Fe	Mn	Zn
Season Variety	2010	2011	(mg/plant)	(mg/plant)	(mg/plant)	(mg/plant)	(µg /plant)	(µg /plant)	(µg /plant)
Giza-6	12.48	11.99	458.3	36.75	152.7	81.30	701.7	624.3	417.1
R92	12.99	13.32	430.2	39.21	164.0	64.15	714.3	567.4	309.1
Gregory	11.56	11.76	383.3	34.46	145.0	66.09	649.6	531.0	327.1
LSD at $_{0.05}$	ns	0.48	29.6	4.56	13.9	2.06	54.4	55.8	17.4

Table 3. Yield and yield attributes in three peanut varieties as affected by varietals differences at 2010 and 2011 seasons (n=40)

Parameters	Plant height (cm)		Branches number/plant		Pods number/plant		Pod eight/ plant (g)		100-pod weight (g)		Seed weight/ Plant (g)		100-seed weight (g)		Pod yield (Ardab/fed.)		Shelling percentage	
Season Variety	2010	2011	2010	2011	2010	2011	2010	2011	2010	2011	2010	2011	2010	2011	2010	2011	2010	2011
GIZA-6	22.40	25.64	4.75	4.97	37.64	20.77	75.87	38.08	208.9	176.6	51.54	23.95	91.22	74.00	28.12	18.69	69.11	63.96
R92	25.56	26.09	4.73	4.92	33.36	28.47	53.99	40.11	166.8	173.0	38.55	27.87	81.49	78.57	21.75	22.34	68.34	66.36
GREGORY	21.19	19.80	4.80	4.95	32.36	17.93	52.65	32.47	173.3	182.1	33.52	20.87	80.97	75.83	18.08	22.00	68.62	66.10
LSD at $_{0.05}$	3.64	2.05	NS	NS	4.08	2.48	9.50	2.29	6.60	4.46	8.57	1.90	1.83	2.81	2.23	1.94	NS	1.76

Table 4. Dry weight and nutrients uptake (average two seasons) of leaves in three peanut varieties at 90 day from planting as affected by phosphorus fertilization (P) at 2010 and 2011 seasons (n=12)

Parameters	DW of leaves (g/plant)		N (mg/plant)	P (mg/plant)	K (mg/plant)	Mg (mg/plant)	Fe (mg/plant)	Mn (mg/plant)	Zn (mg/plant)
Season P	2010	2011							
SSP $_S$*	10.89	11.38	330.80	28.97	131.87	54.52	557.72	553.52	327.80
UP $_S$	17.16	16.23	492.07	51.24	217.28	94.76	999.08	896.08	532.66
MAP $_S$	11.71	12.47	333.70	35.85	154.52	70.08	679.15	540.71	350.50
MKP $_S$	16.91	16.57	545.26	53.39	214.88	95.71	1017.64	785.78	481.69
DAP $_S$	10.15	10.30	322.45	31.16	116.51	60.76	620.32	405.57	268.40
SSP $_F$**	10.49	10.87	371.93	31.04	134.84	55.33	629.16	409.80	301.01
UP $_F$	9.70	10.47	386.40	31.72	122.65	53.00	459.18	440.12	293.86
MAP $_F$	9.80	10.08	442.99	28.22	122.61	61.40	497.57	484.12	260.92
MKP $_F$	13.83	13.50	595.91	38.72	174.06	84.33	779.07	663.21	358.4
DAP $_F$	12.84	10.47	418.07	37.75	150.06	75.25	646.35	563.59	335.72
LSD at $_{0.05}$	0.97	0.71	28.55	3.32	14.56	6.75	61.06	53.84	31.99

** S= soil application, ** F = foliar application*

Table 5. Yield and yield attributes in three peanut varieties as affected by phosphorus fertilization (P) at 2010 and 2011 seasons (n=12)

Parameters	Plant height (cm)		Branches number/plant		Pods number/plant		Pod weight/ plant (g)		100-pod weight (g)		Seed weight/plant (g)		100-seed weight (g)		Pod yield (Ardab/fed.)		Shelling percentage	
Season P	2010	2011	2010	2011	2010	2011	2010	2011	2010	2011	2010	2011	2010	2011	2010	2011	2010	2011
SSP $_S$*	21.98	24.20	4.73	5.05	35.00	20.78	62.67	34.24	172.04	169.56	46.23	26.49	89.36	76.11	22.95	21.29	68.99	71.90
UP $_S$	22.33	23.30	4.73	5.46	29.42	22.78	64.36	39.80	166.23	182.44	44.08	24.67	72.94	74.22	24.12	19.43	66.57	69.78
MAP $_S$	24.20	23.80	4.66	5.26	32.07	20.00	66.29	38.27	189.32	183.78	45.08	27.76	84.57	73.44	23.86	19.70	73.49	70.78
MKP $_S$	23.53	22.26	4.60	5.08	31.07	27.00	70.29	44.76	200.87	189.78	46.56	30.31	92.74	83.00	25.20	25.64	66.79	63.97
DAP $_S$	23.00	25.66	4.75	4.88	36.90	21.11	44.89	35.13	174.20	170.00	33.60	20.71	82.48	78.00	19.36	19.83	68.92	58.62
SSP $_F$**	24.31	25.82	5.06	4.78	36.58	24.89	50.98	32.56	162.33	174.78	31.36	23.02	84.31	78.44	21.88	20.63	66.60	64.87
UP $_F$	22.05	23.64	4.97	4.71	39.01	22.47	69.40	36.69	187.40	168.89	37.17	21.89	84.16	72.67	23.75	20.51	68.93	61.94
MAP $_F$	24.10	22.00	4.53	4.78	37.84	23.00	61.60	36.90	192.92	165.00	43.64	21.32	88.68	82.44	22.43	20.62	67.62	61.47
MKP $_F$	22.25	24.77	4.63	4.66	36.14	20.22	65.93	35.40	191.87	183.78	44.10	24.01	79.96	73.56	22.74	20.15	68.01	65.84
DAP $_F$	22.70	22.98	4.93	4.71	30.47	21.67	51.98	35.12	192.87	188.22	40.19	22.13	86.40	69.44	20.20	22.29	71.00	65.59
LSD at $_{0.05}$	NS	2.12	NS	0.53	NS	2.61	8.05	4.81	14.65	10.21	8.68	4.12	10.66	7.55	3.07	1.85	5.05	6.55

** S= soil application, ** F = foliar application*

Table 6. Dry weight and nutrients uptake (average two seasons) of leaves in three peanut varieties at 90 day from planting as affected by interactions between variety and phosphorus fertilization (P) at 2010 and 2011 seasons (n=4)

Parameters		DW of leaves (g/plant)		N	P	K	Mg	Fe	Mn	Zn
Var.	P	2010	2011	(mg/plant)	(mg/plant)	(mg/plant)	(mg/plant)	(µg /plant)	(µg /plant)	(µg /plant)
Giza-6	SSP $_S$*	9.79	10.65	293.78	23.46	110.12	53.81	535.24	594.45	323.93
	UP $_S$	18.01	16.70	522.18	53.10	217.01	112.58	1171.52	1082.45	651.69
	MAP $_S$	8.79	9.80	248.85	26.32	122.95	55.84	533.06	456.05	301.93
	MKP $_S$	19.21	18.65	621.10	58.60	223.84	124.87	1314.13	956.65	655.48
	DAP $_S$	11.93	11.50	433.46	37.77	133.21	72.24	732.73	420.48	358.16
	SSP $_F$**	8.46	9.55	328.11	26.19	130.46	57.12	560.80	287.50	284.87
	UP $_F$	10.54	10.75	472.81	33.70	133.27	70.67	398.15	504.27	418.85
	MAP $_F$	11.43	11.25	557.33	33.70	146.44	76.54	588.06	580.82	350.13
	MKP $_F$	14.08	13.00	740.76	38.70	168.21	99.22	550.03	779.54	424.42
	DAP $_F$	12.61	13.05	364.90	35.93	141.83	90.12	632.88	580.51	401.50
R92	SSP $_S$*	13.76	13.50	427.39	39.23	171.97	64.59	684.42	618.01	405.74
	UP $_S$	18.71	18.35	528.47	57.04	244.25	92.70	950.70	856.52	515.90
	MAP $_S$	8.29	9.65	238.24	26.14	104.94	46.95	462.85	337.66	238.06
	MKP $_S$	14.33	14.35	462.92	46.51	188.50	66.81	712.26	623.11	315.56
	DAP $_S$	8.37	9.05	243.15	24.33	99.21	49.77	513.35	377.07	177.80
	SSP $_F$**	12.97	13.00	439.80	38.27	155.66	55.09	723.84	568.20	305.94
	UP $_F$	10.68	11.30	384.43	35.86	138.84	45.40	580.24	462.45	236.79
	MAP $_F$	7.92	8.65	336.40	23.38	99.38	43.97	395.38	375.96	151.72
	MKP $_F$	17.04	17.05	568.18	46.85	218.05	89.43	1219.72	705.20	353.49
	DAP $_F$	17.88	18.25	673.34	54.48	219.66	86.73	899.87	750.20	390.15
Gregory	SSP $_S$*	9.13	10.00	271.22	24.23	113.50	45.16	453.50	448.11	253.72
	UP $_S$	14.78	13.65	425.55	43.57	190.56	79.00	875.02	749.26	430.37
	MAP $_S$	18.06	17.95	514.00	55.10	235.65	107.46	1041.53	828.42	511.51
	MKP $_S$	17.19	16.70	551.74	55.07	232.30	95.43	1026.53	777.57	474.02
	DAP $_S$	10.14	10.35	290.75	31.35	117.09	60.27	614.87	419.16	269.22
	SSP $_F$**	10.05	10.05	347.88	28.66	118.40	53.77	602.83	373.70	312.21
	UP $_F$	7.87	9.35	301.94	25.61	95.84	42.92	399.14	353.65	225.94
	MAP $_F$	10.04	10.35	435.25	27.58	122.01	63.67	509.29	495.57	280.92
	MKP $_F$	10.38	10.45	478.81	30.61	135.93	64.33	567.47	504.88	297.29
	DAP $_F$	8.03	8.70	215.96	22.85	88.69	48.91	406.30	360.05	215.51
LSD at $_{0.05}$		1.64	1.20	48.20	5.61	24.58	11.39	103.08	90.90	54.01

Table 7. Yield and yield attributes in three peanut varieties as affected by interactions between variety and phosphorus fertilization(P) at 2010 and 2011 seasons (n=4)

Parameters		Plant height (cm)		Branches number/plant		Pods number/plant		Pod weight/plant (g)		100-pod weight (g)		Seed weight/ Plant (g)		100-seed weight (g)		Pod yield (Ardab/fed.)		Shelling percentage	
Var.	**P**	**2010**	**2011**	**2010**	**2011**	**2010**	**2011**	**2010**	**2011**	**2010**	**2011**	**2010**	**2011**	**2010**	**2011**	**2010**	**2011**	**2010**	**2011**
Giza-6	SSP $_{S}$*	21.40	27.33	4.80	5.86	26.86	20.00	56.87	32.27	179.00	164.33	46.53	24.67	101.97	74.33	26.46	19.43	65.00	72.70
	UP $_{S}$	22.06	28.83	4.60	5.20	31.40	16.66	90.13	38.47	198.17	190.00	41.03	20.27	80.37	72.33	29.40	15.53	62.73	66.97
	MAP $_{S}$	23.66	23.40	4.40	5.20	32.30	19.66	71.60	35.07	239.20	203.67	58.53	30.27	89.43	85.67	31.43	19.06	77.50	76.63
	MKP $_{S}$	24.06	24.13	4.86	5.20	26.93	24.00	84.00	48.53	198.43	168.00	58.57	35.53	92.50	67.33	30.03	25.80	64.90	66.43
	DAP $_{S}$	20.80	26.73	4.53	5.13	42.63	19.33	70.07	38.07	217.97	177.33	41.13	18.73	88.37	76.00	21.53	16.83	68.90	54.90
	SSP $_{F}$**	24.73	29.60	5.20	4.80	45.36	23.33	71.47	33.33	201.87	169.00	46.93	23.33	92.47	72.00	28.56	17.70	68.10	62.43
	UP $_{F}$	20.26	23.46	5.06	4.73	44.26	23.06	82.20	41.07	213.90	184.67	49.70	23.53	92.50	70.00	29.33	17.60	71.33	58.37
	MAP $_{F}$	21.63	23.86	4.60	5.06	46.80	23.33	89.47	32.40	229.63	145.33	53.17	21.67	85.07	73.33	30.66	19.36	69.46	58.30
	MKP $_{F}$	23.06	26.00	4.60	4.66	44.63	19.66	83.40	36.20	201.17	178.67	64.17	20.40	95.37	68.00	28.96	17.00	72.23	57.93
	DAP $_{F}$	22.26	23.06	4.86	4.80	35.20	18.66	59.53	45.37	209.40	185.33	55.60	21.07	94.17	81.00	24.83	18.56	70.97	64.93
R92	SSP $_{S}$*	24.86	26.80	4.86	4.93	46.86	28.00	88.26	44.80	180.53	172.00	61.27	30.73	78.57	81.33	23.96	25.72	71.37	71.57
	UP $_{S}$	25.86	23.20	5.06	5.40	31.06	37.00	57.73	46.67	126.30	181.33	55.70	35.93	74.03	81.67	22.36	19.43	63.23	69.40
	MAP $_{S}$	27.53	27.26	4.93	5.00	37.46	21.33	60.60	43.60	182.53	158.33	40.00	33.86	80.07	62.00	26.30	20.23	81.80	77.67
	MKP $_{S}$	26.66	23.13	4.53	5.20	40.33	38.66	45.93	49.47	175.83	201.67	40.50	33.07	92.10	77.33	26.10	23.70	65.50	65.60
	DAP $_{S}$	26.86	26.73	4.73	4.46	29.06	23.66	28.73	39.33	151.03	152.67	28.57	21.40	88.73	78.67	20.50	20.40	74.67	57.43
	SSP $_{F}$**	25.20	27.13	4.86	4.70	33.13	31.66	43.93	39.13	126.00	162.00	24.20	24.13	88.63	77.33	19.46	22.10	67.13	62.00
	UP $_{F}$	24.36	27.20	4.83	4.93	34.36	24.33	57.20	36.20	172.90	156.67	28.37	24.73	74.57	73.33	24.26	22.46	64.10	63.67
	MAP $_{F}$	27.80	25.73	4.26	4.66	25.46	26.66	58.40	43.20	174.37	187.67	43.37	22.10	90.93	86.67	16.76	20.30	60.53	59.47
	MKP $_{F}$	23.33	27.53	4.50	5.06	32.46	24.66	49.73	34.07	190.10	175.33	33.73	27.57	75.57	81.33	19.83	21.70	62.73	68.73
	DAP $_{F}$	23.10	26.20	4.73	4.80	23.33	28.66	49.40	24.67	188.83	182.33	29.77	25.20	71.70	86.00	18.00	27.37	72.37	68.10
Gregory	SSP $_{S}$*	19.70	18.46	4.53	5.36	31.26	14.33	42.86	25.67	156.60	172.33	30.90	24.07	87.53	72.67	18.43	18.73	70.60	71.43
	UP $_{S}$	19.06	17.86	4.53	5.80	25.80	14.66	45.20	34.27	174.23	176.00	35.50	17.80	64.43	68.67	20.60	23.33	73.73	72.97
	MAP $_{S}$	21.40	20.73	4.66	5.60	26.46	19.00	66.67	36.13	180.87	189.33	36.70	19.13	84.20	72.67	13.60	19.80	61.17	58.03
	MKP $_{S}$	21.00	19.53	4.40	4.86	25.93	18.33	80.93	35.93	204.50	199.67	40.60	22.33	81.43	63.67	19.46	27.43	69.97	59.87
	DAP $_{S}$	19.86	23.53	5.00	5.06	26.46	20.33	35.87	28.00	153.60	180.00	31.10	22.00	70.33	79.33	16.06	22.26	63.20	63.53
	SSP $_{F}$**	21.33	20.73	5.13	4.86	25.93	19.66	37.53	25.20	159.13	193.33	22.93	21.60	71.83	86.00	17.63	22.10	64.57	70.17
	UP $_{F}$	23.00	20.26	5.03	4.46	39.00	20.00	68.80	32.80	175.40	165.33	33.43	17.40	85.40	74.67	17.66	21.46	71.37	63.80
	MAP $_{F}$	21.53	16.40	4.73	4.63	31.23	19.00	36.93	35.10	163.97	162.00	34.40	20.20	102.23	87.33	19.86	22.20	72.87	66.63
	MKP $_{F}$	22.86	20.80	4.80	4.26	38.40	16.33	64.67	36.27	184.33	185.67	34.40	24.07	68.93	71.33	19.43	21.76	69.07	70.87
	DAP $_{F}$	20.36	19.70	5.20	4.53	26.26	17.66	47.00	35.33	180.37	197.00	35.20	20.13	93.33	82.00	17.76	20.93	69.67	63.73
LSD at $_{0.05}$		ns	3.68	ns	ns	12.64	4.52	13.95	8.33	17.72	17.67	15.03	7.14	ns	ns	5.31	3.20	ns	ns

** S= soil application, ** F = foliar application*

4. CONCLUSION

It could be concluded that under sandy soil condition, at Ismailia Governorate, superiority of dry weight of leaves, nutrient uptake of leaves (N, P, K, Mg, Fe, Mn and Zn), plant height, pods number/plant, weight of pods and seeds/plant, 100-pod and seed weight/plant, pods yield/faddan and shelling percentage were recorded by Giza-6 and R92 cultivars. In addition, soil application of MKP could be used to obtain high yield and yield components of peanut plants. Also, to obtained peanut leaves with high N, P, K, Mg, Fe, Mn and Zn uptake and dry weight, MKP or UP application should be applied to soil. Moreover, the application of different sources of phosphorus fertilizer as a soil application is better than the foliar application under studied conditions.

ACKNOWLEDGEMENTS

This work was carried out as a part of the activities of the Egypto-German Project" Micronutrients and other Plant Nutrition Problems in Egypt" conducted by National Research Centre, Cairo (Coordinator: Prof. Dr. M.M. El-Fouly) and the Institute of Plant Nutrition, Technical University of Munich (Prof. Dr. A. Amberger).

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Fageria NK, Baliger VC, Jones CA. Growth and mineral nutrition of field crops. Mareel Dekker, Inc., NY, USA. 1997;494.
2. Abdel Wahab AF, Biomy AHM, ElFarghal WM. Effect of some natural soil amendments on biological nitrogen fixation, growth and green yield of pea plants grown on sandy soils. Foyoum J Agric Res and Environ. 2003;17:47-54.
3. Poehlman JM. The Mungbean. Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi, India; 1991.
4. Sankar AS, Reddy PR, Rao IVS. Nodulation and nitrogen fixation in groundnut as affected by seed size and phosphorus. Legume Research. 1984;7:1-5.
5. Asiedu EA, Van Gastel AJG, Gregg BR. Extension agents technical crop guidelines for assisting seed producers in Ghana. 2000;9.
6. Ikisan. Biological nitrogen fixation. In http.//www. Ikisan. Com/links/ap. Groundnut Nitrogen fixation. Sht. Ml; 2000. Accessed 18 January 2010.
7. El-Far IA, Ramadan BR. Response of yield, yield components and seed quality of peanut to plant density and PK fertilization in sandy calcareous soil. Proc. 9th Conf. Agron., Minufiya Univ., 2000;1-2:453-466.
8. Ali AAG, Mowafy SAE. Effect of different levels of potassium and phosphorus fertilizers with the foliar application of zinc and boron on peanut in sandy soils. Zagazig J Agric Res. 2003;30:335-358.
9. Tomar RAS, Kushwaha HS, Tomar SPS. Response of groundnut (Arachis hypogaea L.) varieties to phosphorus and zinc under rain fed conditions. Indian J Agron. 1990;35:391-394.
10. El-Habbasha SF, Kandil AA, Abu-Hagaza NS, Abdel-Haleem AK, Khalafallah MA, Behiary TG. Effect of Phosphorus levels and some biofertilizers on dry matter, yield and yield attributes of groundnut. Bull Fac Agric Cairo Univ. 2005;56:237-252.

11. Gobarah ME, Mohamed MH, Tawfik MM. Effect of phosphorus fertilizer and foliar spraying with zinc on growth, yield and quality of groundnut under reclaimed sandy soils. J Appl Sci Res. 2006;2(80):491-496.
12. Tran Thi Thu Ha. Effect of phosphorus fertilizer on groundnut yield in poor alluvial and sandy soils of Thua Thien Hue. Better Crops Intl. 2003;17:16-17.
13. Roemheld V, El-Fouly MM. Foliar nutrient application: Challenge and limits crop production. Proc. 2nd International Workshop on "Foliar Fertilization" April 4-10 Bangkok, Thailand. 1999;1-32.
14. Abou-El-Nour EAA. Can supplemented potassium foliar feeding reduce the recommended soil potassium Pak. J Biol Sci. 2002;5(3):259-262.
15. El-Fouly MM, El-Sayed AA. Foliar fertilization: An environmentally friendly application of fertilizers. Dahlia Greidinger International symposium on "Fertilizaton and Enveronmententent" 24-27 March, Haifa, Israel, Ed. John J. 1997;346-357
16. Ankerman D, Large L. Soil and plant analysis, technical bulletin, A and L agricultural laboratories inc. USA. 1974;82.
17. Shaffer DA, Hartmann AF. The iodometric determination of copper and its use in sugar analysis. 1. Method for the determination of reducing sugars in blood, urine, milk and other solution. J Boil Chem. 1921;45:365.
18. Snedecor GW, Cochran WG. Statistical Methods, 6th Edition the Iowa State College, Ames Iowa, USA; 1967.
19. Waller RA, Duncan DB. A bays rule for the symmetric multiple comparisons problem. Am Stat Assoc J. 1969;14-85.
20. Rahman MHH, Khanam D, Hossain AKM. Effect of inoculation and fertilization on growth and yield of some varieties of groundnut. Legume Res. 1992;15(3-4):137-140.
21. Abd-alla AA, El-Howeity MA, Desoky AH. Response of peanut crop cultivated in newly reclaimed soil to inoculation with plant growth – promoting rihzobacteria. Minufiya J Agric Res. 2009;34(6):2281-2304.
22. El-Shouny MM, El-Shikha SA, Abd El-Warth M, Masoud AM. Improvement of sandy soil properties and its productivity of peanut by using organic compost and foliar spray with boron. Minufiya J Agric Res. 2009;34(6):2261-2229.
23. Sharma BM, Yaday JSP. Availability of phosphorus to grain as influenced by phosphatic fertilization and irrigation regimes. Indian J Agric Sci. 1997;46:205-210.
24. Atayese MO. Field response of groundnut (*Arachis hypogaea L.*) cultivars to mycrohizal inoculation and phosphorus fertilizer in Abeokuta, South West Nigeria. American-Eurasian J Agric & Environ Sci. 2007;2(1):16-23.
25. Kausale SP, Patel CI, Kote GM, Lomteand DM. Influence of different levels and sources of phosphorus, pressmud and phosphorus solubilizing microorganisms on nodulation. Yield and quality of groundnut. Legume Res. 2007;30(2):113-117.
26. Marschner H. Mineral Nutrition of Higher Plants. Inst. of Plant Nutrition, Univ. of Hoheheim, F.R.G. Academic. Prss, Harcout, Brace. Jovanvich Publisher. London; 1986.
27. Sarma BK, AmeerBasha S, Singh DP, Singh UP. Use of nonconventional chemicals as alternative approach to protect chickpea (Cicerarietinum) from Scelrotinics tem rot. Crop Prot. 2007;26:1042-1048.
28. Reuveni M, Agapov V, Reuveni R. Controlling powdery mildew caused by Sharerothecafulingniea in cucumber by spraying phosphate and potassium salts. Crop Prot. 1996;15:49-53.

29. Nasr-Alla AE, Osman FAA, Soliman KG. Effect of increased phosphorus, potassium or sulfur application in their different combinations on yield, yield components and chemical composition of peanut in a newly reclaimed sand soil. Zagazig J Agric Res. 1998;25(3):557–579.
30. Migawer, Ekram A, Mona A, Soliman M. Performance of two peanut cultivars and their response to npk fertilization in newly reclaimed loamy sand soil. J Agric Sci Mansoura Univ. 2001;26(11):6653–6667.

Peer-review history:
The peer review history for this paper can be accessed here:
http://www.sciencedomain.org/review-history.php?iid=472&id=24&aid=4041