EFFECT OF PHOSPHORUS FERTILIZATION AND PHOSPHATE DISSOLVING BACTERIA ON PEANUT YIELD

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ABSTRACT: *Two field experiments were conducted at Ismailia Agricultural Research Station through seasons of 2007& 2008 to study the influence of phosphorus fertilization as superphosphate at the rat of 0, 15, 30 and 45 kg P_2O_5 /fed and their combination with phosphate dissolving bacteria (Bacillus megatherium var. phosphaticum); PDB on peanut yield, yield components and some biochemical components. Obtained results revealed that:*

1. *Application of mineral phosphate at 30kg P_2O_5/fed. increased the seed index,, pods yield, seed yield, and shilling percentage and also protein, oil and macronutrient (NPK) content over untreated plants.*
2. *Treatments showed an increment under PDB inoculation comparing with untreated ones.*
3. *Interaction between mineral phosphate and bio-phosphatic fertilization had a positive effect for most of the studied characters and revealed that application of 30kg P_2O_5/fed. combined with phosphate dissolving bacteria gave the best results.*

Key words: Phosphorus, Bioferilizer, Candysov, Peanut, Nutrients uptakc.

INTRODUCTION

Peanut (*Arachis hypogaea*, L.) is considered to be one of the most important edible oil crops which due to its high nutritive value of its seeds for human and the produced cake as well as the green leaf hay for livestock, in addition to the importance seed oil for industrial purposes. Increasing of peanut production in order to cover the local consumption and exported outside could be achieved by introducing high productivity varieties and improving the cultural practices and managements as well as chosen the proper planting density- peanut crop has different groups of varieties (AbdEl-Maksoud, 2008).

Phosphorus has been called "The key of life" because it is directly involved in most vital processes. Phosphorus (P) is one of the most universal deficient nutrients in soil; hence phosphorus fertilization is a common practice necessary for good crop production. In alkaline soils as Egyptian ones, and particularly in poor P sandy soils, the soluble phosphate is derived from either organic matter or applied as mineralized phosphate fertilizers such as superphosphate and orthophosphoric acid.

Phosphorus was found to increase seed and pod yield / fed., shelling percentage, N, P, K uptake in grain, seed crude protein and seed oil (El Hamzawi-Dalia 2001).P-soil application in three portions gave the highest increments in seed, straw and seed protein yields as well as micronutrients Nassar *et al* (2005). Bhatol *et al.* (1994) reported that seed oil content of groundnuts by application of P up to 50 kg P_2O_5 /ha. and uptake of N, P and K were also increased by application of 25kg P_2O_5/ha. Deshmukh *et al.* (1993) showed that phosphorus application increased N, P and K uptake. El Mallah(1998) stated that phosphorus application significantly increased N, P,K uptake in grains of peanut.

Use of soil microorganisms which can either fix atmospheric nitrogen, solubilize phosphate, synthesis of growth promoting substances or by enhancing the decomposition of plant residues to release vital nutrients and increase humic content of soils, will be environmentally begin approach for nutrient management and ecosystem function Wu *et.al.,* (2005).

Of the well-known biofertilizers are the microbial inoculants which applied to seeds or soil in order to increase soil fertility and plant growth. It includes several microorganisms such as phosphate dissolving bacteria (PDB). Soil micro-organisms known as phosphate solubilizing bacteria (PSB), which if found in the root zone, they play a fundamental role in converting the fixed form to be soluble and ready for plant uptake. In addition, the microbial breakdown of soil organic matter is associated with an increase in CO_2 production, which in turn, increases the solubility of soil phosphates (Zayed, 1998). The role of PSB in solubilizing the fixed phosphates and increasing P uptake by growing plants was also reported by Osman *et al.* (1974). Increasing plant dry matter due to inoculation by PDB was attributed to the reduction of the rhizosphere pH and hence the solubility of phosphates (Kucey, 1988).

El-Akabawy *et al.* (2001) founded that using biofertilizers increased yield and also minimizing the huge amounts of using the chemical fertilizers that is of great need nowadays. Ahmed *et al.,* (2002) indicated that application 30kg P_2O_5 /fed. and biofertilization (PDO) increase soybean seed yield and its content of nutrients as well as oil and protein content. Hanafy *et al* (2005)., reported that application of PDB with full dose of P_2O_5 surpassed PDB with half dose of P_2O_5 on growth fiber yield and chemical composition in flax plant. Hamissa *et al.,* (2000) postulated that total N uptake by faba bean seeds and yield in both seasons, significantly increased with the combination of 30kg/fed. and inoculation with PDB. Inoculation with phosphate dissolving bacteria cause increases in grain and straw yield of rice and macronutrients content (N, P and K) in grain at harvest stage as well as protein in grain of rice (Ewais Magda *et al.*, 2003).

Thus the present investigation was conducted to study the effect of biofertilizer under different phosphorus levels on yield, yield component and some chemical composition of peanut plants.

MATERIALS AND METHODS

Two field experiments were carried out on sandy soil at Ismailia Agricultural Research Station longitude 30° 34 49.45 ˝, latitude 32° 15 55.40˝ and Elevation:15 m during the two successive summer seasons of 2007 and 2008 to study the effect of seed inoculation with as (PDB) phosphate dissolving bacteria (*Bacillus megaterium* var. phosphaticum) supplied from Agricultural Microbiology Research Section) under four levels of single superphosphate (SSP) (0,15,30and45kgP_2O_5/fed.) on peanut (*Arachis hypogaea* L.) Varaiety Giza 5. Superphosphate added to the soil before planting. All seeds under treatments were inoculated with specific rhizobia (bradyrhizobium japonicum), then immediately they were sown.
The experimental design was split plot with three replicates, the plot area was 10.5m^2.

The treatments were as follows:

1. Control treatment without any additions.P0
2. SSP {(15 kg P_2O_5/ fed.) P1
3. SSP (30 kg P_2O_5/ fed.).P2
4. SSP (45 kg P_2O_5/ fed.) P3
5. SSP (0 kg P_2O_5/ fed.) with PDB.P0
6. SSP (15 kg P_2O_5/ fed.) with PDB. P1
7. SSP (30 kg P_2O_5/ fed.) with PDB. .P2
8. SSP (45 kg P_2O_5/ fed.) with PDB. .P3

Representative surface soil sample (0-30 cm) was taken before performance of the experiment. Some physical and chemical analyses of the studied soil sample were determined according to the methods described by Chapman and Prartt (1961) and Jackson (1973) as shown in Table (1).

Table (1): Chemical and physical properties of the investigated soil

PH (1:2:5)	E.C ds/m	Soluble cations(meg/L)				Soluble anions(meg/L)			
		Ca++	Mg++	Na+	K+	CO3--H	HCO3-	Cl-	SO4--
7.62	0.55	1.62	1.54	2.1	0.54	--	1.92	1.61	2.27

Available N(mgkg^{-1})	Available P(mgkg^{-1})	Available K(mgkg^{-1})
16.80	5.4	39

Coarse sand %	Fine sand%	Silt %	Clay %	Ca CO3 %	O: M %	Soil texture
76.18	15.17	2.35	6.30	0.9	0.30	Sandy soil

All the experimental plots received 24 K_2O kg/fed. as potassium sulphat ($48\%K_2O$) at sowing and 30 kg N/fed as ammonium sulphat (20.5%N) after 15 days from sowing in two equal doses one after planting and one month from sowing.

At harvesting time, ten guarded plants were labeled from each plot to estimate.

The following character

1. Weight of 100seed (g).
2. Weight of pods yield (kg/fed).
3. Weight of seed yield (kg/fed).
4. Weight of husk yield (kg/fed).
5. Shilling percentage (%) = seed weight x100/pod weight.
6. N, P and K uptake.
7. Protein yield (kg/fed).
8. Oil yield (kg/fed).

Peanut seeds were chemically analyzed to determine N, P and K contents.N% was determined by micro-Kjeldahl method, and then multiplied by 6.25 to obtain protein content. Oil % in seed was determined by using Soxhlt apparatus and petroleum ether as an organic solvent as described by A.O.A.C (1990). Phosphorus was determined colorimeterically while potassium was estimated by flam-photometer according to Jakson(1973). Data was subjected to statistical analysis and the mean values were compared by L.S.D according to Snedecor and Cochran (1982).

RESULTS AND DISCUSSION

1- Effect of mineral phosphorus on yield and its component:

Data presented in Table (2), generally, indicate significant increment in all characters was obtained for weight of 100 seed, pods yield, seed yield, while shilling percentage) insignificantly increment was obtained for the husk yield. That increment was due to the increase the rate of applied phosphorus fertilizers. P has enhancing impact on plant growth and biological yield through its importance as energy storage and transfer necessary for metabolic processes (Marschner,1998). That is because phosphorus is one important in plant bioenergetics. As a component of ATP, phosphorus is needed for the conversion of light energy to chemical energy (ATP) during photosynthesis. Phosphorus can also be used to modify the activity of various enzymes by phosphorylation, and can be used for cell signaling (Cell signaling is part of a complex system of communication that governs basic cellular activities and coordinates cell actions). Since ATP can be used for the biosynthesis of many plants bimolecular, phosphorus is important for plant growth and flower/seed formation (Mengel and Kirkby 1987). These results are in agreement with those obtained by Nassar *et al.*, (2005) on faba bean, El Hamzawi-Dalia (2001), El Mallah(1998), Bhatol *et al.* (1994), Sison and Pava (1990) on ground nut .

Table (2): Effect of biofertilizer and different levels of phosphorus and their combinations on yield components of peanut plants .

Treatments		Seed index 100seed weight (g)	Pod yield (kg/fed)	seed yield (kg/fed)	Husk yield (kg/fed)	%shilling
Inoculation	P Levels (kg P_2O_5/fed)					
Without PDB	0 (P_0)	72.23	1260	811.00	449.00	64.38
	15(P_1)	73.83	1335	890.00	445.00	66.69
	30(P_2)	77.87	1400	946.00	454.00	67.58
	45(P_3)	78.83	1330	887.00	443.00	66.69
Mean		75.69	1331.25	883.50	447.75	66.34
With PDB	0 (P_0)	75.47	1299	850.00	449.00	65.44
	15(P_1)	79.03	1575	1054.00	521.00	66.93
	30(P_2)	93.90	1610	1098.00	512.00	68.22
	45(P_3)	79.73	1550	1035.00	515.00	66.78
mean		82.03	1508.50	1009.25	499.25	66.84
Average	P0	73.85	1279.50	830.50	449.00	64.91
	P1	76.43	1455.00	972.00	483.00	66.81
	P2	85.89	1505.00	1022.00	483.00	67.90
	P3	79.28	1440.00	961.00	479.00	66.74
mean		78.86	1419.88	946.38	473.50	66.59
L. S. D at 5%						
P		2.45	5.97	14.67	n.s	1.79
Inoculation		1.75	4.22	10.39	22.8	n.s
Interaction effect: P x Inoculation		2.92	6.33	15.66	n.s	n.s

- PDB: Phosphate Dissolving Bacteria

Effect of (PDB) on yield and its components:

Soil micro-organisms known as phosphate solubilizing bacteria (PSB), which if found in the root zone, it play a fundamental role in converting the fixed form to be soluble and ready for plant uptake. Concerning the effect of biofertilizer inoculation data in Table (2) show that the inoculation of peanut seeds with phosphate dissolving bacteria (PDB) gave a significant increment in the yield and its characters compared with untreated seeds and were found to be 4.48, 3.09 and 4.8 for weight of 100seed (g), pod yield (kg/fed.) and seed yield (kg/fed.) respectively, while the shilling percentage was insignificant and these results also agree with Azzam Omran(2005) on sunflower., Ewais-Magda *et al.*, (2003) on rice, and Ahmed *et al.*, (2002)on-soybean .

Effect of interaction between phosphorus and (PDB) on yield and its components:

The interaction between the phosphorus levels and the biofertilizer effect was significant as it weights were appears in data in Table (2) that had enhanced in weight of 100seed, pods yield, seed yield of peanut plants. Accumulated weights were more in ascending order as the increase in P level and the best values were at 30kg P_2O_5 combined with PDB inoculation. The percentage of increase in weight of 100seed, yield pods, seed yield percentages were 30, 27.8, 35.4 and 14 respectively. Similar results were obtained by Shaban and Manal (2009)on corn, Sarg, Sawsan(2004) on sugar pea, Ahmed *et al.*, (2002) on soybean and Hamissa *et al*,(2000) who found that yield was significantly increased with the combination of 30kgP_2O_5/fed. and inoculation with biophosphatic of faba been plants. While the husk yield and the percentage of shilling were insignificant increment obtained.

2-Mineral phosphorus on seed Protein and Oil contents:

Protein and oil percentage and yield (kg/fed.) as affected by different levels of phosphorus are shown in Table (3). Data cleared that phosphorus applications significantly responded increasing of the two studied parameters in comparison with unfertilized treatment. The percentages of increase were 59.6, 86, 5.9 and 23.5 for protein and oil percentage and yield (kg/fed.) respectively. Applying phosphorus helped plants to absorb more nitrogen to keep the balance between nitrogen and phosphorus within the plant, increased photosynthesis, reduced respiration and the activity of succinate dehydrogenase and increased the activity of nitrogenase and nitrate reductase and the accumulation of amino acids and protein in seeds. Phosphorus is one important in plant bioenergetics. As a component of ATP, phosphorus is needed for the conversion of light energy to chemical energy (ATP) during photosynthesis. Phosphorus can also be used to modify the activity of various enzymes by phosphorylation, and can be used for cell signaling. Since ATP can be used for the biosynthesis. Similar results were obtained by Nassar *et al* (2005) on faba bean. ; El Hamzawi-Dalia (2001) on peanut, Abd El-Lateef *et al.*, (1998) on soybean, Patel and Thakur(1997) on havlm and seeds of groundnuts.

Effect of (PDB) on seed Protein and Oil contents:

Results in Table (3) show also that the inoculated treatment has increasing effect in percentage of protein and oil and its yield (kg/fed.) as compared with untreament plots.

The treatment of biofertilizer produced an increase in percentage of protein and oil and its yield (kg/fed.) as shown in Table (3) over the control. The increase of protein content under the inoculation conditions could also be triggered by hormones which presented with the inoculation conditions and it is tentatively predicated that such protein might represent phytohermone receptors (Davies, 1995) phytohermones have been implicated in the regulation of several enzymes and the metabolic change occurring in the early stages of germination are the results of the activity of various enzymes (Kumar *et al.,* 1987). Similar results were obtained by Nassar *et al.,* (2004) on lentil and Ewais-Magda *et al.,* (2003) on rice

Table (3): Effect of biofertilizer and different levels of phosphorus and their combinations on protein and oil of peanut seed.

Treatments		Protein %	Protein (kg/fed)	Oil %	Oil (kg/fed)
Inoculation	P Levels (kg P_2O_5/fed)				
Without PDB	0 (P_0)	19.58	158.86	43.44	352.30
	15(P_1)	21.88	194.67	44.44	395.57
	30(P_2)	31.25	295.54	46.00	435.14
	45(P_3)	25.63	227.31	45.45	403.10
mean		24.58	219.10	44.83	396.53
With PDB	0 (P_0)	22.08	187.77	45.55	387.20
	15(P_1)	24.79	261.24	46.47	489.79
	30(P_2)	36.25	397.98	49.49	543.38
	45(P_3)	26.67	276.13	46.50	481.24
mean		27.45	280.78	47.00	475.40
Average		20.83	173.31	44.50	369.75
		23.33	227.96	45.46	442.68
		33.75	346.76	47.75	489.26
		26.15	251.72	45.98	442.17
mean		26.02	249.94	45.92	435.97
L. S. D at 5%					
P		2.24	13.12	1.27	13.0
Inoculation		n.s	9.27	0.903	9.19
Interaction effect: P x Inoculation		n.s	15.23	n.s	16.45

Effect of interaction between phosphorus and (PDB) on seed Protein and Oil contents

Concerning the effects of P levels and biofertilizer inoculation on peanuts seed data on Table (3) show that both of two factors had significant and positive effect on protein and oil yield since the percentage insignificant. Similar results were obtained by Shaban and Manal (2009) on corn. ; Azzam and Omran (2005) on sunflower and Ahmed *et al* (2002) on soybean

3- Effect of phosphorus on N, P and K contents:

With respect to phosphate rates results in Table (4) showed that the increases of N, P and K content of peanut seeds were in a harmony with increasing rates of phosphorus fertilizer under study, so application of phosphorus at rate 30Kg/fed recorded the highest values compared with control. These percentage of increment were 59.7,86,42,66,5.3,22.9 respectively. Similar finding for increase NPK concentration and uptake by peanut seeds due to P-application were obtained by Nassar *et al.;* (2005)on faba bean, Ewais-Magda *et al.*, (2003) on rice El Hamzawi-Dalia (2001) on groundnut (Bhatol *et al.* 1994),

Effect of(PDB) on N, P and K contents:

Data in Table (4) further show that inoculation with biofertilizer increased macronutrients contents of peanut seed than the control. These may be due to increasing growth as results of improvement the media of the root zone. These results are agreement with those obtained by Magda *et al.*, (2003) on rice, and Heggo and Barakha (1993) reported that maize inoculated with phosphate dissolving bacteria increased plant growth, N, P and K contents.

Effect of interaction between phosphorus and (PDB) on N, P and K contents:

Concerning the effect of P levels and biofertilizer in inoculation on N,P and K concentration and uptake by peanut seeds, data in Table (4) indicate that both factor on macronutrient gave an increase related to the treatment of superphosphate and P-dissolving bacteria and the highest values were with 30kg P_2O_5/fed and inoculation. These result agreement with those obtained by Shaban and Manal (2009) on corn. These may be due to increasing soil microorganism have enormous potential in providing soil phosphates for plant growth. Phosphorus biofertilizer increased the availability of accumulated phosphates for plant growth by solubilization (Gyaneshwar *et al.* 1998). In addition, the microorganisms involved in P solubilization as well as better scavenging of soluble P can enhanced plant growth by increasing the efficiency of biological nitrogen fixation, enhancing the availability of other trace elements and by production of plant growth promoting substances (Gyaneshwar *et al.* 1998). Also, the increase in element uptake was mainly related to the enhancing effect of phosphate fertilization on yield components. The promoting effect of phosphorus on mineral composition of peanut may be due to the fundamental role of phosphorus in the synthesis of nucleo protein and lare of enzymatic. (Marschner,1998).

Table (4): Effect of PDB and different levels of phosphorus and their combinations on macronutrients content of peanut seed.

Treatments							
Inoculation	P levels	N %	N mg/kg	P %	P mg/kg	K %	K mg/kg
Without PDB	0 (P_0)	3.13	25.42	0.59	4.78	0.76	6.16
	15(p_1)	3.50	31.15	0.63	5.58	0.77	6.82
	30(P_2)	5.00	47.29	0.84	7.94	0.80	7.57
	45(P_3)	4.10	36.37	0.81	7.19	0.78	6.92
mean		3.93	35.06	0.72	6.37	0.78	6.87
With PDB	0 (P_0)	3.53	30.04	0.80	6.80	0.78	6.63
	15(P_1)	3.97	41.80	0.88	9.28	0.79	8.33
	30(P_2)	5.80	63.68	1.05	11.52	0.85	9.33
	45(P_3)	4.27	44.18	0.98	10.15	0.82	8.49
mean		4.39	44.92	0.93	9.44	0.81	8.19
Average	P0	3.33	27.73	0.70	5.79	0.77	6.40
	P1	3.73	36.47	0.75	7.43	0.78	7.57
	P2	5.40	55.48	0.95	9.73	0.83	8.45
	P3	4.18	40.28	0.90	8.67	0.80	7.70
mean		4.16	39.99	0.82	7.90	0.79	7.53
L. S. D at 5%							
P		0.217	2.10	0.07	0.82	0.0217	0.24
Inoculation		0.150	1.49	0.055	0.58	0.015	0.17
Interaction effect: P x Inoculation		0.253	25	n.s	n.s	n.s	0.29

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تأثير التسميد الفوسفاتى و الحيوى على محصول الفول السودانى

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الملخص العربي

اقيمت تجربتان حقليتان فى محطة بحوث الاسماعلية خلال موسمى الزراعة ٢٠٠٧/٢٠٠٨ وذلك لدراسة تأثيرالتسميد الفوسفاتى (صفر-١٥-٣٠-٤٥ كجم فو٢ا٥ /فدان) على صورة سوبر فوسفات سواء بمفرده او مع البكتيريا المذيبة للفوسفور على محصول الفول السودانى ومكوناتة المحصولية وبعض المواد البيوكميائية .

وقد اظهرت النتائج مايلى:

١- ادت اضافة سماد السوبر فوسفات عند ٣٠ كجم فو٢ا٥/فدان الى زيادة فى وزن ١٠٠ بذرة، وزن القرون ، وزن البذور ، نسبة التصافى والمحتوى من البروتين، الزيت ، النيتروجين والفوسفور والبوتاسيوم مقارنة بالكنترول .

٢- أظهرت النتائج ان تلقيح البذور بالبكتيريا المذيبة للفوسفور تفوقا فى المحصول بالمقارنة بالغير معاملة .

٣- ادى التفاعل بين السماد الفوسفاتى والتسميد الحيوى الحصول على تأثير مفيد وايجابى على اغلب الصفات المدروسة وقد ظهرت افضل النتائج عند اضافة ٣٠كجم فو٢ا٥/فدان مع البكتيريا المذيبة للفوسفور .