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RESPONSE OF SOME PEANUT CULTIVARS TO BIO- AND ORGANO-MINERAL FERTILIZATION

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ABSTRACT: A field experiment was carried out during 2001 growth season at the Experimental Farm of the Faculty of Agriculture, Suez Canal University. The objective of the present work is to evaluate the effect of the individual or the combined bio- (rhizobium and phosphate solubilizing bacteria, PSB), organic (composted town refuse, CTR) and mineral fertilization on the productivity, seeds N, P, protein, and oil contents of three peanut (*Arachis hypogaea* L., cv) cultivars (Gregory, NC9 and Early Punch "Giza 5") grown on a sandy soil. Peanut seeds were treated with liquid medium of rhizobium while phosphate solubilizing bacteria (*Pseudomonas spp.*) inoculate as a liquid medium were added with irrigation water. Soil was treated with the CTR and superphosphate (15.5% P_2O_5) at rates of 20 t ha^{-1} and 37.5 kg ha^{-1}, respectively. Nitrogen as NH_4NO_3 (33.5% N) and potassium as K_2SO_4 (48% K_2O) were added to the soil at rates of 20 and 30 kg ha^{-1}, respectively.

The highest root and straw dry weights, pod, seed and biological yields, 100-pods and -seeds weights mean values were obtained when peanut plants inoculated with combined rhizobium and PSB comparing with the individual bacterial inoculation. The combined or the Individual rhizobium and PSB inoculants and the addition of CTR showed more nodules numbers and weight than the individual mineral fertilization.

Bio- and organo-mineral fertilization treatments were more effective in increasing N, P, protein and oil seed contents comparing with the individual mineral fertilization. Gregory peanut cultivar significantly surpassed NC9 and Early Punch cultivars regarding to

the effect of the individual mineral and combined bio-mineral or organo- mineral fertilization.

Key Words: sandy soil, peanut cultivars, composted town refuse, Rhizobium, phosphate-solubilizing bacteria.

INTRODUCTION

Peanut (*Arachis hypogaea* L., cv) is important oil crop in Egypt. In fact, this crop is grown in Egypt not only for oil production but also for fresh human consumption or exportation because of its high protein content (Gabr, 1998). Legumes (i.e. peanut) can obtain much of their N-requirement through symbiotic-N fixation by effective rhizobial strains. In Egypt, multi-strains inoculants are produced to provide compensatory mechanisms to meet the constraints imposed by the host-strain-environment interactions (Abdel-Aziz, 2001).

Richardson (1994) signaled two strategies to improve the efficiency of P fertilizer utilization: (1) management of existing populations of soil microorganisms to optimize their capacity for P transformation and to synchronize their nutrient mobilization activity with that of plant requirements, and (2) the introduction of a specific inoculant to enhance either the supply and availability of soil P or the uptake of P by plant roots. However, the success of an introduced microorganism for phosphate solubilization has been related to both its capacity to readily colonize plant roots (Salih et al. 1989) and the activity of the phosphate-solubilizing microbial population already present in soil (Kucey et al. 1989). Moreover, fertilizer applications to soil also affect the activities of diverse groups of soil microorganisms, directly by supplying nutrients and indirectly through greater carbon availability from root exudates resulting from increased plant growth (Sarathchandra et al. 1993).

Several P-solubilizing microorganisms, are able to solubilize unavailable soil P and increase the yield of crops (Richardson, 1994). Moreover, some strains of rhizobia are phosphate solubilizing bacteria (PSB) and like other plant growth promoting rhizobacteria they can colonize the roots and increase the yield of nonlegume crops (Höflich *et al.*, 1995; Chabot *et al.*, 1996a,b). A major barrier to the successful agronomic use of bacterial inocula is the need to establish high population densities of the introduced bacterium in the root environment (Kloepper *et al.*, 1989).

The objective of the present work is to evaluate the effect of Rhizobium, phosphate solubilizing bacteria and composted town refuse on the productivity and seeds N and P contents of three peanut (*Arachis hypogaea* L., cv) cultivars (Gregory, NC9 and Early Punch) grown on a sandy soil.

MATERIALS AND METHODS

A field experiment was carried out during 2001 growth season at the Experimental Farm of the Faculty of Agriculture, Suez Canal University. The present work is carried out to evaluate the effect of Rhizobium, phosphate solubilizing bacteria (PSB) and composted town refuse (CTR) on the productivity, seeds N, P, protein and oil contents of three peanut (*Arachis hypogaea* L., cv) cultivars (Gregory, NC9 and Early Punch "Giza 5") grown on a sandy soil. Tables (1 and 2) show some characteristics of soil and composted town refuse used in the study.

Soil was treated with composted town refuse and superphosphate (15.5% P_2O_5) at rates of 20 t ha^{-1} and 37.5 kg ha^{-1}, respectively, 7 days before sowing. Area of the experimental plot unit was 4m x 5m. The peanut seeds were sown in furrows 30 cm apart and 25 cm spacing within the furrows.

Peanut seeds were treated with liquid medium of rhizobium while phosphate solubilizing bacteria (*Pseudomonas spp.*) inoculate as a liquid medium were added at rate of 1000 ml ha^{-1} to the peanut plants 3 days after germination in irrigation water. Also, 3 days after germination, nitrogen as NH_4NO_3 (33.5% N) and potassium as K_2SO_4 (48% K_2O) were added to the soil at rates of 20 and 30 kg ha^{-1}, respectively. So, the experimental treatments were as follows:

1. NPK (control)
2. NPK + Composted town refuse (CTR)
3. NPK + Rhizobium (R)
4. NPK + phosphate solubilizing bacteria (PSB)
5. NPK + R + PSB

Table (1). Some properties of the used soil.

Chemical properties	
pH (in 1: 2.5 water suspension)	7.30
EC, dSm^{-1}(in saturated paste)	1.2
Total N, %	0.10
Total P, %	0.03
Total K, %	0.11
Organic matter, %	0.35
Physical properties	
Coarse sand, %	52.6
Fine sand, %	31.3
Silt, %	3.5
Clay, %	2.6
Textural class	Sand

Table (2). Some properties of the used-composted town refuse.

Parameter	Values
pH (in 1: 2.5 water suspension)	7.90
EC, dSm^{-1}(in saturated paste)	4.70
Total N, %	0.96
Total P, %	0.65
Total K, %	0.81
Organic matter, %	22.9

At the end of filling pods stage, root samples were taken to determine nodule numbers and weights. Root samples were collected from 0-40 cm depth and washed from soil particles on 1 mm sieve within 24 h. Living roots were separated from dead roots and debris by hand. Nodules were carefully removed and freshly weighed. At full maturity, peanut shoots, pods and seeds were taken for measurements of yield. Plant samples were oven dried at 70 °C, ground, digested and analyzed for N (as well as seed protein content) and P seed contents according to Chapman and Pratt (1961). Seed oil content was determined by using Soxhlet apparatus according to AOAC (1975). Soil and composted town refuse samples were prepared and analyzed according to Page *et al.* (1982). Split-plot design with three replicates was used and Plabstat version 2D computer program was used for statistical analysis.

RESULTS AND DISCUSSION

Results obtained on the effect of mineral, bio- and organic-mineral fertilization on root and straw dry weights and pod, seed and biological yields of three peanut cultivars grown on a sandy soil are presented in Table (3). There are highly significant differences between the different fertilization treatments and peanut cultivars. It is clearly shown that peanut plants were highly responded to the combined organic-mineral fertilization or bio-mineral fertilization treatments comparing with the individual application of mineral fertilization treatment. The highest root and straw dry weights and pod, seed and biological yields mean values were obtained for peanut plants inoculated with combined rhizobium and phosphate solubilizing bacteria (PSB) comparing with the individual bacterial inoculation. Root and straw dry weights and pod, seed and biological yields were much higher for peanut inoculated with rhizobium comparing with PSB inoculation. Also, root and straw dry weights and pod, seed and biological yields were higher for soil treated with CTR comparing with PSB inoculation. Gregory peanut cultivar significantly surpassed NC9 and Early Punch cultivars regarding to the effect of the individual mineral and combined bio-mineral or organo-mineral fertilization.

Similar trends were found in 100-pods and -seeds weights of peanut (Table, 4) as previously mentioned for the effect of mineral, bio-mineral and organic-mineral fertilization on growth yield characters (Table, 3). The highest 100-pods and -seeds weights were recorded in peanut plant treated with combined rhizobium, PSB and mineral fertilizers. Also, Gregory soybean cultivar gave the highest 100-pods and -seeds weights comparing with NC9 and Early Punch cultivars.

The same finding was obtained by Mabrouk and Zayed, (2001), since they found that the application of organic fertilizers (farmyard manure and composted

Table (3). Effect of rhizobium (R), phosphate solubilizing bacteria (PSB) and composted town refuse (CTR) on root, straw and pods weights and seed and biological yields of three peanut cultivars.

Treatments	Cultivars: Gregory	NC9	Early punch	Mean
	Root dry weight, kg ha^{-1}			
NPK	180	174	169	174.3
" + CTR	270	285	248	258.7
" + R	285	283	270	279.3
" + PSB	215	202	195	204.0
" + R + PSB	303	295	278	292.0
Mean	250.6	242.4	232.0	241.7
	Straw dry weight, kg ha^{-1}			
NPK	5643	5839	5629	5703.7
" + CTR	9520	9441	9110	9357.0
" + R	9980	9823	5986	9796.3
" + PSB	9602	7079	6697	7792.9
" + R + PSB	10257	10201	9502	9986.7
Mean	9000.4	8476.6	8104.9	8527.3
	Pods yield, kg ha^{-1}			
NPK	3647	3488	3276	3470.3
" + CTR	4851	4023	3973	4282.3
" + R	5211	5029	4689	4976.3
" + PSB	4168	3713	3594	3825.0
" + R + PSB	5732	5297	5089	5372.7
Mean	4721.8	4310.0	4124.2	4385.3
	Seed yield, kg ha^{-1}			
NPK	2572	2313	2211	2365.3
" + CTR	3497	2868	2757	3040.7
" + R	3628	3467	3140	3411.7
" + PSB	2956	2664	2535	2718.3
" + R + PSB	3894	3682	3404	3660.0
Mean	3309.4	2998.8	2809.4	3039.2
	Biological yield, kg ha^{-1}			
NPK	9666	9308	9071	9348.3
" + CTR	14562	13801	13334	13899.0
" + R	15319	15292	14545	15052.0
" + PSB	11462	10817	10490	10923.0
" + R + PSB	16236	15849	14869	15651.3
Mean	13449.0	13013.4	12461.8	12974.7

$LSD_{0.05}$ for:	Treatment	Cultivar	Treatment X cultivar
Root dry weight	0.72	0.94	2.14
Straw dry weight	11.56	6.97	8.53
Pods yield	3.79	5.90	8.91
Seed yield	5.36	4.72	5.07
Biological yield	8.82	10.03	12.53

sewage sludge) to the soil and/or addition of rhizobium inoculate with irrigation water resulted in increasing straw, pods and seed yield of peanut. Also, Badawi and El-Moursy (1997) found that seeds inoculation with rhizobium improved the growth characters and significantly increased the yield and its components of peanut. They found that rhizobium inoculation and phosphorus fertilization effects were obvious on the increasing of 100-pods and-seeds weights of peanut. The fact that increasing the yield of crops by using P-solubilizing bacteria, that able to solubilize unavailable soil P, were reported by many workers (Richardson, 1994; Höflich *et al.*, 1995; Chabot *et al.*, 1996a,b).

Nodules fresh weight and numbers of peanut cultivars as affected by mineral-, organic- and bio-fertilization are shown in Table (5). The combined or the Individual rhizobium and PSB inoculations and the addition of CTR showed more nodules numbers and weight than the individual mineral fertilization. Peanut plants treated with bacterial inoculates usually give high nodule numbers and weights as compared with CTR one. There are highly significant differences between the three peanut cultivars under the different fertilization treatments. Nodules fresh weights and numbers mean values were 7.97, 7.20 and 6.74 g/plant and 196, 179 and 167 nodules/plant for Gregory, NC9 and Early punch, respectively.

Inoculation of rhizobium and PSB stimulated the total population of bacteria in the rhizosphere. The extent of their effect varied in all treatments due to the type of fertilization. The beneficial effect of microbial inoculants of rhizobia reported by many workers (Dessale and Konde, 1984; Gaur and Alagawadi, 1987; Martensson and Witter, 1992; Richardson, 1994) have extensively documented PSB on nodule formation.

Data on the effect of mineral, bio-mineral and organic-mineral fertilization on N, P, protein and oil seed contents are presented in Table (6). The type of fertilization was significantly influenced seed N as well as seed protein content, since bio- mineral and organic- mineral fertilization treatments were more effective in increasing N, P, protein and oil seed contents comparing with the individual mineral fertilization.

Table (4). Effect of rhizobium (R), phosphate solubilizing bacteria (PSB) and composted town refuse (CTR) on 100-pods and -seeds of three peanut cultivars.

Treatments	Cultivars			Mean
	Gregory	NC9	Early punch	
		100-pods weight, g		
NPK	111.5	107.8	105.6	108.3
" + CTR	126.3	124.8	122.2	124.4
" + R	136.2	132.8	129.5	132.8
" + PSB	121.5	119.8	116.2	119.2
" + R + PSB	138.8	137.2	132.4	136.1
Mean	126.9	124.5	121.2	124.2
		100-seeds weight, g		
NPK	76.9	75.2	73.2	75.1
" + CTR	88.9	88.0	85.4	87.4
" + R	95.8	92.1	90.5	92.8
" + PSB	85.6	83.8	80.3	83.2
" + R + PSB	97.0	95.9	92.5	95.1
Mean	88.8	87.0	84.4	86.7

$LSD_{0.05}$ for:	Treatment	Cultivar	Treatment X cultivar
100-pods weight	1.64	1.98	NS
100-seeds weight	0.99	0.32	NS

Table (5). Effect of rhizobium (R), phosphate solubilizing bacteria (PSB) and composted town refuse (CTR) on nodules numbers and fresh weight of three peanut cultivars.

Treatments	Cultivars			Mean
	Gregory	NC9	Early punch	
		Nodules fresh weight, g/plant		
NPK	6.20	5.68	5.28	5.72
" + CTR	7.11	6.36	6.15	6.54
" + R	8.80	8.28	7.48	8.19
" + PSB	8.39	6.88	6.63	7.30
" + R + PSB	9.33	8.78	8.17	8.76
Mean	7.97	7.20	6.74	7.30
		Nodules numbers/plant		
NPK	155	140	130	141.7
" + CTR	175	160	150	161.7
" + R	210	205	185	200.0
" + PSB	210	170	165	181.7
" + R + PSB	230	220	205	218.3
Mean	196	179	167	180.7

$LSD_{0.05}$ for:	Treatment	Cultivar	Treatment X cultivar
Nodules fresh weight	0.062	0.091	0.176
Nodules numbers	1.50	2.97	1.34

Table (6). Effect of rhizobium (R), phosphate solubilizing bacteria (PSB) and composted town refuse (CTR) on seed N, P, protein and oil contents of three peanut cultivars.

Treatments	Cultivars			Mean
	Gregory	NC9	Early punch	
		N, %		
NPK	2.35	2.12	2.02	2.16
" + CTR	2.71	2.44	2.32	2.49
" + R	3.32	3.17	2.87	3.12
" + PSB	3.20	2.63	2.52	2.78
" + R + PSB	3.56	3.37	3.12	3.35
Mean	3.03	2.75	2.57	2.78
		P, %		
NPK	0.280	0.252	0.241	0.258
" + CTR	0.381	0.312	0.302	0.332
" + R	0.322	0.290	0.267	0.296
" + PSB	0.395	0.378	0.342	0.372
" + R + PSB	0.424	0.401	0.370	0.398
Mean	0..360	0.327	0.306	0.331
		Protein, %		
NPK	14.7	13.3	12.6	13.5
" + CTR	16.9	15.3	14.5	15.6
" + R	20.8	19.8	17.9	19.5
" + PSB	20.0	16.4	15.8	17.4
" + R + PSB	22.3	21.1	19.5	21.0
Mean	18.9	17.2	16.1	17.4
		Oil, %		
NPK	39.6	35.6	34.0	36.4
" + CTR	55.9	53.4	48.4	52.5
' + R	53.8	44.2	42.5	46.8
" + PSB	45.5	41.0	39.0	41.9
" + R + PSB	60.0	56.7	52.4	56.4
Mean	51.0	46.2	43.3	46.8

$LSD_{0.05}$ for:	Treatment	Cultivar	Treatment X cultivar
N	0.09	0.08	0.09
P	0.001	0.001	0.003
Protein	0.31	0.11	0.26
Oil	0.39	0.45	0.51

Peanut plants treated with combined and individual rhizobium and PSB inoculants give higher seed N and protein contents than uninoculated treatments. However, peanut plants received combined PSB and rhizobium and individual PSB inoculants were usually had higher seed P content as compared with those treated with CTR or received individual rhizobium inoculant. Combined rhizobium and PSB inoculants or CTR were more effective in increasing oil seed content as compared with the individual inoculant. Generally, Gregory peanut cultivar was more responded to different fertilization treatments than NC9 and Early Punch cultivars. The increase in N, protein, P and oil seed contents may be attributed to the fact that, the inoculation of soil or seeds give higher number of bacterial nodules, which fix more N_2 and led to the increase in photosynthetic assimilation and hence increases the dry matter accumulation as well as increases growth characters.

These results are in agreement with those obtained by Badawi and El-Moursy (1997) and Ahmed et al., (1997), since they found that the highest dry matter accumulation, seed yield, seed oil and protein contents were achieved due to combined mineral-bio-organic fertilization. Seed or soil inoculation with PSB was found to improve dry weight and nutrient content of various crops. The favorable effect was due to the improved p nutrition by solubilization of insoluble P and the production of growth promoting substances by PSB (Khalafallah et al., 1982).

It could be concluded that rhizobia and phosphate solubilizing bacterial inoculants play an important role in plant nutrition through the increase in N and P uptake by peanut plant, and their use as an important contribution to bio-fertilization of agricultural crops.

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استجابة بعض أصناف الفول السودانى للتسميد الحيوى- المعدنى والتسميد العضوى - المعدنى

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أجريت تجربة حقلية خلال موسم ٢٠٠١ فى المزرعة التجريبية لجامعة قناة السويس ، لمحاولة تقييم استجابة ثلاثة أصناف من الفول السودانى (جريجورى - إن سى ٩ - إيرلى بانش) للتلقيح بالريزوبيم والبكتيريا المذيبة للفوسفات والتسميد العضوى (مكمورة مخلفات المدن) والتسميد المعدنى. وفى هذه الدراسة تم استخدام المعاملات التالية:

١- تسميد معدنى
٢- تسميد معدنى + تسميد عضوى
٣- تسميد معدنى + تلقيح بالريزبيوم
٤- تسيمد معدنى + تلقيح بالبكتيريا المذيبة للفوسفات
٥- تسميد معدنى + تلقيح بالريزبيوم + تلقيح بالبكتيريا المذيبة للفوسفات

وقد تم الحصول على النتائج التالية:

١- زاد وزن كل من الجذور والقش ومحصول القرون والبذور والمحصول البيولوجى ووزن ١٠٠ قرن ووزن ١٠٠ بذرة ووزن وعدد العقد الجذرية ومحتوى البذور من النتروجين والفوسفور والبروتين والزيت باستخدام كل من التسميد الحيوى أو العضوى مع التسميد المعدنى بالمقارنة باستخدام التسميد المعدنى منفردا.
٢- تم الحصول على أعلى قيم لوزن الجذور والقش ومحصول القرون والبذور والمحصول البيولوجى ووزن ١٠٠ قرن ووزن ١٠٠ بذرة ووزن وعدد العقد الجذرية ومحتوى البذور من النتروجين والفوسفور والبروتين والزيت باستخدام معاملة "التسميد المعدنى + تلقيح بالريزبيوم + تلقيح بالبكتيريا المذيبة للفوسفات"
٣- أعطى للصنف "جريجورى" أعلى استجابة لمعاملات التسميد تحت الدراسة يليه صنف "إن سى ٩" ثم صنف "إيرلى بانش".