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Enhancement of Groundnut Productivity by Inoculation with *Bradyrhizobium* and Rizobacteria under Different Levels of Compost in Sandy Soils

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TWO FIELD experiments were conducted at the Agricultural Research Farm of the Higher Institute for Agriculture Co-operation during the two successive seasons of 2008 and 2009. These experiments aimed to study the effect of inoculation with *Bradyrhizobium* spp. either alone or in combination with (*Pseudomonas fluorescens*) on yield and some yield components under different levels of compost using drip irrigation system.

Results showed that plants inoculated with *Bradyrhizobium* spp. only or in combination with rhizobacteria exhibited significant increases in pod yield and some yield components as compared with the uninoculated plants.

The response of groundnut, yield and yield components to elevating the organic fertilizer rate was positively significant, higher rate of compost 15-ton/fed (1hectare= 2.4 feddan) showed higher values of all tested traits in both seasons.

Spraying groundnut plants with humex increased significantly all tested traits compared with those without humex in both seasons.

The effect of the first and second orders interactions on yield and yield components were significant.

Keywords: Groundnut, *Bradyrhizobium,* Rhizobacteria, Compost, Sandy soil.

Peanut (*Arachis hypogaea* L.) is considered to be one of the most important source of edible oil crop in the world. The seeds characterized with high nutritive value for humans. Groundnut seeds contain high oil content (50%), which is utilized in different industries, in addition to 26-28% protein, 20% carbohydrates and 5% fiber (Fageria *et al*., 1997). Groundnut like other legumes forms symbiosis relationship with rhizobia.

Symbiotic nitrogen fixation by legumes plays an important role in sustaining crop productivity and maintaining the fertility of the semi-arid lands (Desoky *et al.,* 2011).

Egyptian soils are very poor in organic matter content, which does not exceed 2% and often less than 1%, due to arid climate and dominancy of basic soil conditions. Moreover, the sustainable supply of organic matter to soils is very essential, particularly under the intensive cropping system of Egyptian agriculture.

Over the last few years, a diverse array of beneficial rhizobacteria has been shown to promote plant growth. The mechanism by which these rhizobacteria enhance plant growth is not clear, but it is postulated that they may: (a) produce of secondary metabolites such as antibiotics, cyanide and hormonelike substances, (b) produce of siderophores, (c) fix dinitrogen (d) increase phosphate solubilization, (e) enhance mineral uptake and/or (f) antagonistic to soil borne root pathogens (Vargas *et al*., 2009).

Enhancement of nodulation and biological nitrogen fixation of legumes by co-inoculation with plant growth promoting (PGP) microorganisms are becoming a practical way to improve nitrogen availability in sustainable agricultural production system (Bai *et al.,* 2002 and Abdel-Wahab *et al.,* 2008).

The present work aimed to study the effect of co-inoclation with *Bradyrhizobium* and rhizobacteria." *Pseudomonas"* under different levels of compost on yield and some yield components of groundnut in sandy soil.

Materials and Methods

The present work was conducted to investigate the effect of biofertilizations on groundnut productivity under deferent levels of compost in sandy soil.

Materials

Groundnut seeds

Groundnut seeds variety (Ismaeilia 1) were kindly provided from the Field Crops Research Institute, Agricultural Research Center (ARC), Giza, Egypt.

Organic fertilizer

Compost : Compost was used as a source of organic materials . It was obtained from Moshtohor Factorty in Qaluobeia Governorate , its main chemical and biological traits are shown in Table 1. Compost was applied at the following two levels, *i.e.* 8 and 15 ton/feddan.

Canda Humex: Canda humex is an extract from humic, fulvic and active humein, applied at a rate of 2L/fed splited into three equal doses applied at 15, 30,45 days from sowing as a foliar application.

TABLE 1. Chemical analysis of the compost used during 2008 and 2009 seasons.

Characterization	Seasons	
	2008	2009
pH	7.71	7.62
E.C(ds/m)	4.68	3.81
Organic-C (%)	20.18	19.89
Total-N (%)	1.31	1.26
C/N ratio	15.40	15.78
Organic matter %	34.71	34.21
Total –P%	0.78	0.59
Total –K %	1.75	1.68
Total Soluble-N (ppm)	143.70	132.8
Available- P (ppm)	163.80	146.7
Available-K (ppm)	574.80	518.6
Dehydrogenase activity (µg TPF/g)	90.81	90.81
Seed germination index for cress at 48 hr	114.6	108.7

Bacterial inocula

Bradyrhizobium sp. (strain USDA 3456) and *Pseudomonas fluorescens* (strain IFO 2034) were kindly obtained from the Biofertilizers Production Unit, Agric. Microbiol. Dept., Soils, Water and Environ. Res. Inst. (SWERI), ARC,Giza, Egypt.

Bradyrhizobium was cultured in a yeast extract mannitol broth medium (Vincent, 1970) and *Pseudomons* was grown in king's medium B (Atlas, 1995). Cultures were incubated at 28^{o}C for three days on a rotary shaker unit. Population density reached to 10^9 cfu/ml culture. Powdered vermiculite supplemented with 10% Irish peat was packed into polyethylene bags (200 g carrier per bag), then sealed and sterilized with gamma irradiation (5.0 x 10 rads). Each bacterial culture (120 ml of log phase growing culture) was injected into a sterilized carrier to satisfy 60% (w/w) of the carrier mixture and mixed thoroughly.

Methods

Field experiments

Two field experiments were conducted under drip irrigation system at the Experimental Station, Agricultural Research Higher Institute for Agriculture Co-operation during the two successive summer seasons of 2008 and 2009. These experiments aimed to study the effect of inoculation with *Bradyrhizobium* spp. either alone or combined with plant growth-promoting rhizobacteria (PGPR) on nodulation, growth, yield and yield components of groundnut under different levels of organic fertilizer (compost and Canda humex) in sandy soil. The physical and chemical properties of the experimental soil are presented in Table 2.

TABLE 2. Physical and chemical properties of soil used in the first and second season .

Property	1st Season		2nd Season	
	15-cm deep	**30-cm deep**	**15-cm deep**	**30-cm deep**
Particle size distribution (%)				
Coarse Sand	11.30	11.14	12.10	11.90
Fine Sand	74.95	76.66	74.30	75.40
Silt	9.75	8.58	8.70	8.50
Clay	4.00	3.62	4.90	4.20
Texture	**Sandy**	**Sandy**	**Sandy**	**Sandy**
Bulck density (g/cm^3)	1.28	1.33	1.30	1.32
$CaCO_3$ (%)	1.84	1.74	1.68	1.62
Water Holding capacity (%)	23.00	24.0	24.20	24.80
pH (soil paste)	7.50	7.65	7.46	7.62
EC (dS/m)	0.24	0.43	0.31	0.52
Soluble cations and anions (meq/L):				
Ca^{++}	0.88	0.72	0.82	0.76
Mg^{++}	0.19	0.45	0.24	0.49
Na^{+}	1.06	2.26	1.16	2.42
K^{+}	0.32	0.71	0.42	0.98
$CO_3^{=}$	---	---	----	----
HCO_3^{-}	1.00	1.10	1.20	1.36
Cl^{-}	0.35	0.70	0.41	0.79
$SO_4^{=}$	1.10	2.34	1.03	2.50
Total soluble- N mg kg^{-1}	15.00	20.0	22.00	26.00
Available –P mg kg^{-1}	3.40	5.0	4.300	6.60
Available –K mg kg^{-1}	88.00	96.0	92.50	98.60
Total –N(N%)	0.024	0.025	0.026	0.027
Organic matter (%)	0.42	0.33	0.40	0.30
*DTPA-extractable. Fe mg kg^{-1}	1.07	1.20	1.22	1.31
Mn mg kg^{-1}	0.55	0.60	0.52	0.66
Zn mg kg^{-1}	0.25	0.20	0.31	0.29
Cu mg kg^{-1}	0.05	0.03	0.05	0.04

* DTPA: Diethylene triamine Penta Aacetic acid

The following treatments were applied

1-Uninoculated plants (control)
2-Inoculation with *Bradyrhizobium* sp.
3-Inoculation with *Bradyrhizobium* sp. and PGPR *(Pseudomonas fluorescens)*.

The above biofertilizer treatments were carried out in presence of two levels of compost, *i.e.,* 8 and 15-ton/feddan applied 15 days before sowing with or without the organic liquid humex.

Groundnut seeds were inoculated with gamma irradiated vermiculite-based inoculant of each bacterium at a rate of 300g/40kg seeds using Arabic gum solution (16%) as addhisive agent.

The experimental design to split-split plot with three replicates. The main plots included compost levels and the organic liquid humex represents the sub plots, whereas biofertilization treatments were assigned to the sub sub plots. Plot area was $10.5m^2$ (1/400 fed).

All plots received the recommended doses from superphosphate (15.5% P_2O_5) at a rate of 200kg/fed and potassium sulfate (48% K_2O) at a rate of 50 kg/fed. Nitrogen fertilizer was applied at a rate of 20 kg N/fed in the form of ammonium sulphate (20.5%N) after 15 days from planting as activator dose.

At harvest, random plant samples of ten guarded plants each was collected from each plot to determine the following traits:

1-Number of pods/plant.
2-Weight of 100- pods (g).
3-Weight of 100 -seeds (g).

The middle three rows of each plot with 3 m^2 area were harvested to determine the following traits:

1- Pod yield (ardab/fed).
2- Shelling percentage (seed weight/pod weight) x100.
***** 1 ardab = 75 kg seeds peanut
* 1 hectare = 2.4 feddan

Methods of analyses

- Soil and compost properties were determined according to Piper (1950) and Page *et al.*(1982).
- Seed crude protein percentage was calculated by N% X 6.25 (A.O.A.C., 1990)
- Oil % was determined according to A.O.A.C. (1990)

Statistical analysis

The obtained data were subjected to the proper Analysis of Variance (ANOVA) and L.S.D. test was used to compare the treatment means according to the procedures outlined by Snedecor & Cochran (1980) using MSTAT computer program.

Results and Discussion

Number of pods, weight of 100- pods and seed index

Number of pods, weight of 100- pods and weight of 100- seeds as affected by co-inoculation with both *Bradeyrhizobium* and rhizobacteria under different levels of compost are presented in Table 3. Results elucidated that, inoculation of peanut plants with *Bradyrhizobium* only or combined with *Pseudomonas* gave significant increases in number of pods 15.31 and 38.94% in the first season, respectively. The corresponding increases in the second season were 16.89 and 23.86%, respectively. However, this co-inoculation were more detectable under sandy soil conditions due to the low nutrient content of that soil. These results are in accordance with those obtained by Gupta *et al.* (2003) and Dey *et al.* (2004) .

TABLE 3. Number of pods, weight of 100-pods and weight of 100-seeds as affected by co-inoculation with *Bradyrhizobium* and *Pseudomonas* under different levels of compost during 2008 and 2009 seasons.

Compost (ton/fed) / Humex treatments / Biofertilization	Number of pods/plant				Mean	Weight of 100 pods (g)				Mean	Weight of 100 seeds (g)				Mean
	8		15			8		15			8		15		
	- humex	+ humex	- humex	+humex		- humex	+humex	-humex	+humex		-humex	+humex	-humex	+humex	
	First season (2008)														
Control	22.33	26.00	27.00	33.33	27.17	156.67	178.80	191.47	216.00	185.73	66.73	72.63	75.50	85.10	74.99
Bradyrhizobium(*Br*)	26.00	30.00	31.67	37.67	31.33	146.00	177.33	195.27	221.93	185.13	72.23	76.67	80.33	88.70	79.48
Br. + *Pseudomonas*	33.00	36.33	38.00	43.67	37.72	162.87	177.07	197.07	226.80	190.95	76.10	80.90	86.43	95.53	84.74
Mean	27.11	30.78	32.00	38.22	32.08	155.18	177.73	194.60	221.58	187.27	71.67	76.73	80.76	89.78	79.74
L.SD at 0.05	C: 4.07	B: 2.61	H: 0.92	C x B x H: 2.25		C: 14.98	B: 4.68	H:3.99	C x B x H: 9.79		C: 0.050	B: 2.04	H: 1.82	C x B x H:4.45	
	Second season (2009)														
Control	29.67	33.00	36.67	39.00	34.08	174.73	190.53	204.30	209.07	194.66	72.40	75.87	84.00	85.07	79.33
Bradyrhizobium(*Br*)	36.00	38.67	42.33	44.67	40.42	186.93	197.30	210.87	218.73	203.46	80.67	83.73	86.23	87.33	84.49
Br. + *Pseudomonas*	39.00	41.00	44.33	47.00	42.83	201.67	206.57	210.37	230.20	212.20	81.87	85.33	89.33	94.63	87.79
Mean	34.89	37.56	41.11	43.56	39.28	187.78	198.13	208.51	219.33	203.44	78.31	81.64	86.52	89.01	83.29
L.SD at 0.05	C: 0.63	B: 1.28	H:1.06	C x B x H: 2.34		C: 5.84	B: 2.37	H: 3.03	C x B x H: 7.41		C: 1.84	B: 1.49	H: 0.85	C x B x H: 2.08	

Regarding the effect of compost, data in Table 3 revealed that applying compost up to 15 ton/fed caused significant increases in number of pods, weight of 100- pods and weight of 100- seeds over the other level of compost (8-ton/fed). These increases were 21.70 and 16.87% in number of pods, 20.2 and 10.89% in weight of 100- pods and 14.92 and 9.74% in 100- seeds weight in the first and second seasons, respectively. The distinct role of the organic materials in improving peanut productivity in sandy soil, might be due to the improving of soil fertility and plant nutritional status that support plant health growth (Abdel-Wahab *et al.,* 2009).

Owing to the effect to humex, data in Table 3 indicated that number of pods, weight of 100- pods and weight of 100- seeds /plant increased with spraying peanut plants by humex. These increases were 16.71 and 6.74% in number of pods, 14.16 and 5.33% in weight of 100 -pods and 9.24 and 3.53% in weight of 100- seed over the non-sprayed plants in the first and second seasons, respectively. These results are in accordance with those of by EL-Ghamry *et al.* (2009) , who found that number of pods/plant and weight of 100- seeds increased along with the application of humic acid.

The interaction effect between inoculation and rates of compost are shown in Table 3. The highest values of number of pods/plant, weight of 100 pods and weight of 100- seeds were due to the treatment received inoculation with mixture strains (*Bradyrhizobium* + *Pseudomonas*) combined with 15-ton compost/fed in both seasons, respectively. The promotive effect of compost might be magnified by presence of rhizobacteria, which enhance nodulation and nitrogen fixation resulting in higher productivity of peanut. The synergistic effect of bio-organic fertilization on legumes productivity in newly reclaimed soils was confirmed by Abdel-Hafez & Abo EL-Soud (2007).

Results in Table 3 revealed that the highest values of number of pods (38.22 and 43.56), weight of 100 pods (221.58 and 219.33) and weight of 100- seeds (89.78 and 89.01) recorded in peanut plants treated with 15-ton compost/fed foliarad with humex. These results are mostly in agreement with those of Saruhan *et al.* (2011). They demonstrated that humic acid compounds may have various biochemical effects either at cell wall, membrane level or in the cytoplasm, including the increases of photosynthesis and respiration rates in plants, enhanced protein synthesis and plant hormone-like activity and consequently enhanced the growth and productivity.

Data in Table 3 also showed that the interaction effect between biofertilizer and foliar application of humex had significant effect on some harvest traits , in both seasons. The highest values number of pods/plant, weight of 100-pods and weight of 100- seeds were achieved with the mixture strains (*Bradyrhizobium* + *Pseudomonas*) combined with humex. In fact, PGPR (*Pseudomonas*) have been shown to greatly improve the productivity and quality of many legumes, when co-inoculated with rhizobia. These results could be attributed to the improvement of the moisture retention and nutrient supply potentials of sandy soils after humic substances application (Sugaya & Sivasamy, 2006). In this concern, Saruhan *et al.* (2011) reported that organic materials (*i.e.,* humic substances) treatments increased the yield and yield components of treated plants.

Furthermore, data in Table 3 showed that the interaction effect between compost, biofertilizer inoculation and foliar application of humex had significant effects on yield and its components. The maximum number of pods/plant (43.67 and 47.00), weight of 100- pods (22.68 and 230.2) and weight of 100-seeds were achieved when peanut plants were fertilized with compost at a rate of 15-ton/fed combined with dual inoculation of rhizobacteria and foliarad with humex. These results could be attributed to the availability of more N_2 fixation due to biofertilizer application, the production of growth regulators substances such as indole acetic acid, gibberellins, pyridoxine and others, which stimulate plant growth and subsequently affect peanut yield and its attributes.

Pods yield and shelling percentage

The effect of inoculation with *Bradyrhizobium* associated with rhizobacteria on pods yield and shelling percentage is given in Table 4. Results showed that irrespective of organic fertilization, the uninoculated plants recorded the lowest values of pods yield (12.18 and 15.08 ardab/fed) and shelling percentages (52.38 and 55.83) in both seasons, respectively. The maximum pods yield (16.97 and 19.96 ardab/fed) and shelling percentage (61.00 and 63.64) were due to the inoculation with *Bradyrhizobium* + *Pseudomonas* followed by inoculation with *Bradyrhizobium,* which recorded pods yield of 14.79 and 17.88% ardab/fed and shelling percentages of 59.28 and 61.46 in both seasons, respectively. This synergistic effect of rhizobacteria on peanut yield are due to their ability to enhance the nodulation development that resulted in various enhances the production of substances like-hormones, siderophores, phosphate solubilization. These led to increase the nutrients uptake through increasing the root perforation. (Dilleep Kumar *et al.,* 2001 and Tilak *et al*., 2005).

Concerning the effect of compost rates, results showed that high compost rates caused significant increases in pods yield and shelling% in both tested seasons. The beneficial effect of such organic amendment incorporated into soil on peanut yield may be due to the regulation of soil temperature, conservation of moisture and improvement in humic content of the soil, which are important factors in increasing the number of microfolora and its activity and hence greater nutrients availability . (Abdel-Wahab *et al.,* 2007 and EL-Kramany *et al*., 2007).

Data in Table 4 indicated that humex foliar spray increased significantly pods yield by 8.83 and 8.95% and shelling by 3.19 and 4.04% over the non-sprayed plants (control) in both seasons, respectively. EL-Ghamry *et al*.(2009) reported that the increment in growth parameters and yield may be due to that humic acid is extremely important component because it constitutes a stable fraction of carbon, thus regulating the carbon cycle and release of nutrients, including nitrogen, phosphorus and sulfur, which reduced the inorganic fertilizer needed for plant growth. Also**,** Shehata & EL-Helaly (2010) showed that humic substances increased the yield of corn , oats, tobacco roots, soyabeans, peanut,clover marigold, pepper, strawberry and snap beans.

TABLE 4. Pod yield and shelling % affected by co-inoculation with *Bradyrhizobium* and *Pseudomonas* under different levels of compost and humex during 2008 and 2009 seasons.

Compost (ton/fed) and humex treatments / Biofertilization	Pod yield ardab/fed				Mean	Shelling %				Mean
	8		15			8		15		
	- humex	+ humex	- humex	+ humex		- humex	+ humex	- humex	+humex	
First season (2008)										
Control	9.17	9.93	14.54	15.07	12.18	46.33	49.53	56.37	57.28	52.38
Bradyrhizobium(Br)	12.23	12.97	16.17	17.80	14.79	54.90	56.53	62.17	63.53	57.03
Br. + Pseudomonas	14.40	16.37	17.53	19.57	16.97	55.30	58.20	64.83	65.67	61.00
Mean	11.93	13.03	16.08	17.48	14.65	52.18	54.75	61.12	62.16	56.80
L.SD at 0.05	C: 0.30	B: 0.56	H: 0.38	C x B x H: 0.94		C: 5.88	B: 1.95	H: 1.69	C x B x H: 4.15	
Second season (2009)										
Control	12.20	13.70	16.17	18.23	15.08	50.07	52.70	59.73	60.83	55.83
Bradyrhizobium(Br)	14.87	16.30	19.27	21.10	17.88	55.57	58.17	64.77	67.33	61.46
Br. + Pseudomonas	17.37	18.00	21.43	23.03	19.96	58.30	60.03	66.27	69.97	63.64
Mean	14.81	16.00	18.96	20.79	17.64	54.64	56.97	63.59	66.04	60.31
L.SD at 0.05 C: 0.62	B: 0.53	H: 0.56	C x B x H: 1.37			C: 1.41	B: 1.24	H: 0.77	C x B x H: 1.89	

The interaction effect between biofertilization treatments and compost levels was significant in both growing seasons (Table 4). The highest values of pods (18.55 and 22.23 ardab/fed) and shelling percentage (65.25 and 68.12) in both seasons were obtained by peanut plants inoculated with *Bradyrhizobium* plus *Pseudomonas* along with 15 ton/fed compost. This synergistic effect of rhizobacteria on peanut yield could be attributed to N_2 fixation and/or production of growth promoting substances such as auxin, gibberillins and cytokinins, which positively affect plant growth. The present results are in harmony with those reported by Abdel Wahab *et al.* (2007) and EL-Sawy *et al.* (2006) who found that co-inoculation with *Bradyrhizobium* and rhizobacteria caused significant increases in yield and yield components of groundnut plants.

The interaction effect between biofertilizer and foliarad with humex had significant effect on pods yield/fed and shelling % in both seasons (Table 4). The highest values of these traits were achieved by peanut plants inoculated with mixture of strains (*Bradyrhizobium* + *Pseudomonas*) combined with humex. These results could be attributed to the improvement of the moisture retention and nutrient supply potentiality of sandy soils after humic substances application (Sugaya & Sivasamy, 2006). In this concern, Saruhan *et al*. (2011) reported that organic materials (*i.e.*, humic substances) treatments increased the yield and yield components.

Meanwhile, the interaction effect between compost rates, biofertilizer inoculation and foliar application of humex had significant effects on pods yield and shelling percentages (Table 4). The maximum values of pods yield (19.57 and 23.03 ardab/fed) and shelling percentages (65.67 and 69.97) were achieved when peanut plants were fertilized with compost at a rate of 15-ton/fed combined with dual inoculation of rhizobacteria and foliar application of humex. These results could be attributed to more N_2 fixation due to biofertilizer application, the production of growth regulators substances such as indol acetic acid, gibberellins, pyridoxine and others, which stimulate plant growth and subsequently affect groundnut yield and its attributes. Similar observations were reported by EL-Ghamry *et al.* (2009).

Protein and oil percentages of groundnut seeds

The effect of inoculation with *Bradyrhizobium* singly or combined with *Pseudomonas* under different levels of compost on protein and oil percentages of peanut seeds is given in Table 5. Results indicated that the highest crude protein content of 25.13 and 25.94% and oil percentages of 47.76 and 48.82 recorded by the plants inoculated with *Badyrhizobium* + *Pseudomonas* followed by those inoculated with *Bradyhirzobium* ,which recorded 23.97 and 24.90% of crude protein and 47.03 and 48.06% of oil in both seasons, respectively. These results are in agreement with those of EL-Sawi *et al.* (2006) and Mekhemar *et al.* (2007) who showed that inoculation with *Bradyhirzobium* increased in biomass, seed and protein yields over the uninoculated control.

TABLE 5. Protein and oil % as affected by co-inoculation with *Bradyrhizobium* and *Pseudomonas* under different levels of compost and humex during 2008 and 2009 seasons.

Compost (ton/fed) and humex treatments / Biofertilization	Seed chemical content (%)									
	Protein				Mean	Oil				Mean
	8		15			8		15		
	- humex	+ humex	- humex	+ humex		- humex	+ humex	- humex	+ humex	
	First Season (2008)									
Control	20.86	21.56	22.22	22.76	21.87	44.07	44.60	44.87	46.40	44.98
Bradyrhizobium(Br.)	23.15	23.67	24.25	24.81	23.97	45.30	46.50	47.80	48.50	47.03
Br. + *Pseudomonas*	24.36	24.59	25.33	25.91	25.13	45.83	47.27	48.47	49.53	47.76
Mean	22.79	23.30	23.93	24.49	23.66	45.07	46.12	47.04	48.14	46.59
L.SD at 0.05	C: 0.28	B: 0.82	H:0.61	C x B x H:1.47		C: 0.58	B: 0.49	H: 0.45	C x B x H: 1.12	
	Second season (2009)									
Control	22.32	22.99	23.39	23.89	23.15	44.57	45.53	46.60	47.63	46.08
Bradyrhizobium(Br)	24.18	24.81	25.06	25.56	24.90	46.17	47.43	48.57	50.07	48.06
Br. + *Pseudomonas*	25.17	25.62	26.23	26.76	25.94	47.27	48.43	49.30	50.27	48.82
Mean	23.89	24.48	24.89	25.40	24.67	46.00	47.13	48.16	49.32	47.65
L.SD at 0.05	C:1.24	B:0.86	H:0.39	C x B x H : 06		C: 0.44	B: 0.34	H: 0.29	C x B x H : 0.71	

Regarding the effect of compost, data in Table 5 revealed that increasing the level of compost up to 15-ton/fed caused significant increases of protein and oil percentages compared to the other level of compost in both seasons. These increases were 5.03 and 4.01% in protein and 4.39 and 4.66% in oil in both seasons, respectively. These results are similar to those obtained by EL-Kramany *et al.* (2007), who found that the addition of high level of compost significantly increased the protein and oil percentages.

Data in Table 5 indicated that peanut seeds protein and oil percentages increased by spraying plants with humex. These increases were 2.31 and 2.26% in protein and 2.32 and 2.44% in oil over the non-sprayed plants in both seasons, respectively. In this concern Ali & Mostafa (2009) found that applying humic acid gave the highest values of pods yield/fed, protein and oil percentages of seeds.

Table 5 shows the effect of the interaction between compost and biofertilization treatments on protein and oil contents of peanut seeds. Results confirmed again the superiority of using 15 ton/fed compost in combination with the mixture of bacterial inoculation treatment. The corresponding higher percentages of seed crude protein were 25.62 and 26.50 and oil (49.00 and 49.78) in both seasons, respectively. These results are in agreement with those obtained by EL-Sawi *et al.* (2006).

Results also revealed that, the interaction effect between compost and humex on protein and oil percentages were significant except for protein percentage in the first season (Table 5). The highest percentages of protein of 24.49 and 25.40 and oil of 48.14 and 49.37 were achieved when peanut plants fertilized with 15 ton compost/fed combined with humex. These results are in accordance with those obtained by Ali & Mostafa (2009) and Saruhan *et al* .(2011) who showed that application of organic materials increased the concentration of crude protein and oil% in seeds.

Data in Table 5 also showed that the combined effect of inoculation and foliar spray with humex on protein and oil percentages. The available results confirmed again the superiority of dual inoculation of *Bradyrhizobium* + *Pseudomonas* along with humax foliar spray, which recorded the highest values of protein percentages (25.42 and 26.18) and oil percentages (48.40 and 49.35) in both seasons, respectively. These results are in agreement with those obtained by Ali & Mostafa (2009) who found that applying humic substances combined with biofertilizer recorded the highest values of protein and oil percentages.

The interaction effect between compost rate, biofertilizer inoculation and foliar application with humex significantly increased protein and oil percentages in both seasons (Table 5). The highest percentages of protein (25.91 and 26.76) and oil (49.53 and 50.27) were obtained by applying 15-ton compost/fed combined with dual inoculation with *Bradyrhizobium* and *Pseudomonas* and foliar spray with humex in the 1st and 2 nd seasons, respectively. The response of protein and oil contents to the tested three factors were not the same.

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تحسين إنتاجية الفول السودانى عن طريق التلقيح *بالبرادى ريزوبيم والريزوبكتيريا* تحت مستويات مختلفة من الكمبوست فى الأراضى الرملية

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أجريت تجربتين حقليتين فى المزرعة البحثية الخاصة باالمعهد العالى للتعاون الزراعى خلال الموسمين الصيفين ٢٠٠٨، ٢٠٠٩ وذلك لدراسة تأثير التلقيح البكتيرى *بالبرادى ريزوبيم* *Bradyrhizobium* إما بصورة منفردة أو بالأشتراك مع البكتريا المشجعة للنمو *سيدوموناس فلوريسنس* *Pseudomonas fluorescens* على حاصل البذور وبعض مكونات الحاصل تحت مستويات مختلفة من الكمبوست تحت نظام الرى بالتنقيط .

- أظهرت نتائج التجارب الحقلية إلى أن النباتات الملقحة *بالبرادى ريزوبيم* فقط او بالاشتراك مع *الريزوباكتيريا* أعطت زيادة معنوية فى محصول القرون وبعض مكونات الحاصل مقارنة بالنباتات غير الملقحة.
- أدى التسميد العضوى (الكمبوست) إلى حدوث زيادة معنوية فى حاصل البذور وبعض مكوناته وعموماً أعطى إستخدام المعدل العالى من السماد العضوى كمبوست (١٥ طن/فدان) أعلى قيم لجميع الصفات تحت الدراسة فى كلا الموسمين.
- أعطى رش نباتات الفول السودانى بمركب الهيومكس (٢ لتر/فدان) اعطى زيادة معنوية فى جميع الصفات تحت الدراسة فى كلا الموسمين.
- أظهر التفاعل بين الكمبوست والرش بالهيومكس وكذلك التفاعل بين التسميد الحيوى والهيومكس إلى حدوث زيادة معنوية فى حاصل البذور وبعض مكوناته، كما كان للتفاعل الثلاثى بين الكمبوست ، التسميد الحيوى والرش بالهيومكس نفس التأثيرات خلال موسمى الزراعة .