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EFFECT OF SOIL AMENDMENTS WITH VARIOUS ORGANIC WASTES WITH MULTI-BIOFERTILIZERS ON PEANUT PLANTS IN SANDY SOIL

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ABSTRACT

A newly cultivated sandy soil was supplemented with composted (rice straw, maize stalks, water hyacinth) or farmyard manure (FYM) in the presence and absence of multi-biofertilizers to evaluate its effect on growth, yield and yield components of peanut plants grown in pot experiment. Counts of phosphate dissolving bacteria, *Azospirillum* spp. and *Pseudomonas* spp. were always higher in the rhizosphere of plants growing in soil treated with various composted plant residues in the presence and absence of biofertilizers as compared to FYM or chemical fertilizer application. The amendment of soil with composted rice straw recorded higher counts of tested microorganisms in peanut rhizosphere as compared to composted water hyacinth or maize stalks under biofertilizers application. The dry weight of different peanut organs and the fresh weight of nodules were increased as a result of organic wastes fertilization alone or in combined with biofertilizers as compared to chemical fertilizer treatment. Significant differences in peanut yield of pods and seeds were obtained between composted rice straw or water hyacinth along with biofertilizers and NPK treatment (control). Generally, the addition of biofertilizers with different organic wastes led to improve the quantity and quality yield of peanut plants as compared to various organic wastes alone or chemical fertilizer application. Concentration of P, Zn, Mn, Fe and Cu in peanut seeds exhibited marked increases over chemical fertilization as a result of biofertlization under different organic wastes application. Peanut seeds contained the greatest percentage of protein and oil when plants were fertilized with composted water hyacinth or rice straw in the presence of biofertilizers.
Keywords: biofertilizers, compost, organic wastes, peanut

INTRODUCTION

Peanut (*Arachis hypogaea* L.) is considered to be one of the most important crops which thrive in the newly reclaimed sandy soils as a leguminous crop of high nutritive value and a source of edible oil. These soil types are poor in organic matter and nutrient elements. Organic matter is a key component of soils affecting their physical, chemical and biological properties and is important as a source of energy and nutrient elements for soil ecosystem. Maintenance of sufficient levels of organic matter in soils is prerequisite for sustainable and high production of crops, Arafat (1994).

Fresh organic matter should not be added directly to soil, however, because the initial degradation process may produce considerable microbial growth with temporary N immobilization. Microorganisms may also immobilize soil nutrients, particularly in soils with residues which have a wide C:N ratio. So, organic residues should be composed to narrow the C:N ratio during humification before being applied to soil as crop amendments. Composting of plant residues with mineral fertilizers results in a product similar in every respect to that obtained from farmyard manure. Sound management of organic residues plays a crucial role in bio-organic farming. Using single-strain biofertilizers as rhizobial inoculants, long ago, has been applied in legume field. Nowadays emphasis has already been placed on research and development activities which led to the concept of multi-strain biofertilizers. (Saber, 2001). The highest number of flowers/plant and pod yield of peanut was obtained almost by using 20 m^3/fed. of organic manure (Salama et al, 1994). The importance of bio-organic to peanut plants was emphasized by Ahmed *et al.* (1997) who stated that the highest dry matter accumulation kernels yield and oil percentage in kernel of peanut were achieved by fertilization with 60 m^3/fed farmyard manure plus biofertilization with microbien.

The aim of this investigation is to study the effect of various organic wastes in the presence and absence of multi-biofertilizers on growth, chemical composition, yield and yield components of peanut as well as its quality.

MATERIALS AND METHODS

A pot experiment was conducted in the greenhouse of National Research Center (NRC), Giza Province, Egypt using four organic wastes i.e. rice straw, maize stalks, water hyacinth and farmyard manure (FYM). A sandy soil was collected from Mansoria, Giza Governorate having sand 86.1%, silt 9.3%, clay 4.6%, pH 8.32, EC 0.55 dsm^{-1}, organic matter 0.41%, $CaCO_3$ 2.83%, total N 0.042% and total P 135 ppm. The soil was air dried, sieved and packed (25 kg/pot) in plastic pots 40 cm in diameter and 40 cm in depth. The experiment was conducted in a complete randomized block design with 8 replicates and included 9 treatments, as follows:

1- NPK (chemical fertilizer)
2- Farmyard manure
3- Farmyard manure + multi-biofertilizers
4- Composted rice straw
5- Composted rice straw + multi-biofertilizers
6- Composted maize stalks
7- Composted maize stalks + multi-biofertilizers
8- Composted water hyacinth
9- Composted water hyacinth + multi-biofertilizers

Treatment of chemical fertilization (NPK) was applied at the rate of 150 kg/ fed ammonium sulphate (20.6% N) were applied after three weeks from sowing, 200 kg/fed calcium superphosphate (15.5% P_2O_5) and 50 kg/fed potassium sulphate (48% K_2O) were applied before sowing.

Preparation and application of compost

The plant materials (rice straw, maize stalks and water hyacinth) were air-dried, sieved to pass through 0.2 mm sieve and moistened to 70% of their water holding capacity. Each plant material was composted in association with a chemical accelerator (7 kg superphosphate, 40 kg ammonium sulphate and 35 kg calcium carbonate and 100 kg fertile soil per ton dry matter). Treated plant materials were packed plastic bags containing 20 kg, and were turned off every two weeks. The moisture content during the composting course, 120 days, was kept at a proper level throughout irrigation. The chemical analysis of composted organic wastes and FYM were determined (Table, 1). Composted organic wastes or FYM were added and mixed with soil before sowing in organic fertilization pots according to analysis done on the same source, at rates were expected to supply the same amount of nitrogen to peanut plants in pots received mineral fertilizer (30 kg N/fed.) i.e. 16.9, 18.0 and 16.2 t/fed with composted rice straw, maize stalks, and water hyacinth ,respectively, while FYM was applied at the rate of 43.5 t/fed.

Table (1): Chemical analysis of composted organic wastes and farmyard manure used.

Organic materials	pH	EC dsm^{-1}	O.C. %	Total N %	Total P %	C/N
Farmyard manure	7.96	2.91	25.61	0.69	0.34	37.12
Composted rice straw	7.32	2.85	35.11	1.78	0.15	19.72
Composted maize stalks	7.24	2.68	36.14	1.67	0.12	21.64
Composted water hyacinth	8.07	4.20	32.38	1.85	0.22	17.50

Preparation and application of biofertilizers

Highly efficient strains of *Bradyrhizobium* sp., phosphate dissolving bacteria (*Bacillus megaterium* var. *phosphaticum*), *Azospirillum* spp. and *Pseudomonas* spp. were independently grown in nutrient broth (Difco, 1969) for 48 hours at 30°C in a rotary shaking incubator. Liquid broth cultures initially containing $8x10^7$, $7x10^8$, $5x10^7$ and $3x10^7$ viable cell/ml, respectively. In biofertilization treatments, 100 ml of either tested microorganisms suspension were added to the soil in each biofertilized pot just after sowing. The pots were sown on 20 May 1999 at the rate of 5 seeds of peanut (*Arachis hypogaea* L.) C.V. Giza 5 (early punch). The seedlings were thinned to two after 20 days from sowing. The moisture content was kept in the pots at a proper level by eventual irrigation.

Microbial analysis

Counts of phosphate dissolving bacteria, *Azospirillum* spp. and *Pseudomonas* spp. in the rhizosphere of peanut plants were enumerated at intervals 20,40, 60 and 80 days after sowing under different fertilization treatments. The serial dilution plate method was used for counting PDB on modified Bunt and Rovira medium (Abd El-Hafez, 1966), while the most prople numbers was used for counting *Azospirillum* spp. on semi solid malate medium (Dobereiner *et al.*, 1976) and *Pseudomanas* spp. on KB medium (Sands and Rovira, 1970). After 60 days sowing, eight plants (4 pots) were uprooted carefully from each treatment and number and fresh weight of nodules per plant were recorded.

Plant analysis

The fresh and dry weight of roots and shoots as well as R/S ratio were measured from plant sample taken for nodulation score.

At harvest, yield components of peanut i.e. number of pods/plant, weight of mono pods/plant, shelling percentage and yield of pods and seeds/plant were estimated. An addition to, quality of peanut yield i.e. number of pods and seeds/100 g, number of seeds/pod, weight of 100 pods and weight of 100 seeds (seed index) were recorded.

Phosphorus and micronutrients (Fe, Zn, Mn and Cu) as well as protein and oil contents were determined in seeds according to A.O.A.C. (1984).

Collected data were exposed to the proper statistical analysis and least significance difference (L.S.D.) at 5% (Snedecor and Cochran, 1990).

RESULTS AND DISCUSSION

Behaviours of tested microorganisms in rhizosphere of peanut plants

Phosphate dissolving bacteria (PDB), *Azospirillum* spp. and *Pseudomonas* spp. occurred in higher densities in biofertilized rhizosphere of peanut plants during growth in soil amendments with different organic wastes as compared with NPK treatment (Fig. 1). The increase in biological activities caused by organic manure might be due to available carbon sources on which microorganisms live besides conserving soil moisture and maintaining favourable soil temperature (Lou and Sun, 1994). Microbiological analysis, however, indicate a pronounced differences in the counts of tested microorganisms in both biofertilized or non-biofertilized rhizosphere under different organic manures.

On the other hand, the counts of tried microorganisms were always higher in the rhizosphere of plants growing in soil treated with various composted organic wastes in the presence and absence biofertilizers as compared to FYM or chemical fertilizer application. The beneficial effect of organic composts may be attributed to its favourable effect on microbial population and nutrient availability (Khalifa *et al.* 1997 and Moharram,1999). The highest densities of applied microorganisms in peanut rhizosphere were detectable within the period between 20 and 40 days after planting under different composted organic wastes and after 60 days under FYM application. Counts of PDB were generally higher in the rhizosphere compared to either *Azospirillum* spp. or *Pseudomonas* spp. under different treatments.

It is worthy to state that, the various types of composted organic wastes showed a distinguishable different responses on the counts of tested microorganisms in the rhizosphere of plants (Fig. 1). These results may be due to the nature of the material and their chemical composition as well as final C/N ratio (Table 1). Generally, the amendment of soil with composted rice straw in the presence of biofertilizers recorded higher counts of tested microorganisms in peanut rhizosphere as compared to composted water hyacinth or maize stalks.

fig 1

Plant growth

Data presented in Table (2) show that all organic manures treatments in the presence and absence of biofertilizers surpassed that of chemical fertilizer treatment for increasing the dry matter accumulation in the different peanut organs, i.e. roots, shoots and consequently the whole plants as well as R/S ratio. These increases were insignificant between NPK and organic manures treatments in the absence of biofertilizers. However, differences were significant when organic manures applied in combination with biofertilizers, except composed maize stalks application. This finding indicates the vital role of bio-organic fertilization in more release of available nutrient elements to be absorbed by plant roots and this in turn increase dry matter content in the different peanut plant organs (Saber & Kabesh, 1990 on lentil and Ahiabor & Hirata, 1994 on peanut). On the other hand, the ability of organic compost to produce such effects varies greatly with the type of organic waste used (Abd El-Moez, 1996). Application of composted rice straw associated with biofertilizers exhibited higher values in dry weight of different peanut organs as compared to the other organic wastes, while composted water hyacinth along with biofertilizers recorded the highest R/S ratio.

Regarding the fresh weight and number of nodules, data in Table (2) indicate that the fresh weight and number of nodules were increased as a result of organic wastes application alone or in combined with biofertilizers as compared to chemical fertilizer treatment (Radwan, 1990). Generally, the associative action of composed FYM and biofertilizers yielded higher fresh weight and number of nodules compared to other organic wastes. However, no significant differences were calculated in fresh weight and number of nodules between FYM and the different composted organic wastes under biofertilizers application.

Table (2): Effect of some organic wastes in the presence and absence of biofertilizers on dry weight of peanut as well as fresh weight and number of nodules (60 days after sowing).

Treatments	Dry weight (g/plant)			R/S	Nodules fresh weight (g/plant)	No. of nodules (plant)
	Roots	Shoots	Whole plant			
NPK (chemical fertilizer)	3.02	6.64	9.66	0.46	0.492	10
FYM	3.30	6.42	9.72	0.51	0.611	12
FYM+ biofertilizers (bio.)	3.51	6.79	10.30	0.52	0.673	14
Composted rice straw	3.43	6.51	9.94	0.53	0.614	13
Composted rice straw + (bio.)	4.11	7.55	11.66	0.54	0.650	14
Composted maize stalks	3.26	6.49	9.75	0.50	0.553	13
Composted maize stalks + (bio.)	3.49	6.57	10.06	0.53	0.627	13
Composted water hyacinth	3.50	6.28	9.78	0.56	0.579	11
Composted water hyacinth+ (bio.)	3.95	6.93	10.88	0.57	0.645	12
L.S.D. at 5%	0.66	0.78	0.81	0.06	0.067	4

Peanut yield and its components

Results presented in Table (3) reveal that all tested organic wastes,in combination with biofertilizers caused increases in the yield components i.e.

number and yield of pods, seed yield and shelling percentage comparing to chemical fertilizer. On the other hand, NPK treatment recorded the highest weight of mono-pods as compared with organic wastes fertilization. Similar finding was noticed by (Hussein and Radwan, 2002). No significant differences in yield of pods and seeds were obtained between different organic wastes alone and NPK treatment. However, these differences were significant between composted rice straw or water hyacinth along with biofertilizers and chemical fertilizer.

Concerning the effect of biofertilizers on the efficiency of applied organic wastes, associating biofertilizers with composted rice straw, composted water hyacinth and FYM caused a significant increases in seed yield amounted by 20.86, 13.19 and 20.21%, respectively compared to organic wastes alone, but this increase did not reach the level of significance under composted maize stalks along with biofertilizers (12.21%) as compared to non-biofrtilized treatment (Table 3). These results can be related to the role of multi-biofertilizers in relation to plant growth i.e. symbiotic and asymbiotic nitrogen fixation, mobilizing plant nutrient elements and/or secreting plant growth promoting principles biocontrolling soil borne diseases (Saber, 2001).

Table (3): Effect of some organic wastes in the presence and absence of biofertilizers on yield of peanut plants

Treatments	No. of pods /plant	Weight of mono-pods (g/plant)	Yield of pods (g/plant)	Yield of seeds (g/plant)	Shelling %
NPK (chemical fertilizer)	27	9.67	68.11	43.52	63.90
FYM	26	8.52	62.40	41.01	65.70
FYM + biofertilizers (bio.)	28	7.49	73.64	49.30	66.90
Composted rice straw	26	9.16	64.39	43.62	67.74
Composted rice straw + (bio.)	29	7.54	75.80	52.72	69.55
Composted maize stalks	24	9.59	61.01	40.94	67.10
Composted maize stalks + (bio.)	28	8.28	68.25	45.98	67.51
Composted water hyacinth	25	8.44	66.58	45.05	67.66
Composted water hyacinth + (bio.)	28	7.15	74.57	50.99	68.38
L.S.D. at 5%	3	1.32	7.16	5.47	4.90

Regarding the characteristic of peanut yield components as related with its quality, data in Table (4) indicate that, significant differences calculated in number of pods and seeds per 100 g, number of seeds per pod, weight of 100 g pods and seed index between different composted organic wastes and chemical fertilizer, while these differences were not significant between FYM and NPK treatment. These results may be due to the higher levels of organic matter and nutrients in composts than in traditional FYM (Badr El-Din *et al*., 2000) as well as the positive effect of composting on reduction of the germination capacity of weeds and soil-borne pathogens (Sivapalan *et al.,* 1993). Generally, the addition of biofertilizers with all applied organic wastes led to improve the quantity and quality of peanut yield characterization as compared to different organic wastes alone or to chemical fertilizer application.

Table (4): Effect of some organic wastes in the presence and absence of biofertilizers on peanut yield components.

Treatments	No. of pods /100g	No. of seeds /100g	No. of seeds /pod	Weight of 100 pods(g)	Seed index (g)
NPK (chemical fertilizer)	47	111	1.97	209	83
FYM	45	107	1.90	215	87
FYM + biofertilizers (bio.)	42	103	1.97	236	91
Composted rice straw	42	104	1.92	246	92
Composted rice straw + (bio.)	41	102	1.97	256	96
Composted maize stalks	43	105	1.90	242	91
Composted maize stalks + (bio.)	42	104	1.93	225	93
Composted water hyacinth	43	104	1.94	249	92
Composted water hyacinth + (bio.)	41	102	1.99	269	95
L.S.D. at 5%	3	5	N.S.	31	7

Nutrient content and oil percentage in peanut seeds

As showing in Table (5), there is a significant difference in protein percentage between the different composted residues along with biofertilizers and FYM or NPK treatments. This means that composted organic wastes combined with biofertilizers can provide plants with essential nutrient elements required for protein formation. The biofertilized peanut plants and supplemented with composted water hyacinth contained the highest protein percentage comparing to the other fertilization treatments. The lowest percentage of protein was recorded with chemical fertilizer treatment.

Data in Table (5) point to increases in the contents of P, Zn, Mn, Fe and Cu in peanut seeds as a result of biofertlization under different organic wastes application, compared to chemical fertilization. These increases, however, were not significant, excepted that P-content was significantly increased compared to FYM alone or chemical fertilizer. These effects might be due to that in bio-organic farming system a set of soil microorganisms, processing the ability of mobilizing the unavailable forms of nutrient elements to available forms, has been successfully (Saber, 1994).

Table (5): Effect of some organic wastes in the presence and absence of biofertilizers on chemical composition of peanut seeds.

Treatments	Protein %	P %	Zn ppm	Mn ppm	Fe ppm	Cu ppm	Oil %
NPK (chemical fertilizer)	20.25	0.34	36.11	10.13	83.40	8.45	50.59
FYM	20.34	0.35	36.52	10.37	85.12	8.61	52.21
FYM + biofertilizers (bio.)	21.31	0.38	36.91	11.09	87.15	8.72	54.18
Composted rice straw	22.05	0.40	36.72	11.21	86.33	8.66	53.29
Composted rice straw + (bio.)	22.76	0.41	37.03	11.83	88.79	8.79	55.11
Composted maize stalks	21.82	0.39	36.62	10.63	86.46	8.67	53.72
Composted maize stalks + (bio.)	22.35	0.40	36.89	11.12	88.12	8.69	54.33
Composted water hyacinth	22.21	0.40	36.93	11.02	88.35	8.73	53.95
Composted water hyacinth + (bio.)	22.84	0.42	37.38	12.14	89.14	8.85	55.43
L.S.D. at 5%	1.46	0.05	N.S.	N.S.	N.S.	N.S.	3.48

Concerning the oil percentage in peanut seeds, data in Table (5) reveal that the associative action of biofertilizers and organic wastes led to a significant increase in the oil percentage in seeds as compared to chemical fertilizer treatment. From the same Table it could be indicate that tissues of peanut seeds contained the greatest percentage of oil when plants were fertilized with composted water hyacinth or rice straw in the presence of biofertilizers. The lowest value of oil content obtained was due to chemical fertilizer treatment or when plants were supplied with FYM in the absence of biofertilizers.

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تأثير إمداد التربة بمخلفات عضوية متنوعة مع مخصبات أحيائية متعددة السلالات على الفول السودانى فى الأرض الرملية

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أضيفت مخلفات عضوية مكمورة من (قش الأرز أو حطب الذرة أو ورد النيل) أو السباخ البلدى مع أسمدة أحيائية متعددة السلالات إلى أرض رملية وذلك لتقييم تأثيرهما على النمو والمحصول ومكوناته للفول السودانى النامى فى تجربة أصص فى صوبة المركز القومى للبحوث بالجيزة .

- كانت أعداد كل من البكتريا المذيبة للفوسفات وبكتريا الأزوسبيريللم وبكتريا السيدوموناس أعلى دائماً فى منطقة جذور النباتات المنزرعة فى التربة المعاملة بالمخلفات العضوية المكمورة فى وجود أو غياب الأسمدة الأحيائية بالمقارنة بالسباخ البلدى أو التسميد الكيماوى.
- سجلت التربة المسمدة بقش الأرز المكمور أعلى أعداد للميكروبات تحت الدراسة فى منطقة جذور نباتات الفول السودانى إذا ما قورنت بكل من ورد النيل أو سيقان الذرة المكمورة.
- زاد الوزن الجاف فى الأجزاء المختلفة لنباتات الفول السودانى والوزن الطازج للعقد الجذرية نتيجة التسميد بالمخلفات العضوية سواء بمفردها أو فى وجود الأسمدة الأحيائية وذلك بالمقارنة بمعاملة التسميد الكيماوى.
- ظهرت اختلافات معنوية فى محصول القرون والبذور بين معاملات قش الأرز المكمور أو ورد النيل المكمور فى وجود الأسمدة الأحيائية وبين معاملة التسميد الكيماوى.
- أدى إضافة الأسمدة الأحيائية مع المخلفات العضوية المختلفة إلى تحسين صفات المحصول وذلك بالمقارنة باستخدام المخلفات العضوية بمفردها أو بالتسميد الكيماوى.
- سجل تركيز من عناصر الفوسفور والزنك والمنجنيز والحديد والنحاس فى البذور زيادة ملحوظة فاقت التسميد الكيماوى نتيجة للتسميد الأحيائى وتحت استخدام المخلفات العضوية المختلفة.
- تميزت بذور الفول السودانى بأعلى نسبة من البروتين والزيت عندما سمدت النباتات بقش الأرز المكمور أو ورد النيل المكمور فى وجود التسميد الأحيائى