 Egypt. J.Microbiol. **46**, pp. 153- 175 (2011)

Potency of Composts and their Teas Applied to Sandy Soil on Controlling Damping –off Disease and Peanut Growth and Yield

M.M.El-Shinnawi, A.F.Abdel-Wahab[*], M.A. El-Howeity[**],[#] and Sh. A. Abdel-Gawad[*]
*Fac. Agric., Minufiya Univ.; Minufiya; [*]Res. Inst. Soil, Water & Environ., ARC and **Environ. Stud.& Res. Inst., Minufiya Univ., Sadat City, Egypt .*

IN A GREENHOUSE trial, peanut seeds *(Arachis hypogaea*) were sown in a potted sandy soil amended with tea-deprived plant residues compost (TDPC), tea-deprived cattle manure compost (TDCC), teas of such composts (PRCT& CMCT) or intact forms of those composts (IPRC& ICMC). Half of the experimental treatments were infected with the fungus *Rhizoctonia solani* which induces damping- off disease. Fungicide "Rhizolex" was used for the un-amended infected pots. The following results were obtained:

1-The organic treatments exerted significant reductions of pre-and post-emergence damping –off disease and increased the healthy survival of peanut plants, as compared with the un-composted control, of the fungal infected pots. Nevertheless, the fungicide treatment surpassed those of compost forms in such concern.
2-Nodulation status of peanut roots was severely injured by disease incidence, but improved by the introduced organics.
3-Aspects of plant growth, crop yield and its components, as well as major biochemical constituents of peanut pods and straw increased with application of compost variables, generally in both the un-infected and infected treatments.
4-Differences between the particular forms of plant residues compost and animal manure compost were mostly insignificant, concerning their effect on the experimental measures.
5-The positive action of the applied compost forms revealed the order: ICMC=IPRC > IPRC>TDCC= TDPC> CMCT> PRCT. Such order reflected the extent of potency of mature composts, in general, and their intact forms, in particular, as plant growth stimulators and natural biocontrol agents.

Keywords: Manuring, Biocontrol, Fungal pathogenisty, *Rhizoctonia solani*, Legumes, Diazotrophy.

Compost does several tasks to benefit the soil that synthetic fertilizers or other amendments cannot do. It adds organic matter, which improves soil structure, aggregate formation, drought protection, stopping soil erosion, buffering, reduces fertilizer requirements and gave nutrients needed by plants, as well as

[#]Corresponding author: M.A. El-Howeity , Tel: 02 0482603208, fax:02 0482600404 , E –mail address: elhweity @yahoo.com.

inoculates the soil with vast numbers of beneficial microbes. Thus, compost can modify soil physical properties and strongly affects its chemical and biological properties. Composted materials are considered the major source of available nutrients. Also, composts act as chelating agents that can bond to a metal (usually iron, zinc, copper, or manganese) by more than one bond and form a ring or cyclic structure and becomes more available to plants and general mobility in soils (Miller & Donahue,1990).

Damping-off and root rot diseases are considered as ones of the most destructive plant diseases, which cause tremendous losses. These diseases are caused by several soil borne fungi such as *Fusarium solani*, and *Sclerotium rolfsii* (El-Masry *et al*., 2002). Fungicides are used to control these diseases, but such chemical control is not always effective, and the intensive use of fungicides increases environmental pollution, health hazards and sometimes induces phytotoxicity. To reduce the deleterious effects of fungicides, the use of an efficient alternative method to control such rhizofungi has become very needful manner (El-Sayed , 2007).

Application of compost has been advocated by “organic” farmers for many years as a way to reduce or eliminate the use of pesticides and soil fumigants. Indeed, suppression of soil-borne plant pathogens by organics had been well documented by some investigators (Hoitink *et al.,* 1993). Compost for disease reduction is a form of biological control. In a general sense, biological control of disease is that “mediated by an additional organism (s), which changes the outcome of the interaction between the environment, a pathogen, and the plant host” (Maloy & Murray, 2001). Addition of compost amendments leads to numerous shifts and changes in the soil microbial community which can result in a disease suppressive or conducive environment. Disease suppression can be seen broadly as a function of soil ecosystem health (Van Bruggen & Semenov, 2000).

In the past twenty years, water extracts of compost have been applied as foliar sprays, seed dips, and soil drenches for fertility benefits and disease control. Various terms have been applied to these extracts: compost tea, compost extract, amended extract, steep age, slurry, and watery fermented compost extract. “Compost tea” (CT) is the most common designation used by researchers and practitioners for extracts prepared in numerous ways. CT experimentation has grown very rapidly in the past ten years. In simplest terms, CT is the combination of compost with water for a specified period of time to yield a liquid for agronomic use (Scheuerell & Mahaffee, 2002).

The present work was designed to study the possibility of utilizing two different commercial composts, derived from plant and animal sources, or their teas, added to a sandy soil, as biocontrol agents against the damping –off disease induced by the pathogenic fungus *Rhizoctonia solani*, as well as the subsequent action on plant growth and crop yield of peanut.

Materials and Methods

Materials

Soil

Surface samples (0-30 cm) of agricultural sandy soil were collected from Ismaeilya, Egypt. Such samples were air –dried and ground to pass through a 2mm sieve. Initial analyses for the main physical, chemical and microbiological characteristics of this soil were carried out following the standard methods of Page *et al.* (1982) and data appear in Table 1.

TABLE 1. Main physical, chemical and microbiological characteristics of the used soil.

Characteristic	Value
Particle size distribution (%):	
Sand	90.5
Silt	2.2
Clay	7.3
Texture grade	Sandy
Water saturation (%)	20.20
pH (1)2.5 soil/ water suspension)	7.30
E.C (1:5 Soil/water extract) (dS m^{-1} ,25^oC)	0.28
Soluble cations (meq/l):	
Ca^{++}	0.56
Mg^{++}	0.30
Na^{+}	1.90
K^{+}	0.60
Soluble anions (meq/l):	
$CO^{=}_3$	--
HCO^-_3	0.95
Cl^-	0.50
$SO_4^{=-}$	1.91
Organic matter (%)	0.36
Total N (ppm)	100.00
NH^+_4 (ppm)	18.99
NO^-_3 (ppm)	6.76
Available P (ppm)	7.79
Total bacteria (cfu */ g soil)	$3.6x10^5$
Total fungi (cfu / g soil)	$1.5x10^3$
Total actinomycetes (cfu/g soil)	$2.8x10^4$
Dehydrogenase activity(µg TPF/ 100 g dry Soil)	23.40
CO_2-evolution rate ($mgCO_2$/100gdry soil/day)	12.24

⋅cfu= colony – forming unit.

Composts

Two commercial mature compost types were used, namely plant residues compost and cattle manure compost. They were obtained from Ismaeilya Agric. Exp. Station, for the first, and from private producer, for the second, in Egypt. Air –dried samples of both composts were subjected to analyses for some physico- chemical and nutritional characteristics (Table 2). Microbiological and biochemical aspects of such composts were also assayed (Table 3). Methods of determination were according to Page *et al.* (1982).

TABLE 2. Physico-chemical and nutritional properties of the used composts.

Property	**Plant residues compost**	**Cattle manure compost**
Bulk density (kg/m^3)	532	594
Moisture content (air- dry) (%)	25.70	27.40
pH (1:10, water suspension)	7.60	8.00
EC (1:10, water extract) (dSm^{-1})	2.46	2.78
Organic C (%)	17.28	20.19
Organic matter (%)	29.72	34.73
Total N(%)	1.03	1.25
C/N ratio	16.78	16.15
NH_4^+-N (ppm)	78.2	99.4
NO_3^- - N(ppm)	135.4	178.8
Total P (%)	0.52	0.57
Total K (%)	0.61	0.77
Total Fe (ppm)	21.1	30.3
Total Mn (ppm)	27.3	34.3
Total Zn (ppm)	6.5	13.6
Total Cu (ppm)	16.8	16.2

TABLE 3. Microbiological and biochemical aspects of the used composts.

Measure	Plant residues compost	Cattle manure compost
No. of mesoophilic bacteria (x 10^7cfu/g)	7.630	7.740
No.of thermophilic bacteria (x 10^7cfu/g)	0.390	0.370
No.of mesoophilic fungi (x 10^7cfu/g)	6.450	6.480
No.of thermophilic fungi(x 10^7cfu/g)	0.023	0.020
No.of mesoophilic actinomycets(x 10^7cfu/g)	6.850	6.950
No.of thermophilic actinomycets (x10^7cfu/g)	0.033	0.030
No. of *Bacillus* sp. (x 10^7cfu/g)	0.60	0.62
No.of *Azospirillum* (x 10^7cfu/g)	0.47	0.55
No.of *Azotobacter* (x 10^7cfu/g)	0.55	0.57
No.of Cellulose dec. bact. (x 10^7cfu/g)	0.51	0.56
Dehydrogenase activity (mg TPF / g)	172.3	180.0
Nitrogenase activity (nmol C_2H_4 /g /hr)	139.7	155.6
CO_2-evolution (mg CO_2/g/ day)	1.67	1.73

* cfu= colony -forming unit.

Compost teas

Tea of each compost was obtained by mixing a 1:10(w/v, compost to tap water) ratio, left at ambient summer temperature (28-35 ºC) for 7 days, and the suspension was then filtered. The filtrate is the "Compost Tea". Chemical, nutritional, and microbiological properties of such teas were determined according to Scheuerell & Mahaffee (2002) and data are presented in Table 4.

Other materials

- Pathogenic fungus "*Rhizoctonia solani*" inoculum.
- Seeds of peanut " *Arachis hypogaea*, cv.Giza5".
- Diazotrophic Bradyrhizobial inoculum.
- Fungicide "Rhizolex" .

Methods

Greenhouse experiment

A greenhouse experiment was conducted at the Res. Inst. of Soil, Water & Environment ARC, Giza, Egypt, in the summer season of 2009. Earthenware pots, of 35cm-diameter, each was filled with 10kg of the sandy soil and sterilized with a formaldehyde solution (5%) and left to dry, then fertilized with super phosphate(15.5 P_2O_5) at a rate of 2g/pot (500 kgh^{-1}). The potted soil were infected with the pathogenic fungus *Rhizoctonia solani* inoculum, at a rate of 2% (w/w),except some to be used as un-infected controls. Moisture content was maintained at 80%of the water holding capacity (WHC) of the soil for seven days to support the fungal growth. Solid composts were then added to the un-infected and infected groups of pots. Five seeds of peanut, inoculated with bradyrhizobia, were sown into each pot. After emergence, the seedlings were thinned to three per pot.

TABLE 4. Chemical, nutritional and microbiological properties of the compost teas.

Property	Plant residues compost tea	Animal manure compost tea
pH	7.3	8.1
EC(dS/m)	3.45	3.95
Total- N (ppm)	130.0	150.0
NH_4^+ -N(ppm)	54.5	59.2
NO_3^- -N (ppm)	35.3	38.9
Total soluble-N(ppm)	89.8	98.1
Available –P(ppm)	97.8	132.3
Available- K(ppm)	120.0	150.0
Available – Fe (ppm)	12.3	16.7
Available – Mn (ppm)	3.9	3.4
Available – Zn (ppm)	5.1	5.8
Available – Cu (ppm)	1.1	1.4
Log N0. of bacteria	7.28	7.73
Log N0. of fungi	5.45	5.29
Log N0. of actinomycetes	6.39	6.65
Log N0. of *Azotobacter*	4.13	4.61
Log N0.of *Azospirillum*	4.00	4.10
Log N0. of *Bacillus* sp .	5.21	5.41
Log N0.of Cellulose decomposers	4.60	4.86

The treatments undertaken were as follows:

Composts and teas

- Tea-deprived plant residues compost (TDPC) and tea –deprived cattle manure compost (TDCC), each was applied at a rate of 100 g/pot (a rate ordinarily practiced in Egyptian agriculture), before cultivation.
- Plant residues compost tea (PRCT) and cattle manure compost tea (CMCT), each was applied at a rate of 500 ml/ pot, at two doses, *i.e.* 15 and 30 days after cultivation.
- Intact plant residues compost (IPRC) and intact cattle manure compost (ICMC), each was applied, at a rate of 100 g/pot, prior to cultivation. Intact compost refers to its full or integrated form.

- The fungicide "Rhizolex", was applied, as recommended, after 10 days of sowing to a number of infected pots that were left un-amended with composts or their teas.

- Controls, denied from each of organic amendments, fungal infection and /or fungicide application, were included.

Each treatment comprised six replicates, arranged in a complete randomized design. All pots were fertilized with potassium sulphate (48% K_2O), at a rate of 0.5g /pot (125 kgh^{-1}), and ammonium sulphate (21%N), at a rate of 1g/pot (250 kgh^{-1}), after 10 days of sowing . The pots were regularly watered to keep the moisture content at 60% WHC throughout.

Determinations

a) Extents of pre-and post- emergence damping –off of peanut plants were recorded after 15 and 45 days of cultivating the fungal infected pots.

b) Nodulation status of peanut roots, *i.e.* number and dry weight of nodules, was detected after 60 days of planting.

c) Plant growth parameters, *i.e.* content of chlorophyll, dry matter weight, and contents of N,P& K in plant tissues, were quantified after 60 days of sowing .

d) Weights of crop yield and its components (pods& straw) , as well as contents of macro-nutrients (N,P&K) and biochemical constituents (seed and straw proteins and seed oil)were determined at harvest (120 days of cultivation).

The following techniques were followed for plant analyses, according to AOAC (1990):

-Chlorophyll ("a"&"b") contents were measured, in fresh leaf disks, spectrophotometrically at 650 and 665nm wave lengths.

-Dry weight, was estimated for the air-dry samples oven dried at 70 ºC for 48 hr.

-Nutrient contents , were determined in the wet acid digest , *i.e.* total N by micro-Kjelahl techique , total P spectrophotometrically using ammonium molybdate and stannus chloride reagents and total K flame – photometrically.

-Protein content, was calculated by multiplying the total nitrogen content by the factor" 6.25".

- Oil content was determined by extraction of seeds, using Soxhlet apparatus, in presence of petroleum ether.

Statistical analysis

The obtained experimental data were subjected to analysis of variance (ANOVA) and L.S.D. test was used to compare the results, according to the procedures outlined by Snedecor & Cochran (1980) , using MSTAT computer software program (MSTAT Ver., 1.42).

Results and Discussion

Effect of composting on damping – off disease of peanut plants

Extents of pre- and post-emergence damping – off disease of peanut plants grown on the sandy soil, as affected by application of solid composts or their teas, under artificial infection with the pathogenic fungus *Rhzioctonia solani*, are shown in Table 5. It was evident that soil manuring with any of both intact composts resulted in significant reductions of the pre- and post-emergence damping – off, as well as increased the healthy survival of peanut plants, as compared with the control (uncomposted). Mostly, there were no differences observed between both the intact compost treatments, at neither pre- nor post-emergence of peanut plants. Consequently, such intact composts recorded the higher percentage of plant survival (65 %) among the used organic amendments, whereas the others descendingly followed, in the order: TDPC=TDCC> CMCT >PRCT. However, addition of the fungicide "Rhizolex" showed the greatest eradication power on *Rhzioctonia solani*, and thus exerted the least extent (0.0%) of pre- and post-emergence damping – off of peanut plants, thus achieved the maximum survival percentage (100 %) .

TABLE 5. Effect of compost types or their addition form on the damping – off of peanut plants under artificial infection with *Rhizoctonia solani* .

Treatment *	Pre-emergence (%)		Post-emergence (%)		Survival (%)	
	Uninfected	Infected	Uninfected	Infected	Uninfected	Infected
Control	13.3	46.7	6.7	40.0	80.0	13.3
TDPC	0.0	20.0	0.0	20.7	100.0	60.0
PRCT	0.0	25.0	0.0	25.0	100.0	50.0
IPRC	0.0	20.0	0.0	15.0	100.0	65.0
TDCC	0.0	20.0	0.0	20.0	100.0	60.0
CMCT	0.0	24.7	0.0	20.0	100.0	53.3
ICMC	0.0	20.0	0.0	15.0	100.0	65.0
Fungicide	0.0	0.0	0.0	0.0	100.0	100.0
L.S.D. at 0.05 T [a)]	9.0		11.8		14.8	
L. S. D. at 0.05 I [b)]	4.5		N.S		7.4	
L.S.D. at 0.05 TxI	N.S [c)]		N.S		N.S	

*TDPC= tea –deprived plant residues compost, PRCT= plant residues compost tea, IPRC= intact plant residues compost, , TDCC= tea-deprived cattle manure compost, CMCT=cattle manure compost tea, ICMC= intact cattle manure compost, fungicide " Rhizolex".
a) T= organic amendments b) I=fungal infection c) N S. = insignificant.

From the obtained results, it is possible to deduce that, since both forms of solid composts (intact or tea-deprived) harbor great numbers and diversity of microbial communities (Table 3), which could act as biocontrol agents. Also, these composts are rich media with a nutritional base for soil endogenous microorganisms, resulting in a sustained suppression of the fungal caused damping – off of peanut plants. In fact, suppression occurred on *Rhizoctonia solani* was not correlated with the total microbial activity or culturable population of bacteria, actinomycetes, and fungi, but rather with the population of undefined specific antagonistic fungal and bacterial species. Compost teas, with their reasonable composition (Table 4), also proved to have an appreciable role in controlling the severity of such fungal disease (Scheuerell & Mahaffee, 2002). Intact compost is actually characterized by a rich and diverse microbial population and biochemicals much more than the other derivates, this efficiently contributes to its biocontrolling potency. Despite the uppermost inhibitory action of the fungicide, organic amendments could be appreciated for bio-protection of plants against pathogens, from the environmental point of view, to reduce pollution. This is actually in favour of "Organic Farming" practices.

Several specific biocontrol agents have been proposed to consistently induce suppression to *Rhizoctonia* damping – off of plants. Proposed microbial species, which can suppress. *R.solani* include isolates of *Trichoderma* , *Penicillium*, *Bacillus* spp. and *Streptomyces* spp . Biocontrol consisting of combinations of effective fungal isolates and bacterial strains is more efficient than a single agent (Hoitink & Boehm, 1999) . Earlier, Kwok *et al.* (1987) isolated *Pesudomonas, Bacillus cereus* and *Flavobacterium* spp. from compost that suppressed *Rhizoctonia* damping – off. Also, Joshi *et al.* (2009) demonstrated that biocontrol agents like *Trichoderma* and *Pesdumonas* spp. had been attributed to a major role in determining the suppressive activity of compost against *R. solani* and some foliar diseases. Moreover, composts and compost teas could control *R.solani* through different mechanisms, which triggered by their habitant biocontrols and competition among microbial populations for available carbon and nitrogen. Other proposed mechanisms include parasitism, production of inhibitory compounds or hydrolytic enzymes, nutrients competition and induction of systemic resistance in plants (El-Masry *et al*., 2002). Some investigators suggested that the chemical properties of compost teas, namely nutritional elements and organic molecules such as humic or phenolic compounds might protect the plant against diseases through improved growth status, direct toxicity toward pathogen or induced systemic resistance (Siddiqui *et al.,* 2008 and Kone *et al*.,j 2010).

Effect of composting on nodulation status of peanut roots

Results illustrated in Fig. 1&2 demonstrate the effect of composts or their teas on nodulation status of the peanut roots under artificial infection with *Rhizoctonia solani,* after 60 days of sowing. The figures reveal that, irrespective of compost addition, the intentional fungal infection of soil greatly inhibited the nodulation capacity of the roots of such leguminous plant, where it decreased the nodule numbers by 29.12% in comparison to the un-infected control treatment. Depression of nodule formation occurred as a consequence of the attack of the pathogenic fungus, which impaired the root system and shortened the energy delivered to the roots under disease severity. The deleterious influences of soil borne diseases on nodulation status of legumes had been reported by some investigators (Hassanein *et al*., 2006 and El–Sayed, 2007). On the other hand, introduction of the solid composts recorded higher numbers of nodules and their dry weights as compared with soil drench with compost teas. However, the highest values of nodulation aspects were obtained by the addition of each intact compost, where the nodule weights increased above the control by 179.12 or 187.82 %, with IPRC or ICMC, respectively. Such trend was shown under both un- infected and infected conditions.

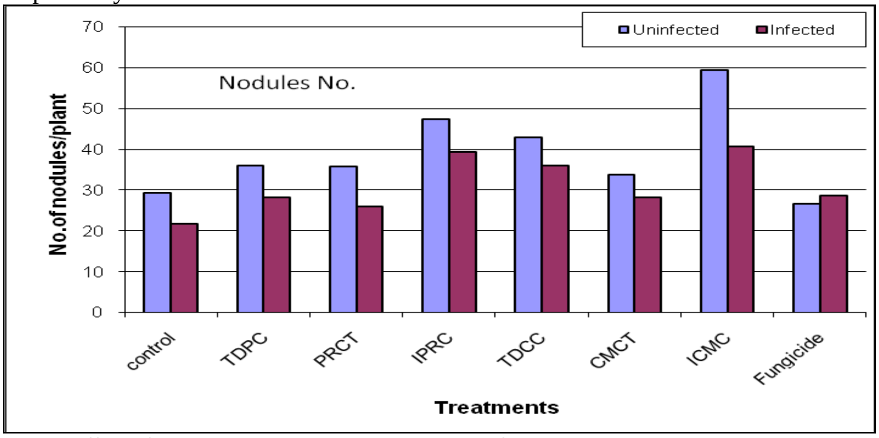

Fig. 1. Effect of composts or their teas on number of nodules /plant on peanut roots under artificial infection with *Rhizoctonia solani*, after 60 days of planting .
TDPC= tea –deprived plant residues compost, PRCT= plant residues compost tea, IPRC= intact plant residues compost, , TDCC= tea-deprived cattle manure compost, CMCT=cattle manure compost tea, ICMC= intact cattle manure compost, Fungicide= Rhizolex.

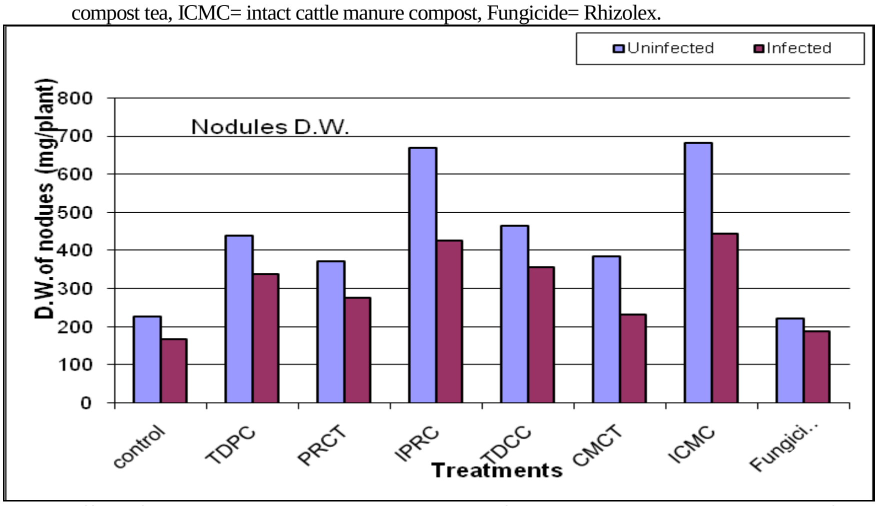

Fig. 2. Effect of composts or their teas on dry weight of nodules on peanut roots underartificial infection with *Rhizoctonia solani*, after 60 days of planting.
TDPC= tea –deprived plant residues compost, PRCT= plant residues compost tea, IPRC= intact plant residues compost, , TDCC= tea-deprived cattle manure compost, CMCT=cattle manure compost tea, ICMC= intact cattle manure compost, Fungicide= Rhizolex.

In presence of *Rhizoctonia solani*, the number of nodules ranged from 26.0 to 40.7 nodule/plant, with nodular tissue weights ranging from 276.0 to 445.0 mg/plant for the organic amendments, whereas the corresponding values brought about in absence of fungal infection were 33.7 to 59.3 and 372.3 to 681.9 mg/plant, respectively for nodule numbers and weights. These results thus declared that addition of either solid compost enhanced the nodulation status of peanut roots, particularly in case of the intact form of composts. This could be attributed to a suppressive action mediated by an efficient biocontrol capacity of the used composts, as well as to their stimulation of plant growth, via nutritional support and presence of growth-promoting substances mainly produced by the inoculating specific rhizobia and other present rhizobacteria.

Many groups of rhizobacteria can trigger a number of mechanisms such as production of IAA and /or flavonoids-like substances (Ahmad *et al*., 2005) , siderophores excretion (Compant *et al*., 2005) and improvement of nutrients availability, particularly phosphate (Dobbelaere *et al*., 2003) . Additionally, the composts, and to a lower extent their teas, have a prominent role in improving the physical, chemical and biological properties of soil and thus supporting the plant health (El-Tahlawy, 2006) .

Effects of composting on peanut plant growth aspects

Effects of the different compost types or their teas on the growth features of peanut plants grown on either un-infected or intentionally infected sandy soil with *Rizoctonia solani*, after 60 days of planting are illustrated in Fig. 3 - 5. It was evident that, regardless of compost addition, infection of the sandy soil with such pathogen significantly reduced the growth measures of peanut plants, represented by dry matter weight and chlorophyll contents. Diminution percentages reported for the infected control treatments were 11.31, 30.89, 30.09, 30.71 and 26.25% for shoot and root dry matters, and chlorophylls "a"," b" and total chlorophyll ("a+b") contents, respectively lower than the un-infected counterparts. Such reduction in the plant growth traits reflected the adverse effect of *R.solani,* which could constrain the physiological processes including photosynthesis and consequently symbiotic performance of peanut- *Bradyrhizobium* system. Such deleterious impact of soil borne pathogens on growth aspects of legumes had been observed by Hassanein *et al.* (2006) and Joshi *et al.* (2009). Apart from disease incidence, amendments with solid composts or their teas resulted in significant increases of growth vigor of the peanut plants, as compared with the un-amended treatments. The two tested compost types exhibited nearly the same positive effect on the plant growth with a distinct superiority of their intact forms, comparatively to the other treatments. For instance, addition of tea-deprived composts, TDPC or TDCC, respectively achieved increases percentages reaching 25.66 or 27.24% for shoots dry weight, 54.29 or 61.43 % for roots dry weight and 24.70 or 20.24 % for total chlorophyll content, above the un-amended control treatment. Whereas, the corresponding values obtained for the treatments receiving either compost tea PRCT or CMCT, were 17.63 or 10.92 % , 31.43 or 37.14 % and 15.79 or 8.10 % , respectively.

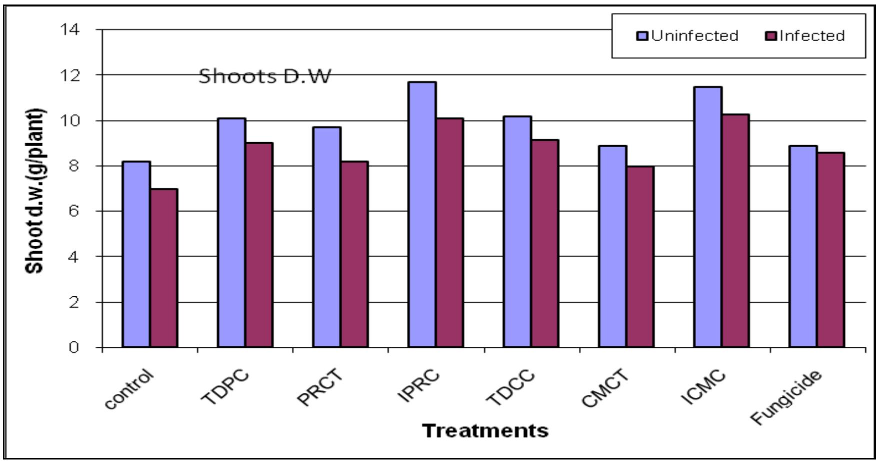

Fig. 3. Effect of different composts or their teas on shoot dry weight (g/plant) of peanut plants under artificial infection with *Rhizoctonia solani* ,after 60 days of planting.
TDPC= tea –deprived plant residues compost, PRCT= plant residues compost tea, IPRC= intact plant residues compost, , TDCC= tea-deprived cattle manure compost, CMCT=cattle manure compost tea, ICMC= intact cattle manure compost, Fungicide= Rhizolex

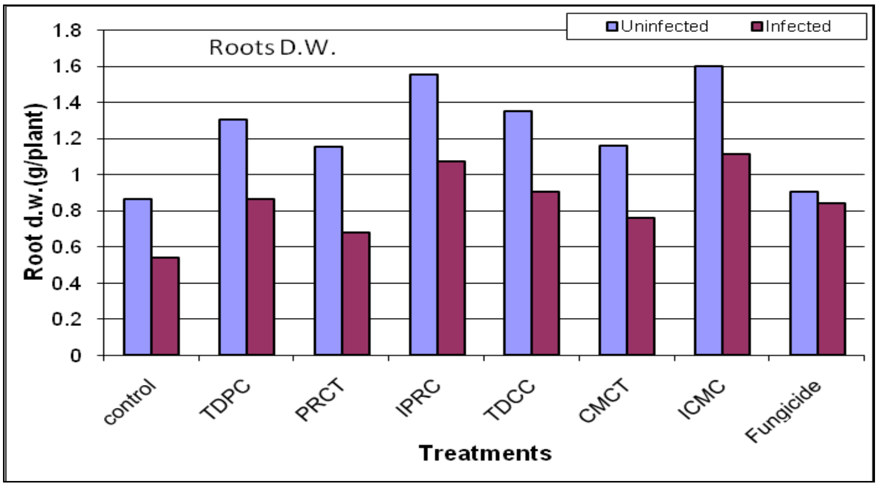

Fig. 4.Effect of different composts or their teas on roots dry weight of peanut plants under artificial infection with *Rhizoctonia solani,* after 60 days of planting.
TDPC= tea –deprived plant residues compost, PRCT= plant residues compost tea, IPRC= intact plant residues compost, , TDCC= tea-deprived cattle manure compost, CMCT=cattle manure compost tea, ICMC= intact cattle manure compost, Fungicide= Rhizolex.

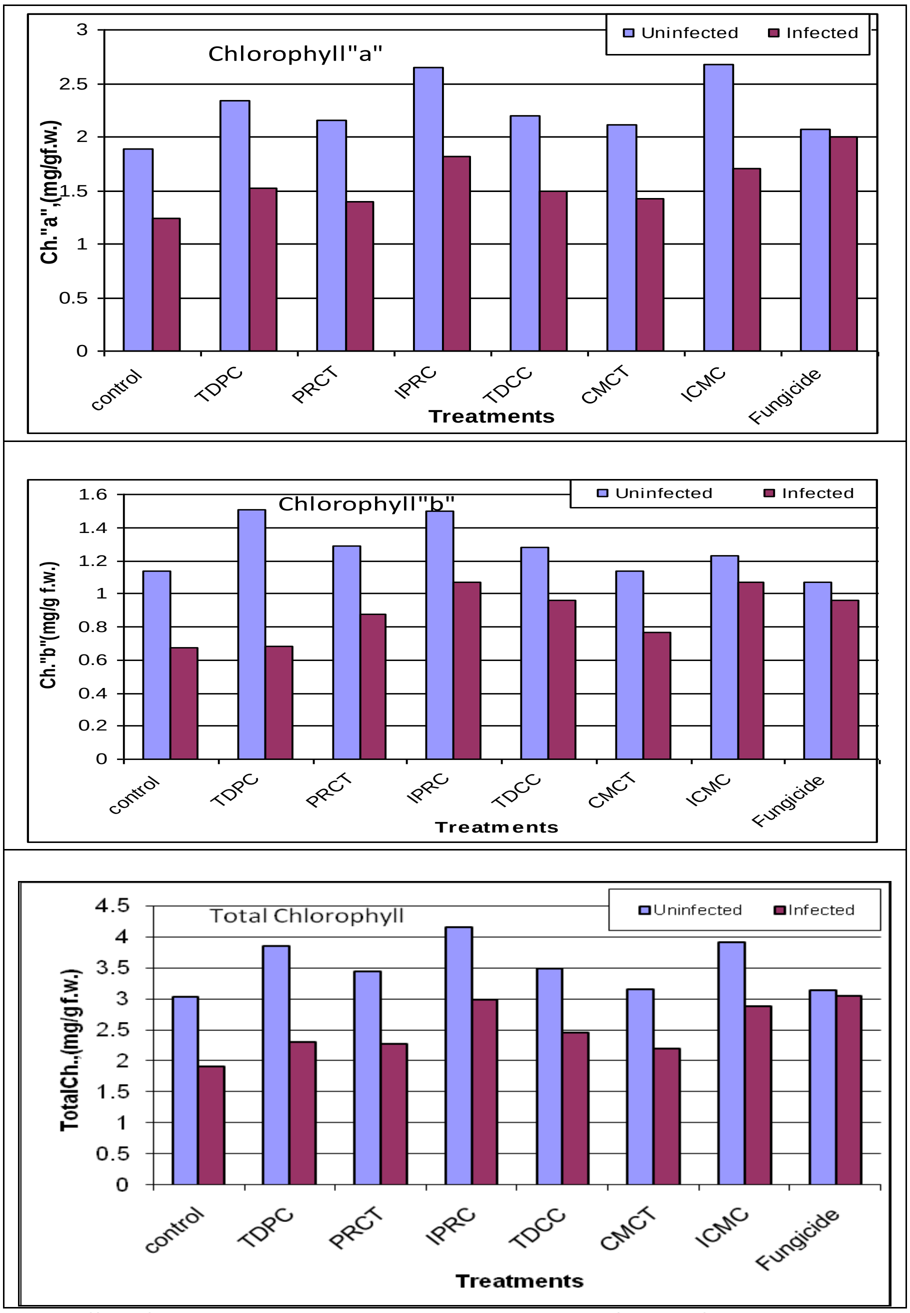

Fig. 5. Effect of composts or their teas on chlorophyll contents of peanut fresh shoots under artificial infection with *Rhizoctonia solani*, after 60 days of planting. *TDPC= tea –deprived plant residues compost, PRCT= plant residues compost tea, IPRC= intact plant residues compost, , TDCC= tea-deprived cattle manure compost, CMCT=cattle manure compost tea, ICMC= intact cattle manure compost, Fungicide= Rhizolex.

However, the highest values of growth aspects were gained by the plants treated with any of the two intact composts. IPRC achieved increase percentages of shoot and root dry matters, as well as total chlorophyll content reaching 43.55, 87.14 and 44.53%, respectively, whilst the corresponding values obtained due to adding the ICMC, were 43.16, 66.00 and 37.65%, respectively, above the control. The promotive effect of compost on the growth vigor of peanut plants was certainly attributed to improving the nutritional status through stimulating the availability and uptake of nutrients, beside the action of plant growth promoting substances originated from microbial population of both composts, together with the rhizobial inoculation for N_2-fixation (Tilak *et al*. 2005) .In this concern, Abdel-Wahab *et al.* (2008), reported that rhizobacteria incorporated with composted materials sustain their action resulting in enhanced plant growth vigor and nitrogen fixation performance by improving the efficiency of mineral nutrition and biological activity for faba bean plants.

In regard to the interaction of fungal infection and organic treatments, the results exerted that addition of composts had a remarkable influence on encouraging the plant growth, either in absence or presence of *R. solani* . Under pathogenisty conditions, introduction of the organic amendments, particularly the intact form of solid composts, achieved a plant growth vigor surpassing that of the fungicide treatment. Shoots dry matter of the infected treatments ranged from 7.00 to 10.26 g/plant and roots dry mass ranged from 0.54 to 1.11 g/plant, as well as the total chlorophyll content in plant leaves ranged from 1.91 to 3.05 mg/g . Additionally, the highest values of growth aspects were monitored in case of using the two solid composts in their intact forms, with very slight differences between them, *e.g.* addition of IPRC, recorded 10.12 g/plant, 1.07 g/plant and 2.98 mg/g for shoots dry weight, roots dry weight and total chlorophyll content, respectively .The corresponding values obtained by application of the ICMC were 10.26,1.11 and 2.88 , respectively .These results clearly exhibited that utilization of mature compost, of either plant or animal source , as organic amendment and biocontrol agent, could restrict the plant damping – off caused by *R. solani*, via enhancement of plant growth and performance of diazotrophy, beside their direct inhibitory effect on the pathogenic fungus . Similar findings were found by El-Sayed (2007) and Joshi *et al.* (2009).

Effect of composting on macro-nutrient contents of peanut plant tissues

Contents of nitrogen, phosphorus and potassium accumulated in the peanut plant tissues, as influenced by the tested composts or their teas in absence or presence of *Rhizoctonia solani* infection are illustrated in Fig. 6 & 7. Regardless of compost addition, data revealed that the artificial infection of the sandy soil used with such pathogenic fungus caused a significant depression in N, P and K contents of the peanut tissues. Diminution percentages occurred in such nutrient contents of plant shoots, due to disease incidence, were 13.74, 12.63 and 5.94% for N,P and K lower than the un-infected soil, whereas the corresponding values for peanut roots were 27.23, 23.57 and 11.69 %, respectively. The declination observed in N content indicated that the dinitrogen fixation process was relatively impaired, due to the fungal infection. In addition, disease incidence caused a damage of root system resulting in reducing the uptake of both phosphorus and potassium. Similar trend was obtained by El-Sayed (2007). In respect of the main effect of compost practicing, the present results clearly denoted that the use of either compost type or its tea led to significant increases of the total contents of such nutrients accumulated in the plant organs, in comparison to the un-amended control. Topdressing of solid composts exhibited remarkable augmentations in the nutrient contents of the plants, as compared with the soil drenched with compost teas. Obviously, application of IPRC resulted in elevating the contents of N,P and K in peanut shoots by 65.11, 86.48 and 55.58%, respectively above the control. The corresponding figures obtained for ICMC were 66.54, 88.12 and 55.92%, respectively, for the mentioned nutrients. Regarding the macro-nutrients content of peanut roots, results exhibited the same trend of the plant shoots . Based on these findings, it was evident that, addition of any intact solid compost had a distinct positive effect on the elemental contents of peanut plants. This is elucidated by the ability of organic substances (humic and other various organic acids) and biological agents (*e.g.* rhizobacteria) to enhance the availability and uptake of such elements, beside their encouraging action on the biological nitrogen fixation process (Tilak *et al.,* 2005 and El-Tahlawy, 2006).

Application of the organic amendments to the fungal infected soil led to raising the contents of the determined macro-nutrients. It showed a trend, among the different treatments, similar to that above –mentioned for the growth traits of peanut plants. This is a consequence of the beneficial action of the used forms of compost additions, through their nutritional and biocontrolling capacities (Hoitink *et al*., 1993 and Joshi *et al*., 2009).

Effect of composting on peanut yield and its components and main biochemical constituents

Response of peanut yield with its major components (pods& straw) and biochemical constituents (seed & straw protein and seed oil) to the different compost treatments under artificial infection with *Rhizoctonia solani* is shown in Fig. 8 and 9. Irrespective of the organic amendments, data clearly revealed that the intentional fungal pathogenisty of the sandy soil planted with peanut, tended to significantly diminish the different measures of crop yield, compared to the un-infected treatments. Decrease percentages occurred, in account of the fungal disease incidence, reached 15.80, 13.87, 7.17, 5.59 and 5.60% lower than the un-infected control treatment, respectively for pod yield, straw yield, seed protein content, seed oil content and straw protein content. Such diminutions could be explained by inhibiting the nodulation efficiency and performance of N_2 fixation, as well as the plant growth and its nutritional status. Many previous reports had come to similar conclusion concerning the depression of crop yield as a result of soil borne fungal infections (El-Sayed, 2007). Regardless of the presence of fungal infection, results obtained clearly displayed that utility of organic approaches by both solid composts, significantly increased the peanut yield components and their main biochemicals, compared to the soil drench with compost teas. The increase percentages, as a result of soil topdressing with the TDPC, were 38.97,26.31,20.58,22.28 & 8.19% versus 19.26, 20.41, 15.81, 15.47 & 2.16% due to soil drench with PRCT, above the unamended control for pod yield, straw yield, seed protein content , seed oil content and straw protein content , respectively. However, application of the intact solid composts exerted salient superiority in enhancing the peanut yield measures, as they showed increase percentages for the TPRC, reaching 51.70, 37.93, 26.60, 26.15 &14.07%, pod, straw, seed protein content, seed oil content and straw protein content , respectively for the mentioned yield components and constituents, above the unamended control. The corresponding values for the ICMC were 54.18, 41.12, 27.50, 26.25 and 15.65 %, respectively as well.

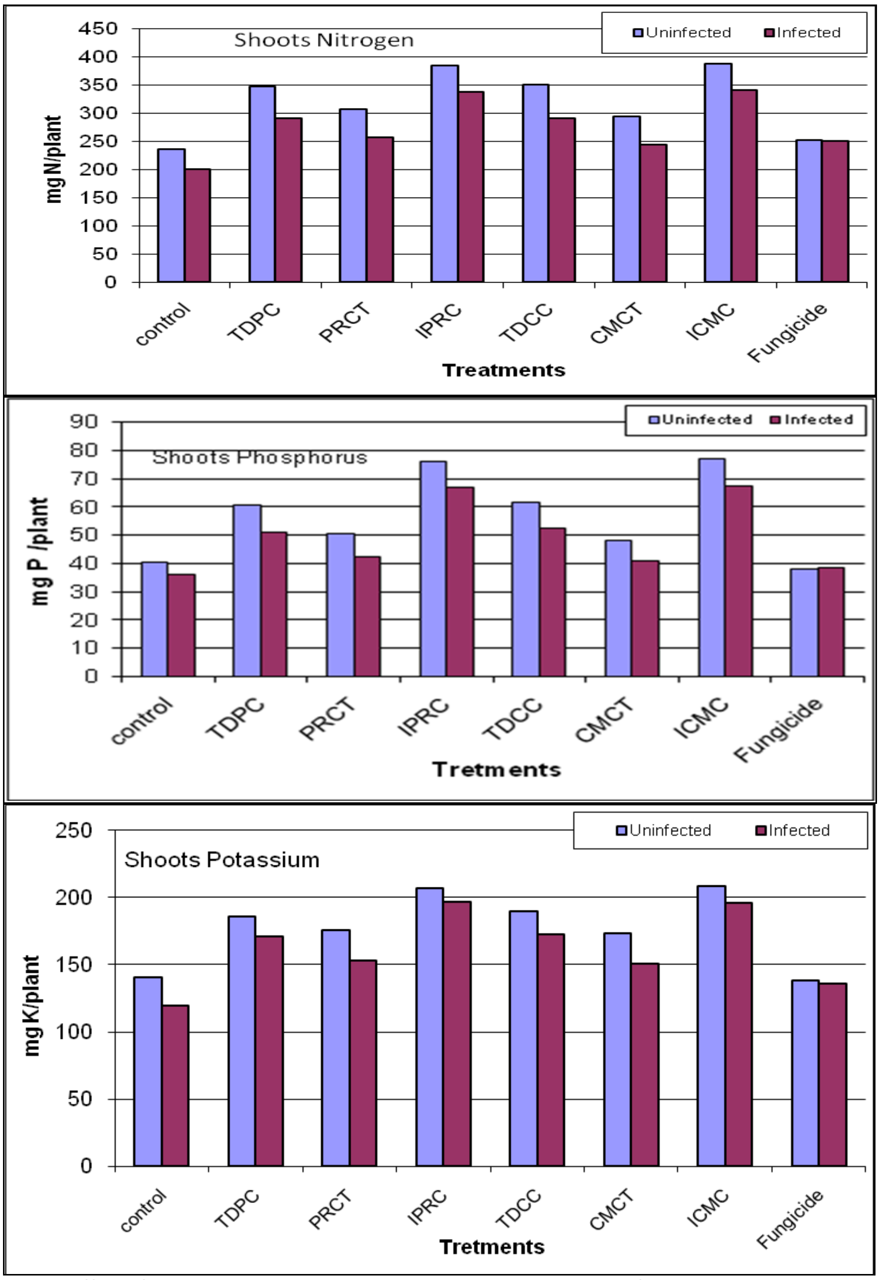

Fig. 6. Effect of composts or their teas on macro-nutrient contents of peanut dry shoots under artificial infection with *Rhizoctonia solani,* after 60 days of planting.

TDPC= tea –deprived plant residues compost, PRCT= plant residues compost tea, IPRC= intact plant residues compost, TDCC=tea-deprived cattle manure compost, CMCT=cattle manure compost tea, ICMC= intact cattle manure compost, Fungicide=Rhizolex

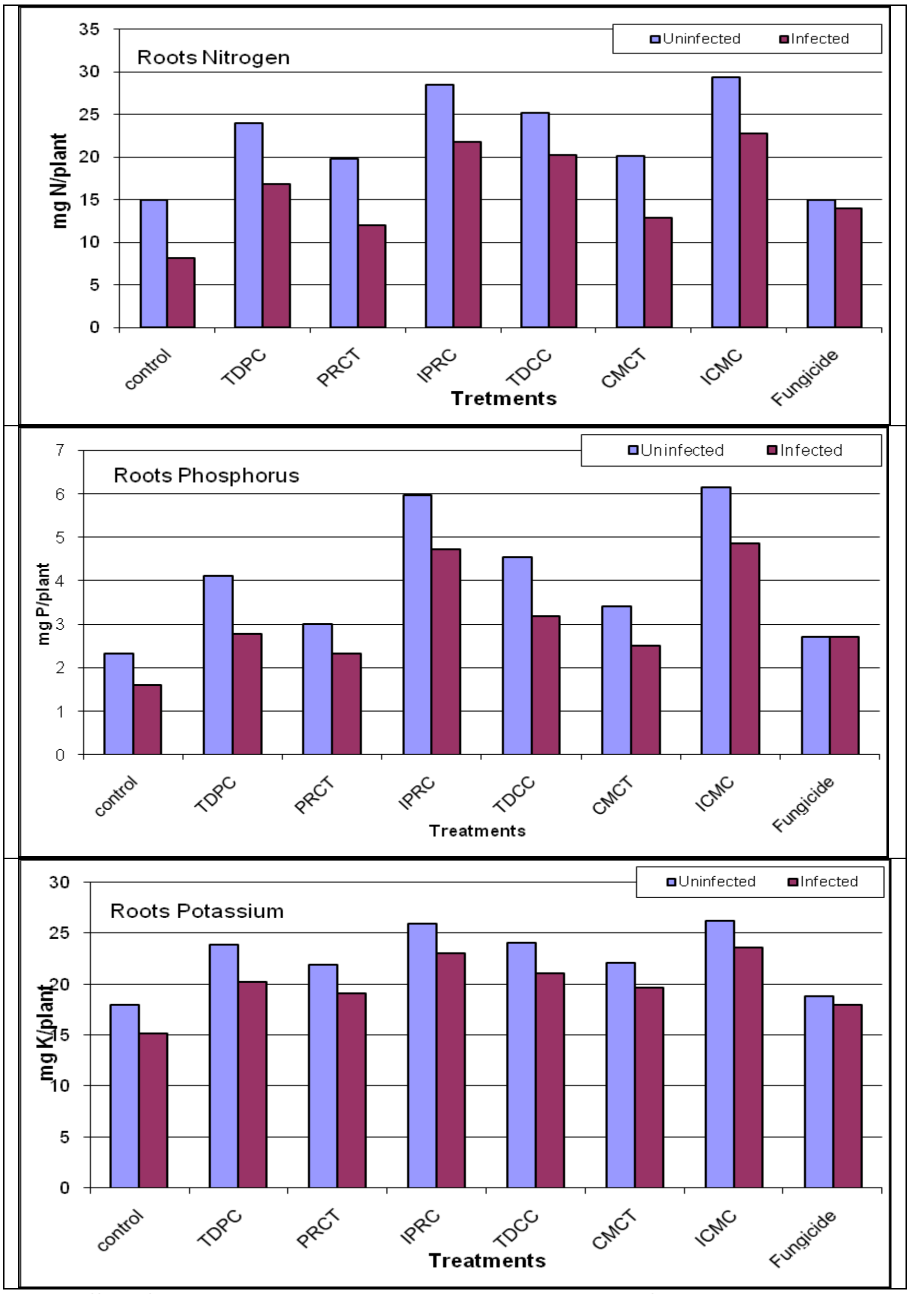

Fig. 7. Effect of composts or their teas on macro- nutrient contents of peanut dry roots under artificial infection with *Rhizoctonia solani,* after 60 days of planting.
TDPC= tea – deprived plant residues compost, PRCT= plant residues compost tea, IPRC= intact plant residues compost, , TDCC= tea-deprived cattle manure compost, CMCT=cattle manure compost tea, ICMC= intact cattle manure compost, Fungicide=Rhizolex.

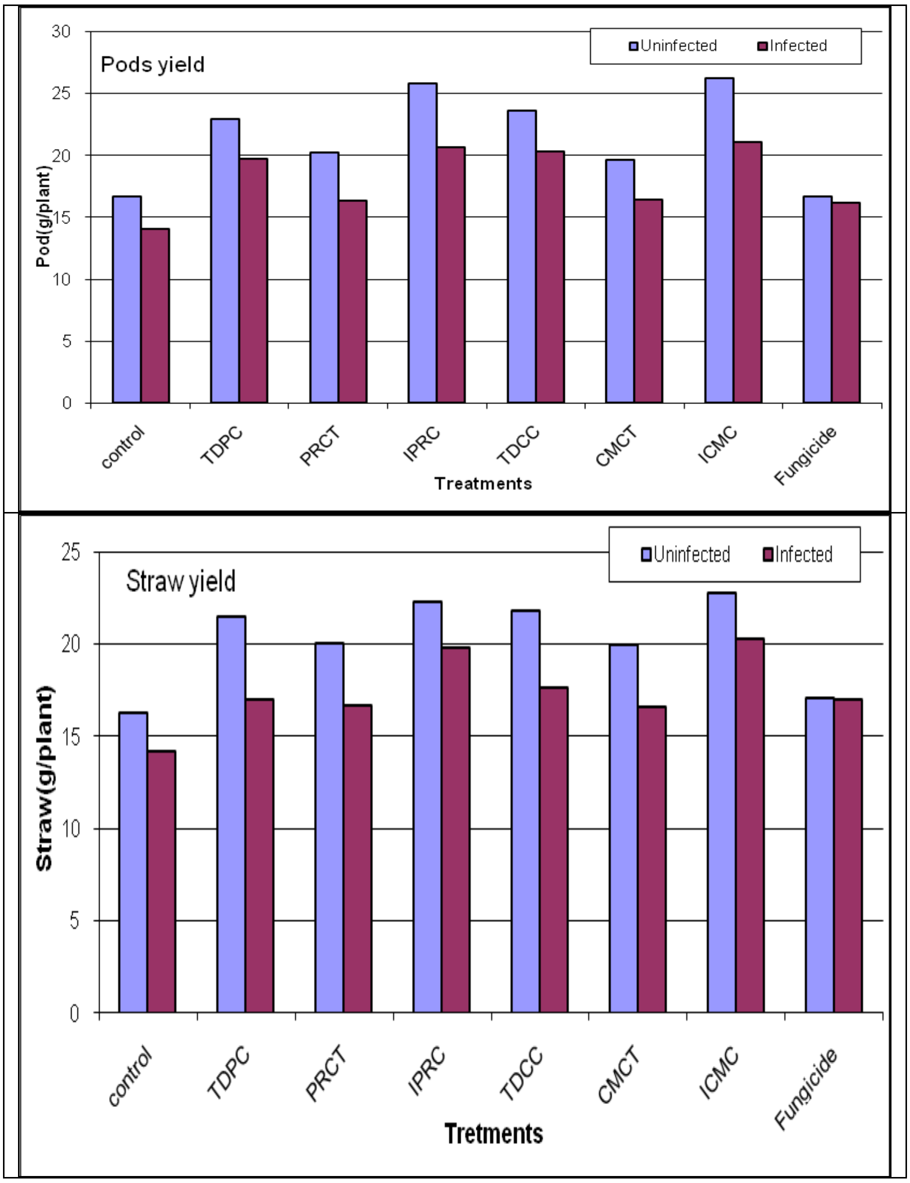

Fig.8. Effect of composts or their teas on yield components (pods and straw) of peanut crop under artificial infection with *Rhizoctonia solani,* after 120 days of planting.
TDPC= tea –deprived plant residues compost, PRCT= plant residues compost tea, IPRC= intact plant residues compost, , TDCC= tea-deprived cattle manure compost, CMCT=cattle manure compost tea, ICMC= intact cattle manure compost, Fungicide=Rhizolex.

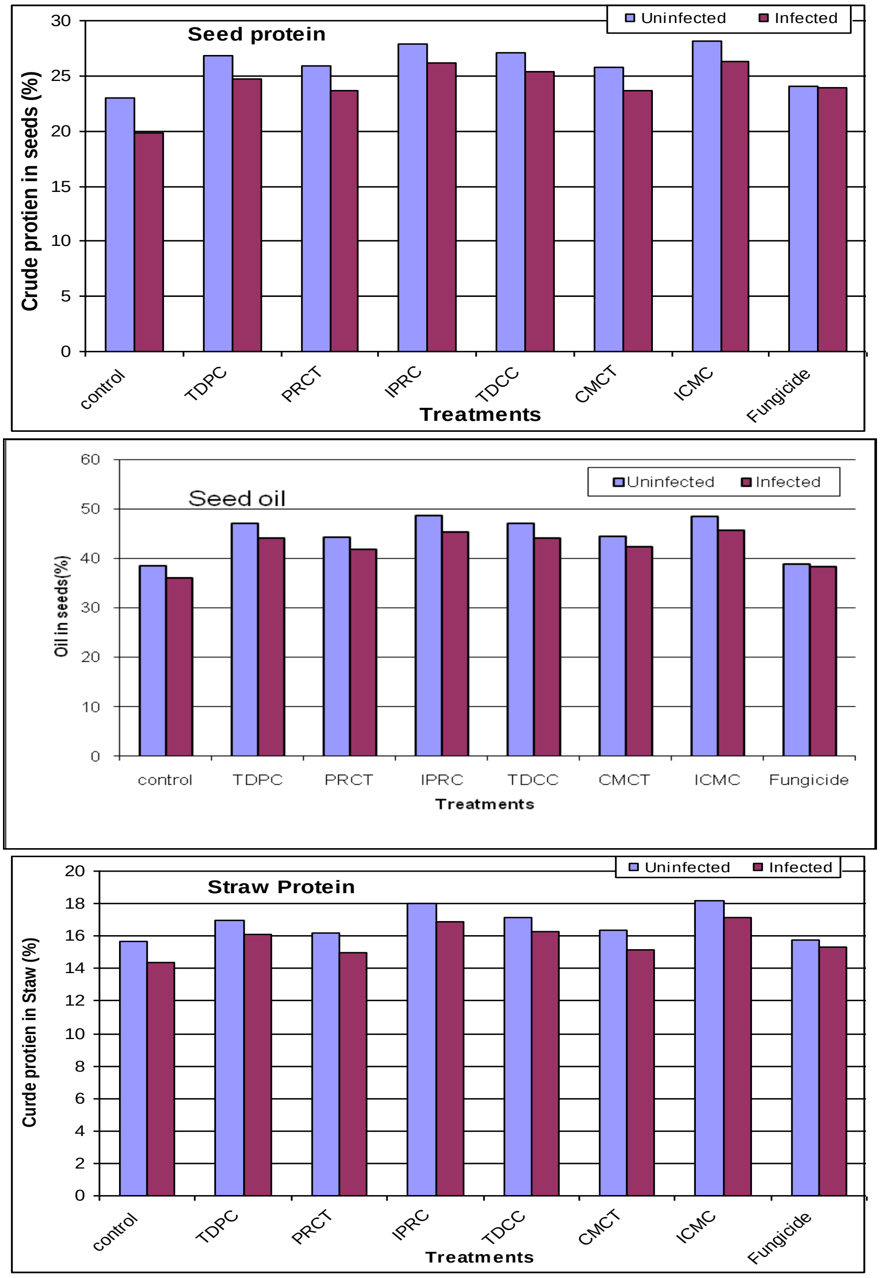

Fig. 9. Effect of composts or their teas on main biochemical constituents of peanut seeds and straw under artificial infestation with *Rhizoctonia solani,* after 120 days of planting. PRC=Plant residues compost, CMC=Cattle manure compost, PRCE=PRC+its tea, CMCE= CMC +its tea, IPRC= intact plant residues compost, , TDCC= tea-deprived cattle manure compost, CMCT=cattle manure compost tea, ICMC= intact cattle manure compost, Fungicide=Rhizolex .

It could be deduced from the mentioned results that incorporation of mature intact compost, rich in biological and chemical traits, to soil directly before sowing, actually leads to encouraging the growth of peanut plants, and produces high quantity and quality of crop yield, due to improving soil conditions and its nutritional status, in general, and the sandy soils in particular. The promotive effect of bio-organic amendments on legume production in newly reclaimed soils had been confirmed by several investigations (El-Tahlawy, 2006 and Abdel-Wahab *et al*., 2008).

Interaction of *Rhizoctonia* infection and the different approaches of compost treatments, obviously declared that application of such bioorganics provided a high power to the growing plants, to resist and combat the pathogen invation,leading eventionaly to increase their yield. The peanut crop figures fluctuated between 14.00 and 21.03 g/plant for pod yield, 14.17 and 20.30 g/plant for straw yield, 19.77 and 26.36 % for seed protein content, 36.00 and 45.63% for seed oil content and 14.86 and 17.11% for straw protein content, amongst the different approaches of the tested amendments. The biocontrol efficiency of such materials could alleviate the pathogenic virulence, leading to boost peanut crop production .These appreciable properties of composts are originated from their native microorganisms, beside presence of some active substances such as humic and phenolic compounds (Siddiqui *et al*., 2008). Beneficial microorganisms known as plant growth promoting rhizobacteria (PGPR), abundantly present in composts , expectedly enhance crop yield through several synergistic effects and active mechanisms , which include augmentation of nutrient availability, production of regulating biochemicals, excretion of fungal cell wall lytic enzymes , antibiosis and providing higher- level of immunity (Hiotink *et al*., 1993).

Conclusion

Fungicide, treatments despite its highest eradication power against the pathogenic fungus, came inferior to those of the organic additions regarding the studied parameters of plant growth and yield of peanut crop cultivated in the sandy soil. This was due certainly to the absence of organic supplements as rich sources of plant nutrients and growth promoting substances and other potential benefits.

As long as, mature compost, top dressed onto soil prior to sowing, are efficient fertilizing and biocontrolling amendments for crop cultivation, compost teas , being easily handled and transported , may be a desirable practice in other cases. Compost teas can be suitable for smaller agricultural areas, *e.g*. greenhouses, plastic cultures and gardens of flowers and or mental plants. Likewise, such teas could be properly used in nursery plantations, for horticultural seedlings to be grown in container media, especially those nutrionally poor substrates, *e.g*. sand, vermiculite or peat moss. In such cases, compost teas serve as nutrient sources and natural bioprotecting agents against pathogenic microorganisms (Scheurell, 2002).

Further studies are thus invited to ascertain the feasibility of such practices under different conditions and variables, in order to support the concept of organic farming.

References

Abdel-Wahab, A.F.M. (2008) Evaluation of enriched compost and its role in synergy with rhizobacteria and N-fertilization for improving maize productivity in sandy soil. J.Agric. *Sci.,Ain Shams Univ*. **16**, 319-334

.

Ahmad, F., Ahmad, I. and Khan, M.S. (2005) Indole acetic acid production by indigenous isolates of *Azotobacter* and *Pseudomonas fluorescent* in the presence and absence of tryptophan. *Turk. J. Biol*. **29**, 29-34.

A.O.A.C. (1990) "*Official Methods of Analysis*".15thed. Association of Official Analytical Chemists, Washington D.C., USA.

Compant, S., Duffy, B., Nowak, J., Clement, C. and Ait, B.E. (2005) Use of plant growth-promoting bacteria for biocontrol of plant diseases, principles, mechanizms of action, and future prospects. *Appl. Environ. Microbiol*. **72**, 4951-4959.

Dobbelaere, S., Vanderleyden, J. and Okon, Y. (2003) Plant growth promoting effects of diazotrophs in the rhizosphere. *Crit. Rev. Plant Sci*. **22**, 107-149.

El-Masry, M.H., Khalil, A.I., Hassouna, M.S. and Ibrahim, H.A.H. (2002) *In situ* and *in vitro* suppressive effect of composts and their water extracts on some phytopathogenic agricultural fungi. *World J. Microbiol. Biotech.* **18**, 551–558.

El-Sayed, S.Y.S. (2007) Utilization of some biological resources in biocontrol and promotion of some legume plants growth. *M.Sc. Thesis,* Faculty of Women for Arts, Science and Education, Ain Shams University**,** Cairo, Egypt .

.

El-Tahlawy, Y.A.Gh. (2006) Microbial impact on productivity of some medicinal plants. *M.Sc. Thesis*, Fac. of Agric. Ain Shams Univ., Cairo, Egypt.

Hassanein, A.M., El-Garhy, A.M. and Mekhemar, G.A.A. (2006) Symbiotic nitrogen fixation process in faba bean and chickpea as affected by biological and chemical control of root-rot. *J. Agric. Sci., Mansoura Univ*. **31**, 963-980.

Hoitink,H.A.J. and Boehm, M.J. (1999) Biocontrol within the context of soil microbial communities, a substrate –dependent phenomenon. *Annu.Rev.Phytophathol*, **37**, 427-446.

Hoitink, H.A.J., Boehm, M.J. and Hadar, Y. (1993) Mechanisms of suppression of soil borne plant pathogens in compost-amended substrates. In: "*Science and Engineering of Composting: Design, Environmental, Microbiological, and Utilization Aspects"* Hoitink, H.A.J., Keener, M. (Ed.),. Renaissance Publications,Worthington, Ohio, USA.

Joshi, D., Hooda , K.S., Bhatt , J.C., Mina, B.L. and Gupta, H.S. (2009) Suppressive effects of composts on soil-borne and foliar diseases of French bean in the field in the western Indian Himalayas. *Crop Protection*, **28** , 608–615.

Koné, S.B., Antoine, D., Russell, T. J., Hani, A. and Avis, J. (2010) Suppressive effect of non-aerated compost teas on foliar fungal pathogens of tomato. *Biological Control*, **52**, 167–173

Kwok, O.C.H., Hoitink, H.A.J. and Chen, W. (1987) Characterization of bacteria involved in suppresion of *Pythium* damping off. *Phytopath.* **77**, 1707.

Maloy, O. and Murray, T. (2001) "*Encyclopedia of Plant Pathology*", Vol. 1. John Wiley & Sons, Inc., New York, USA.

Miller, R.W. and Donahue, R.L. (1990) "*Introduction to Soil and Plant Growth*". 6^{th} ed. Prentice Hall, Engle Wood Clifs, NJ, USA.

Page, A.L, Miller, R.H. and Keeney, D.R. (1982) "*Methods of Soil Analysis*". Parts 1&2. Amer.Soc.Agron. Madison, Wis., USA.

Scheuerell, S. J. (2002) Understanding how compost tea can control disease. *Biocycle,* **44** (2), 20-25.

Scheuerell, S. and Mahaffee, W. (2002) Compost tea principles and prospects for plant disease control. *Compost Sci. and Utili*. **10** (4), 313–338.

Siddiqui, Y., Meon S., Ismail, M.R. and Ali, A. (2008) *Trichoderma*-fortified compost extracts for the control of *Choanephora* wet rot in okra production. *Crop Protection*, **27**, 385–390.

Snedecor, G.W. and Cochran, W.G. (1980) *Statistical Methods*. 7^{th} ed., Iowa State Univ. Press, Ames, Iowa, USA.

Tilak, K.V.B.R., Ranganayaki, N. , Pal, K.K. , De, R., Saxena, A.K., Nautiyal, C.S. , MIttal, S., Tripathi, A.K. and Johri, B.N. (2005) Diversity of plant growth and soil health supporting bacteria. *Curr. Sci*. **89**, 136-150.

Van Bruggen, A. and Semenov, A. (2000) In search of biological indicators for soil health and disease suppression. *Appl. Soil Ecol*. **15**, 13-24.

(*Received* 2/1/2011;
accepted 11/4/2011)

فعالية إضافة الكومبوست وشاي الكومبوست للأرض الرملية للحد من مرض الذبول وتحسين نمو وإنتاجية الفول السوداني

ماهر مراد الشناوى ،عاطف فتح الله عبد الوهاب* ، محمد أحمد الحويطى ، شبل عبدالله عبد الجواد***
قسم علوم الاراضى - كلية الزراعة –جامعة المنوفية- المنوفية *معهد الأراضى والمياه والبيئة- مركز البحوث الزراعية و**معهد الدراسات والبحوث البيئية – جامعة المنوفية- المنوفية – مصر.

فى تجربة أصص تم زراعة بذور الفول السوداني فى ارض رملية مضاف إليها كومبوست نباتي , كومبوست حيواني و شاي الكومبوست المستخلص من كلا النوعين وكانت المعاملات كالاتى: كومبوست نباتي منزوع منه الشاي (TDPC) ، كومبوست حيواني منزوع منه الشاي (TDCC) وشاي الكومبوست النباتي والحيواني (PRCT& CMCT)، والصورة الكاملة لكلا النوعين النباتي والحيواني (IPRC& ICMC) نصف معاملات التجربة تم معاملتها بالعدوى الصناعية بفطر *Rhizoctonia solani* والذى يحدث مرض ذبول البادرات وكذلك تم استخدام المبيد الفطري ريزوليكس للمقارنة وكانت أهم النتائج المتحصل عليها هي:

١- أظهرت المعاملات العضوية انخفاض معنوي لمرض ذبول البادرات وأدت إلى زيادة صحة البادرات المعاملة بالعدوى الصناعية بالفطر مقارنة بالنباتات الغير معاملة بالكومبوست (الكنترول) وقد تفوق استخدام المبيد الفطري فى منع الإصابة مقارنة بالصور العضوية.
٢- أظهرت المعاملة بالفطر ضررا بالغا بحالة التعقيد على جذور النباتات , وأدى إدخال الصور العضوية إلى تحسن كبير فى حالة التعقيد على جذور النباتات .
٣- تحسنت جميع مظاهر النمو الخضري وكذلك المحصول ومكوناته (القرون – القش) مع الإضافات العضوية سواء المعاملة بالفطر والغير معاملة .
٤- الأختلافات بين صور الكومبوست المضاف سواء النباتي والحيواني كانت غير معنوية مع القياسات المختلفة .
٥- الفعل الايجابي لصور الكومبوست المضاف أظهرت الترتيب التالي :

ICMC=IPRC > IPRC>TDCC= TDPC> CMCT> PRCT

وقد عكست هذه النتائج فعالية الكومبوست وصوره على تحسين النمو وإمكانية استخدامه في المقاومة الحيوية للأمراض الفطرية.