Soil Amendment and Seed Treatments with Compost Tea as Alternative Fungicide for Controlling Root Rot Disease of Bean Plants

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(Received: January 1, 2011and Accepted: February 23, 2011)

ABSTRACT

Clarified compost tea of three different plant sources of slurries of spent mushroom substrate (SMS), path and/or rice straw, were used as inhibitors for different foliar and soil borne pathogens. *Fusarium solani* Mart sacc., *Macrophomina phaseolina* Tassi and *Rhizoctonia solani* Kuhn proved to be the most dominant isolated fungi from roots of bean plants infected with root rot disease in Noubaria district (El-Behera Governorate, Egypt). Meanwhile, *Fusarium oxysporium, Phythium* spp. and *Sclerotium rolfsii* were frequently recorded. Pathogenicity test proved that the most effective fungi on beans were *F. solani* and *R. solani*, followed by *M. phaseolina*. In greenhouse trails, soil amendment with compost tea (1) (SMS) showed high effect in reducing root rot incidence caused by *F. solani, R. solani* and *M. phaseolinae* at pre-emergence damping-off stage. The same treatment reduced root rot disease after 45 days caused by the previous three pathogens. Seed treatment with compost tea reduced root rot diseases at the pre– and post emergence stages. Meanwhile, coating seeds with compost tea had a good effect in reducing root rot incidence under field conditions. After 40 and 60 days of sowing, amended soil increased fresh pods yield in the two successive seasons 2009 and 2010. It possessed a strong antifungal active effct against soil borne pathogens. It is worth to recommend the practical use of compost tea or seed treatments to control soil borne plant pathogens as a substitute of chemical fungicides without any risk to human, animal and environment.

Key words: Soil amendment, Seed treatment, Compost tea, Root rots disease, Beans, Egypt.

INTRODUCTION

Controlling soil borne pathogens depends mainly on fungicidal applications, causing hazards to human health and environment (Rauf, 2000). In recent years soil amendment and seed treatment are gaining importance in management of many plant pathogens as alternative methods for chemical fungicides. Literature pertaining to preparation and various uses of compost and compost tea to promote plant health is voluminous (Satish, *et al.* 2000).

Use of compost tea for the control of foliar and soil borne disease of common beans plants (*Phaseolus vulgaris* L.) proved vulnerable to root rot diseases caused by *Fusarium solani* Mart sacc., *Rhizoctonia solani* Kuhn and *Macrophomina phaseolina* which attack roots causing damping-off and root rot diseases as well causing substantial losses to bean crops (Rauf, 2000). Also, seed coating or dressing with compost tea was the most effective treatment for controlling root rot diseases (Jahn and Puls, 1998).

Soil amendment with agricultural wastes, formulated as compost and compost tea, showed effective disease control and increased yield of many crops (Liu & Huany, 2000 and El–Mohamedy, 2004). Nemec *et al.* (1996) stated that amended plants with a formulation of compost tea which included many microorganisms such as: *T. harzianum, B. subtilis, Gilocladium virens* and *Streptomyces* sp., had played a role as bio-control agents and reduced root rot diseases in grown citrus plants. Compost tea as seed treatment, integrates in the biological and physiological of disease control was recently been used as an alternative method for controlling many seed and soil borne pathogens (Warren & Bennett, 1999 and El–Mohamedy, 2004).

The present study aimed to evaluate the efficacy of soil amendment with compost tea and/or seed treatment for controlling bean plant root rot pathogens under greenhouse and field conditions.

MATERIALS AND METHODS

Compost preparation

Five mixtures of animal manure (cow dung) and poultry manure were mixed at constant ratios. Spent mushroom substrate (SMS), path and rice straw as plant sources were used for preparing three kinds of compost. C/N ratio was about 30:1. Some of the physical and chemical characters of composted materials *i.e.* as organic matter, organic carbon, total nitrogen, C/N ratio; total phosphorus and total potassium were evaluated. Pathogenic indicators (total colifrom bacteria, fecal colifrom bacteria and *Salmonella & Shigella*), acid producing bacteria and nematode were determined.

Aerobic composting of the organic wastes (animal manure; cow dung and poultry manure) was mixed at different ratios with constant rate of rice straw SMS or path to give a C/N ratio of about 30:1. Mixtures were moistened to about 60% of their water holding capacity and performed in five Gonya (plastic perforated bags to provide aeration and prohibit anaerobic fermentation). Each mixture was turned weekly and moistened to reach 60 % of water holding capacity. Physical and chemical properties were monitored during the composting period which extended for ten weeks, including maturation time. These analyses were pH value, electric conductivity (EC), organic matter (OM), organic carbon (OC), total nitrogen (TN), ash, C/N ratio, total phosphorus, total potassium, acid producing bacteria, total coliform bacteria, fecal colifrom bacteria, *Salmonella*, *Shigella* bacteria and nematode as adopted by (Ingham *et al.* 1985). The physical and chemical characteristics of the raw materials used for compost are shown in table (1).

Animal manure (cow dung) and poultry manure were collected and subjected to analysis. The SMS, path and rice straw were used to adjust the C/N ratio during composting. Compost extracts were prepared by using 10g. compost to 90ml. water and then diluted to 1/100 and1/1000 concentrations. Bulk density was determined according to Nell, *et al.* (1983). Moisture content of compost, pH value, organic matter, organic carbon and total nitrogen, ammonical nitrogen, nitrate nitrogen were determined according to the standard methods of Page *et al.* (1982).

Total and soluble potassium were determined by a flame photometrical method (Chapment and Pratt, 1961). Soluble and total phosphorus were also determined colormetrically according to Olsen and Dean (1965).

Preparation of compost tea

Compost was prepared after 8 – 12 weeks as follows:

1- A bucket was filled by half-full with water.
2- Aeration bubble air through the water was made for 10-20 minutes before adding the compost.
3- Compost was added to fill bucket to nearly the top with enough space for bubbling.
4- Molasses (about 2 % of the volume) were added as food source for bacteria or fungi but realized that the amount needs to be kept minimal or growth of bacteria and fungi will use oxygen in the air faster than the aquarium pump can replace it.
5- Aerator provided with continuous flow of air was used to create enough turbulence to provide mixing.
6- Brewed for 4h, 1 week and 2 weeks, minimum, longer was better. Then, the aerator was turned off and left the brew to settle for half hour until most of the solids were on the bottom of the bucket. The soluble portion of the tea was decanted from the top, leaving the insoluble solids to be returned to the compost pile. If the tea is used in a back sprayer, preparation of compost under laboratory or outdoor conditions should be prepared under temperatures ranging between 15 and 20 °C. The period needed for the compost to be covered with water, was called "extraction time". It might be necessary to strain the tea through cheese cloth, or a fine mesh tea sieve to prevent plugging of the sprayer nozzles. The induction time is the time span between application and inoculation of the pathogen (Ingham *et al.* 1985).

Table (1): Physical and chemical properties of three types of composts tested

Character	Compost (1) with (SMS)		Compost (2) with path		Compost (3) with rice straw	
	Unit	Quantity	Unit	Quantity	Unit	Quantity
Density	(kg/m³)	755	(kg/m³)	690	(kg/m³)	710
Moisture content	%	33	%	31	%	19
pH (1:10)		8.11	d/sm	8.18	dS/m	5.64
Electric conductivity EC (1:10)	dS/m	3.38	d/sm	3.63	dS/m	3.32
Total nitrogen	%	1.13	ppm	1.05	ppm	0.82
Ammonical nitrogen	ppm	773	ppm	793	ppm	202
Nitrate nitrogen	ppm	Nd	ppm	Nd	ppm	11
Organic matter (om)	%	31.61	%	31.27	%	32.59
Organic carbon (oc)	%	18.33	%	18.13	%	18.90
Ash	%	68.39	%	68.73	%	67.41
C/N	Ratio	1:16.2	Ratio	1:17:26	Ratio	1:23.04
Total phosphorus	%	0.66	%	0.86	%	0.79
Total Potassium	%	0.60	%	0.93	%	0.40
Harb seeds	---	Nd	---	Nd	---	Nd
Nematode	Larva 200g	Nd	Larva 200g	Nd	Larva 200gm	Nd

Nd = not detected. Result on oven dry basic except moisture content and density

Water Content and Dry Residue (WC) in % = $\frac{\text{initial weight - final weight x 100 (+/-0.1)}}{\text{Initial weight}}$

Dry residue (DR) in % =100 – WC

Table (2): Physical and chemical properties of compost tea analysis

Item	Compost tea (1) SMS)(		Compost tea (2) Path)(		Compost tea (3) Rice straw)(	
	Unit	Quantity	Unit	Quantity	Unit	Quantity
Smell	---	Normal	---	Accepted	---	Accepted
Color	---	Dark	---	Blacklight	---	Dark
Total solids	g/L	2.35	g/L	8.55	g/L	102
pH (1:10)	dS/m	7.28	dS/m	6.19	dS/m	5.09
Electric conductivity EC (1:10)	dS/m	2.76	dS/m	8.34	dS/m	24.3
Total Nitrogen	ppm	197	ppm	238	ppm	2616
NH_4 -N	ppm	116	ppm	37	ppm	301
No_3 – N	ppm	Nd	ppm	Nd	ppm	153
Chemical Oxygen Demand (COD)	ppm	896	ppm	1476	ppm	10330
Biological Oxygen Demand (BOD)	ppm	310	ppm	450	ppm	290
Total P	ppm	4100	Cfu /ml	5100	ppm	2310
Total K	ppm	260	Cfu /ml	970	ppm	2300
Total bacterial count	Cfu /ml	$66x10^5$	Cfu /ml	$53x10^6$	Cfu /ml	$170x10^5$
Total actinomycetes	Cfu /ml	$65x10^4$	Cfu /ml	$62x10^5$	Cfu /ml	$63x10^4$
Total fungi	Cfu /ml	$35x10^2$	Cfu /ml	$40x10^3$	Cfu /ml	$30x10^3$
Total Coli form bacteria	Cfu /ml	Nd	Cfu /ml	Nd	Cfu /ml	Nd
Fecal Coli form bacteria	Cfu /ml	Nd	Cfu /ml	Nd	Cfu /ml	Nd
Salmonella & *Shegella* bacteria	Cfu /ml	Nd	Cfu /ml	Nd	Cfu /ml	Nd

Nd = not detected. Result on oven dry basic except moisture content and density
Water Content and Dry Residue (WC) in % = {initial weight-final weight x 100 (+/-0.1)}/ initial weight
Dry residue (DR) in % =100 - WC

Populations of total and fecal coliform bacteria, *Salmonella* and *Shigalla* were counted according to (Chapment & Prat, 1961).

C/N ratio is traditionally been used to determine the degree of compost maturity and quality. As the values of C/N ratios usually show a reduction during the composting process, at all the mixtures under this study, the C/N ratios narrowed from the initial value about (30:1) to reach 14.2, 13.1 and 11.5:1 for the mixtures 1, 2 and 3, respectively (Table 2). Many authors reported that a C/N ratio below 20 is an indication of acceptable maturity (Jimenez and Garcia, 1991). Analyses of compost tea are present in biological oxygen demand in total count of bacteria, fungi and actinomycetes of compost tea were adjusted in the three types of compost tea which prepared from different sources of compost.

Casual organisms

Samples of bean plants showing root rot disease symptoms were collected from different locations at Noubaria region. All samples were subjected to isolation trials for causal organisms. The purified isolated fungi were identified according to cultural and microscopic characters reported by Gilman, (1957) and Nelson *et al.* (1983). Number of each isolate of fungus was recorded and percentage of frequency in each location was calculated.

Pathogenicity test

Fusarium solani, Rhizoctonia solani and *Macrophomina phaseolina* were high frequency isolated fungi and selected for this study. Their pathogenic ability to induce root rot on bean plants was estimated as follows:

- plastic pots (20 cm diameter) contained sterilized sandy loam soil infected individually with inocula of each fungus was grown on sand–barley medium (1:1 w/w) and 40% water) for two weeks at 25+1°C.
- Ten pots were chosen for each fungus.
- Check treatment (control) was prepared without addition of tested fungi.
- Surface sterilized seeds of beans were sown at the rate of 3 seeds /pot.
- Percentage of pre– and post–emergence damping–off incidence was determined after 15 and 45 days from sowing.

Greenhouse experiment

Efficacy of amended soil and/ or dressing of seeds with compost tea for controlling root rot pathogens were evaluated. Bean seeds were initially washed with tap water to remove soluble materials. Seeds were dressed in compost tea at the rate of (2L of compost tea/1 kg of seeds) according to (Harman and Taylor, 1988). Seeds were shaken at 150 rpm for 48hr, then dried at room temperature and placed in polyethylene bags for further studies.

Efficacy of soil amendment and seed dressing with compost tea

Sandy loam was artificially infected with inoculate of each of *F. solani, R. solani* and *M. phaseolina* in plastic pots (20. cm diameter). The following treatments were used; untreated bean seeds were sown in infected soil, previously amended with compost tea 14 days before seed sowing while treated seeds (soaked for 15 min. in compost tea) were sown in infected soil. Control treatment (untreated healthy seeds) was sown in infected soil with pathogenic fungi. Ten bean seeds were sown in each pot and ten pots were used as replicates for each treatment. Percentage of damping- off and root rot incidence, during 45 days of sowing date, were estimated, based on percentage of healthy survival plants.

Field experiments

Two field experiments were carried out during 2009 and 2010 seasons under field conditions in naturally heavily infected soil with bean plant root rot pathogens at Noubaria district. Highly effective treatments for controlling the root rot pathogens under greenhouse conditions were chosen for evaluation under field conditions. Eighteen treatments and six untreated soils and seeds (as control) were used in this experiment. Five replicates were used in each treatment. Field plots (3m x 7m) comprised of 10 rows and 60 pits /row were arranged in a randomized complete block design. Bean seeds were sown in all treatments at the rate of 3 seeds/ pit. All plots were planted by early October, 2009 and by mid-March 2010. Cultivated plots received the traditional agricultural practices.

Percentages of root rot disease incidence at pre- and post–emergence stages of bean plants were recorded after 20, 40 and 60 days from sowing date. Obtained bean yield was determined as fresh pods for each treatment at the end of each growing season and average of the accumulated yield kg/ plot was also calculated.

Population dynamics of fungi and bacteria in soil rhizosphere

This experiment was carried out at soils, Water and Environment Res. Institute, A.R.C. Giza, Egypt, using plates count technique (Allen, 1961). Samples of soil obtained from the rizosphere of the treated plants at the end of experiments were diluted to 10, 100, 1000, 10000 and 100000 ppm. To determine total counts of fungi in the rhizosphere soil of all tested treatments, PDA medium supplemented with 250 ppm choromycetin was applied (Papavizes and Lumsden, 1982).

Stock cultures of various bacteria isolated from rhizosphere soil, were maintained on agar slants at 4°C in nutrient broth medium. A loopfull of the stock culture was used for preparing the inocula. The inocula used in the experiments were obtained from a 24 h shake culture grown aerobically in nutrient broth medium at 30°C (Weltzien and Kttererer, 1986). Total counts of fungi and bacteria were expressed as colony forming units (cfu) per gram dry soil.

Statistical analysis

Tukey test for multiple comparisons among means was applied (Neler *et al.* 1985).

RESULTS AND DISCUSSION

Causal organisms

Seventy-two fungal isolates, representing five species belong to five genera, *i.e. Fusarium* spp. (30 isolates), *Macrophomina phaseolina* (18 isolates), *Rhizoctonia solani* (15 isolates), *Pythium* spp. (5 isolates) and *Sclerotium rolfsii* (8 isolates), were isolated from bean plants showing root rot disease symptoms.

Data in table (3) indicate that the most dominant fungi were; *F. solani* (30%), followed by *R. solani, M. phaseolina. F. oxysporum, S. rolfsii* and *Pythium* spp. which were less frequently isolated. Root rot disease on bean plants caused by *F. solani, R. solani* and *M. phaseolina* significantly decreased either in artificially infected soil in the greenhouse or in naturally infected soil in the field. This agree with that obtained by Rauf, (2000).

Greenhouse experiments

Pathogenicity test: proved that all tested fungal isolates were able to cause root rot infection in bean plants with different degrees at both pre- and post-emergence stages. Data in table (4) show that, *F. solani, R. solani* and *M. phaseolina* were the most fungi isolates which caused damping–off and root rot disease to bean plants. *F. solani* caused a highly significant effect on pre- and post–emergence stages at the rate of 37.3 and 55.0%, respectively. *R. solani* and *M. phaseolina* had less aggressive effect. The least percent of survival plants (7.7 %) was recorded by *F. solani*, followed by 29.9 and 46.8% by *R. solani* and *M. phaseolina*, respectively. The previous three pathogens were the most dominant isolated fungi from infected roots of common bean plants in Noubaria district. Meanwhile, *F. oxysporum, Sclerotium rolfsii* and *Phythium* spp. were less frequent. The most pathogenic fungi on bean plants were *F. solani* and *R. solani*, followed by *M. phaseolina.* Many investigators recorded *F. solani, R. solani, M. phaseolina, F. oxysporum* and *Phythium* spp. among the main pathogens causing root rot disease of bean plants (Satish *et al.*, 2000).

Efficacy of soil amendment and seed treatments on damping–off and root rot disease incidence

Data in tables (5 and 6) indicate that all treatments significantly reduced the percentage of root rot diseases caused by *F. solani, R. solani* and *M. phaseolina.* The three compost tea (1, 2 and 3) were effective as they reduced *Fusarium* root rot by 73.9, 56.5 and 47.8%, *Rhizoctonia* root rot by 78.6, 75.5 and 67.8% and *M. phaseolina* charcoal rot by 70.0, 62.5 and 54%, respectively.

Table (3): Frequency of isolated fungi from roots of bean plants showing root rot disease symptoms at different locations in Noubaria district

Noubaria Location	Frequency of isolated fungi %						
	F. solani	*R.solani*	*M. phaseolina*	*F.oxysporum*	*Phythium* Spp.	*S rolfsii*	Total
El-Boustan						9.0	30.5
El-Essraa	35.3	17.6	29.4	5.9	5.9	5.9	23.6
Emam Malk	36.3	18.1	18.1	18.1	0	18.1	15.2
El-Ghazali	23.8	8.6	23.0	18.4	18.4	15.4	18
NRC farm	22.2	34.3	22.2	11.1	5.0	11.1	12.5
Mean	30.0	20.0	23.6	12.5	6.9	9.7	100

Samples were collected through 60 days at growing season. *Number of isolates.

Table (4): Pathogenicty of isolated fungi to induce root rot infection in bean plants sown in artificially infected soil under greenhouse conditions

Fungal isolate	Root rot incidence %		
	Pre-emergence (15days)	Post-emergence (30days)	Survival plants (%) (45days)
Fusarium solani	37.3c	55.0d	7.7d
Rhizoctonia solani	32.5b	57.5c	10.0c
Macrophomina phaseolina	30.0b	52.5b	17.5b
Control	5.0a	5.0a	90.0a

Figures with the same letter are not significantly different (P = 0.05)
Percentages survival plants were estimated after 45 days of inoculation by deducting pre- and post-emergence from total plants.

Table (5): Effect of soil amendment with compost tea products at pre-emergence incidence in bean plants under greenhouse conditions

Treatment	%pre- emergence damping – off					
	F. solani	Reduction%	*R. solani*	Reduction%	*M. phaseolina*	Reduction%
			Compost tea(1)			
Soil amendment	12d	73.9	12c	78.6	14c	70.0
Seed coating	18c	60.8	16c	71.4	18bc	62.5
			Compost tea(2)			
Soil amendment	20c	56.5	14c	75.0	18bc	62.5
Seed coating	26b	43.5	30b	46.4	24b	50.0
			Compost tea(3)			
Soil amendment	24b 47.8	47.8	18c	67.8	22b	54.2
Seed coating	26b	43.5	32b	42.9	25b	47.9
Control	46a		56.0a		48.0a	

Figures with same letter are not significantly different (P = 0.05)

Table (6): Root rot disease incidence and survival plants (%) of bean sown in artificially infested soil affected by different soil and seed treatments under greenhouse conditions

Treatment	% root rot incidence after 45 days post emergence						% survival plants		
	F. solani	Reduction %	*R. solani*	Reduction %	*M Phaseolina*	Reduction %	*F. Solani*	*R. solani*	*M phaseolina*
				Compost tea (1)					
Soil amended	12c	73.9	8c	76.4	10c	72.2	88e	92c	90b
Seed coating	16c	60.2	12c	64.2	16c	55.5	84d	88e	84c
				Compost tea (2)					
Soil amended	18c	60.8	14c	58.8	20bc	44.4	82d	86e	80b
Seed coating	32b	30.4	24b	23.5	28b	22.2	68c	76c	72b
				Compost tea (3)					
Soil amended	42a	8.7	30a	11.7	34a	5.5	52b	70a	66a
Seed coating	34a	26.1	20b	41.2	24b	33.3	66c	82b	76b
Control	46a		34a		36a		54a	66c	64a

- Figures with same letter not significantly different (P = 0.05).
- Reduction = {(control - treatment)/ Control} x100

Table (7): Effect of different soil and seed treatments with SMS compost on root rot disease incidence of bean plants in naturally infected field during 2009 and 2010 seasons

Treatments	Root rot incidence %						
	Pre-emergence (20 days)	Reduction %	Pos-temergence (40 days)	Reduction %	Pos-temergence (60 days)	Reduction %	Survival plants (%)
	Compost tea (SMS) (1)			Season (2009)			
Soil amended	8.5c	63.8	5.3d	79.2	5.0d	76.5	81.2
Seed coating	6.7c	71.4	8.0c	68.6	8.5c	60.0	76.8a
Control	23.5a	-	25.5a	-	21.3a	-	29.7c
	Compost tea (SMS) (1)			Season (2010)			
Soil amended	8.6d	68.1	9.0c	71.4	7.0c	66.6	75.4a
Seed coating	5.8c	78.5	13.5b	57.1	10.7b	49.0	70.0b
Control	27.0	-	31.5a	-	21.0a	20.5	20.5d

- Figures with the same letter are not significantly different (P = 0.05).
- Reduction = {(control – treatment) / Control} x100

Table (8): Yield of fresh pods of bean plants as affected by different soil and seed coating treatments under field conditions during the two successive seasons of 2009 and 2010

Treatments	Average accumulated pods			
	Season 2009 yield (kg/plot)	Increase %	Season 2010 yield (kg/plot)	Increase %
	Compost tea (SMS)(1)			
Soil amendment	29.6	63.04	24.6	53.75
Seed coating	26.5	44.02	21.8	36.25
Control	18.4	---	16.0	--

Table (9): Fungal and bacterial cultures for bioassay population dynamics of fungi and bacteria in soil rhizosphere

Organisms	Lowest concentration for a zone (μy*/disk)	Medium (pH)
Fusarium oxysporum f. sp *cucumerium*. KF- 1036	12.5	SLA (4.0)
Helminthosporium sigmoideum var. *irregulare* IFO.5273	200	Sab (5.6)
Glomerella cingulata. IFO- 9767	100	SLA (5.6)
Gibberella zea. IFO- 9462	50	SLA (5.6)
Candida albicans. IFO- 1594	>200	Sab (5.6)
Saccharomyces cerevisiae . IFO- 1007	>200	Sab (5.6)
Schizosaccharomyces pombe . IFO- 0366	>200	Sab (5.6)
Pseudomanas syringa IFO- 14053	>200	NB (7.0)
P. fluorescens . IFO- 14160	>200	NB (7.0
Agrobacterium tumefaceins . IFO- 3058	>200	NB(7.0)
Bacillus subtilis . IFO- 14140	>200	NB(7.0)
B cereus . IFO- 13597	>200	NB(7.0)
Streptomy scabies . IFO- 13768	>200	NB(7.0)
T. harzianum	15.3	SLA (5.0)

* μy = Number of microorganisms / disk

Moderate effect was obtained using the coated seeds. These treatments reduced root rot disease incidence in infected soils; *F. solani* by 60.8, 43.5 and 43.5 %, *R. solani* by 71.4, 46.4 and 42.9% and *M. phaseolina* by 62.5, 50.5 and 47.9%. Results in table (6) clearly showed also that all treatments significantly increased the percentages of survival of bean plants.

Amended soils with the different three compost tea and/ or seed treatments significantly reduced root rot diseases caused by *F. solani* which reduced diseases by73.9 and 60.2%. for compost tea (1), 60.8 and 30.4% for compost tea (2), 26.1 % for seed coating of compost tea (3). *M. phaseolina* reduction reached 72.2 and 64% for compost tea (1), 44.4 and 22.2% for compost tea (2) and 33.3% for seed coating of compost tea (3), respectively. Meanwhile, there was no significant difference between soil amendment with compost tea (3) which reduced *Fusarium* rot by 8.7 and by 5.5 % for *M. phaseolina* and compost tea (1) caused high significant effect on *F. solani, R. solani* and *M. phaseolina* root rots on bean plants.

There was no significant difference between treatments in compost tea (2) and (3). Treatments of compost tea (1) showed highest percentage of bean plant survival compared with other treatments. Application of compost tea on bean seeds caused a reduction in root rot incidence, this may be due to the failure of bio-protection on seed or in the rhizosphere at a sufficient level for disease control and releasing high level of exudates during germination (Conway, *et al.* 2001).

Field experiments

Data in table (7) show that the two applied treatments significantly reduced the percentages of root rot incidence at both pre- and post–emergence stages. Soil amended with compost tea (1) resulted in reducing root rot incidence by 63.8 and 68.1% at pre-emergence stage during 2009 and 2010 seasons, respectively. It also reduced root rot incidence at the post–emergence stage after 40 and 60 days by 79.2, 76.5 and 71.4, 66.6 % during the same seasons, respectively.

Seed treatment caused reduction of root rot disease incidence on bean plants by 71.4 and 78.5 % during 2009 and 2010 seasons at pre-emergence stage and by 68.6, 60.0 % and 57.1 and 49.0 % at post-emergence stage after 40 and 60 days from sowing date, respectively.

Amending soil or seed coating with SMS compost tea gave a good result in reducing root rot on bean plants in naturally infected field conditions compared with the control treatment. This reduction resulted in increasing of seedling stand and survival plants which positively reflected on the obtained yield. Seed coating (seed dressing) of bean seeds caused a high significant reduction in root rot incidence under field conditions during 2009 and 2010 seasons. Furthermore, yield of fresh pods was increased when compared with the control treatment. Moreover, population density of *T. harzianum* or/ and *B. subtilis* in the rhizosphere soil of bean plants increased where the highest propagates counts were recorded. These results are in agreement with those of Osburn & Scharoth, (1989) and Jahn & Puls, (1998).

Fresh pods yield of bean plants affected by different soil and seed treatments

Data in table (8) show that soil amendment and seed coating by SMS compost tea (1) caused a significant increase in bean fresh pods yield when compared with the control. Increasing of yield was estimated by 63.04 & 44.02 % and 53.75 & 36.25 % in 2009 and 2010 seasons, respectively. Moreover, persistence of microorganisms and their viability in rhizosphere soil of bean plants were enhanced and high counts were recorded. Soil amendment with agriculture wastes alone or in a combination with bio- control agents was recommended for controlling soil borne pathogens and for increasing the yield of many crops, (Liu & Huany, 2000 and El–Mohamedy, 2004).

Population dynamics of fungi and bacteria in soil rhizosphere

Data in table (9) show that micro flora of the soil amended with compost tea played a major role in suppression of soil–borne phytopathogens. There are two possible origins for the antifungal agents; 1) secondary microbial metabolites (further studies are needed) and/or 2) identification of their structures by nuclear magnetic resonance (NMR) spectrometry and mass spectrometry (MS) is necessary. Elad *et al.* (1986) found that stem rot of groundnut was reduced by about 83%, when *T. harzianum* formulation in wheat bran–sand soil mixture was added to soil (30 g/kg soil) with organic materials formulated with bio–control agents. This was attributed to: 1) increasing the activity of the indigenous microflora which resulting of suppression of pathogens population through competition or specific inhibition (Papavizas and Lumsden, 1982), 2) releasing degradation compounds such carbon dioxide, ammonia nitrates, saponin or enzymes which may be toxic to the pathogens (Neler *et al.*, 1985 and Liu and Huany, 2000), 3) inducing plant defense mechanisms, as stated by Windham *et al.* (1986) and 4) cellulases and glucanases are prevalent in high concentrations in the soil as a result of biodegradation of cellulose and lignin (Juri *et al.* 1986).

Soil amendment with compost tea of bean seeds caused high decrease in root rot disease incidence, increased yield of fresh pods and enhanced the persistence and availability of populations of antimicrobial propagules (cfu) in rhizosphere soil of bean plants. So, it could be suggested that such soil and seed treatments could represent an environmentally eco-friendly strategy for controlling seed and soil borne pathogens as a substitute of chemical fungicides.

This study indicated that compost tea possessed a strong antifungal effect and may be active against soil borne microorganisms

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