Journal of Phytopathology and Pest Management 5(1): 88-100, 2018
pISSN:2356-8577 eISSN: 2356-6507
Journal homepage: http://ppmj.net/

Application of date palm leaves compost and plant growth promoting rhizobacteria for controlling faba bean root rot disease in New Valley, Egypt

M. F. Abdel-Monaim*, S. M. Khalil Manal, H. Abdel-Baset Sahar

Plant Pathology Research Institute, Agricultural Research Center, Giza 12619, Egypt

Abstract

This study was designed to investigate the effect of date palm leaves compost (DPLC) individually and/or in combined with plant growth promoting rhizobacteria (PGPR) for controlling faba bean root rot disease caused by *Rhizoctonia solani* and *Fusarium solani* under greenhouse and field conditions. The obtained data indicate that DPLC at different concentrations significantly decreased root rot incidence either under artificial infection in pot or natural infection in field as well as increased growth and yield parameters during growing season 2013-2014. Date palm leaves compost at 8 ton/ feddan (feddan = 1.038 acres) recorded the highest protection against root rot disease and gave the highest increased of plant growth and yield parameters. On the other hand, PGPR *viz.* *Bacillus megaterium*, *B. cereus* and *Pseudomonas fluorescens* individually or mixed significantly decreased root rot incidence under greenhouse and field conditions. The mixed of PGPR strains significantly suppressed the diseases more than used alone of them. Plant growth promoting rhizobacteria increased efficacy of DPLC for controlling root rot disease in faba bean more than the applied of DPLC or PGPR alone under greenhouse and field conditions during both tested seasons as well as increased of nodulations, growth and yield parameters. The application mixed of PGPR strains and DPLC at 8 ton/feddan recorded the highest reduction of root rot incidence and increase of nodulations, growth and yield parameters during both growing seasons.

Keywords: date palm leaves compost, faba bean, nodulation, PGPR, root rot disease.

* **Corresponding author:** M. F. Abdel-Monaim,
E-mail: fowzy_2008@yahoo.com

Introduction

Faba bean (*Vicia faba* L.), family Fabaceae considered the most important nutritive popular food crop in the world and Egypt. It plays a major role in the Egyptian diet as a source of protein. Faba bean crop rich in protein (protein content ranges from 26 to 41%) and the supply of essential amino acids (Fernández et al., 1996). Several investigators recorded that diseases found on faba bean considered the most destructive and cause considerable losses in yield over 50%. Several root rot pathogens such as *Rhizoctonia solani* and *Fusarium solani* are reported to attack faba bean roots and stem base causing serious losses in seed germination and plant stand as well (Abdel-Monaim, 2013). In view of difficulties and problems associated with chemical control of soil borne plant pathogens and environmental pollution, employment of bio-control agents for plant disease management is considered as a good alternative (Abdel-Monaim, 2013). However, more attention has been given to plant growth promoting rhizobacteria (PGPR), as the most important alternative to chemicals, to help eco-friendly biological control of soil borne pathogens. The potential of PGPR to protect plant roots from soil borne pathogens was demonstrated in several research works (Abdel-Monaim, 2013). They found that inoculated of faba bean with PGPR strains significantly reduced root rot disease either under artificial infection in pot experiments or natural infection in fields and also enhanced nodulation status in the roots as well as increasing plant growth. On the other hand, suppression of these plant pathogens is considered an urgent need for present agriculture practices. Therefore, the use of compost to suppress the root rot pathogens has been extensively reviewed by many workers (Sabet et al., 2013; Muhammad et al., 2001). Composted organic material such as plant debris and animal manure add nutrient to the soil thereby increasing the soil fertility. This improves plant growth and makes the plant less prone to infection by pathogens. Organic substrates had been reported to have lower bulk density, hence better root-substrate relation. It has also been reported to provide adequate nutrients to the seedlings and reduces their predisposal to soil borne pests and diseases (Bonanomi et al., 2007). Different mechanisms were suggested to explain the role of compost application to control soil-borne plant pathogens such as enhancement beneficial microorganisms which secrete lytic enzymes and antibiotic, containing microorganisms which competed for nutrients, or activation of disease-resistance genes (induce resistance) in plants (Litterick et al., 2004). The effect of compost on disease suppression is thought to be through a combination of microbial competition, referred to as general suppression, and effects of specific antagonists through commensalism, hyperparasitism or induced resistance, generally referred to as specific suppression. The reliability of compost in suppressing disease can be increased by combining it with a biocontrol agent (Hoitink and Boehm, 1999). El-Mougy et al. (2014) found that the combined treatments between mixture of animal plus plant compost and *Trichoderma harzianum* were more effective for suppressed lupine root rot under field conations than the used alone on them. Abdel-Razik et al. (2012) found that the combined Planta Rich and Rich Composts (CMs) treatments with yeast seed treatment increased the suppressive effect of CMs on the faba bean root rot and wilt severity under greenhouse and field conditions. El-Wakil et al. (2009)

and Mahmoud (2016) have reported that common seed-borne fungi of faba bean can be controlled by the seed treatment with bread yeast before sowing in the soil supplemented with two types of composts. The aim of this work was to study the effect of combined application of suppressive date palm leaves compost (DPLC) to soil and seed treatment with the plant growth promoting rhizobacteria (PGPR) on the control of root rot of faba bean as well as effect on growth and seed yield.

Materials and methods

Source of fungal pathogens: The highly pathogenic fungal isolates *viz*. *Rhizoctonia solani* and *Fusarium solani* isolated from diseased faba bean plants collected from New Valley Governorate (Abdel-Monaim, 2013) were used in this study.

Preparation of fungal inoculum: The inocula of the obtained isolates were prepared from one week old culture grown on 50 mL potato dextrose broth (PDB) medium in conical flask (250 mL) and incubated at 25 ± 1°C. The content of flask was homogenized in a blender for one min. Plastic pots were filled with sterilized soil and mixing with fungal inocula at rate 100 mL homogenized culture per pot, seven days before planting (Abdel-Monaim, 2013).

Preparation of plant growth promoting rhizobacteria (PGPR) strains: Strains of *Bacillus megaterium, B. cereus* and *Pseudomonas fluorescens* were provided from Department of Plant Pathology, New Valley Research Station, Agricultural Research Center, Giza, Egypt. The bacterial isolates were cultured individually in nutrient broth medium in 250 ml flasks and incubated at 25±1 °C for 48 h, and then a cell suspension of each strain was adjusted to provide 2.5×10^{8} cfu/ml (Abdel-Monaim, 2013)

Preparation of date palm leaves compost (DPLC): Date palm leaves compost was prepared by the following method described by Abu-Alfadhal (1970) with some modification of Ali (2011).The dried date palm leaves (DPL) were chopped into 10 cm segments and buried in 2×1 m size concrete pit with a 1.1 m depth. The compost layers were built in such a way that each layer was about 25 cm deep. First a layer of 96 kg of dried date palm leaves was placed in the bottom and then, the desired quantity of a mixture of ammonium sulfate, Tri-super phosphate, fine (100 μ) calcium carbonate and clay in a ratio of 35:7:35: 100 kg, respectively, per ton of dried date palm leaves was distributed homogeneously. Each layer was sprayed with 77 L of water having a total salinity of 640 mg L^{-1} Total Dissolved Solids (TDS). In all, there were 4 identical layers of DPL, making the total depth of DPL up to 1 m in height. The compaction of date palm leaves was done manually at the time of making each compost layer for proper decomposition. Initially, the compost layers were stirred after six weeks followed by remixing the compost layers with an interval of 3-weeks. After 6-months, the compost pit was opened. The completely decomposed date palm leaves (compost) were separated from the un-decomposed part of date palm leaves which was mainly the hard mid-rib of the palm leaves. The decomposed portion of the date palm leaves (compost) was used in the experiments. The analysis of the tested CMs was done by the Central Laboratory of Soil and Water Department, El-Kharga Agricultural Research Station, New Valley, Egypt (Table 1).

Table 1: Characteristics of date palm leaves compost used in this investigation

Analysis	Value
Weight of m3	600 kg
Moisture (%)	27.00
pH (1:10)	8.38
EC (1:10)	3.45 DS/m
Total nitrogen (%)	0.90
Organic substances (%)	26.97
Organic carbon (%)	14.64
C:N ratio	17:37
Total phosphorus (%)	0.79
Total potassium (%)	0.94

Greenhouse experiments: The experiments were conducted at the New Valley Research Station under greenhouse conditions. Faba bean (*V. fabae* L.) cultivar Masr 1 used in this study, was obtained from Legume Crop Research Department, Field Crop Research Institute, Agricultural Research Center, Ministry of Agriculture, Egypt. Date palm leaves compost (DPLC) was added to soil in pots (30 cm in diam., containing 5 kg soil) at rates equivalent to 2, 4, 6, 8 and 10 ton/feddan (feddan= 4200 m^2) in a pot experiment of evaluating suppressive effect of DPLC alone on the tested diseases. Soil was infested with the tested pathogens *viz*. *R. solani* and *F. solani* individually at rate 100 mL homogenized culture per pot prepared as above. Untreated infested pots were used as a control. All pots were irrigated for 7 days to enhance fungal growth and to ensure even distribution of the inoculums. Surface sterilized faba bean seeds (cv. Misr 1) were sown at rate 5 seeds per pot. Four pots were used as replicates for each treatment. Pots were irrigated as needed. All pots were examined after 90 days from sowing to record the percentage of root rot severity.

Disease reactions were assessed according to the severity of symptoms after 90 days using a rating scale of 0 to 5 on the basis of root discoloration as follows, 0 = roots without discoloration (no infection), 1= 1-25%, 2= 26-50%, 3= 51- 75%, 4= up to 76% root discoloration, and 5= completely dead plants. For each replicate a disease severity index (DSI) similar to that one described by Liu et al. [1995] was calculated as follows:

$$DSI = \Sigma d/(d\ max \times n) \times 100$$

Where: d is the disease rating of each plant, d max the maximum disease rating and n the total number of plants/samples examined in each replicate.

In this experiment the highly effective of DPL compost concentration in pots were used (8 ton/ feddan). Plastic pots (30 cm in diam.) filled with soil mixed with DPLC (equivalent 8 ton per feddan) and inoculated with 100 mL homogenized culture per pot prepared as above each of *R. solani* and *F. solani* individually then irrigated and left 7 days. Faba bean seeds, either untreated or pre-treated with PGPR strains viz. *B. megaterium*, *B. cereus*, *P. fluorescens* and mixed from them were individually sown in pots containing, either infested soil+ DPLC and/or infested soil only. The treatments were prepared each pathogenic fungus as follows:

1. Untreated seeds sown in pots containing infested soil (control treatment)
2. Seed treated with *B. megaterium* and sown in pots containing infested soil
3. Seed treated with *B. cereus* and sown in pots containing infested soil
4. Seed treated with *P. fluorescens* and sown in pots containing infested soil
5. Seed treated with mixed of PGPR and sown in pots containing infested soil
6. Seed treated with *B. megaterium* and sown in pots containing infested soil + DPLC
7. Seed treated with *B. cereus* and sown in pots containing infested soil + DPLC
8. Seed treated with *P. fluorescens* and sown in pots containing infested soil + DPLC
9. Seed treated with mixed of PGPR and sown in pots containing infested soil + DPLC
10. Untreated seeds sown in pots containing infested soil+ DPLC

Four pots were used as replicates for each treatment, and five seeds were sown in each pot. The root rot severity recorded as above.

Field experiments: Two experiments were implemented in New Valley Agricultural Research Station during season 2013 -2014 in case of the first experiment and during two successive seasons of 2014-2015 and 2015-2016 in case of the second experiment. The both experiments applied in a field naturally infested with the root rot and wilt diseases causal organisms, divided into 3×3.5 m^2 plots. Each unit included 5 rows; each row was 3.5 m in length and 60 cm width. In the first experiment, DPLC was applied at rate of 2, 4, 6, 8 and 10 ton /fed. to the prepared field plots before sowing. Faba bean seeds (cv. Misr 1) were sown in hills 25 cm apart on both sides of 6 cm ridges, 2 seeds per hill, in plots amended, or not, with DPLC. In case of second experiment, the tested DPLC was applied at the rate of 8 ton/feddan to the prepared field plots before sowing. Faba bean seeds (cv. Misr 1) treated, or untreated, with PGPR strains viz. *B. megaterium*, *B. cereus*, *P. fluorescens* and mixed of them (as mentioned before) were sown as before in plots amended, or not, with DPLC. The experiment was arranged in complete randomized block with three replicates. In control treatment, faba bean seeds were soaked in water for 12 hr and sown at the same rate. The normal cultural practices of growing faba bean were followed. Root rot severity for each replicate was calculated as above in both experiments. Number and dry weight of nodules per plant was recorded 60 days after sowing. At harvest, plant height (cm), number of branches/plant, number of pods/plant, number of seeds/plant, 100-seed weight and total yield (kg/feddan) were recorded. Protein percentage content in seeds was recorded using the method of Jackson (1973).

Statistical analysis: Analyses of variance were carried out using MSTATC, 1991 program ver. 2.10 (1991). Least significant difference was employed to test for significant difference between treatments at $p \leq 0.05$ (Gomez & Gomez, 1984).

Results

Effect of different concentrations of date palm leaves compost (DPLC) on root rot incidence, growth and yield parameters: The results in Figure (1) indicated that date palm leaves compost (DPLC) at all tested concentrations suppressed root rot incidence caused by the tested soil borne pathogenic fungi *viz. R. solani*, and *F. solani* in pot experiments compared with control. The efficacy of DPLC for controlling root rot and wilt diseases were increased by increasing concentrations until 8 ton /feddan then decreased at 10 ton / feddan. The applied of DPLC at 8 ton/feddan recorded the highest decreased root rot severity caused by *R. solani* and/or *F. solani*. While, the applied 2 ton /feddan recorded the lowest decreased of root rot both tested pathogenic fungi. Also, the results obtained in field experiment indicate that increasing the tested rates of DPLC from 2 up to 10 ton /feddan significantly reduced root rot severity percentage (Table 2). The highest decrease in incidence of root rot of faba bean was achieved by using DPLC at 8 ton/feddan followed by 10 ton/feddan level. The obtained data also, indicate that added the DPLC to soil significantly increased all growth and yield parameters *viz.* plant height, number of branches, pods and seeds /plant, total seed yield/feddan and seed index of faba bean under field conditions at all the tested concentrations compared with control. While protein content in seeds un-affected with DPLC. Application of DPLC at 8 ton /feddan recorded the highest all growth and yield parameters, while used of 2 ton /feddan of DPLC recorded the lowest increased of these characteristics.

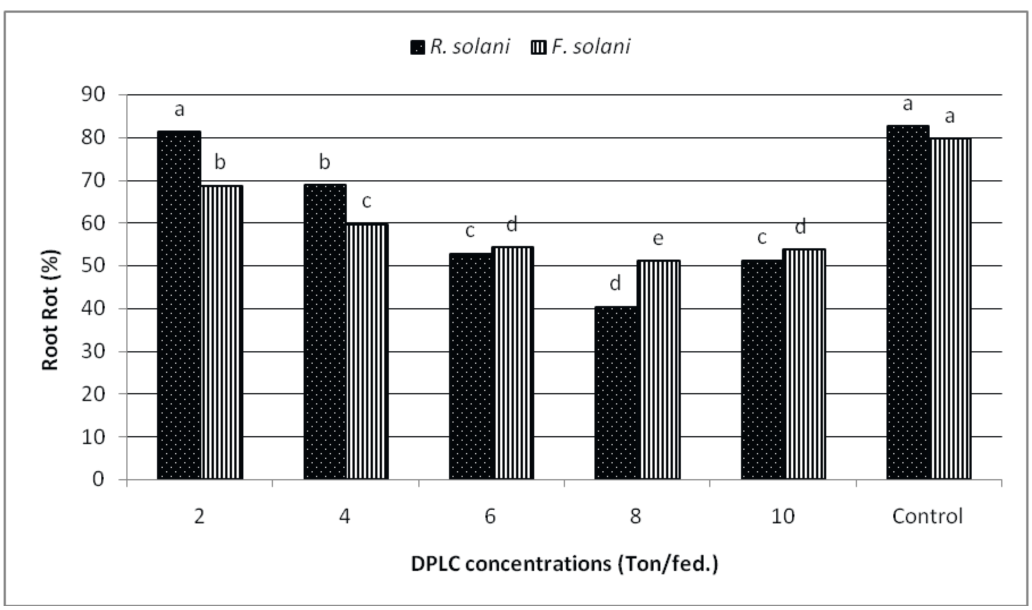

Figure 1: Effect of different concentrations of date palm leaves compost (DPLC) on root rot severity caused by *R. solani*, *F. solani* in pots. Different letters indicate significant differences between DPLC concentrations according to L.S.D. test ($P \leq 0.05$).

Table 2: Effect of different concentrations of date palm leaves compost (DPLC) on root rot severity under field during growing season 2013-2014.

Date palm leaves compost conc. (Ton/fed.)	Root rot (%)	Plant height (cm)	Number of branches/plant	Number of pods/plant	Number of seeds plant	Seed index	Seed yield /feddan (Kg)	Protein (%)
2	34.78 b	75.6d	2.8b	12.9c	31.4d	73.6c	1299.3d	27.6a
4	31.72 c	78.9c	3.1a	13.4b	32.4c	74.6bc	1325.6c	28.1a
6	29.20 d	81.4b	3.2a	13.7ab	35.4b	75.3b	1399.6b	27.8a
8	24.55 e	84.9a	3.3a	14.2a	36.5a	77.1a	1455.2a	27.6a
10	34.89 b	84.2a	3.3a	14.1a	36.4a	77.0a	1445.6a	27.6a
Control	50.41 a	69.2e	2.2c	12.8c	29.1e	72.0d	1168.3e	27.4a

Different letters indicate significant differences among treatments within the same column according to least significant difference test (P ≤ 0.05).

Table 3: Effect of plant growth promoting rhizobacteria (PGPR) and date palm leaves compost (DPLC) on root rot and nodulation under field conditions during growing seasons 2014-2015 and 2015-2016.

Treatments	Season 2014-2015			Season 2015-2016		
	Root rot (%)	Number of nodules/plant	Dry weight of nodules/ plant (mg)	Root rot (%)	Number of nodules/plant	Dry weight of nodules/ plant (mg)
Bacillus megaterium (Bm)	21.16f	123.33f	0.243f	27.02e	115.33g	0.235g
Bacillus cereus (Bc)	28.85b	120.0f	0.229g	36.28b	109.67h	0.215i
Pseudomonas fluorescens(Ps)	24.22d	136.67e	0.255e	21.25f	130.67f	0.242f
Bm+ Bc+Ps	13.28g	149.33d	0.280d	16.63h	142.0bc	0.274d
Date palm leaves compost (DPLC)	27.87c	122.33f	0.233g	35.78c	118.67g	0.229h
DPLC+Bm	24.04d	156.0b	0.299b	20.32g	142.67c	0.281c
DPLC+Bc	22.91e	146.67d	0.255e	28.56d	135.67e	0.249e
DPLC+Ps	13.88g	153.33c	0.293c	15.11i	145.67b	0.291b
DPLC+ Bm+ Bc+Ps	10.38h	188.33a	0.352a	14.65j	169.33a	0.342a
Control	45.17a	88.33g	0.156h	54.31a	70.67i	0.144j

Different letters indicate significant differences among treatments within the same column according to least significant difference test (P ≤ 0.05).

Effect of PGPR and DPLC on root rot disease under greenhouse conditions: Data present in Figure (2) showed that all treatments significantly reduced root rot incidence caused by *R. solani* and *F. solani* compared with untreated control in pots. Application of mixed plant growth promoting rhizobacteria reduced root rot severity more than used alone of them. Plant growth promoting rhizobacteria increased efficacy of DPLC for controlling root rot disease in faba bean caused with any tested fungi more than the applied of DPLC alone. Date palm leaves compost in combined with mixed PGPR strains recorded the lowest root rot caused by *R. solani* and *F. solani*.

Effect of PGPR and DPLC on root rot incidence and nodulation of faba bean under field conditions: Data present in Table (3) showed that all treatments significantly decreased root rot incidence compared with untreated control in both growing seasons (2014-2015 and 2015-2016). The mixed of PGPR was more effective than used of them alone. The decreased of root rot incidence was much higher and significantly greater in the presence of date palm leaves compost (DPLC). Moreover, mixed application of DPLC and PGPR was more effective than DPLC alone. Mixed of PGPR strains combined with DPLC recoded the lowest root rot incidence in both growing seasons. Also, all treatments significantly increased number and dry weight of nodule per plants compared with control in both growing seasons (2014-2015 and 2015-2016). Mixed application of PGPR and DPLC was more effective for increasing number and dry weight of nodules per plant than used of PGPR or compost alone. The highest number of nodules per plant was recorded in case of faba bean seeds treated with PGPR mixed and amendment DPLC to soil being 188.33 and 169.33 /plant compared with 88.33 and 70.67 in control in both seasons, respectively. Also, this treatment recorded the highest dry weight of nodules per plant being 0352 and 0.342 mg/plant compared with 0.156 and 0.144 mg /plant in control in both seasons, respectively.

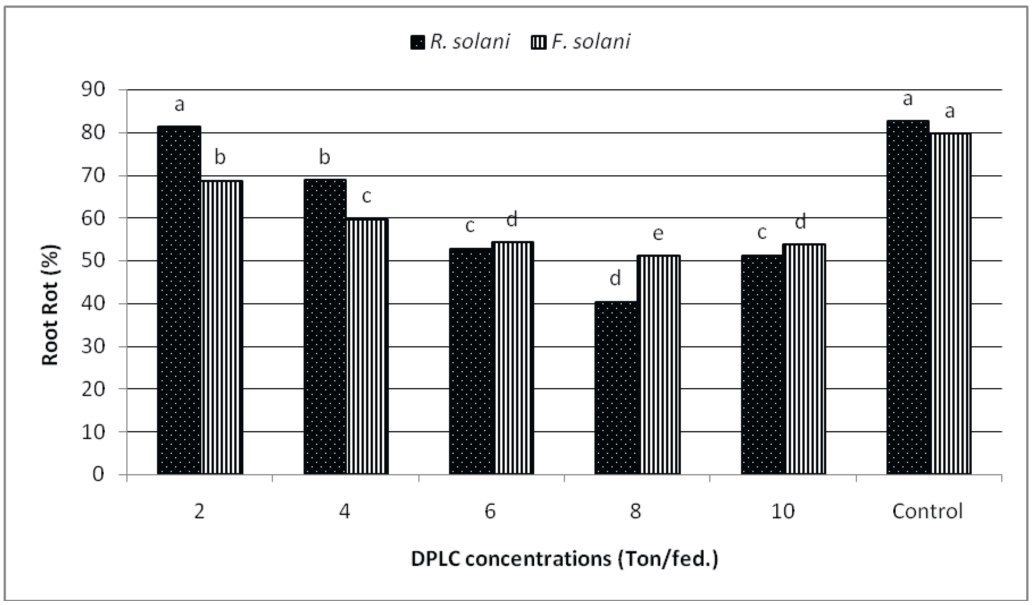

Figure 2: Effect of plant growth promoting rhizobacteria (PGPR) and date palm leaves compost (DPLC) on root rot incidence under artificial infestation with *R. solani* and *F. solani* in pots. Different letters indicate significant differences between treatments according to L.S.D. test ($P \leq 0.05$).

Effect of PGPR and DPLC on plant growth and yield parameters of faba bean under field conditions: The treatments tested significantly improved plant height and increased number of branches, pods and seeds/ plant, weight of 100 seeds, total seed yield, dry seed content of protein compared with check treatment during the two experimental seasons (Table 4 and 5). Seeds treated with mixed of PGPR strains increased all growth and yield parameters more than seed treated with alone of them in both growing seasons. Also, mixed application of PGPR strains and DPLC was more increased growth and yield parameters than DPLC alone. Faba bean treated with mixed of PGPR strains and soil amendment with DPLC at 8 ton/feddan recorded the highest plant height and increased number of branches, pods and seeds plant^{-1}, weight of 100 seeds, total seed yield.

Table 4: Effect of plant growth promoting rhizobacteria (PGPR) and date palm leaves compost (DPLC) on plant growth and yield parameters under field conditions during growing season 2014-2015.

Treatments	Plant height (cm)	Number of branches/ plant	Number of pods /plant	Number of seeds/ plant	Seed index	Seed yield/ fed. (Kg)	Protein (%)
Bacillus megaterium (Bm)	99.3de	3.1cd	15.3c	42.3de	80.2d	1498.6f	27.6b
Bacillus cereus (Bc)	85.3f	2.9d	14.2d	39.6e	77.9f	1457.2g	28.3a
Pseudomonas fluorescens (Ps)	102.3d	3.3c	16.9bc	44.6d	82.3bc	1593.6d	27.9ab
Bm+ Bc+Ps	114.5bc	3.6b	18.4b	51.4b	82.9bc	1623.2b	28.5a
Date palm leaves compost (DPLC)	83.6f	3.2cd	13.5e	35.6f	76.6g	1352.2h	27.3bc
DPLC+Bm	112.3d	3.3c	17.6b	48.9c	82.1c	1563.2d	27.6b
DPLC+Bc	96.7e	3.1cd	15.9c	43.2d	79.3e	1488.6f	28.3a
DPLC+Ps	119.3b	3.5bc	18.6b	50.8b	83.3b	1655.8b	28.4a
DPLC+ Bm+ Bc+Ps	134.6a	4.2a	22.2a	63.2a	85.6a	1745.4a	28.7a
Control	74.3g	2.4e	11.2f	28.3g	74.5h	1196.2j	26.9c

Different letters indicate significant differences among treatments within the same column according to least significant difference test ($P \leq 0.05$).

Table 5: Effect of plant growth promoting rhizobacteria (PGPR) and date palm leaves compost (DPLC) on plant growth and yield parameters under field conditions during growing season 2015-2016.

Treatments	Plant height (cm)	Number of branches/ plant	Number of pods /plant	Number of seeds/ plant	Seed index	Seed yield/ fed. (Kg)	Protein (%)
Bacillus megaterium (Bm)	95.3e	2.9cd	15.2d	44.3e	81c	1469.8e	27.9ab
Bacillus cereus (Bc)	82.3h	2.8d	13.6f	38.9g	78.3d	1472.3e	28.4a
Pseudomonas fluorescens (Ps)	99.3d	3.1c	17.2c	45.2e	83.5a	1602.1c	28.1a
Bm+ Bc+Ps	115.2b	3.5b	18.6b	50.3c	83.5a	1624.1c	28.3a
Date palm leaves compost (DPLC)	84.1g	3.3bc	13.5f	33.5h	75.4e	1342.9f	27.6c
DPLC+Bm	111c	3.3bc	17.2c	48.6d	83.2ab	1549.8d	27.4c
DPLC+Bc	93.5f	3c	14.6e	42.9f	78.4d	1463.5e	27.9ab
DPLC+Ps	116.2b	3.6b	18.4b	52.1b	82.6ab	1658.3b	28.1a
DPLC+ Bm+ Bc+Ps	133a	4.1a	21.5a	61.4a	84.2a	1715.6a	28.3a
Control	71.6i	2.3e	11.4g	27.4i	72.9f	1152.3g	27.3c

Different letters indicate significant differences among treatments within the same column according to least significant difference test ($P \leq 0.05$).

Discussion

Faba bean (*Vicia faba* L.) is one of the most important legume crops. It is infected with many fungal pathogens causing considerable yield losses where root-rot disease is the most important fungal diseases affecting faba bean production in Egypt (Abdel-Monaim, 2013; Abdel-Kader, 2011). Soil-borne pathogenic fungi, among the major factors limiting the productivity of agro-ecosystems, are often difficult to control with conventional strategies such as the use of resistant host cultivars and synthetic fungicides. The lack of reliable chemical controls, the occurrence of fungicide resistance in pathogens, and the breakdown or circumvention of host resistance by pathogen populations (McDonald & Linde 2002) are some of the reasons underlying efforts to develop new disease control measures. In this context, the search for alternatives with high efficiency, low cost and limited environmental impact is a challenge for eco-sustainable modern agriculture. In the research for alternatives to chemical treatments, biological control may be a useful tool (El-Wakil, et al., 2009). Soil amendment with compost is an agronomically increasing practice and it favours plant development and improves soil quality, as well as having suppressive effect on many soil-borne plant pathogenic fungi (Abdel-Razik et al., 2012; El-Wakil, et al., 2009). Supplemented soil artificially infested with the root rot pathogens in greenhouse and natural infection under field conditions with date palm leaves compost (DPLC) at rates equivalent to 2,4,6,8 and 10 ton/feddan have a suppressive effect on the severity of the tested diseases. Also, added DPLC to soil in field increased plant growth and yield parameters compared with control. Date palm leaves compost at 8 ton /feddan recorded the highest protection against root rot pathogens in pots and field experiments as well as increased plant growth and yield parameters in field. Such results confirm previous reports indicating that composted soil has the potential to protect different plants from soil-borne root pathogen such as *R. solani* and *F. solani* in faba bean and other crops (Abo-Elyousr et al., 2014; Abdel-Razik et al., 2012) and to promote growth and yield of faba bean plants by improving soil chemical, physical and biological properties (El-Wakil et al., 2009). This may be due to changes in the overall population of the antagonistic resident soil bacteria and fungi which compete with the pathogens as well as changes in the amount and availability of soil nutrients to plants associated with CMs application as mentioned by Abo-Elyousr et al. (2014). Aryantha and Guest (2006) have reported that the beneficial effects induced by composts are due to increase the activities of soil microbes in the plant rhizosphere. Some of them produce plant growth hormones and stimulate plant growth directly, while others produce natural chelators called siderophores that keep iron at a high level in available form to plant in soil. The suppressive effect of compost is due to combination of biotic factors. The biotic factor including the inhabiting microbes (bio-agents) *viz.* plant growth promoting rhizobacteria strains (*B. megaterium*, *B. cereus* and *P. fluorescens*) is might be partly responsible for the efficacy of compost in decreasing soil borne diseases (Nawar, 2008).Moreover, application of PGPR strains in combined with compost led to increase the plant resistance to diseases through utilization of these bio agents in increasing synthesis of phenolic and ligneous compounds. This may explain the high decrease in disease incidence in mixed treatments. Therefore, in the present research was made to know to the effect of PGPR strains individually or in combined with DPLC at 8 ton /feddan in artificial infested with *R. solani*, *F. solani* and natural infection under field conditions as well as plant growth and yield parameters. The obtained data indicate that all PGPR strains and DPLC individually or in combined significantly decreased root rot incidence under greenhouse and field conditions compared with control. Also, these treatments improved plant growth (plant height and number of branches /plant) and increased yield parameters (number of pods, seeds /plant, seed index and total yield / feddan) in field. Application mixed of PGPR strains and DPLC was decreased root rot and wilt incidence as well as increased plant growth and yield parameters more than applied DPLC or PGPR alone. These results are in agreement with those reported by Abdel-Razik et al. (2012) and Pugliese et al., (2011). Suppression of root rot disease could be due the beneficial effect of such microbes in single way or in combination with others on the pathogen and/or the suspect or on the host-parasite interaction lead to control of root rot disease of faba bean. Also, PGPR able to produced many enzymes such as chitinases and glucanases produced by the biocontrol agent are responsible for suppression of the plant pathogen. These enzymes function by breaking down the polysaccharides, chitin, and β-glucanase that are responsible for the rigidity of fungal cell walls, thereby destroying cell wall integrity (Termorshuizen et al., 2006). In conclusion, we can recommend that use mixed of PGPR *viz. B. megaterium, B. cereus, p. fluorescens* alone or in combination with date palm leaves compost for controlling root rot disease of faba bean under greenhouse and field conditions may be useful tools to control these diseases as well as improved plant growth and yield components in field.

References

Abdel-Kader MM, El-Mougy NS, Lashin SM, 2011. Essential oils and *Trichoderma harzianum* as an integrated control measure against faba bean root rot pathogens. Journal of Plant Protection Research **51**:306–13.

Abdel-Monaim MF, 2013. Improvement of bio-control of damping-off and root rot/wilt of faba bean by salicylic acid and hydrogen peroxide. Mycobiology **41**(1): 47–55.

Abdel-Razik SA, Sallam NMA, Eraky AMI, Hassan MHA, 2012. Integrated control of root rot and wilt disease of faba bean by soil amendment with suppressive compost in combination with seed coating with an antagonistic yeast. Archives of Phytopathology and Plant Protection **45** (14): 1692–1704.

Abu-Alfadhal MM, 1970. Organic manures. 1st Edition, Al-Saadah Publishers, Cairo, Egypt.

Ali YSS, 2011. Effect of mixing date palm leaves compost (DPLC) with vermiculite, perlite, sand and clay on vegetative growth of dahlia (*Dahlia pinnata*), marigold (*Tagetes erecta*), zinnia (*Zinnia elegans*) and cosmos (*Cosmos bipinnatus*) Plants. Research Journal of Environmental Sciences **5**: 655–665.

Aryantha NP, Guest DI, 2006. Mycoparasitic and antagonistic inhibition on *Phytophthoracinnamomirands* by microbial agents isolated from manure composts. Plant Pathology Journal **5**:291–298.

Bonanomi G, Antignani V, Pane C, Scala F, 2007. Suppression of soilborne fungal diseases with organic amendments. Journal of Plant Pathology **89**(3): 311–324.

El-Mougy NS, Abdel-Kader MM, Abdel-Kareem F, 2014. Application of commercial composts and/or *Trichoderma harzianum* for controlling lupine root rot disease under field conditions. International Journal of Engineering and Innovative Technology **4**(2): 68–73.

El-Wakil MA, El-Refai IM, Awadallah OA, El-Metwally MA, Mohammed MS, 2009. Seedborne pathogens of faba bean in Egypt: detection and pathogencity. Plant Pathology Journal **8**: 90–97.

Elyousr KAM, Zein El-Abdean W, Hassan MHA, El-Sheakh MM, 2014. Enhance suppressive effect of compost on soybean Rhizoctonia root rot by soil treatment with *Trichoderma harzianum*. Journal of Plant Physiology & Pathology **2**(2): 1–6.

Fernández MM, López-Jurado M, Aranda P, Urbano G, 1996. Nutritional assessment of raw and processed faba bean (*Vicia faba* L.) cultivar major in growing rats. Journal of Agricultural and Food Chemistry **44**(9): 2766–2772.

Gomez KA, Gomez AA, 1984. Statistical procedures for agricultural research. A Wiley-Interscience Publication, New York, USA.

Hoitink HAJ, Boehm MJ, 1999. Biocontrol within the context of soil microbial communities: a substrate dependent phenomenon. Annual Review of Phytopathology **37**: 427–446.

Jackson ML, 1973. Soil chemical analysis. Prentice Hall, New Delhi, India.

Litterick AM, Harrier L, Wallace P, Watson CA, Wood M, 2004. The role of uncomposted materials, composts, manures, and compost extracts in reducing pest and disease incidence and severity in sustainable temperate agricultural and horticultural crop production—A review. Critical Reviews in Plant Sciences **23**(6): 453–479.

Liu L, Kloepper JW, Tuzun S, 1995. Induction of systemic resistance in cucumber against Fusarium wilt by plant growth-promoting rhizobacteria. Phytopathology **85**: 695–8.

Mahmoud AF, 2016. Evaluation of certain antagonistic fungal species for biological control of faba bean wilt disease incited by *Fusarium oxysporum*. Journal of Phytopathology and Pest Management **3**(2): 1–14.

McDonald BA, Linde C, 2002. Pathogen population genetics, evolutionary potential, and durable resistance. Annual Review of Phytopathology **40**: 349–379.

MSTAT-C, 1991. A Software program for the design, management and analysis of agronomic research experiments. Michigan State University, East Lansing, Michigan, USA, pp. 400.

Muhammad S, Suberu HA, Amusa NA, Agaji MD, 2001. The Effect of soil amendment with sawdust and rice husks on the growth and incidence of seedling blight of *Tamarrindus indica* Linn caused by *Macrophomina phaseolina* and *Rhizoctonia solani*. Moor Journal of Agricultural Research **2**: 40–46.

Nawar LS, 2008. Control of root-rot of green been with composted rice straw fortified with *Trichoderma harzianum*. American-Eurasian Journal of Agricultural & Environmental Sciences **3**: 370–379.

Pugliese M, Liu B, Gullino LM, Garibaldi A, 2011. Microbial enrichment of compost with biological control agents to enhance suppressiveness to four soil-borne diseases in greenhouse. Journal of Plant Diseases and Protection **118**: 45–50.

Sabet KK, Saber MM, El-Naggar MA, El-Mougy NS, El-Deeb HM, El-Shahawy IE, 2013. Using commercial compost as control measures against cucumber root-rot disease. Journal of Mycology **13**: 1–12.

Termorshuizen AJ, van Rijn E, van der Gaag DJ, Alabouvette C, Chen Y, Lagerlöf J, Malandrakis AA, Paplomatas EJ, Rämert B, Ryckeboer J, Steinberg C, Zmora-Nahum S, 2006. Suppressiveness of 18 composts against 7 pathosystems: variability in pathogen response. Soil Biology & Biochemistry **38**: 2461–2477.