POTENTIAL IMPACTS OF RHIZOBIUM AND COMPOST TEA ENRICHED WITH RHIZOBACTERIA FOR ENHANCING PROTECTION OF FABA BEAN AGAINST BROAD BEAN MOTTLE VIRUS (BBMV)

BY

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ABSTRACT

Potential resistance of faba bean plants against broad bean mottle virus (BBMV) due to application of some biofertilizers such as *Rhizobium leguminosarum* biovar *viciae* and prepared tea compost enriched with selected plant growth-promoting rhizobacteria (PGPR) strains was investigated under greenhouse conditions. Significant improvements in three faba bean cultivars were obtained due to the used biofertlizers individually or in their combination. On contrary, considerable reductions in all tested parameters were occurred as a result of the viral disease even after 45 and 75 days from planting time. To a great extent, disease severity was reduced and clear recovery was obtained if diseased plants were fertilized with compost tea and inoculated with rhizobia. Numbers of nodules per plant were highly increased from 22.22 for the infected untreated plants to 77.99 for the infected plants inoculated with rhizobia and sprayed with compost tea and accordingly, the nodular dry weight was increased from 23.44 to 102.11 mg plant^{-1}. The beneficial effects of the used treatments were extended to increase the activities of peroxidase and polyphenoloxidase enzymes in comparison with control plants. Data obtained clearly showed that the application of suggested biofertilizers increased the defensive capacity of faba bean plants against the harmful effect of BBMV via exploiting the interactions between rhizobium and the supplemented compost tea.

Key words: *Vicia faba*, compost tea, PGPR, *Rhizobium*, BBMV, bio-fertilization.

INTRODUCTION

Faba bean (*Vicia faba* L.) is a major leguminous crop a one of the main pulse important source of protein for the Egyptian people (Nassib *et al*., 1991). As well as, its beneficial effects on soil quality and productivity were also described. Leaf mottling and malformation, caused by broad bean mottle virus (BBMV), is a dangerous disease for faba bean plants which causes great losses in grain yield production of 75 % for faba bean crop (Sandoval *et al*., 2007). This virus is a member of the group of bromoviruses (Lane, 1981), which have a tripartite, positive-sense RNA genome. Several BBMV strains on faba bean plants have been well described by Makkouk *et al*. (1988). Beneficial effects on plant biomass exerted by plant growth-promoting rhizobacteria (PGPR) often associated with increased rates of plant development and resistence against plant pests e. g. biological control (Kloepper, 1993). In comparison with "systemic acquire resistance (SAR), the term "induced systemic resistance" (ISR) is an alternative term sometimes used to denote induced resistance by non-pathogenic biotic agents, e.g., PGPR (Van Loon *et al*., 1998). The well-known symbiotic association between legumes and rhizobia is the most important link in these crops under different environmental conditions. Application of infective and effective specific rhizobial strains, under suitable conditions, legumes inoculation such faba bean may increase yields and qualities of cultivated crops (Abo El-Soud *et al*., 2003).

Disease control may be achieved by a range of synthetic chemicals, but their widespread use leads to development of pathogen resistance as well as pollution of the environment. Consequently, there is a need for safe alternative methods for disease managment including biocontrol and cultural practices. There has been considerable interest in using compost of crop residues (Bollen, 1993). Compost tea is one of the most promise bio-fertilizer recently responsible for developing different management controlling programs e. g. plant pest, disease and fertility (Sheuerell and Mahaffee, 2002). Foliar spraying of compost tea has shown some potential for controlling a number of diseases. Tea compost may therefore contain such microorganisms, or their metabolites, acted as plant growth promoting and/or as bio-control agents (Brinton, 1995 and McQuilken *et al.*, 1994). The postulated mechanisms of tea compost are plant response to nutrients and phytohormone as well as the biological effect of the plant associated microorganisms. Compost effects and its aqueous extract in combination with *Serratia sp.* as PGPR on nodulation, N_2-fixation, plant growth and seed yield of two verities of faba bean were tested by Abdel-Wahab and Said (2004).

The present study aims to evaluate the potential use of rhizobial inoculation and tea compost seeded with the some selected plant growth-promoting rhizobacteria (PGPR) strains in integrated biofertilization management for enhancing protection of faba bean varieties against infection with broad bean mottle virus (BBMV).

MATERIALS AND METHODS

Greenhouse pot experiment:

The experimental work was carried out at Sakha Agricultural Research Station, Kafr El-Sheikh, using seeds of three faba bean (*Vicia faba* L.) cultivars e. g. Masr-1, Sakha-1 and Giza-843, inoculated with an effective strain of *Rhizobium leguminosarum* biovar *viciae* and sprayed with compost tea enriched with some selected plant growth-promoting rhizobacteria (PGPR). Pots of 35 cm in diameter filled with 8 Kg clay soil with 7.30 pH value, EC 2.19 ds m^{-1} and nitrogen content 0.16 %, respectively. EC and pH were estimated in diluted soil water suspension (1:2.5) and nitrogen content was determined according to micro-kjeldahl method (Jackson, 1973). Five seeds of faba been were planted in each pot, the germinated seedlings were thinned to three pot^{-1} after 8 days from sowing. Each treatment was represented by four replicates. Pots treated with water were acted as control. The cultural practices, i.e. fertilization, irrigation and pest control were carried out as commonly used.

Rhizobial strain:

Rhizobium leguminosarum biovar *viciae* strain No. 312317 was isolated from nodules of faba bean plants collected from Kafr El-sheikh governorate according to the procedure conducted by

Vincent (1970). Roots were washed thoroughly to remove adhering soil particles. Numbers of effective nodules were chosen from each plant; surface sterilized by 0.25 % sodium hypochlorite solution for 5 minutes, washed several times with sterilized water and then crushed in droplets of sterilized distilled water. Bacterial pinky fluid was dispersed on the surface of plates of yeast extract Mannitol agar medium containing bromothymol blue. Plates were incubated at 28°C for 5 days. Typical rhizobial colonies were selected and maintained on slant of yeast extract Mannitol agar supplemented with 0.3 Ca_2 CO_3. Rhizobial isolate was subjected to morphological, cultural and biochemical tests (Vincent, 1970) and identified according to the methods described by Somasegran and Hoben (1985). For further tests, rhizobial isolate was stored at 4 °C as stock culture. For seed inoculation, liqued cultures containing 10^9cfu ml^{-1} were used at the time of planting by pippetting 5 ml to the soil around each seed.

Compost tea:

For compost tea preparation, rice straw was chopped and collected in heap form. The chopped rice straw was incorporated with farmyard manurer, bentonite, rock phosphate, urea and elemental sulfur at rates of 10, 15, 10, 2.5 and 1%, respectively and received suitable water. Turning process was done every 30 days with keeping the moisture within the range of 40-60 % along the composting process. After the first turning, fungal inoculant of *T. viridi* (750 ml ton^{-1}) was spreaded on the compost heap to accelerate the decomposition rate. At maturity stage, heaps which inoculated with *T. viridi* were also inoculated with *Azotobacter chroococcum, Azosperillum brasilense* and *Paenibacillus polymexa* (400 g solid carrier ton^{-1}) according to Badawi (2003). To prepare tea compost, 1 kg maturated compost was immersed in 10 L water and filtered. For foliar spraying, filtrate was diluted five times using distilled water and regular applied every 15 days during the vegetative stage. At the flowering stage, foliar spraying was stopped to avoid falling of the flowers. After that, further spraying was done. Chemical and biological properties of the compost tea are presented in **Table 1.**

Table 1. Chemical and biological characters of the compost tea.

Character	Value
pH	7.20
EC (ds m^{-1} at 25 °C)	3.51
C/N ratio	14.05
Total soluble Nitrogen (ppm)	103.7
Available Phosphorus (ppm)	19.80
Cross seed germination teast (%)*	91.20
Total count of bacteria (cfu/ml)	8.7×10^7
Total count of fungi (cfu/ml)	1.3×10^6
Total count of actinomycetes (cfu/ml)	1.2×10^6

Cross germination test was carried out using *Eruca sativum* seeds after 72 h.

Viral infection:

To obtain the pathogenic virus, diseased plants showing sever mottling accompanied with distortion were collected from scattered areas within faba bean fields in Kafr El-Sheikh governorate. Samples were washed thoroughly to remove any adhering particles, surface sterilized by 0.25 % sodium hypochloride for 5 minutes, washed several times and then crushed in sterilized distilled water to obtain the viral juice. For pathogencity test, healthy seedlings of faba bean were treated with the viral juice. The virus was identified as broad bean mottle virus (BBMV) according to ELISA test in the Dept. of Virus and Phytoplasma Res., ARC, Egypt.

Experimental installation:

The present investigation was conducted on faba bean plants including individual and combined treatments of inoculation with rhizobium and compost tea application. Each treatment was represented by four replicates. Pots were kept in greenhouse and watered when needed. After 45 and 75 days from planting, plant growth parameters of leaf area (leaf area meter Mod. 3100), number and dry weight of the nodules were determined. According to Moran (1982), fourth leaf from plant tip was taken to estimate photosynthetic pigments (chlorophyll a, b and total) using Spectronic 20. At harvest (130 days from planting), dry matter of shoots, roots and seeds were determined. Total nitrogen and phosphorus contents in the seeds were also determined as described by Jackson (1973).

Peroxidase and polyphenoloxidase enzymes activities:

Effect of the studied treatments on the activities of some defense-responsible enzymes of both peroxidase and polyphenoloxidase were estimated in the shoots after 45 days from planting (Maxwell and Bateman, 1967). To achieve this objective, crude enzyme extract was prepared. Therefore, leaf samples were cleaned, weighted and triturated in a china mortar in the presence of 0.1 M sodium phosphate as buffer solution (pH 7.1). Samples of one g fresh weight in 2 ml buffer solution were filtrated through cheese cloth and centrifuged at 300 rpm for 20 min. at 6^{o} C according to Maxwell and Bateman (1967).

Peroxidase:

The methods described by Srivastava (1987) were applied to assay peroxidase activity. A combination consists of 0.5 ml of 0.1 M sodium phosphate, 0.3 ml enzyme extract, 0.3 ml of 0.05 M pyrogallol ($C_6 H_3 COH_3$), 0.1 ml of 10% H2 O2 were diluted to 3 ml volume. At 425 nm, absorbances of the samples were measured and optical densities (OD) were recorded after 0, 5, 10, 15, and 20 min. intervals using spectrephotometer (Jenway 6105 UV/VIS). OD $min^{-1}g^{-1}$ fresh weight was used as activity indication.

Polyphenoloxidase:

The activity of polyphenoloxidase enzyme was determined according to the method adopted by Matta and Dimond (1963). The reaction mixture contained 1.0 ml enzyme extract, 1.0 ml of 0.2 M sodium phosphate buffer at PH 7.0, 10 ml of 0.001 M catechol ($C_6 H_4 (OH)_2$) and 3.0 ml distilled water. The absorbance was measurcd at 495 nm and the optical densities were recorded at 0, 1, 2, 3, 4, and 5 min. intervals. Polyphenoloxidase activities were expressed as changes in the optical density/min./g fresh weight. In each determination, control treatment (blank) contained all chemical reagents except the enzyme extract, its recorded value was subscribed from all readings.

Statistical analysis:

The obtained data were statistically tested for one-way analysis of variance (ANOVA) using SPSS computer software program and Duncan's multiple range tests were applied for comparing means (Duncan, 1955).

RESULTS AND DISCUSSION

Vegetative growth:

The effect of rhizobium inoculation and compost tea on vegetative growth parameters of faba bean varieties were estimated at two growing stages. Leaf area and total chlorophyll (a + b) **(Table 2)** illustrate significant increases of those parameters in comparison with the viral infected untreated plants were recorded. The results were more pronounced at later stages of plant growth, indicating well establishment with the experimental conditions.

Table 2. Effect of proposed biofertilizers application on leaf area and chlorophyll formation of three faba bean cultivars.

Verities	Masr-1		Sakha-1		Giza-843	
Treatments	Leaf area Cm^2	Chl. a + b mg cm^{-2}	Leaf area Cm^2	Chl. a + b mg cm^{-2}	Leaf area Cm^2	Chl. a + b mg cm^{-2}
45 days after planting						
Control	41.03ijk	33.09 j	32.78 m	32.87 j	36.87 klm	32.49 j
R	73.31 a	42.00 de	62.69 bc	39.02 gh	54.75 de	41.43 ef
Ct	74.70 a	41.27 ef	60.95 c	40.53efg	52.54 ef	41.22 ef
R+Ct	75.21 a	43.54 ed	66.65 b	45.84 a	74.70 a	44.03 bc
V	42.66 ij	32.97 j	35.49 lm	31.46 j	24.73 n	29.80 k
R+V	50.63 ef	45.50 ab	38.26jkl	45.08abc	43.67 hi	38.87 gh
R+Ct	50.09efg	39.91 fg	40.67ijk	37.43 h	38.40 jkl	35.29 i
R+V+Ct	58.00 ed	45.90 a	47.75fgh	46.66 a	45.48 ghi	45.00 abc
75 days after planting						
Control	57.69efg	45.54abc	52.93ghi	43.52 bc	64.74 de	43.37 bc
R	78.96 ab	53.12 ab	74.56 bc	53.86 ab	58.40efg	51.61 ab
Ct	78.45 ab	50.13abc	74.81 bc	52.25 ab	77.45 ab	51.42 ab
R+Ct	78.94 ab	51.22 ab	69.34 cd	50.61 ab	83.49 a	49.85 abc
V	31.89 j	19.08 d	28.89 j	20.83 d	33.89 j	17.61 d
R+V	54.23 gh	55.58 a	46.16 i	47.70abc	56.32 fg	48.36 abc
R+Ct	64.49 de	56.28 a	47.73 hi	54.71 ab	45.98 i	38.57 c
R+V+Ct	64.06 de	52.22 ab	63.96def	53.86 ab	62.01def	53.45 ab

Where; R: Rhizobium, Ct: Compost tea and V: Broad bean mottle virus(BBMV).

After 75 days from planting, leaf area and total chlorophyll data were severe reduced for the viral infected untreated plants, but further enhancements of these data were obtained due to rhizobium inoculation and/or compost tea fertilization. Such increases in leaf area and in photosynthetic pigments formation could be attributed to the increase of nitrogen content of plants as a result of symbiotic

N_2-fixation activity beside the role of fertilization with compost tea. So, results obtained herein indicate that the harmful effect of BBMV on plant growth could be reduced via exploiting the interactions between compost tea with its high nutritional value (Emino and Warman, 2004), and rhizobial inoculation that can enrich the plant and soil with N_2 element (Biswas *et al.*, 2000). Therefore, compost tea could be considered as an effective bio-fertilizer consists of essential components required to cell division, cell elongation and photosynthetic pigments formation due to its enriched in macro-and microelements, phytohormons and vitamins.

Symbiotic N_2-fixation:

The effect of rhizobium and/or compost tea on N_2-fixation and growth of plants are presented in **Table 3**. Regarding the healthy plants inoculated only with rhizobia, numbers of nodule formation are increased at the later growing stage of all tested cultivars, indicating enhancement of the physiological state in the plants. So, numbers of nodules were increased to 95.66, 95.33 and 99.00 per plant with dry weight of nodular tissues of 374, 381.33 and 362 mg/plant in Masr-1, Sakha-1 and Giza-843 respectively after 75 days from planting. While, the corresponding values of control treatment showed only 20.66, 20.33 and 26.66 nodules/plant and 38.33, 53 and 39.33 mg/plant of nodule dry weight at late stages of growth, respectively. Similar positive effect on nodule formation was also observed with the individual treatment of compost tea fertilization but with less magnitude, indicating the enhancing role of compost tea on indigenous rhizobia in plant rhizosphere. These could be observed clearly from the superiority of combined treatment of rhizobia and compost tea on nodulation pattern. It shows however that, the control plants were nod void of nodules. As well as, effect of rhizobial inoculation and fertilization with compost tea showed clear improvements.

On average number of nodules are increased from 22.55 (control) to 96.67 (rhizobial inoculation), 89.86 (compost tea) and to 114.78 (rhizobium+compost tea). Accordingly, nodular dry weight was on the averages of 39.33 to 372.50, 358.00 and 363.33 mg/plant, respectively. So for nodulation was further strengthened by the application of compost tea. These may be attributed to the better environment condition in plant rhizosphere besides its role in increasing the level of supply in available form of nutritional elements required at trace levels both by the plant and by the nodule system. This was true at the two investigation periods, but especially after the disease expression at the late stage of growth.

Table 3. N_2-fixation parameters of faba bean cultivars treated with rhizobial inoculation and compost tea fertilization against BBMV.

Verities / Treatments	Masr-1		Sakha-1		Giza-843	
	No. of nodules $Plant^{-1}$	D. w. of nodules mg/plant	No. of nodules $Plant^{-1}$	D. w. of nodules mg/plant	No. of nodules $Plant^{-1}$	D. w. of nodules mg/plant
45 days after planting						
Control	13.66gh	23.66 k	17.33 g	25.66 k	14.00gh	23.33 k
R	76.00 c	151.0cd	77.66 c	157.0 b	74.33 c	150.33cd
Ct	64.66 d	142.0 f	66.33 d	148.0de	64.66 d	146.00 e
R+Ct	83.66 b	162.66a	87.66 b	164.33a	97.66 a	153.00 c
V	13.66gh	16.33 l	11.00 hi	15.00 l	9.00 i	17.33 l
R+V	55.33 e	64.66 h	57.00 e	65.33 h	63.00 d	59.00 i
R+Ct	47.66 f	56.33 i	54.66 e	56.00 i	54.00 e	50.66 j
R+V+Ct	74.00 c	74.33 g	76.00 c	72.00 g	74.66 c	74.66 g
75 days after planting						
Control	20.66 l	38.33 m	20.33 l	53.00 l	26.66 k	39.33 m
R	95.66cd	374.0 c	95.33 d	381.66b	99.00 c	362.0 d
Ct	97.66cd	360.33d	84.66 ef	363.0d	87.33 e	353.0 e
R+Ct	115.66a	410.66a	112.33b	371.33c	116.33a	308.66 f
V	26.66 k	23.00 n	27.00 k	22.66 n	13.00 m	24.66 n
R+V	74.66 hi	85.00 i	75.66 h	85.66 i	77.66 h	82.66 ij
R+Ct	77.66 h	76.33 jk	71.66 i	74.33 k	66.66 j	71.33 k
R+V+Ct	81.66fg	100.3gh	81.00 g	107.33g	71.33 i	98.66 h

Where; R: Rhizobium, Ct: Compost tea and V: Broad bean mottle virus(BBMV).

With viral infection, the results are completely changed towards a negative side. The difference in nodule numbers between control treatment and BBMV infected faba bean varieties was much smaller, indicating the activity of the native rhizobia, though they record the lowest nodulation pattern on the tested cultivars. The nodular dry weight behaved in similar manner as in nodule numbers. An predictable improvement in nodule numbers and nodular dry weight were resulted due to the stimulatory effect of rhizobia and/or compost tea treatments towards the viral infected plants. The difference in nodule number was reflected in the total dry weight of nodules per plant. It has been proved that there is a relationship between the mass of effective nodules and quantity of nitrogen fixed (Badr, 1984). It is worthy to mention that the obtained results herein showed that the weight of nodular tissue on plant infected with BBMV achieved the least values which can affect negatively on the N_2-fixation efficiency (Tu *et al.*, 1970b). In addition Tu *et al.* (1970a) found that nodules of soybean mosaic virus (SMV) infected soybean contained higher total N than did their healthy counterparts, however, this increase accompanied by a decrease in leghaemoglobin, indicating metabolic disturbance caused by the infection, probably indirect. Tu and Ford 1970 and Van Schreven (1958) reported that inhibition in symbiotic N_2-fixation due to viral infection may be related to the increase in free amino acids in nodules due to increase of total nitrogen which alter the C/N ration which may reduce the normal rate of N_2-fixation.

Enzyme activities:

To obtain more clear indication on some defense-responsible enzymes, mean activities of peroxidase and polyphenoloxidase of the tested faba bean cultivars were determined at different time courses in this study. For peroxidase, data describing increasing of its activity per folds of all treatments in relative to controls at different periods are plotted in **Fig. 1.** It is quite evidence that, the greatest activities were achieved by using combination of rhizobium inoculation and compost tea together on the viral infected plants more than on the healthy plants, indicating induction of systemic acquire resistant (SAR). It indicates that the combination treatment was more effective to induce peroxidase activity than the separate treatments of rhizobia or compost tea. These are in accordance with Saravanakumar *et al.* (2007), who stated that induction of peroxidase activity was significantly higher of about two-fold increase in enzyme activity in tea plants treated with *Pseudomonas fluorescens* Pf1 compared to the untreated control. On contrary, lowest peroxidase activities were achieved in the viral infected untreated plants, indicating suppression of the defense mechanism strongly due to viral infection.

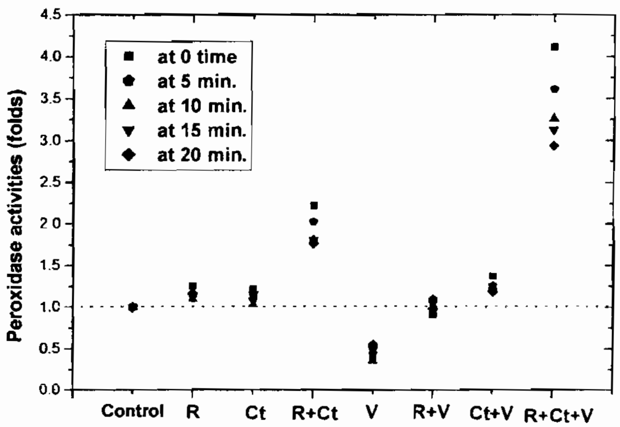

Fig. 1. Peroxidase activities in faba bean at different time courses, where; R: Rhizobium, Ct: Compost tea and V: BBMV.

For polyphenoloxidase, data represented in **Fig. 2** illustrates similar trend as for peroxidase. So, higher induction of polyphenoloxidase activities was done in the diseased plants treated with the combination of rhizobium and compost tea in comparison with the other treatments. Sivakumar and Sharma (2003) showed higher induction of polyphenoloxidase in tea plants treated with *P. fluorescens* due to accumulation of higher phenolic compounds, which may play an important role in defense mechanism in plants against pathogen. These consequences are in agreement with the findings of Saravanakumar *et al.* (2007), who found that the assay of defense enzymes in the plants treated with PGPR bio-fertilizations induced a greater amount of peroxidase and polyphenoloxidase in comparison with the control plants.

Regarding dry weight of shoot, root and seeds, averages data of the tested faba bean cultivars presented in **Fig. 3**, showed the same trend. Stimulation effects for rhizobial inoculation and compost tea fertilization or their combination, but inhibitive effects for viral infection are recorded.

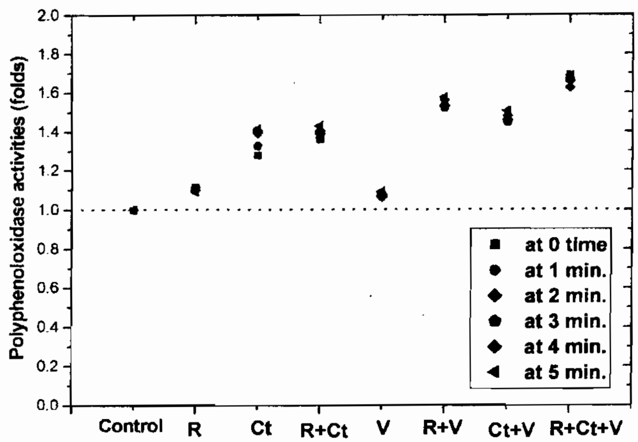

Fig. 2. Polyphenoloxidase activities in faba bean at different time courses, where; R: Rhizobium, Ct: Compost tea and V: BBMV.

Dry weight of shoot, root and seeds of the cultivars were significantly reduced to 21.62, 2.82 and 49.35 g plant^{-1}, respectively in the viral infected plants. These were further increased to 33.98, 7.85 and 91.92 g/plant due to the combined treatment of rhizobium and compost tea together. Infected plants produced less dry matter in different botanical organs, indicating inhibition of the metabolic activity under pathogenic conditions. These results were in agreement with the findings of Sandoval *et al.* (2007), who found that the losses in productivity were varied from 36 to 75 % in the grain yield of broad bean infected with BBMV in comparison with the healthy plants.

The harmful effect of BBMV was also extended to the accumulation of total nitrogen and phosphorus content of faba bean seeds. Averages data of the tested cultivars are located in **Fig. 4.** In which, accumulation of higher amount of both nitrogen and phosphorus in the seeds due to the combined treatment of rhizobia and compost tea were obtained, indicating activation of the metabolic activity. On contrary, high deficient in N and P contents in the diseased plants was also achieved even more than in the control. It indicats sever reduction in the metabolic activity in the diseased untreated plants.

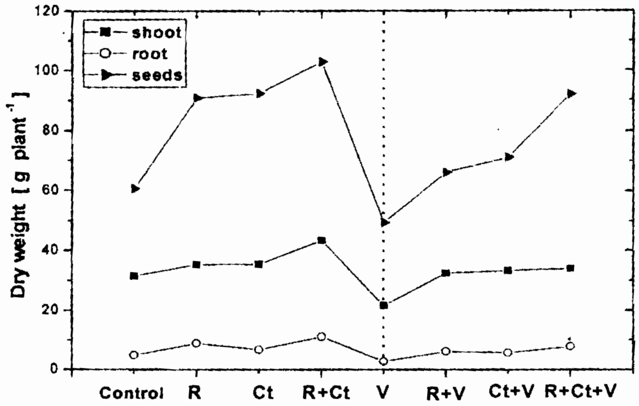

Fig. 3. Dry weight of shoots, roots and seeds in averages of faba bean cultivars, where; R: Rhizobium, Ct: Compost tea and V: BBMV.

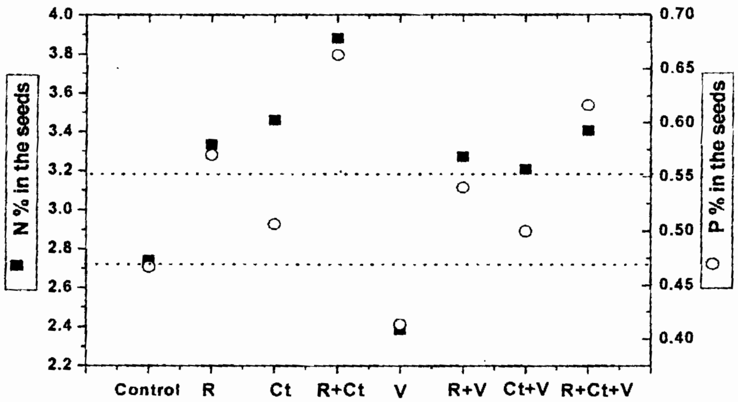

Fig. 4. Total nitrogen and phosphorus contents in averages of faba bean seeds, where; R: Rhizobium, C: Compost tea and V: BBMV.

All other treatments showed positive effect and achieved intermediate values between those two extremes, indicating that rhizobial inoculation or fertilization with compost tea, seldom preventing disease from occurring but generally reducing its extent of severity (Hammerschmidt *et al.*, 2001). According to Matiru and

Dakora (2004), rhizobia naturally produce auxins, cytokinins, absicic acids, rhiboflavin, lipo-chito-oligosaccharides and vitamins. These molecules promote plant growth and colonization rhizobia and their adaptation in faba bean roots would be enhanced to increase plant development, and grain yield.

Therefore, the results indicate that the defensive capacity of faba bean plants against BBMV could be enhanced through biological N_2-fixation and fertilization with compost tea. This conclusion was based on several evidences including rhizobial inoculation and fertilization with compost tea. In growth promotion, rhizobial inoculation can fix appreciable amount of N_2 and enrich the plant and soil with this important nutrient (Sprent and Sprent 1991); increase nutrient uptake and P solubilizer (Biswas *et al.*, 2000 and Yanni *et al.*, 2001) and production of siderosphores, responsible for the fungal inhibition in plant rhizosphere (Yanni *et al.*, 1997). Moreover, rhizobia are also verified as biocontrol agents via induction of phenolic acids in the plants infected by *Rhizoctonia solani*. These phenolics mediate defense responses of crop plants against phytopathogenes that cause various devastating diseases (Mishra *et al.*, 2006). Dakora (2003) reported that rhizobia have a great potential against pathogens and promoting growth of the host plant.

Foliar fertilization with compost tea with its remarkable nutritional values that are present in soluble chemical components into an aqueous sphere (Weltzien 1990 and Dazzo and Yanni 2006), play an important role in controlling several plant diseases and it contains beneficial biotic agents that can induce systemic resistant (ISR) in the plant. Similary, Bharathi et al. (2004), reported that PGPR-microorganisms, involving in compost tea, can induce the systemic resistance in the plants against different pathogens. Formerly investigations of Cucumber mosaic virus in cucumber (Raupach et al. 1996) and of tomato mottle virus in tomato (Polston *et al.*, 1993) and the presented results of BBMV in faba bean, demonstrate that PGPR-mediated induced resistance represents available and environmentally-friendly approach to crop disease management, particularly for viral diseases which are often difficult or impossible to control with synthetic chemicals. Such composting extracts are also likely to be useful in low input agricultural systems in developing countries, where chemicals are either too expensive for small farmers to buy or commercially unobtainable.

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الملخـــص العربــــى

التـــأثيرات المحتملـــة للريزوبيـــا ومســـتخلص الكومبوســـت المـــزود بالريزوبكتيريا فى تحسين وقايـــة نباتات الفول ضد فيروس BBMV

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نتيجة أضافة بعض المخصبات الحيوية مثـــل *Rhizobium leguminosarum* biovar *viciae* ومستخلص الكومبوســـت الغنـــى ببعض السلالات المختارة من الريزوبكتيريـــا المشـــجعة لنمـــو النبـــات (PGPR) ، فقد درست القدرة الدفاعية لنباتات الفـــول ضـــد فيـــروس (BBMV) تحت ظروف الصوبة . ولقد ظهر تحسن معنوى واضح فى ثلاث اصناف من الفول بسبب المخصـــبات الحيويـــة المســـتخدمة بصورة فردية أو بخليطهما . على النقيض ، فقد أنخفضت قيم الصفات المختبرة نتيجة للمرض الفيروسى سواء كان ذلك بعد ٤٥ أو ٧٥ يوم من الزراعة . فقد أنخفضت الشدة المرضية للنباتات المصابة بشكل واضـــح عندما لقحت هذه النباتات بالريزوبيا ورشـــت بمســـتخلص الكومبوســـت المحسن . كما زادت أعداد العقد الجذرية لكل نبات من ٢٢,٢٢ للنباتات المصابة الغير معاملة الى ٧٧,٩٩ للنباتات المصابة الملقحة بالريزوبيـــا ورشت بمستخلص الكومبوست المحسن . وتبعا لذلك فقـــد أزداد الـــوزن الجاف للعقد الجذرية من ٢٣,٤٤ الى ١٠٢,١١ مجم / نبات بسبب هـــذه المعاملة . لذلك فان كفاءة أستخدام هذا الخليط قد أمتدت أيضا الى حـــث النشاط الأنزيمى لكل من البيروكسيديز والبولى فينول أوكسيديز بصورة كبيرة بالمقارنة بالكنترول . وأوضحت نتائج أستخدام المخصبات الحيوية المقترحة أزدياد السعة الدفاعية لنباتات الفول ضد التأثير الضار لفيروس BBMV بسبب الأستفادة من الفعل المتبادل بين الريزوبيا ومســـتخلص الكومبوست المحسن .