11 *Egypt. J. Phytopathol.*, Vol. **43**, No. 1-2, pp. 129-142 (2015)

Evaluation of some Commercial Bio-Products on Damping-Off and the Yield of Bean Crop

S.M. Abolmaaty*; El-Meneisy, Afaf Z.A. and N.Y. Abd El-Ghafar****

* *Central Lab. Agric. Climate, ARC, Dokki, Giza, Egypt.*
** *Dept. Plant Pathol., Fac. Agric., Ain Shams Univ., Egypt.*

Damping-off and root-rot diseases have significant impact on bean production and geographically wide spread and when being severe can completely destroy the legume crop. In this study, certain commercial products, *i.e*. Bio-Cure B, Bio-Cure F, Bio-Healthy, Rhizo-N, Symbion-N, Symbion-NG and Symbion-NR, were evaluated for their efficacy to control damping-off disease and their effect on the yield of bean, under naturally infested field conditions during growing seasons of 2012-2015. Three pathogenic fungi, *i.e. Rhizoctonia solani*, *Fusarium solani* and *Pythium ultimum,* were isolated from diseased bean seedlings showing damping-off symptoms collected from Qaha region, Qaluibiya Governorate. Disease incidence was decreased with application of commercial bio-products as seed or soil drench treatments. Application of the tested bio-products as soil drench treatment was more effective against damping-off disease and increasing nodule production and the yield than their application as seed treatment. Rhizo-N was the most effective to control the disease, but Bio-Health was the lowest effective and Bio-Cure B, Bio-Cure F, Symbion-N, Symbion-NG and Symbion-NR recorded moderate effects. Meantime, nodule production and yield of bean were increased with application of the tested bio-products compared to the check treatment. Nitrogen fixation bacterial products, *i.e.* Symbion-N, Symbion-NG and Symbion-NR, were the most effective to increase the yield and nodule formation compared to the tested bio-control products, *i.e*. Bio-Cure B, Bio-Cure F, Bio-Health and Rhizo-N, which gave moderate effects. Application of Bio-Cure F or Rhizo-N or Symbion-NR for three times as soil drench treatment were more effective to control the disease and to increase the yield and nodule formation than when applied one time, during 2015 growing season.

Keywords: Bean, bio-products, damping-off, *Fusarium solani*, nitrogen fixation bacteria, *Pythium ultimum* and *Rhizoctonia solani*.

Root-rot and damping-off diseases which are distributed world-wide; and even with the use of seed treatment fungicides and fumigants, crop loss due to these diseases ranges from 5% to 10% (Lewis and Lumsden, 2001). Because of the detrimental effects of chemical control for possible development of pathogen resistance, the use of antagonistic bacteria and fungi for disease control has been investigated (Abd Elmoez, 2013). Antagonistic microorganism for disease control may be applied by seed treatment, drenches to soil or soilless mix, or by the addition of granules, or sold matrices (Whipps, 1997 and Boland and Kuyrendall, 1998).

Over the past few decades, agricultural production has increased and farmers rely on chemical pesticide as a relatively dependable method of protecting plants against Soil borne pathogens (Compant *et al*., 2005 and Adesina *et al*., 2007). Increasing use of chemical pesticides causes several negative effects on the environment, as well as on human health (Gerhardson, 2002). Many studies have reported the efficiency of natural activity of various fungi and bacteria against fungal pathogens and this is considered as very appealing alternative to chemical fungicides (Gerhardson, 2002 and Welbaum *et al*., 2004).

Antagonistic rhizo-bacteria more specifically, fluorescent pseudomonads are well known to suppress fungal root disease of various crops such as common bean (Ahmad and Tehrani, 2009). Isolates of *Bacillus subtilis* have inhibitory activity against different soil borne pathogens and reported to control damping-off and improve plant establishment and seedling vigour in the field (Li and Yang, 2005). Other fungal bio-control agents including *Trichoderma* spp. and *Gliocladium* spp. have also suppressed wide range of important soil borne plant pathogens (Chet and Baker, 1981 and Montealegre *et al.*, 2005). *Trichoderma harzianum* was effective against soil borne pathogens, *i.e*. *Rhizoctonia solani* (Hagedorn and Rand, 1974) and *Phytopthora cactorum* improving plant stand and growth (Chet and Baker, 1981; Smith *et al.*, 1990; Tronsom, 1996 and Yobo *et al.*, 2011).

Rhizobia, as species of *Rhizobium*, *Mesorhizobium*, *Bradyrhizobium*, *Azorhizobium* and *Sinorhizobium*, form intimate symbiotic relationships with legumes by responding chemotactically to flavonoid molecules released as signals by the legume host. These plant compounds induce the expression of nodulation genes in rhizobia, which in turn produce lipo-chito-oligosaccharide signal that trigger mitotic cell division in roots, leading to nodule formation (Dakora, 1995 and Lhuissier *et al*., 2001). Nitrogen is required for cellular synthesis of enzymes, proteins, chlorophyll, DNA and RNA, and is therefore important in plant growth and the production of food and feed. For nodulating legume, nitrogen is provided through symbiotic fixation of atmospheric N_2 by nitrogenase fixation (BNF) accounts for 65% of the nitrogen currently utilized in agriculture and will continue to be important in future crop productivity, especially in sustainable systems (Matiru and Dakora, 2004).

The present investigation aimed to evaluate the effectiveness of certain bio-products for suppression of damping-off disease of bean and their effect on nodule formation and the yield of bean plants under field conditions.

Materials and Methods

1- Source of seeds:

Tested seeds of bean (cv. Branco) were obtained from Hortic. Res. Inst., Agric. Res. Centre, Giza, Egypt. The seeds have 80% germination, 99% of purification and treated with the fungicide (Rizolex-T). Tested seeds were surface washed several times under tap water and then left on folds of filter papers at room temperature to remove axis of water before sowing.

2- Pathogenic fungi:

Diseased bean seedling, *i.e.* roots and basal stem parts, which showing typical damping-off and root-rot disease symptoms, were collected from Qaha farm, Vegetable Unit, Hortic. Res. Inst., Agric. Res. Centre, through the growing season of 2012-2013. Infected seedlings were excised and carefully washed with tap water to remove any adhesive soil. Small segments of infected seedlings were superficially sterilized in sodium hypochlorite 2% for 2 min. Then, the fragments were rinsed several times in sterilized water, blotted to dry on sterilized filter papers then placed on potato dextrose agar (PDA) plates and incubated at 27±1°C for 7 days. The developed fungal colonies were picked up. The isolated fungi were purified using the single spore or the hyphal tip techniques (Dhingra and Sinclair, 1985). Purified fungi were identify on basis of their morphological characteristics, spore morphology were described and identified according to the description of Gilman (1957), Nelson *et al*. (1983), Barnett and Hunter (1986) and Moubasher *et al.* (1988).

3- Bio-products:

Seven commercial bio-products recommended to practices the concept integrated plant nutrition system (IPNS) were tested (Table 1). The majority of entrapped microorganisms in these products are characterized by the ability to establish entophytic association with various plants. These products were applied as seed treatment and soil drench treatment. Also, the fungicide Rizolex-T (Tolclofos-methyl + thiram, Sumitomo, Japan) was applied at the recommended dose (3g/kg seed) as check treatment for comparison.

Table 1. The experimental bio formulation profiles

Commercial bio-product	Microorganism	Microbial load	Additive	Major function
Bio-Cure B	*Pseudomonas fluorescence*	1×10^9 cells ml^{-1}	None	Biological control
Bio-Cure F	*Trichoderma viride*	2×10^6 cells ml^{-1}	None	Biological control
Bio-Health WGP	*Bacillus megaterium* + *Trichoderma harzianum*	2.5×10^4 spores + 1×10^7 spores g^{-1}	Amino acids + trace elements + humic acid + fulvic acid + vitamins + auxins	Biological control
Rhizo-N	*Bacillus subtilis*	3×10^7 cells g^{-1}	None	Biological control
Symbion-N	*Azospirillum lipoferum*	1×10^9 cells ml^{-1}	None	Nitrogen fixation
Symbion-NG	*Gluconacetobacter diazotrophicus*	1×10^9 cells ml^{-1}	None	Nitrogen fixation
Symbion-NR	*Rhizobium phaseoli*	1×10^9 cells ml^{-1}	None	Nitrogen fixation

4- Field experiments:

These experiments were conducted at Qaha farm, Vegetable Unit, Hortic. Res. Inst., Agric. Res. Centre, through growing seasons of 2013/14 and 2014/15, under natural heavily infested clay-soil with pathogens causing damping-off and root-rot diseases of bean. All agricultural practices were applied as recommended by Min. of Agric. and land Reclamation. These experiments were designed as a randomized complete block design with four plots as replicates. Each plot was 3x3.5 m with five rows and the seeds were sown in hills (2 seeds/hill and 20 cm apart).

5- Effect of bio-products on incidence of the diseases:

Seven commercial liquid products, *i.e*. Bio-Cure B, Bio-Cure F, Bio-Health, Rhizo-N, Symbion-N, Symbion-NG and Symbion-NR, were applied as seed and soil drench treatments. In case of seed treatments, bean seeds were individually soaked per treatment in 100 ml of each commercial liquid product plus 1% of Carboxy-methyl cellulose per 100 seed in 250 ml flask for one hour. The seeds were air-dried at overnight before planting (Brannen and Kenney, 1997). In case of soil drench treatment, bean seedlings were drenched with solution of commercial products (100 ml/hill). The solutions were added to the soil just after direct sowing. Also, commercial products (Bio-Cure F, Rhizo-N and Symbion-NG) were selected as the better products compared to the other products through previous examine. Under field conditions, these products were applied one or two or three time at zero or ten or twenty days after sowing, respectively, as soil drench treatments during growing season of 2013/14 and 2014/15.

6- Disease assessment:

Percentages per- and post-emergence damping-off as well as healthy survival plants in each treatment were determined 15, 30 and 60 days after sowing using the following formulas according to El-Helaly *et al.* (1970):

Pre-emergence (%)= No. of non-germinated seeds / Total No. of sown seeds x100
Post-emergence (%)= No. of dead seedlings / Total No. of sown seeds x100
Survival plants (%)= No. of survivals / Total No. of sown seeds x100

The efficiency of the tested bio-products to the check was determined using the equation of Wang *et al.* (1994) as follows:

Efficiency (%) = (A-B) / A x 100

Whereas, A= Disease severity in the check and B= Disease severity in the treatment.

7-Effect of bio-products on nodule production and yield of green pods of bean:

Bio-products were applied as seed and soil drench treatments, during growing seasons 2013-14 and 2014-15. Bean roots (20 plant /treatment) were harvested 90 days after sowing to account number of nodules (Caetano-Anolles *et al*., 1992). The yield of green pods was estimated as number and weight of pods (g) per plant/week, where the pods were harvested weekly 60 days after sowing for other 60 days and correlated to the number of plants per treatment (Helmy *et al*., 1998).

8- Statistical analysis:

Data were statistically analysed for least significant difference test according to Snedecor and Cochran (1980).

Results and Discussion

Pathogenic fungi:

Several fungal isolates were isolated from different naturally infected roots and basal stems of bean seedlings collected from Qaha region, Qaluibiya Governorate. Purified isolates were identified as *Rhizoctonia solani*, *Fusarium solani* and *Pythium ultimum*. These isolates were varied in their pathogenicity to cause damping-off and root-rot disease under artificial inoculation conditions. Fusarium root-rot caused by the soil borne fungal pathogen *Fusarium solani* f.sp. *Phaseoli* (Burk.) Snyd and Hans. has been reported to reduce bean yield (Burke and Hall, 1991). The pathogen invades underground roots and stem directly through the epidermis, stomata's and wounds (Christou and Snyder, 1962) and, in accordance; it is the main causal agent of damping-off disease of seedling as well as root- and stem-rot in young transplants of several plant species. Also, *R. solani* is distributed world-wide with a wide host range and causes different symptoms depending on the time of infection (Ahmad and Tehrani, 2009).

Effect of some bio-products on incidence of damping-off, nodule production and yield of green pods of beans:

1- Using commercial bio-products:

Application of bio-products as seed or soil drench treatments against damping-off disease of bean was studied during growing seasons of 2013-14 and 2014-15 at Qaha region, Qaluibiya Governorate, under field conditions (Tables 2 and 3). Disease incidence was decreased with application of the different bio-products as seed or soil treatments compared to the check treatment. Application of the bio-products as soil drench treatment was more effective than seed treatment against pre-and post- emergence damping-off, where efficiency of disease control reached 27.5-31.8% and 20.7-29.3% as soil treatment and 15.7-24.2% or 10.3-22.4% as seed treatment, respectively, but percentage of plant survival was 73.7-73.1% for seed treatment. Meantime, application of fungicide (Rizolex-T) as compared to the check and other bio fertilizers, where the efficiency was 60.2-62.9% for seed treatment and 62.3-65.5% for soil drench treatment, but percentage of plant survival was 86.3 and 87.1%, respectively. Rhizo-N was the most effective compared to other bio-fertilizers, where the efficiency was 24.2-32.2% against per-emergence damping-off and 22.4-29.3% against post-emergence damping-off, but percentage of plant survival was 73.1-75.8%, respectively. Meanwhile, Bio-Cure B, Bio-Cure F, Symbion-N, Symbion-NG and Symbion-NR recorded moderately effects compared to the check, where percentages of efficiency were 22.0-30.9, 23.3-31.8, 18.6-30.1, 17.8- 29.7 and 20.3-30.5% against pre-emergence damping-off, and was 19.0-28.4, 20.7-27.6, 14.7-28.4, 12.1-22.4 and 16.4-24.1% against post-emergence damping-off, but percentage of plant survival was 72.2-75.1, 72.7-75.5,70.9-72.2, 68.5-74.4 and 71.8%, respectively. Meanwhile, Bio-Health was less effective compared to the check and other bio-products, where the efficiency was 15.7-27.5% against post-emergence damping-off, but percentage of plant servile was 69.7-73.7%, respectively.

Table 2. Effect of seed treatment by different bio-products on incidence of bean damping-off during growing seasons of 2013/14 and 2014/15 under field conditions

Treatment	Pre-emergence (%)				Post-emergence (%)				Survival plants (%)		
	A*	B	Mean	C	A	B	Mean	C	A	B	Mean
Bio-Cure B	18.1	18.7	18.4	22.0	9.2	9.6	9.4	19.0	72.7	71.7	72.2
Bio-Cure F	17.8	18.4	18.1	23.3	9.0	9.4	9.2	20.7	73.2	72.2	72.7
Bio-Health	19.4	20.4	19.9	15.7	9.9	10.9	10.4	10.3	70.7	68.7	69.7
Rhizo-N	17.8	18.0	17,9	24.2	8.6	9.4	9.0	22.4	73.6	72.6	73.1
Symbion-N	19.0	19.4	19.2	18.6	9.8	10.0	9.9	14.7	71.2	70.6	70.9
Symbion-NG	19.1	19.7	19.4	17.8	10.0	10.4	10.2	12.1	70.9	69.9	68.5
Symbion-NR	18.6	19.0	18.8	20.3	9.5	9.9	9.7	16.4	71.9	71.1	71.5
Rizolex-T	9.1	9.7	9.4	60.2	4.1	4.5	4.3	62.9	86.8	85.8	86.3
Check	23.2	24.0	23.6	0.0	11.2	12.0	11.6	0.0	65.6	64.4	64.8
LSD at 5% for: Treatment= 1.2; Disease= 3.4; Season= 1.0; Interaction= 3.9											

* A= Growing season of 2013/14; B= Growing season of 2014/15 and C= Efficiency (%).

Table 3. Effect of soil drench treatment by different bio-products on incidence of bean damping-off during growing seasons of 2013/14 and 2014/15 under field conditions

Treatment	Pre-emergence (%)				Post-emergence (%)				Survival plants (%)		
	A	B	Mean	C	A	B	Mean	C	A	B	Mean
Bio-Cure B	16.0	16.6	16.3	30.9	8.2	9.0	8.6	28.4	75.2	74.7	75.1
Bio-Cure F	15.8	16.4	16.1	31.8	8.0	8.8	8.4	27.6	76.2	74.8	75.5
Bio-Health	16.7	17.5	17.1	27.5	9.0	9.4	9.2	20.7	74.3	73.1	73.7
Rhizo-N	15.7	16.3	16.0	32.2	7.9	8.5	8.2	29.3	76.4	75.2	75.8
Symbion-N	15.9	17.1	16.5	30.1	8.0	8.6	8.3	28.4	76.1	74.3	75.2
Symbion-NG	16.2	17.0	16.6	29.7	8.6	9.4	9.0	22.4	75.2	73.6	74.4
Symbion-NR	16.0	16.8	16.4	30.5	8.5	9.1	8.8	24.1	75.5	74.1	74.8
Rizolex-T	8.8	9.0	8.9	62.4	3.3	4.7	4.0	65.5	87.9	86.3	87.1
Check	23.2	24.0	23.6	0.0	11.2	12.0	11.6	0.0	65.6	64.4	64.8
LSD at 5% for: Treatment= 1.0; Disease= 3.5; Season= 1.2; Interaction= 3.8											

* As described in footnote of Table (2).

However, effect of different bio-products on nodule production and yield of bean plants (number of pods and yield/ plant/ week) were studied (Tables 4 and 5). The yield and nodule production were increased with application of different bio-products compared to the check. Application of bio-products as soil drench treatment were more effective than seed treatment, where number of nodule was 28.7-39.9 and 25.6-33.9 per plant, number of pods was 10.1-16.9 and 9.8-14.4 per plant/ week, respectively. Nitrogen fixation bacteria (Symbion-N, Symbion-NG and Symbion-NR) were the most effective, where number of nodule was 29.8-39.9 per plant, number of pods was 13.0-16.9 per plant/week and the yield was 140.1-165.6 (g)/plant/week, respectively. Meantime, biological control products (Bio-Cure B,

Table 4. Effect of seed treatment by different bio-products on nodule production and yield of bean plants during growing seasons of 2012/13 and 2013/14 under field conditions

Treatment	Nodule number/plant			Pods number/plant/week			Green pods (g)/plant/week		
	A*	B	Mean	A	B	Mean	A	B	Mean
Bio-Cure B	25.6	26.9	26.5	9.1	10.7	9.8	109.7	111.6	110.7
Bio-Cure F	25.9	26.9	26.8	9.3	10.5	9.9	115.5	117.6	116.6
Bio-Health	24.8	26.4	25.6	9.5	10.5	10	113.6	115.9	114.8
Rhizo-N	25.0	27.4	26.2	10.2	11.0	10.6	120.4	122.2	121.3
Symbion-N	29.2	30.6	29.9	12.6	13.4	13	139.0	141.1	140.1
Symbion-NG	29.1	30.5	29.8	12.9	14.1	13.5	141.9	143.6	142.8
Symbion-NR	32.9	34.9	33.9	13.8	15.6	14.4	157.0	159.8	158.4
Rizolex-T	23.6	25.6	24.2	9.4	10.6	10	122.3	124.1	123.2
Check	23.0	23.8	23.4	8.3	9.9	9.1	101.6	103.9	102.8
LSD at 5% for: Treatment= 0.8; Disease= 2.9; Season= 1.0; Interaction= 3.3									

* A= Growing season of 2012/13 and B= Growing season of 2013/14.

Table 5. Effect of soil drench treatment by different bio-products on nodule production and yield of bean plants during growing seasons of 2013/14 and 2014/15 under field conditions

Treatment	Nodule number/plant			Pods umber/plant/week			Green pods (g)/plant/week		
	A*	B	Mean	A	B	Mean	A	B	Mean
Bio-Cure B	29.8	31.0	30.4	9.8	10.4	10.1	118.6	120.6	119.6
Bio-Cure F	30.1	31.7	30.9	10.2	11.2	10.7	118.9	120.9	119.8
Bio-Health	28.0	29.4	28.7	10.0	11.8	10.4	119.9	120.9	120.9
Rhizo-N	31.0	31.4	31.2	10.8	11.4	11.1	127.5	130.5	128.5
Symbion-N	34.9	35.9	35.4	13.8	14.2	14.0	147.1	150.7	148.9
Symbion-NG	33.7	34.3	34.0	14.1	15.7	14.9	149.8	151.6	150.7
Symbion-NR	38.8	39.8	39.3	16.2	17.6	16.9	164.8	166.4	165.6
Rizolex-T	23.9	24.9	24.4	9.8	11.0	10.4	124.3	126.5	125.9
Check	23.0	23.8	23.4	9.0	9.6	9.3	103.6	104.4	104.0
LSD at 5% for: Treatment= 0.8; Disease= 2.9; Season= 1.0; Interaction= 3.3									

* As described in footnote of Table (2).

Bio-Cure F, Bio-Health, Rhizo-N) were moderately effective, where number of nodule was 25.6-31.2 per plant, number of pods was 9.8-11.1 per plant/week and the yield was 110.7-128.5 (g)/plant/week, respectively but, application of the fungicide (Rizolex-T) was less effective, where number of nodule was 24.2-24.4 per plant, number of pods was 10.0-10.4 per plant/week and the yield was 123.2-125.9 g/plant/week.

The use of bio-fertilizers and bio-pesticides is an alternative for sustaining high production with low ecological impact. Different soil borne bacteria and fungi are able to classic plant roots and may have beneficial effects on plants. Beside mycrorrhiza fungi and rhizobia, other plant growth promoting rhizobacter (PGPR) and fungi can stimulate plant rigor by suppressing plant disease (Van Wees *et al*., 2008). *Bacillus subtilis* A-13 strain was applied as the first commercial rhizobacter bio-control product (Broadbent *et al.*, 1977) as well as the related strain GBO7 (sold under the trade names Quantum®, Kodiak® and Epic®). These products are used in combination with seed treatment fungicides to protect the seeds against the infector by fungal soil pathogens. The activity *B. subtilis* antifungal is through production of iturin compound with a broad spectrum of antibiotic activity (Klich *et al*., 1991). Some PGPR strains may activate the host defense systems based on lack of direct antibiosis of the strains toward pathogens on correlation of bio-control with plant growth promotion (Scheffer, 1983 and Voisard *et al*., 1989). A large variety of antifungal metabolites are produced by fluorescent Pseudomonads, *i.e.* hydrogen cyanide (Voisard *et al*., 1989), phloroglucinol (Keel *at el*., 1996), Pyoluteorin (Kraus and Loper, 1995) and pyrrolnitrin (Pfender *et al.*, 1993). The species of *Trichoderma* that capable to hyper parasitizing pathogenic fungi are highly efficient antagonists (Barnett and Binder, 1973 and Durrell, 1968).

2- Effect of application numbers:

Bio-Cure F, Rhizo-N and Symbion-NR were selected from the previous experiments due to their high efficiency against damping-off. These bio-products were applied as soil drench treatment for one, two or three times (Tables 6 and 7) to control damping-off disease of bean and to evaluate their effect on nodule production and the yield of bean, during growing season of 2014/15. Disease severity was decreased with increasing application number of bio-products from one to three times, where the efficiency was increased from 32.3 to 35.5%, 33.9 to 37.5% and 30.2 to 31.9% for pre-emergence damping-off and from 22.2 to 25.9%, 25.9 to 30.6% and from 19.4 to 21.3% for post-emergence damping-off. Also, the percentage of survived plants was from 71.8 to 76.0%, 75.6 to 77.0% and 74.2 to 74.6% from Bio-Cure F, Rhizo-N and Symbion-NR, respectively. Application of Bio-Cure F, Rhizo-N and Symbion-NR led to increase nodules production, pod number and the yield with increasing application number from one to three times. Where nodule number were increased from 28.9 to 37.6, 30.4 to 41.3 and 38.9 to 55.2 per plant, pod number was increased from 9.7 to 14.8, 10.7 to 15.4 and 16.5 to 21.6 per plant/week and the yield was increased from 116.4 to 132.4, 120.5 to 134.3 and 160.7 to 199.8 per plant/week, respectively.

Meanwhile, Symbion-NR was the most effective one to increase nodules number and the yield compared to the other bio-product, but Rhizo-N was the most effective agents damping-off compared to the other bio-products. *Gluconacetobacter diazotrophicus* is a nitrogen-fixing bacterium producing acetic acid that could be produced also as phytohormones such as indole acetic acid (IAA) and gibberellic acid (GA), solubilization of plant macro and micronutrients like P and Z and act as bio-control against the phytopathogenic (Saravanan, *et al*., 2007). Common bean

Table 6. Effect of number of applications of three bio-products as soil drench on bean damping-off incidence during growing season of 2014/15 under field conditions

Treatment	No. of applications	Pre-emergence (%)		Post-emergence (%)		Plant survival (%)
		A*	B	A	B	
Bio-Cure F	1	16.8	32.3	8.4	22.2	71.8
	2	16.4	33.9	8.2	24.1	75.4
	3	16.0	35.5	8.0	25.9	76.0
Rhizo-N	1	16.4	33.9	8.0	25.9	75.6
	2	16.0	35.5	7.8	27.8	76.2
	3	15.5	37.5	7.5	30.6	77.0
Symbion-NR	1	17.3	30.2	8.7	19.4	74.2
	2	17.1	31.0	8.6	20.4	74.3
	3	16.9	31.9	8.5	21.3	74.6
Check	0	24.8	0.0	10.8	0	64.4
LSD at 5%		1.6		1.2		1.0

* A= Infected Seedling (%) B= Efficiency (%).

Table 7. Effect of number of applications of three bio-products as soil drench on nodule production and yield of bean plants during growing season of 2014/15 under field conditions

Treatment	No. of applications	Nodule number/plant	Pods number/plant/week	Green pods (g)/plant/week
Bio-Cure F	1	28.9	9.7	116.4
	2	35.8	13.2	127.2
	3	37.6	14.8	132.4
Rhizo-N	1	30.4	10.7	120.5
	2	38.6	14.0	131.7
	3	41.3	15.4	134.3
Symbion-NR	1	38.9	16.5	160.7
	2	48.6	19.2	189.7
	3	55.2	21.6	199.8
Check	0	23.0	9.1	102..2
LSD at 5%		2.4	1.6	1.1

growth and pod yield conspicuously improved due to bio formulation application indicating the beneficial effects of the entrapped microorganisms. Much remains to be learned associations and apparently a more pronounced growth- enhancing effect on host plants (Bais *et al.*, 2004). The availability of the co-formulated bio-agents of a bacterium and specific *Rhizobium strains* could be important means to reduce the need for chemical treatments that can inhibit nodulation and nitrogen fixation. Such treatment is necessary for growth plants; bioperparate inocula containing both Rhizobium and the bio-control agent may permit their use without damage to nodulation and nitrogen fixation (Abd Elmoez, 2013).

Also, Brown (1962) observed that *Azotobacter* spp. beside the N-fixation was able to produce growth substances and fungal antibiotics, and the response of the crops to the inoculation could be attributed to the substances produced by the organisms. Chung and Wu (2000) recorded the efficiency of *Bacillus megaterium* to reduce damping-off and root-rot diseases caused by *R. solani*. Zeidan (2000) and Emara (2005) found that application of *Bacillus* spp. and *Rhizobium* spp. led to increase the plant P uptake, water status inside the plant tissues and hence increases the plant amino acids and activate its rates and enhance the action of succinic and lactic acids which induce the root growth.

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(Received 10/09/2015;
in revised form 16/10/2015)

تقييم بعض المنتجات الحيوية التجارية على أمراض موت البادرات وعفن الجذور وأنتاجية محصول الفاصوليا

شاكر محمد ابو المعاطى*، عفاف زين العابدين المنيسى، ناجى يسين عبد الغفار****

* **المعمل المركزى للمناخ الزراعى** - مركز البحوث الزراعية - **وزارة الزراعة و استصلاح الاراضى.**

** **قسم أمراض النبات** - كلية الزراعة ـ جامعة عين شمس.

تسبب أمراض موت البادرات وعفن الجذور فقد كبير فى إنتاج محصول الفاصوليا تحت الظروف البيئية المصرية. أجريت تلك الدراسة لتقيم فعالية بعض المنتجات التجارية الحيوية (بيوكيور بى ـ بيوكيور أف – بيوهلث – ريزوان ـ سيمبيوأن ـ سيمبيوأن جى ـ سيمبيون أن ار) لمكافحة تلك الأمرض و المحصول وتكوين العقد البكتيرية فى نباتات الفاصوليا تحت ظروف الاصابة الطبيعة فى الحقل خلال مولسم الزراعة من ٢٠١٢ الى ٢٠١٥. عزلت فطريات *Rhizoctonia solani* و *Fusarium solani* و *Pythium ultimum* من بادرات فاصوليا مصابة بأعراض أمراض أعفان الجذور وموت البادرات جمعت من منطقة قها بمحافظة القليوبية التى نفذت فيها جميع تجارب البحث. أستخدمت تلك المنتجات الحيوية كمعاملة للبذور او رى التربة تحت ظروف العدوى الطبيعية خلال مواسم النمو ٢٠١٢-٢٠١٣ و ٢٠١٣-٢٠١٤ واظهرت تلك المنتجات كفاءة فى حفض الأصابة بالامراض و زيادة المحصول وزيادة التعقد البكتيرى بالمقارنة مع معاملة المقارنة. كان المنتج التجارى الحيوى الريزوان هو الاكثر كفاءة فى مكافحة مرض موت البادرات ولكن البيوهلث كان الاقل فعالية فى حين كان بيوكيور بى وبيوكيور أف و سيمبيوأن جي و سيمبيون أن ارو سيمبيوأن متوسط الفاعلية. ادى استخدام المنتجات التجارية الحيوية الى زيادة محصول الفاصوليا وتعداد العقد البكتيرية على جذور نباتات الفاصوليا بالمقارنة مع معاملة المقارنة. المنتجات البكتيرية الحيوية المثبتة للنيتريوجين الجوى (سيمبيوأن ـ سيمبيوأن جى ـ سيمبيون أن ار) كانت أكثر فعالية فى زيادة محصول الفاصوليا وتعداد العقد البكتيرية بالمقارنة مع منتجات المكافحة الحيوية (بيوكيور بى ـ بيوكيور أف ـ بيوهلث ـ ريزوان) التي أظهرت كفاءة معتدلة. اختيرت أفضل المنتجات الحيوية من نتائج التجارب السابقة وهى الريزوان و البيوكيور أف و السيمبيون أن ار لأستخدامها فى عدة توقيتات ولاكثر من مرة خلال موسم النمو ٢٠١٤-٢٠١٥ كمعاملة رى للتربة وأظهرت النتائج أن اضافة تلك المنتجات لثلاث مرات كمعاملة تربة كانت أكثر كفاءة في مكافحة المرض وزيادة المحصول وزيادة تعداد العقد البكتيرية بالمقارنة مع استخدامهم مرة واحدة فقط.