International Journal of Biochemistry Research & Review

28(1): 1-9, 2019; Article no.IJBCRR.51350
ISSN: 2231-086X, NLM ID: 101654445

Ecofriendly Management of Seedling Diseases of Chickpea (*Cicer arietinum*)

Farid Ahmed[1*], Mahbuba Kaniz Hasna[2], Md. Babul Akter[3], Md. Tanjilur Rahman Mondal[4] and K. M. Eadun Nabi[2]

[1]Horticulture Division, Bangladesh Institute of Nuclear Agriculture, BAU Campus, Mymensingh-2202, Bangladesh.
[2]Plant Pathology Division, Bangladesh Institute of Nuclear Agriculture, BAU Campus, Mymensingh-2202, Bangladesh.
[3]Bangladesh Institute of Nuclear Agriculture, Sub-Station, Barishal, Bangladesh.
[4]Bangladesh Institute of Nuclear Agriculture, Sub-Station, Rangpur, Bangladesh.

Authors' contributions

This work was completed in collaboration among all authors. Authors FA, MTRM and KMEN designed the experiment, performed the statistical analysis, develop the protocol, managed the literature searches and wrote the first draft of the manuscript. Authors MKH and MBA check and improve the manuscript. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/IJBCRR/2019/v28i130133
Editor(s):
(1) Dr. Emel Banu Buyukunal, Associate Professor, Department of Biology, Kahramanmaras Sutcu Imam University, Turkey.
(2) Dr. Fidanka Trajkova, Associate Professor, Faculty of Agriculture, Goce Delcev University of Stip, Macedonia.
(3) Dr. Chunying Li, Center for Molecular and Translational Medicine, Institute of Biomedical Sciences, Georgia State University, USA.
(4) Dr. Muhammad Abdul Rehman Rashid, Assistant Professor, Department of Plant Breeding and Genetics, University of Agriculture Faisalabad, Pakistan.
Reviewers:
(1) Cristiane Ramos Vieira, University of Cuiabá, Brazil.
(2) Anita Liška, Josip Juraj Strossmayer University of Osijek, Croatia.
(3) R. Mahalakshmi, India.
Complete Peer review History: http://www.sdiarticle4.com/review-history/51350

Original Research Article

Received 10 August 2019
Accepted 18 October 2019
Published 23 October 2019

ABSTRACT

The experiment was carried out in the field of Plant Pathology Department, Bangladesh Agricultural University, Mymensingh, Bangladesh to determine the effect of BARI-biofertilizer and Integrated Pest Management (IPM) biopesticide for controlling foot and root rot diseases of chickpea. It was observed that both BARI-Biofertilizer and IPM biopesticide resulted significantly lower disease incidence of seedlings of the test pulse over the control. Soil treatment with BARI-Biofertilizer

**Corresponding author: E-mail: faridbina.hort@gmail.com;*

resulted the lowest disease incidence of chickpea var. Hyprosola, Binasola-2, Binasola-3 and Binasola-4 at 20 DAS (Days after sowing) that displayed reduction of disease incidence up to 83.77%, 54.48%, 70.76% and 71.45% respectively over control. While at 28 DAS, showedup to 82.82%, 71.92%, 84.72% and 68.39%, respectively, reduction of disease incidence over control. At 35 DAS, exhibited up to 79.91%, 73.18%, 81.32% and 73.44%, respectively, reduction of disease incidence over control. BARI-biofertilizer and IPM biopesticide increased fresh weight of plant, number of nodules per plant and fresh weight of nodules per plant.

Keywords: Seedling diseases; chickpea; Cicer arietinum; plant pathology.

1. INTRODUCTION

Chickpea (*Cicer arietinum* L.) is one of the most important cheap protein source in comparison with high cost animal protein and also for animals in Bangladesh [1]. It is specially considered as poor man's meat [2]. Price of animal protein is increasing and availability is decreasing day by day and therefore the protein shortage in the diet of the people in our country can be met up through improvement of varieties and increasing the production like chickpea. Moreover, legumes have the remarkable quality of fixing the symbiotic nitrogen having relationship with *Rhizobia* and improving soil fertility.

Chickpeais are cultivated in all areas of about 5028.74 ha with average yield of 0.987t/ha [3]. There are many causes associated with lower yield of pulses in the country where disease play one of the most important factors. Many phytopathogenic soil-borne as well as seed borne fungi are responsible for disease development which attack plants during seedling to maturity stages and these fungi are more destructive at seedling stage. Foot rot and root rot (*Fusarium oxysporum f. sp. ciceri* and *Sclerotium rolfsii Sacc.*) is considered as the important and destructive disease of pulse of the world [4,5].

Chemical control of soil borne *F. oxysporum* and *S. rolfsii* is practically impossible and impractical. Hundred percent mortality occurs in Bangladesh due to foot and root rot and wilt infected plants [4,6]. Indiscriminate uses of chemicals also causes environmental pollution and health hazards. The use of antagonistic bacteria as biological control means may provide a alternative for plant pathologist. *Trichoderma harzianum* has been found as effective biocontrol agent of soil and seed borne plant pathogenic fungi [7,8,9]. Seed treatment with *Rhizobium leguminosarum* pv. *viceae* was effective to reduce damping-off and to increase seedling height, root nodule mass, root biomass, shoot biomass and seed yield of pea and lentil [10]. *T. harzianum* has been reported as effective biocontrol agent of soil and seed borne plant pathogenic fungi [7,8,9]. Considering the above facts the present study was undertaken to find out the effect of BARI-biofertilizer and IPM biopesticide on foot and root rot disease of chickpea under field condition.

2. MATERIALS AND METHODS

2.1 Collection of Seeds, Biofertilizer and Biopesticide

Chickpea seeds of variety cv. Hyprosola, Binasola-2, Binasola-3 and Binasola-4 were collected from Bangladesh Institute of Nuclear Agriculture, Mymensingh. IPM-biopesticide (based on *Trichoderma* sp.) was collected from IPM laboratory, Department of Plant Pathology, BAU, Mymensingh. BARI-biofertilizer was collected from Bangladesh Agricultural Research Institute (BARI), Joydevpur, Gazipur.

2.2 Field Evaluation of Biofertilizer and Biopesticide for Controlling Foot and Root Rot

The experiment was conducted in the field of Department of Plant Pathology, Bangladesh Agricultural University (BAU), Mymensingh, during November, 2017 to April, 2018. The land type was medium high, with loamy soil texture, pH range 5.5-6.8, low in organic matter content, and medium K (Potassium) bearing minerals. The soil of the experimental plots was sandy loam in texture belongs to Sonatola soil series under Old Brahmaputra Flood Plain. The experiment was laid out in a Randomized Complete Block Design with four replications with unit plot size of 6m × 2m. The space for line to line was 30cm and plant to plant was 12cm. The treatments were: (i) T_1 = Control, (ii) T_2 = IPM biopesticide as soil treatment, (iii) T_3 = IPM biopesticide in lines at sowing time, (iv) T_4 =

IPM biopesticide as seed treatment, (v) T_5 = BARI-biofertilizer as seed treatment and (vi) T_6 = BARI-biofertilizer in lines at sowing time.

The biopesticide was mixed with top soil with 6.4 g/m2 at 7 days before sowing. At the time of sowing Biopesticide was given1 g/line. For seed treatment required amount of seeds were taken in a beaker and few drops of water was added for moistening the seed surface uniformly to allow maximum adherence of the IPM Biopesticide on the whole surface of seeds. Seeds were then treated with IPM Biopesticide with 4% of seed weight until the whole surfaces of seeds were coated with the IPM Biopesticide. Similarly, seeds of chickpea were treated with Biofertilizer with 4% of seed weight and the required amount of Biofertilizer (2 kg/ha) was given in lines at the time of sowing. Seeds were sown in lines at about 5cm depth with 18 kg/ha. Three times weeding was done at 15, 30 and 45 (Ddays after sowing) (DAS). No irrigation was done in the field. The crop was found to be infested with cut worm. Chemical insecticide, diazinon 60 EC with 1.7 litreL/ha was used in the field for controlling the insect.

2.3 Collection of Data and Statistical Analysis

Data of disease incidence (%) were recorded at 20 DAS, 28 DAS and 35 DAS. The weight of each plant (g), no. of nodules per plant and weight of nodule per plant (g) were recorded at 60 DAS and 85 DAS. The incidence of foot and root rot disease in the experimental plots was recorded by following formula:

% plant infection = (Number of infected plants/ Total number of plants) X 100

The data were analyzed following a statistical package (MSTATC) programme. Treatment means were compared with Duncan's Multiple Range Test (DMRT) [11].

3. RESULTS AND DISCUSSION

3.1 Effect of Biofertilizer and Biopesticide on Disease Incidence of Foot and Root Rot

Disease incidence was reduced in plots treated with IPM biopesticide and BARI biofertilizer. The lowest disease incidence was recorded by treating soil at sowing time with BARI-biofertilizer, while the highest disease incidence was recorded in control plots (Table 1 and Table 2). The lowest disease incidence at 20 DAS, 28 DAS and 35 DAS were 3.47%, 5.06% and 5.94%, respectively, for Hyprosola; 11.37%, 9.42% and 8.46%, respectively, for Binasola-2; 8.56%, 6.96% and 8.54%, respectively, for Binasola-3; & 9.49%, 12.81% and 11.33%, respectively for Binasola-4. The highest disease incidence at 20 DAS, 28 DAS and 35 DAS were 21.38%, 29.45% and 29.56%, respectively, for Hyprosola; 24.98%, 33.55% and 31.54%, respectively, for Binasola-2; 29.27%, 45.55% and 45.72%, respectively, for Binasola-3; 33.24%, 40.52% and 42.66%, respectively, for Binasola-4. Treating soil with BARI-biofertilizer resulted disease reduction for Hyprosola, Binasola-2, Binasola-3 and Binasola-4 upto 83.77%, 54.48%, 70.76% and 71.45%, respectively at 20 DAS; upto 82.82%, 71.92%, 84.72%and 68.39%, respectively at 28 DAS; upto 79.91%, 73.18%, 81.32% and 73.44%at 35 DAS.

BARI-biofertilizer treated seeds showed the lower disease incidence of chickpea var. Hyprosola, Binasola-2, Binasola-3 and Binasola-4 and resulted upto 57.53%, 46.64%, 59.62% and 62.94%, respectively reduction of disease at 20 DAS and at 28 DAS resulted upto 55.55%, 57.44%, 74.29% and 59.28%, respectively; at 35 DAS resulted upto 55.92%, 55.83%, 71.54% and 62.92%, respectively reduction of disease incidence over control. Treating of seeds with biofertilizer and *Rhizobium* inoculant BINA-CP-620 resulted in pot trials up to 87.50% reduction in foot and root rot of chickpea [12]. Biocontrol of root-rot disease complex of chickpea might be achieved by the combined use of *Rhizobium, G. intraradices* and *P. straita* or use of *Rhizobium* plus *P. straita* [13].

IPM Biopesticide as soil treatment showed the lower disease incidence of chickpea var. Hyprosola, Binasola-2, Binasola-3 and Binasola-4 and resulted upto 59.03%, 48.16%, 47.42% and 55.23%, respectively reduction of disease at 20 DAS while at 28 DAS resulted upto 62.82%, 52.79%, 64.06% and 52.12%, respectively reduction of disease but at 35 DAS resulted upto 70.70%, 51.59%, 55.88% and 70.11%, respectively reduction of disease incidence over control. *T. harzianum* and *T. viride* as the most efficient in inhibiting the growth of *Fusarium oxysporum* f. sp. *ciceri* by 60% and 58%, respectively [8]. *Trichoderma lignorum, T. viride* and *T. virens* inhibited the growth of *S. rolfsii* by 68% and 67%, while the growth of *R. bataticola* was inhibited to the extent of 76% by *T. viride* and *T. harzianum* [8].

Table 1. Data for IPM Biopesticide as soil treatment for disease incidence Binasola-4 at 35 DAS over control; and BARI-Biofertilizer as seed treatment for Binasola-2 at 20 DAS

Treatments	Disease incidence (%)					
	Hyprosola			Binasola-2		
	20 DAS	28 DAS	35 DAS	20 DAS	28 DAS	35 DAS
Control	21.38 [a]	29.45 [a]	29.56 [a]	24.98 [a]	33.55 [a]	31.54 [a]
IPM Biopesticide as soil treatment	8.76 [b]	10.95 [c]	8.66 [c]	12.95 [b]	15.84 [c]	15.27 [b]
IPM Biopesticide in lines at sowing time	12.20 [b]	21.11 [b]	15.56 [b]	13.49 [b]	14.53 [cd]	15.34 [b]
IPM Biopesticide as seed treatment	11.94 [b]	18.63 [b]	12.62 [b]	14.40 [b]	21.21 [b]	15.67 [b]
BARI- Biofertilizer as seed treatment	9.076 [b]	13.09 [c]	13.03 [b]	12.33 [b]	14.28 [cd]	13.93 [b]
BARI- Biofertilizer in lines at sowing time	3.47 [c]	5.06 [d]	5.94 [c]	11.37 [b]	9.42 [d]	8.46 [c]
LSD (p ≥ 0.05)	3.65	5.05	3.95	4.81	5.06	4.76

Data presents the mean of four replications. In a column, data with similar letter do not differ

Table 2. Effect of IPM biopesticide and BARI-biofertilizer on disease incidence of foot and root rot of chickpea cv. Binasola-3 and Binasola-4

Treatments	Disease incidence (%)					
	Binasola-3			Binasola-4		
	20 DAS	28 DAS	35 DAS	20 DAS	28 DAS	35 DAS
Control	29.27 [a]	45.55 [a]	45.72 [a]	33.24 [a]	40.52 [a]	42.66 [a]
IPM Biopesticide as soil treatment	15.39 [b]	16.37 [bc]	20.17 [bc]	14.88 [cd]	19.40 [bcd]	15.75 [cd]
IPM Biopesticide in lines at sowing time	16.12 [b]	22.75 [b]	23.07 [b]	23.31 [b]	25.95 [b]	24.82 [b]
IPM Biopesticide as seed treatment	14.30 [b]	16.23 [bc]	18.80 [bc]	17.85 [c]	21.56 [bc]	19.49 [bc]
BARI- Biofertilizer as seed treatment	11.82 [bc]	11.71 [cd]	13.01 [cd]	12.32 [de]	16.50 [cd]	15.82 [cd]
BARI- Biofertilizer in lines at sowing time	8.56 [c]	6.96 [d]	8.54 [d]	9.487 [e]	12.81 [d]	11.33 [d]
LSD (p ≥ 0.05)	4.15	7.63	6.95	3.93	7.71	7.44

Data presents the mean of four replications. In a column, data with similar letter do not differ

3.2 Effect of Biofertilizer and Biopesticide on fresh weight of plant

In Hyprosola the maximum fresh weight of plant by 20.31 g at 60 DAS and by 58.89 g at 85 DAS were recorded in case of treating soil at sowing time with BARI-biofertilizer, while the minimum fresh weight of plant by 11.92 g and by 36.81 g were recorded in control (Table 3). The fresh weight of seedlings was found to be increased by treating the soil with BARI-biofertilizer up to 70.39 and 59.98% at 60 DAS and 85 DAS, respectively, over the control. In Binasola-2 the maximum fresh weight of plant by 27.41 g at 60 DAS and 79.14 g at 85 DAS, was recorded in case of treating soil with BARI-biofertilizer. While the minimum fresh weight of plant by 11.32 g and 34.06 g, were recorded in control (Table 4).

The fresh weight of seedlings was found to be increased up to 142.14% and 132.35% respectively over control. In Binasola-3 the maximum fresh weight of plant by 25.71 g at 60 DAS and 74.89 g at 85 DAS was recorded in case of treating soil at sowing time with BARI-biofertilizer, while the minimum fresh weight of plant by 9.66 g and 30.51 g was recorded in control (Table 5). The fresh weight of seedlings was found to be increased up to 167.19% and 145.46%, respectively, over control. In Binasola-4 the maximum fresh weight of plant by 25.54 g at 60 DAS and 77.65 g at 85 DAS were recorded in case of treating soil at sowing time with BARI-biofertilizer while the minimum fresh weight of plant by 12.85 g and 37.77 g were recorded in control (Table 6). The fresh weight of seedlings was found to be increased upto 98.75% and 105.59%, respectively, over control.

IPM biopesticide as soil treatment (7 days before sowing) increased the fresh weight of chickpea var. Hyprosola, Binasola-2, Binasola-3 and Binasola-4 by, 51.51%, 76.41%, 96.58% and 64.75%, respectively, at 60 DAS; and by 30.86%, 60.31%, 38.84% and 18.16%, respectively, at 85 DAS over control. Seed treatment with *T. harzianum* grown on blackgram resulted to increase fresh shoot weight up to 263.33% and fresh root weight 157.14% over control [14].

Fig. 1. The chickpea seedling; A: foot and root rot infected, B: healthy

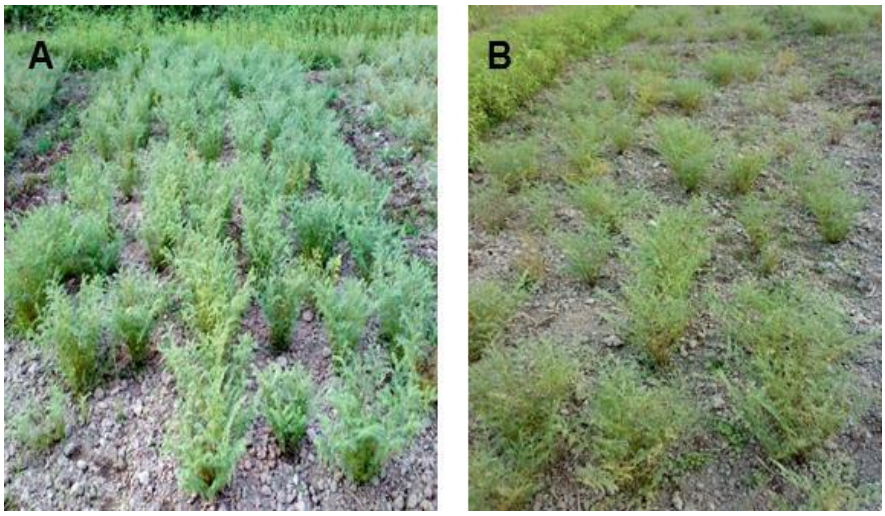

Fig. 2. Field view; A: BARI-Biofertilizer treated plot showing lower diseases incidence, B: BARI-Biofertilizer untreated plot (control) showing higher diseases incidence

Fig. 3. The chickpea seedling; A: high number of nodules from BARI-Biofertilizer treated plot (left) and low number of nodules from untreated plot (right), B: Isolated nodules

Table 3. Effect of IPM biopesticide and BARI-biofertilizer on fresh weight of plant, number of nodules per plant and fresh weight of nodules per plant of chickpea cv. Hyprosola

Treatments	Fresh weight of plant (g)		Number of nodules/plant		Fresh weight of nodules/plant (g)	
	60 DAS	85 DAS	60 DAS	85 DAS	60 DAS	85 DAS
Control	11.92 b	36.81 c	4.14 c	4.43 c	0.62 b	0.91 b
IPM Biopesticide as soil treatment	18.06 a	48.17 b	7.71 b	6.29 bc	0.67 b	1.19 b
IPM Biopesticide in lines at sowing time	13.16 b	45.97 b	6.00 bc	6.86 bc	0.47 b	1.19 b
IPM Biopesticide as seed treatment	13.40 b	43.36 b	5.00 c	5.00 c	0.48 b	1.27 b
BARI- Biofertilizer as seed treatment	20.25 a	55.57 a	14.86 a	9.14 b	1.46 a	2.15 a
BARI- Biofertilizer in lines at sowing time	20.31 a	58.89 a	16.29 a	18.14 a	1.69 a	2.38 a
LSD (p ≥ 0.05)	3.23	6.11	2.17	3.02	0.30	0.44

Data presents the mean of four replications. In a column, data with similar letter do not differ

Table 4. Effect of IPM biopesticide and BARI-biofertilizer on fresh weight of plant, number of nodules per plant and fresh weight of nodules per plant of chickpea cv. Binasola-2

Treatments	Fresh weight of plant (g)		Number of nodules/plant		Fresh weight of nodules/plant (g)	
	60 DAS	85 DAS	60 DAS	85 DAS	60 DAS	85 DAS
Control	11.32 ^{c}	34.06 ^{c}	7.86 ^{c}	7.29 ^{b}	0.53 ^{b}	1.02 ^{d}
IPM Biopesticide as soil treatment	19.97 ^{b}	54.60 ^{b}	13.57^{ab}	7.86 ^{b}	1.16 ^{a}	1.87 ^{b}
IPM Biopesticide in lines at sowing time	20.24 ^{b}	54.46 ^{b}	12.00 ^{b}	7.71 ^{b}	0.72 ^{b}	1.39 ^{c}
IPM Biopesticide as seed treatment	16.46 ^{b}	50.53 ^{b}	7.86 ^{c}	8.86 ^{b}	1.132 ^{a}	1.60^{bc}
BARI- Biofertilizer as seed treatment	26.73 ^{a}	76.59 ^{a}	14.57^{ab}	13.57 ^{a}	1.313 ^{a}	2.66 ^{a}
BARI- Biofertilizer in lines at sowing time	27.41 ^{a}	79.14 ^{a}	16.43 ^{a}	15.00 ^{a}	1.4 ^{a}	2.69 ^{a}
LSD (p ≥ 0.05)	3.87	5.35	2.88	1.71	0.30	0.35

Data presents the mean of four replications. In a column, data with similar letter do not differ

3.3 Effect of Biofertilizer and Biopesticide on Number of Nodules

IPM biopesticide and BARI-biofertilizer applied in different methods showed effect on number of nodules/plant at 60 DAS and 85 DAS. In Hyprosola maximum number of nodule was 16.29 at 60 DAS and 18.14 at 85 DAS in case of treating soil with BARI-Biofertilizer in lines at sowing time (Table 3). In case of treating seeds with BARI-Biofertilizer 14.86 and 9.41 nodules/plant were recorded. On the other hand, the lowest number of nodules/plant by 4.14 and 4.43 was observed under control. The number of nodules/plant of seedlings was found to be increased up to 293.48% and 309.48% respectively, in relation about the control.

In Binasola-2 maximum number of nodule 16.43 at 60 DAS and 15.00 at 85 DAS was found in case of treating soil with BARI-biofertilizer in lines at sowing time (Table 4). The number of nodules per plant was recorded 14.57 and 13.57 in case of treating seeds with BARI-Biofertilizer at 60 and 85 DAS, respectively. The lowest number of nodules/plant 7.86 and 7.29 were observed in control. The number of nodules/plant of seedlings was found to be increased by treating soil with BARI-biofertilizer up to 109.03% and 105.76%, respectively, over control. In Binasola-3 maximum number of nodule was 19.57 at 60 DAS and 10.71 at 85 DAS in case of treating soil with BARI-biofertilizer in lines at sowing time (Table 5). The number of nodules per plant was 17.71 and 10.00 in case of treating seeds with BARI-biofertilizer. On the other hand, the lowest number of nodules/plant 8.71 and 8.27 was observed in control. The number of nodules/plant of seedlings was found to be increased up to 124.68% and 46.30%, respectively, over control. In Binasola-4 maximum number of nodule was 17.00 at 60 DAS and 11.29 at 85 DAS in case of treating soil with BARI-biofertilizer in lines at sowing time (Table 6).The number of nodules per

plant was 15.71 and 10.00 in case of treating seeds with BARI-biofertilizer. The lowest number of nodules/plant 6.00 and 6.14 was observed in control. The number of nodules/plant of seedlings was found to be increased up to 183.33% and 83.88%, respectively, over control.

Use of BARI-biofertilizer in different methods resulted higher number of nodules per plant in chickpea. Mung (*Vigna radiata* L.) seed treated with *Rhizobium* had the number of nodulation, biomass and grain yield increased [15]. Biofertilizer as seed treatment resulted 53.9% higher nodules/plant over control [12]. Biofertilizer and *Rhizobium* strains, viz. BINA-LT-L4, BINA-LT-634 and BINA-LT-640, increased number of nodules/plant in 58.4% in a study [16].

3.4 Effect of Biofertilizer and Biopesticide on Fresh Weight of Nodules

In Hyprosola the maximum fresh weight of nodules/plant by 1.69 g at 60 DAS and by 2.38 g at 85 DAS, was observed in case of treating soil with BARI-biofertilizer (Table 3). Seed treatment with BARI-biofertilizer also showed higher fresh weight of nodules/plant, while the minimum fresh weight of nodules/plant by 0.62 g at 60 DAS and 0.91 g at 85 DAS were observed in control. The fresh weight of nodules of seedlings was found to be increased up to 172.58% and 161.54% respectively over control. In Binasola-2 the maximum fresh weight of nodules/plant by 1.40 g at 60 DAS and 2.69 g at 85 DAS, was observed in case of treating soil with BARI-biofertilizer (Table 4).

Seed treatment with BARI-biofertilizer also showed higher fresh weights of nodules/plant, while the minimum fresh weight of nodules/plant by 0.53 g and 1.02 g were observed in control. The fresh weight of nodules of seedlings was found to be increased up to 164.15% and 163.73%, respectively, over control. In Binasola-3 the maximum fresh weight of nodules/plant by 1.34 g at 60 DAS and 2.65 g at 85 DAS was observed in case of treating soil with BARI-biofertilizer (Table 5). Seed treatment with BARI-biofertilizer also showed higher fresh

Table 5. Data for increasing number of nodules/plant of Binasola-3 over control with Bari biofertilizer-seed treatment

Treatments	Fresh weight of plant (g)		Number of nodules/plant		Fresh weight of nodules/plant (g)	
	60 DAS	85 DAS	60 DAS	85 DAS	60 DAS	85 DAS
Control	9.66^{c}	30.51^{c}	8.71^{b}	8.27^{abc}	0.41^{c}	0.98^{c}
IPM Biopesticide as soil treatment	18.99^{b}	42.36^{b}	8.86^{b}	8.00^{abc}	0.79^{b}	1.47^{b}
IPM Biopesticide in lines at sowing time	14.53^{bc}	40.50^{b}	6.000^{b}	7.29^{bc}	0.66^{b}	1.20^{bc}
IPM Biopesticide as seed treatment	18.08^{b}	40.15^{b}	9.14^{b}	6.571^{c}	0.62^{b}	1.33^{bc}
BARI- Biofertilizer as seed treatment	25.60^{a}	70.92^{a}	17.71^{a}	10.00^{ab}	1.21^{a}	2.43^{a}
BARI- Biofertilizer in lines at sowing time	25.71^{a}	74.89^{a}	19.57^{a}	10.71^{a}	1.34^{a}	2.65^{a}
LSD ($p \geq 0.05$)	5.792	5.192	3.263	2.598	0.2100	0.3604

Data presents the mean of four replications. In a column, data with similar letter do not differ

Table 6. Effect of IPM biopesticide and Bari-biofertilizer on fresh weight of plant, number of nodules per plant and fresh weight of nodules per plant of chickpea cv. Binasola-4

Treatments	Fresh weight of plant (g)		Number of nodules/plant		Fresh weight of nodules/plant (g)	
	60 DAS	85 DAS	60 DAS	85 DAS	60 DAS	85 DAS
Control	12.85^{d}	37.77^{b}	6.00^{c}	6.14^{c}	0.23^{d}	1.03^{c}
IPM Biopesticide as soil treatment	21.17^{b}	44.63^{b}	11.00^{b}	8.43^{b}	0.88^{b}	1.65^{b}
IPM Biopesticide in lines at sowing time	18.45^{c}	42.56^{b}	11.29^{b}	7.57^{bc}	0.95^{b}	1.38^{bc}
IPM Biopesticide as seed treatment	15.04^{d}	38.53^{b}	9.00^{b}	6.57^{c}	0.49^{c}	1.28^{bc}
BARI- Biofertilizer as seed treatment	24.69^{a}	75.60^{a}	15.71^{a}	10.00^{a}	1.26^{a}	2.41^{a}
BARI- Biofertilizer in lines at sowing time	25.54^{a}	77.65^{a}	17.00^{a}	11.29^{a}	1.34^{a}	2.70^{a}
LSD ($p \geq 0.05$)	2.721	8.621	2.655	1.411	0.2392	0.3996

Data presents the mean of four replications. In a column, data with similar letter do not differ

weight of nodules/plant, while the minimum fresh weight of nodules/plant by 0.41 g and 0.98 g, were observed in control. The fresh weight of nodules of seedlings was found to be increased up to 226.83% and 170.40%, respectively, over control. In Binasola-4 the maximum fresh weight of plant, by 25.54 g at 60 DAS and 77.65 g at 85 DAS, were recorded in case of treating soil at sowing time with BARI-biofertilizer. While the minimum fresh weight of plant, by 12.85 g and 37.77 g, were recorded in control (Table 6). The fresh weight of seedlings was found to be increased up to 98.75% and 105.59%, respectively, over control.

The fresh weight of nodules increased when the soil was treated with BARI-biofertilizer in case of chickpea variety. In chickpea they found 35% increase of weight of nodules [17]. Also found 61.39% increase of weight of nodules in chickpea [18].

4. CONCLUSION

In the present study it was observed that both BARI-Biofertilizer and IPM biopesticide resulted lower disease incidence of seedlings of Hyprosola, Binasola-2, Binasola-3 and Binasola-4, over the control. Therefore, control of pulse diseases by biocontrol means can be an important point of consideration. BARI-biofertilizer and IPM biopesticide also increased fresh weight of plant, number of nodules per plant and fresh weight of nodules per plant. The findings of the present study has pointed out that BARI-biofertilizer in soil or in seed treatment and IPM biopesticide can be used for successful cultivation of chickpea. But, more research needs to be carried out under field condition in different pulse growing areas of Bangladesh.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Sattar MA, Podder AK, Chanda MC. Rhizobial biofertilizers; the most promising BNF technology for increased legume production in Bangladesh. In Proc. International Symposium on Biological Nitrogen Fixation associated with rice (Rahman, M. ed.). Kluwer Academic Publishers, DPSS 70. 1996;15-20.
2. Kaul AK, Gouwda CLL. Pulses in Bangladesh. Bangladesh Agril.Res. Council, Dhaka, Bangladesh. 1982;1.
3. BBS. Yearbook of Agricultural Statistics, Bangladesh. Bangladesh Bureau of Statistics, Statistics Division, Ministry of Planning, Govt. of the People's Republic of Bangladesh. Dhaka. 2018;102-103.
4. Fakir GA. Status of research on pulse disease at the BAU, Dept. of plant Path. BAU, Mymensingh. 1983a;20.
5. Ahmed HU. Disease problems of pulse and oil seed crops in Bangladesh. A paper presented in the 1st National Phytopath. Conf. BARI, Gazipur. 1985;18.
6. Fakir GA. Dal fashalarrog tar protikar. Dept. of plant Path. BAU, Mymensingh. 1983b;20.
7. Banyal OK, Amar Singh. Integrated management of rajmash diseases in dry temperate region of north-western Himalayas. Department of Plant Pathology, CSK Himachal Pradesh Krishi Vishva vidyalaya, Palampur 176062, India. Indian Phytopathology. 2007;60(3):317-321.
8. Mandhare VK, Suryawanshi AV. Efficacy of some botanicals and *Trichoderma* species against soil borne pathogens infecting chickpea. Seed Technology Research Unit, Mahatma Phule Krishi Vidyapeeth, Rahuri 413 722, Maharashtra, India. Journal of Food Legumes. 2008; 21(2):122-124.
9. Mahesh K, Jain AK, Praveen K, Savita C, Sanjay K. Bio-efficacy of *Trichoderma* spp. against management of chickpea damping-off caused by *Rhizoctonia solani* Kuhn. Department of Microbiology, J. V. College, Baraut, Baghpat - 250 611 (U.P.), India. Plant Archives. 2008;8(1):399-400.
10. Huang HC, Erickson RS. Effect of seed treatment with *Rhizobium leguminosarum* on Pythium damping-off, seedling height, root nodulation, root biomass, shoot biomass, and seed yield of pea and lentil. Agriculture and Agri-Food Canada, Lethbridge Research Centre, Crop Production Systems, PO Box 3000, Lethbridge, AB T1J 4B1, Canada. Journal of Phytopathology. 2007;155(1):31-37.
11. Gomez KA, Gomez AA. Statistical Procedures for Agricultural Research, 2nd ed., Intl. Rice Res. Inst., Jhon Willy and Sons, New York, Chichseter, Toronto, Sigapore. 1984;187-240.
12. Kibria MG, Hossain I. Controlling foot and root rot of lentil with Biofertilizer and

Rhizobial strains. Bangladesh J. Seed Sci. & Tech. 2004a;8(1&2):117-120.

13. Akhtar MS, Siddiqui ZA. Biocontrol of a root rot disease complex of chickpea by *Glomus intraradices*, *Rhizobium* sp. and *Pseudomonas straita*. Section of Mycology and Plant Pathology, Department of Botany, Aligarh Muslim University, Aligarh-202002, UP, India. Crop Protection. 2008; 27(3/5):410-417.
14. Shamsuzzaman SM, Islam A, Hossain I. *Trichoderma* culture and germination of sweet gourd seed. Bangladesh J. Seed Sci. & Tech. 2003b;7(1&2):91-95.
15. Sharma LC, Bhargava AK, Jagdesh. Seed dressing fungicides in combination with *Rhizobium* in Moog (*Vigna radiata* L.) Wilezek and their effect on nodulation and yield. Indian J. Mycol. and Plant Pathol. 1995;25(122):42.
16. Kibria MG, Hossain I. Seed Treatment with Biofertilizer and Rhizobial Strains in controlling foot rot of chickpea. Bangladesh J. Seed Sci. and Tech. 2004b;8(1&2):49-52.
17. Khaitov B, Kurbonov A, Abdiev A, Adilov M. Effect of chickpea in association with *Rhizobium* to crop productivity and soil fertility. Eurasian J Soil Sci. 2016;5(2):105-112.
18. Zaman S, Mazid MA, Kabir G. Effect of *Rhizobium* inoculant on nodulation, yield and yield traits of chickpea (*Cicer arietinum*) in four different soils of greater Rajshahi. J. Life Earth Sci. 2011;6:45-50.

© 2019 Ahmed et al.; This is an Open Access article distributed under the terms of the Creative Commons Attribution License (http://creativecommons.org/licenses/by/4.0), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Peer-review history:
The peer review history for this paper can be accessed here:
http://www.sdiarticle4.com/review-history/51350