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Integrated Management of Foot Rot of Chick pea Using Bio control Agents under Field Condition

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ABSTRACT
The effect of cowdung, Bangladesh Institute of Nuclear Agriculture (BINA)-biofertilizer, and Bangladesh Agricultural University (BAU)-biofungicide, alone or in combination, was evaluated for controlling foot rot disease of **Chickpea**. The results reflect that BINA-biofertilizer and BAU biofungicide (peat soil-based Rhizobium leguminosarum and black gram bran-based (Trichoderma harzianum) are compatible and have combined effects in controlling the pathogenic fungi Fusarium oxysporum and Sclerotium rolfsii, which cause the root rot of **Chickpea**. Cowdung mixing with soil (at 5 t/ha) during final land preparation and seed coating with BINA-biofertilizer and BAU-biofungicide (at 2.5% of seed weight) before sowing recorded 77.50% field emergence of **Chickpea**, which showed up to 23.39 % higher field emergence over the control. Post-emergence deaths of plants due to foot rot disease were significantly reduced after combined seed treatment with BINA-biofertilizer and BAU-biofungicide. Among the treatments that was used, only BAU-biofungicide as the seed treating agent resulted in higher plant stand (83.63%). Use of BINA-biofertilizer and BAU-biofungicide as seed treating biocontrol agents and application of cowdung in the soil as an organic source of nutrient that result result in higher shoot and root lengths, and dry shoot and root weights of **Chickpea** . BINA-biofertilizer significantly increased the number of nodules per plant and nodules weight of **Chickpea**. Seeds treating with BAU-biofungicide and BINA-biofertilizer and soil amendment with cowdung increased the biomass production of **Chickpea** up to 56.67% over the control.

1. Introduction

Different phytopathogenic soilborne as well as seedborne fungi are responsible for disease development of pulses, which attack plants during seedling to maturity stages and are more destructive at the seedling stage [8]. Foot rot (causal agents F. oxysporum and S. rolfsii) is considered as an important and destructive disease of pulses in almost all legume-growing countries of the world [1]. Control of the soilborne pathogens F. oxysporum and S. rolfsii with chemicals is practically difficult. On the other hand, indiscriminate use of chemicals causes environmental pollution and health hazards [9]. Nowadays, integrated Disease Management (IDM) is very much popular for controlling plant diseases. There are several tactics within IDM, among them biological control being one of the most important tactics [18]. Trichoderma may be used as an ecofriendly biocontrol agent in this regard. The biocontrol agent Trichoderma has the potential to protect seedlings against several plant pathogenic fungi. Trichoderma spp. have been widely used as antagonistic fungal agents against several pests as well as plant growth enhancers [28]. Trichoderma harzianum has been reported to be effective in controlling seed- and soilborne diseases of different crops, namely legumes and vegetables [2, 6, 12, 20, 24, 26]. The use of antagonistic bacteria as a biological control means may provide a great alternative for plant pathologists [11]. Hossain et al. [11] also reported prominent antagonistic effect of Rhizobium against foot and root rot pathogens (F. oxysporum and S. rolfsii) of pulses. This antagonist also increased the percentage of seedling emergence, plant height, fresh weight, and vigour index [12, 22]. It has been reported that rhiozobial strains have significant effect in reducing the severity of foot and root of chickpea [16]. Rhizobium spp. and Trichoderma sp. are compatible and have combined effects in controlling the fungi F. oxysporum and S. rolfsii, which caused the root rot of lentil [21]. Application of cowdung and manures in the soil is aimed to supply nutrients to the crops, creating a positive environment of inducing disease resistance to the plant. As a result, plants may recover from the disease or be resistant to disease, or overcome the disease epidemic [14, 17]. Considering the above facts the present study was undertaken to find out the effect of cowdung, BINA-biofertilizer (peat-based R. leguminosarum), and BAU-biofungicide (organic substrate-based T. harzianum), either alone or in combination on foot rot disease of **Chickpea** under field conditions.

MATERIALS AND METHODS

Collection of BINA-Biofertilizer Peat-based biofertilizer was collected from the Soil Microbiology Laboratory of the Bangladesh Institute of Nuclear Agriculture (BINA), Mymensingh, Bangladesh. The composition of the bio-fertilizer was peat soil and Rhizobium leguminosarum. The R. leguminosarum was firstly collected from the nodules of legume plants. After collection, Rhizobium broth was prepared. Sterilized 500 g peat soil was poured in a polythene bag and inoculated with a previously prepared 5 ml broth of R. leguminosarum (1011 CFU/ml) and mixed thoroughly for proper distribution. Then the materials were incubated for 7 days at 25 ± 2o C. After 7 days of incubation, it was ready for use. The material can be stored up to 6 months at 22 ± 1o C for future use.

Collection of BAU-Biofungicide

BAU-biofungicide was collected from the Disease Resistance Laboratory, Department of Plant Pathology, BAU, Mymensingh, Bangladesh. BAU-biofungicide was invented from a naturally occurring fungus, Trichoderma harzianum growing on an organic substrate (black gram bran). The T. harzianum was firstly collected from the rhizosphere of a **Chickpea** field. The isolated fungi were cultured on potato dextrose

agar (PDA) at 28 ± 2o C. Then 50 g of black gram bran was moistened with 1.5 ml of water and sterilized in an autoclave. After cooling, the sterilized substrate was inoculated with previously prepared 7-dayold culture of T. harzianum (four to five 1 cm block of T. harzianum). After 7 days of incubation, it was ready for use. The material can be stored up to 6 months at 22 ± 1o C for future use

Collection of Seeds of Pulse

Seed samples of **Chickpea** (var. Hyprochola) were collected from the Bangladesh Institute of Nuclear Agriculture (BINA), Mymensingh, Bangladesh. The collected seeds were kept in a paper bag and stored in the refrigerator at 5-7o C for one month for subsequent studies.

Seed Treatment

Required amounts of seeds were taken in a beaker and a few drops of water were added for moistening the seed surface uniformly to allow maximum adherence of BAU-biofungicide on the whole surface of seeds. Seeds were treated with BAU-biofungicide at 2.5% weight of seeds until the whole surface of the seeds were coated, where 2.5% biofungicide contained 106 conidia [19]. For seed coating with biofertilizer, seeds were initially moistened with water. Then the seeds were thoroughly mixed with biofertilizer (at 2.5% of seed weight) where the biofertilzer contained 108 Rhizobium cells/mg formulations. The inoculant-coated seeds were placed in a cool and dry place under shade for drying. The treated seeds were kept in paper bags and stored in the refrigerator at 5-7o C for one month for subsequent studies.

In the present study, the following treatments were used:

Control
Cowdung
BINA-biofertilizer
BAU-biofungicide
Cowdung + BINA-biofertilizer
Cowdung + BAU-biofungicide
BINA-biofertilizer + BAU-biofungicide
Cowdung + BINA-biofertilizer + BAU-biofungicide Cowdung

(5 t/ha) was mixed with the soil during the final land preparation as per treatment specification [15].

Field Experiment

Seed sowing. The field experiment was conducted in a randomized block design with 3 replications. The size of the individual plot was 2 m × 1 m, and the spaces between the plots and blocks were 1 m and 1 m, respectively. Treated seeds were sown (35 kg/ha) in lines about 2.0 cm in depth and the seeds were immediately covered with soil. Two times of weeding were preformed, one after 25 days and another 40 days after sowing. No plant protecting chemicals (insecticides or fungicides) were applied in the field.

Determination of foot rot disease.

The experimental plots were inspected routinely to observe the foot rot disease on plant. In case of complexity to identify the disease, symptoms-bearing plants were collected from the field using polythene bag and brought to the Disease Resistance Laboratory, Department of Plant Pathology, BAU, Mymensingh. From the infected plants, the fungi were isolated following tissue planting methods [4]. After incubation, the fungi that grew over potato dextrose agar (PDA) were purified by the hyphal tip culture method. The isolated fungi were identified as F. oxysporum and S. rolfsii according to reference mycology books and manuals [3, 5, 25]. The pure cultures of the fungi were preserved in PDA slants at 4°C in the refrigerator as stock culture for future use.

Data collection and analysis.

Data on different parameters (viz., germination, post-emergence death of plants, plant stand, shoot length, root length, dry shoot weight, dry root weight, number of nodule/plant, weight of nodule/plant, and biomass) were taken. Five plants were randomly selected and uprooted carefully from each plot for recording data. Data were expressed as the means ± standard errors. The results were analyzed using the SPSS statistical package (ver. 16, SPSS Inc.,Chicago, IL, USA) and Microsoft excel program.

RESULTS

Table 1. Effect of Cowdung, BINA-Biofertilizer, and BAU-Biofungicide Either Alone or in Combination on Germination, Post-Emergence Death of Plants, and Plant Stand of Chickpea

Treatment	**Germination (%)**	**Post emergence death (%)**	**Plant stand (%)**
T_1 = Control	**62.83d**	**49.33a**	**52.25c**
T_2 = Cowdung	**67.67bcd (+ 7.70)**	**48.83ab (- 1.01)**	**55.16bc (+ 5.57)**
T_3 = BINA-Biofertilizer	**74.17ab (+ 18.09)**	**23.07bc (- 53.23)**	**76.93a (+ 47.23)**
T_4 = BAU-Biofungicide	**77.50a (+ 23.39)**	**16.36c (- 66.83)**	**83.63a (+ 60.05)**
T_5 = Cowdung + BINA- Biofertilizer	**68.83abcd (+ 9.55)**	**29.83abc (- 39.52)**	**71.12a (+ 36.11)**
T_6 = Cowdung + BAU-Biofungicide	**75.33ab (+ 19.89)**	**24.79bc (- 49.75)**	**75.06abc (+ 43.66)**
T_7 = BINA-Biofertilizer + BAU-Biofungicide	**65.00cd (+ 3.45)**	**18.88c (- 61.72)**	**81.12a (+ 55.25)**
T_8 = Cowdung + BINA-Biofertilizer + BAU-Biofungicide	**71.00abcd (+ 13.00)**	**27.05bc (- 45.17)**	**72.82ab (+ 39.36)**
LSD ($p \geq 0.05$)	**8.528**	**20.37**	**19.03**

Data represents the mean of three replications.

Data in parenthesis indicate % increase or decrease over control.

% increase (+)

% decrease (-)

The effects of cowdung, BINA-biofertilizer, and BAU-biofungicide either alone or in combination on germination of **Chickpea** (var. Hyprochola) is shown in Table 1. The treatments resulted in significant effects on the germination of seeds of **Chickpea**. The highest germination (77.50%) was recorded by treating seeds with BAU-biofungicide & application of cowdung in the soil as an organic source of nutrient, and the result was statistically identical with cowdung, BINA-biofertilizer, BAU-biofungicide, cowdung + BINA-biofertilizer, cowdung + BAU-biofungicide, and BINA-biofertilizer + BAU-biofungicide, whereas the lowest germination (62.83%) was recorded in the control it has been observed that seed germination increased up to 23.39% over control when seeds were treated only with BAU-Biofungicide. The post-emergence death of **Chickpea** (var. Hyprochola) plants due to foot rot was found to be caused by F. oxysporum and S. rolfsii. The minimum postemergence death of plants (16.36%) was obtained by treatment of seeds with BAU-biofungicide which was followed by BINA-biofertilizer, cowdung + BAU-biofungicide, and cowdung + BINAbiofertilizer + BAU-biofungicide, respectively and The post-emergence death of plants was found to be decreased by treating seeds only BAU-Biofungicide up to 66.83% over the control.The maximum plant stand (83.63%) was obtained by seed treatment with BAU-biofungicide, which was statistically identical with the combinations of seed treatment with BINA-biofertilizer + BAU-biofungicide (81.12%). The lowest plant stand (52.25%) was recorded in the control. It has been observed that treating seeds. Only BAU-Biofungicide increased plant stand upto (60.05%) over the control (untreated).

Table-2 .Effect of Cowdung, BINA-Biofertilizer and BAU-Biofungicide Either Alone or in Combination on Shoot and Root Lengths of Chickpea (var. Hyprochola)

Treatment	**Shoot length (cm)**			**Root length (cm)**		
	60 DAS	**80 DAS**	**110 DAS**	**60 DAS**	**80 DAS**	**110 DAS**
T_1 = Control	29.67	40.20b	47.33	7.98	8.20b	8.72b
T_2 = Cowdung	30.73	48.07b	49.73	9.27	8.60b	8.92b
T_3 = BINA-Biofertilizer	32.8	52.73ab	54.13	9.23	9.80b	10.00b

T_4 = BAU-Biofungicide	32.33	51.20b	57.67	9.2	9.13b	9.27b
T_5 = Cowdung + BINA- Biofertilizer	31.87	49.47b	49.6	9.13	9.23b	9.13b
T_6 = Cowdung + BAU- Biofungicide	33	46.40b	47.8	9	9.67b	9.48b
T_7 = BINA-Biofertilizer +BAU- Biofungicide	29.73	58.67a	59.8	9.8	14.73a	14.90a
T_8 = Cowdung + BINA- Biofertilizer +BAU -fungicide	32.93	59.40b	60.80	9.95	14.93b	15.23b
LSD (p ≥0.05)	NS	7.787	NS	NS	2.934	2.98

DAS = Days after sowing.

NS = Not significant

Data represents the mean of three replications.

The effects of cowdung, BINA-biofertilizer, and BAU-biofungicide either alone in combination were evaluated regarding shoot length of plants (Table 2). The effects of different treatments on shoot length of **Chickpea** (var. Hyprochola) at 60 DAS, 80 DAS, and 110 DAS showed marked variation. In the case of 60, 80, and 100 DAS, maximum shoot lengths of 32.93 cm, 59.40 cm, and 60.80 cm, respectively, were found after application of cowdung in the soil and treating seeds with BAU-biofungicide and BINA-biofertilizer, whereas the minimum shoot lengths at 60, 80, and 100 DAS were 29.67 cm, 40.20 cm, and 47.33 cm, respectively, in the control. It has been observed that the length of roots at 60, 80, and 110 DAS varied significantly under different treatments. The highest root lengths at 60 DAS, 80 DAS, and 110 DAS were 9.95cm, 14.93 cm, and 15.23 cm, respectively, when the seeds were treated with BAU-biofungicide and BINA-biofertilizer and soil was incorporated with cowdung. On the other hand, the lowest root lengths of 7.98 cm, 8.20 cm, and 8.72 cm were recorded at 60 DAS, 80 DAS, and 110 DAS under the control. It was evident that all the treatments increased the root lengths of plant over the control

Table-3. Effects of Cowdung, BINA-Biofertilizer, and BAUBiofungicide Either Alone or in Combination on Dry Shoot and Root Weight, Number of Nodule/Plant, and Weight of Nodule/Plant of Chickpea

Treatment	Dry shoot weight (g)	Dry root weight (g)	Number of nodule/ plant	Weight of nodule/ plant (g)

	80 DAS	110 DAS	80 DAS	110 DAS	60 DAS	80 DAS	60 DAS	80 DAS
T_1 = Control	**9.39**	**5.69b**	**1.090**	**1.027**	**10.40c**	**3.400b**	**0.3140bc**	0.1600c
T_2 = Cowdung	**9.55**	**7.18ab**	**1.760**	**1.123**	**12.73bc**	**4.333b**	**0.3927c**	0.3167c
T_3 = BINA-Biofertilizer	**11.54**	**9.71a**	**1.690**	**1.263**	**18.33a**	**7.133a (109.79)**	**1.792a**	(97.93)
T_4 = BAU-Biofungicide	**10.88**	**9.51a**	**1.607**	**1.550**	**11.80c**	**4.867ab**	**0.4827abc**	.491a
T_5 = Cowdung + BINA-	**10.93**	**8.77ab**	**1.920**	**1.240**	**17.00ab**	**6.933a**	**1.121ab**	(518.87)
T_6 = Cowdung + BAU-Biofungicide	**10.73**	**9.32b**	**1.980**	**1.280**	**12.20bc**	**4.133b**	**0.4260bc**	0.4353bc
T_7 = BINA-Biofertilizer + BAU-Biofungicide	**11.92**	**9.49b**	**1.543**	**1.240**	**13.67abc**	**5.400ab (58.82)**	**1.520ab**	(172.06)
T_8 = Cowdung + BINA-Biofertilizer + BAU-Biofungicide	**12.31**	**10.75b**	**1.983**	**1.323**	**18.13a**	**5.733ab (68.61)**	**1.6413abc**	0.9900ab
LSD ($p \geq 0.05$)	**NS**	**2.532**	**NS**	**NS**	**4.482**	**2.446**	**0.6691**	(518.75)

DAS = Days after sowing.

NS = Not significant

Data represents the mean of three replications.

Except for the cowdung, most of the treatments (viz., BINA-biofertilizer, BAU-biofungicide, cowdung + BINA-biofertilizer, cowdung + BAU-biofungicide, BINA-biofertilizer + BAU-biofungicide, and cowdung + BINA-biofertilizer + BAU-biofungicide) significantly increased the dry shoot weight of **Chickpea** over the control at 80 DAS and 110 DAS, respectively (Table 3). Cowdung, BINA-biofertilizer, and BAU-biofungicide in combination showed increase in dry root weight of the **Chickpea** variety. Maximum dry root weights of 1.983 g and 1.323 g at 80 DAS and 110 DAS were recorded when seeds were treated with BAU-biofungicide and BINA-biofertilizer and soil amendment with cowdung. Minimum dry root weight (1.027 g) at 110 DAS was recorded in the control. Cowdung, BINA-biofertilizer, and

BAU-biofungicide either alone or in combination showed significant effects on the number of nodule/plant. The maximum number of nodule (18.33) at 60 DAS was obtained by treating seeds with BINA-biofertilizer, which was followed by seed treatment with BINA-biofertilizer and BAU-biofungicide and applying cowdung in the soil. On the other hand, the minimum number of nodules (10.40) was observed under control treatment. It was observed that treating seeds with BINA-biofertilizer increased the number of nodule/plant up to 76.25% over the control. Maximum weight of nodules (1.792 and 1.6413 g) at 60 DAS was recorded when the seeds were treated with BINA-biofertilizer alone or in combination with BAU-biofungicide and soil application of cowdung, whereas the lowest weight of nodules (0.3140 g) was observed in the control

Table-4. Effect of cowdung, BINA-Biofertilizer and BAU-Biofungicide either alone or in combination on Biomass production of chickpea at harvest

Treatment	Biomass per plot at	Biomass at harvest
T_1 = Control	**2442b**	**12.21e**
T_2 = Cowdung	**3108a**	**15.54d**
T_3 = BINA-Biofertilizer	**3825a**	**18.13a**
T_4 = BAU-Biofungicide	**3475a**	**17.38bc**
T_5 = Cowdung + BINA- Biofertilizer	**3450a**	**17.25bc**
T_6 = Cowdung + BAU-Biofungicide	**3317a**	**16.59c**
T_7 = BINA-Biofertilizer +BAU-Biofungicide	**3517a**	**17.59b**
T_8 = Cowdung + BINA-Biofertilizer + BAU-Biofungicide	**3733a**	**19.67a**
LSD ($p \geq 0.05$)	**660.20**	**0.5887**

Data represents the mean of three replications.

Data in parenthesis indicate % increase over control.

Cowdung, BINA-biofertilizer, and BAU-biofungicide either alone or in combination showed significant effects on biomass production of the **Chickpea** (var. Hyprochola) (Table. 4). The maximum biomass production (19.67 t/ha) was recorded by applying cowdung in soil and treating seeds with BINA-biofertilizer and BAU-biofungicide. On the other hand, the minimum biomass production (12.21

t/ha) was recorded in the control. It has been observed that applying cowdung in the soil and seed treated with BINA-biofertilizer and BAU-biofungicide increased biomass production up to 61.09 % over the control.

DISCUSSION

The field experiments were carried out to find out the effects of cowdung, BINA-biofertilizer, and BAU-biofungicide either alone or in combination in controlling foot rot disease of **Chickpea** (var. Hyprochola). It has been observed that application of cowdung in the soil and seed treatment with BINA-biofertilizer and BAU-biofungicide either alone or in combination have a great effect on germination of seeds, post-emergence death of plants, plant stand, shoot and root length, dry weight of shoot and root, number of nodule/ plant, weight of nodule/plant, and biomass production of **Chickpea.** Application of cowdung in the soil and seed treatment with BAU-biofungicide either alone or in combination with BINA-biofertilizer shown 77.50% seed germination, which indicated a 23.39% increased seed germination over the control. Hossain and Fakir [10] used antagonist Trichoderma as the seed-treating agent and obtained increased number of germination of okra, bottle gourd, sweet gourd, white gourd, sanke gourd, cucumber, and tomato ibria, M.G. and I. Hossain. 2004b. [31] Seed Treatment with Biofertilizer and Rhizobial Strains in Controlling foot rot of chickpea. In another study, increased germination of sweet gourd seed up to 13% over control with the same antagonist has also been observed [13, 22]. Post-emergence death of plants of **Chickpea** due to foot rot (F. oxysporum and S. rolfsii) was found to be reduced by treating seeds with BAU-biofungicide and BINA-biofertilizer either alone or in combination. The mycoparasitism of both T. harzianum and T. longibrachitum on Fusarium oxysporum f. sp. phaseoli causing wilt disease in beans has been studied. The pathogen was completely engulfed by the hyphae of Trichoderma and treated seeds reduced the post-emergence death of seedling [29]. Another study observed that seeds of **chickpea** treated with rhizobial inoculants resulted in significant effect in reducing the severity of foot and root rot up to 70.16% [16]. In this study , post-emergence death of plants was found to be decreased by treating seeds only BAU-Biofungicide up to 66.83% over the control.Singh, R.S., D. Singh and H.V. Singh. 1997. [34]. Effect of fungal antagonists on the growth of chickpea plants and wilt caused by *Fusarium oxysporum f.sp. ciceri.*The plant stand of the **Chickpea** has been found to increase owing to the use of cowdung, BINA-biofertilizer, and BAU-biofungicide either alone or in combination. Among the treatments, BAU-biofungicide increased the plant stand of **Chickpea** up to 60.05% over the control, which was followed by seed treatment with BAU-biofungicide and BINA-biofertilizer and soil application of cowdung. Application of cowdung in the soil and use of BINA-biofertilizer and BAU-biofungicide as seed treating biocontrol agent displayed higher shoot length, root length, dry shoot weight and root weight, number of nodule/plant, and weight of nodule/ plant over the control. This study is in accordance with the findings of Shoresh et al. [24] who recorded mycoparasitism of Trichoderma against the chickpea wilt caused by F. oxysporum and found that the plant becomes healthy and the growth of chickpea roots, shoots, and leaves was enhanced. In another experiment, it has been found that Mung (Vinga radiata L.) seed inoculation with rhizobium increased nodulation (in terms of their number and dry weight), over the control [23]. Application of Trichoderma as a seed-treating agent resulted in higher shoot length, root length, and shoot weight of vegetable seedlings [12, 13, 21]. Biomass production of **Chickpea** has been found to be increased owing to use of cowdung, BINAbiofertilizer, and BAU-biofungicide either alone or in combination with one another. Among the treatments used in the present study, combined use of cowdung, BINA-biofertilizer, and BAU-biofungicide resulted in higheist increase biomass production of

Chickpea by 61.09 % in comparison with the control. This finding is also supported by many researchers [7, 11, 23, 27]. From the present study, we observed that combined use of cowdung, BINA-biofertilizer, and BAU-biofungicide showed a profound effect in reducing root rot disease and in increasing plant growth parameters of **Chickpea** under field conditions. It has been clearly pointed out that BAU-biofungicide in combination with cowdung and BINA-biofertilizer can successfully be used for cultivation of **Chickpea**

REFERENCES

1. Ahmed, H. U. 1985. Disease problems of pulse and oil seed crops in Bangladesh. A paper presented in the 1st National Phytopathology. *Conf. BARI Gazipur.*

2. Anonymous. 2003. *Use of BAU-Biofungicide to Control Seed Borne Diseases of Vegetables and Pulses.* Agricultural technologies developed by Bangladesh Agricultural University Research System (BAURES), Mymensingh.

3. Barnett, H. L. and B. B. Hunter. 1972. *Illustrated Genera of Imperfect Fungi. 3rd Ed*. Burges Co., Minneapolis, USA.

4. Baxter, A. P., I. H. Rong, C. Roux, and E. J. Van der Linde. 1999. *Collecting and Preserving Fungi-A Manual for Mycology*. Plant Protection Research Institute. Private Bag X134, Pretoria, 0001 South Africa.

5. Booth, C. 1971. *The Genus Fusarium*. Commonwealth Mycology Institute Kew, Survey, England.

6. Chowdhury, M. S. M., I. Hossain, G. A. Fakir, F. M. Aminuzzaman, and M. R. Islam. 2000. Tolerance of *Trichoderma harzianum* and *Gliocladium viride* to agrochemicals and their antagonistic effect on seed borne mycoflora of pigeon pea. *Bangladesh J. Seed Sci. Tech*. 4: 83-86.

7. Devi, H. J., T. K. Maity, and N. C. Paria. 2003. Effect of different sources of nitrogen on yield and economics of cabbage. Environ. Ecol. 21: 878-880.

8. Fakir, G. A. 1983. Status of research on pulse disease at the BAU, Department of Plant Pathology BAU, Mymensingh.

9. Gerhardson, B. 2002. Biological substitutes for pesticides. Trends Biotechnol. 20: 338-343.

10. Hossain, I. and G. A. Fakir. 2001. *Biological Control of Seed Borne Pathogens of Some Crops, 1st Ed. Seed Pathology Laboratory (SPL)*, Bangladesh Agricultural University (BAU), Mymensingh, Bangladesh.

11. Hossain, I., M. A. I. Khan, and A. K. Podder. 1999. Seed treatment with *Rhizobium* in controlling *Fusarium oxysporum* and *Sclerotium rolfsii* for biomass and seed production of lentil (Lens *cuilinaris M.*). Bangladesh J. *Environ. Sci.* 5: 61-64.

12. Hossain, I. and M. H. A. Naznin. 2005. BAU biofungicide in controlling seedling disease of some summer vegetables. BAU *Res. Progr*. 15: 32-35.

13. Hossain, I. and S. M. Shamsuzzaman. 2003. Developing *Trichoderma* based bio-fungicide using agro-waste. BAU Res. Prog. 14: 49-50.

14. Hossain, I., G. Yahia, and M. Jahiruddin. 1995. Effect of copper boron and molybdenum on leaf spot disease and grain set of wheat. Bangladesh J. Training Dev. 8: 77-81.

15. Islam, S. M. 1995. Crop Nutrition and Nutrient Deficiency Symptom. *Division of Soil Science,* Bangladesh Agricultural Research Institutes, Joydebpur, Gazipur.

16. Kibria, M. G. and I. Hossain. 2004. Seed treatment with biofertilizer and *rhizobial* strains in controlling foot rot of chickpea. Bangladesh J. *Seed Sci. Tech. 8: 49-52.*

17. Kundu, S., I. Hossain, and M. Jahiruddin. 1996. Effect of boron on leaf blotch (*Bipolaris sorokiniana*) and grain yield of wheat cv. Kanchan. Progress. Agric. 7: 171-175.

18. Kwok, O. C. H., P. C. Fahy, H. A. J. Hoitink, and G. A. Kuter. 1987. Interaction between bacteria and

Trichoderma hamature in suppression of *Rhizoctonia* damping-off in bark compost media. Phytopathology 77: 1206-1212.

19. Naznin, H. A. and I. Hossain. 2004. Effect of BAU-biofungicide on germination and seedling vigour of some summer vegetables. *Bangladesh J. Seed Sci. Tech*. 8: 85-90.

20. Ozbay, N. and S. E. Newman. 2004. Biological control with *Trichoderma spp*. with emphasis on *T. harzianum*. Pakistan J. Biol. Sci. 7: 478-484.

21. Shaban, W. I. and M. A. El-Bramawy. 2011. Impact of dual inoculation with Rhizobium and *Trichoderma* on damping off, root rot diseases and plant growth parameters of some legumes field crop under greenhouse conditions. Int. Res. J. Agric. Sci. Soil Sci. 1: 98-108.

22. Shamsuzzaman, S. M., A. Islam, and I. Hossain. 2003. Production of *Trichoderma conidia* in agro-wastes. Bangladesh J. *Environ. Sci. 9: 146-150.*

23. Sharma, L. C., A. K. Bhargava, and C. Jagdesh. 1995. Seed dressing fungicides in combination with Rhizobium in Moog (Vigna radiate L.) Wilezek and their effect on nodulation and yield. Indian J. Mycol. Plant Pathol. 25: 42.

24. Shoresh, M., I. Yedidia, and I. Chet. 2005. Involvement of Jasmonic acid/ethylene signaling pathway in the systemic resistance induced in cucumber by *Trichoderma asperellum* T2O3. Phytopathology 95: 76-84.

25. Singh, R. S. 1982. Plant Pathogens. The Fungi. Oxford and IBM Publishing Co., New Delhi.

26. Sultana, N., M. S. M. Chowdhury, and I. Hossain. 2001. Growth and storability of *Trichoderma harzianum* and its effect on germination of tomato seeds. Bangladesh J. Seed Sci. Tech. 5: 117-121.

27. Sultana, N. and I. Hossain. 1999. Biological control of foot and root rot of lentil with *Trichoderma harzianum*. Bangladesh J. Seed Sci. Tech. 3: 107-111.

28. Verma, M., K. Satinder, R. D. Brar, R. Y. Tyagi, and J. R. Valero. 2007. Antagonistic fungi, *Trichoderma* spp.: Panoply of biological control. Biochem. Eng. J. 37: 1-20.

29. Younis, N. A. 2005. Mycoparasitism of *Trichoderma harzianum* and *Trichoderma longibrachiatum* on *Fusarium oxysporum f.sp. phaseoli* the causal of bean wilt disease. Bull. Faculty Agric. Cairo Univ. 56: 201-219

30. ibria, M.G. and I. Hossain. 2004b. Seed Treatment with Biofertilizer and Rhizobial Strains in Controlling foot rot of chickpea. Bangladesh J. Seed Sci. and Tech. 8(1&2): 49-52.

31.Mahbuba, B. 1997. Efficacy of *Trichoderma harzianum* as a biocontrol agent for controlling *Fusarium oxysporum* and *Sclerotium rolfsii* in food legumes. M.S. Thesis, Department of Plant Pathology, Bangladesh Agricultural University, Mymensingh. 56-57 pp.

32.Sesan, T. 1988. Present state of research on biological control of fungus disease of legumes. Probleme de protectia Plantelor 16(3): 219-236.

33.Shamsuzzaman, S.M., Islam, A. and Hossain, I. 2003b. *Trichoderma* culture and germination of sweet gourd seed. Bangladesh J. Seed Sci. & Tech. 7(1&2): 91-95.

34.Singh, R.S., D. Singh and H.V. Singh. 1997. Effect of fungal antagonists on the growth of chickpea plants and wilt caused by *Fusarium oxysporum f.sp. ciceri*. PI. Disease Res. 12(2): 103-107.