

Screening of BARI *Rhizobium* Biofertilizers against Foot and Root Rot of Chickpea

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ABSTRACT

The experiment was conducted at the sick plot, Pulses Research Centre, Ishurdi, Pabna, Bangladesh during two consecutive years of 2010-11 and 2011-12 to screen out the effective BARI *Rhizobium* Biofertilizers against foot and root rot of chickpea. Six BARI *Rhizobium* strains viz. BARI Rca 201, BARI Rca 220, BARI Rca 202, BARI chickpea Rajshahi, BARI Rca IC 59 and BARI Chickpea pulse 1 were used as treatments. In 2010-11, foot and root rot incidence ranged from 9.78-26.63%, while the lowest incidence was recorded in BARI Chickpea Rajshahi, but the highest incidence was recorded in untreated control. BARI Chickpea Rajshahi gave the highest plant survival (90.22%) and control treatment gave the lowest plant survival (72.55%). BARI Chickpea Rajshahi treated plots reduced maximum foot and root rot incidence (63.27%) over untreated control. Similar trends of the results were observed in 2011-12. The highest yield was obtained from BARI Chickpea Rajshahi with 2090 and 2040 kg/ha during 2010-11 and 2011-12, respectively, and the lowest yield was obtained from untreated control for both the years.

Keywords: Screening, *Rhizobium* biofertilizers, foot and root rot, yield, chickpea

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INTRODUCTION

Chickpea (*Cicer arietinum*) is cultivated as sole and intercrops. It is the third major pulse crops of Bangladesh in respect of acreage and production. Chickpea is consumed as a dry pulse crop, but also snack foods, sweets, condiments even as green vegetable in the world. Chickpeas contain protein, complex carbohydrates, and fibre, while low in fat and cholesterol. Seeds contain average about 20% protein, 5% fat and 55% carbohydrate (Nikam *et al.*, 2007). The production of chickpea is decreasing every year due to cultural and genetic factors, susceptibility to disease, and delay in sowing by the farmers (Anonymous, 1989). The average yield of chickpea is also low due to various diseases. Among the diseases, foot and root rot of chickpea caused by *Fusarium oxysporum* and *Sclerotium rolfsii* (Dey *et al.*, 1993) are common and the most serious disease in Bangladesh. It causes seedling death at early stage resulting very poor plant stand that ultimately produces very low yield.

Foot and root rot disease of many crops caused by *Fusarium oxysporum* and *Sclerotium rolfsii* which are soil-borne pathogens commonly occurs in the tropical and sub-tropical regions of the world (Aycock, 1966). The fungi can attack the crop during any time from seedling to the flowering stage and are comparatively more destructive at the seedling stage. Foot and root rot diseases may cause 100% seedling mortality in monoculture under conducive weather conditions for disease development (Begum, 2003). The pathogenic fungi are soil-borne in nature; hence, seed treatment with *Rhizobium* Biofertilizers might be effective in controlling foot and root rot disease and increasing grain yield of chickpea. Moreover, by seed treatment, very low quantities of Biofertilizer are required compared to a foliar application with fungicides. Again, it reduces the risk of environmental pollution, health hazard and not much costly to the growers. Some bacteria associated with the roots of crop plants have beneficial effects on their host, and are referred to as plant growth promoting rhizobacteria (PGPR) (Kloepper and Schroth, 1978). The rhizosphere is subjected to dramatic changes and its dynamic nature creates interactions that result in biocontrol of diseases (Rovira, 1965 & 1969). PGPR (free living bacteria) affects on plant growth and disease suppression. *Rhizobium* may reduce growth of pathogens in the rhizosphere area. Integrated use of Vitavax 200 and biocontrol agents was effective in improving seedling emergence and yield as well as in reducing wilt incidence of chickpea (Gupta, 2006). Treatment of seeds with Biofertilizer resulted in 85.2 and 73.1% reduction in death of plants due to infection by *Fusarium oxysporum* in lentil and chickpea, respectively (Hossain, 2000). Treatment of seed with *Rhizobium* strains significantly reduced the incidence of damping off and increased seedling height of chickpea (Huang and Erickson, 2007). *Rhizobium* strain BINAR P36 largely controlled the foot and root rot and produced higher green pod yield of Bush bean (Khalequzzaman and Hossain, 2008). It has been observed that *Rhizobium* also reduced foot and root rots of leguminous crops. Bangladesh Agricultural Research Institute (BARI) has developed some peat based *Rhizobium* Biofertilizers. Among the BARI *Rhizobium* Biofertilizers, which *Rhizobium* Biofertilizers are effective in controlling foot and root rot of chickpea would be found out. These types of research work are needed in Bangladesh. So, the present study was undertaken to screen out the effective BARI *Rhizobium* Biofertilizers against foot and root rot and yield of chickpea.

MATERIALS AND METHODS

The experiment was conducted in the sick plot at Pulses Research Centre, Bangladesh Agricultural Research Institute (BARI), Ishurdi, Pabna, Bangladesh during two consecutive years of 2010-11 and 2011-12. The experimental plot was prepared with five ploughings and cross ploughings followed by laddering to break the clods as well as level the soil. The weeds and stubbles of previous crops were collected and removed from the soil. No any chemical fertilizers were applied. The experiment was carried out following Randomized Complete Block Design with three replications. The unit plot size was 1.6 m x 1.5 m and plant spacing was 40 cm with continuous sowing for the experiment. Six BARI *Rhizobium* Biofertilizers viz. BARI Rca 201, BARI Rca 220, BARI Rca 202, BARI chickpea Rajshahi, BARI Rca IC 59 and BARI Chickpea pulse 1 were used as treatments. Chickpea variety BARIchola 1 was used in this experiment. Seeds were initially moistened with molasses at the rate of 40 g per kg seed and then the seeds were thoroughly mixed with peat based BARI *Rhizobium* Biofertilizers @ 40 g per kg seed before sowing, where biofertilizer contained 10⁸ Rhizobial cells/mg (Somasegaran and Hoben, 1994). The inoculant-coated seeds were sown at the afternoon on November 9, 2010, and November 16, 2011, respectively, and furrow was filled up just after seed sowing. Intercultural operations were done as per needed and to maintain

the normal hygienic condition of crop in the field. During the growing period, the plots were regularly inspected to record the incidence of foot and root rot disease from seedling to maturity stage of the crop. Dead plants were counted and removed from the field. Disease plant parts were collected and brought into the laboratory for identifying foot and root rot causal pathogens. The crop was harvested on March 16, 2011, and March 20, 2012, respectively. Data were recorded on foot and root rot, plant survival, plant height, number of pods/plant, number of seeds/plant, weight of seeds/plant and yield (kg/ha). The incidence of foot and root rot of lentil was recorded at every alternate day. The incidence of foot and root rot of chickpea was calculated by the following formula:

$$\text{Incidence of foot and root rot (\%)} = \frac{\text{Number of infected plants}}{\text{Total number of plants}} \times 100$$

The recorded data were analyzed statistically to find out the level of significance and the variations among the respective data were compared following Duncan's New Multiple Range Test (DMRT) according to Gomez and Gomez (1984).

RESULTS AND DISCUSSION

Results of BARI *Rhizobium* Biofertilizers on foot and root rot and plant height of chickpea during 2010-11 are presented in Table 1. BARI *Rhizobium* strains showed a significant effect on foot and root rot of chickpea. Foot and root rot incidence ranged from 9.78-26.63%, while the lowest incidence was recorded in BARI Chickpea Rajshahi, which was not statistically similar to all other treatment, but the highest incidence was recorded in untreated control. BARI Chickpea Rajshahi gave the highest plant survival (90.22%), and control treatment gave the lowest plant survival (72.55%). BARI Chickpea Rajshahi treated plots reduced maximum foot and root rot incidence (63.27%) over untreated control followed by BARI Rca IC 59 and BARI Chickpea pulse 1. Plant height was not significantly influenced by *Rhizobium* strains. BARI Rca IC 59 gave the highest plant height (57.70 cm) and BARI Rca 202 resulted the lowest (55.20 cm) plant.

Table 1: Effect of BARI *Rhizobium* Biofertilizers on foot and root rot and plant height of Chickpea during 2010-11

<i>Rhizobium</i> Biofertilizers	Foot and root rot (%)	Plant Survival (%)	Disease reduction over control (%)	Plant height (cm) ^{NS}
BARI Rca 201	15.57 b	84.43	41.53	55.40
BARI Rca 220	16.18 b	83.82	39.24	58.20
BARI Rca 202	15.81 b	84.19	42.99	55.20
BARI Chickpea Rajshahi	9.78 c	90.22	63.27	56.33
BARI Rca IC 59	13.78 b	86.22	48.25	57.70
BARI Chickpea pulse 1	14.16 b	85.84	46.82	57.53
Control (Untreated)	26.63 a	73.37	-	56.87

In a column, similar letter does not differ significantly at 5% level of probability.

BARI = Bangladesh Agricultural Research Institute

NS=Not Significant

Results of BARI *Rhizobium* Biofertilizers on foot and root rot and plant height of chickpea during 2011-12 are presented in Table 2. BARI *Rhizobium* strains showed a significant effect on foot and root rot of chickpea. Foot and root rot incidence ranged from 8.90-27.45%, while the lowest incidence was recorded in BARI Chickpea Rajshahi, that were not

statistically similar to all other treatments but the highest incidence was observed in untreated control. BARI Chickpea Rajshahi gave the highest plant survival (91.10%), and control treatment gave the lowest plant survival (72.55%). BARI Chickpea Rajshahi treated plots reduced maximum foot and root rot incidence (67.58%) over untreated control. Plant height was not significantly influenced by *Rhizobium* strains. BARI Rca IC 59 gave the tallest plant (56.25 cm) and BARI Rca 201 resulted the smallest (52.07 cm).

Table 2: Effect of BARI *Rhizobium* Biofertilizers on foot and root rot and plant height of Chickpea during 2011-12

<i>Rhizobium</i> Biofertilizers	Foot and root rot (%)	Plant survival (%)	Disease reduction over control (%)	Plant Height (cm) ^{NS}
BARI Rca 201	18.01 cd	81.99	34.39	52.07
BARI Rca 220	21.82 b	78.18	20.51	53.40
BARI Rca 202	19.99 bc	80.01	27.18	52.53
BARI Chickpea Rajshahi	8.90 f	91.10	67.58	52.53
BARI Rca IC 59	14.41 e	85.59	47.51	56.25
BARI Chickpea pulse 1	16.67 de	83.33	29.27	54.27
Control (Untreated)	27.45 a	72.55	-	54.30

In a column, similar letter does not differ significantly at 5% level of probability.

BARI = Bangladesh Agricultural Research Institute

NS=Not Significant

Results of BARI *Rhizobium* Biofertilizers on on yield and yield contributing characters of Chickpea during 2010-11 are presented in Table 3. Number of pod/plant, number of seeds/plant, weight of seeds/plant and yield under BARI *Rhizobium* strains varied significantly from one to another. The highest number of pod/plant (47.80), number of seeds/plant (71.63), weight of seeds/plant (9.58 g) and yield (2090 kg/ha) were obtained from BARI Chickpea Rajshahi which was followed by BARI Rca IC 59 and BARI Chickpea pulse, and the lowest of these parameters were obtained from untreated control.

Table 3: Effect of BARI *Rhizobium* Biofertilizers on yield and yield contributing characters of Chickpea during 2010-11

<i>Rhizobium</i> Biofertilizers	No. of pod / plant	No. of seed / plant	Wt. of seed / plant (g)	Yield (kg/ha)
BARI Rca 201	38.33 c	54.37 bc	7.43 bc	1876 abc
BARI Rca 220	33.87 d	49.10 c	6.83 cd	1738 bc
BARI Rca 202	37.20 cd	50.47 c	7.39 bc	1807 bc
BARI Chickpea Rajshahi	47.80 a	71.63 a	9.58 a	2090 a
BARI Rca IC 59	46.93 ab	71.00 a	9.39 ab	2019 ab
BARI Chickpea pulse 1	43.27 b	63.47 ab	8.70 abc	1946 abc
Control (Untreated)	28.77 e	45.97 c	5.33 d	1668 c

In a column, similar letter does not differ significantly at 5% level of probability.

BARI = Bangladesh Agricultural Research Institute

Number of pod/plant, number of seeds/plant, weight of seeds/plant and yield of chickpea under BARI *Rhizobium* strains varied significantly from one to another during 2011-12 (Table 4). The highest number of pod/plant (37.87), number of seeds/plant (51.80), weight of seeds/plant (7.25 g) and yield (2040 kg/ha) were obtained from BARI Chickpea

Rajshahi which was followed by BARI Rca IC 59 and BARI Chickpea pulse, and the lowest of these parameters were obtained from untreated control.

Table 4: Effect of BARI *Rhizobium* Biofertilizers on yield and yield contributing characters of Chickpea during 2011-12

<i>Rhizobium</i> Biofertilizers	No. of pod / plant	No. of seed / plant	Wt. of seed / plant (g)	Yield (kg/ha)
BARI Rca 201	27.60 c	40.40 bc	5.18 cd	1825 abc
BARI Rca 220	21.27 de	33.86 de	4.31 ef	1668 cd
BARI Rca 202	24.00 cd	39.46 cd	4.87 de	1758 bcd
BARI Chickpea Rajshahi	37.87 a	51.80 a	7.25 a	2040 a
BARI Rca IC 59	33.07 b	46.08 b	6.14 b	1968 ab
BARI Chickpea pulse 1	31.53 b	44.13 bc	5.64 bc	1895 ab
Control (Untreated)	19.93 e	30.11 e	3.93 f	1551 d

In a column, similar letter does not differ significantly at 5% level of probability.

BARI = Bangladesh Agricultural Research Institute

From the above study, it has been observed that BARI *Rhizobium* strains showed significant effect on foot and root rot of chickpea during 2010-11 and 2011-12. Similar trends of the results were found in both the years. The lowest incidence of foot and root rot of chickpea was recorded in BARI Chickpea Rajshahi which was not statistically similar to all other treatment, but the highest incidence was recorded in untreated control. BARI Chickpea Rajshahi gave the highest plant survival and control treatment gave the lowest plant survival. BARI Chickpea Rajshahi treated plots reduced maximum foot and root rot incidence over untreated control. Hossain (2000) found that treatment of seeds with Biofertilizer resulted in 85.2 and 73.1% reduction in death of plants due to infection by *Fusarium oxysporum* in lentil and chickpea, respectively, while Hossain *et al.* (2000) observed that the highest reduction (69.4%) of Fusarial foot and root rot in chickpea over untreated control was with *Rhizobium* inoculation @ 50 g/kg seed (when moistened with molasses). Khalequzzaman *et al.* (2010) found that BARI lentil 5 inoculated with BARI Biofertilizer Rlc 104 showed minimum (11.2%) incidence of foot and root rot, leading to maximum plant survival (88.8%). Hossain (2000) found that treatment of seeds with Biofertilizer also showed 76.7 and 87.0% reduction in death of plants of lentil and chickpea, respectively, due to infection by *Sclerotium rolfsii*. Arfaoui *et al.* (2005) reported that *Rhizobium* isolates protected chickpea plants from *F. oxysporum*. Hossain *et al.* (1999a) reported that treatment with Bavistin (0.2%) and Biofertilizer (*Rhizobium*) @ 50 g/kg seed resulted in the best control of seed borne fungi *F. oxysporum* of lentil. Huang and Erickson (2007) showed that treatment of seed with *Rhizobium* strains significantly reduced the incidence of damping off and increased the seedling height of chickpea. Khalequzzaman and Hossain (2008) conducted an experiment on foot and root rot of Bush bean with *Rhizobium* strains and Biofertilizers, and found that *Rhizobium* strain BINAR P36 largely controlled the foot and root rot of Bush bean. Kucuk (2013) showed the effects of 20 *Rhizobium* strains isolated from *Phaseolus vulgaris* L., *Trifolium repens* var. *repens*, *Cicer arietinum* L., *Lens culinaris* Medik., *Vigna unguiculata* L. and *Phaseolus vulgaris* L. 'Red Kidney' plants on mycelium growth of *Fusarium oxysporum*, *F. moniliforme*, *F. solani*, *F. culmorum*, *F. oxysporum* F1 strain, *F. oxysporum* F2 strain, *F. oxysporum* F3 strain, *F. oxysporum* F4 strain were observed on solid medium and found that the most *Rhizobium* strains were effective against the *Fusarium* species. Yaqub and Shahzad (2011) found that *Sclerotium rolfsii* showed significant negative effect on plant growth due to severe root colonization, whereas, presence of the microbial antagonists showed significant positive effect on plant growth by reducing the colonization of roots by *S. rolfsii*. Hannan (2012) found that

BINA-biofertilizer and BAU-biofungicide (black gram bran-based *Trichoderma harzianum*) were compatible and had combined effects in controlling the pathogenic fungi *Fusarium oxysporum* and *Sclerotium rolfsii*, which cause the root rot of lentil. Post-emergence deaths of plants due to foot rot disease were significantly reduced after combined seed treatment with BINA-biofertilizer and BAU-biofungicide. Hannan *et al.* (2013) applied cowdung in soil and treated seed with BINA-Biofertilizer and BAU-Biofungicide and found that field emergence was higher up to 26.47%, post-emergence deaths of plants due to foot rot disease were also successfully reduced in grasspea. Shaban and El-Bramawy (2011) exhibited that *Rhizobium* spp. and *Trichoderma* sp. fungi showed combined effects in controlling the fungi, which caused the damping off and root rot. Hoque *et al.* (2015) evaluated *Rhizobium leguminosarum* against foot and root rot pathogens *Fusarium oxysporum* and *Sclerotium rolfsii* of lentil. In dual culture method, the highest zone of inhibition of *F. oxysporum* (57.37%) was measured against *R. leguminosarum* isolate. In paper towel test, a minimum number of dead seeds (9.00), no abnormal and diseased seedlings were counted from *R. leguminosarum* treated seeds. In water agar test tube test, minimum number of dead seed (12.00) and abnormal seedlings (2.00) were counted from *R. leguminosarum* treated seeds.

Number of pod/plant, number of seeds/plant, weight of seeds/plant and yield of chickpea under BARI *Rhizobium* strains varied significantly from one to another during 2010-11 and 2011-12. Similar trends of the results were found in both the years. The highest number of pod/plant, number of seeds/plant, weight of seeds/plant and yield were obtained from BARI Chickpea Rajshahi which was followed by BARI Rca IC 59 and BARI Chickpea pulse, and the lowest of these parameters were obtained from untreated control. Khalequzzaman and Hossain (2008) found that the tallest plant (41.1 cm) was observed in *Rhizobium* strain (BINAR P36) inoculated plots and the shortest plant (33.08 cm) was in untreated control of Bush bean. 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 resulted higher plant stand, shoot and root length, and dry shoot and root weight of Grass pea (Hannan *et al.*, 2013). Khalequzzaman and Hossain (2008) also found that the highest number of pods/plant (14.6) was recorded in case of using BINAR P36 inoculated plots and the lowest (7.8) in untreated control of Bush bean. Hossain *et al.* (1999b) reported that *Rhizobium* inoculants increased significantly pods/plant of lentil up to 42.1% over the untreated control. Rai and Singh (1979) stated that inoculation with *Rhizobium* bacteria led to a significant increase in seed yield of chickpea compared with the uninoculated control, but Harnadez and Hill (1983) observed that inoculation with *Rhizobium* strain CC 1192 increased seed yield of chickpea by 29%, and Sandhu (1984) reported that lentil seed inoculation with *Rhizobium* culture improved yield by 8–22%, but Pal and Ghosh (1986) reported that seed inoculation with *Rhizobium leguminosarum* strain L 25 and L 20 increased seed yield by 59.8% in lentil and up to 38.87% in chickpea. Seed inoculation with *Rhizobium leguminosarum* strain L 25 and L 20 increased seed yield by 59.8% in lentil and up to 38.87% in chickpea (Pal and Ghosh, 1986). Khalequzzaman (2008) found that Biofertilizer increased grain yield that was at par with the fungicides in lentil and chickpea. Khalequzzaman and Hossain (2008) conducted an experiment on foot and root rot of Bush bean with *Rhizobium* strains and Biofertilizers, and found that *Rhizobium* strain BINAR P36 produced higher green pod yield of Bush bean. Seed yield increase with *Rhizobium* Biofertilizer has also been reported by Hossain *et al.* (1999b), Solaiman (1999), Hossain and Mohammed (2002), and Kibria and Hossain (2002). Khalequzzaman *et al.* (2010) found that BARI lentil 5 inoculated with BARI Biofertilizer Rlc 104 gave the highest yield (1952.9 kg/ha). Shaban and El-Bramawy (2011) exhibited that *Rhizobium* spp. and *Trichoderma* sp. fungi showed combined effects on improvement in

many plant growth parameters, which are ultimately expressed in increasing the yield components of branches plant⁻¹, pods plant⁻¹, seeds pod⁻¹, mean seed weight and then increase seed yield of the legume field crops: broad bean, chickpea and lupine plants.

CONCLUSION

From the above study, it may be concluded that seed treatment with BARI Chickpea Rajshahi @ 40 g/kg seeds showed better performance followed by BARI Rca IC 59 and BARI Chickpea pulse 1 in respect of foot and root rot disease control and increase yield of chickpea.

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