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Field Performance of BAU-Biofungicaide for Management of Narrow Brown Leaf Spot and Bacterial Leaf Blight Disease of Rice CV. BRRI Dhan29

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Abstract

Potent (0.1%) and BAU-Biofungicide (2%) revealed the significant reduction both in disease severity and incidence of narrow brown leaf spot disease, and the lowest disease severity and incidence of bacterial leaf blight disease were 3.00% and 5.83%, respectively in BRRI dhan29 in 2012 year. BAU-Biofungicide (*Trichoderma* based preparation), extract of garlic (*Allium sativum*) and neem (*Azadirachta indica*), Bavistin DF (Carbandazim) and Potent 250 EC (Propiconazole) were evaluated in controlling narrow brown leaf spot and bacterial leaf blight disease (*Xanthomonas oryzae* pv. *Oryzae*) under field condition for producing seed quality and controlling seed borne pathogen of rice cv BRRI dhan29 during 2012 and 2013 years. Maximum normal seedling (87.67%) and 37.49% higher increase in vigour index on seed quality test of harvested seeds were observed with BAU-Biofungicide (3%) over control. BAU-Biofungicide (2 and 3%) and Potent 250 EC (0.1%) were found to be effective in controlling seed borne pathogens. BAU-Biofungicide has also been attributed as profound contribution on quality seed production of harvested seed of BAU-Biofungicide sprayed plot.

Keywords: BAU-Biofungicide; Cercospora oryzae Miyake; Potent; Seed borne pathogen; Seed quality; *Xanthomonas oryzae* pv. *Oryzae*

Introduction

Rice (*Oryza sativa* L.) is the most important staple food crop in Bangladesh. Its cultivation is approximately 11.91 million hectares and total rice production is 56.42 million tons [1]. Average yield of rice is 4.74 t/ha which is very lower in compared to neighboring countries, whereas Japan produce 6.62 t/ha [1]. Many factors of biotic and abiotic stresses are responsible for the low yield of rice in our country. However, the rice disease is considered to be the major constraint for sustaining rice productivity. The rice production environments in the tropics having many rice pathogens cause varying degrees of devastating damage. Of these, the narrow brown leaf spot is distributed in the worldwide as foliar disease and prevalent in global rice grown areas [2,3], and its yield loss has also been reported in Bangladesh [4]. Narrow brown leaf spot disease is caused by *Cercospora oryzae* Miyake and its infection proceeds on leaves, sheaths and panicles [5]. The pathogen is also airborne and endures in crop residue and on seed. In respect to susceptible cultivar, significant economic yield losses were reported with worm weather [6]. Bacterial leaf blight (BLB) is the most important vascular disease which is difficult to control, and uses of higher nitrogen rate produced higher grain yield, while yield was greatly reduced due to BLB [7]. Bacterial leaf blight (*Xanthomonas oryzae* pv. *Oryzae*) disease in rice causes epidemic losses in all rice growing areas of the world and even destructive in Asia [8,9]. Disease injury causes significant reductions in filled grains and yield loss ranges from 31-44% [10].

Seeds play a vital role to produce quality and healthy seeds which has the significant effect on yield of rice. About 40% of the rice seeds are obtained from farmers' own harvest and 60% come from the Bangladesh Agricultural Development Corporation (BADC), Non governmental organizations (NGOs) and private seed companies in Bangladesh. Meanwhile, farmers - saved rice seeds are also of magnificence in carrying seed-borne pathogens [11]. The certified seeds are recognized as good quality seeds in the country, but the quality of these seeds are judged only by moisture, purity and germination, where the health of seeds is not considered. Quality good seed consists of major characteristics such as high yielding potentiality, viability and free from infection by pathogens [12]. Seed borne infection of rice seed by *Bipolaris oryzae* (brown spot), *Fusarium moniliforme* (bakanae) and *Alternaria padwiickii* (stack burn), *F. oxysporum, Curvularia lunata*, *species of Nigrospora, Aspergillus flavus* and *Sarocladium oryzae* (sheath rot) greatly affects in seed quality [13]. These organisms cause grain discoloration and reduce market value*.* Poor quality rice seeds reduce the productivity of modern cultivars in attaining its genetic potential [14].

Application of fungicides for the control of plant diseases is the most effective management option. Moreover, indiscriminate use of chemicals breaks down the natural ecological balance by killing the beneficial and/or antagonistic soil microbes. However, exploring of judicious, less expensive, less hazardous and eco-friendly management practices are essential tool to combat the problem [15]. Bioagents have also been attempted in minimizing the disease to reduce crop losses [16,17]. BAU-Biofungicide (*Trichoderma* based preparation) results in significant higher germination and plant resistance, less disease incidence and higher yield of rice [18]. *Trichoderma* spp. produces hydrolytic enzymes (chitinases, glucanases, and proteases) to breach the fungal cell wall as successful invasion in the fungal hosts [19,20] and releases antimicrobial metabolites act as hyperparasitism [21]. Plant extract as garlic has its highly significant antifungal function and antimicrobial properties [22,23] and extract of neem also shows antifungal effects [18,24,25]. The present study has been designed as eco-friendly management of the narrow brown leaf spot and bacterial leaf blight diseases of rice for improving seed quality and controlling seed borne pathogens.

Materials and Method

Use of BAU-Biofungicide and Fungicide

BAU-Biofungicide (*Trichoderma* based preparation) was used at 2% and 3%. BAU-Biofungicide is a *Trichoderma* based preparation [26]. Bavistin DF (Carbendazim) and Potent 250 EC (Propiconazole) were also used at 0.1% and 0.05% concentration.

Preparation of Plant Extracts

Healthy leaves of neem and garlic cloves were collected, and washed thoroughly under running tap water followed by sterile distilled water (SDW). The extracts were prepared by homogenizing plant parts using a blender and prepared at 1% and 2% concentration by dilution with water and kept in conical flasks separately before use.

Field Experiments

The experiments were conducted with rice cv. BRRI dhan29 during two Boro seasons in two successive years 2012 and 2013. The experiments were carried out in the field Laboratory of the Department of Agronomy, Bangladesh Agricultural University (BAU), Mymensingh. The experiment was led by using Randomized Complete Block Design (RCBD) having three replications. The field was fertilized as per recommendation of Bangladesh Rice Research Institute, Gazipur [27]. The individual plot size was 10 m^2. Block to block and plot to plot distances were 2.0 m and 1.5 m, respectively. Thirty five day old seedlings were uprooted from seed bed and three seedlings per hill were transplanted on January 21 in two successive years 2012 and 2013. Hill to hill and row to row distances were 15 cm and 20 cm, respectively. The spray schedule was started just after commencement of disease symptoms and three sprays were followed at 15 days interval. Symptoms have been assessed at 80, 95 and 110 days after transplantation. Disease severity and incidence of each plot was assessed following the procedure of Standard Evaluation System for Rice [28].

Tray Method

The experiment was conducted in the nethouse of the Seed Pathology Centre, (BAU), Mymensingh. Sand was collected from Brahmaputra River, Mymensingh. The collected sand was sterilized with formalin (40%) at the rate of 5 ml formalin Diluted with 20 ml of water for 4 kg sand [29]. The formalin treated soil was covered with polythene sheet for 48 h and then exposed for 48 h for aeration before setting experiment. The plastic trays (12″ × 8″) were filled with the sand. The experiment was carried out in Complete Randomized Design with three replications. Three hundred harvested seeds of each treatment including control were sown in plastic trays (100 seeds/tray) maintaining equal distances among the seeds. Plants were watered as when necessary for maintaining proper moisture. Randomly selected 10 seedlings were uprooted carefully from each tray and washed thoroughly with running tap water. Data was recorded for each treatment at 14 days after sowing (DAS) on different parameters. Vigour Index (VI) was computed using the following formula of Baki and Anderson [30]:

Vigor index = (Mean shoot length + Mean root length) × % Germination

Laboratory Experiments (Blotter Method)

The harvested seeds of each year were tested by blotter method for seed health test to detect seed borne pathogens associated with seed of each sample [31]. Each seed borne infection was recorded and expressed in percentage [32].

Statistical Analysis

The recorded data on different parameters were analyzed by using MSTAT-C computer program to find out the significance of variation resulting from experimental treatments. The difference between the treatment means were evaluated for significance using Duncan's Multiple Range Test (DMRT) following the procedure of Gomez and Gomaz [33].

Results

Analysis of Disease Severity and Incidence

The highest reduction of 85.00 and 87.69% in severity of narrow brown leaf spot of rice was recorded at 110 DAT with foliar application of Potent 250 EC (0.1%) followed by BAU-Biofungicide (2%) (85.19 & 81.54%) in 2012 and 2013 years, respectively, while the lowest incidence was observed (5.92 & 6.04%) in Potent (0.1%) followed by BAU-Biofungicide (2%) presented in Table 1. The low disease severity (5.00%) and incidence (10.21%) of narrow brown leaf spot disease were also noted at 110 DAT in Bavistin (0.1%) in 2013. Minimum disease severity and incidence in bacterial leaf blight were obtained as 3.00 and 5.83% at 110 DAT, respectively with BAU-Biofungicide (3%) in 2012 followed by Potent (0.1% and 0.05%). The good effect of Bavistin in controlling bacterial leaf blight disease was found in this experiment as shown in Table 2.

Treatment (dose)	Narrow Brown Leaf Spot											
	Disease severity (%)						Disease incidence (%)					
	At 80 DAT		At 95 DAT		At 110 DAT		At 80 DAT		At 95 DAT		At 110 DAT	
	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013
BAU-Biofungicide (2%)	4.47c	4.00c	4.23e	4.00d	2.27g	3.00e	9.18d	9.82d	10.40e	11.92d	6.23g	7.16ef
	-40.4	-50	-63.44	-66.67	-85.19	-81.54	-44.02	-47.6	-62.35	-60.87	-82.85	-82.41
BAU-Biofungicide (3%)	4.53c	-	4.13e	-	2.37g	-	9.13d	-	10.39e	-	6.30g	-
	-39.6		-64.3		-84.54		-44.33		-62.38		-82.86	
Garlic (1%)	5.27bc	5.50bc	6.97cd	7.50c	8.67cd	9.00c	13.04bc	13.51bc	16.55c	18.69c	23.27c	23.37c
	-29.73	-31.25	-39.76	-37.5	-43.44	-44.62	-20.49	-27.91	-40.08	-38.64	-35.95	-42.59
Garlic (2%)	5.00bc	-	6.00d	-	7.22de	-	11.86c	-	13.65d	-	18.08d	-
	-33.33		-48.14		-52.90		-27.68		-50.58		-35.95	
Neem (1%)	6.07b	6.50ab	9.00b	9.75b	11.38b	11.75b	14.15b	15.80b	22.12b	24.88b	28.00b	30.35b
	-19.07	-18.75	-22.21	-18.75	-25.77	-28.8	-13.72	-15.69	-19.91	-18.32	-22.93	-25.45
Neem (2%)	6.00b	-	8.20bc	-	10.12bc	-	13.53bc	-	19.88b	-	24.32c	-
	-20		-29.13		-33.99		-17.5		-28.02		-33.06	
Bavistin DF (0.1%)	5.10bc	5.25bc	6.07d	6.25cd	5.02f	5.00d	11.81c	11.15cd	13.16d	14.70d	10.26f	10.21e
	-32	-34.38	-47.54	-47.92	-67.25	-69.23	-27.99	-40.5	-52.35	-51.74	-71.76	-74.92
Bavistin DF (0.05%)	5.67bc	6.00b	7.00cd	7.50c	6.26ef	6.50d	12.53bc	13.31bc	16.17c	18.86c	13.24e	14.80d
	-24.4	-25	-39.5	-37.5	-59.17	-60	-23.6	-28.98	-41.46	-38.08	-63.56	-63.65

Potent 250 EC (0.1%)	4.47c	4.00c	4.10e	4.00d	2.30g	2.00e	9.18d	10.23d	10.29e	11.80d	5.92g	6.04df
	-40.4	-50	-64.56	-66.67	-85	-87.69	-44.02	-45.41	-62.74	-61.26	-83.7	-85.16
Potent 250 EC (0.05%)	4.50c	4.00c	4.00e	4.50d	2.40g	2.50e	9.14d	10.49d	10.39e	12.49d	5.97g	7.28ef
	-40	-50	-65.43	-62.5	-84.34	-84.62	-44.27	-44.02	-62.38	-59	-83.57	-82.12
Control (water)	7.50a	8.00a	11.57a	12.00a	15.33a	16.25a	16.40a	18.74a	27.62a	30.46a	36.33a	40.71a

Table 1: Effect of BAU-Biofungicide, extracts of garlic and neem, Bavistin and Potent on severity and incidence of narrow brown leaf spot disease of rice cv BRRI dhan29 in 2012 and 2013.
In a column, figures having same letter(s) do not differ significantly at 5% level of significance by Duncan's multiple range tests.
DAT = Days after Transplanting
Data represent the means of three replications
Data in parentheses indicate % disease severity and % disease incidence reduction over control
(-) = Not tested in 2013

Treatment (dose)	Disease severity (%)						Disease incidence (%)					
	At 80 DAT		At 95 DAT		At 110 DAT		At 80 DAT		At 95 DAT		At 110 DAT	
	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013
BAU-Biofungicide (2%)	4.00b	4.0c	5.00de	5.00e	3.33e	3.50e	9.17c	7.75c	8.02c	7.00d	6.08g	5.50e
	-27.27	-38.46	-34.81	-42.86	-67.76	-67.44	-19.06	-32.61	-45.55	-56.03	-64.36	-69.44
BAU-Biofungicide (3%)	4.00b	-	4.67e	-	3.00e	-	9.00c	-	7.99c	-	5.83g	-
	-27.27		-39.11		-70.96		-20.56		-45.76		-65.83	
Garlic (1%)	4.50ab	5.50ab	7.00ab	7.25b	6.87b	7.50b	10.33b	10.50ab	11.87ab	12.17b	13.20b	13.63b
	-18.18	-15.38	-8.74	-17.14	-33.49	-30.23	-8.83	-8.7	-19.42	-23.56	-22.63	-24.28
Garlic (2%)	4.00b	-	6.67abc	-	6.33bc	-	9.83bc	-	10.50bc	-	11.33c	-
	-27.27		-13.04		-38.72		-13.24		-28.72		-33.59	
Neem (1%)	4.50b	5.0bc	6.67abc	7.00bc	6.33bc	7.25bc	10.33b	10.25ab	10.39bc	9.48c	10.00d	10.00c
	-18.18	-23.08	-13.04	-20	-38.72	-32.56	-8.83	-10.87	-29.46	-40.45	-41.38	-44.44
Neem (2%)	4.25b	-	6.33abcd	-	6.00bcd	-	9.50bc	-	10.08bc	-	9.36de	-
	-22.73		-17.47		-41.92		-16.15		-31.57		-45.13	
Bavistin DF (0.1%)	5.00ab	4.50bc	5.67bcde	6.00cde	5.33bcd	5.75cd	9.40bc	10.00ab	10.27bc	9.50c	8.58ef	8.00cd
	-9.09	-30.77	-26.08	-31.43	-48.4	-46.51	-17.04	-13.04	-30.28	-40.33	-49.71	-55.56
Bavistin DF (0.05%)	5.00ab	5.0bc	6.00bcde	6.25bcd	5.67bcd	6.00bcd	10.00bc	10.50ab	10.50bc	10.16c	9.33de	8.85cd
	-9.09	-23.08	-21.77	-28.57	-45.11	-44.17	-11.74	-8.7	-37.02	-36.18	-45.31	-50.83
Potent 250 EC (0.1%)	4.00b	4.25c	5.67bcde	5.50de	4.33de	5.25d	9.33bc	9.25bc	9.83bc	8.75c	7.61f	7.25de
	-27.27	-34.62	-26.08	-37.14	-58.08	-51.16	-17.65	-19.57	-33.27	-45.04	-55.39	-59.72
Potent 250 EC (0.05%)	4.50ab	4.5bc	5.33cde	5.75de	4.67cde	5.50d	9.83bc	9.50abc	10.49bc	9.25c	7.87f	7.50cde
	-18.18	-30.77	-30.51	-34.29	-57.79	-48.84	-13.24	-17.39	-28.78	-41.9	-53.87	-58.33
Control (water)	5.50a	6.50a	7.67a	8.75a	10.33a	10.75a	11.33a	11.50a	14.73a	15.92a	17.06a	18.0a

Table 2: Effect of different treatments on severity and incidence of Bacterial Leaf Blight disease of rice cv BRRI dhan29 in 2012 and 2013
In a column, figures having same letter(s) do not differ significantly at 5% level of significance by Duncan's multiple range tests.
DAT = Days after Transplanting
Data represent the means of three replications
Data in parentheses indicate % disease severity and % disease incidence reduction over control
(-) = Not tested in 2013

Evaluation of Seed Quality Improvement

BAU-Biofungicide (2%) and Potent (0.1%) resulted in maximum (96.33%) germination. Higher increase (30.85%) in normal seedlings was found with BAU-Biofungicide (3%) in 2012 as well as in Potent 250 EC (0.1%) having increase of 32.83% over control in 2013. Highest reduction of diseased seedling (54.55%) over control was achieved both in BAU-Biofungicide (2%) and Potent (0.1%). Potent (0.1%) also exhibited the highest shoot weight (40.67 mg) and root weight (37.33 mg), while BAU-Biofungicide (2%) showed shoot weight 40.00 mg and root weight 36.00 mg in 2012 and 2013, respectively. Highest increase in vigor index (37.49%) was appeared with BAU-Biofungicide (3%) followed by Potent 250 EC (0.1%) compared to control **(Table 3)**.

Treatment (dose)	Germination (%)		Normal seedling (%)		Diseased seedling (%)		Shoot weight (mg)		Root weight		Vigour index	
	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013
BAU-Biofungicide (2%)	96.33a	96.00ab	86.67ab	86.00a	5.00c	5.00d	40.00abc	39.67a	35.00a	36.00ab	2125.00ab	2136.62a
	(+14.68)	(+12.94)	(+29.36)	(+30.30)	(-50.00)	(-54.55)	(+21.21)	(+23.97)	(+29.63)	(+36.73)	(+35.87)	(+34.92)
BAU-Biofungicide (3%)	96.00a	-	87.67a	-	4.67c	-	39.67abc	-	35.00a	-	2150.40a	-
	(+14.29)		(+30.85)		(-53.30)		(+20.21)		(+29.63)		(+37.49)	
Garlic (1%)	89.33ab	90.00abc	73.66c	75.00bc	9.67a	8.67b	36.00bcd	36.00ab	29.00bcd	28.67de	1736.67de	1766.75bc
	(+6.35)	(+5.88)	(+9.94)	(+13.64)	(-3.30)	(-21.18)	(+ 9.09)	(+12.50)	(+7.41)	(+8.89)	(+11.04)	(+11.57)
Garlic (2%)	90.00ab	-	76.67c	-	8.00b	-	36.33abcd	-	31.00bc	-	1830.92cde	-
	(+7.14)		(+14.43)		(-20.00)		(+10.09)		(+14.81)		(+17.07)	
Neem (1%)	86.33ab	86.00bc	70.00c	69.00bc	9.33a	9.00b	35.00d	34.33bc	28.67cd	29.00de	1671.67de	1660.46bc
	(+2.77)	(+1.18)	(+4.48)	(+4.55)	(-6.70)	(-18.18)	(+6.06)	(+7.28)	(+6.19)	(+10.14)	(+6.88)	(+4.85)
Neem (2%)	87.33ab	-	73.33c	-	8.00b	-	35.67cd	-	30.00bcd	-	1747.90de	-
	(+3.96)		(+9.45)		(-20.00)		(+8.09)		(+11.11)		(+11.76)	
Bavistin DF (0.1%)	90.00ab	89.67abc	77.33bc	77.00b	7.67b	7.33c	37.00abcd	36.33ab	32.67ab	33.00bc	1920.58abcd	1899.50ab
	(+7.14)	(+5.49)	(+15.42)	(+16.67)	(-23.30)	(-33.36)	(+12.12)	(+13.53)	(+21.00)	(+25.33)	(+22.80)	(+19.95)
Bavistin DF (0.05%)	88.67ab	87.67abc	74.67bc	74.00bc	7.67b	8.00bc	36.00bcd	35.00bc	30.00bcd	30.33cd	1807.33cde	1774.77bc
	(+5.56)	(+3.14)	(+11.45)	(+12.12)	(-23.30)	(-27.27)	(+9.09)	(+9.38)	(+11.11)	(+15.19)	(+15.56)	(+12.07)
Potent 250 EC (0.1%)	96.33a	96.33a	88.66a	87.67a	5.00c	5.00d	40.67a	40.00a	36.00a	37.33a	2127.32ab	2125.93a
	(0.1%)	(+13.33)	(+32.33)	(+32.83)	(-50.00)	(-54.55)	(+23.24)	(+25.00)	(+33.33)	(+41.78)	(+36.02)	(+34.25)
Potent 250 EC (0.05%)	96.00a	96.33a	87.67a	86.33a	5.33c	6.00d	40.50ab	39.33a	35.67a	37.00a	2103.60abc	2100.97a
	(+14.29)	(+13.33)	(+30.85)	(+30.80)	(-46.70)	(-45.45)	(+22.73)	(+22.91)	(+32.11)	(+40.52)	(+34.50)	(+32.67)
Control (water)	84.00b	85.00c	67.00c	66.00c	10.00a	11.00a	33.00d	32.00c	27.00d	26.33e	1564.00d	1583.60c

Table 3: Effect of different treatments on germination(%) and vigour index at 14 days after sowing of harvested seeds of rice cv. BRRI dhan29 following tray method during Boro season in 2012 and 2013.
In a column, figures having same letter(s) do not differ significantly at 5% level of significance by DMRT
Data represent the means of three replications
Data in parentheses indicate % increased (+) and % decreased (-) over control
DAS = Days after sowing
(-) = Not tested in 2013

Seed Borne Pathogen Determination

The harvested seeds of different treatments were found to be detected as seed borne fungi, viz. *B. oryzae*, *Curvularia lunata, Fusarium oxysporum, Fusarium moniliforme, Sarocladium oryzae* and *Penicillium sp.* (Table 4). The lowest (2.00%) seed borne infection of *B. oryzae* was observed in harvested seeds as foliar application of BAU-Biofungicide (3%) followed by BAU-Biofungicide (2.00%) and Potent 250 EC (0.1%). The highest (65.22%) reduction of seed borne infection of *C. lunata* was determined with BAU-Biofungicide (2%) over control followed by Neem (2%). Minimum infection (10.50%) of *F. oxysporum* was marked in BAU-Biofungicide (3%) followed by BAU-Biofungicide (2%) and Potent (0.1 & 0.05%). Maximum reduction of *F. moniliforme* (72.22%) was recorded with BAU-Biofungicide (3%) followed by BAU-Biofungicide (2%) over control. Seed borne infection of *S. oryzae* was not identified in Potent (0.1 and 0.05%). Hundred percent reduction of *Penicillium sp.* was found with BAU-Biofungicide (2%) followed by BAU-Biofungicide (3%) and Potent (0.1 & 0.05%) over control.

Treatment (dose)	*Bipolaris oryzae*		*Curvularia lunata*		*Fusarium oxysporum*		*Fusarium moniliforme*		*Sarocladium oryzae*		*Penicillium sp.*	
	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013
BAU-Biofungicide (2%)	2.50e	2.00e	4.75e	4.00e	12.75e	10.00d	1.50d	2.50d	1.50cd	1.00d	0.00e	1.50e
	(-70.59)	(-66.67)	(-64.81)	(-65.22)	(-32.89)	(-42.03)	(-66.67)	(-50.0)	(-57.14)	(-73.33)	(-100.00)	(-75.00)
BAU-Biofungicide (3%)	2.00e	-	5.00e	-	10.50f	-	1.25d	-	1.00d	-	1.00d	-
	(-76.47)		(-62.96)		(-44.74)		(-72.22)		(-71.43)		(-80.95)	
Garlic (1%)	6.50b	4.25bc	7.00d	6.50cd	16.00bc	12.50c	2.50c	2.75cd	2.00bc	2.00c	1.00d	2.25cde
	(-23.53)	(-29.17)	(-48.15)	(-43.48)	(-15.79)	(-27.54)	(-44.44)	(-45.0)	(-42.86)	(- 46.67)	(-80.95)	(-62.50)
Garlic (2%)	5.50c	-	5.50e	-	16.25bc	-	2.50c	-	1.00d	-	0.00e	-
	(-35.29)		(-59.26)		(-14.47)		(-44.44)		(-71.43)		(-100.00)	
Neem (1%)	4.00d	3.50cd	5.25e	5.00de	16.50bc	15.00b	2.75bc	3.50bc	2.00bc	3.00b	2.50b	3.50b
	(-52.94)	(-41.67)	(-61.11)	(-56.52)	(-13.16)	(-13.04)	(-38.89)	(-30.0)	(-42.86)	(-20.00)	(-52.38)	(-41.67)
Neem (2%)	4.00d	-	5.00e	-	14.00de	-	3.00bc	-	2.00bc	-	2.00bc	-
	(-52.94)		(-62.96)		(-26.32)		(-33.33)		(-42.86)		(-61.90)	
Bavistin DF (0.1%)	8.50a	4.75b	11.00c	8.00bc	17.75ab	17.00a	3.50b	3.75b	2.50b	2.00c	2.50b	3.00bc
	(-0.00)	(-20.83)	(-18.52)	(-30.43)	(-6.58)	(-1.45)	(-22.22)	(-25.0)	(-28.57)	(-46.67)	(-52.38)	(-50.00)
Bavistin DF (0.05%)	8.50a	5.00ab	11.50bc	8.50b	18.50a	16.50ab	4.50a	5.00a	3.50a	3.00b	2.00bc	3.50b
	(-0.00)	(-16.67)	(-14.81)	(-26.09)	(-2.63)	(-4.35)	(-0.00)	(-0.00)	(-0.00)	(-20.00)	(-61.90)	(-41.67)
Potent 250 EC (0.1%)	3.50d	2.25e	12.50ab	8.25b	13.25de	11.00cd	2.50c	3.00bcd	0.00e	0.00e	1.50cd	2.00de
	(-58.82)	(-62.50)	(-7.41)	(-28.26)	(-30.26)	(-36.23)	(-44.44)	(-40.0)	(-100.00)	(-100.00)	(-71.43)	(-66.67)
Potent 250 EC (0.05%)	5.00c	3.00de	13.50a	9.00b	14.75cd	11.75c	3.00bc	3.50bc	0.00e	0.00e	1.00d	2.50cd
	(-41.18)	(-50.00)	(-0.00)	(-21.74)	(-22.37)	(-31.88)	(-33.33)	(-30.0)	(-100.0)	(-100.00)	(-80.95)	(-58.33)
Control (water)	8.50a	6.00a	13.50a	11.50a	19.00a	17.25a	4.50a	5.00a	3.50a	3.75a	5.25a	6.00a

Table 4: Effect of different treatments on germination (%) and seed borne fungi in seeds of cv BRRI dhan29 following Blotter method during Boro season in 2012 and 2013.
In a column, figures having same letter(s) do not differ significantly at 5 % level of significance by DMRT
Data represent the means of four replications
Data in parentheses indicate % increased (+) and % decreased (-) over control
(-) = Not tested in 2013

Discussion

Mahmud and Hossain [18] reported that BAU-Biofungicide (2%) and Tilt 250 EC (0.1%) resulted in significant reduction of disease incidence of narrow brown leaf spot disease. This finding was complementing with Zhou and Uppala [34] who observed the lowest severity of narrow brown leaf spot in propiconazole under field conditions. Mukherjee and Maheswari [35] reported that *Trichoderma harzianum* was found to have highly antagonistic effect on narrow brown leaf spot of paddy. These findings were also supported by Razu and Hossain [15]. Mahmud et al. [13] reported that BAU-Biofungicide (2%) exhibited the lowest disease severity of bacterial leaf blight disease when it was applied as foliar spray in the field. Similar findings were also supported by Tang, et al. [36], Gangwar & Sinha, and Razu & Hossain [37,15]. Significant reduction of disease severity in bacterial leaf blight of rice was noted with the application of *Trichoderma harzianum* due to higher phenolic content production on rice leaves as reported by Gangwar and Sinha [37]. Similar observation was also reported by Kumawat, et al. [38].

Mahmud and Hossain [18] reported that application of BAU-Biofungicide (2%) and Potent 250 EC (0.1%) signified maximum germination and highest seedling of harvested seeds. These findings were in accordance with the observation of Biswas, et al. [39] who reported that *Trichoderma* treated rice seeds showed maximum germination (92%) and increased shoot and root length. This result was similar to the findings of Brotman, et al. [40] and López-Bucio, et al. [41]. They observed that *Trichoderma* spp. induced the plant to release phytoalexins and phenols that provided tolerance to abiotic stresses and enhanced the development of root system. Mahmud and Hossain [18] also reported that BAU-Biofungicide (2%) remarked maximum reduction of diseased seedling, and highest increase (36.17%)) in vigour index of harvested seeds of rice cv BR11. These findings were also reported by Hossain, et al. (2015).

Mahmud and Hossain [18] tested the efficacy of *T. harzianum* against *B. oryzae* and observed the significant growth reduction of rice brown spot pathogen. Similar findings were also reported by Sarkar, et al. [42], Biswas, et al. [39] and Biswas, et al. [43]. Biswas et al. [43] also observed 70% disease reduction when the seeds were treated with *Trichoderma* spp. Mahmud and Hossain [25] reported that BAU-Biofungicide (2%) reduced (67.57%) seed borne infection of *C. lunata* of harvested seeds when it was applied as foliar spray. This finding was also supported by Jat and Agalave [44]. Gwa and Nwankiti [45] reported that *T. harzianum* significantly inhibited the growth of seed borne pathogen (*F. oxysporum)*. *F. oxysporum* was reduced significantly with propiconazole (0.1%) as reported by Manasa, et al. [46]. *Trichoderma* species showed the maximum retardation in growth (52.54%) of seed borne infection of *F. moniliforme* which was studied by Gwa and Nwankiti [47], and they also observed that *T. harzianum* was found to be antagonistic on *F. moniliforme* due to antibiosis and mycoparasitism. Bora and Ali (2019) reported that significant growth inhibition (65.21%) of *T. harzianum* against *S. oryzae* was observed. The highest reduction in seed borne infection of *S. oryzae* was also found in propiconazole (0.1%) as the reporting of Mahmud and Hossain [18]. *Trichoderma* showed antagonistic effect against *Penicillium spp.* as reported by Jat and Agalave [44]. Similar findings were reported by Borrás and Aguilar [48].

BAU-Biofungicide (2%) was highly effective in reducing disease incidence of narrow brown leaf spot and bacterial leaf blight in the field. BAU-Biofungicide and Potent (0.1%) also increased germination of seeds, seedling growth and vigor index, and inhibited seed borne pathogens of harvested seeds of BAU-Biofungicide and Potent (0.1%) sprayed plot.

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