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Effect of *Trichoderma* and fungicide on seedling establishment and yield performance of dry direct seeded *boro* rice

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Abstract

Poor seedling establishment and seedling mortality is the major barrier to optimum stand establishment in dry direct seeded *boro* rice. Experiments were carried out at the Agronomy Field Laboratory, Bangladesh Agricultural University (BAU), Mymensingh, Bangladesh during January to June 2013 to study the effect of *Trichoderma* and fungicide application on seedling establishment and yield performance of dry direct seeded *Boro* rice. The experiment comprised ten treatment combinations of *Trichoderma* and fungicides viz. seed treatment with *Trichoderma* (M_1), seed treatment with *Trichoderma*+spraying of Thiovit (M_2), seed treatment with *Trichoderma* + spraying of Propiconazole (M_3), seed treatment with *Trichoderma* + spraying of Thiovit and Propiconazole (M_4), spraying of Thiovit (M_5), spraying of Propiconazole (M_6), seed treatment with Thiovit + spraying of Propiconazole (M_7), seed treatment with Propiconazole + spraying of Thiovit (M_8), spraying of mixture of Thiovit and Propiconazole (M_9), and control (no fungicide or *Trichoderma*) (M_{10}).The experiments used Randomized Complete Block Design (RCBD) with three replications. Experiment revealed that seed treatment with *Trichoderma harzianum* followed by spraying of Thiovit gave the highest yield of rice. The study concludes that *Trichoderma* and then application of sulphur fungicide at 20 days after sowing could be practiced for ensuring high seedling establishment and yield of rice under dry direct seeded system in *boro* season.

Keywords: *Trichoderma harzianum,* Fungicide, Seedling, *Boro* rice

Introduction

Rice is the most important and extensively cultivated cereal crop in Bangladesh and it contributes to ninety five percent of the total food grain consumed. It is cultivated in 11.527 million hectare of land which is about 80% of the total cultivated land (14.41 million hectares) of Bangladesh. The total production of rice was 30.415 million metric tons in 2012-13. Rice is usually cultivated in three growing seasons (viz. *Aus, Aman* and *Boro*). The contribution of *Boro, Aman* and *Aus* rice production in 2011-12 were 53.81%, 38.27% and 7.91%, respectively (BBS, 2013). As *Boro* rice gives the highest yield among the three seasons, farmers are very much interested to grow *Boro* rice. In Bangladesh *Boro* rice is mainly cultivated in puddle transplanted system that requires huge amount of water. The crop can successfully be grown by direct seeding on dry un-puddled soil with less irrigation (Bouman *et al*., 2005) that would save 50-70% of irrigation water (Peng *et al*., 2006). About 60% irrigation water compared with puddle transplanting system (Mandal *et al*., 2009 and Rahman *et al*., 2012) can be saved if *Boro* rice is cultivated in dry direct seeded system. It can also save diesel and electricity as well as save the environment by decreasing the emission of methane and carbon dioxide. Poor seedling establishment is a major constraint in adopting of dry direct seeded *Boro* rice cultivation system (Itabari *et al*., 1993). Optimum crop stand establishment is the prerequisite for successful crop production. Crops often fail to establish quickly and uniformly, leading to decreased yield because of low plant population. Seedling establishment of crops depends on the infestation of soil and seed borne fungi, lack of soil moisture, low temperature and low germination percentage of seed and so on. At low temperature, soil and seed borne fungi are to be more active to kill the seedlings of *Boro* rice. Seed treatment with *Trichoderma* and application of fungicide (sulphur or others) could be overcome the seedlings death.

BAU-biofungicide named *Trichoderma harzianum* is invented from naturally occurring fungus to protect crops from different diseases caused by different harmful fungi. *Trichoderma* protects seeds from huge number of soil borne as well as seed borne fungi that can attack the seeds before germination and after germination in the soil. It also controls pre-emergence and post-emergence death of seedlings. Seed treatment with *Trichoderma* significantly increases germination and protects seed and seedling from soil borne fungi as well as increase plant stand in the field (Hossain, 2011). So the establishment of seedling in the field is increased by the treatment of seed with *Trichoderma* and ultimately the crop yield is increased. The application of sulphur fungicide or other fungicides increased germination percentage, field emergence and percent survival. Thiovit increased the yield, depending on the rate and time of spraying, by 11-55% (Jarvan and Kuskla, 2005).The highest seed yield was found in the Vitavax- 200-treated seeds (Jain, 2004). So application of fungicides can help crop establishment by increasing field emergence and percent survival.

The above discussion indicates seed treatment with *Trichoderma harzianum* and application of fungicides are the effective tools for rapid and uniform seedling emergence and increase the survival rate of crop plants as well as help to increase yield. However, these techniques have not yet been developed in Bangladesh. The present study sought to investigate the effect of *Trichoderma* and fungicide application on seedling establishment and yield performance of dry direct seeded *Boro* rice.

Materials and Methods

The experiment was conducted at the Agronomy Field Laboratory, Bangladesh Agricultural University (BAU), Mymensingh, Bangladesh during *Boro* season from January to June 2013. The experimental field is located at 24º25´N latitude and 90º50´E longitude having an altitude of 18 m. The experimental site is a medium high land belonging to the Sonatala series of Old Brahmaputra Floodplain Agro-ecological Zone (AEZ-9). The soil was silt loam with pH 6.5. Soil contained 1.78% organic matter, 0.14% total N, 1.98 µg g^{-1} available P, 0.10 meq $100g^{-1}$ exchangeable K and 4.56 µg g^{-1} available S. The crop experienced very low rainfall (0-15 mm) during January – March which coincided with the vegetative stage. The experiment comprised ten treatment combinations viz. seed treatment with *Trichoderma* (M_1), seed treatment with *Trichoderma*+spraying of Thiovit (M_2), seed treatment with *Trichoderma* + spraying of Propiconazole (M_3), seed treatment with *Trichoderma* + spraying of Thiovit and Propiconazole (M_4), spraying of Thiovit (M_5), spraying of Propiconazole (M_6), seed treatment with Thiovit + spraying of Propiconazole (M_7), seed treatment with Propiconazole + spraying of Thiovit (M_8), spraying of mixture of Thiovit and Propiconazole (M_9), and control (no fungicide or *Trichoderma*) (M_{10}). Treatment combinations were assigned to Randomized Complete Block Design (RCBD) with three replications. The plot size was 4.0 m × 2.5 m maintained a plant spacing of 25 cm × 15 cm. BRRI dhan28 was was sown in furrows with 4-5 seeds $hill^{-1}$ on 16 January 2013 under dry direct seeded system. *Trichoderma harzianum* inoculums, a BAU-biofungicide was mixed at the rate of 4% of seed weight just before seed sowing (Hossain, 2011). The experimental plots were fertilized with well decomposed cow dung @ 5 t ha^{-1} .The land was fertilized with urea, triple supper phosphate (TSP), muriate of potash (MoP), gypsum and zinc sulphate @ 120, 14, 58, 8 and 1 kg ha^{-1} (BARC, 2005). Sulphur fungicide Thiovit (80% Sulphur) and propiconazol fungicide (Potent) were applied in every plot at 20 DAS at the rate of 2.5 kg ha^{-1} and 0.5 litre per hectare, respectively. Five grams of Thiovit was mixed with 1 litre of water and 1ml Potent was mixed with 1 litre of water. Weeding was done by hand with niri and by the application of herbicide. Panida (Pendimethalin) was applied at 2 DAS as pre-emergence herbicide at the rate of 2 litre ha^{-1}. Only 2 irrigations were required for keeping 2-3 cm standing water in the crop field.. Irrigation water was measured by volumetric method (Misra and Ahmed, 1987).The crop was harvested on 31 May 2013 at maturity stage. At 10, 18 and 30 DAS emerged seedlings of central fourth and fifth lines (2 m^2) of each plot were counted and converted into per square meter. Randomly ten seedlings were uprooted from 1 m inside of each plot at 30 DAS. Average shoot and root length of the seedlings were measured with a scale in centimeter (cm). At panicle initiation (PI) stage (77 DAS), randomly ten rice plants were cut with a sickle at soil level from about 1 meter inside of each experimental plot. Shoot length was measured with a scale in cm and the mean of ten shoots was shoot length (cm) $seedlings^{-1}$. At 30 DAS ten Shoots and roots were uprooted, cut, separated and dried at 70 ºC for 72 hours in an oven. Then they were cooled at room temperature and weighed by an electric balance in gram (g) to calculate average shoot and root dry matter (g) $seedlings^{-1}$. Average plant height was calculated. Number of tillers m^{-2} was counted from the harvested crop. Number of panicles (effective tillers) m^{-2} was also calculated. Ten panicles were selected to calculate average panicle length. Number of filled grain or grain and sterile spikelets in each panicle was counted. Then grains $panicle^{-1}$ and sterile spikelets $panicle^{-1}$ was measured by calculating the mean value. One thousand clean dried grains were counted at 14% moisture .Grain yield and straw yield was also measured at 14% moisture content after sun drying, cleaning and weighing separately and finally converted into t ha^{-1}. Harvest index was calculated as percentage of grain yield to total above ground biomass. The data were compiled and tabulated in proper form and subjected to statistical analysis. Analysis of variance (ANOVA) was done with the help of computer package program MSTAT-C and mean comparisons of the treatments were evaluated by Duncan's Multiple Range Test (DMRT) (Gomez and Gomez, 1984).

Results and Discussion

Number of seedlings was significantly influenced by seed treatment with *Trichoderma*. However the highest numbers 86.66, 113.00 and 112.33m^{-2} of seedling at 10, 18 and 30 DAS was observed from seed treatment with *Trichoderma* respectively. The lowest number of seedling was found in no *Trichoderma* and fungicide application (Table 1). It is revealed that seed treatment with *Trichoderma* produced higher number of seedlings. This result is consistent with that of Hamed *et al*. (2011) and Rahman (2006). Shoot and root length was significantly influenced by seed treatment with *Trichoderma*. The highest shoot and root length (20.19 and 8.25 cm) was recorded from seed treatment with *Trichoderma* and those found lowest (16.10 and 5.82 cm) from no *Trichoderma* and fungicide application (Table 2). It clearly indicates that seed treatment with *Trichoderma* gained higher shoot and root length. Azarmi *et al*. (2011) and Nzanza *et al*. (2011) also found that *T. harzianum* treated plants improved shoot and root length. Shoot dry and root dry matter was significantly influenced by *Trichoderma* and sulphur fungicide application. The highest shoot dry matter (22.59 g) was found from seed treatment with *Trichoderma* and spraying of propiconazole fungicide at 20 DAS and at the same time the highest root dry matter (9.95 g) was found by seed treatment with *Trichoderma* (Table 2). The lowest shoot and root dry matter (18.54 and 6.98 g) was observed in no *Trichoderma* or fungicide application (Table 2). It is revealed that seed treatment with *Trichoderma* and spraying of sulphur fungicide (propiconazole) produced higher shoot and root dry matter. The result of the present study supports to Azarmi *et al.* (2011) and Nzanza *et al.* (2011) that was the highest shoot and root dry matter with *Trichoderma* treatment over the control.

Seed treatment with *Trichoderma* and fungicide had no significant effect on plant height and panicle length. However, numerically the highest number of tillers (426.00 m^{-2}) and highest number of panicle (380.33 m^{-2}) was observed from seed treatment with *Trichoderma* and spraying of sulphur fungicide at 20 DAS (Table 3). The numerical highest number of grain (98.00 $panicle^{-1}$) was obtained from seed treatment with *Trichoderma* and spraying of sulphur fungicide at 20 DAS. The lowest number of grain (75.66 $panicle^{-1}$) was obtained from no fungicide or *Trichoderma* application (Table 4). There was no significant difference in 1000-grain weight and number of sterile spikelets due to the effect of *Trichoderma* and fungicide application (Table 4).

Grain yield was significantly influenced by seed treatment with *Trichoderma* and spraying of sulphur fungicide at 20 DAS. The highest grain yield (6.28 tha^{-1}) was obtained from seed treatment with *Trichoderma* and spraying of sulphur fungicide at 20 DAS and lowest grain yield (3.41 tha^{-1}) was obtained from no fungicide or *Trichoderma* application (Table 4). This indicates that seed treatment with Trichoderma and spraying of sulphur fungicide at 20 DAS produced higher grain yield. Our results were in accordance with Islam (2009) and Shultana *et al*. (2009) who found similar significant efficacy of BAU bio-fertilizer.

Straw yield was significantly influenced by seed treatment with *Trichoderma*. The highest straw yield (7.54 tha^{-1}) was gained from seed treatment with *Trichoderma* and lowest straw yield (4.12 tha^{-1}) was obtained from no fungicide or *Trichoderma* application (Table 4). It clearly indicates that seed treatment with *Trichodema* produced higher straw yield. This result was consistent with findings of Hossain *et al*. (2009). Seed treatment with *Trichoderma* and fungicide had no significant effect on harvest index (Table 4).

Table 1. Effect of *Trichoderma* and fungicide on number of seedlings of dry direct seeded *Boro* rice at 10, 18 and 30 days after sowing

Treatment	No. of seedlings m^{-2} at 10 DAS	No. of seedlings m^{2} at 18 DAS	No. of seedlings m^{-2} at 30 DAS
M_1	86.66a	113.00a	111.66a
M_2	85.33a	112.66a	112.33a
M_3	83.33a	111.33a	109.66a
M_4	85.00a	109.66a	107.66a
M_5	51.33b	79.33b	73.33b
M_6	52.00b	78.00b	69.66b
M_7	83.00a	107.66a	106.00a
M_8	77.00a	106.33a	105.00a
M_9	45.00b	71.66b	65.00b
M_{10}	48.66b	74.00b	65.00b
Lsd	10.33	10.52	9.612
S	3.476	3.540	3.235
CV (%)	8.63**	6.36**	6.06**

Note: * and ** indicate at 1% and 5% level of significance
DAS – Days after sowing

Table 2. Effect of *Trichoderma* and fungicide on shoot and root dry matter of direct seeded *Boro* rice

Treatment	Shoot length at 30 DAS (cm)	Root length at 30 DAS (cm)	Shoot dry matter at 30 DAS (g)	Root dry matter at 30 DAS (g)
M_1	20.19a	8.25a	21.98ab	9.95a
M_2	19.12abc	7.15abc	22.42a	8.75ab
M_3	19.73ab	6.32bcd	22.59a	8.30ab
M_4	18.38abcd	7.32ab	21.31abc	7.82b
M_5	17.71bcd	6.26bcd	18.94c	7.00b
M_6	17.60bcd	6.11bcd	18.70c	7.54b
M_7	18.73abc	6.83bcd	20.95abc	8.13b
M_8	18.41abcd	6.73bcd	19.77abc	8.75ab
M_9	16.78cd	6.03cd	19.24bc	7.02b
M_{10}	16.10d	5.82d	18.54c	6.98b
Lsd	2.117	1.11	2.544	1.63
S	0.7125	0.3737	0.856	0.5486
CV (%)	6.75*	9.68**	7.25*	11.84*

Note: * and ** indicate at 1% and 5% level of significance
DAS – Days after sowing

Table 3. Effect of *Trichoderma* and fungicide on different growth status of dry direct seeded *Boro* rice

Treatment	Plant height (cm)	No. of tillers m^{-2}	No. of panicles m^{-2}	Panicle length (cm)
M_1	98.06	411.33a	364.00a	22.62
M_2	100.00	426.00a	380.33a	22.73
M_3	97.93	320.66bcd	300.33b	23.83
M_4	98.73	319.33bcd	276.66bc	22.17
M_5	98.20	340.33b	267.00bcd	24.16
M_6	96.80	337.66bc	288.33b	22.59
M_7	96.66	324.00bc	270.00bcd	23.14
M_8	99.00	326.00bc	276.33bc	23.52
M_9	97.13	287.33d	251.00cd	22.50
M_{10}	97.00	302.66cd	237.66d	22.45
Lsd	4.104	31.55	30.97	1.836
S	1.381	10.62	10.42	0.618
CV (%)	2.44^{NS}	5.42**	6.20**	4.66^{NS}

Note: * and ** indicate at 1% and 5%
NS – Not significant

Table 4. Effect of *Trichoderma* and fungicide on yield contributing characters and yield of dry direct seeded *Boro* rice

Treatment	No. of grain $pancle^{-1}$	No. of sterile spikelets $pancle^{-1}$	1000 grain wt(g)	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})	Harvest index (%)
M_1	92.66c	15.66	22.09	6.08ab	7.54a	44.64
M_2	98.00a	18.00	21.72	6.28a	7.45a	45.72
M_3	93.00c	17.00	21.68	5.65bc	6.75b	45.55
M_4	90.00d	18.66	22.31	5.29c	6.38b	45.32
M_5	78.66h	16.00	22.04	4.42d	5.47c	44.68
M_6	87.33f	19.00	22.13	4.69d	5.53c	45.83
M_7	88.66e	18.33	22.10	5.36c	6.62b	44.80
M_8	96.00b	15.66	22.02	5.30c	6.33b	45.54
M_9	83.33g	16.00	21.89	4.63d	5.68c	44.93
M_{10}	75.66i	16.00	21.74	3.41e	4.12d	45.28
Lsd	0.488	2.91	0.736	0.488	0.515	1.365
S	0.164	0.980	0.248	0.164	0.173	0.459
CV (%)	8.23*	9.96^{NS}	1.95^{NS}	5.57**	4.85**	1.76^{NS}

Note: * and ** indicate at 1% and 5%
NS – Not significant

Conclusion

Trichoderma along with the sulphur fungicide treatments can improve the seedling establishment and increase the yield of dry direct seeded *Boro* rice. The optimum number of seedlings and proper growth of seedlings could be achieved with the application of sulphur fungicide and *Trichoderma* treatments in dry direct seeded *Boro* rice.

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