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Evaluation of Fungicides for the Control of Rice False Smut (*Ustilaginoidea virens*)

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ABSTRACT

Outbreak of false smut, caused by the fungus *Ustilaginoidea virens* has been recorded in recent years in the popular rice variety 'BRRI dhan49' from various parts of Bangladesh. Registered and/or recommended fungicides are not yet available for chemically controlling the disease. Consequently, uses of unregistered fungicides are common by the farmers for the management of the disease. The present study was, therefore, undertaken to identify effectiveness of any fungicides to control rice false smut disease. Seven synthetic foliar fungicides were evaluated in the naturally induced diseased plots. Each fungicide was applied as spray twice, at panicle initiation and at early flowering stage. Compared to the control (no fungicide application), the fungicide 'Controller 300 EC' reduced the hill infection by 57%, followed by 'Green 300 EC', 'Cuprofix 30 Disperss' and Diazole 300 EC, each of those suppressed the hill infection by 50%. While Cuprofix 30 Disperss, compared to the control, resulted in the lowest number of infected panicle per hill, it was statistically similar to rest of the fungicides except for Confidence 10 SL. Fungicides and control did not have any significant variation on the number of infected florets per panicle. With respect to per unit (hill infection × number of infected panicle per hill) disease suppression Controller 300 EC was the best. However, none of the fungicides reached the level of the disease suppression, the essential criterion for registration and/or recommendation of a fungicide under Bangladesh conditions. It is concluded that more multi-location and multi-season experiments will be required to reach a decisive conclusion on foliar chemical options for controlling rice false smut disease under Bangladesh conditions.

Kew words: Florets, panicles, disease suppression

INTRODUCTION

Rice false smut (RFSm), caused by *Ustilaginoidea virens* (Che.) Tak. (teleomorph *Villosiclava virens*) (White *et al.,* 2000; Tanaka *et al.,* 2008), is one of the most serious diseases of rice world wide (Ou 1972; Rush *et al.,* 2000; Ahonsi and Adeoti 2002; Atia 2004; Bischoff *et al.,* 2004; Tsuda *et al.,* 2006; Zhou *et al.,* 2008; Brooks *et al.,* 2009; Ladhalakshmi *et al.,* 2012; Nessa *et al*., 2015a). The disease affects rice grains and induces considerable losses both in yield and quality (Atia, 2004). It generally infects 1–15% of tillers with at least two to three spore balls per infected panicle (Rush *et al.,* 2000; Nessa *et al*., 2015b). However, the panicle infection may increase to 60% or higher in years of severe infection causing considerable empty grains and reduced grain weight (Li *et al.,* 1986; Lu *et al.,* 2009; Nessa *et al*., 2015b).

The infection with *U. virens* is reported to be favoured by high relative humidity (>90%) (Yashoda *et al.,* 2000), high rainfall (Sugha *et al.,* 1992), low sunshine hours (Nessa *et al*., 2015c), temperatures in the range of 25 to 30°C (Chen *et al.,* 1994; Yashoda *et al.,* 2000), late sowing or maturing (Nessa *et al*., 2015c; Sarker *et al*., 2016) and high soil fertility (Singh and Khan 1989, Ahonsi *et al.,* 2000) as well as high amount of nitrogen (Li *et al.,* 1986). In addition, large-scale expansion of high yielding rice varieties or hybrid rice (Singh *et al*., 1987; Biswas, 2001), over use of chemical fertilizers and more frequent irrigation (Deng, 1989; Zhou *et al.,* 2004; Lu *et al.,*

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2009) also have been recorded as factors for wide spreading of this disease.

RFSm was once considered as minor among the fungi diseases in Bangladesh (Mian and Shahjahan, 1987). Recently, its status has been elevated to major disease due to frequent and widespread occurrence. The outbreak of this disease has been recorded from various parts of Bangladesh predominantly in the variety BRRI dhan49 during T. Aman season. Due to increasing incidence of RFSm in recent years, farmers in Bangladesh are forced to apply fungicides indiscriminately. This is because there is no registered fungicide for the disease and there is no fungicide recommendation to control the disease. This study was, therefore, carried out to elucidate the performance of foliar fungicides in order to ascertain their effectiveness in controlling rice false smut disease under Bangladesh conditions.

MATERIALS AND METHODS

Experimental site

The field experiment was carried out during Transplanted Aman season of 2011 in the experimental farm of the regional station, Rajshahi, of the Bangladesh Rice Research Institute (BRRI). The farm is a High Gangetic River Flood Plain located at 24°30′ N latitude and 38°20′ E longitude. The soil is calcareous alkaline type and pH ranged from 7.0-8.2. The weather is hot and humid during Aman season.

Plant material and fungicide

The high yielding popular T. Aman rice variety BRRI dhan49 was used as test material. Seven fungicides namely Green 30 EC, Confidence 10 SL, Karisma 28 SC, Cuprofix 30 Disperss, Nativo 75 WG, Dizole 300 EC and Controller 300 EC were evaluated against the RFSm disease (Table 1).

Transplanting and management practices

Thirty-one-day-old seedlings of BRRI dhan49 were transplanted in a 20 × 20 cm spacing on July 25, 2011. The size of individual plots was 3 × 3 m. Crop husbandries such as irrigation, fertilizers, weeding were done following standard recommended rice production practices (BRRI 2011).

Treatment and experimental design

Treatment included the seven fungicides and one control (no fungicide application). They were set in a randomized complete block design and replicated three times. Each chemical was sprayed twice, one at panicle initiation stage and the other at early flowering stage. In the experiment field, the disease infection occurred naturally.

Data collection and analysis

Data were recorded on percentage of hill infection, number of total tillers per hill, number of healthy and infected panicles per hill, number of infected florets per panicle, number of filled and unfilled grains per panicle and thousand-grain weight (TGW). The average values of three replications were then subjected to analysis of variance. The DMRT was performed for the mean comparison when treatment differences were found significant. The data were analysed using CROPSTAT software.

Table 1. List of fungicides with their trade name, chemical group and dose.

Trade name	Chemical group	Dose
Green 30 EC	Difeconazole+Tebuconazole	0.8 ml/L
Confidence 10 SL	Validamycine	3.0 ml/L
Karisma 28 SC	Azoxystrobin+Cyproconazole	0.8 ml/L
Cuprofix 30 Disperss	Copper+Mancozeb	4.5 g/L
Nativo 75 WG	Tebuconazole+Trifloxystrobin	0.5 g/L
Dizole 300 EC	Difeconazole+Propiconazole	0.5 ml/L
Controller 300 EC	Difeconazole+Propiconazole	0.5 ml/L

RESULTS

Percent hill infection

The infection of RFSm in the experimental field ranged from 20.0 to 46.0% of the hills, where the incidence was the highest in the control (untreated) plots (Table 2). The fungicide Controller appeared to be the best performer reducing the disease by about 57% (compared to the control). Fungicides Green 300EC, Cuprofix 30 Disperss and Diazole 300 EC decreased the disease incidence by about 50.0%, whereas Karisma 28 SC suppressed the disease by about 46%. Compared to the others, the performance of Confidence 10 SL (disease reduction by 31%) and Nativo 75 WG (disease reduction by 25%) was poor.

Table 3 shows the number of tillers as well as number of panicles per hill as per treatment. It also shows that fungicides did not affect the total number of tillers and number of panicles per hill.

Number of infected panicles per hill and number of infected florets per panicle

The number of infected panicles per hill was the highest in the control plot (2.51), where as it was lower in the plots treated with fungicides Cuprofix 30 Disperss (1.44) and Controller 300 EC (1.57) (Fig. 1). It may be reiterated that both the fungicides were also found effective in disease reduction in hill infection (50-57%). The fungicides Diazole 300 EC and Karisma 28 SC also produced relatively less number of infected panicles per hill *viz* 1.69 and 1.87 respectively, compared to control (2.51).

The number of infected florets per panicle was statistically similar with all the seven fungicides and the control (Fig. 2).

Number of filled grains and unfilled grains per panicle

None of the fungicides (including the control) showed significant difference in the number of filled grains per panicle (Table 4). Numerically, the highest number of filled grain was found in Cuprofix (145.0) followed by Nativo 75 WG (137.3) and Confidence 10 SL (136.5). The control plots, where no fungicide was applied, produced the lowest number of filled grains per panicle (127.5). This result indicates that

Table 2. Reduction of false smut incidence (%) in seven fungicides over control.

Fungicide	Hill infection (%)	Disease reduction over control (%)
Green 30 EC	23	50
Confidence 10 SL	32	31
Karisma 28 SC	25	46
Cuprofix 30 Disperss	23	50
Nativo 75 WG	36	25
Dizole 300 EC	23	50
Controller 300 EC	20	57
Control (untreated)	46	-

Number of total tillers per hill and number of panicles per hill.

Table 3. Effect of fungicides on the number of total tillers and panicles per hill.

Fungicide	Total tiller/hill (no.)	Panicles/hill (no.)
Green 30 EC	14.89 a	13.32 a
Confidence 10 SL	13.40 a	12.41 a
Karisma 28 SC	13.66 a	12.41 a
Cuprofix 30 Disperss	13.76 a	12.34 a
Nativo 75 WG	14.35 a	12.68 a
Dizole 300 EC	13.64 a	12.22 a
Controller 300 EC	14.68 a	13.30 a
Control (Untreated)	13.31 a	12.06 a

Values with the same letters in a column are not significantly different at p=0.05.

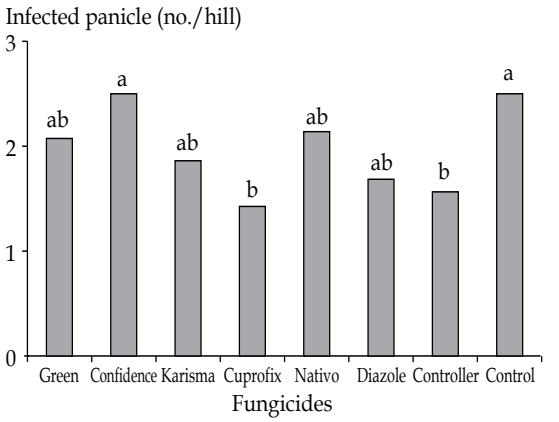

Fig. 1. Number of infected panicles per hill in different fungicides.

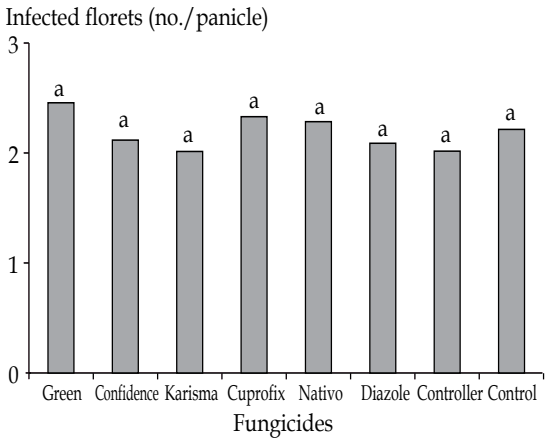

Fig. 2. Number of infected florets per panicle in different fungicides.

fungicides influenced the number of filled grains to a small extent. However, the number of unfilled grains per panicle varied among the fungicide treatments. The lowest unfilled grains was recorded in Confidence 10 SL (14.87) followed by Controller 300 EC (15.80). On the other hand, the highest unfilled grain was recorded in Green 30 EC (29.8) followed by Dizole 300 EC (23.3).

Thousand-grain weight (g)

There were significant differences among the seven fungicides for the trait TGW (Table 4). Maximum TGW was obtained from the fungicides Cuprofix (30.6 g) followed by Nativo (27.0 g) and Karisma (25.9 g). On the other hand, it was the lowest in the fungicides Diazole (20.7 g) and Confidence (23.4 g). TGW for the control plot was 24.3 g.

DISCUSSION

The present investigation evaluated the efficacy of seven synthetic foliar fungicides for the control of rice false smut under natural disease incidence scenario. We found that Green 30 Dizole 300 EC and Controller 300 EC had reduced the disease severity (% hill infection) substantially compared to the untreated plot. Other tested fungicides viz, Confidence 10 SL, Karishma 28 SC and Nativo 75 WG were comparatively less effective. The fungicides Controller 300 EC showed highest efficacy to control this disease. Green 300 EC, Cuprofix 30 Disperss and Dizole 300 EC also recorded as moderately good for their efficiency to overcome this disease. Chen *et al.,* 1994 found that spraying plants with copper oxychloride or thiophanate-methyl at booting stage reduced RFSm. Pramjit *et al.* (2006) reported that Tilt 25 EC (Propiconazole) and Contaf 5 EC (Hexaconazole) effectively controlled the RFSm incidence when these fungicides were applied at boot stage. Many authors reported that the fungus invade into rice spikelets before heading of rice plants i.e., at the booting stage (Ashizawa and Kataoka 2005; Zhou *et al.,* 2003) and infect rice florets. We sprayed the fungicide started at panicle initiation and further at early flowering stage and hence the above mentioned three difeconazole+propiconazole/ tebuconazole fungicides especially Controller 300 EC might had effectively controlled the invasion of fungi into florets. Controller 300 EC has been prepared from propiconazole mixing with difeconazole. Therefore the result of this

Table 4. Number of filled grain, unfilled grain and 1000-grain weight in different fungicide treatments.

Treatment	Filled grain/ panicle (no.)	Unfilled grain/panicle (no.)	1000 Grain weight (g)
Green 30 EC	130.3 a	29.80 a	24.2 ab
Confidence 10 SL	136.5 a	14.87 b	23.4 ab
Karisma 28 SC	131.9 a	17.87 ab	25.9 ab
Cuprofix 30 Disperss	145.0 a	20.80 ab	30.6 a
Nativo 75 WG	137.3 a	15.53 b	27.0 ab
Dizole 300 EC	135.9 a	23.27 ab	20.7 b
Controller 300 EC	130.9 a	15.80 b	21.4 ab
Control (Untreated)	127.5 a	24.33 ab	24.3 ab

Values with the same letters in a column are not significantly different at p=0.05.

study is partially comply with the previous report (Paramjit *et al.,* 2006).

We noticed that the number of total tillers per hill and number of panicles per hill had no significant differences among the tested chemicals implied that neither the fungicides nor the infection of false smut had any impact for the afore mentioned traits. Although Chlamydospores germinate on coleoptile cells and can invade through intercellular space, but it had no influence on tillering of the plant. Disease infection process of false smut generally happened in the florets at the booting stage, when the effective tiller has already determined. However, there were notable differences for the number of infected panicles per hill. The fungicides Cuprofix 30 Disperss and Controller 300 EC were identified as good for the control of infected panicles per hill. Yashoda *et al.* (2000) also reported the similar results. They found that Carbendazim reduced the disease severity significantly. The nature of RFSm incidence generally happened sporadically or aggregation in spaces in the rice field (Nessa *et. al.,* 2015b; Rush *et al.,* 2000). The tested fungicides could not prevent the fungi similarly might be due to nature of natural inoculum distribution pattern in the field. Not only the sporadic distribution pattern of false smut inoculum but also the level of inoculum pressure or aggregation might have influence on the prevention capacity of tested fungicides against the disease.

Epidemiological studies revealed that the chlamydospores survive in the soil and become a primary source of infection of the rice plants. Germinated chlamydospores on coleoptile epidermal cells invade intercellularly and reach the meristematic tissues of rice plants (Ikegami 1962). It was also found that the infection levels became very low after the coleoptiles reached 10 mm in length. However, the fungus invade into rice spikelets before heading i.e., at the booting stage (Ashizawa and Kataoka 2005; Zhou *et al.,* 2003) and infect rice florets. Artificial inoculum pressure by injecting conidia and hyphae at the booting stage induced more floret infection and thereby larger number of smut balls (Hu *et al.,* 2013). The epidemiology of the disease is relatively well studied, but the relationship between the pathogen population density in the soil, their distribution pattern in the field and disease severity in the paddy fields are unknown. These might have influenced in the difference of panicle infection in association with the varied level of fungicides effect.

TGW also varied considerably among the treated plot. We observed that the fungicides Cuprofix 30 Disperss and Nativo 75 WG increased grain weight more than the control plot, indicated that fungicides might have increased the grain weight of rice. Our findings were also supported by different researchers (Yashoda *et al.,* 2000; Paramjit and Sweety, 2006). They noticed that the application of fungicides not only increased the yield but also improved the quality of rice grain. However, grain weight was comparatively lower in the Controller 300 EC and Dizole 300 EC treated plots but these fungicides controlled the disease better. Therefore, it is necessary to check further whether these fungicides have any negative effect on the grain weight.

CONCLUSION

In conclusion, the fungicide Controller 300 EC reduced the hill, panicle and rice floret infection more compared to other tested fungicides. Cuprofix 30 Disperss was effective next to the Controller 300 EC. However, none of the fungicides was found effective for the complete control of false smut disease in rice. This findings echo the results from a recently conducted field survey (Sarker *et al.*, 2016). Previous reports (Chen *et al.,* 1994; Paramjit *et al.,* 2006), the results and above discussion indicate that mixture of propiconazole with copper fungicides might be more effective in controlling the false smut disease in rice. Further investigation in this regard is suggested.

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