

Effect of Plant Debris Removal on the Incidence of Rice Sheath Blight Disease in Bangladesh

S Parveen^{1*}, M S Hossain², M A Ali³ and M A Ali⁴

ABSTRACT

Sheath blight caused by *Rhizoctonia solani* is a major disease of rice (*Oryza sativa* L.) in Bangladesh that affects the crop in almost every season. The effect of floating debris removal on the incidence of sheath blight was assessed from the previously infected fields of three upazilas of Rajshahi district during T. Aman 2010. Each field was divided into two plots. Floating debris were removed from one plot while the other plot remained unremoved. Percent hill infection was higher in control plots from where floating debris were not removed (FDNR) than that of FDR plots from where floating debris were removed from the fields of Tanore, Godagari and Paba at 35 days after transplanting. The percent hill infection was 8.89% in FDR plots and 56.67% in FDNR in Tanore with a difference of 47.78%. Maximum 63.01% reduction in hill infection was found in Tanore between FDR and FDNR, whereas significant reduction in hill infection was found in Godagari (46.75%) at maximum tillering stage. The reduction in the incidence of sheath blight was 51.08% in Paba at maturity stage due to removal of floating debris from the field before transplanting. The average yield of three fields was 4.79 t ha⁻¹ in FDR plot, whereas in FDNR, it was 4.18 t ha⁻¹ in Tanore. Thus there was an yield difference of 0.61 t ha⁻¹ in between FDR and FDNR plots. However, there was negative relationship between tiller infection and grain yield of rice. It is evident that the regression equation that the grain yield was 6.75 t ha⁻¹ in the FDNR plots when there was no infections but infection in the tillers reduced the grain yield by 0.41 unit for every unit increase in tiller infection.

Key words: Plant debris, sheath blight, rice

INTRODUCTION

Bangladesh agriculture involves food production for 163.65 million people (Salam *et al.*, 2014). Since independence, there has been a three-fold increase in rice production in Bangladesh, which jumped from nearly 11 MT in 1971-72 to about 34.86 MT in 2014-15 (AIS, 2016). Rice production area in Bangladesh during 2017-18 was 11.01 million hectare of land in which nearly 36.27 million tons of rice was produced (AIS, 2019). In the last few years (2009-10 to 2013-14), rice production has increased by 0.34 MT per year (BBS, 2014).

In Bangladesh, rice covers about 80% of cultivable land (Anonymous, 2006a). Again, 20.8% of the plant populations are being infected by the disease (Anonymous, 2006b).

Among the diseases, sheath blight is one of the major rice disease in Bangladesh.

Sheath blight (ShB) of rice was first reported in Japan by Miyakie in 1910. It is caused by *Rhizoctonia solani* Kuhn. It is considered as the most damaging and major epidemic disease of rice (Li *et al.*, 2012). During offseason, pathogen survives as sclerotia or mycelia, or both, in soil or plant debris and on weeds in rice growing regions (Kumar *et al.*, 2012). Sclerotium is the primary inoculum that overwinters and infects the subsequent rice crop. Under favourable conditions, ShB spreads rapidly through mycelia in all directions (Su *et al.*, 2012). *Rhizoctonia solani* is a universal soil saprotrophic and facultative plant parasite (Ogoshi, 1996; Anees *et al.*, 2010). It survives in soil as sclerotia (Tsai *et al.*, 2012). *Rhizoctonia*

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solani survives in unfavourable conditions by forming sclerotia or dormant mycelia (Anees *et al.*, 2010). Sclerotia spread during land preparation and flooding of the field by irrigation water (Brooks, 2007). During permanent flooding the sclerotia may float and move within or other fields through water flow. Sclerotia or hyphae attach to the plant, infecting and causing ShB disease.

In Bangladesh 31 rice diseases have been identified of which ten are considering as major (Miah and Shahjahan, 1987) and ShB perhaps the number one major disease of rice in Bangladesh. It is an important rice disease, especially in intensive rice cropping systems. Incidence and development of ShB of rice depends on weather parameter, host and soil factor (Damicone *et al.*, 1993). Disease spread and intensity is dependent on the amount of infectious inoculum present in planting material and residues of previous crop. Large lesions formed on infected sheaths of lower leaves may lead to softness of the stem thereby initiating stem lodging (Wu *et al.*, 2012). The average incidence of ShB in Bangladesh is about 20.3% (Ali *et al.*, 2003). The losses caused by ShB in Bangladesh may ranges from 14 to 31% under farmer's field (Shahjahan *et al.*, 1986). The presence of one or many factors may enhance the severity of the disease beyond economic threshold levels, thereby incurring low to high yield losses.

Disease management programme against ShB can concrete on different approaches such as incorporating cultural practices, exploitation of host resistance, biological control with *T. harzianum* and *T. viride* and chemical control. The control of ShB in the field so far is relied mainly on the use of fungicides by the farmers. Chemical control is not considered sustainable because of its toxic residual effect. But, there is ample scope of useing different cultural practices such as clean cultivation, soil solarization during drymonths (April-May) for management of ShB of rice. For clean cultivation, burning the

crop residues, destroy grasses and other hosts from the field and alongside the levee or allow decomposition during land preparation, collecting and burying floating debris after final land preparation may reduce infection foci. Straw burning advocated to reduce sclerotial density in the soil and modification of cultural practices during growing stages of plants may be effective in controlling rice ShB, because the sources of inoculums are proved to be one of the most important aspects of the disease development (Sharma *et al.*, 1994). Therefore, the present study was under taken to evaluate the effect of plant debris removal from the rice field for controlling ShB disease in Bangladesh.

MATERIALS AND METHODS

The experiment was conducted during T. Aman 2010 in the farmer's fields of three upazilas namely Tanore, Godagari and Paba of Rajshahi district. In each upazila, three rice fields were selected, where size of each field was 33-50 decimal. The selected field had a history of ShB infestation. After final land preparation, floating debris were settled down at the corner of the field removed by using a sieve or a white cotton cloth. Each field was divided into two plots of equal size. Each plot was used as experimental unit. There were two experimental units in each farmer's field. One plot was designated as FDR (Floating debris removed) and another as FDNR (Floating debris not removed) (Fig. 1). Thirty-day-old and 2-3 seedlings per hill of Gutisharna were transplanted with a spacing of 20 cm × 15 cm. Fertilizers were applied @ 405:150:202:135:10 g/decimal of urea, TSP, MOP, gypsum and zinc sulphate. All fertilizers were applied in basal, except urea (Anonymous, 2010).

Nine hills were selected by putting a bamboo stick in W pattern (Fig. 1) at random from each of FDR and FDNR plots. Number of infected and healthy hills from nine hills at 35

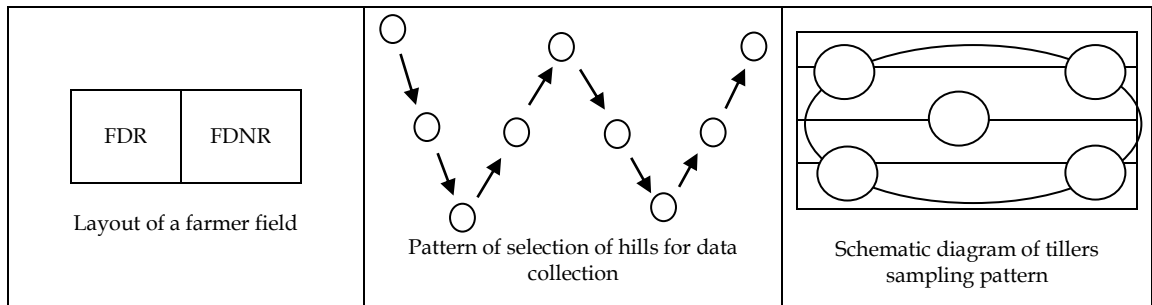


Fig 1. Field layout, pattern of hill selection and tillers sampling pattern for data collection.

DAT and maximum tillering stages and number of infected and healthy tillers from nine hills at maturity stage were counted. Data on disease incidence (% hill infection and % tiller infection) and yield were recorded based on five hills. Percent reduction of tiller infection due to removal of floating debris at 35 DAT, maximum tillering and maturity stage was calculated by the following formula:

$$\text{Reduction (\%)} = \frac{\text{No. of infected tiller in FDNR} - \text{No. of infected tiller in FDR}}{\text{No. of infected tiller in FDNR}} \times 100$$

Paired t-test was used for analysis of the data. The mean of FDR and FDNR was compared by t-test. Different level of tiller infection was obtained from individual spot from where corresponding yield was recorded.

RESULTS AND DISCUSSION

Table 1 shows the effect of floating debris removal on the incidence of ShB disease at 35 days after transplanting (DAT). Data on ShB incidence in hill infection clearly indicate that removal of debris floating on the irrigation or rain water in the field before transplanting (after final land preparation) had significant impact on the development of rice ShB in the field. Percent hill infection was higher in control plots from where floating debris were not removed (FDNR) than that of FDR plots from where floating debris were removed

from the fields of Tanore, Godagari and Paba upazila of Rajshahi district. The percent hill infection was 8.89% in FDR plots whereas in FDNR, it was 56.67% in Tanore. Thus there was a difference of 47.78% infection in between FDR and FDNR. In Godagari, the percent hill infection was 16.67% in FDR plots whereas in FDNR, it was 65.57%. There was a difference of 48.9% infection in between FDR and FDNR. In Paba, percent hill infection of FDNR was 65.56% whereas in FDR, it was 13.33%. The difference between FDNR and FDR was 52.23% in Paba. Castilla *et al.* (1996) also studied on inoculum potential of sclerotia of *Rhizoctonia solani* in floating debris of rice field to measure of inoculum efficiency of rice ShB. The rate of reduction in the incidence of ShB was similar in all locations. However, there was little numerical differences. Figure 2 shows percent reduction of incidence of ShB at 35 DAT in FDR and FDNR plots under natural field conditions during T. Aman season. Reduction in hill infection was 84.3% in Tanore, whereas 74.57% in Godagari and 79.66% in Paba due to removal of floating debris from the field before transplanting. Hashiba and Mogi (1976) also reported that mature sclerotia detached from rice plant can survive on the surface of soil or in soil. In the following growing season, sclerotia float on the water surface, germinate and infect rice tillers. Sclerotia can survive on or in soil during the winter then germinate and infect plants (Hashiba and Mogi, 1976; Lee and Rush, 1983; Ou, 1985).

Table 1. Effect of floating debris removal on the incidence of rice sheath blight disease (% hill infection) at 35 DAT.

Treatment	Disease incidence (%)		
	Tanore	Godagari	Paba
FDR	8.89	16.67	13.33
FDNR (Control)	56.67	65.57	65.56
Difference	47.78	48.9	52.23
Significance (P=0.05)	*	*	*

DAT= Days after transplanting, FDR=Floating debris removed and FDNR=Floating debris not removed. * Significant at the 5% level by paired t-test.

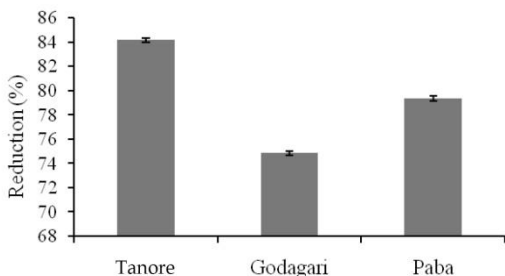


Fig. 2. Reduction of hill infection in FDR plots over FDNR in different locations at 35 DAT (FDR=Floating debris removed; FDNR=Floating debris not removed).

Table 2 shows the effect of removal of floating debris on the incidence of rice ShB at maximum tillering stage. Results on the effect of floating debris collection are observed as same as 35 DAT. Percent hill infection was higher in FDNR plot than that of FDR plot in the fields of Tanore, Godagari and Paba. The percent hill infection was 30% in FDR plots whereas in FDNR, it was 81.11% in Tanore. Thus there was a difference of 51.11% infection in between FDR and FDNR. In Godagari, the percent hill infection was 45.56% in FDR plots whereas in FDNR, it was 85.56%. There was a difference of 40% infection in between FDR and FDNR. In Paba, percent hill infection of FDNR was 87.78% whereas in FDR, it was 44.45%. The difference in between FDNR and FDR was 43.33% in Paba. Kobayashi *et al.* (1997) also studied the incidence of ShB and primary inocula and found that the number of diseased hills was

higher in the plots with debris than that in the plots without debris. The percentage of diseased hill in the plots without plant debris reached to 3.9% by one month after heading, whereas in plots containing plant debris at the rate of 2 kg and 4 kg per 35 m², the values were 11 and 18% respectively (Kobayashi *et al.*, 1997). Figure 3 shows the percent reduction of hill infection of ShB at maximum tillering stage. Maximum 63.01% reduction in hill infection was found in Tanore, whereas significant reduction in hill infection was found in Godagari (46.75%). Similarly the reduction in the ShB incidence was 49.36%, found in Paba due to removal of floating debris from the field before transplanting. Disease development from sclerotia present in the soil however, depends on cultivar reaction, cultural practices and the micro-environment within the canopy, among other factors at maximum tillering to booting stage (Ui *et al.*, 1976).

Table 2. Effect of floating debris removal on the incidence of rice sheath blight disease (% hill infection) at maximum tillering stage.

Treatment	Disease incidence (%)		
	Tanore	Godagari	Paba
FDR	30	45.56	44.45
FDNR (Control)	81.11	85.56	87.78
Difference	51.11	40	43.33
Significance (P=0.05)	*	*	*

DAT=Days after transplanting, FDR=Floating debris removed and FDNR=Floating debris not removed. * Significant at the 5% level by paired t-test.

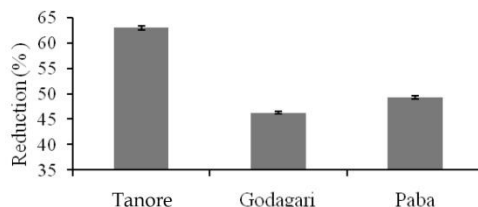


Fig. 3. Reduction of hill infection in FDR plots over FDNR in different locations at maximum tillering stage.

Table 3 shows the effect of removal of floating debris on the incidence of rice ShB at maturity stage. It was recorded that percent tiller infection was higher in FDNR plot than that of FDR plot at maturity stage in the fields of Tanore, Godagari and Paba. The percent tiller infection was 2.37% in FDR plots whereas in FDNR, it was 6.48% in Tanore. Thus there was a difference of 4.11% infection in between FDR and FDNR. In Godagari, the percent tiller infection was 3.26% in FDR plots whereas in FDNR, it was 6.39%. Thus there was a difference of 3.13% infection in between FDR and FDNR. At the same time, percent tiller infection of FDNR was 6.93% whereas in FDR, it was 3.39% observed in Paba. The difference between FDNR and FDR was 3.54% in Paba. It was observed that difference between FDR and FDNR were significant at all the locations. Figure 4 shows the percent reduction of tiller infection of ShB disease at maturity stage. In Tanore, 63.42% reduction in tiller infection was found. A similar significant reduction in tiller infection was also found in Godagari (48.98%). The reduction in ShB incidence was 51.08%, found in Paba due to removal of floating debris from the field before transplanting. Kobayashi *et al.* (1997) also found that the plots with sclerotia showed greater number of diseased hills in proportion to the number of sclerotia than the plots without sclerotia. Inoculum potential of sclerotia was about three times as much as that of plant debris. These result suggested that mycelium in plant debris may play a role as primary inocula of the disease.

Table 4 shows the effect of removal of floating debris on the yield performance of Gutiswarna variety due to ShB disease of rice after harvesting. The rate of reduction in ShB incidence was similar in all locations. However, there was little numerical differences. Yield performance of Gutiswarna due to ShB disease of rice was higher in FDR plot than that of FDNR plot at maturity stage in the fields of Tanore, Godagari and Paba.

The average yield of three fields was 4.79 t ha⁻¹ in FDR plot, whereas in FDNR, it was 4.18 t ha⁻¹ in Tanore. Thus there was an yield difference of 0.61 t ha⁻¹ in between FDR and FDNR plots. Figure 5 shows that the reduction in yield was 12.73% at Tanore. In Godagari, the average yield of three fields was 4.43 t ha⁻¹ in FDR plot but 4.14 t ha⁻¹ in FDNR. Thus, there was a difference of 0.29 t ha⁻¹ in between FDR and FDNR. In Godagari, 6.54% yield reduction was observed. At the same time, the average yield of FDNR plot was 3.80 t ha⁻¹ in Paba. It was 4.15 t ha⁻¹ in FDR. Difference in yield between FDNR and FDR was 0.35 t ha⁻¹ in Paba. Consequently 8.43% yield reduction due to ShB incidence was found in Paba as a result of removal of floating debris from the field before transplanting. The best way to manage the disease would be to reduce the inocula through practices convenient to the farmers (Ou, 1985; Shahjahan *et al.*, 1987).

Figure 6 and 7 show the relationship between the percent tiller infection of ShB disease and yield of Gutiswarna was established through critical point model for FDR and FDNR plots. Yield was affected by the presence of ShB infection in the tillers significantly reduced the grain yield in FDNR plots. The regression lines indicated that decrease in yield was associated with the increase of ShB incidence in the tillers. There was negative relationship between tiller infection and grain yield of rice with every unit increase in tiller infection, there was a corresponding yield loss of 0.46 units of grains in FGR plots. It is evident from the regression equation that the grain yield was 6.75 t ha⁻¹ in the FDNR plots when there was no infections but infection in the tillers reduced the grain yield by 0.41 unit for every unit increase in tiller infection. The relationship between X (random variable) and Y (dependent variable) was negative. The R² value proved that the negative contribution of X on Y was significant.

Table 3. Effect of floating debris removal on the incidence of rice sheath blight disease (% tiller infection) at maturity stage.

Treatment	Disease incidence (%)		
	Tanore	Godagari	Paba
FDR	2.37	3.26	3.39
FDNR (Control)	6.48	6.39	6.93
Difference	4.11	3.13	3.54
Significance (P=0.05)	*	*	*

FDR=Floating debris removed and FDNR=Floating debris not removed. * Significant at the 5% level by paired t-test.

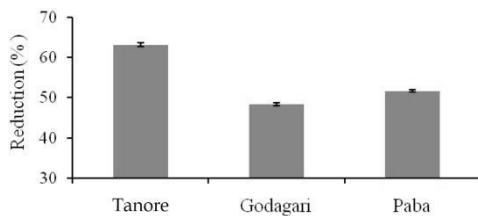


Fig. 4. Reduction of tiller infection in FDR plots over FDNR in different locations at maturity stage.

Table 4. Effect of removal of floating debris on sheath blight and yield of rice.

Treatment	Yield (t ha ⁻¹)		
	Tanore	Godagari	Paba
FDR	4.79	4.43	4.15
FDNR (Control)	4.18	4.14	3.80
Difference	0.61	0.29	0.35
Significance (P=0.05)	*	*	*

FDR=Floating debris removed and FDNR=Floating debris not removed. * Significant at the 5% level by paired t-test.

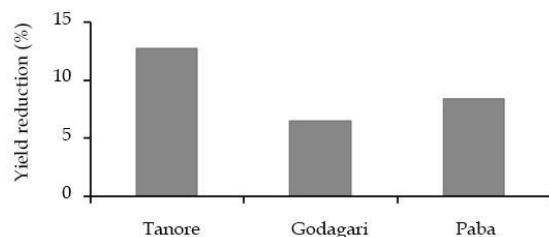


Fig. 5. Yield reduction in FDR plots over FDNR by sheath blight due to presence of floating debris at different locations.

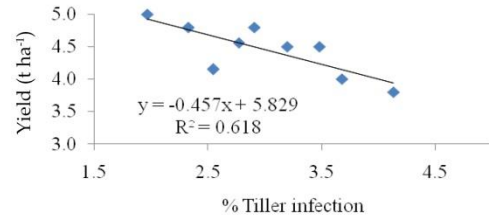


Fig. 6. Correlation between tiller infection at maturity stage and yield in FDR plot.

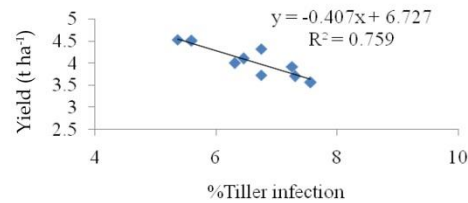


Fig. 7. Correlation between tiller infection at maturity stage and yield in FDNR plots.

CONCLUSION

The highest tiller infection was found in FDNR (Floating debris not removed) plots than that of FDR (Floating debris removed) plots in the fields. Removal of debris floating on the irrigation/rain water in the field after final land preparation (before transplanting) had significant impact on the lesser development of ShB disease. Yield of Gutiswarna was higher in FDR plot than that of FDNR plot at maturity stage. There was low incidence of ShB in FDR plots. Inoculum potential of sclerotia and mycelia associated with floating debris need to be assessed in the rice fields.

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