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EVALUATION OF DIFFERENT PLANTING METHODS AGAINST MAJOR DISEASES OF SELECTED *BORO* RICE VARIETIES

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ABSTRACT

The System of Rice Intensification (SRI), an innovation that was first emerged in Madagascar in the 1980s and has now diffused to more than 50 countries. The present study was conducted as field experiment in the central farm of Sher-e- Bangla Agricultural University (SAU) using RCBD design and the lab experiment was carried out in Molecular Biology and Plant Virology Laboratory under the Department of Plant Pathology, Sher-e-Bangla Agricultural University, Dhaka-1207. The experiment was carried out to adopt SRI as an alternative approach for management of major rice diseases in Bangladesh, during the period of November, 2020 to June, 2021. From the study it was revealed that all the selected planting methods gave the significantly effect on percent disease incidence (% DI) and severity (% DS) of major rice diseases viz. blast, brown spot, sheath blight and bacterial leaf blight in selected *Boro* rice varieties (BRRI dhan 28, BRRI dhan 89, BRRI dhan 92 and purple rice). The highest disease incidence and severity was recorded in conventional planting method and the lowest in basic SRI method. The moderate disease incidence and severity was recorded in modern SRI method which was statistically non-significant with Basic SRI method but significant with conventional method. However, it is necessary for further trial in different variety and AEZs as field experiment. So, it may be recommended that the System of Rice Intensification (SRI) may be alternative for management of major rice diseases.

Keywords: BLB, Elite Rice Varieties, Rice Blast, Sheath blight, SRI Method.

INTRODUCTION

The world population is rapidly increasing and approaching about seven billion and about half of them depend on rice as their staple food (IRRI, 2010). More than 90

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percent of the world's rice is produced and consumed in Asia where over half of the world population lives. Bangladesh is one of the most important rice growing countries in Asia where the crop is grown throughout the year in three seasons. Rice is the staple food of about 165.1 million people of Bangladesh (BBS, 2022). Rice sector contributes one-half of the agricultural GDP and one-sixth of the national income in Bangladesh.

According to FAO world rice production was about 509.87 million metric ton (M Ton) in 2021-22 whereas in the same time Bangladesh produces about 36 million metric ton rice. Average rice yield in Bangladesh is about 3.041 metric ton/ hectare (BBS, 2020) and world average yield is 4.4 metric ton/ hectare (FAO 2020). Our population is increasing and arable land is decreasing and we need to increase 2.7% production yearly. Objectives of Sustainable Development Goal (SDG) and 8th five years plan are to doubling agricultural productivity and ensure food security. There are many constraints in rice production in Bangladesh. Insect, pests and diseases are the important limiting factors of rice production in Bangladesh. So far in Bangladesh, about 31 diseases are recorded to occur in rice including 10 major diseases (Shahjahan et al., 1987).

SRI is a farming methodology aimed at increasing the yield of rice produced in farming. It is a low-water, labor-intensive method that uses younger seedlings singly spaced and typically hand weeded with special tools. SRI was developed in 1980's by Fr. Henri de Laulanié, S.J. and SRI was discovered by Prof. Dr. Norman Thomas Uphoff, CIIFAD, Cornell University, USA. It is just altering the management practice to make more productive phenotype from same genotype of rice. Artificial environment is created for growth and development of rice for exploitation of its genetic potentiality. It promotes the growth of root systems, increase the abundance and diversity of soil organism.

The System of Rice Intensification, which known as SRI methodology, it is an innovation in rice production systems by raising productivity of the land, labor, water and capital, particularly focus on water management in irrigation-based rice production (Uphoff et al., 2002). In this proposed study, we focus on adaptation of SRI methodology as an alternative approach for management of major biotic stresses of rice production in Bangladesh as well as limiting water use in rice production. The ultimate goal of the proposed study is to manage the abiotic and biotic stresses of rice in Bangladesh against the climate change effect, i.e., mitigation of climate change. The present study was carried out to achieve the following specific objectives; to manage the major biotic stresses of rice in Bangladesh by adaptation of SRI methodology as alternative treatments and to reduce the uses of chemicals (pesticides) and enhance the use of irrigated water efficiently.

MATERIALS AND METHODS

Experimental site and duration

The field experiment was conducted at central farm of Sher-e-Bangla Agricultural University and the lab experiment was done in Molecular Biology and Plant Virology Laboratory under the department of Plant Pathology.

Variety selection, seed collection and sprouting

Four rice varieties viz.; BRRI Dhan 28, BRRI Dhan 89, BRRI Dhan 92 and Purple Rice (Wild variety) were selected which are cultivated in *Boro* season in Bangladesh. Before sowing in seed bed, seeds were taken out from water and placed in four gunny bags in room temperature for 72 hours for sprouting. Before sowing in seed bed, seeds were taken out from water and placed in four gunny bags in room temperature for 72 hours for sprouting. After sprouting, seeds were sown in plastic trays. Plastic trays were placed in the net house.

Planting methods

The treatments of the experiment were three selected planting methods which are modern SRI method, basic SRI method and conventional method. Seedlings were uprooted from the seedbed and tray very carefully and transplanted in the experimental field. Transplantation was done having 2-3 leaves seedlings uprooted with soil very carefully from seedling trays. These seedlings transplanted in the selected plots in rows and only one seedling was placed per hill. Row to row distance and plant to plant distance were maintained 25 cm and 25 cm. In case of basic SRI method, 30 days old seedlings having 5-6 leaves raised in the seed bed were transplanted in the selected plots in rows and only one seedling was placed in per hill. Row to row distance and plant to plant distance were maintained 25 cm and 25 cm respectively. For conventional method 30 days old seedling having 5-6 leaves raised in the seed bed were transplanted in the selected plots. Three to five seedlings were placed in each hill and distance between row to row and plant to plant were maintained 20 cm and 15 cm respectively.

Water Management

Irrigation was given to maintain soil moisture near saturation initially and water was let in when surface soil develops hairline cracks. After completion of weeding the water was let out of the field. After the panicle initiation stage until maturity, one inch of water was maintained in the field until maturity.

Parameter Assessed

Parameters; disease incidence (%) and severity (%), plant height (cm), number of tiller $hill^{-1}$, number of panicle $hill^{-1}$, day of maturation (days), panicle length (cm), grain/ panicle, 1000 seeds weight (gm) and yield/ ha (ton) were assessed.

Assessment of percent disease incidence and severity

For recording the disease incidence and severity of major rice diseases. In total ten (10) hills were selected from each of the plot. Data were recorded on visual observation and on the basis of typical symptoms. In case of blast of rice, infected leave, node, and panicle were considered to record the percent disease incidence and severity. In case of brown spot, infected leaf and grain were observed to measure the percent disease incidence and severity. In case of sheath blight, infected leaf sheath was investigated to calculate percent disease incidence and severity of the disease at tillering and panicle initiation stage. In case of bacterial leaf blight, leave (leaf blade and flag leaf) were observed to measure at early morning and evening to measure percent disease incidence and severity. Percent disease incidence was estimated by using the following formula-

$$\text{Disease incidence (\%)} = \frac{\text{No. of infected hill or hill parts}}{\text{No. of inspected hill}} \times 100$$

Disease severity (%) was recorded by following IRRI recommended grading scale (0-5 scale of Standard Evaluation System for Rice) Horsfall and Barrett (1980) which is given below:

$$\text{Disease severity (\%)} = \frac{\text{No. of infected leaves/hill}}{\text{Total no of leaves/ hill}} \times 100$$

Parameters on yield and yield attributing

Each variety of rice was harvested at full ripening stage. Moreover, ten hills of each unit plot were selected randomly and harvested separately. Then thirty hills (As each variety consists three replication) from each variety were mix together for each treatments. Weights of harvested rice of each treatment were measured and mean weight was recorded. Yield per hectare was measured from yield per plot.

Isolation of pathogens

Fungi and bacteria were isolated from infected leaves following tissue planting method (Agrios, 2006). In case of bacterial gram staining test was performed for identification and characterization.

Data analysis

Collected data was input in excel sheet and data was analyzed using computer based software Statistix 10. Range test was performed through the co-efficient of variance test for LSD value.

RESULTS AND DISCUSSION

Effect of selected planting methods on the percent disease incidence and severity of major rice diseases in selected elite *Boro* rice varieties

Selected planting methods gave significant effect on disease incidence and severity of major rice diseases viz. blast, brown spot, sheath blight and bacterial leaf blight in selected *Boro* rice varieties. In BRRI dhan 28, the highest disease incidence (%) of blast, brown spot, sheath blight and bacterial leaf blight was recorded in conventional planting method (27.78, 53.33, 29 and 35 respectively) and the lowest percent disease incidence (23.33, 23.33, 15.55 and 23.33 respectively) was found in Basic SRI method (Fig. 1). The moderate disease incidence (25.33, 28.33, 24.94, and 23.33 respectively) was recorded in modern SRI method. The highest disease severity (%) of blast, brown spot, sheath blight and bacterial leaf blight in BRRI dhan 28 were recorded in conventional planting method (28.39, 51.1, 24.97 and 33.27 respectively) and the lowest % disease severity (14.73, 21.86, 17.6 and 27.00 respectively) were found in basic SRI method (Fig. 2). The moderate percent disease severity (18.85, 25.8, 22.24 and 16.42 respectively) was recorded in modern SRI method.

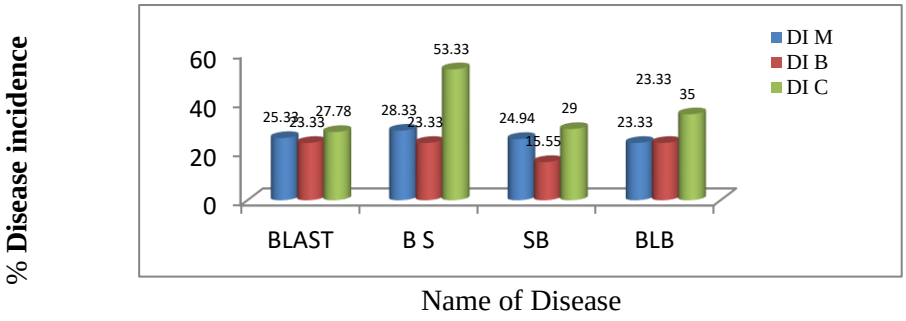

Figure 1. % Disease incidence of major rice diseases in BRRI dhan 28

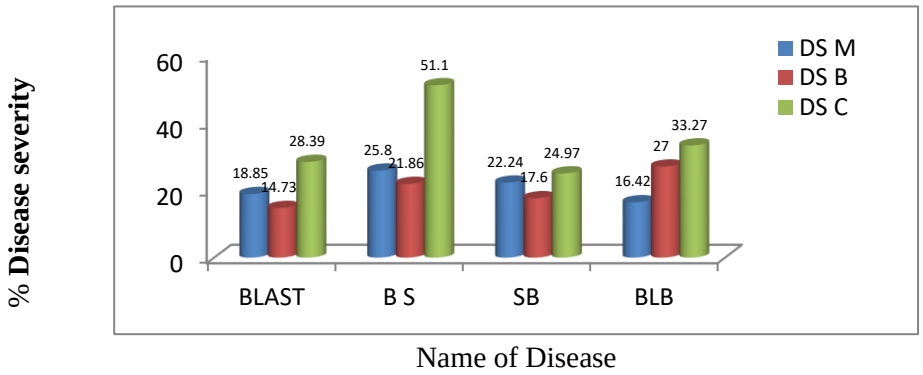

Figure 2. % Disease severity of major rice diseases in BRRI dhan 28

In BRRI dhan 89, the highest disease incidence (%) of blast, brown spot, sheath blight and bacterial leaf blight were recorded in conventional planting method (26.67, 36.67, 33 and 21.33 respectively) and the lowest % disease incidence (14.11, 16.67, 10.00 and 10.00 respectively) were found in Basic SRI method (Fig. 3). In modern SRI method, the disease incidence (%) was found higher than basic SRI method and lower as compare to conventional method (22.22, 20.32, 17.78 and 19.00 respectively). The highest disease severity (%) of blast, brown spot, sheath blight and bacterial leaf blight in BRRI dhan 89 were recorded in conventional planting method (18.6, 49.07, 18.09 and 27.16 respectively) and the lowest % disease severity (5.88, 10.75, 12.32 and 11.44 respectively) was found in basic SRI method (Fig. 4). The moderate % disease severity (10.86, 12.5, 10.99 and 11.28 respectively) was recorded in modern SRI method which was statistically non-significant with basic SRI method but significant with conventional method.

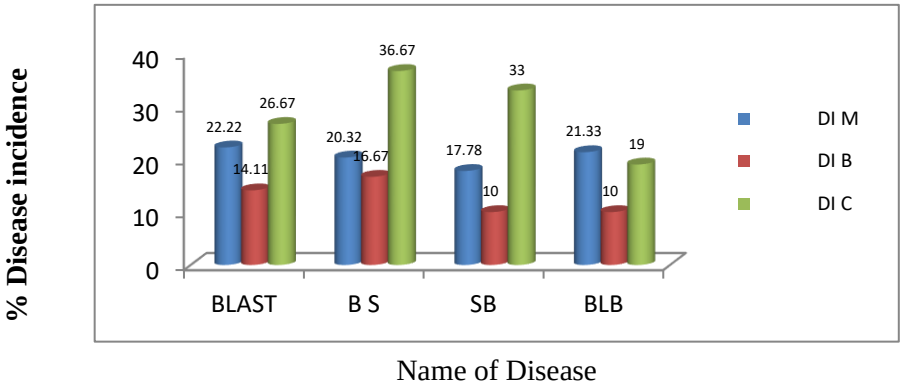

Figure 3. % Disease incidence of major rice diseases in BRRI dhan 89

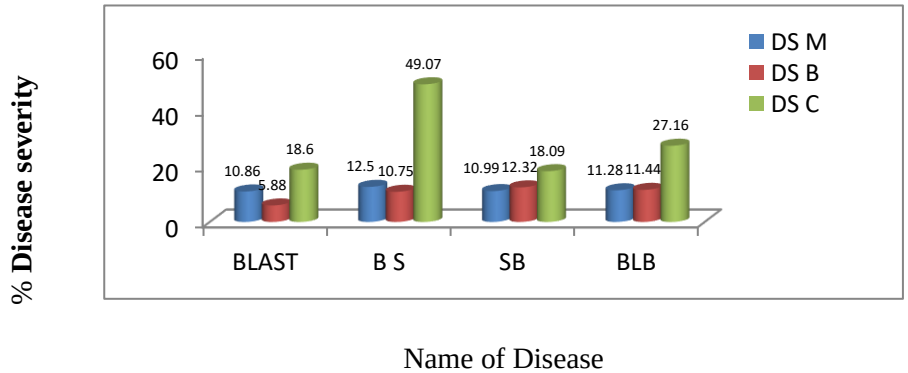

Figure 4. % Disease severity of major rice diseases in BRRI dhan 89

In BRRI dhan 92, the highest disease incidence (%) of blast, brown spot, sheath blight and bacterial leaf blight were recorded in conventional planting method (25.55, 43.33, 38 and 23.33 respectively) and the lowest % disease incidence (18.89, 22.22, 18.99 and 10.00 respectively) were found in Basic SRI method (Fig. 5). In modern SRI method, the moderate % disease incidence (24.44, 23.33, 24.44 and 16.67 respectively) was recorded which was statistically non-significant with basic SRI method and significant with conventional method. Highest disease severity (%) of blast, brown spot, sheath blight and bacterial leaf blight in BRRI dhan 92 were recorded in conventional planting method (22.34, 45.24, 26.39 and 34.71 respectively) and lowest % disease severity (16.57, 13.25, 14.76 and 13.65 respectively) were found in basic SRI method (Fig. 6). The moderate % disease severities (20.45, 15.20, 14.86 and 15.00 respectively) were recorded in modern SRI method.

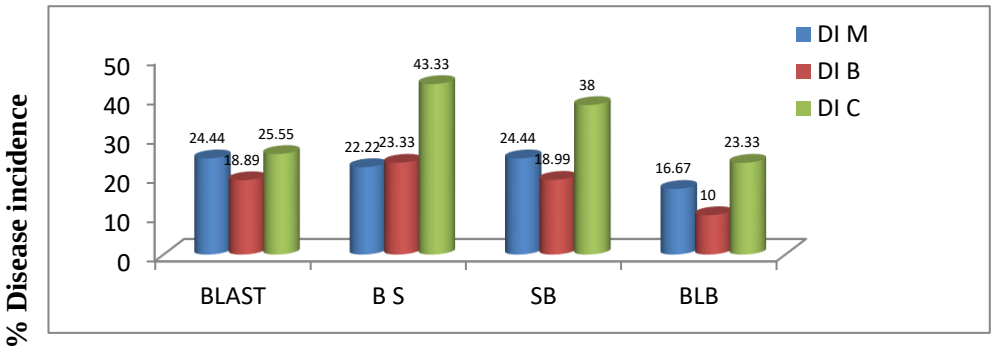

Figure 5. % Disease incidence of major rice diseases in BRRI dhan 92

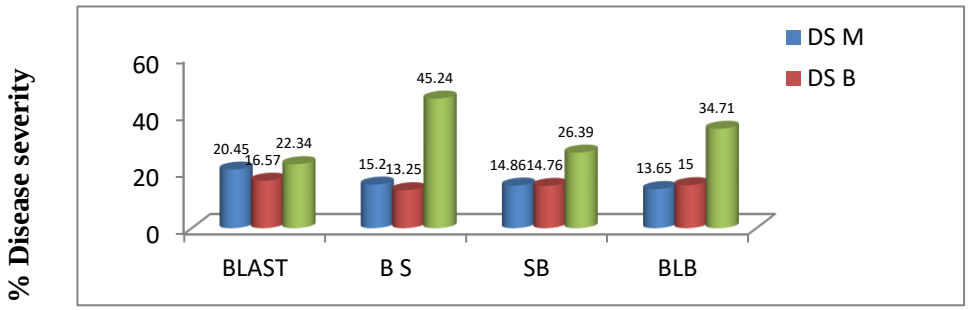

Figure 6. % Disease severity of major rice diseases in BRRI dhan 92

In case of Purple rice, the highest disease incidence (%) of blast, brown spot, sheath blight and bacterial leaf blight were found in conventional planting method (27.50, 30.00, 45.00 and 33.50 respectively) and the lowest disease incidence (%) (20.00, 16.67, 18.99 and 26.67 respectively) were found in basic SRI method (Fig. 7). In modern SRI method, the moderate % disease incidences (26.60, 23.33, 29.00 and 33.00 respectively) were recorded. Highest disease severity (%) of blast, brown spot, sheath blight and bacterial leaf blight in Purple rice were recorded in conventional planting method (30.52, 48.86, 29.67 and 38.24 respectively) and lowest % disease severity (16.61, 25.77, 18.44 and 24.40 respectively) were found in basic SRI method (Fig. 8). The moderate % disease severity (22.3, 22.61, 25.74 and 29.77 respectively) was recorded in modern SRI method.

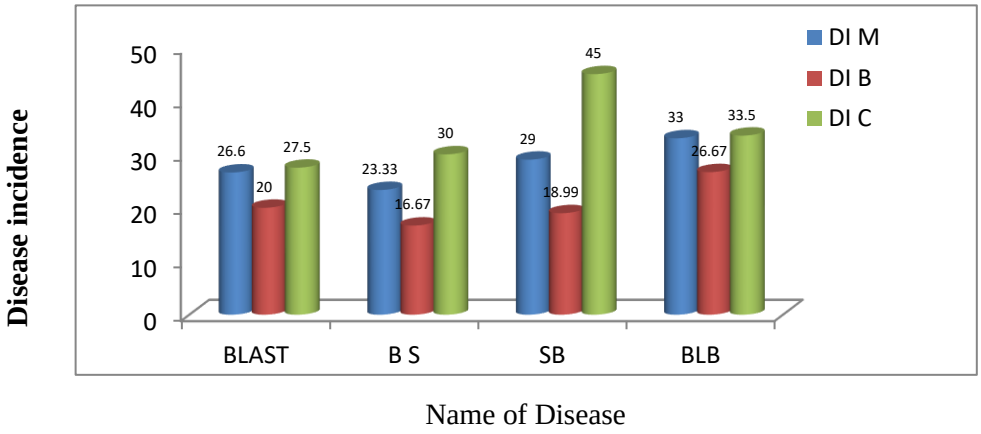

Figure 7. % Disease incidence of major rice diseases in Purple Rice

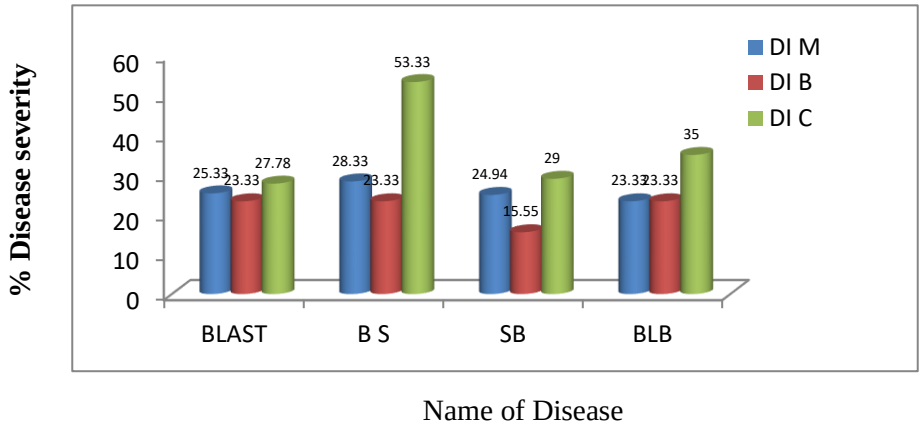

Figure 8. % Disease severity of major rice diseases in Purple Rice

From this study, it was revealed that the lowest disease incidence and severity of major diseases viz. blast, brown spot, sheath blight and bacterial leaf blight was recorded in basic SRI method as compare to conventional and modern SRI method in selected varieties used in this study. Disease incidence and severity interpreted not only the production but also the quality of grain yield. The expected output of the present study was to minimize the disease incidence and severity of the major rice diseases through adoption of SRI method. So, it is needed to use environmentally safe approaches to overcome the loss of grain yield in rice due to major diseases (Yeamin et al., 2016; Emerick et al., 2016). These transitions in agriculture are based upon a growing appreciation of agro-ecological principles that re-embed agricultural crops within the ecosystems in which they have emerged, inter dependent with the myriad of flora and fauna that have co-evolved with plants over hundreds of millions of years (Uphoff et al., 2002 & 2006).

Isolation and characterization of identified fungal pathogens and bacterium

All fungal pathogens were isolated, re-isolated and purified in potato sucrose agar (PSA) media. At initial stage, the rice blast pathogen, *Magnaporthe oryzae* was produced white mycelial growth and later on it turned into brown to black in colour. Initially, the brown spot pathogen, *Bipolaris oryzae* was produced dark brown mycelial growth and later on it turned into blackish. Causal organism of sheath blight, *Rhizictonia solani* was also isolated in PSA media. At early stage mycelial color was light brown and turn into dark brown at later stage and resting spores sclerotia were formed which mustard seed like and brown in color. Causal organism of bacterial leaf blight (BLB), *Xanthomonas oryzae* pv. *oryzae* was isolated in NA media and identified bacterium was characterized on the basis of colony and morphological structures. Results are presented in Fig. 9.

Results from the present study regarding characterization of causal agent match with some recent reports. Rice blast (causal organism, *Magnaporthe oryzae*) is a serious fungal disease that is threatening global food security (Shammy, 2018). Brown spot caused by the fungus, *(Bipolaris oryzae*) is one of the most prevalent rice diseases in the world where rice is grown (Groth and Hollier, 2016). Sheath blight is a soil borne disease caused by the fungus (*Rhizoctonia solani)* that occurs in areas with high temperature (28-32°C), high levels of nitrogen fertilizer, and relative humidity of crop canopy from 85-100%. This disease causes significant grain yield and quality losses. Yield losses up to 50% have been reported under most conducive environments. Bacterial leaf blight (BLB) is an important bacterial disease of rice caused by bacterium, *Xanthomonas oryzae* pv. *oryzae*.

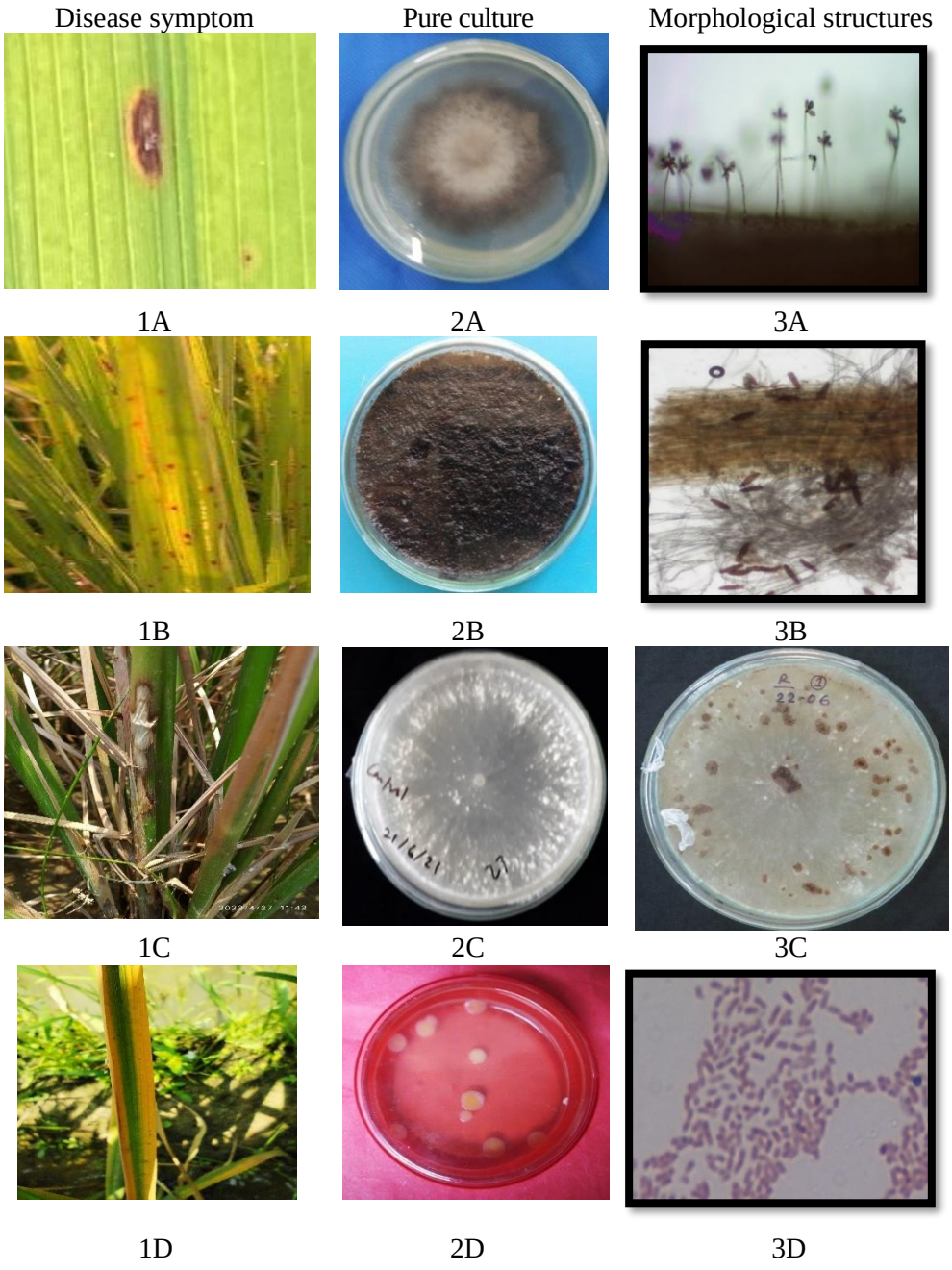

Figure 9. Morphological and cultural characterization of identified fungal pathogens. [{Blast of Rice, *Magnaporthe oryzae (1-3A)}*, *{Brown spot, Bipolaris oryzae (1-3B)}*, {Sheath blight, *Rhizictonia Solani (1-3C)}* and {Bacterial leaf blight, *Xanthomonas oryzae* pv. *oryzae*., (1-3D)}]

Effect of planting methods on growth and yield parameters in selected elite *Boro* rice varieties

In case of BRRI dhan 28, the highest plant height (100 cm) was measured in basic SRI method followed by modern SRI method (98 cm) and the lowest plant height (92 cm) was calculated in conventional method. In case of BRRI dhan 89, the highest plant height (106 cm) was recorded in modern SRI method while, the lowest plant height (97 cm) was found in conventional method which was statistically similar with basic SRI method (97 cm). In case of BRRI dhan 92, the highest plant height was found in conventional method (102 cm) and the lowest plant height was recorded in modern SRI method (100 cm) which was statistically similar with basic SRI method (100 cm). In case of Purple rice, the highest plant height was discovered in modern SRI method (96 cm) and the lowest plant height was recorded in conventional method (93 cm) which was statistically similar with basic SRI method (93 cm).

In case of BRRI dhan 28, the highest number of tiller was recorded in basic SRI method (18) followed by modern SRI method (15) and the lowest number of tiller per hill was recorded in conventional method (11). In case of BRRI dhan 89, the highest number of tiller was also recorded in basic SRI method (17) followed by modern SRI method (15) and the lowest number of tiller per hill was recorded in conventional method (13). Basic SRI Method dominated over other methods calculating number of tiller per hill in case of BRRI dhan 92 as well. In total, 18 tiller per panicle was found in basic SRI method which was the highest followed by modern SRI method (16) and the lowest was in conventional method (14). In case of Purple rice, the highest number of tiller per hill was recorded in basic SRI method (18) followed by modern SRI method (17) and the lowest number of tiller was recorded in conventional method (14).

In case of BRRI dhan 28, the highest number of panicle per hill was observed in basic SRI method (18) followed by modern SRI method (15) and the lowest number of panicle per hill was found in conventional method (11). In case of BRRI dhan 89, the highest number of panicle per hill was also recorded in basic SRI method (17) followed by modern SRI method (15) and the lowest number of panicle per hill was recorded in conventional method (13). In case of BRRI dhan 92, 18 panicle per hill was recorded in basic SRI method which was the highest followed by modern SRI method (16) and the lowest panicle per hill was recorded in conventional method (14). In case of Purple rice, the highest number of panicle per hill was found in basic SRI method (18) followed by modern SRI method (17) and the lowest number of panicle per hill was recorded in conventional method (14).

In case of BRRI dhan 28, the highest weight per plot was calculated in basic SRI method (4.58 kg) followed by modern SRI method (3.84 kg) and the lowest weight was found in conventional method (3.31 kg). The highest weight per plot also found in basic SRI method (4.90 kg) in BRRI dhan 89 followed by modern SRI method (4.47kg) and the lowest weight was recorded in conventional method (4.04 kg). In

case of BRRI dhan 92, the highest weight per plot was calculated in basic SRI method (4.94 kg) followed by modern SRI method (4.13 kg) and the lowest weight was found in conventional method (4.05 kg). In case of Purple rice, the highest weight per plot was found in basic SRI method (3.53 kg) followed by modern SRI method (3.40 kg) and the lowest weight was seen in conventional method (2.80 kg) (Table 1). Except weight of 1000 seeds, basic SRI method dominates over other methods and in conventional method those data was the lowest. Weight of 1000 seeds was almost same in all planting methods. We found maximum plant height (103.2 cm) in modern SRI method for BRRI Rice 89. All other growth and yield parameter was maximum in basic SRI method and minimum in conventional method. We also found maximum plant height (102.1 cm) in conventional method for BRRI Rice 92 but it did not make any contribution in yield. Rest parameters were higher in basic SRI method. Maximum plant height (96.4 cm) was observed in modern SRI method in purple rice followed by basic SRI and conventional method (93.8 cm and 93.5 cm respectively). But basic SRI method dominated in other yield contributing character over modern SRI and conventional method. There was a significant difference between basic SRI and conventional method in grain per panicle parameter. In basic SRI, 183 grain was produced in a panicle on an average whereas only 123 grain was produced in each panicle in conventional method.

Table 1. Yield and yield contributing parameters of in selected *Boro* rice varieties

Variety	Method	Plant height (cm)	Tiller No.	Panicle No.	Yield/ha (ton)
BRRI dhan 28	Modern SRI	98.2	15	15	6.4
	Basic SRI	100.2	18.1	18.1	7.63
	Conventional	92.8	11.4	11.4	5.52
BRRI dhan 89	Modern SRI	103.2	15.2	15.2	7.45
	Basic SRI	97.6	17.6	17.6	8.16
	Conventional	97.3	11.4	11.4	6.75
BRRI dhan 92	Modern SRI	100.6	16.2	16.2	6.88
	Basic SRI	100.7	18.3	18.3	8.23
	Conventional	102.1	14.3	14.3	6.75
Purple Rice	Modern SRI	96.4	17.3	17.3	5.67
	Basic SRI	93.8	18.2	18.2	5.88
	Conventional	93.5	14.1	14.1	4.67
	CV (%)	3.87	8.66	8.66	4.0

From the present study it was also found that yield and yield attributes were got higher compare to conventional method. SRI methods only enabled farmers and irrigation managers to reduce the water requirements of irrigated rice by 25-50 %, this is one of the important points for government, international agencies and environmental organizations to promote the adoption of SRI. It is an important characteristic of SRI method. In this study, water was irrigated in wet and dry alternative cycle of soil moisture and got maximum number of tiller than conventional method in all cultivated rice varieties. From the study it was revealed that in case of BRRI dhan 28, in total 18 tillers per hill was recorded in basic SRI method and only 11 tiller was found in conventional method. Same results were found in BRRI dhan 89, BRRI dhan 92 and Purple rice. Technological change in agriculture drives much of the structural transformation that defines the process of economic development in low-income agrarian nations (Gollin et al., 2002). SRI can fulfill all these demands. It does not need much cost than conventional method though it is seems one more labor is required here. Basically, it's a method of management of major rice disease by alternate method along with production enhancement. So, this method should be accepted by the rice producers. SRI is an environmentally friendly technology. As minimum disease incidence and severity occurred here compare to conventional method, less pesticide is required here to spray. That's why SRI is an environment friendly technology.

CONCLUSION

From this study, it can be concluded that basic SRI is the best planting method for the management of major rice diseases in Bangladesh along with adoption to climate change for selected *Boro* rice varieties. We found minimum disease incidence and minimum diseases severities in basic SRI method compare with modern SRI and conventional method. Moreover, maximum yield was recorded in basic SRI method for all four selected *Boro* rice varieties compare with other planting methods. Although it was the first study here in Bangladesh in plain land, SRI method was used as an alternative for management the major rice diseases, which correlated with research that took place in Madagascar.

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