



Assessing the Effectiveness of Newly Developed Fungicides in Managing Rice Blast Disease

Sumaya Akter¹, Md. Mahbubul Haque², Jannatul Farhouse³, Nipa Rani Paul⁴, Ismat Ara⁵ and Md. Ibrahim Khalil⁶

^{2,3,4,6} Plant Pathology Division, Bangladesh Institute of Nuclear Agriculture (BINA), Mymensingh-2202, Bangladesh

^{1 & 5} MS student, Bangladesh Agricultural University, Mymensingh, Bangladesh

*Correspondence: mahbub.bina@gmail.com; Phone: +8801712343820

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Abstract: Rice blast, which is caused by the fungus *Magnaporthe oryzae*, is a highly destructive disease that poses a significant threat to rice cultivation. It results in considerable crop damage, affecting both the yield and quality of rice. This makes rice blast a major concern for farmers and a significant issue in terms of food production. These studies were carried out at Bangladesh Institute of Nuclear Agriculture (BINA), Mymensingh with the aim to manage rice blast disease by means of different fungicides under in-vitro and field conditions. In-vitro bioassay of six chemical fungicide(s) viz. Amister top 325SC, Seltima, Nativo 75 WG, Filia 525 SE, Avalon 27SC and Trooper 75 WP was done against *Magnaporthe oryzae* following poison food technique in the Plant Pathology Lab of BINA. The maximum mycelial growth inhibition (73.43%) of *Magnaporthe oryzae* was obtained by Avalon 27SC (Picoxystrobin 6.70%+ Tricyclazole 20.33%), Nativo 75WG (Tebuconazol 50% + Trifloxistrobin 25%) and Seltima (Pyrachlostrobin 10%) at 0.0125% concentrations and 100% growth inhibition was obtained by all the six fungicides at 0.1% and 0.5% concentrations. In vivo evaluation of five fungicides viz. Amister top 325SC, Seltima, Nativo 75 WG, Filia 525 SE and Avalon 27SC against rice blast was carried out in research plot of the Plant Pathology of BINA. From the result, it was concluded that all the fungicides were effective in controlling leaf blast but Avalon 27SC (Picoxystrobin 6.70%+ Tricyclazole 20.33%) @ 0.2% was more effective among other fungicides, showing least leaf blast severity mean at three time interval (1.00, 1.33 and 1.46), least incidence (11.90%, 15.08%, 16.67%), and the highest grain yield (7.58 t ha⁻¹).

Keywords: Control; Disease; Fungicides; *Magnaporthe oryzae*; Rice blast; Severity.

INTRODUCTION

Rice (*Oryza sativa* L.) is a major staple food crop for half of the world's population. It provides 21% of global human per capita energy and 15% per capita protein (Akter et al. 2019). The rice sector contributes one-half of the agricultural GDP and one-sixth of the national income in Bangladesh, which is accounting for nearly 11.63 percent of gross domestic production. Bangladesh produces 37.8 million tons of rice with seven-million tons surplus where the domestic needs were 29.1 million tons in 2019 (FAO, 2021). Rice is reported to be attacked by more than 70 different diseases caused by various fungi, bacteria, viruses or nematodes (Zhang et al., 2009), where in Bangladesh rice is subjected to attack by 32 diseases (Kabir et al. 2015). Among them, rice blast caused by *Magnaporthe oryzae*, a

fearsome fungal disease in Bangladesh. The blast is one of the most devastating diseases in rice growing regions of the world, is responsible for 11-15% yield loss annually. Also, after severe damage to paddy may lead to a sharp decline in production in the year 2017. Bangladesh Rice Research Institute (BRRI) assumes that over 5,000 hectares of Boro cropland in southern, mid-northern and northern regions were damaged by the neck blast attack (BRRI, 2019). The incidence of rice blast was recorded on Boro season (November to May: irrigated ecosystem) and transplanted Aman (July to December: rainfed ecosystem) in all over Bangladesh. The government of Bangladesh is taking initiative to the extension of the Aus coverage.

It means rice is grown with intensive care throughout the year. Thus, the popular varieties are getting susceptible to some pest and diseases. Even the pests are getting the

opportunities to change their races for better adaptation. At present 267 races of rice blast have already been identified in our environment. Thus, disease pressure is in increasing trend and may be a devastating experience in the near future. This phenomenon is not for Bangladesh but for the other 85 countries where rice is grown. As a result, the pests of rice also sustain everywhere. Hence, rice blast is considered as a serious and recurrent problem in many of rice growing countries. The blast is a trans-boundary disease, travels through the air from one region to the other, one country to another country (Daily Sun, 2017). Infected seed also act as a carrier too. The favorable weather is low night temperature (conversely higher day temperature), unusually windy and foggy weather in the morning and dew on the leaf, drizzle etc. The drizzle brings down the spores (seeds of fungi able to grow as new fungi) on the leaf, node or on panicles. No sooner a spore drops on the rice plant it starts growing to produce conidiophore and conidium (asexually produced spore) within 3-4 days. Within 7-10 days it starts growing millions of spores if favorable conditions prevail to cause a devastating impact on the rice crop. The intensity of the disease depends on the weather, the tolerance ability of a variety. The aromatic variety and the variety with sticky cooked rice are more susceptible to the disease than the ordinary variety. The crop might get susceptible due to nutritional imbalance i.e., excess nitrogen and low potassium. Inequity water supply to crops is a key factor to enhance the disease as well (Rahman, 2017). The pathogen might attack at any of the growth stages of the rice plant from seedling to the pre-maturity stage of the crop. A recent report says that the fungi are able to infect the root system also. The disease gets the name as per the affected organ of the plant (Sultana et al., 2019). If the leaf is affected, the disease is called leaf blast, if a node, then it is called node blast, accordingly, neck-blast (neck- first node of panicle), panicle blast etc. The symptom varies with the organs affected. The *P. oryzae* is a seed-borne pathogen and can over-winter within plant debris, rice stubbles and also survive with the alternate host (Hubert et al., 2015; Pak et al., 2017). Disease severity is very much influenced by environmental factors and climatic changes. This blast pathogen might attack any of the growth stages of the rice plant from seedling to the premature stage of the crop. But leaf blast, node blast and neck blast, three different symptoms are observed in the affected organ of the infected rice plant. Leaf blast is characterized by eye-shaped spots on the leaves, neck and node blast are by their certain kind of necrosis. Node infection includes infected nodes appearing black-brown and dry and often occurs in a banded pattern.

This kind of infection often causes the culm to break. The neck blast infects the panicle causing failure of the seeds to fill or causing the entire panicle to fall over as it is rotted. Infections of the necks can be very destructive and directly reduces the economic value of the produce. The lesions are often greyish brown discoloration of the branches of the panicle and over time, the branches may break at the lesion. Out of three symptoms, neck blast is more destructive (Prasad et al., 2011). In Bangladesh the

frequency of blast occurrence has increased with invasion into new areas (north and northwest part of the country) in recent years. The BRR1 dhan29 and BRR1 dhan28 are the most popular and mega varieties recognized highly susceptible to blast disease (Anonymous, 2011). Moreover, all local and improved aromatic rice varieties grown in wet season are vulnerable to neck blast. The rice blast has the ability to change its race for its existence. Accordingly, a tolerant rice variety may lose the potentiality to tolerate to the new race of fungi. The frequency of neck-blast in rice plant is so prompt that a farmer could hardly recognize the symptom prior to the damage. Even they have suggested to spraying appropriate fungicide from Tricyclazole group during late booting to flowering stage of course in the afternoon. Unfortunately, farmers are failed to follow the instruction properly. Since neck blast of rice is increasingly destructive in grain production, ways to controlling the disease need to be developed resistant varieties are required to stabilize seed production. But it's very difficult, laborious, costly and time consuming to develop a resistant variety against this disease. On the other hand, various cultural and biological control methods are not effective in field conditions due to infestation of various alternate host and climatic condition in the growing season. Though production costs, the chance of environmental pollution and health hazards are high in chemical fungicides but chemical control of blast disease has become very much popular all over the world. In order to reduce losses caused by blast, farmers have utilized both seed treatments and foliar sprays with fungicides. (Chaudhary and Sah, 1998; Chaudhary, 1999; Balgude and Gaikwad, 2019). From the last decade, Nativio and Trooper fungicides belong to Tebuconazole + Trifloxistrobin and Tricyclazole groups were identified as most effective against blast but these are expensive fungicides for the growers in Bangladesh (Sultana, 2020). In order to battle *Magnaporthe oryzae*, the performance of a few selected fungicides that are currently on the market has been assessed, along with their effective doses and spray frequency, in both in-vitro and field settings. The current study project was undertaken with the aforementioned facts in mind in order to determine the comparative efficiency of different foliar fungicides for the management of rice blast disease.

MATERIALS AND METHODS

Study area: Experimental site and climate

Conducted a study on the blast disease of rice (*Oryza sativa* L.) caused by *Magnaporthe oryzae*. The study aimed to assess the effectiveness of several new fungicides and their optimal doses for controlling rice blast disease in both laboratory and field conditions.

Laboratory experiment

Isolates of *Magnaporthe oryzae* were obtained from the Plant Pathology Division of Bangladesh Institute of Nuclear Agriculture (BINA), Mymensingh. For the re cultivation, a sterile block cutter was used to transfer a roughly standard amount of fungus to the middle of a brand-new PSA plate. All isolates were developed for 10

days under ideal incubation conditions. To obtain a pure culture that was utilized for inoculation, a fungal stock was sequentially cultured five to seven times. To obtain a pure culture, immunization was performed using stock culture. During this time, the incubation temperature was 24°C, and UV light and darkness alternated for 12/12 hours. Pure culture materials were carefully sterilized before usage. For the in vitro inhibition test, six distinct fungicides were employed, each with four distinct concentrations. The concentrations were determined based on the recommended dosage for each fungicide (Table 1). The average of two diameters at right angles to one another was measured after 10 days to determine the rate of radial mycelial growth.

Field Experiment

The field trials for this study were conducted on a suitable piece of land belonging to the Plant Pathology Division of the Bangladesh Institute of Nuclear Agriculture (BINA) in Mymensingh. The experimental field had a silty-loam texture and was well-drained, medium high land. The rice variety used for the experiment was Binadhan-18, which is a moderate duration and high-yielding boro rice variety that was released in 2015 and is susceptible to blast disease. Eighteen plots were used in the experiment, each measuring 2 m x 1 m and consisting of 13 rows with a crop

Calculating the average mycelial growth required three replications of the same methods. The effectiveness of the fungicides was then determined using the formula (Dubey et al.,2005) to compute the percent growth inhibition.

$$\text{Growth inhibition (\%)} = \frac{(C-T)}{C} \times 100$$

Where, C= control plate, T = Mean mycelial growth in treated plate. The experiment was carried out using a completely randomized design (CRD), with each treatment having three replicates. The data gathered was analyzed using Statistix10.

geometry of 20 cm x 20 cm. Each row contained 15 hills, and three seedlings were planted in each hill. The experimental field was fertilized according to the recommended dose in the Fertilizer Recommendation Guide (BARC, 2012) using chemical fertilizers. To evaluate the effectiveness of various fungicides on reducing the incidence and severity of rice blast disease and improving yield-contributing factors, five top-performing fungicides from different chemical groups were utilized in the field study. Six treatments, including a control, were implemented in the experiment, as shown in Table 2.

Table 1. List of fungicides used in the laboratory experiment along with their active ingredients.

| Treatment | Fungicide name | Company Name | Active ingredient | Concentration |
|-----------|-------------------|----------------|---|--------------------------------|
| T1 | Amister top 325SC | Syngenta | 200 g/l azoxystrobin + 125 g/l difenoconazole | |
| T2 | Seltima | Semco | Pyrachlostrobin 10% | |
| T3 | Nativo 75 WG | Bayer | Tebuconazole 50%+ Trifloxystrobin 25% WG | |
| T4 | Filia 525 SE | Syngenta | Propiconazole (12.5%) + Tricyclazole (40%), | |
| T5 | Avalon 27SC | Auto Crop Care | Picoxystrobin 6.70%+ Tricyclazole 20.33% | 0.0125%, 0.025%, 0.1% and 0.5% |
| T6 | Trooper 75 WP | Auto Crop Care | Tricyclazole (75%) | |
| T7 | Control | | Only PDA medium | |

Table2. Fungicides evaluated under field condition against rice blast

| Treatment | Trade Name | Company Name | Treatment combination | Concentration |
|-----------|------------------------|----------------|---|---------------|
| T1 | Amister top 325SC | Syngenta | 200 g/l azoxystrobin + 125 g/l difenoconazole | 2mL/L of H2O |
| T2 | Seltima | Semco | Pyrachlostrobin 10% | 2mL/L of H2O |
| T3 | Nativo 75 WG | Bayer | Tebuconazole 50%+ Trifloxystrobin 25% WG | 2g/L of H2O |
| T4 | Filia 525 SE | Syngenta | Propiconazole (12.5%) + Tricyclazole (40%), | 2mL/L of H2O |
| T5 | Avalon 27SC (proposed) | Auto Crop Care | Picoxystrobin 6.70%+ Tricyclazole 20.33% | 2g/L of H2O |
| T6 | Control | | | |

Once the plots were prepared, 30-day-old seedlings were transplanted into the well-prepared puddle field plots. Intercultural operations were carried out to ensure and maintain normal growth and development of the rice plants, and weeding was conducted three times while irrigation was performed as needed. In this study, fungicide solutions were sprayed twice on the 18 plots, starting from the panicle stage. The first spray was administered at 45 days after transplanting (DAT) during the late tillering stage, and the second spray was given seven days after the first spray at 52 DAT (Kabir et al., 2004). The remaining three plots were used as the control for this experiment. To assess the incidence and severity of rice blast disease, each plot was examined, and affected plants from each unit plot were selected. Typical blast symptoms on the leaf and neck region of the infected plant were observed, and data were recorded at two-time points: 52 DAT (7 days after the first spray) and 59 DAT (7 days after the second spray). The percentage of disease incidence was calculated using the

Table 3. Disease scoring scale for leaf blast of rice caused by *Magnaporthe oryzae* (Source: IRRI, 2013)

| Score | Description | Host Behavior |
|-------|--|----------------------|
| 0 | No lesions observed | Highly Resistant |
| 1 | No lesions, or small brown specks of pinhead size (0.1-1.0mm), less than 1% leaf area affected | Resistant |
| 2 | Typical blast lesions covering 1-5% leaf area covered | Moderately Resistant |
| 3 | 6-10% leaf area covered by typical blast lesions | Moderately Resistant |
| 4 | 11-20% leaf area covered by typical blast lesions | Moderately Resistant |
| 5 | 21-30% leaf area covered by typical blast lesions | Moderately Resistant |
| 6 | 31-40% leaf area covered by typical blast lesions | Susceptible |
| 7 | 41-50% leaf area covered by typical blast lesions | Susceptible |
| 8 | 51-75% leaf area covered by typical blast lesions | Highly Susceptible |
| 9 | Typical blast lesions covering >75% leaf area or all the leaves dead | Highly Susceptible |

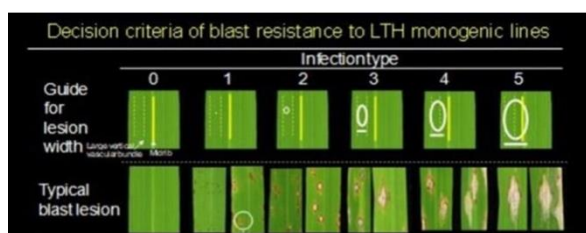


Figure 1: Scale for assessing disease severity for rice blast disease (Source: Goto and Yamanaka, 1968, Mackill and Bonman, 1992).

Data were collected on several yield-contributing parameters, including plant height, the number of total tillers per hill, the number of effective tillers per hill, the number of non-effective tillers per hill, the number of infected panicles per hill, the number of non-infected panicles per hill, and the weight of 1000 grains. The experiment was designed using a randomized complete

formula of Rajput and Bartaria (1995). The severity of the disease on foliage was observed and recorded using a 0-9 scale (SES, IRRI, 2013, Table 3) before and 15 days after the first and second spray applications. An observation on the incidence of neck blast was made after the second application of treatments, i.e., 75 days after transplanting, by selecting 10 hills from each plot.

No. of infected plants

Disease incidence (%) = $\frac{\text{Total no. of plants}}{\text{Total no. of plants}} \times 100$

The disease severity of naturally infected rice plants in 36 plots was evaluated using a disease severity scale based on Mackill and Bonman (1992). The severity of the disease was measured at two-time points, 52 and 59 DAT, which were seven days after the spray application. The crop was harvested plot-wise on November 15, 2018, at a time when approximately 80-85% of the grains had become straw-colored.

block design (RCBD) with three replications. The collected data on various parameters were subjected to statistical analysis using the Analysis of Variance (ANOVA) technique to determine the level of significance. The treatment means were compared using Duncan's Multiple Range Test (DMRT) at a 5% level of significance. The Statistix10 statistical package was used for data analysis.

RESULTS

Confirmation and Development of a pure culture of *Magnaporthe oryzae*

The process of re-culturing the *M. oryzae* isolate BD 576 involved several steps to ensure the growth of healthy colonies. First, the stock culture was transferred to OMA plates to provide a suitable growth medium. Next, the colonies were observed for morphological features that are characteristic of *M. oryzae*, such as the pear-shaped conidia. Once the identity of the fungus was confirmed, slides were prepared from the colonies to further analyze the morphology. A sterilized block cutter was used to transfer a standard amount of fungal material to a fresh OMA plate,

which was then incubated under optimal conditions for 10 days. This process was necessary to ensure that the fungus remained healthy and viable for subsequent experiments.

Effect of fungicides on radial mycelial growth of *Magnaporthe oryzae*

The study aimed to investigate the effect of five selected fungicides (Avalon 27SC, Nativo 75 WG, Seltima, Trooper 75 WP, Filia 525 SE, and Amister top 325 SC) on the radial mycelial growth and disease incidence and severity of rice blast caused by *P. oryzae*. The in vitro experiment showed that 100% mycelial growth inhibition occurred in plates containing 0.0125%, 0.025%, 0.05%, and 0.1% concentrations of Avalon 27SC, Nativo 75 WG, Seltima, Trooper 75 WP, Filia 525 SE, and Amister top 325 SC fungicides. Control plates and plates containing Blitox 50 WP, Feyasta Z-78, and Bounty 36WP showed the maximum radial mycelial growth. Moreover, the results of percent growth inhibition showed that Avalon 27SC was the most effective in inhibiting the growth of *P. oryzae* followed by Nativo 75 WG and Seltima. However, Trooper 75 WP, Filia 525 SE, and Amister top 325 SC were less effective in inhibiting the growth of *P. oryzae*. In the field experiment, the five selected fungicides were evaluated for disease incidence and severity. The results showed that Avalon 27SC, Nativo 75 WG, Seltima, Trooper 75 WP, Filia 525 SE, and Amister top 325 SC fungicides had varying efficacy against rice blast disease. The study also observed the effect of different concentrations of fungicides on the radial mycelial growth of *P. oryzae*, and the results showed that the higher concentrations of fungicides were more effective in inhibiting the mycelial growth of *P. oryzae*.

Effect of foliar spray of fungicides on the yield contributing parameters of rice

The field experiment showed significant differences in various yield parameters between treated and control plots. T2 (Seltima) treated plots showed the maximum plant height of 99.27cm, followed by T1 (Amister top 325SC) and T5 (Avalon 27SC) treated plots. However, the minimum plant height of 91.33 cm was recorded in T4 (Filia 525 SE) followed by T3 (Nativo 75 WG) treated plots. T5 (Avalon 27SC) treated plots recorded the maximum number of total tillers (14.33), effective tillers (9.67), non-infected panicles (9.67) and zero infected panicles per hill, followed by T3 (Nativo 75 WG) and T4 (Filia 525 SE) treated plots. T1 (Amister top 325SC) treated plots recorded the minimum total tillers (9.67), effective tillers (8.67), non-infected panicle (8.67) and zero infected

panicle per hill. The weight of 1000 seeds of rice showed non-significant differences under different treatments, ranging from 26.50 to 28.35g. T3 (Nativo 75 WG) treated plants showed the maximum weight of thousand seeds (28.35g) followed by T₁ (Amister top 325SC) treated plots. The control plots showed the lowest weight of thousand seeds (9.42g). The highest yield was obtained from T2 (Seltima) followed by T5 (Avalon 27SC), while the lowest yield was obtained from T6 (Control) followed by T3 (Nativo 75 WG). These findings indicate that the use of certain fungicides can significantly improve yield parameters in rice crops affected by *P. oryzae*.



Figure 2. Pure culture of *Magnaporthe oryzae* (10 days old) and Conidia of *Magnaporthe oryzae* under microscope

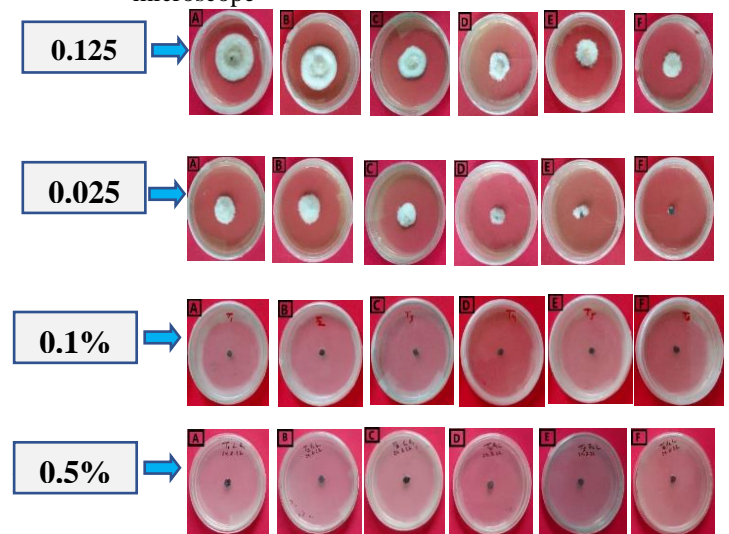


Figure 3. Radial mycelial growth status of *Magnaporthe oryzae* on OMA plates under different concentrations

Table 4: Mycelial growth and percent mycelial growth inhibition of *M. oryzae* on PDA plates containing 0.0125% of different fungicide(s)

| Name of the fungicides | Mycelial growth (cm) at 10 DAI | % inhibition of mycelia growth over control |
|------------------------|--------------------------------|---|
| T1 (Amister top 325SC) | 1.60 c | 54.29 |
| T2 (Seltima) | 1.03 d | 70.48 |
| T3 (Nativo 75 WG) | 0.94 d | 72.95 |
| T4 (Filia 525 SE) | 1.91 bc | 45.33 |
| T5 (Avalon 27SC) | 0.93 d | 73.43 |
| T6 (Trooper 75 WP) | 2.00 b | 42.86 |
| T7 (Control) | 3.50 a | - |
| LSD (0.05) | 0.3778 | |
| CV (%) | 7.95 | |
| SEM (+/-) | 0.1106 | |

Table5. Mycelial growth and percent mycelial growth inhibition of *M. oryzae* on PDA plates containing 0.025% of different fungicide(s) separately over control.

| Name of the fungicides | Mycelial growth (cm) at 10 DAI | % inhibition of mycelia growth over control |
|------------------------|--------------------------------|---|
| T1 (Amister top 325SC) | 0.90 bcd | 74.29 |
| T2 (Seltima) | 0.91 bc | 73.91 |
| T3 (Nativo 75 WG) | 0.34 d | 90.19 |
| T4 (Filia 525 SE) | 1.04 bc | 70.09 |
| T5 (Avalon 27SC) | 0.40 cd | 88.57 |
| T6 (Trooper 75 WP) | 1.23 b | 64.86 |
| T7 (Control) | 3.50 a | |
| LSD (0.05) | 0.5291 | |
| CV% | 13.57 | |
| SEM (+/-) | 0.146 | |

Table 6: Effect of fungicides on disease incidence and severity of rice blast

| Treatments | Disease incidence % (leaf blast) | | | Disease Severity (0-9) | | | Disease incidence % (neck blast) (75 DAT) |
|------------------------|----------------------------------|-----------------|--------|------------------------|-------------------------|-------------------------|---|
| | After 1st spray | After 2nd spray | 2nd | Before spray | 15 days after 1st spray | 15 days after 2nd spray | |
| T1 (Amister top 325SC) | 17.86bc | 25.79bc | 1.00b | 1.86b | 1.93cd | 26.98b | |
| T2 (Seltima) | 22.36b | 26.58b | 1.33b | 1.60bc | 2.20bc | 30.95b | |
| T3 (Nativo 75 WG) | 21.82b | 23.01bc | 1.33b | 1.66bc | 2.40bc | 26.19b | |
| T4(Filia 525 SE) | 23.01ab | 23.01bc | 1.00b | 1.40c | 2.46b | 27.38b | |
| T5(Avalon 27SC) | 11.90c | 15.08 | 1.00b | 1.33c | 1.46d | 16.67c | |
| T6 (Control) | 29.36a | 50.39a | 2.00a | 2.73a | 3.33a | 99.20a | |
| LSD (0.05) | 6.68 | 10.99 | 0.63 | 0.3515 | 0.5314 | 8.0553 | |
| CV % | 17.46 | 22.11 | 27.36 | 10.94 | 12.7 | 11.68 | |
| SEM (+/-) | 2.12 | 3.4876 | 0.2018 | 0.116 | 0.2385 | 2.5564 | |

Table 7: Effect of different fungicides on yield and yield contributing characters of rice

| Fungicide | Plant height (cm) | No. of total tiller /hill | No. of effective tiller/ hill | No. of Infected panicle | No. of Non-infected panicle | 1000 grain weight | Yield (t/ha) |
|------------------------|-------------------|---------------------------|-------------------------------|-------------------------|-----------------------------|-------------------|--------------|
| T1 (Amister top 325SC) | 99.2a | 9.6c | 8.6bc | 0b | 8.66bc | 27.36a | 7.52a |
| T2 (Seltima) | 99.2a | 10.6c | 9.3abc | 0.33b | 9.33abc | 27.02a | 7.58a |

| | | | | | | | |
|-------------------|--------|--------|--------|--------|--------|--------|--------|
| T3 (Nativo 75 WG) | 92.4b | 14ab | 10.6a | 0.66b | 10.66a | 28.35a | 6.10b |
| T4 (Filia 525 SE) | 91.3b | 11bc | 8c | 1ab | 8c | 27.12a | 7.12ab |
| T5 (Avalon 27SC) | 98.8a | 14.3a | 9.6ab | 0b | 9.66ab | 26.85a | 7.54a |
| T6 (Control) | 99.3a | 15a | 10ab | 2a | 10ab | 26.50a | 4.43c |
| LSD (0.05) | 3.9355 | 3.3326 | 1.356 | 1.2864 | 1.356 | 2.4352 | 1.2418 |
| CV % | 2.24 | 14.72 | 7.94 | 106.07 | 7.94 | 4.92 | 10.16 |
| SEM (+/-) | 1.248 | 1.05 | 0.4303 | 0.4082 | 0.4303 | 0.7728 | 0.3941 |

DISCUSSION

According to the results of in vitro study, Rice blast (*Magnaporthe oryzae*), which is responsible for over 30% of the world's lost rice production and could feed 60 million people, is a major worry in the fight against global food insecurity. These losses lower consumer welfare and food security while also raising the price of rice globally (Rossman et al., 1990). The fungus *Magnaporthe oryzae* is the source of the common and harmful illness known as "rice blast," which affects farmed rice. It is the most destructive pathogen of rice worldwide. Around 50% of production may be lost in a field moderately affected by infection (Devi & Sharma, 2010). It is estimated that each year enough of rice is destroyed by rice blast alone to feed 60 million people (Zeigler et al., 1994). Although rice blast is a disease that is widely known in Bangladesh, in recent years, rice blast, a particularly dangerous fungal disease, has caused production losses of up to 70 to 80% in Bangladesh (Simkhada, 2022). It is required to identify an efficient control measure to solve this issue. The main focus of the current research is how fungicides, particularly with the novel combinations that are on the market, can be utilized to control this disease in Bangladesh. The current study's findings showed that fungicides containing Picoxystrobin 6.70%+ Tricyclazole 20.33%, Tebuconazole 50%+ Trifloxystrobin 25% WG, and Pyrachlostrobin 10% were more effective at controlling *Magnaporthe oryzae* than fungicides containing Tricyclazole 75%, Propiconazole 12.5%+ Tricyclazole 40%, and 200 g/L azoxystrobin + 125 g. These results are consistent with those of Surapu et al. (2017), who found that Tricyclazole completely inhibited growth at 800 ppm and at a maximum of 600 ppm under in vitro conditions. Sultana R. (2019) found that Trifloxystrobin 25% + Tebuconazol 50%, Tebuconazol, Hexaconazol, Mancozeb, Zineb 68%+ Hexaconazole 14% and Carbendazim containing fungicides were more effective in controlling *P. oryzae* compared to Tricyclazole, Metalaxyl, Zineb, Pyraclostrobin, Metiram, Copper oxychloride containing fungicides. Joshi and Mandokhot (2002) conducted a field trial to determine the efficacy of Tricyclazole at different concentrations for controlling blast of rice. Tricyclazole was discovered to be the best of these at three doses (0.12, 0.06, and 0.05%). Our results are consistent with those of Neelakanth et al. (2017), who found that tricyclazole and trifloxystrobin + tebuconazole were both 100% effective at inhibiting the growth of *P. oryzae* mycelium. According to research by Akhilesh et al. (2017), Tebuconazole+Trifloxystrobin (50%+25%) WG (98.40, 99.90, and 99.90%) had the highest percentage of

fungus mycelial growth suppression at all concentrations tested, with mean values of 99.40 and 99.18 percent, respectively. Tebuconazole 50%+Trifloxystrobin 25% (WG) was discovered to be the most efficient fungicide against the leaf blast disease, according to Kulmitra et al. (2017) and Singh et al. (2019). The findings of Konda et al. (2016) and Neelakanth et al. (2017), which found that Nativo at greater concentrations significantly hindered the growth of fungal mycelium, are in agreement with this outcome. At low concentrations of 0.0125% and 0.025%, respectively, Picoxystrobin 6.70%+ Tricyclazole 20.33% demonstrated better growth inhibition than the others in the current study. At higher concentrations of 0.5% and 1%, however, all of the fungicides were effective in controlling leaf blast as compared to untreated (control). To ascertain their impact on rice grain production and leaf blast, various fungicides were tested in the field. The outcome demonstrated that, in comparison to untreated (control) plots, all fungicides were successful in controlling leaf blast. On the other hand, the high est leaf blast incidence (29.36%, 50.39%) was observed in control (T6) plots followed by T4 (Filia 525 SE) treated plots. In addition, the lowest neck blast incidence (16.67%) was recorded in T5 (Avalon 27SC) treated plots followed by T3 (Nativo 75 WG) treated plots at 75 DAT and the highest neck blast incidence (99.20%) was observed in control (T6) plots followed by T2 (Seltima) treated plots at 75 DAT compared to other treatments were used in this experiment. Perusal of the field experiment data revealed that, there was no significant differences between treatments before application of fungicides and the leaf blast severity ranged between 1.00-2.00. At 15 days after first spray, all the treatments gave significant control of leaf blast disease in paddy compared to untreated control. Application of Picoxystrobin 6.70%+ Tricyclazole 20.33% recorded least leaf blast severity (1.33) followed by Propiconazole (12.5%) + Tricyclazole (40%) (1.40). Non-significant difference was found between the treatments Pyrachlostrobin 10% WP and Tebuconazole 50%+ Trifloxystrobin 25% WG (1.60 and 1.66 respectively) and these treatments were found to be significantly superior to 200 g/L azoxystrobin + 125 g/L difenoconazole. Least efficacy was recorded with treatment 200 g/L azoxystrobin + 125 g/L difenoconazole (1.86). At 15 days after second spray, application of Picoxystrobin 6.70%+ Tricyclazole 20.33% recorded least leaf blast severity (1.46) followed by 200 g/L azoxystrobin + 125 g/L difenoconazole (1.93). When all the different fungicidal treatments were compared with respect to percent disease severity over control, it has been found that Picoxystrobin 6.70%+ Tricyclazole 20.33% (Avalon 27SC) was the most efficient. Ten fungicides were

evaluated for management of rice blast by Ganesh et al., (2012) and found that the per cent disease index was significantly less (15.56) in tricyclazole sprayed plots followed by kitazine (17.63) and ediphenphos (18.03). The findings are in line with Pandey, (2016) who reported that among the 11 fungicides evaluated, Tricyclazole @ 0.6 g/L, was found significantly superior in controlling the leaf blast disease severity. Among the twenty-two fungicides evaluated by Govindraj et al., (2016), Tricyclazole was found to be the best fungicide in controlling the blast disease. (Mahesh et al., 2016) reported that, among the fungicides evaluated, spraying of Picoxystrobin 7.5%+Tricyclazole 22.5% w/v 30SC @ 300g a.i./ha gave effective control of leaf and neck blast of paddy with highest grain yield. These findings were also supported by the findings of Pandey (2016), who observed least disease severity (35.62%) in the plots treated with Tricyclazole and Ganesh Naik et al. (2012) who observed Tricyclazole to be effective in controlling leaf blast with lowest Percent Disease Incidence (PDI, 16.01) and increase in yield as well. Our findings are in line with the findings of Dubey (1995), Dutta et al. (2012), Enyinnia (1996), which showed that tricyclazole was effective against rice blast with great reduction of disease % and superior in controlling disease severity over control. Singh et al. (2019) evaluated that Tebuconazole 50 % + Trifloxystrobin 25 % (WG) treated plants showed minimum disease intensity (11.46 %). In the same way, Picoxystrobin 6.70%+ Tricyclazole 20.33% was discovered to be superior among various treated fungicides in terms of yield attributing parameter, i.e., plant height (98.87), the number of tiller per hill (14.33), the number of effective tiller per hill (9.67), the number of infected tiller (0.00), the number of non-infected tiller (9.67), and thousand grain weight (26.85), followed by Additionally, our findings are consistent with those of Prabhu et al. (2003), Magar et al. (2015), and Sood and Kapoor (1997) who found that the application of fungicides boosted rice yield. Further the findings of Varier et al. (1903) also support our result which showed that tricyclazole treated seeds @4 gha-1 proved to be effective. Our findings are also in line with Devaraju et al. (2013), Pandey (2016), Ganesh et al. (2012) and Sachin and Rana (2011) where tricyclazole significantly increased the number of tillers per hill and yield. Qudsia (2017) studied that Amistar Top 325 SC (Azoxystrobin + Difenconazole) performed best to control the rice blast incidence (11%) and contributed to high yield (4.68 t/ha) compared to Nativo 75 WG (Tebuconazole + Trifloxystrobin), Dora 10 WG (Difenoconazole), Dorazole 50 EC (Difenconazole + Propiconazole), Score 250 EC (Difenoconazole) and Kocide 3000 52.4 WG (Copper hydroxide). Singh et al. (2019) evaluated that Tebuconazole 50 % + Trifloxystrobin 25 % (WG) treated plants showed minimum disease intensity (11.46 %) and highest grain yield (4102.11 kg/ha). The findings are in line with Devaraju et al., (2013) who studied the efficacy of different fungicidal sprays viz., carbendazim, mancozeb and tricyclazole at three growth stages viz., 50 percent flowering, milk/dough stage and physiological maturity for control of blast disease

(*Pyricularia grisea*) in rice and observed that tricyclazole significantly increased number of tillers/hill (8.63) and productive tillers/hill (8), number of filled spiklets/panicle (58) in compared to different treatment combinations. Based on the findings of the present study it may be concluded that Picoxystrobin 6.70%+ Tricyclazole 20.33%, Tebuconazole 50%+ Trifloxystrobin 25% WG fungicides were more effective to Control *Magnaporthe oryzae* at a very low concentration in in vitro condition as it inhibited radial mycelial growth up to 73.43% and 72.95% at only 0.0125% concentrations. On the other hand, Avalon 27SC (Picoxystrobin 6.70%+ Tricyclazole 20.33%) @ 2g/L of H₂O was found to be superior for controlling leaf and neck blast of rice though all the fungicides were effective in controlling leaf blast as compared to untreated (control) plots in the rice fields. Tricyclazole is being extensively used in Bangladesh for controlling rice blast and wheat blast. It is a kind of official fungicide for these two diseases. The present study also revealed Avalon 27SC as the best among 6 fungicides used. Good thing is that, some other 2-3 fungicides (i.e., Nativo, Amister top) were found equally effective. The present results thus created an opportunity to think of an alternative to Avalon 27SC in case if there arises the situation called fungicide resistance.

CONCLUSIONS

This research work was conducted to find out the efficacy of some selected fungicides against rice blast disease control in in vitro and field conditions. Based on the findings of the present study it may be concluded that some fungicides were more effective to inhibit *Magnaporthe oryzae* at a very low concentration in in vitro condition as it inhibited radial mycelial growth inhibition (100%) of *Magnaporthe oryzae* was obtained by Avalon 27SC, Nativo 75WG, Seltima at 0.0125%, 0.025% concentrations. Again, there were 100% growth inhibitions seen in all the treatment plates at 0.1% and 0.5% high concentration. Thus, from above findings, it can be concluded that this combination (Picoxystrobin+Tricyclazole) can be recommended for farmers to use against leaf blast as it is very effective and easily available in the market.

Conflict of Interest

There is no conflict of interest to declare.

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