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Efficacy of Different Level of Systemic Fungicides on Management of Rice Blast at Baitadi, Nepal

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Abstract

Rice blast (Pyriculariaoryzae Cavara) is one of the most devastating diseases affecting the rice crop in across the world. Systemic fungicides are used for the suppression of blast diseases caused by fungal pathogens. Propiconazole and Carbendazim are commercial chemical control products available in markets for the control of the fungal pathogen. An experiment was conducted to examine the effectiveness of systemic fungicide on suppression of rice blast incidence in farmers' field during wet seasons in 2016. The treatments consisted of the use of different levels of propiconazole and Carbendazim on 'Rato Basmati' a landrace rice variety. The experiments were arranged in a randomized complete block design with three replications. The disease was scored according to the standard scale developed by the International Rice Research Institute (IRRI). Disease severity and Area under Disease Progressive curve (AUDPC) was computed based on that scale score. Propiconazole and Carbendazim at different levels reduce disease development than no treatment (control). But its efficacy was not consistent. The magnitude of disease suppression by Propiconazole was high as compared to Carbendazim. The application of propiconazole at the rate of 1.5 ml effectively reduced disease severity and AUDPC at different dates. So propiconazole at the rate of 1.5 ml thrice at weekly intervals is effective to reduce the disease development.

Keywords: Chemical control, plant pathogen, *Pyriculariaoryzae,* disease severity.

Introduction

Rice (*Oryza sativa*) is the most commonly consumed food, as a cereal grain, for a large part of the world's human population, particularly in Asia. It is the third-highest produced agricultural commodity in the world with a production of 741.5 million tons (FAOSTAT, 2014). Asia being the largest producer contributes more than 87% of total world rice production (Bandumula, 2017). But still, the production of rice in this region is constrained by several insect pests and diseases. Rice blast caused by fungal pathogen *pyriculariaoryzae*cavara (Syn.*Magnaportheoryzae* B.C Couch). Elliptical lesion on leaves on vegetative and reproductive stages is common symptoms of rice blast (Bastiaans, 1991) and further induces grain sterility, reduces grain size, and ultimately affecting the yield. (Khan et al., 2014). It was known to occur in 85 countries of the world and annual yield loss is about 75% in India and 50% in the Philippines of total rice production (Padmanabhan, 1965). Yet the use of resistance cultivar, chemical fungicides, sustainable agronomic practices, and biotechnological method can control the blast (Ribot et al., 2008). Cultivation of resistance varieties could be the most economic and efficient management approach but the preference of farmers is high on susceptible cultivar due to its high market demand. Due to the changing the environmental conditions, the pathogen also changes themselves breaking the host resistance thus making the host susceptible to the particular pathogen (Ghimire, et al., 2019). Agronomical and botanical approaches is cannot use alone for proper disease management and biological approaches fetch high cost of application and not recommended for the immediate result (Qudsia et al., 2017).

So chemical fungicide is familiar among the farmers due to its widespread availability and eases to use for disease management (Flor et al., 2018). The judicious use of fungicide provides efficient and effective results in the management of disease (Manandhar et al., 1998).

However the long term and haphazard use of chemical fungicides particularly with the same mode of action causes the resistance among those fungal population (Kiyosawa, 1982) and also have an adverse effect on human health, beneficial plant-microbe interaction, soil and water of rice ecosystem (Dors et al., 2011; Phong, et al., 2009).

Therefore, this research was carried out to determine the efficacy and the appropriate dose of two systemic fungicides, propiconazole and carbendazim against rice blast in natural epiphytic condition.

Methods and Materials

The experiment was undertaken in the research field of Gokuleshwor Agriculture and Animal Science College, Baitadi, Nepal. Situated at longitude $80^0 50'$ E, latitude $24^0 75'$N, with an elevation of 700masl. The soil texture of the study site was sandy loam, slightly acidic, and moderate organic matter. The temperature during the experimental period ranged from 20.73^0C to 35.15^0C with an average of 32.24^0C. The average relative humidity during the experimentation period was 60.51%.

The experiment was undertaken on rainy season of June 2, 2016, using the landrace 'Rato Basmati' layout in Randomized Complete Block Design (RCBD) with 3 replications and 7 treatments viz. 1.5ml, 2ml, 2.5ml of Propiconazole, 1.5g, 2g, 2.5g of Carbendazim, and control (No treatment). The individual plot size was $1m^2$. Each plot contains 25 hills and, in each hill, tree seedlings were planted (spacing $20*20cm^2$). 1m spacing was left between each replication and 0.5m left between two plots for a border effect. All the treatment was applied thrice at 61days after transplantation, 68 days after transplantation, and 74 days after transplantation. Fertilizers were applied at the rate of 140:60:40 NPK /ha via urea (46%N), Di-ammonium Phosphate (16%N & 46% P2O5) and Murate of potash (60% K2O). One third dose of nitrogen, the full dose of phosphorous and a full dose of potash was applied as basal. The remaining dose of nitrogen was applied in two splits at 20 and 40 days after transplantation.

Data on disease severity was collected from 61 days after transplantation on weekly interval until the constant rate was observed. Ten plants were randomly selected from each plot for scoring. After 1 week of fungicide application again disease scoring was done. Scoring was done using the 0-9 scale and then converted into the percentage of disease by using the formula (IRRI, 1996)

$$Disease\ Severity = \frac{Sum\ of\ Score \times 100}{Number\ of\ Observation \times Highest\ number\ in\ rating\ scale}$$

Table 1. Leaf blast disease rating scale (IRRI,1996)

Scale	Description	Host Behavior
0	No lesion observed	Highly Resistant
1	Small brown specks of pinpoint size	Resistant
2	Small roundish to slightly elongated, necrotic gray spots, about 1-2 mm in diameter, with a distinct brown margin. Lesions are mostly found on the lower leaves	Moderately Resistant
3	Lesion type same as in 2, but a significant number of lesions on the upper leaves	Moderately Resistant
4	Typical susceptible blast lesions, 3 mm or longer infecting less than 4% of leaf area	Moderately Susceptible
5	Typical susceptible blast lesions of 3mm or longer infecting 4-10% of the leaf area	Moderately Susceptible
6	Typical susceptible blast lesions of 3 mm or longer infecting 11-25% of the leaf area	Susceptible
7	Typical susceptible blast lesions of 3 mm or longer infecting 26-50% of the leaf area	Susceptible
8	Typical susceptible blast lesions of 3 mm or longer infecting 51-75% of the leaf area many leaves are dead	Highly Susceptible
9	Typical susceptible blast lesions of 3 mm or longer infecting more than 75% leaf area affected	Highly Susceptible

Estimation of area under disease progress curve (AUDPC)

The area under the disease progress curve (AUDPC) was calculated by summarizing the progress of disease severity. The pattern of the epidemic in terms of several lesions, amount of diseased tissue, or some diseased plants is given by a curve, called the disease progress curve, which shows the epidemic over time, and the area covered by this curve is known as AUDPC. AUDPC values from double-digit and AUDPC from flag leaf (F) and penultimate leaf (F-1) were separately calculated by using the formula given by (Shaner, 1977).

$$\text{AUDPC} = \sum_{i=1}^{n} (Y_{i+1} + Y_i) 0.5 (T_{i+1} - T_i)$$

Where,
Yi= disease scored on i^{th} first date
Ti= date on which the disease was scored
n = number of dates on which disease was scored

Analysis of variance on Disease severity and Area Under Disease Progressive Curve (AUDPC) was done by using R Agricolae (1.3). Mean Comparison was done using Least Significant Difference (LSD) (Gomez & Gomez, 1984) at a 5% level of significance.

Results and Discussion

Disease severity

Application of chemical fungicides helps to manage the disease, but the dose and rate of fungicides should be adjusted. More doses than the recommended also cause a negative impact on plant physiology and disease development by encouraging other races of the pathogen to emerge. Low dose (1.5ml) of propiconazole performed well to manage the disease in the study, a similar result was also obtained by (Usman, Wakil, & Sahi, 2009) while evaluating the effectiveness of different chemical fungicides for the management of rice blast. leaf blast is controlled by carbendazim, Pyroquilon, thiophanate methyl, and chlobenthiazone but Trizole is effective in controlling the disease severity (Gouramanis, 1997).

Table 2. Disease severity at different scoring

Disease severity at different days after transplanting			
Treatments	**1st 61 days**	**2nd 68 days**	**3rd 74 days**
1.5 ml Propiconazole	15.93 bc	19.74 b	33.18 e
2 ml Propiconazole	12.59 c	21.52 cd	42.00 de
2.5 ml Propiconazole	14.23 bc	29.29 ab	52.59 bc
1.5 g Carbendazim	18.67 ab	28.00 abc	61.44
2 g Carbendazim	15.18 bc	25.23 bcd	47.66 cd
2.5 g Carbendazim	16.78 bc	24.22 bcd	56.52 bc
Control	23.03 a	32.52 a	68.92 a
Mean	16.62	25.78	51.75
LSD	5.05*	6.32**	9.66**
SEm(±)	1.64	2.05	3.13
CV%	17.09	13.79	10.50

The table 2 shows the blast severity under various doses of two different systemic fungicidal treatments. Rate and source of fungicide show the significant difference over disease severity. In the initial stage of disease severity, 2ml Propiconazole (12.59) worked efficiently, followed by 2.5ml Propiconazole (14.23). In terms of Carbendazim dose, 2g (15.18) shows low disease severity followed by 2.5g Carbendazim (16.78). While in control disease severity was observed maximum (23.03). Observing the second scoring 1.5ml (19.74) shows better results followed by 2ml of propiconazole (21.52). In terms of carbendazim, 2.5g (24.22) is quite better followed by 2g (25.23) but still, they are statistically similar. Similarly, on the third day of scoring the mean value of disease severity was obtained 51.5. Propiconazole at a rate of 1.5ml (33.18) is effectively followed by 2ml of propiconazole (42.00). In terms of carbendazim 2g dose possessed (47.66) value followed by 2.5g (56.52).

Different treatments possessed various disease severities at different scoring dates. The application of chemical fungicide at different doses worked differently for the management of rice blast. From the figure1, a 1.5ml dose of Propiconazole which is from the Trizole group showed minimum disease severity till the end scoring. Similarly, 2ml of the same Propiconazole in first scoring checked the disease development but in the next scorings, the disease was higher as compared to 1.5ml propiconazole. This might be due to a higher dose initially suppressed the disease but the same dose didn't effectively work to minimize the disease in the next scorings. Rice blast didn't manage without the application of any one of the chemical fungicides. So, in control plot disease severity was maximum from the initial scoring and the same trend followed.

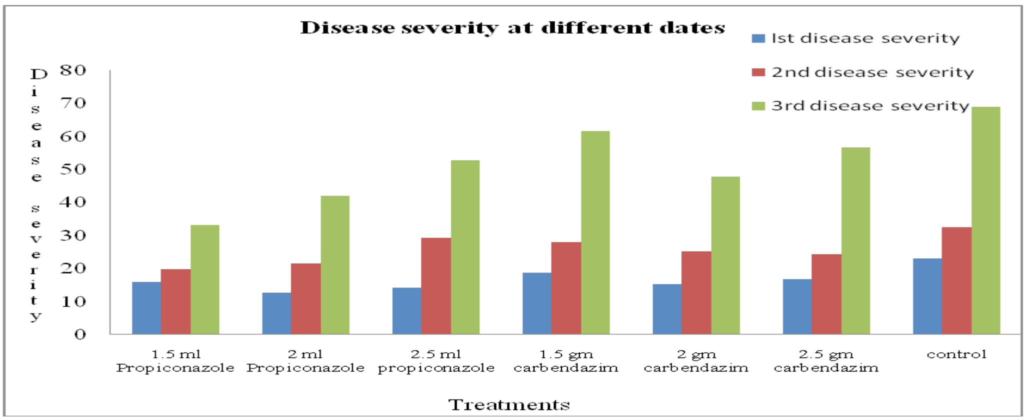

Figure 1. Disease Severity at different dates

Area under disease progressive curve (AUDPC)

Observation on the Area under disease progressive (AUDPC) Table 3. 2ml Propiconazole is quite effective followed by 1.5ml while they both are statistically at par. In terms of carbendazim dose, 2g is effective in reducing the AUDPC value followed by 2.5g Carbendazim. Without the application of chemical fungicides AUDPC value was maximum which possessed value which was higher than the mean value during all the observation on Table 3. Magar et al. (2015) evaluated the effect of systemic fungicides reported that optimum dose is effective to control the leaf blast. Evaluation of seven different fungicides appropriate doses of Trizole is effective than others in lowering the blast pathogen. (Sood & Kapoor, 1997).

Table 3. Area under disease progressive curve (AUDPC) at different dates

Treatments	Ist AUDPC	2nd AUDPC	Total AUDPC
1.5ml Propiconazole	107.00 cd	158.8 e	265.8 e
2 ml Propiconazole	102.3 d	190.6 de	292.9 de
2.5ml Propiconazole	130.6 bc	245.6 bc	376.2 bc
1.5g Carbendazim	140.00 b	268.3 ab	408.3 b
2g Carbendazim	121.2 bcd	218.7 cd	339.9 cd
2.5g Carbendazim	123.0 bcd	242.2 bc	365.2 bc
Control	166.6 a	304.3 a	471.0 a
Mean	127.25	232.63	359.89
LSD	23.71**	39.15**	50.13**
SEm(±)	7.69	12.70	16.27
CV%	10.47	9.46	7.83

The area under Disease Progress Curve (AUDPC) was calculated after the end of the of disease scoring. Different treatments possessed different values of AUDPC. Two chemical fungicides of varying doses were used for the management of the rice blast. The response of the rice blast was different for each treatment. 1.5ml of propiconazole worked very efficiently throughout the research period and the AUDPC value per day was also low (22.15) but in other treatments per day disease area increment was higher except 1.5ml propiconazole. In the control plot, disease development was very fast. Per day disease area increase was (39.25) so this plot possessed maximum AUDPC value.

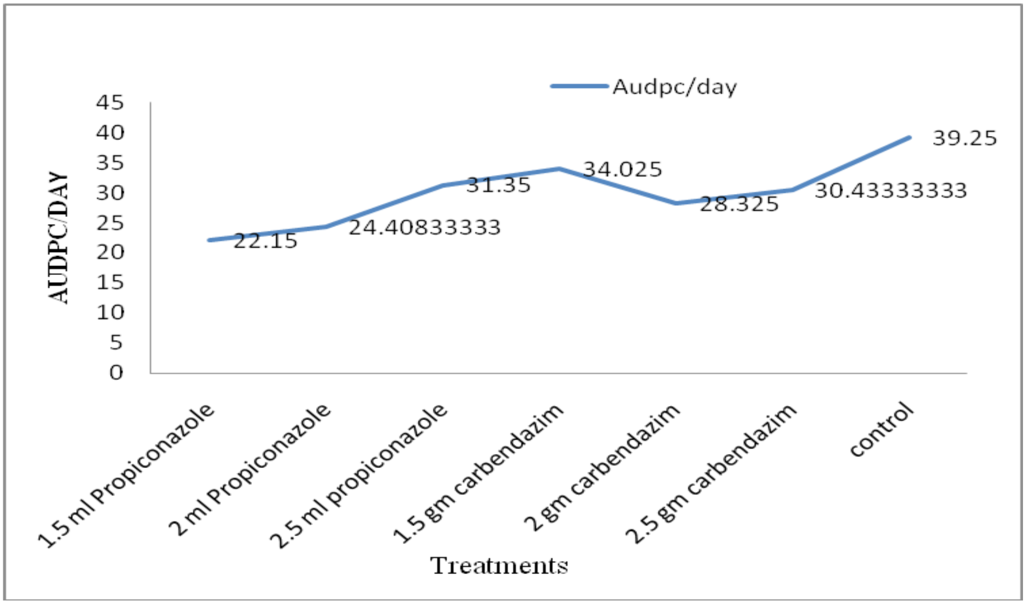

Figure 2. AUDPC per day value of different treatment

Conclusion

The use of propiconazole is shown to be effective in reducing disease severity and Area under disease progressive curve and in protecting the rice due to blast infection, especially in seasons with high blast pressure, at the field scale. An appropriate level of fungicide should be used as a defense against blast pathogen. Propiconazole at the rate of 1.5ml could reduce the intensity of blast pathogen in the subtropical climatic condition of Nepal as compared to a different level and Carbendazim.

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