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Research Article

Evaluation of different chemical fungicides against rice blast in field conditions

Rachana Moktan[1*], Anjeela Aryal[1], Sagar Karki[1], Ashbin Kumar Devkota[1], Basistha Acharya[2], Darbin Joshi[3] and Krishna Aryal[1]

[1]Institute of Agriculture and Animal Science, Prithu Technical College, Deukhuri, Dang, Nepal
[2] Directorate of Agricultural Research (DoAR), Khajura, Banke, Lumbini Province, Nepal
[3]International Maize and Wheat Improvement Center, Kathmandu, Nepal
[*]Correspondence: rachanamoktan23316@gmail.com
[*]ORCID: https://orcid.org /0000-0002-7529-7019
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ABSTRACT
Evaluation of different fungicides against rice blast was carried out in research plot of the Agronomy farm of IAAS, Prithu Technical College, Lamahi Municpality, Dang district of the Lumbini Province, inner terai region of Nepal during June to November, 2017. The objective of the experiment was to evaluate the efficiency of different chemical fungicides against rice blast. The experiment was conducted in Randomized Complete Block Design with the use of susceptible variety 'Mansuli'. Different fungicides like Hexaconazole 5% SC (Udaan), Propiconazole 25% EC (Tilt), Captan 70% + Hexaconazole 5% WP, Validamycin 3% L, Tricyclazole 75% WP (TRIP) and Biomycin (Kasugamycin 3% S.L.) were applied five times at weekly interval with the doses of 2mL/L of H_2O, 1.5mL/L of H_2O, 2g/L of H_2O, 2mL/L of H_2O, 2g/L of H_2O and 2mL/L of H_2O respectively. From the result, it was concluded that all the fungicides were effective in controlling leaf blast but Tricyclazole 75% WP (TRIP) was more effective among other fungicides and untreated control plots with least leaf blast severity (27.85%), least incidence (35.5%), least mean AUDPC (64.64%) and highest grain yield (3.93 t ha^{-1}) followed by Biomycin. It is thus concluded that fungicide Tricyclazole 75% WP should be sprayed five times at weekly interval for the management of leaf blast in rice.
Keywords: Control, disease, fungicides, *Pyricularia oryzea*, rice blast, severity

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INTRODUCTION

Rice (*Oryza sativa* L.) is considered to be the most important cereal crop grown in different countries around the world. Asian region contributes about 92% of the global production. Rice not only possess economic and religious value but also possess social value in the Nepalese society (Amgai, 2005) and is grown extensively under a wide range of agro-ecological conditions from lowland terai (60 masl) to high mountain valley (3050 masl) (Paudel, 2011). It is a good source of carbohydrate (75-80% starch), 7% protein with different amino acids. It is one of the major crops in Nepal and also considered to be the staple food.

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Rice cultivation covers about 5312 ha with the production of 5510 tones and productivity of only 541.9 t ha^{-1} in Nepal (MoALD, 2018/2019). Various biotic and abiotic factors are responsible for the low yield of rice. Out of them, disease is one of the most important factors contributing to considerable loss in the production. The losses in rice production due to diseases and pests is about 37% annually. The two major diseases of rice in Nepal are blast and bacterial blight (NARC, 1997; Chaudhary, B., 1999; Shrestha, S. M, 1993; Manandhar, e*t al*., 1992). Most severe disease of rice is rice blast (Naidu *et al*., 2016; Moletti *et al*., 1988; Mbodi *et al*., 1987). The teleomorphic stage of the blast disease causing fungus is *Magnaporthe grisea* whereas *P. oryzae* and *P. grisea* is anamorphic stage (Rossman *et* al., 1990). Blast is locally known as "Maruwa Rog" in Nepali. The fungus can infect most parts of the plant, but the most destructive phase being nodal or panicle infection (Ou, 1985). The disease may kill the host plant or development of seeds are prevented when the pathogen infects on neck or panicle. It occurs in nearly all rice growing areas of the world. (Robert, 1991).

But it is more problematic in the humid region as the conidia are not produced below 88% relative humidity. In 1996 rice blast was recorded for the first time in Nepal and since 1996 it has been threatening rice production in Nepal (Manandhar, 1987; Manandhar *et al.,* 1992; Chaudhary 1999). Depending on cultivar susceptibility, environmental conditions and management system, it causes yield losses up to 100%. Keeping this in view, various efforts have been made to find out the effective and successful control and preventive measures for the efficient management of rice blast. Various systemic and broad-spectrum fungicides have been effective for controlling rice blast throughout the world mostly in temperate or subtropical regions. Fungicides are effective in controlling rice blast ranging from 40 to 84% (Swamy *et al*., 2009). Considering the above facts, this research aimed to determine comparative efficiency of different foliar fungicides for the management and control of rice blast disease to enhance the grain yield.

MATERIALS AND METHODS

Experimental Site

The experiment was conducted in research plot of the Agronomy farm of IAAS, Prithu Technical College, Lamahi municipality, ward no.3 of Dang district during June to November, 2017. The experimental site was situated at 410 km west from Kathmandu, the capital of Nepal. Geographically, it is located at 27.9904' N Latitude and 82.3018' E Longitudes at the elevation of 725 masl. The soil of the experimental site was silty loam having slightly acidic pH (6.7), low organic matter (2.16%), medium total nitrogen (0.11%), medium available phosphorus (46 kg ha^{-1}) and medium available potassium (190.88 kg ha^{-1}). This location falls in inner terai region of Province no. 5 of Nepal. Deukhuri's climate is nearly tropical and it is well watered by the river as well as possessing abundant groundwater.

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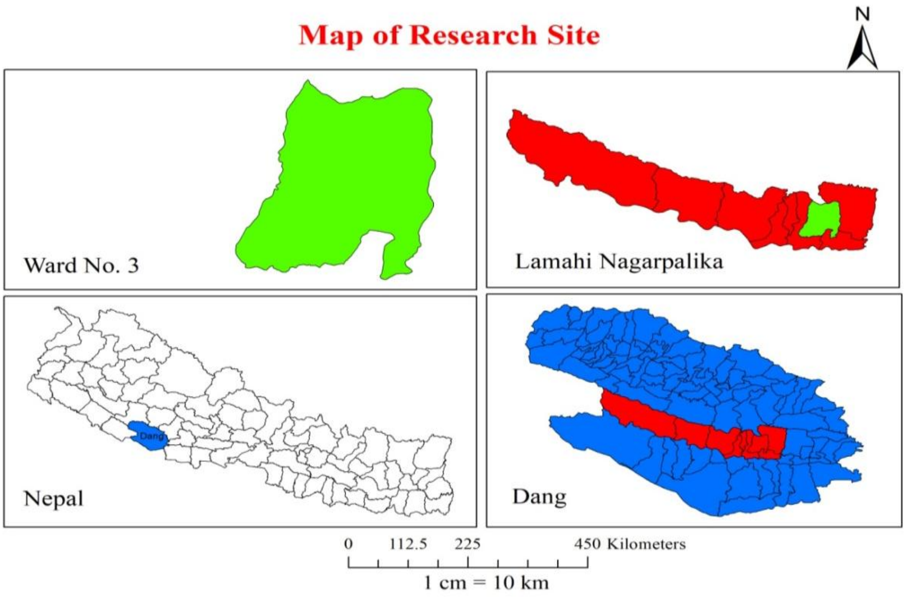
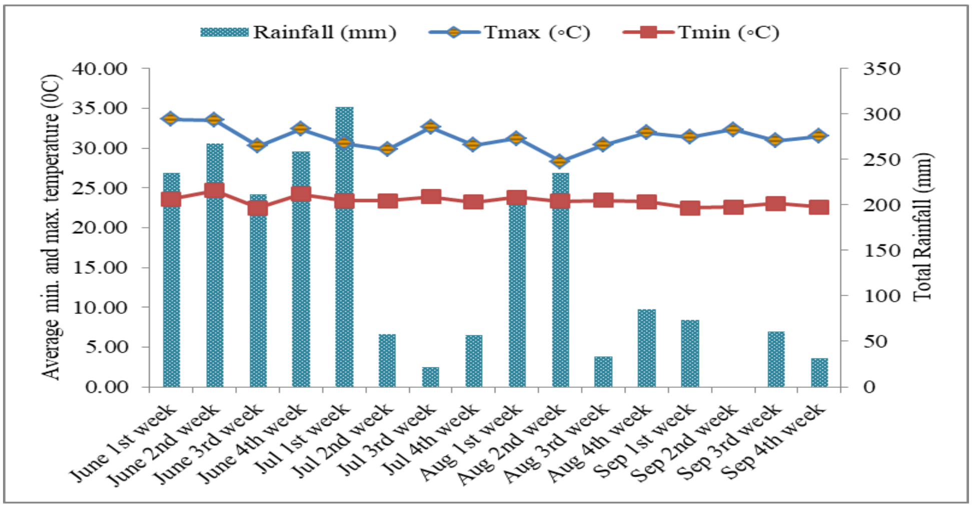


Figure 1. Map of experimental site

Meteorological Information

The site has monsoon type of climate and more than 75% of rainfall occurs during four months of the monsoon period (June - September). The maximum rainfall was recorded during 1st week of July, lowest on 3rd week of July and no rainfall on 2nd week of September. Similarly, maximum temperature was observed in July 1st week and minimum on 3rd week of June.



Source: Meteorological information, Kathmandu

Figure 2: Rainfall pattern of Lamahi, Dang throughout the research period

Experimental design and treatment factors

The experiment was laid out in randomized complete block design with three replications and seven treatments. 0.5m spacing was left between each replication and between two plots for border effect. The plot size for each treatment was 7.8m^2 (2.6m×3m) with 13 rows in each

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plot maintaining the crop geometry of 20cm × 20cm. Each row had 15 hills and in each hill three seedlings were planted.

Table 1. Different treatment combinations used in the experiment

Treatment number	Treatment combination	Trade Name
T1	Hexaconazole 5% SC	Force Plus
T2	Propiconazole 25% EC	Tilt 25 EC
T3	Captan 70% + Hexane 5% WP	Taqat 75% WP
T4	Validamycin 3% L	Validacin, Valimon and Solacol
T5	Tricyclazole 75% WP	Beam 75 WP
T6	Biomycin 3% SC	Kasu- B
T7	Control	

Planting Materials and Cultural Practices

Blast susceptible variety Sankharika and Mansuli were used for the experiment which were collected from Kapilbastu and Nepal Agriculture Research Council, Khajura, Banke. The variety is recommended for terai and inner terai domain of Nepal. A raised nursery bed was prepared on 24thJestha, 2074 of 1m^2 area. The bed was broadcasted with Mansuli variety. The seed bed was covered with soil lightly and mulching was done to prevent the seed from being eaten by birds, to protect from heavy rain, wind and for quick germination of seeds. Light irrigation was done at the time of sowing of seeds. Thereafter, irrigation was done whenever required. The experimental field was well puddled manually by using spade. Then the 25 days old seedlings were transplanted in each plot by maintaining plant to plant and row to row spacing of 20cm. The whole field was surrounded by one row of highly susceptible cultivar 'Sankharika' and also there was a row between two replications to provide the uniform source of inoculum.

Weeding was done at 25 days after transplanting and 15 days after panicle initiation. Similarly, irrigation was done during seedling stage, tillering stage, panicle initiation, flowering, milk and dough stage. A well decomposed Farm Yard Manure (FYM) was applied in the field at the time of ploughing @ 6 t ha^{-1}. Similarly, fertilizer was applied @ 120:40:0 kg ha^{-1} through urea and DAP. One third dose of Nitrogen and full dose of Phosphorus were applied at the time of final land preparation as basal dose. Remaining dose of N was applied in two split doses at active tillering stage and panicle initiation stage respectively. Different fungicides like Hexaconazole 5% SC (Udaan), Propiconazole 25% EC (Tilt), Captan 70% + Hexaconazole 5% WP, Validamycin 3% L, Tricyclazole 75% WP (TRIP) and Biomycin (Kasugamycin 3% S.L.) were applied five times at weekly interval with the doses of 2mL/L of H_2O, 1.5mL/L of H_2O, 2g/L of H_2O, 2mL/L of H_2O, 2g/L^1 of H_2O and 2mL/L of H_2O respectively.

Data Collection and analysis

Plant Parameters

The disease was scored from randomly selected 25 plants from each plot, one week after the last application of fungicides by using 0 – 9 disease rating scale given by International Rice Research Institute (IRRI, 1996) as shown in table below and then converting into percent disease incidence and severity by using the following formula.

$$\text{Disease incidence\%} = \frac{\text{Number of infected plants}}{\text{Total number of plants observed}} \times 100$$

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$$\text{Disease severity \%} = \frac{\text{Sum of all numerical rating}}{\text{No of plants observed} \times \text{max.reading of scale}(9)} \times 100$$

AUDPC values were calculated from leaf blast severity as per the procedure of (Das *et al*., 1992; Shrestha *et al*., 2019a)

$$\text{AUDPC} = \sum_{i=1}^{n-1} \left[\frac{(x_{i+1} + x_i)}{2}\right] \times (t_{i+1} - t)$$

Where,
x_i= disease severity at i^{th} date
t_i= date from sowing up to date of disease score
n= number of dates on which disease was recorded

All the data from the experimental plot collected was subjected to analysis of variance (ANOVA). Microsoft word 2007 was used for word processing; MS excels for tables, graphs and simple statistical analysis. R-package was used for statistical analysis and SPSS for correlation determination among yield attributing characters.

Table 2. Disease scoring scale for leaf blast of rice caused by *Pyricularia oryzae* (IRRI System, 1996

Scale	Description	Host Behaviour
0	No lesion observed	Highly Resistant
1	Small brown specks of pin point size	Resistant
2	Small roundish to slightly elongated, necrotic gray spots, about 1-2 mm in with a distinct brown margin. Lesions found on the lower leaves.	Moderately Resistant
3	Lesion type same as in 2, but 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 3 mm 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	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

(Source: IRRI, 1996)

RESULTS AND DISCUSSION

Different fungicides were evaluated in field condition to determine their effect on leaf blast and grain yield of rice. The result showed that all the fungicides were effective in controlling leaf blast as compared to untreated (control) plots. Among them Tricyclazole was found to be superior in terms of low disease incidence% (35.5%) and low disease severity% (27.85%). 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

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controlling disease severity over control. The Area under disease progressive curve (AUDPC) was calculated by summarizing the progress of disease severity recorded five times at weekly interval starting from August 6. The Analysis of variance (ANOVA) revealed highly significant ($p < 0.001$) difference between the treatments on AUDPC value. The mean AUDPC value ranged from 64.64 to 137.92 with the highest value on control (137.92) followed by Validamycin (118.22) whereas, the least AUDPC was recorded in Tricyclazole (64.64) followed by Biomycin (82.58) which indicates that Tricyclazole was effective than other fungicides. Our findings are in contrary with the findings of Oghosi *et al*. (2018) which showed that AUDPC value of tricyclazole to be minimum over control and other fungicides treatments.

Table 3. Effect of different fungicides for the control of leaf blast of rice.

S.N.	Treatments	Disease severity%	Disease incidence%	Mean AUDPC
1	Tricyclazole 75%WP	27.85^{d}	35.5^{b}	64.64^{d}
2	Biomycin 3%SC	38.22^{cd}	43.42^{ab}	82.85^{cd}
3	Propiconazole 25%EC	45.48^{bcd}	44^{ab}	84.16^{cd}
4	Captan70% + Hexane5% WP	45.93^{bcd}	44.58^{ab}	91.08^{bcd}
5	Hexaconazole 5% SC	49.04^{bc}	45.42^{a}	101.10^{bc}
6	Validamycin 3% L	63.99^{ab}	54.92^{ab}	118.22^{ab}
7	Control	70.67^{a}	62.33^{a}	137.92^{a}
	Grand Mean	48.74	47.16	97.1
	LSD (0.05)	19.94	19.53	33.52
	CV%	22.49	23.27	19.4
	SEM (±)	9.15	8.96	15.38
	F-test	**	**	**

*Treatments means followed by the common letter or letters within the column are not significantly different among each other based on LSD at 5% level of significance. LSD = Least significant difference, SEM = Standard error of mean, CV = Coefficient of variation, and *= Significant at 0.05 level, **= Significant at 0.01 level and ***= Significant at 0.001 level*

Table 4. Effect of different fungicides in grain yield of rice.

S.N	Treatments	Plant Height (cm)	Tiller No.	Grain Yield (t ha^{-1})
1	Tricyclazole 75%WP	96.4^{a}	13^{a}	3.93
2	Biomycin 3%SC	95.23^{ab}	12.33^{ab}	3.89
3	Propiconazole 25%EC	93.87^{ab}	12^{ab}	3.69
4	Captan70% + Hexane5% WP	87.9^{bc}	12^{ab}	3.56
5	Hexaconazole 5% SC	83.07^{cd}	12^{ab}	3.38
6	Validamycin 3% L	75.47^{de}	11.67^{bc}	3.31
7	Control	69.5^{e}	10.67^{c}	3.27
	Grand Mean	85.89	11.95	3.49
	LSD (0.05)	8.42	1.19	1.25
	CV%	5.57	5.51	20.14
	SEM (±)	3.87	0.94	0.57
	F-test	*	***	NS
	F-test	*	***	NS

*Treatments means followed by the common letter or letters within the column are not significantly different among each other based on LSD at 5% level of significance. LSD = Least significant difference, SEM = Standard error of mean, CV = Coefficient of variation, and *= Significant at 0.05 level, **= Significant at 0.01 level and ***= Significant at 0.001 level*

Similarly, among various treated fungicides, Tricyclazole was found to be superior in terms of plant height and yield attributing parameter i.e. number of tillers per hill (13) and grain yield (3.93 t ha^{-1}) although the treatment showed non-significant difference to grain yield.

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Sachin and Rana (2011) also observed increase in grain yield with the application of tricyclazole.

Our result also corroborates with the findings of Prabhu *et al*. (2003), Usman *et al*. (2009), Magar *et al*. (2015), and Sood and Kapoor (1997) where fungicide application increased the 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), Hai *et al.* (2007), Ganesh *et al.* (2012), and Sachin and Rana (2011) where tricyclazole significantly increased the number of tillers per hill and yield. The result obtained from the experiment is shown in the Table 3.

CONCLUSION

Rice blast has caused severe loss in the yield of grains over the years leading to scarcity of food. Since rice is the staple crop of Nepalese people, it is necessary to adopt appropriate strategy for the control of blast. From the research, it was found that fungicides treatments were effective against leaf blast as compared to control one. Tricyclazole was the most significant among other fungicides with low AUDPC value (64.64), least disease severity% (27.85%), least disease incidence% (27.85%) and high grain yield (3.93 t ha^{-1}). Thus, from above findings, it can be concluded that Tricyclazole can be recommended for farmers to use against leaf blast as it is very effective and easily available in the market.

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Authors' contributions

R. Moktan designated the research plan, conducted experiment and recorded data, A. Aryal, S. Karki and A. K. Devkota assisted in analyzing the data and preparing manuscript. B. Acharya, D. Joshi and K. Aryal supervised the experiment and edited the paper.

Conflict of interest

The authors declare no conflict of interest regarding the publication of this manuscript.

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