Research article

INTEGRATED APPROACHES TO MANAGE LEAF BLAST DISEASE OF RICE IN FARMER'S FIELD AT GODAWARI, LALITPUR

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ABSTRACT

Blast, caused by *Pyricularia oryzae* is the most important disease of rice (*Oryza sativa*) in Nepal. With the aim of finding effective control measures against leaf blast disease, an experiment was done in randomized complete block design with three replications in farmer's field at Godawari, during the main seasons of 2018 and 2019. Three plant extracts; commercially available Nimbecidine, leaf extract of Asuro and Titepati, two bio-control agent *Trichoderma viride* and Kisan *Pseudomonas* along with one fungicide Kasugamycin were used as treatments. First spray was given as a prophylactic spray at jointing stage and treatments were applied 3 times at 14 days interval. Disease scoring was done according to a 0–9 scale. The result concluded that application of 0.2% Kasugamycin, 2% stock solution of Titepati and 1% *T. viride* were produced highest percentage disease control among the treatments by 54.76%, 47.62% and 30.96% respectively. Similarly, 0.2% Kasugamycin, 1% *Trichoderma* and 2% solution of Titepati treated plot produces the highest yield 5.87 t/ha, 5.49 t/ha and 4.68 t/ha respectively. To reduce leaf blast and higher grain yield of rice, Kasugamycin is the first priority and Titepati is second and for bio control *Trichoderma* is suggested as alternate approaches.

Keywords : *Bio-controls, botanicals, disease control, fungicide, leaf blast*

INTRODUCTION

Rice (*Oryza sativa*) is a cereal crop and belongs to the Graminae family, which is native to Asia. In Nepal, it is one of the most important crops, followed by maize and wheat covering 1.45 million ha with total production of 5.5 million ton in the country with the productivity of 3.79 t/ha (MoALD, 2020). It is grown in a diverse environment ranging from tropical plains to foot of the mountain and higher elevation (3050 masl) in Chhumchure, Jumla. This disease was recorded in 1966 for the first time (Khadka and Shah, 1967) in Nepal. It is distributed throughout the rice growing area of the country that is from plain (below 100 m)

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to the Jumla valley (3,050 m), the highest point where rice is grown in the world (Manandhar, 1987). The blast disease can strike all aerial parts of the plant. Most infections occur on the leaves, causing diamond-shaped lesions with a gray or white center to appear (Scardaci *et al*., 1997).

The disease results in yield loss as high as 70-80% (Ou, 1985) when predisposition factors like high mean temperature values, degree of relative humidity higher than 85-89%, presence of dew, drought stress and excessive nitrogen fertilization favor epidemic development (Piotti *et al*., 2005). In Nepal, rice blast is most serious disease in both terai and hilly region, causing an average yield loss of 125 kg/ha in the hills and 112 kg/ha in the terai (IRRI, 1996). The disease is more devastating in valleys, river basins, foot-hills and hills of Nepal, although it is prevalent throughout the rice growing areas in the country (Chhetri, 2015).

In Kathmandu valley, the blast disease causes significant loss in yield in traditional as well as improved varieties. In valleys and hills, early introduced varieties such as Taichung native1 and some of the Chainung series were found badly damaged by this diseases and causing severe yield losses (Shah, 1985). The disease pressure is concentrated to Chainung 242, the extensively growing rice cultivar in Kathamdu valley (Manandhar, 1987). The Chainung 242 with a wide popularity among the Newari community has high level of susceptibility under conducive weather conditions. In spite of being a susceptible, their economic importance for making Chiura (flattened rice), rice pudding, Sel roti (traditional homemade ring-shaped sweet rice bread) and Chhyang (jad). So, it was very necessary to manage these diseases by integration of all available disease management practices. Therefore, the field trials were conducted by integration of botanicals, biological and chemical methods to find out effective and environmentally safe management measures of rice leaf blast and improve the food security of people by minimizing the disease.

MATERIALS AND METHODS

A field experiment was conducted in consecutive two years during the main seasons of 2018 and 2019 in farmer's field at Godawari Municipality, ward no. 14, Lalitpur district. A rice blast susceptible and commonly cultivated rice cultivar Chainung 242 was selected for the study. The site lies in the sub-tropical zone with an altitude of about 1579 masl between 27°35'55"N latitude and 85°23'14"E longitude. The experimental design was randomized complete block design with three replications and seven treatments.

The details of the treatments were as follows:
T1: Foliar spray with Kasu-B (Kasugamycin 3% SL) @ 2 ml/l
T2: Foliar spray with Nimbecidine (Azadirachtin 300 ppm) @ 10 ml/l
T3: Foliar spray with stock solution of Asuro (leaf extract) @ 20 ml/l
T4: Foliar spray with stock stock solution of Titepati (leaf extract) @ 20 ml/l
T5: Foliar spray with *Trichoderma viride* ($1x10^8$CFU/g) (commercial product) @ 10 g/l
T6: Foliar spray Kisan *Pseudomonas* ($1x10^7$CFU/ml) @ 10 ml/l

T7: Control in which plants sprayed only with water.

Each plot size was 6 m^2 (2 m x 3 m) in which replications were separated by 1 m and plots within each replication separated by 0.5 m. Seed sowing was done on 27th and 28th June in 2018 and 2019 respectively. Twenty four days old seedlings were transplanted manually @ 2 seedlings per hill at spacing of 20 cm × 20 cm. The first spray of treatments were done immediately after appearance of leaf blast disease symptoms and was followed by two sprays at 14 days intervals. Fresh leaves of Titepati/mugwort (*Artimisia indica*) and Asuro/Malabar nut (*Justicia adhatoda*) were used as botanicals in which leaves were harvested and thoroughly washed in tap water 3 to 4 times. These materials were dried in the shed for six days. While preparing the extracts, the unwanted debris were removed, surface sterilized for 2 minute in 70% ethanol. The paste was obtained by grinding 100 g of fresh leaf in 100 ml of sterile distilled water using a mortar and pestle. The paste was squeezed and filtered through 4 folds of sterile cotton wool into a 100 ml conical flask resulting in a stock solution which was stored in the refrigerator until used. These prepared stock solutions were mixed in 20 ml/l water (Asuro and Titepati) for spray as treatments. 700 ml volume of each treatment was sprayed in each plot. Disease scoring was done just before the application of treatments, by using 0-9 disease rating scale given by International Rice Research Institute (IRRI, 2002) as shown in Table 1.

Table 1. A scale used for rating leaf blast disease in rice

Scale	Description	Host Behavior
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 diameter with a distinct brown margin. Lesion are mostly 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, 3mm or longer infecting less than 4% of the leaf area.	Moderately Susceptible
5	Typical susceptible blast lesions, 3mm or longer infecting less 4-10% of the leaf area	Moderately Susceptible
6	Typical susceptible blast lesions of 3mm or longer infecting 11-25% of the leaf area	Susceptible
7	Typical susceptible blast lesions of 3mm or longer infecting 26-50% of the leaf area	Susceptible
8	Typical susceptible blast lesions of 3mm or longer infecting 51-75% of the leaf area, many leaves are dead	Highly Susceptible
9	Typical susceptible blast lesions of 3mm or longer infecting more than 75% leaf area affected	Highly Susceptible

Observation

Grain yields were taken from each plot and means were computed. Thousand grains were selected randomly from the grain yield of each plot immediately after harvest, weighed, with an electronic balance, and weight (g) was taken at 12% moisture content.The data were used to calculate disease severity in each plot by using the following formula and treatment means were computed.

Disease intensity (%) = Sum of all numerical rating/total no of plants observed × maximum rating (9) × 100

The Area under disease progressive curve (AUDPC) was calculated by summarizing the progress of disease severity recorded three times at 14 days interval starting from 35 days after transplanting of rice seedling. Area under disease progression curve (AUDPC) gives quantitative measure of epidemic development and intensity of disease (Das *et al*., 1992) and AUDPC values were computed from the following formula:

$$AUDPC = \sum_{i=1}^{n} (Y_{i+1} + Y_i)/2 \times (T_{i+1} - T_i)$$

Where, Y_i = disease severity on the i^{th} date, Y_{i+1} = disease severity on $(i + 1)^{th}$ date and n = number of dates on which disease scores

The percentage disease reduction over the control by different treatments were calculated using the given formula:

Disease reduction % over control = (C-T)/C × 100

Where, C = Disease severity in control plot T = Disease severity in treatment plot

The increase in yield over the control by different treatments were calculated using the given formula:

Increase in yield over control (%) = (T-C)/C × 100

Where, T = Yield from treatment plot C = Yield from control plot

Statistical analysis

The data were analyzed using R-studio computer package program. Treatment means were compared using Duncan's Multiple Range Test (DMRT) at 5% levels of significance.

RESULTS AND DISCUSSION

The significant difference was observed in all the measured parameters when data combined analysis for two years (2018 and 2019) at all observation dates (35, 49 and 63 days after transplanting). Significantly lowest leaf blast severity was observed with Kasu-B (20.37%, 29.63 and 35.19%), followed by stock solution of Titepati leaf extract (25.93%, 37.04% and 40.74%) and *T. viride* (31.48%, 40.74% and 53.70%), and considerably highest with control (42.59%, 62.96% and 77.78%) at 35 day, 49 day, 63 day respectively (Table 2). The Kasu-B reduced the disease severity by 54.76%. These results were in accordance with Narayana *et* *al*. (2009) and Tiwari *et al.*(1983), who reported that Kasugamycin sprayed in standing rice showed disease severity (6.70%). Titepati leaf extract showed better than other two botanicals (Nimbecidine and Asuro leaf extract) that the disease reduction over control was 47.62%. It has been reported that *A. indica* extracts produces various types of biochemical compounds, including antimutagenic, anticancer, antiviral, antibacterial, anti-allergic, and antioxidant activities (Kumar *et al*., 2014; Rashid *et al*., 2013). Among the Bio-control *T. viride* was good effect of disease reduction % over control (30.96%). This is in line with the result reported by the (Sharma, 2006) also recorded minimum leaf blast severity with *T. viride*. *Trichoderma* spp., the well-known antagonistic fungus, is widely used in agriculture as bio fungicides (Mukherjee *et al.*, 2008). *T. viride* showed antagonistic activity under in vitro and in vivo conditions by inhibition of mycelial growth of *P. grisea* and minimum leaf blast severity (Sharma, 2006). The *Trichoderma* treated seed showed low disease intensity as compared to untreated seed reducing the disease intensity by 10–25% (Aravindan *et al.*, 2016). Singh *et al.* (2012) also showed 23.30 to 30.55% disease incidence in *Trichoderma* treatment and 40.50 to 48.09% in non-treatment.

Table 2. Effect of different treatments on leaf blast severity of rice and Disease reduction percentage over control for combined analysis

Treatments	DI1	DI2	DI3	Disease reduction % over control
Foliar spray of Kasu-B (Kasugamycin 3% SL) @ 2 ml/l	20.37^{d}	29.63^{d}	35.19^{d}	54.76
Foliar spray of Nimbecidine (Azadirachtin 300 ppm) @ 10 ml/l	37.04^{ab}	46.30^{bc}	57.41^{bc}	26.19
Foliar spray of stock solution of Asuro leaf extract @ 20 ml/l	35.19^{ab}	51.85^{b}	64.81^{b}	16.68
Foliar spray of stock solution of Titepati leaf extract @ 20 ml/l	25.93^{cd}	37.04^{cd}	40.74^{d}	47.62
Foliar spray of *Trichoderma viride* @ 10 g/l	31.48^{bc}	40.74^{c}	53.70^{c}	30.96
Foliar spray of Kisan Pseudomonas (*Pseudomonas*) @ 10 ml/l	29.63^{bc}	42.59^{bc}	57.41^{bc}	26.19
Control (only water spray)	42.59^{a}	62.96^{a}	77.78^{a}	
Mean	31.75	44.44	55.29	
CV	16.28	13.68	9.26	
P value	**	***	***	
LSD value ($P<0.01$)	9.192	10.82	9.11	
SEM value	2.98	3.51	2.96	

DI1: Leaf blast severity at 35 days after transplanting, DI2: Leaf blast severity at 49 days after transplanting, DI3: Leaf blast severity at 63 days after transplanting, LSD = Least significant

difference, SEM = Standard error of mean, CV = Coefficient of variance, **: Significant at 0.01 level of significance, ***: Significant at 0.001 level of significance

Area under disease progress curve (AUDPC) also increased with time. Kasu-B (803.70) had the least total AUDPC value than all other treatments, showing it's the best effect on blast management. The disease increment on the control was sharper with total AUDPC value of 1724.07, which indicated clear impact of the treatments. All other treatments had intermediate values between Kasu-B and control (Table 3).

Table 3. Effect of different treatments in AUDPC values of leaf blast of rice

Treatments	AUPDC1	AUDPC2	TAUDPC
Foliar spray of Kasu-B (Kasugamycin 3% SL) @ 2 ml/l	350.00^{d}	453.70^{e}	803.70^{e}
Foliar spray of Nimbecidine (Azadirachtin 300 ppm) @ 10 ml/l	583.33^{b}	725.93^{c}	1309.26^{bc}
Foliar spray of stock solution of Asuro leaf extract @ 20 ml/l	609.26^{b}	816.67^{b}	1425.93^{b}
Foliar spray of stock solution of Titepati leaf extract @ 20 ml/l	440.74^{cd}	544.44^{d}	985.19^{d}
Foliar spray of *Trichoderma viride* @ 10 g/l	505.56^{bc}	661.11^{c}	1166.67^{c}
Foliar spray of Kisan (*Pseudomonas*) @ 10 ml/l	505.56^{bc}	700.00^{c}	1205.56^{c}
Control (only water spray)	738.89^{a}	985.19^{a}	1724.07^{a}
Mean	533.33	698.148	1231.48
CV	12.71	6.527	8.06
P value	***	***	***
LSD value (P<0.001)	120.618	81.07	176.49
SEM value	39.1	26.3	57.3

AUDPC1: AUDPC value between DI1 and DI2, AUDPC2: AUDPC value between DI2 and DI3, TAUDPC: Sum of AUDPC1 and AUDPC2, LSD: Least significant difference, SEM: Standard error of mean, CV: Coefficient of variance, ***: Significant at 0.001 level of significance

The grain yield was negatively associated with rice leaf blast disease severity. This indicated that disease severity alone reduced the yield by 90.76% and remaining 9.24% yield reduction was due to other factors (Fig. 1). Prabhu and Morais (1986) also found negative correlation between yield and disease severity as in our study.

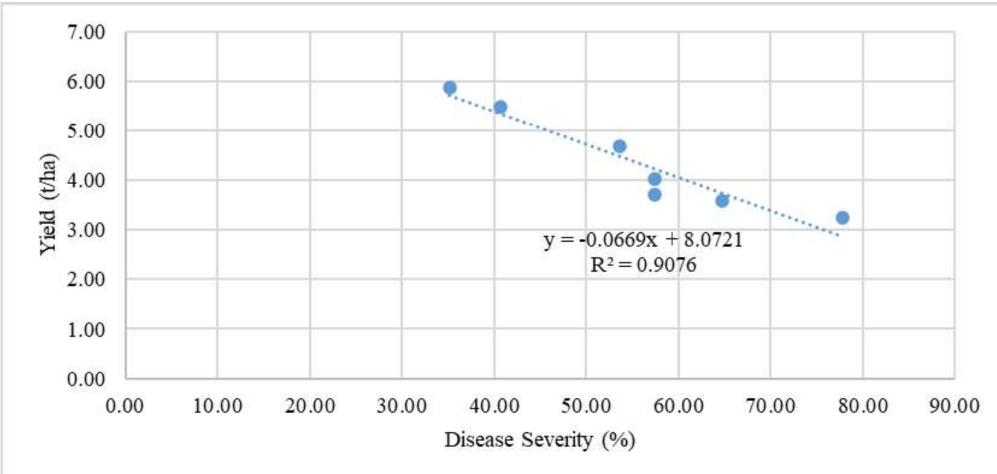

Fig. 1. Relationship between leaf blast severity and yield

Similarly, TAUDPC was also significantly negatively correlated with the yield. 84.84% yield reduction was determined by TAUDPC values and rest by other factors (Fig. 2).

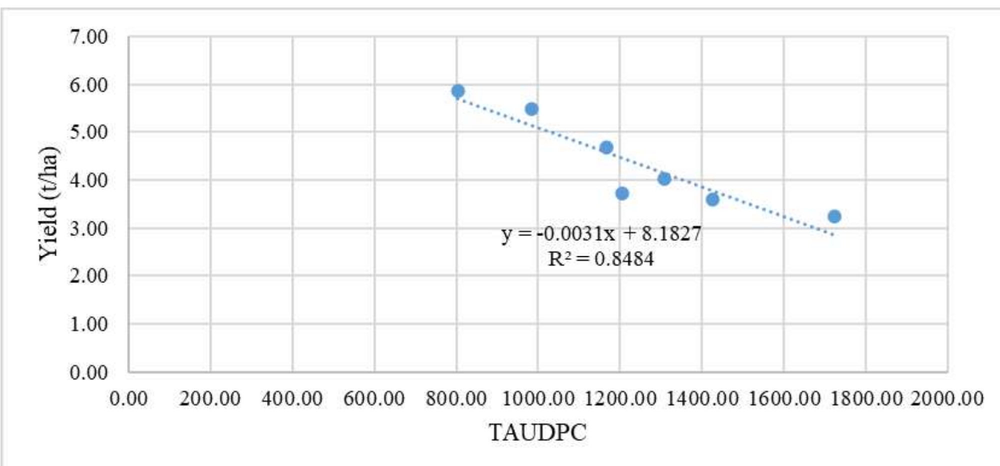

Fig. 2. Relationship of TAUDPC with yield

Test weight and grain yield of rice varied significantly among the treatments. Highest test weight of 25.88 g was found on Kasu-B, followed by Titepati leaf extract (24.25 g) and *T. viride* (23.47 g). Asuro leaf extract (22.06 g) and control (20.79 g) was significantly the least test weight. Treatment varied significantly in grain yield with maximum in Kasu-B (5.87 t/ha). After Kasu-B, Titepati leaf extract (5.49 t/ha) and *T. viride* (4.68 t/ha) respectively. The yield was highest with Kasu-B than with botanical and bio-control agents.

This was obviously due to their efficacy in reducing disease severity and increased test weight. This result was support by Pandey (2018) according to his research that the plot sprayed with botanicals gave effective increase in yield, however, less comparable to standard fungicides. Kasu-B (81.17%) showed highest yield over control, followed by botanical Titepati leaf extract (69.44%) and bio-control *T. viride* (44.44%) (Table 4). Our results are in conformity with Manandhar (1987) that the grain yield was also highest in Kasugamycin treated plot. Zafar (1986) got higher cost-benefit ratio with two and three application of Kasugamycin 2%WP than one application. The results concluded that applications of plant derived Titepati leaf extract showed an effective management of rice blast for the growers. They significantly improve all yield characters, which are effective in crop growth and grain yield. Moreover, applications of these products proved worth, as they are economical, feasible and nature-friendly. More research is required to enhance ingredient composition and their disease combating mechanism.

Table 4. Effect of different treatments on test weight, yield and increase in yield over control

Treatments	Test weight (g)	Yield (t/ha)	Increase in yield over control (%)
Foliar spray of Kasu-B (Kasugamycin 3% SL) @ 2 ml/l	25.88[a]	5.87[a]	81.17
Foliar spray of Nimbecidine (Azadirachtin 300 ppm) @ 10 ml/l	22.21[d]	4.02[d]	24.07
Foliar spray of stock solution of Asuro leaf extract @ 20 ml/l	22.06[d]	3.60[e]	11.11
Foliar spray of stock solution of Titepati leaf extract @ 20 ml/l	24.25[b]	5.49[b]	69.44
Foliar spray of *Trichoderma viride* @ 10 gm/liter	23.47[bc]	4.68[c]	44.44
Foliar spray of Kisan Pseudomonas (*Pseudomonas*) @ 10 ml/l	22.65[cd]	3.71[e]	14.51
Control (only water spray)	20.79[e]	3.24[f]	
Mean	23.04	4.37	
CV	2.09	3.169	
P value	***	***	
LSD value (P<0.001)	0.86	0.2465	
SEM value	0.278	0.08	

LSD: Least significant difference, SEM: Standard error of mean, CV: Coefficient of variance, ***: Significant at 0.001 level of significance

CONCLUSION

For the effective management of blast disease and increase in rice production, we must followed integrated approaches. In our finding, a fungicide, Kasugamycin @ 2 ml/l gave the maximum disease control with highest grain yield. Similarly, 2% stock solution of Titepati leaf extract as botanical and for bio-control, 1% *T. viride* application three times at 14 days interval are suggested for farmers.

ACKNOWLEDGEMENT

This project has been fully supported by Nepal Agricultural Research Council (NARC). The service rendered by Mr. Bhaju Man Maharjan (T-5) and Mr. Saroj Khadka in laying out the experiment and data recording are also duly acknowledged.

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