Tentative Identification of Critical Weather Factors to Circumvent Leaf Blast with Altered Dates of Sowing of Rice in the Foot-hills of Nagaland, India

D. K. Chetri*, L. Daiho and D. N. Upadhyay

Department of Plant Pathology, SASRD, Medziphema, Nagaland University, Dimapur district, Nagaland (797106) India

Article History

Manuscript No. 164
Received in 21st May, 2011
Received in revised form 12th June, 2011
Accepted in final form 4th September, 2011

Correspondence to

*E-mail: dkchetri@rediffmail.com

Keywords

Rice, leaf blast, date of sowing, weather

Abstract

Studies on the effect of date of sowing and meteorological factors on the rice leaf blast severity caused by *Pyricularia grisea* (=*P. oryzae* Cav.,), showed that the crop sown between mid April and mid May recorded significantly less disease severity compared to postponed dates of sowing likely due to more rainfall and high relative humidity. Except for bright sunshine hours exhibiting significant negative correlation with disease severity (r = -0.521), all other weather factors under study showed positive correlation with the same. The prediction equation ($Y=3.74+44.6x_1+8.14x_3-15.29x_4-2.58x_6+7.9x_7$) derived through multiple regression analysis would be useful for forecasting disease severity and can be used as a component of integrated disease management programme for minimizing fungicidal spray.

1. Introduction

Leaf blast disease of rice caused by *Pyricularia grisea* (=*Pyricularia oryzae* Cav.) is one of the important limiting factors in rice cultivation because of its serious and widespread occurrence especially in direct seeded upland paddy causing severe yield loss in Nagaland. It affects the crop in all stages of growth from seedling to maturity being endemic in North-Eastern Hill States in India (Anonymous, 1976). Management options include use of fungicides (Dubey, 2005), disease escape by circumvention of disease by alteration of the dates of sowing in respect of weather variables like temperature, RH, Rainfall and rainy days for transplanted rice (Sharma et al., 1992). As the leaf blast disease is severe in the widely cultivated direct seeded upland rice in the foot hills area of Nagaland, the present investigations were undertaken to study the effect of sowing dates and weather factors on severity of the disease and to understand their practical utility in the integrated disease management strategy of leaf blast.

2. Materials and Methods

The experiment was laid out during two consecutive *kharif* seasons, 2005 and 2006 at the experimental farm of the School of Agricultural Sciences and Rural Development (SASRD), Medziphema, Nagaland, located at 25°45'45" N latitude and 95°53'04" E longitude at an altitude of 310 msl. The experiment consisting of eight date of sowing was laid out in randomized complete block design having three replications with plot size of 2x3 m^2. Widely cultivated local upland rice cultivar of Nagaland '*Lekhumo'* susceptible to leaf blast was sown at an interval of 15 days starting from mid April. Sowing of rice seed was done by dibbling method following upland direct seeded rice culture technique. The leaf blast severity was recorded according to SES 0-9 scale (IRRI, 1985) adopting 2-diagonal sampling technique on 20 randomly selected hills at 30 days after sowing (DAS). The percent disease index (PDI) calculated as given below (Mckinney, 1923):

Maximum and minimum temperature, maximum and mini-

$$PDI = \frac{\text{Sum of numeral ratings}}{\text{Total number of plants observed}} \times \frac{100}{\text{Maximum category (9)}}$$

mum relative humidity, rainfall, no. of rainy days and duration of sunshine hours were recorded from meteorological observatory of ICAR, Jharnapani, Nagaland located at linear distance of 2 km from the experimental site bearing an altitude of 304.8 msl, and the data were averaged between the period of each recording starting from April to September in both the years. Correlation and multiple regression analysis were performed and a multiple linear model, $Y = a + b_i x_i + e$, was used to describe the functional relationship between disease severity and weather factors; where, Y= predicted mean disease severity; a=intercept; b_i=partial regression coefficient; $x_{i=}$independent variables (i=1, 2----n) and e=random error (Gomez and Gomez, 1984).

3. Result and Discussion

Severity of leaf blast was significantly influenced by date of sowing both in 2005 and 2006 including pooled analysis. The crop sown on 16th April showed less disease index (Table 1), which increased with postponement of sowing time. These results support the finding of Chowdhary and Vishwadhar (1988). In 2005, highest PDI (94.5%) was recorded on the 16th June sown data. However, during 2006, the 16th July sown data was at its highest PDI value (93.77%). Meteorological factors prevalent during this disease appearance (30 DAS) were favourable. Result of the analysis also indicates significant difference (p<0.05) in the year and year - treatment interaction. Tiwari and Chaure (1997) also reported that the age of the crop at the time of disease appearance and the meteorological factors prevalent during disease development played significant role. Among the two experimental years, the favorable year for disease development was 2006 as higher mean PDI value (69.69%) was recorded (Figure 1).

Table 1: Severity of rice leaf blast sown on different dates

Date of Sowing Year^{-1}	Percent disease index[a]		
	2005	2006	Pooled
16th Apr	5.03 (12.95)	1.10 (6.02)	3.65 (9.45)
1st May	4.87(11.66)	51.07(45.61)	27.97(28.63)
16th May	28.93(32.52)	81.80(65.03)	55.36(48.77)
1st Jun	89.67(72.30)	90.23(72.18)	89.95(72.24)
16th Jun	94.5(76.48)	84.33(66.77)	89.41(71.63)
1st Jul	79.67(63.43)	78.87(62.92)	79.27(63.17)
16th Jul	84.47(67.01)	93.77(75.79)	89.12(71.40)
1st Aug	83.73(66.32)	76.27(60.97)	80.00(63.64)
CD (p=0.05)			
Year	-	-	2.59
Treatment	8.27	7.05	5.19
Interaction	-	-	7.34

[a]Mean of three replications; figure in parenthesis are sine transformed value

This could be due to higher amount of early rainfall in May, whereas during 2005 higher rainfall was recorded in July and August.

Except for the minimum relative humidity all the weather parameters exhibited significant correlation with the disease

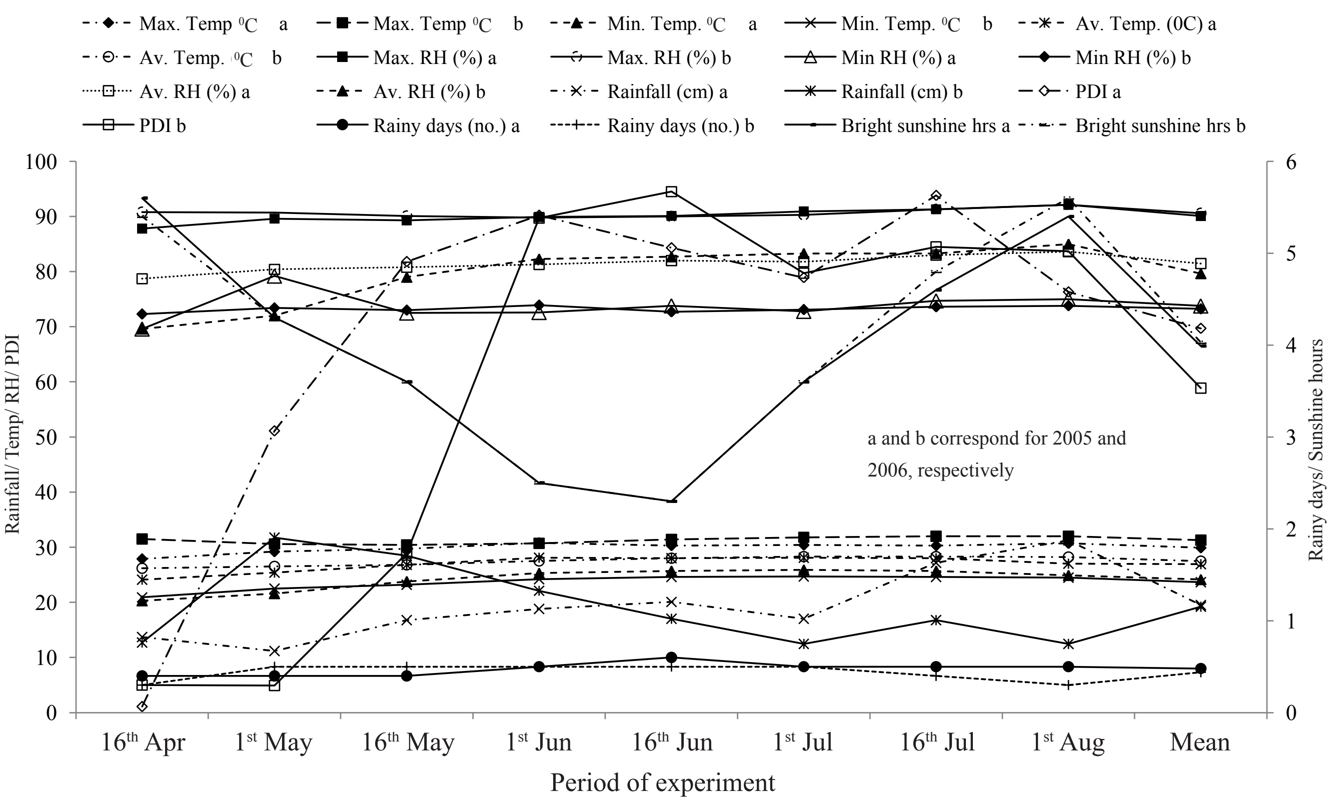

Figure 1: Average of weather parameters and incidence of rice leaf blast sown on different dates during 2005 and 2006

severity (Table 2). Highest positive correlation was observed with minimum temperature (r=0.981) followed by average temperature (r=0.976), average RH (r= 0.952), maximum temperature (r=0.881), no. of rainy days (r=0.688), maximum RH (r=0.539) and rainfall (r =0.442), whereas bright sunshine hour exhibited significantly negative correlation with PDI (r=-0.521) of leaf blast in two years pooled data. Tiwari and Chaure (1997) also reported significant positive correlation of leaf blast with rainfall. However, studies conducted in the northern region of Kerala during *kharif* 1989-91, Premanathan et al. (1999) reported rice blast severity to be positively correlated with bright sunshine hours, while rainfall and number of rainy days were negatively correlated. They attributed the rice leaf blast favorability to tropical, warm and humid agro-climatic zones with high annual average rainfall of 3500 mm prevailing during *kharif.* However, the present study area falls under sub tropical belt with lower average annual rainfall of 200-400 mm.

Lou et al. (1995) in a simulation studies on risk analysis of leaf blast reported that in cool sub tropical zones such as Japan and northern China, elevation of ambient temperature resulted in greater risk of blast epidemics whereas the situation was opposite in the humid tropics and warm humid sub-tropics where lower temperature resulted in a greater risk of blast epidemics. Non-significant correlation between maximum temperature and disease severity during 2006 could be possibly due to adverse effect of other meteorological factors like max. RH and rainfall and host factors.

Based on the results of multiple regression analysis (MRA), the prediction equation was fitted both for 2005 and 2006 as well as pooled data (Table 3a to 3c). During 2005, out of the nine weather factors under study only Maximum temperature, minimum temperature, average relative humidity, rainfall and rainy days contributed significantly (p=0.1) towards disease severity, whereas during 2006 only minimum and average temperatures were significant (p=0.1). Analysis of the pooled data (Table 3c) showed that maximum temperature, average temperature, maximum relative humidity, average relative humidity and rainfall finally contributed to disease severity. The R^2 values showed that these weather factors played an important role in the development of the leaf blast. Thus, the prediction equation $Y=3.74+44.6x_1+8.14x_3-15.29x_4-2.58_{x6}+7.9x_7$

Table 2: Correlation coefficient (r) between weather factors and Per cent disease index (PDI) of rice leaf blast

Year	Correlation Coefficient (r)								
	Weather factors								
	X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	X_9
2005	0.882**	0.934**	0.901**	0.738**	-0.042	0.805**	0.696**	0.894**	-0.464*
2006	0.026	0.908**	0.739**	-0.178	0.627**	0.867**	0.113	0.504*	-0.527**
Pooled	0.881**	0.981**	0.976**	0.539**	0.199	0.952**	0.442*	0.688**	-0.521**

*,** significant at p=0.05 and p=0.01, respectively; X_1= Maximum temperature; X_2=Minimum temperature; X_3=Average temperature; X_4=Maximum relative humidity; X_5=Minimum relative humidity; X_6=Average relative humidity; X_7=Rainfall; X_8=Rainy days; X_9=Bright sunshine hours

Table 3a: Stepwise regression analysis between weather factors and percent disease index (PDI) of leaf blast during 2005

Variable	Parameter Estimate	Standard Error	Type II SS	Model R^2	F Value	Pr > F
Intercept (a)	332.30302	153.20077	107.34145	-	4.70	0.0437
Maximum Temperature (X_1)	11.16968	3.51769	230.03100	0.8691	10.08	0.0052
Minimum Temperature (X_2)	5.82648	1.64169	287.37565	0.9298	12.60	0.0023
Average R/humidity (X_6)	-10.65921	2.45230	431.04646	0.9436	18.89	0.0004
Rainfall (X_7)	4.79761	0.93828	596.49966	0.9589	26.15	<0.0001
Rainy Days (X_8)	157.00814	24.96457	902.43748	0.9736	39.55	<0.0001

Table 3b: Stepwise regression analysis between weather factors and percent disease index (PDI) of leaf blast during 2006

Variable	Parameter Estimate	Standard Error	Type II SS	Model R^2	F Value	Pr > F
Intercept (a)	42.85347	68.48520	16.62565	-	0.39	0.5382
Minimum Temperature (X_2)	29.89028	2.99546	4227.99193	0.8068	99.57	<0.0001
Average R/humidity (X_3)	-25.21736	4.74215	1200.73692	0.9177	28.28	<0.0001

Table 3c: Stepwise regression analysis between weather factors and percent disease index (PDI) of leaf blast (Pooled)

Variable	Parameter Estimate	Standard Error	Type II SS	Model R-Square	F Value	Pr > F
Intercept (a)	332.30302	153.20077	107.34145	-	4.70	0.0437
Maximum Temperature (X_1)	11.16968	3.51769	230.03100	0.8691	10.08	0.0052
Average Temperature (X_3)	5.82648	1.64169	287.37565	0.9298	12.60	0.0023
Maximum R/humidity (X_4)	-10.65921	2.45230	431.04646	0.9436	18.89	0.0004
Average R/humidity (X_6)	4.79761	0.93828	596.49966	0.9589	26.15	<0.0001
Rainfall (X_7)	157.00814	24.96457	902.43748	0.9736	39.55	<0.0001

(where, Y=predicted disease severity; x_1=max. temp.; x_3=avg. temp.; x_4=max. RH; x_6=av. RH; x_7=rainfall) on pooled data (Table 3c) can be used for forecasting leaf blast severity in the area. Six reliable equations with R^2 values of 89 to 95% were derived by Tsai (1986) by using MRA between meteorological variables (RH, hours of RH over 95%, rainfall and rainy days) and the blast infected leaf area.

4. Conclusion

From this study it is indicated that by altering the sowing date between mid April to May last, the crop can be saved from heavy infection of leaf blast. The rice leaf blast is favored by temperature (25-31°C), relative humidity (90%) and higher rainfall, more number of rainy days and cloudy weather. The prediction equation derived through the present study may be useful in forecasting of leaf blast severity in upland direct seeded rice culture in the foot hills of Nagaland, which can be utilized as a component of integrated disease management programme for minimizing fungicidal spray for the control of the disease. However its practical utility in other area needs further longer-term investigation since such predictions cannot be extrapolated across its limits.

5. References

Anonymous, 1976. Survey of plant diseases of important Agricultural and Horticultural crops of North-eastern Hill region. In: Annual Report, ICAR Res. Complex for NEH region, Shillong, 146-150.

Chaudhary, R.G., Vishwadhar, 1988. Epidemiology of rice blast and Effect of date of sowing under upland condition of Arunachal Pradesh. Indian Phytopathology 41(4), 552-557

Dubey, S.C., 2005. Efficacy of fungicides against blast (*Pyricularia grisea*) of rice *(Oryza sativa*). Indian Journal of Agricultural Sciences 75 (6), 367-368.

Gomez, K.A., Gomez A.A., 1984. Statistical procedure for Agricultural Research, Ed 2. John Willey and Sons.

Lou, Y., TeBeest, D.O., Teng, P.S., Fabellar, N.G., 1995. Simulation studies on risk analysis of rice leaf blast epidemics associated with global climate change in several Asian countries. In: Terrestrial Ecosystem Interaction with Global change. Vol.2 (Jul.-Sep., 1995) pp 673-678.Published by Blackwell publishing. Access from http://www.jstor.org/stable/2845969

McKinney, H.H., 1923. A new system of grading plant disease. Journal of Agricultural Research 26, 195-218.

Premanathan, T., Prasad Rao G.S.H.L.V., Mahana, N.K., 1999. Forecasting of rice blast severity in northern region of Kerela. Oryza 36(4), 364-368.

Sharma, S., Kumar, S., Verma, R.N., 1993. Relationship between rice blast and meteorological factors in Nagaland. Indian Phytopathology 46(1), 78-79.

IRRI, 1985. Standard Evaluation System (SES), International Rice Research Institute. Manila, Philippines.

Tsai, W.H., 1986. Prediction of rice leaf blast. III. Meteorological variables and percentage of leaf area infected by *Pyricularia oryzae*. Plant Protection Bulletin 28,111-118

Tiwari, R.K.S., Chaure, N.K., 1997. Effect of date of sowing and meteorological factors on epidemiology of leaf blast *(Pyricularia oryzae* Cav.) of rice in Chattisgarh, Madhya Pradesh. Indian Journal of Plant Protection 25 (1), 27-31.