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STATISTICAL ANALYSIS AND FORECASTING OF RICE BACTERIAL LEAF BLIGHT (BLB) BASED ON CLIMATE FACTOR IN SPSR NELLORE DISTRICT OF ANDHRA PRADESH

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ABSTRACT

This paper presents the rice Bacterial Leaf Blight (BLB) severity and the influence of climatic factors in rice growing in SPSR Nellore district of Andhra Pradesh. The data analysis on BLB incidence with the climate factors in standard weeks of rice growing seasons from 2003 to 2013 revealed that the rainfall distribution varied greatly within rice growing seasons and also over years. The average minimum temperature 23°C, average maximum temperature 29°C, morning relative humidity (81 – 97%) and evening relative humidity (66-90%) observed during crop seasons over years. The BLB severity during the years 2003, 2004, 2005 and 2008 was mild to moderate and during 2009 and 2011 was high. Analysis of 11 years (2003-2013) weather data revealed that the days with RH > 91%, temperature (20°C-31°C) and weekly rainfall are the most critical factors in the development of BLB incidence. The correlation studies revealed that, among the climate variables minimum temperature exhibits negative correlation. Rainfall, maximum temperature, morning relative humidity and evening relative humidity were positively correlated while wind velocity imparted significant positive correlation with bacterial leaf blight infestation. The different combinations of climate factors are found to be useful in the prediction of rice blast through MLR and Logistic regression models. The ANOVA carried out for testing the significance between standard weeks/varieties with respect to BLB incidence.

KEY WORDS: ANOVA, Bacterial leaf blight, Climate factors, Logistic regression, MLR models,

INTRODUCTION

Bacterial leaf blight (BLB), is the major bacterial disease of rice caused by *Xanthomonas oryzae* pv. *oryzae* (ex Ishiyama) Swings *et al*. (1990) is found in most irrigated, rainfed and deep water temperate and tropical rice growing areas. The Blight of rice affect filling of the grains and emergence of panicles. Bacterial leaf blight is devastating and can cause yield losses from 20 to 74 per cent in South-East Asia and India.

Adhikari *et al.* (1994) reported that, bacterial leaf blight progression was highly correlated with environmental factors. Highly significant ($p < 0.01$) correlation was demonstrated between Area Under the Disease Progress Curve (AUDPC) in Philippines during the 1998 and 1990 seasons. Kapoor *et al*. (2004) reported that, the rainfall and distribution varied significantly within growing seasons during 1979-1999. The average monthly temperature (18 – 28°C) and RH (>90%) for more than 9 hours was within the optimum range for disease development. Umer Jamshed *et al*. (2008) concluded that disease severity almost produced high correlation coefficients with monthly average relative humidity and total precipitation both of which dictate leaf wetness duration. Henderson *et al*. (2007) concluded that, of the 12 weather variables examined from potato producing regions across Southern Idaho, two were significant in predicting disease occurrence in the logistic model.

The construction of disease forecasting system, it is imperative to know weather conditions conducive for incidence and spread of particular disease on rice crop. Hence an attempt has been made to generate information for disease forecasting using weather factors.

MATERIAL AND METHODS

The secondary data pertaining to bacterial leaf blight (BLB) incidence on various rice varieties collected from the field experiments conducted under irrigated conditions during *Rabi*, *Kharif* and early *Kharif* season at Agricultural Research Station, Nellore along with climate factors data

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from 2003 to 2013. To work out the relationship between weather parameters and BLB incidence and to forecast BLB incidence, the data was analysed by using the various statistical techniques *viz.,* Simple statistics, Correlation, Multiple Linear Regression (MLR), Logistic Regression and ANOVA. The data was analysed by using SAS 9.3 software.

RESULTS AND DISCUSSION

The data analysis on bacterial leaf blight (BLB) incidence with the weather factors in standard weeks of rice growing seasons from 2003 to 2013 revealed that the rainfall distribution varied greatly within rice growing seasons and also over years. The average minimum temperature 23°C, average maximum temperature 29°C, morning relative humidity (81 – 97%) and evening relative humidity (66 – 90%) observed during crop seasons over years. The BLB severity during the years 2003, 2004, 2005 and 2008 was mild to moderate and during 2009 and 2011 was high. Analysis of 11 years (2003-2013) weather data revealed that the days with RH > 91%, temperature (20°C – 31°C) and weekly rainfall are the most critical factors in the development of BLB incidence (Table 1).

The analysis for the 2009 *kharif* weekly data on bacterial leaf blight (BLB) infestation and weather factors revealed that there exists positive correlation with minimum temperature (0.27), morning relative humidity (0.53) and wind velocity (0.05) while evening relative humidity (0.67) exhibits significant positive correlation. Rainfall (-0.08) and maximum temperature (-0.35) are negatively correlated with the bacterial leaf blight infestation. The MLR model was developed with respect to these factors with $R^2 = 0.74$.

The data analysis pertaining to the *rabi* 2011 for the rice variety NLR 34242 revealed that, among weather parameters wind velocity (0.28) showed positive correlation and the factors rainfall (-0.26) and maximum temperature (-0.61) exhibited negative correlation while minimum temperature (-0.68), morning relative humidity (-0.76) and evening relative humidity (-0.78) exhibit significant negative correlation. From the multiple regression equation it was observed that the influence of weather factors on bacterial leaf blight infestation is 99%.

Overall for the years 2003-2013, correlation studies revealed that, among the climate variables minimum temperature (-0.28) exhibits negative correlation. Rainfall (0.10), maximum temperature (0.2), morning relative humidity (0.4) and evening relative humidity (0.2) were positively correlated while wind velocity (0.52) imparted significant positive correlation with bacterial leaf blight infestation. The MLR model was developed with respect to these factors with $R^2 = 0.58$ (Table 2). The predictions of BLB incidence were shown in Figure 1.

As per the Pathology seasonal incidence data (*Kharif* 2010); analysis of the data pertaining to the bacterial blight incidence on four rice varieties (NLR 34449; NLR 34242; MTU 1010; and BPT 5204), and the impact of different dates of sowing (20th Sept 2010 through 20th Oct 2010 at 10 days interval) revealed that, the bacterial blight incidence was noticed only in the variety BPT 5204. When BPT 5204 was sown on 20th Sept 2010, the variety completely escaped the disease incidence. However, for other three dates of sowing under study, the disease incidence was ranged maximally from 10 to 50%. The other three varieties were completely escaped the disease in all dates of sowing. The disease incidence is not uniform in all the four varieties under study (Table 3).

The logistic regression model was fitted for development of Bacterial leaf blight of various standard weeks. The validation for the year 2013, the probability of BLB development in the 51 and 52nd weeks (December 17th – December 31st) is found to be P (z =1) = 0.0046 < 0.5. Hence, the model reveals that, the probability of occurrence of BLB infestation in the 51 and 52nd standard weeks of the year 2013 is low and the same (no incidence) was recorded in the year 2013. Therefore, the model will be useful for predicting the presence and absence of BLB disease (Table 4).

The analysis of variance on occurring of bacterial leaf blight infestation established that there is significant difference between the varieties (NLR 34449, NLR 34242, MTU 1010, BPT 5204) and between the standard weeks 44, 45, 47 and 5 (October 29th – January 7st) in the year 2008. Almost the same results were established in the year 2009 for the varieties (NLR 34449, NLR 34242, MTU 1010, BPT 5204) and standard weeks 43, 44, 45 and 47 (October 22nd – November 25th) (Table 5). Among four varieties high BLB incidence were noticed on NLR 34449 followed by NLR 34242 variety and low incidence noticed on the MTU 1010 variety. Among four standard weeks, in the 45th week high BLB incidences were noticed. The distribution of BLB incidence for different varieties/ standard weeks were shown in the Figure 2 and 3.

Table 1. Simple Statistics for bacterial leaf blight during the years 2003 to 2013

Variable	N	Mean	Std Dev	Minimum	Maximum
BLB	11	26.58	14.42	0.0013	45.00
Rainfall	11	70.77	111.21	1.20	392.60
Tmax	11	28.52	1.54	26.18	30.83
Tmin	11	22.63	1.72	19.86	24.96
RH FN	11	91.06	4.15	81.43	97.00
RH AN	11	75.97	8.48	66.43	90.00
WV	11	5.51	0.83	3.70	6.53

Table 2. Multiple regression functions for the prediction of bacterial leaf blight

Year	Variety	Equation	R^2
2009 (*Kharif*)	NLR 34242	$-316.18 + (-0.16)X_1 + (2.15)X_2 + (2.45)X_3 + (2.7)X_4 + (-0.15)X_5 + (-4.5)X_6$	0.74
2011 (*Rabi*)	NLR 34242	$294.43 + (-0.38)X_1 + (-10.05)X_2 + (6.07)X_3 + (-0.12)X_4 + (-1.82)X_5 + (3.16)X_6$	0.99
2003-2013	(Polled)	$0.36 + (0.55)X_1 + (0.27)X_2 + (0.29)X_3 + (0.41)X_4 + (0.71)X_5 + (0.16)X_6$	0.58

Table 3. Bacterial blight incidence of various varieties rice in different dates of sowing (*kharif'* 2010)

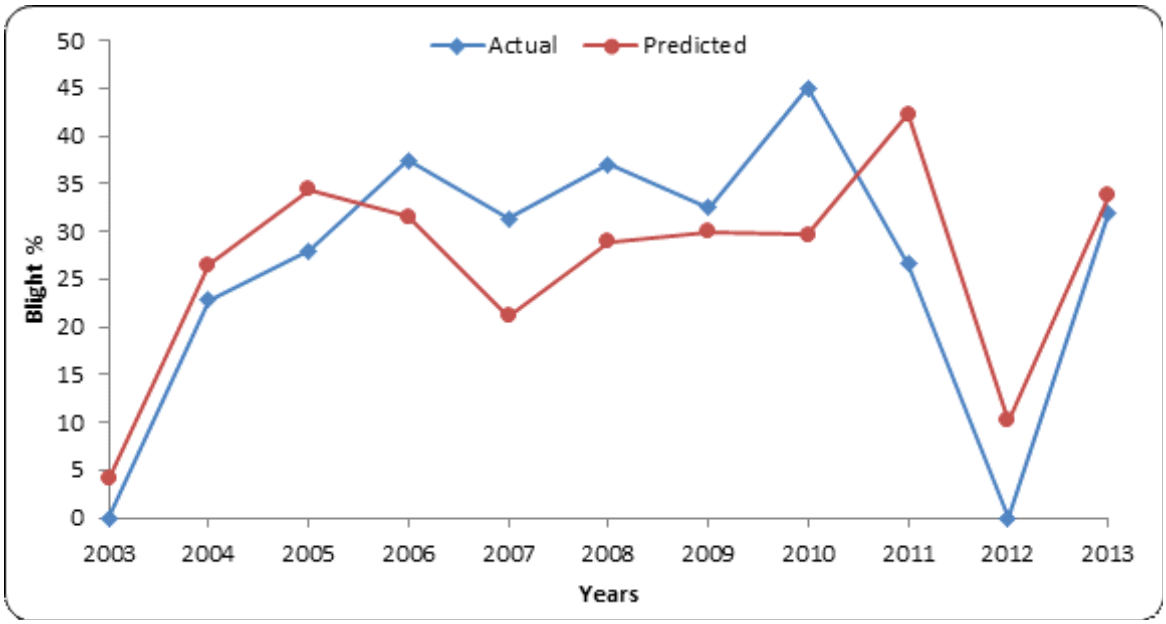
Variety	Dates of Sowing (% Bacterial blight maximum)			
	20-9-2010	30-9-2010	10-10-2010	20-10-2010
NLR 34449	0.00	0.00	0.00	0.00
NLR 34242	0.00	0.00	0.00	0.00
MTU 1010	0.00	0.00	0.00	0.00
BPT 5204	0.00	**50.00**	**50.00**	10.00

Table 4. Logistic regression function of climate factors with bacterial leaf blight incidence for the standard weeks 51 and 52nd

Disease	Equation	R^2
Blight	$290.6 + (4.85)X_1 + (4.02)X_2 + (-28.9)X_3 + (0.49)X_4 + (2.06)X_5$	0.99

Table 5. Analysis of variance between varieties and standard weeks on BLB incidence in 2008 and 2009

Year	Source	DF	SS	Mean Square	F Value	Pr > F
2008	Varieties	3	229.6712	76.5570	4.78	0.0294
	Standard weeks	3	196.4991	65.4997	4.09	0.0436
2009	Varieties	3	61.1613	20.3871	3.48	0.0636
	Standard weeks	3	751.3288	250.4429	42.75	<.0001



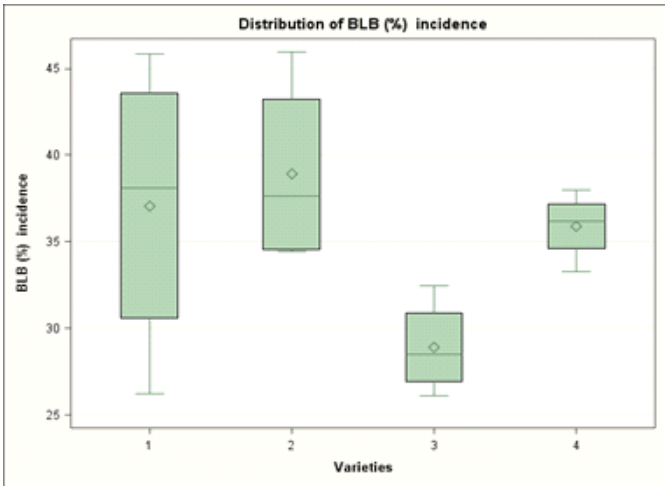


Fig. 2. Distribution of BLB incidence for different varieties in the year 2008

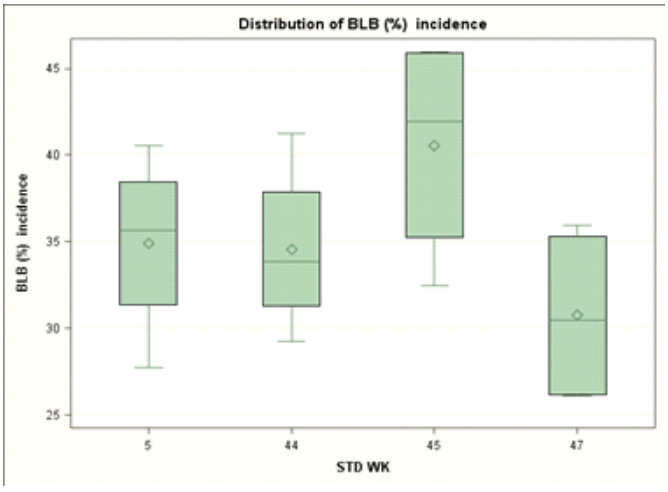


Fig. 3. Distribution of BLB incidence in different standard weeks in the 2008

Finally it concludes that, the different combinations of climate factors are found to be useful in the prediction of rice BLB. During 45th standard week (5th – 11th September) high BLB incidence were noticed and low incidence noticed on MTU 1010 variety under recorded climatic conditions. The developed MLR models for within year and between years and logistic models were found to be useful in the prediction of BLB diseases incidence. Such information helps the farmer's to minimize the losses in crop yield due to disease. Early warnings allow timely and need-based application of disease control measures and prevent application of unnecessary interventions.

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