Plant Archives Vol. 14 No. 2, 2014 pp. 1011-1014 *ISSN 0972-5210*

EFFECT OF WEATHER FACTORS ON EARLY BLIGHT DISEASE DEVELOPMENT IN POTATO

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Abstract

An experiment was carried out in farmer's field of Narendra village near University of Agricultural Sciences , Dharwad (Karnataka), India during *Kharif* 2013 to study the disease development of early blight of potato in relation to weather factors. The weather data was collected from Main Agricultural Research Station, University of Agricultural Sciences, Dharwad (Karnataka), India. The studies revealed that per cent disease index (PDI) was progressing at linear rate throughout the plant growth period and it was negatively correlated with minimum temperature, relative humidity (morning and evening). While positively correlated with maximum temperature and cumulative rainfall. The multiple regression model developed for PDI is $Y= 753.41 – 5.88 X_1 + 28.71 X_2 -11.82 X_3 - 0.78 X_4 + 0.24 X_5$ with R^2 value of 0.98 . The observed and predicted values were in close resemblance to each other.

Key words : *Alternaria solani*, early blight, potato and weather factors.

Introduction

Potato (*Solanum tuberosum* L.) is an important food crop of the world. It is used as vegetable, stock feed and in industries for manufacturing starch, alcoholic beverages and other processed products. Potato is the world's fourth-largest food crop, after maize, wheat and rice. Potato is a highly nutritious food. It provides carbohydrates, proteins, minerals, Vitamin C, a number of B group vitamins and a high quality dietary fiber.

Among all the diseases early blight caused by *Alternaria solani* (Ellis and Martin) Jones and Grout is one of the very important, old and well known diseases of potatoes. It occurs almost everywhere where the potatoes are grown. This disease has been underrated contrast to the more spectacular late blight. Environmental factors such as temperature, wetness duration and relative humidity affect the development of early blight of potato. Yield loss is upto 6-40%. Weather is main limiting factor for early blight disease development since it is beyond our control. So early blight disease development in relation to weather factors has been studied.

Materials and Methods

The effect of weather factors like temperature (maximum and minimum), relative humidity (morning and evening in per cent) rainfall (mm) and number of rainy days on the incidence and development of early blight was studied in the farmer's field near University of Agricultural Sciences, Dharwad campus. The meteorological observations at Main Agriculture Research station, UAS Dharwad were used for this experiment. This study was undertaken during *kharif* 2013. The observations were made on disease incidence and severity starting from first day of its appearance and till the end of the crop. It was correlated with weather parameters by simple correlation.

In the field *i.e.* in control where no fungicides sprays were taken up, 50 plants were examined randomly and scored for disease severity by following 0-9 scale and details of the scale are shown below (Mayee and Datar, 1986).

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Disease scale

Numerical rating	Description
0	No symptoms on leaf
1	Small, irregular brown spots covering 1% or less of the leaf area
3	Small, irregular, brown spots with concentric rings covering 1-10% of the leaf area.
5	Lesions enlarging, irregular, brown with concentric rings covering 11-25% of the leaf area.
7	Lesions coalesce to form irregular brown patches with concentric rings covering 26-50% of the leaf area. Lesions also on stem and petioles.
9	Lesions coalescing to form irregular, dark brown patches with concentric rings covering 51% or more of the leaf area. Lesions seen on the stem and petiole.

Percent disease index (PDI) was calculated by using the following formula (Wheeler, 1969).

$$PDI = \frac{\text{Sum of numerical ratings}}{\text{Total number of leaves observed} \times \text{Maximum disease score}} \times 100$$

The planting was taken on the 7th June, 2013. Observations were taken from 27th standard week at weekly interval.

Results and Discussion

The experimental data, which is presented in table 1 clearly depicts the relationship between the weather factors like temperature, relative humidity and rainfall with the development of the early blight of potato. The PDI was lowest during 27th standard week (5.67) and increased throughout the cropping period. It was peak during last stage that is 34th and 35th standard week (72.66 and 78.33), respectively.

During crop growth period maximum temperature ranged from 23.9^{0}C (30th standard week) to 29.4^{0}C (35th standard week), minimum temperature from 19.3^{0}C (35th standard week) to 20.7^{0}C (29th standard week), relative humidity (morning) from 91 per cent (35th standard week) to 95 per cent (27th – 31st standard week) and relative humidity (evening) from 63 per cent (35th standard week) to 88 per cent (30th standard week). Cumulative rainfall was 276 mm during the crop growth period. Early blight develops more rapidly during periods when environmental conditions alternate between humidity and drought. The attacks cause serious economic losses in potato crops (Bashi and Rotem, 1975). Many scientists have developed epidemiological models, in order to predict when the disease will occur and take up the control measures (Díaz *et al*., 1998; Fry, 1998; Johnson *et al*., 1998 and Shtienberg *et al*., 1989). Almost all these models are

Table 1 : Effect of weather parameters on Per cent Disease Index (PDI) of early blight of potato during *Kharif* 2013.

Standard week no.	Month and date	Age of the crop (Days)	PDI	Temperature (°C)		Relative humidity (%)		Cumulative rainfall (mm)
				Maximum	Minimum	Morning	Evening	
27	July 2-8	25	5.67	26.7	20.6	95.0	74.0	16.2
28	July 9-15	32	14.00	25.5	20.3	95.0	81.0	44.0
29	July 16-22	39	27.33	25.7	20.7	95.0	84.0	80.8
30	July 23-29	46	38.67	23.9	20.1	95.0	88.0	166.4
31	July 30-Aug 5	53	46.00	25.0	20.1	95.0	85.0	226.0
32	Aug 6-12	60	53.66	27.2	20.0	94.0	78.0	244.4
33	Aug 13-19	67	67.00	26.3	20.5	95.0	79.0	256.4
34	Aug 20-26	74	72.66	26.3	19.5	92.0	79.0	268.0
35	Aug 27-Sept 2	81	78.33	29.4	19.3	91.0	63.0	276.0

Table 2 : Correlation coefficient(r) for early blight of potato with weather parameters during 2013.

Weather parameters	Correlation coefficient(r)
Maximum temperature (^{0}C)	0.45
Minimum temperature(^{0}C)	-0.73*
Relative humidity (morning) (%)	-0.71*
Relative humidity (evening) (%)	-0.36
Cumulative rainfall (mm)	0.96*

* = Significant at P=0.05.

Table 2a : Correlation between PDI of early blight of potato in relation to weather parameters during 2013.

Parameters	Y	X_1	X_2	X_3	X_4	X_5
Y PDI	1.000					
X_1 Maximum temperature (^{0}C)	0.459	1.000				
X_2 Minimum temperature (^{0}C)	-0.737*	-0.487	1.000			
X_3 Relative humidity (morning) (%)	-0.719*	-0.733	0.902	1.000		
X_4 Relative humidity (evening) (%)	-0.360	-0.958	0.490	0.729	1.000	
X_5 Cumulative rainfall (mm)	0.963*	0.335	-0.695	-0.592	-0.234	1.000

* = Significant at P=0.05

Table 3 : Multiple linear regression between PDI of early blight of potato in relation to weather parameters during 2013.

Parameter	X_1 Maximum temperature (^{0}C)	X_2 Minimum temperature (^{0}C)	X_3 Relative humidity (morning) (%)	X_4 Relative humidity (evening) (%)	X_5 Cumulative rainfall (mm)
ß-Value(RC)	-5.88	28.71	-11.82	-0.78	0.24
SE of ß(r)	4.60	10.91	3.73	0.90	0.02
Intercept	753.41				
R^2 value	0.98				
Multiple linear regression equation $Y=a+ß_1X_1+ß_2X_2+ß_3X_3+ß_4X_4+ß_5X_5$					
$Y= 753.41 – 5.88\ X_1 + 28.71\ X_2 - 11.82\ X_3 - 0.78\ X_4 + 0.24X_5$					

Where,
Y= PDI X_1 =Maximum temperature (^{0}C) X_2 = Minimum temperature (^{0}C) X_3 =Relative humidity (morning) (%)
X_4= Relative humidity (Evening) (%) X_5 =Rainfall (mm)

Table 4 : Observed and predicted PDI of early blight of potato during *kharif* 2013.

Time interval (week)	Per cent disease index (PDI)	
	Observed	Predicted
1	5.67	13.58
2	14.00	13.19
3	27.33	31.38
4	38.67	41.17
5	46.00	52.50
6	53.66	56.74
7	67.00	63.93
8	72.66	76.74
9	78.33	75.05

based on the use of meteorological parameters, especially relative humidity, temperature and rainfall.

Correlation of PDI with weather parameters

The PDI obtained at different stages of crop growth were correlated with weather parameters recorded during the respective stage. The correlation coefficients are presented in table 2 and 2a. The results in Tables reveals that during 2013, maximum temperature (r = 0.45) was non significantly positively correlated with PDI, minimum temperature (r = -0.73) was significantly negatively correlated with PDI. Morning relative humidity (r = -0.71) was significantly negatively correlated with PDI and evening relative humidity (r = -0.36) was non significantly negatively correlated with PDI. While, cumulative rainfall (0.96) was significantly positively

correlated with PDI.

Alternaria is a saprophytic fungus with an optimal development shown to occur in the temperature ranges of 22–28°C (Hjelmroos, 1993). Relative humidity may not play a major role in early blight disease development. The results found in conformity with Sabariego *et al.* (2000), who reported that negative correlation was observed with humidity. Mehboob *et al*. (2013) also reported relative humidity and wind speed almost had no significant effect on early blight severity of potato. The rainfall during the experimental period might have favoured conidial germination, multiplication and disease development. Kulkarni (1998) reported that intermittent rainfall was found to be more favorable for early blight development in potato.

The data are again subjected to multiple linear regression analysis. The regression co efficient for PDI is given in the table 3.

The regression equation is

$$Y = 753.41 - 5.88X_1 + 28.71X_2 - 11.82X_3 - 0.78X_4 + 0.24X_5$$

Out of five weather variables selected for the study, only cumulative rainfall was found to be contributing significantly negative impact on PDI, while all other variables showed non significant. Including variables maximum and minimum temperature and relative humidity (morning and evening) and rainfall with $R^2 = 0.98$. This indicates that the disease was highly related with weather factors. The increase in severity of the disease was highly dependent on weather parameters. According to these models, the observed and predicted disease severities of early blight of potato during *kharif* 2013 are given in table 4. The results in Table gave actual and predicted PDI value which were in close resemblance to each other.

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