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STUDIES ON EPIDEMIOLOGY OF MAJOR DISEASES OF HORTICULTURAL CROPS

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Abstract

The field experiment was carried out to understand the development of Purple leaf blotch of onion, Early blight of Tomato and Turmeric leaf spot with respect to weather conditions during *kharif* 2011, 2012, 2013 and 2014 at Horticultural Research Station, Mahanandi, Kurnool dt., Andhra Pradesh, India. The data on these three diseases was recorded at each standard week. Corresponding daily weather data was recorded on four consecutive years (2011-2014) during rainy season (July to December). Four years disease data was correlated with corresponding weather data. The weather variables, which showed significant correlation with disease incidence were used for the development of regression equation. The purple leaf blotch, early blight of tomato and turmeric leaf spot were high during 41-46 weeks. Prediction equations were developed for Purple leaf blotch of onion, Early blight of Tomato and Turmeric leaf spot by using three years (2011, 2012 and 2013) disease incidence (Arc sine transformed) and corresponding historical weather data (weekly average). Validation was done with current year disease data (2014) and corresponding weather data. Validation was done for testing the goodness of fit using 2014-15 data. The three equations predicting the next week's disease incidence and showing the disease trend very efficiently in the three pathosystems.

Key words : Fungal diseases, turmeric leaf spot, relative humidity, *Allium cepa* L., Curcuma *longa* L.,

Introduction

Among the horticultural crops, onion, tomato and turmeric are important commercial crops, which are affected by key foliar diseases *viz*., puriple leaf blotch (*Alternaria porri*), early blight (*Alternaria solani*) and leaf spot (*Colletorichum capsici*), respectively. These fungal diseases are highly weather driven air borne diseases. Hence, present studies were taken up to study the influence of major weather factors *viz*., temperature, relative humidity and rainfall on disease progress.

Onion (*Allium cepa* L.) is a high value spice cum bulbous vegetable crop cultivated in almost all parts of the country. In India, onion occupies an area of 0.52 million hectare with the production of 6.50 million tonnes. Even though India ranks first in area under onions in the world and second in production, but its productivity is low (12.5 t/ha) as compared to worlds productivity (Anonymous, 2004). Among several factors, diseases are the most important factors associated with low productivity in onion. Purple blotch caused by *Alternaria porri* is one among the serious fungal diseases that affect onion, causing heavy yield loss ranging from 2.5 to 87.8 per cent during *kharif* season (Srivastava *et al*., 1994).

Tomato production is severely affected by several diseases at all growing stages from seedling to maturity causing considerable reduction in yield (Balanchard, 1992). Of these, early blight caused by the necrotrophic fungus *Alternaria solani* (Ellis and Martin) Jones and Grout, is one of the most common foliar diseases of tomato occurring over a wide range of climatic conditions. Early blight of tomato is important in reducing crop yields (Sahu *et al*., 2013a). Yield losses up to 79% due to early blight.

Turmeric (*Curcuma longa* L.) is intensively cultivated in Andhra Pradesh. The important foliar disease on turmeric reported in Andhra Pradesh is leaf spot caused by *Collectotrichum capsici* [(Syd.) Butler & Bisby]. Leaf spot generally appears in the last week of August or first week of September *i.e*. when the crop is two months old. *C. capsici* is reported to reduce dry rhizome yield by 62.7% (Nair and Ramakrishnan, 1973). It has become a major constraint in successful cultivation of turmeric and

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management of *Colletotrichum* leaf spot is difficult because of rapid disease development. Obviously, prediction of disease occurrence will be the best strategy for optimizing disease management. It can be achieved by monitoring the environmental factor conducive for successful infection of the pathogen.

Materials and Methods

The experiment was conducted in fixed plot design with a spacing of 30 × 15 cm in onion and turmeric and in tomato 60 × 45 in an area of 10 × 10 M. Local popular varieties *viz*., Agrifound Dark Red in onion, NP-5005 in Tomato and Mydukur in turmeric were grown. General agronomical practices were followed for management of these crops. Observations were recorded at first appearance of the disease symptoms on leaves till the harvest at weekly intervals. The percent disease intensity was recorded by using 0-5 scale for onion purple leaf blotch. (Sharma, 1986), 0-5 scale for tomato early blight by Horsefall and Barett (1945) and 0-6 scale for turmeric leaf spot.

The details of 0-5 scale (Sharma, 1986) in onion purple blotch

Scale	Description of the symptoms
0	No disease symptom
1	A few spots towards tip covering 10 per cent leaf area.
2	Several purplish brown patches covering upto 20 per cent of leaf area.
3	Several patches with paler outer zone covering upto 40 per cent leaf area.
4	Leaf streaks covering upto 75 per cent leaf area or breaking of the leaves from center.
5	Complete drying of the leaves or breaking of leaves from center.

The details of 0-5 grade scale as given by Horsefall and Barett, 1945 in tomato early blight

Scale	Description of the symptoms
0	Leaves free from infection
1	Small irregular spots covering <5% leaf area
2	Small irregular brown spots with concentric rings covering 5.1-10%
3	Lesions coalease to form irregular and appears as a typical blight symptom covering 10.1-25% leaf area.
4	Lesions. enlarging, irregular brown with concentric ring covering 10.1-25% leaf area 25.1 to 50% leaf area
5	Lesions coalease to form irregular and appears as a typical blight symptom covering >50% leaf area

Turmeric

The disease rating was recorded by adopting 0-6 scale (Palarpawar and Ghurde, 1989)

Scale	Description of the symptoms
0	No infection
1	0.1 to 10.0% necrotic leaf area.
2	10.1 to 20%necrotic leaf area.
3	20.1 to 30% necrotic leaf area.
4	30.1 to 40% necrotic leaf area.
5	40.1 to 50% necrotic leaf area.
6	More than 50% necrotic leaf area.

The disease intensity (PDI) was calculated according to the formula suggested by Datar and Mayee (1981) given as below:

PDI = Σ of rating of infected leaves on plant/no. of leaves observed in maximum disease score × 100

Daily meteorological data *viz*., temperature, relative humidity and rainy days and total rainfall were recorded for correlation studies. And the disease data were correlated with weekly averages weather parameters. Those parameters, which found significant were used for formulating the prediction equations.

Results and Discussion

During the year 2014-15, in onion, tomato and turmeric the per cent disease index of onion purple leaf blotch, early blight & leaf spot were recorded & ranged from 4.55 to 32.40, 5.72 to 32.17 and 3.85 to 52.73, respectively (table 1, fig. 1).

In onion during 2011, 2012, 2013 and 2014 purple leaf blotch disease was recorded from August 1st week to 2nd week of November. Three years data was used for development of prediction model. The results indicated that the purple leaf blotch disease incidence had significantly negatively correlated with maximum temperature (-0.3638), minimum temperature (-0.3010) and rain fall (-0.05789) and positively correlated with morning relative humidity (0.1349) evening relative humidity (0.2092) (table 2). The coefficient of multiple determination R^2 value was equal to 0.97, which implies that 97% variation in development of purple leaf blotch disease incidence was explained by weather parameters (table 3). The prediction equation was validated using 2014 data (fig. 2). Chadwa and Rajasab (1994) revealed that increased conidial catches of *A. porri* in onion crop have been associated with rain and relative humidity (>60%). Razdan *et al*. (2008) reported that two weather parameters *viz*. maximum temperature and maximum

Table 1 : Epidemiology of major diseases in onion, tomato and turmeric (2014-15) with weather parameters.

Standard week	Per cent Disease Inde× (PDI)			Temperature		Relative Humidity		Rainfall in mm (X5)
	Onion purple leaf blotch	Tomato early blight	Turmeric leaf spot	Max. (X1)	Min. (X2)	R.H.M. (X3)	R.H.E. (X4)	
32	00.00	00.00	00.00	35.84	25.56	71.83	42.00	00.00
33	00.00	00.00	03.85	35.24	25.89	70.29	48.57	01.20
34	04.55	02.91	08.94	36.71	26.24	74.14	46.14	00.17
35	06.95	05.72	13.20	30.63	20.74	88.14	74.00	13.37
36	10.25	11.36	15.14	32.53	24.60	79.71	62.00	02.61
37	14.51	15.16	22.09	33.03	23.93	81.86	53.86	01.23
38	15.92	19.76	26.88	30.26	23.63	89.71	69.29	15.57
39	21.14	21.07	29.93	33.77	25.10	76.86	59.71	00.14
40	23.31	24.97	33.50	34.77	24.56	74.29	51.29	01.49
41	28.69	29.94	36.98	34.43	24.46	78.14	54.86	01.69
42	29.94	30.29	40.10	34.59	23.74	72.00	57.57	01.94
43	30.26	31.85	48.93	32.75	23.54	82.43	65.14	15.17
44	32.29	31.75	51.19	30.70	21.31	77.71	62.86	00.14
45	32.40	32.17	52.73	32.41	19.99	77.29	59.00	00.49

Table 2 : Correlation of disease incidence with weather variables (Pooled Data 2011-14).

	PLB_1	MinT	MaxT	RH1	RH2	RF
PLB	0.9804**	-0.30109*	-0.36383*	0.13497*	0.209269*	-0.05789

	EB_1	MaxT	MinT	RH1	RH2	RF
EB	0.97305**	-0.16131*	-0.26464*	0.19139*	0.405279*	-0.1187

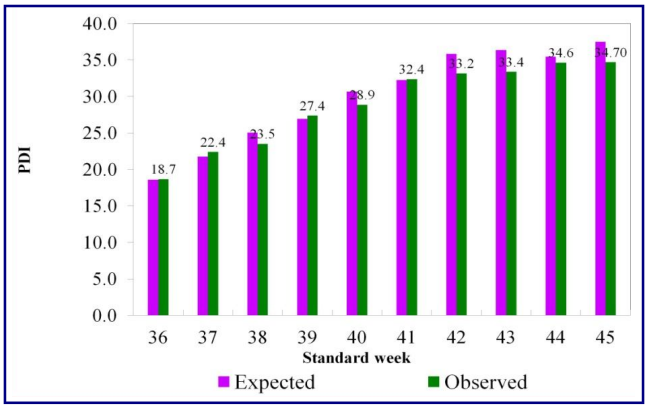
	TLS_1	MinT	MaxT	RH1	RH2	RF
TLS	0.984957	-0.25391	-0.51538	0.006117	0.122479	-0.07884

PLB - Purple Leaf Blotch, **EB** - Early Blight, **TLS** - Turmeric Leaf Spot.

relative humidity explained 95% variability in 2003, whereas, in 2004, rainfall, minimum temperature and maximum relative humidity contributed in disease prediction with 97% precession. In tomato during 2011, 2012, 2013 and 2014, early blight disease was recorded from August 1st week to 2nd week of November. Three years data was used for development of prediction modal. The results indicated that the disease incidence had significantly negatively correlated with maximum temperature (-0.1613), minimum temperature (-0.2646) and with rainfall (-0.1187). The disease was positively correlated with morning relative humidity (0.1913) and evening relative humidity (0.4052). The coefficient of multiple determination R^2 value was equal to 0.93, which implies that 93.0% variation in development of early blight incidence was explained by weather parameters (table 3). The prediction equation was validated using 2014 data (fig. 2). Sahu *et al*. (2014) were also reported that early blight of tomato declined with increase in temperature (maximum and minimum) and relative humidity during morning. However, there was no influence of rainfall and RH during evening on the severity of early blight of tomato. In tomato, our findings of correlations of PDI with different weather parameters are in agreement with earlier findings (Raghavendra, 2006; Sangeetha and Siddaramaiah, 2007 and Devi and Chanu 2012).

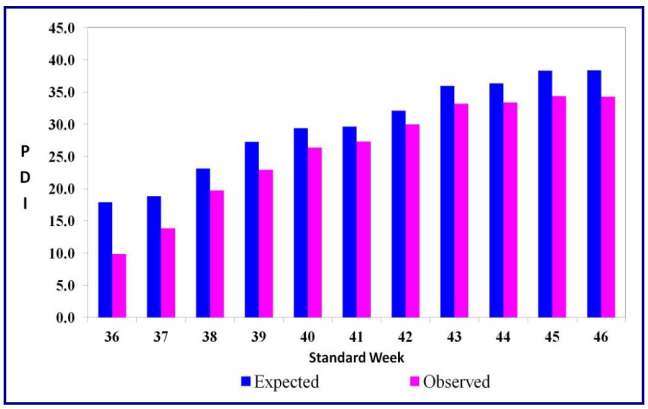
In turmeric during 2011, 2012, 2013 and 2014, leaf spot disease incidence was recorded from August 1th week to November 2nd week. The results indicated that disease incidence has significantly negatively correlated with maximum temperature (-0.5138) and minimum temperature (-02539) and positively correlated with morning relative humidity (0.0061) and evening relative humidity (0.1224) (table 2). The coefficient of multiple determination R^2 value was equal to 0.98, which implies that 98% variation in development of leaf spot incidence

Fig. 1 : Effect of weather factors on onion purple leaf blotch, tomato early blight and turmeric leaf spot during 2014-15 at HRS, Mahanandi.



Y = -16.56+0.963*PLB_1+0.545*MinT-0.128MaxT+0.0228 * RH1 + 0.0654*RH2

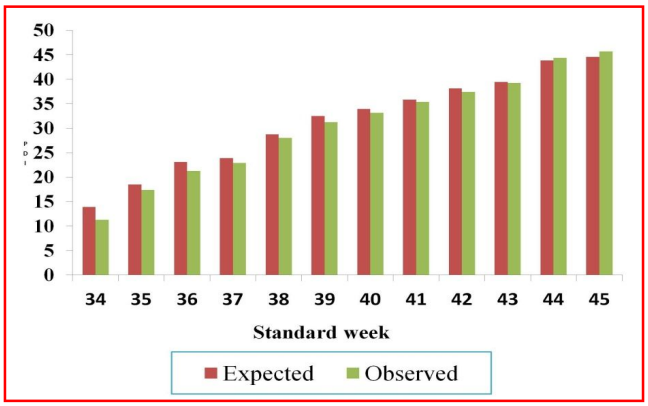
Fig. 2 : Validation of weather based prediction model for purple leaf block of onion during 2014-15.



Y = 18.143+0.863* ELB $_{-1}$-0.037*MaxT-0.443 *MinT-0.077*RH1 + 0.113*RH2

Fig. 3 : Validation of weather based prediction model for early blight of tomato.

was explained by weather parameters (table 3). The prediction equation was validated using 2014 data (fig. 1). These results were similar with the findings of Jayadeep *et al*. (2014), who reported that there is a positive correlations with maximum temperature, sunshine



Y = 0.139 + 0.925*TLB $_{1}$ + 0.243*MaxT-0.008*MinT-0.069*RH1+ 0.045*RH2

Fig. 4 : Validation of weather prediction model for turmeric leaf spot.

and evaporation and negative correlation was observed with minimum temperature, mean temperature, morning relative humidity, evening relative humidity, mean relative humidity, rainfall and rainy days. There was a significant correlation between PDI and minimum temperature and rainy days. Similarly, Udhaykumar *et al*. (2010) reported the temperature of 25°C to be good for disease development.

Conclusion

The data on purple leaf blotch of onion, early blight of tomato and turmeric leaf spot were recorded at weekly interval on standard weeks. Corresponding daily weather data was recorded on four consecutive years (2011-2014) during rainy season (July to December). Using four years disease data was correlated with corresponding weather data. The weather variables, which showed significant correlation with disease incidence were used for the development of regression equation. The purple leaf blotch, early blight of tomato and turmeric leaf spot were high during 41-46 weeks. Disease incidence was high in

Table 3 : Prediction models for three important diseases.

Crop	Disease	Prediction equation (Four years)	R-square
Onion	Purple leaf blotch	Y=-16.56+0.963*PLB_1+0.545*MinT-0.128Ma×T+0.0228*RH1+0.0654*RH2	**R^2 = 0.97**
		Y = Predicted Purple leaf blotch T ma× = Maximum Temperature T min = Minimum Temperature Rh1 = Morning Relative humidity Rh2 = Evening Relative humidity PLB_{-1} = Previous weeks Purple leaf blotch incidence	
Tomato	Early blight	Y= 18.143+0.863* ELB_{-1}-0.037*Ma×T-0.443*MinT-0.077*RH1+0.113*RH2	**R^2 = 0.93**
		Y = Predicted Early blight T max = Maximum Temperature T min = Minimum Temperature Rh1 = Morning Relative humidity Rh2 = Evening Relative humidity ELB_{-1} = Previous weeks Early blight incidence	
Turmeric	Turmeric leaf spot	Y=0.139+0.925*TLB_{-1}+0.243*Ma×T-0.008*MinT-0.069*RH1+0.045*RH2	**R^2 = 0.98**
		Y = Predicted Turmeric leaf spot T max = Maximum Temperature T min = Minimum Temperature Rh1 = Morning Relative humidity Rh2 = Evening Relative humidity TLB_{-1} = Previous weeks Turmeric leaf spot incidence	

matured old leaves than young leaves on purple leaf blotch.

Prediction equations were developed for purple leaf blotch of onion, early blight of tomato and turmeric leaf spot by using three years (2011, 2012 and 2013) disease incidence (Arc sine transformed) and corresponding historical weather data (weekly average). Validation was done with current year disease data (2014) and corresponding weather data. Validation was done for testing the goodness of of fit using 2014-15 data. The three equations predicting the next week's disease incidence and showing the disease trend very efficiently in the three pathosystem.

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