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Epidemiological studies on early blight disease (*Alternaria solani*) of tomato

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Abstract

Early blight of tomato caused by *Alternaria solani* during the winter/spring season is a severe constraint in tomato production. Studies were conducted to understand the development of early blight on tomato cv. pusa ruby with respect to weather conditions. Early blight symptoms were first observed on leaves at 18 days after planting in 2011-12 and 20 days after planting in 2012-13. Increase in disease severity was comparatively higher in the temperature range from 25.6-28.3^{0}C (maximum) and 13.6-16.4^{0}C (minimum) and average relative humidity of 65 percent in the month of January in 2011-12 and also in 2012-13. In the present investigation carried out at IGKV Raipur, maximum temperature (r= -0.801 in 2011-12 and -0.564 in 2012-13), minimum temperature (r=-0.755 in 2011-12 and -0.682 in 2012-13), relative humidity during morning (r=-0.550 in 2011-12 and -0.541 in 2012-13), relative humidity during evening (r=-0.593 in 2012-13) and rainfall (r=-0.531 in 2012-13) had strong negative and significant correlation with disease severity index (DSI) while relative humidity during evening (r=0.342 in 2011-12) and rainfall (r=0.409 in 2011-12) had positive correlation with DSI.

Keywords: *Alternaria solani*, Correlation, Epidemiology, Weather parameters, Tomato

Introduction

Tomato (*Solanum lycopersicum* L.) is an important vegetable crop and cultivated almost year-round in tropical and subtropical regions of the world. In India, it is cultivated during kharif, rabi and summer seasons and occupies an area of 865.0 thousand hectares with production of 16.82 thousand million tonnes from an average productivity of 19.5 metric tonns/ hectare. 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 & Martin) Jones & Grout, is one of the most common foliar diseases of tomato occurring over a wide range of climatic conditions. It is found prominently in areas with dew, rainfall and high relative humidity. The plants are most susceptible at 8-10 week's age. This disease, under severe condition may lead to complete defoliation, in areas with high rainfall, humidity and temperature (24-29 ^{0}C) as well as in semiarid regions where frequent and prolonged night dews occur. The other symptoms associated with the disease includes collar rot (basal stem lesions at the seedling stage), stem lesions in the adult plant stage and fruit rot (Chaerani *et al*. 2006). Yield losses up to 79% due to early blight damage were reported from Canada, India, USA, and Nigeria (Gwary and Nahunnaro 1998). Collar rot can cause seedling losses in the field from 20 to 40 percent. Environmental factors play a key role in the development of the disease. Hence, an attempt was made to study the role of various weather factors on infection and development of early blight of tomato.

Materials and Methods

The experiment was conducted at the Horticulture Research Farm, Indira Gandhi Krishi Vishwavidyalaya Raipur during Rabi season of 2011-12 and 2012-13. Tomato cultivar, Pusa Ruby was sown at 60 x 45 cm spacing in a randomized block design with three replications. In each plot (10 x10 m) ten plants were selected at randomly, labeled and severity of early blight was recorded at seven days interval starting from the date of planting on leaves using 0-5 grade scale as given by Horsefall and Barett (1945).

The Disease Severity Index (DSI) was calculated using the formula (Wheeler, 1969).

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$$DSI = \frac{\text{Sum of individual rating}}{\text{Number of leaves examined x Maximum disease grade}} \times 100$$

The experiments were conducted under open field conditions. No protection was given against the disease. Weather data with respect to maximum and minimum temperature, relative humidity during morning (M), RH evening (E) and rainfall were obtained and recorded with the assistance from the Department of Meteorology, IGKV Raipur and averaged for seven days (Table 1). The weather parameters were correlated to weekly disease severity index by calculating the Karl Pearson's correlation coefficient (r). Correlation coefficient values were tested individually for their significance at 5% probability level using following formula:

$$t = \frac{r\sqrt{(n-2)}}{\sqrt{1-r}}$$

Where,

t: test of significance, r: correlation coefficient and n = number of observations

Results and discussion

Progressive disease development:

Environmental factors mainly decide the epidemic of early blight disease. Planting was done on 41st standard week during 2011-12 and 2012-13. Observations were recorded from 45th standard week at weekly interval. The first appearance of early blight was noticed 28 days after planting (DAP) in 2011-12 and 30 DAP (2012-13) which progressed thereafter (Fig. 1 and 2). The development of the disease was initially slow but it reached to maximum during the 7th standard week of 2012 (78.28%) and also in 2013 (76.70%) which happened in the month of February. During the cropping period maximum temperature ranged from 22.8^{0}C (5th standard week 2012) to 32.6^{0}C (45th standard week 2011), minimum temperature from 9.1^0 C (2nd standard week 2012) to 20.8^{0}C (45th standard week 2011), relative humidity during morning ranged from 81 percent (7th standard week 2012) to 95 percent (46th standard week 2011) and relative humidity during evening ranged from 25 percent (2nd standard week 2012) to 72 percent (4th standard week 2012). However, rainfall ranged from 0 mm (45th standard week 2011) to 34.1 mm (4th standard week 2012) in 2011-12 and in 2012-13 maximum temperature ranged from 25.6^{0}C (4th standard week 2013) to 31.9^{0}C (46th standard week 2012), minimum temperature from 8.3^0 C (6th standard week 2013) to 20.2^{0}C (45th standard week 2012) relative humidity during morning ranged from 77 percent (7th standard week 2013) to 96 percent (52nd standard week 2012) and relative humidity during evening ranged from 37 percent (50th standard week 2013) to 74 (45th standard week 2013). Increase in disease severity index was comparatively higher in the temperature ranged from 26.3- 28.3^{0}C (maximum), 10.5-14.5^{0}C (minimum) and average relative humidity of 65 percent in the month of January in 2011-12 and also in 2012-13. These findings are in agreement with the earlier findings (Sarkar and Sengupta, 1978; Sinha *et al.,* 1992; Broker and Patil, 1995; Rajiv Kumar and Singh, 1996; Das *et al*., 1998 and Kemmitt, 2002).

Correlation study:

To develop a relationship of disease severity index (DSI)

Table 1: Effect of Weather parameters on disease development of early blight of tomato during 2011-12 and 2012-13 at Raipur

S.N.	Std Week	Max T (°C)		Min T (°C)		RH (%) (Morning)		RH (%) (Evening)		Rainfall (mm)		DSI (%)		Increase in DSI (%)	
		2011-12	2012-13	2011-12	2012-13	2011-12	2012-13	2011-12	2012-13	2011-12	2012-13	2011-12	2012-13	2011-12	2012-13
1	45	32.6	31	20.8	20.2	93	88	37	74	0	42.6	0.67	0.61	0.67	0.61
2	46	31.8	31.9	17.7	19.5	95	87	35	73	0	84.4	4.33	1.83	3.66	1.22
3	47	30.8	31.6	15.2	18.4	90	92	27	54	0	2.8	9.67	4.61	5.34	2.78
4	48	32.2	28.9	15.8	18.4	91	89	28	56	0	9.2	13.67	10.21	4	5.6
5	49	31.2	28.5	15.7	17.3	89	92	30	45	0	0	18.33	15.52	4.66	5.31
6	50	30.2	28.4	15.2	12.7	88	87	33	37	0	0	25.71	21.4	7.38	5.88
7	51	29.9	29.6	14.7	16.4	85	85	35	38	0	0	31.2	26.52	5.49	5.12
8	52	29.8	30.1	13.4	14.3	92	96	33	59	0	27.3	36.33	32.3	5.13	5.78
9	1	27.5	28.3	14.5	13.6	84	94	36	45	0	5.6	46.21	38.74	9.88	6.44
10	2	32.7	30	9.1	18.1	90	86	25	33	0	0	52.32	46.3	6.11	7.56
11	3	29.3	28.6	11.9	11	95	86	29	43	0	0	58.6	51.38	6.28	5.08
12	4	26.3	25.6	16.4	14.2	89	87	72	35	34.1	0	64.67	59.2	6.07	7.82
13	5	22.8	28	11	16	86	78	39	57	20.6	1.2	71.21	65.9	6.54	6.7
14	6	26.9	26.3	10.5	8.3	86	85	31	39	0	0	76.23	71.38	5.02	5.48
15	7	25.7	30.7	12.5	14.6	81	77	42	39	0	0	78.28	76.7	2.05	5.32

Max T= Maximum temperature, Min T= Minimum Temperature, RH M= Relative humidity during morning; RH E= Relative humidity during evening; DSI= Disease severity index

with weather variables, correlation analysis was performed and presented in Table 2.

Table 2: Correlation between disease severity index and early blight in relation to weather parameters

S.N.	Weather parameters	Correlation Coefficient 'r' value	
		2011-12	2012-13
1	Maximum temperature (^{0}C)	-0.801**	-0.564*
2	Minimum temperature (^{0}C)	-0.755**	-0.682**
3	Relative humidity morning (%)	-0.550*	-0.541
4	Relative humidity evening (%)	0.342	-0.593
5	Rainfall (mm)	0.409	-0.531

* Significant (P=0.05) level (R value-0.514)
** Significant (P=0.01) level (R value-0.641)

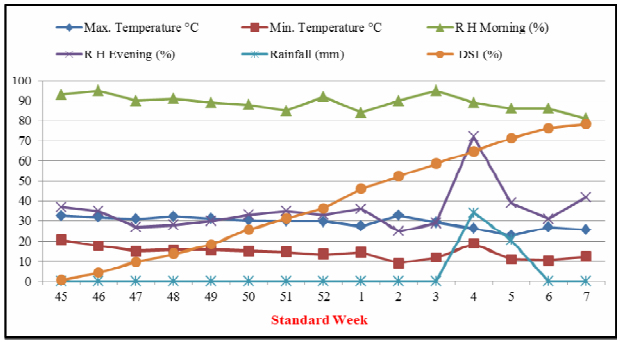

Fig. 1: Progress of early blight of tomato in relation to various weather parameters during 2011-12

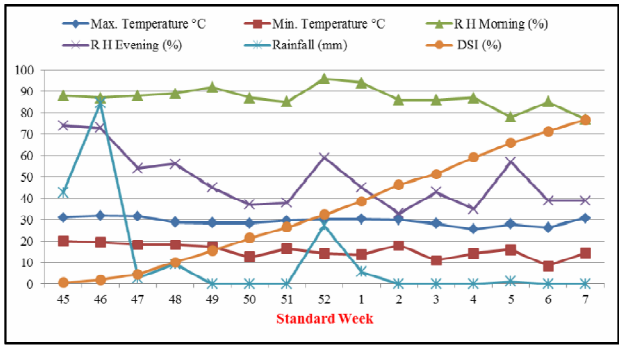

Fig. 2: Progress of early blight of tomato in relation to various weather parameters during 2012-13

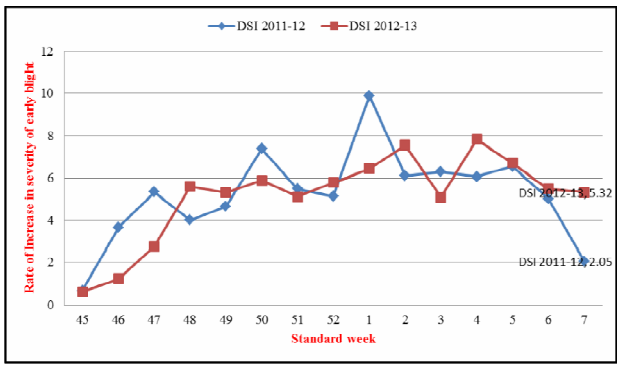

Fig. 3: Rate of increase in severity of early blight of tomato during 2011-12 and 2012-13

The relationship between DSI and weather factors (temperatures and RH) indicated significant negative correlation with maximum temperature (-0.801), minimum temperature (-0.755) and relative humidity during morning (-0.550). DSI was positively correlated with relative humidity during evening (0.342) and rainfall (0.409) during 2011-12. Similarly, during 2012-13, DSI was significant and negatively correlated with maximum temperature (-0.564) minimum temperature (-0.682) and relative humidity during morning (-0.541) & evening (-0.593) and rainfall (-0.531). Our findings of correlations of DSI with different weather parameters are in agreement with earlier findings Mesta *et al*. (2009) and Devi and Chanu 2012). From the results presented, it is very clear that the severity of early blight of tomato declined with increase in temperature (max. & min.) and relative humidity during morning. However, there was no influence of rainfall and RH during evening on the severity of early blight of tomato.

सारांश

शरद व वसंतकालीन टमाटर में टमाटर की फसल में अगेती झुलसा एक महत्वपूर्ण बाधा है। इसे ध्यान में रखते हुए टमाटर की प्रजाति 'पूसा रूबी' पर अगेती झुलसा के विकास को मौसम आधारित दशा में ज्ञात किया गया। अगेती झुलसा के लक्षण पौध रोपण के 18वीं दिन बाद वर्ष 2011–12 व 20 वीं दिन बाद वर्ष 2012–13 में पत्तियाँ उत्पन्न हुए। यह उत्पत्ति छोटे, भूरे, चकटों जो पीले बदरंग भागों से घिरे हुए, चकत्ते बढ़े व गहरे भूरे अथवा काले धब्बे जो केन्द्रित वलय में परिवर्तित हो गये। रोग का संक्रमण उच्च तापमान माध्यम 25. 6–28.3 डिग्री सेन्टीग्रेड पर सबसे अधिक पाया गया व तापमान 13. 6–16.4 डिग्री सेन्टीग्रेड पर सबसे कम था तथा वर्ष 2011–12 के जनवरी माह में औसत सापेक्ष आर्द्रता 65 प्रतिशत था और यही स्थिति वर्ष 2012–13 में थी। यह शोध इन्दिरागाँधी कृषि विश्वविद्यालय, रायपुर में वर्ष 2011–12 में किया गया जहाँ पर अधिकतम तापमान (आर त्र 0.801, 2011–12 व –0.564, 2012–13, कम तापक्रम (आर त्र 0.55; 2011–12 व– 0.541;2012–13), सायंकाल सापेक्ष आर्दता (आर त्र 0.593; 2012–13) तथा वर्षा (आर त्र 0.531; 2012–13) ने प्रबल नकारात्मक व सार्थक सह–सम्बन्ध रोग प्रबलता सूचकांक (डी. एस.आई.) के साथ था जबकि सायंकाल सापेक्ष आर्द्रता (आर त्र 0. 5342; 2011–12) तथा वर्षा (आर त्र 0.409; 2011–12) का रोग प्रबलता सूचकांक (डी.एस.आई.) के साथ पाया गया।

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