Indian Journal of Agricultural Sciences **83** (6): 633–8, June 2013/Article

Impact of weather parameters in the development *Phomopsis* blight and fruit rot of brinjal (*Solanum melongena*)

MUNEESHWAR SHARMA[1] and V K RAZDAN[2]

Sher-E-Kashmir University of Agricultural Sciences and Technology of Jammu, Jammu, Jammu and Kashmir 180 009

Recevied: 2 January 2012; Revised accepted: 25 February 2013

ABSTRACT

Role of weather parameters, such as rainfall, relative humidity and temperature in the development leaf blight and fruit rot [*Phomopsis vexans* (Sacc. & Syd.) Harter] of brinjal (*Solanum melongena* L.) during 2007 and 2008 was studied by performing correlation and regression analysis. Per cent leaf blight and fruit rot (incidence and intensity) recorded during 2007 and 2008 was correlated with the weather parameters and were subjected to regression analysis. The correlation of pooled data for both the years and weather parameters [rainfall, relative humidity (morning and evening) and temperature (maximum and minimum)] revealed that relative humidity (morning) had a positive and significant effect on leaf blight and fruit rot (incidence and intensity), whereas, relative humidity (evening) and temperature (maximum and minimum) had negative but significant effect on the disease development. Multiple correlation coefficients during 2007 and 2008 indicated strong relationship between leaf blight and fruit rot (incidence and intensity) and weather parameters, thereby establishing that rainfall, relative humidity (morning and evening) and temperature (maximum and minimum) had cumulative effect during the course of disease development and induced more than 98.1% variation in leaf blight incidence and 97.2% in intensity, whereas, it contributed more than 96.9% variation in fruit rot incidence and 96.6 per cent in intensity (pooled).

Key words: Brinjal, Leaf blight, Fruit rot, *Phomopsis vexans,* Weather parameters

Phomopsis vexans (Sacc. & Syd.) Harter (Telomorph: *Diaporthe vexans* Gratz) causes leaf blight and fruit rot of brinjal (*Solanum melongena* L.) and is a major constraint in the production and productivity of the crop. Losses due to phomopsis fruit rot ranged to the extent of 10–25% in Punjab (Panwar *et al*. 1970). Climate not only affect plants but also affects the pathogens, insect pests and weeds that reduces crop yield (Anderson *et al.* 2004). The classic disease triangle recognizes the role of environmental factors in disease development on crops, as no virulent pathogen can induce disease on a highly susceptible host if weather parameters are not favourable (Agrios 2005, Ziska and Runion 2007). Fourth assessment report of Intergovernmental Panel on Climate Change (Meehl *et al*. 2007) predicted that due to 21st century emissions, concentration of atmospheric CO_2 will increase from current 368 ppm to 600 ppm and the temperature would rise between 0.9 to 3.5°C leading the world towards global climate change. The present investigation was carried out to correlate the development of leaf blight and fruit rot (incidence and intensity) with the weather parameters, viz. rainfall, relative humidity (morning and evening) and temperature (maximum and minimum) to develop linear predictive model of disease.

[1] REZ (e mail: muneeshwar_s@rediffmail.com), Department of Agriculture Production, Jammu; [2] Professor (e mail: vijayrazdan@rediffmail.com), Division of Plant Pathology

MATERIALS AND METHODS

In order to determine the role of abiotic factors on disease development, brinjal cv Pusa Purple Long was transplanted in 20 m^2 plot during first week of June 2007 and 2008. Data on disease incidence and intensity of leaf blight and fruit rot was recorded at weekly intervals till the maturity of the crop. The observations on leaf blight intensity were recorded using 1-12 point scale proposed by Horsfall and Barratt (1945) given as Grade = Per cent leaf area : 1 = 0, 2 = 0-3, 3 = 3-6, 4 = 6-12, 5 = 12-25, 6 = 25-50, 7 = 50-75, 8 = 75-87, 9 = 87-94, 10 = 94-97, 11 = 97-100, 12 = 100.

The per cent disease intensity on fruit was recorded using 1-8 point scale (Kumar 1998) given as Grade = Hull rot %: 1 = 0, 2 = 0-10, 3 = 11-25, 4 = 26-50, 5 = 51-75, 6 = 76-90, 7 = 91-100, 8 = 100.

The per cent disease incidence and intensity on leaf blight and fruit rot were calculated as given below (Wheeler 1969):

$$\text{Per cent disease incidence} = \frac{\text{No. of diseased plants}}{\text{Total No. of plants observed}} \times 100$$

$$\text{Per cent disease intensity} = \frac{\text{Total sum of numerical ratings}}{\text{Number of samples observed} \times \text{Maximum disease rating}} \times 100$$

The weekly average data of weather parameters, viz rainfall, temperature (maximum and minimum) and relative humidity (morning and evening) during crop growth period, recorded by Agro Meteorological Observatory, SKUAST-Jammu, Chatha was used for correlation and regression analysis.

To determine the role of weather parameters in the development of brinjal leaf blight and fruit rot, the data on disease during the course of disease progression was analyzed by calculating simple and multiple correlations (Gomez and Gomez 1984).

All possible simple correlations were calculated between study variables Y_I/ Y_S and Y_{I1}/ Y_{S1} of leaf blight and fruit rot, respectively, and abiotic factors X_1, X_2, X_3, X_4 and X_5, where Y_I denoted per cent incidence of leaf blight, Y_S per cent intensity of leaf blight, Y_{I1} per cent incidence of fruit rot, Y_{S1} per cent intensity of fruit rot, X_1 rainfall, X_2 relative humidity (morning), X_3 relative humidity (evening), X_4 temperature (maximum) and X_5 temperature (minimum). The test of significance for simple correlation was carried out using Student's t-test (Snedecor and Cochran 1986).

To determine the joint effect of different independent variables in the development of disease (incidence and intensity of leaf blight and fruit rot) during the course of study, multiple correlation coefficients were worked out and linear multiple regression models developed for prediction of incidence as well as intensity of leaf blight and fruit rot. Adequacy of fitted regression equations were judged with the help of coefficient of multiple determination.

The effect of various environmental factors on disease progress was estimated using linear multiple regression analysis with the prediction equations as:

$$Y_i = b_0 + b_1X_1 + b_2X_2 + \ldots\ldots\ldots\ldots\ldots\ldots + b_5X_5$$
$$Y_s = b_0 + b_1X_1 + b_2X_2 + \ldots\ldots\ldots\ldots\ldots\ldots + b_5X_5$$
$$Y_{i1} = b_0 + b_1X_1 + b_2X_2 + \ldots\ldots\ldots\ldots\ldots\ldots + b_5X_5$$
$$Y_{s1} = b_0 + b_1X_1 + b_2X_2 + \ldots\ldots\ldots\ldots\ldots\ldots + b_5X_5$$

where, Y_i denoted per cent disease incidence of leaf blight, Y_s per cent disease intensity of leaf blight, Y_{i1} per cent disease incidence of fruit rot, Y_{s1} per cent disease intensity of fruit rot, b_0 the constant and b_1 to b_5 the regression coefficients of X_1 to X_5, respectively.

RESULTS AND DISCUSSION

Correlation and regression analysis were performed so as to judge the effect of weather parameters on incidence and intensity of leaf blight and fruit rot of brinjal during 2007 and 2008.

From Table 1 it is revealed that leaf blight incidence and intensity of brinjal recorded during 2007 (Fig 1) were affected by all the weather parameters except rainfall which had insignificant, but, positive correlation. The leaf blight incidence and intensity were significantly and positively correlated with relative humidity (morning). Whereas, the relationship was highly significant but negatively correlated with relative humidity (evening) and temperature (maximum and minimum). Leaf blight incidence and intensity of brinjal recorded during 2008 (Fig 2) were insignificantly and

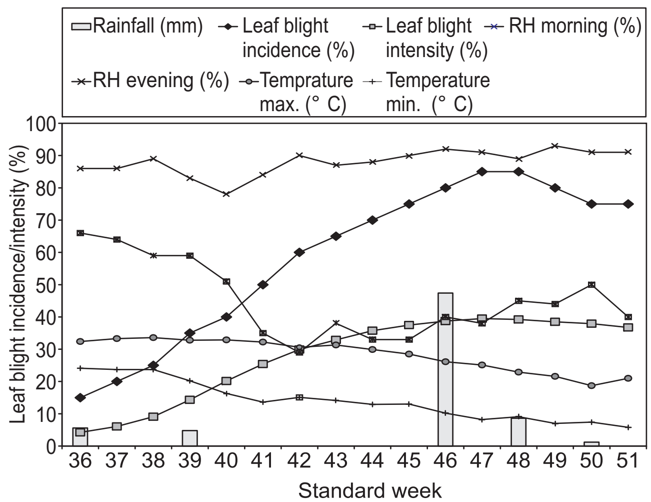

Fig 1 Influence of weather parameters on leaf blight incidence/ intensity recorded during 2007.

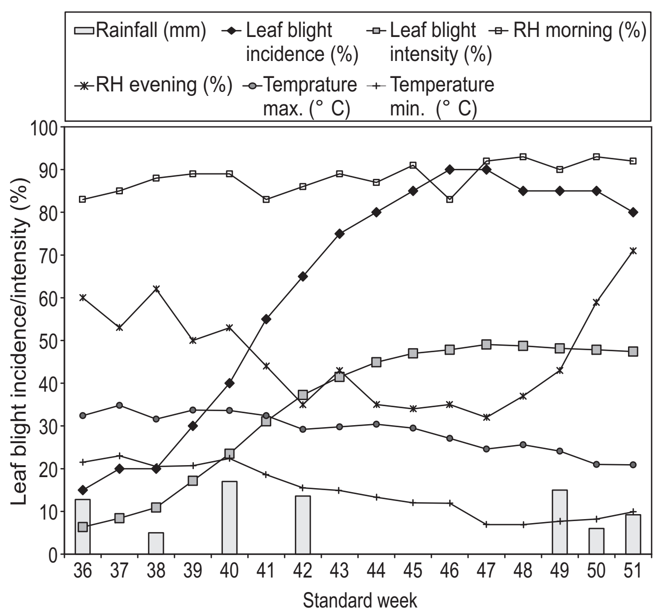

Fig 2 Influence of weather parameters on leaf blight incidence/ intensity recorded during 2008.

Table 1 Correlation matrix showing relationship between leaf blight incidence/intensity and weather parameters

Year		Incidence (Y_1)	Intensity (Y_S)	Rainfall (X_1)	Relative humidity (%)		Temperature (°C)	
					Morning (X_2)	Evening (X_3)	Maximum (X_4)	Minimum (X_5)
2007								
	X_1	0.213	0.187	1.00				
	X_2	0.632**	0.589*	0.241	1.00			
	X_3	–0.752**	–0.798**	–0.030	–0.367	1.00		
	X_4	–0.782**	–0.754**	–0.133	–0.691**	0.291	1.00	
	X_5	–0.943**	–0.945**	–0.133	–0.553*	0.665**	0.868**	1.00
2008								
	X_1	–0.198	–0.160	1.00				
	X_2	0.485	0.521*	–0.006	1.00			
	X_3	–0.529*	–0.494	0.382	0.054	1.00		
	X_4	–0.767**	–0.780**	–0.099	–0.630**	–0.036	1.00	
	X_5	–0.917**	–0.917**	0.135	–0.630**	0.363	0.900**	1.00
Pooled								
	X_1	0.110	0.092	1.00				
	X_2	0.724**	0.705**	–0.103	1.00			
	X_3	–0.715**	–0.716**	0.006	–0.240	1.00		
	X_4	–0.781**	–0.774**	–0.159	–0.857**	0.171	1.00	
	X_5	–0.957**	–0.953**	–0.091	–0.805**	0.529*	0.912**	1.00

*Significant at 5% probability level, ** Significant at 1% probability level

negatively correlated with rainfall. Leaf blight incidence was insignificantly and positively correlated with relative humidity (morning), whereas, leaf blight intensity was significantly and positively correlated with relative humidity (morning). The leaf blight incidence was significantly but negatively correlated with relative humidity (evening), whereas, leaf blight intensity was insignificantly and negatively correlated with relative humidity (evening). Leaf blight incidence and intensity were highly significant and negatively correlated with temperature (maximum and minimum). From pooled data for both the years 2007 and 2008 it is revealed that leaf blight incidence and intensity were insignificantly and negatively correlated with rainfall. The leaf blight incidence and intensity was highly significant and positively correlated with relative humidity (morning), whereas, it shared inverse and highly significant relationships with other weather

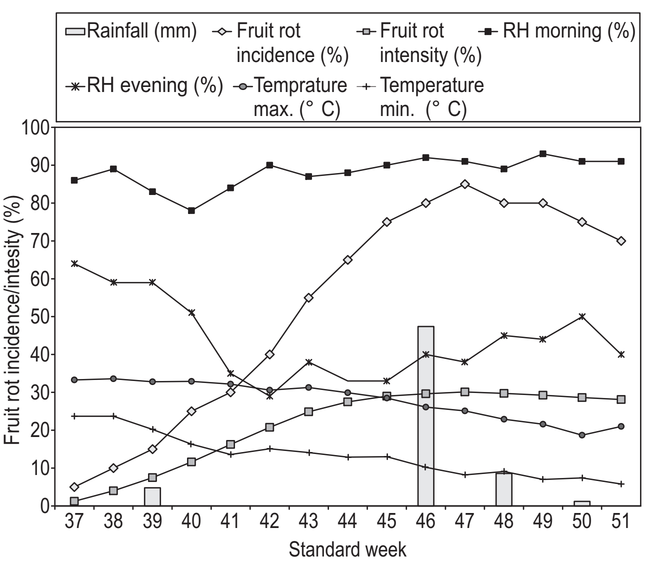

Fig 3 Influence of weather parameters on fruit rot incidence/ intensity recorded during 2007.

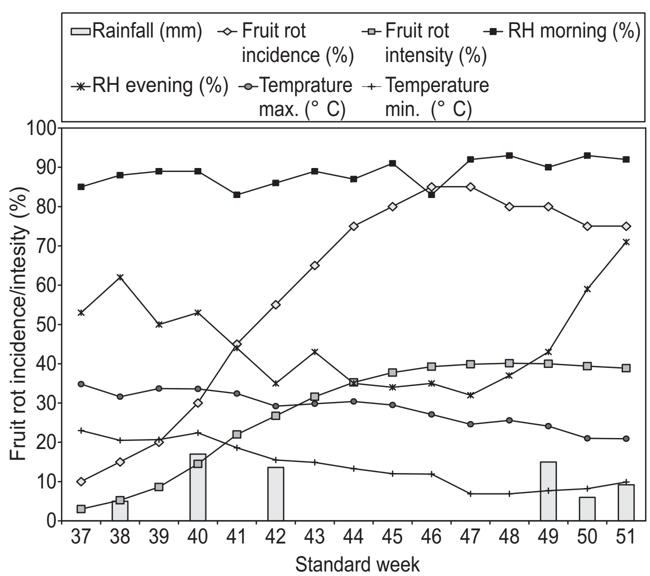

Fig 4 Influence of weather parameters on fruit rot incidence/ intensity recorded during 2008.

Table 2 Correlation matrix showing relationship between fruit rot incidence/intensity and weather parameters

Year		Incidence (Y_I)	Intensity (Y_S)	Rainfall (X_1)	Relative humidity (%)		Temperature (°C)	
					Morning (X_2)	Evening (X_3)	Maximum (X_4)	Minimum (X_5)
2007								
	X_1	0.279	0.234	1.00				
	X_2	0.689**	0.638*	0.248	1.00			
	X_3	–0.595*	–0.723**	–0.051	–0.347	1.00		
	X_4	–0.820**	–0.765**	–0.143	–0.684**	0.219	1.00	
	X_5	–0.913**	–0.922**	–0.163	–0.553*	0.579*	0.880**	1.00
2008								
	X_1	–0.069	–0.018	1.00				
	X_2	0.379	0.424	0.145	1.00			
	X_3	–0.459	–0.393	0.315	0.198	1.00		
	X_4	–0.773**	–0.813**	–0.183	–0.608*	–0.107	1.00	
	X_5	–0.925**	–0.937**	0.036	–0.579*	0.298	0.898**	1.00
Pooled								
	X_1	0.244	0.219	1.00				
	X_2	0.720**	0.693**	–0.038	1.00			
	X_3	–0.603*	–0.618*	–0.091	–0.117	1.00		
	X_4	–0.803**	–0.801**	–0.213	–0.852**	0.088	1.00	
	X_5	–0.953**	–0.956**	–0.188	–0.778**	0.437	0.919**	1.00

*Significant at 5% probability level, ** significant at 1% probability level

parameters, viz. relative humidity (evening), temperature (maximum and minimum).

From Table 2 it is evident that fruit rot incidence and intensity of brinjal recorded during 2007 (Fig 3) were affected by all the weather parameters except rainfall which was insignificant but positively correlated with fruit rot incidence and intensity. The fruit rot incidence and intensity were significantly and positively correlated with relative humidity (morning). The fruit rot incidence and intensity were significantly, however, negatively correlated with relative humidity (evening) and temperature (maximum and minimum). Fruit rot incidence and intensity of brinjal recorded during 2008 (Fig 4) were insignificantly and negatively correlated with rainfall and relative humidity (evening), whereas, relative humidity (morning) was insignificantly, however, positively correlated with fruit rot incidence and intensity. Fruit rot incidence and intensity had highly significant and negatively correlation with temperature (maximum and minimum). The pooled data for the years 2007 and 2008 reveals that rainfall had insignificant, though, positive correlation with fruit rot incidence and intensity. The fruit rot incidence and intensity were significantly and positively correlated with relative humidity (morning), whereas, fruit rot incidence and intensity was significantly, but, negatively correlated with relative humidity (evening) and temperature (maximum and minimum).

From multiple linear regression analysis presented in Table 3 it was found that the joint effect of weather parameters, viz. rainfall, relative humidity (morning and evening) and temperature (maximum and minimum) on leaf blight incidence and intensity recorded during 2007 and 2008 was highly significant and contributed 94.10 and 95.60 per cent and 90.03 and 88.60 per cent variation in leaf blight incidence and intensity, respectively. The pooled data of both the years showed that the joint effect of these weather parameters on leaf blight incidence and intensity was also highly significant contributing 98.10 and 97.20 per cent variation, respectively. The joint effect of these weather parameters during 2007 and 2008 was also highly significant contributing 89.70 and 93.10 per cent and 90.90 and 90.70 per cent (Table 4) variation in fruit rot incidence and intensity, respectively. From the pooled data of both the years also, it was found that the joint effect of the above mentioned weather parameters was highly significant contributing 95.50 and 94.40 per cent variation in fruit rot incidence and intensity, respectively.

The correlation of pooled data for both the years and weather variables such as rainfall, relative humidity (morning and evening) and temperature (maximum and minimum) revealed that relative humidity (morning) had a positive and significant effect on the disease incidence and intensity, whereas, relative humidity (evening) and temperature (maximum and minimum) had negative but significant effect. Multiple correlation coefficients indicated strong relationship between leaf blight and fruit rot (incidence and intensity) and weather variables, thereby establishing that rainfall, relative humidity (morning and evening) and temperature (maximum

Table 3 Multiple regression model of brinjal leaf blight incidence and intensity

Year	Regression model	Coefficient of multiple determination (R^2)	Multiple correlation coefficient (R)
2007			
Leaf blight incidence (Y_i)	$Y_i = 31.261+0.157X_1+0.940X_2–0.445X_3+0.154X_4–2.883X_5$	0.941**	0.970**
Leaf blight intensity (Y_s)	$Y_s = 61.418+0.083X_1+0.123X_2–0.\ 420X_3–0.346X_4–1.139X_5$	0.956**	0.978**
2008			
Leaf blight incidence (Y_i)	$Y_i = 248.197–0.319X_1+0.200X_2–1.259X_3–5.021X_4+0.103X_5$	0.903**	0.950**
Leaf blight intensity (Y_s)	$Y_s = 117.592–0.099X_1+0.326X_2–0.687X_3–2.749X_4+0.004X_5$	0.886**	0.941**
Pooled			
Leaf blight incidence (Y_i)	$Y_i = 10.297+0.328X_1+1.004X_2–0.476X_3+1.667X_4–4.577X_5$	0.981**	0.990**
Leaf blight intensity (Y_s)	$Y_s = 52.063+0.086X_1+0.126X_2–0.302X_3+0.576X_4–2.429X_5$	0.972**	0.986**

**Significant at 1% probability level

X_1, Rainfall; X_2, RH morning; X_3, RH evening; X_4, maximum temperature; X_5, minimum temperature; Y_i, leaf blight incidence; Y_s, leaf blight intensity

Table 4 Multiple regression model of brinjal fruit rot incidence and intensity

Year	Regression model	Coefficient of multiple determination (R^2)	Multiple correlation coefficient (R)
2007			
Fruit rot incidence (Y_{i1})	$Y_{i1} = –70.088+0.219X_1+1.918X_2–0.163X_3+0.464X_4–3.968X_5$	0.897**	0.947**
Fruit rot intensity (Y_{s1})	$Y_{i1} = –34.335+0.072X_1+0.267X_2–0.351X_3–0.346X_4–0.891X_5$	0.931**	0.965**
2008			
Fruit rot incidence (Y_{i1})	$Y_{i1} = 266.400+0.065X_1–1.111X_2–0.537X_3–1.214X_4–3.578X_5$	0.909**	0.953**
Fruit rot intensity (Y_{s1})	$Y_{s1} = 124.768+0.105X_1–0.503X_2–0.197X_3–0.570X_4–1.917X_5$	0.907**	0.952**
Pooled			
Fruit rot incidence (Y_{i1})	$Y_{i1} = –167.202+0.631X_1+2.461X_2–0.213X_3+3.402X_4–6.125X_5$	0.969**	0.984**
Fruit rot intensity (Y_{s1})	$Y_{s1} = 24.080+0.119X_1+0.309X_2–0.245X_3+0.432X_4–2.066X_5$	0.966**	0.983**

**Significant at 1% probability level

X_1, Rainfall; X_2, RH morning; X_3, RH evening; X_4, maximum temperature; X_5, minimum temperature; Y_{i1}, leaf blight incidence; Y_{s1}, leaf blight intensity

and minimum) had a cumulative effect on the disease development and contributed more than 98.1 per cent variation in leaf blight incidence and 97.2 per cent in intensity, whereas, it contributed more than 96.9 per cent variation in fruit rot incidence and 96.6 per cent in intensity. The pooled data of 2007 and 2008 indicated that the optimum temperature of 24.85^{0}C and optimum relative humidity of 91.5 per cent resulted in maximum per cent leaf blight and fruit rot (intensity and incidence). These findings are in conformity with those of Panwar and Chand (1968), Chowdhury and Hasija (1979), Singh (1987), Islam and Pan (1992), Kaushal (1992), Manna *et al.* (2004) and Kumar and Sugha (2006) highlighted the role of temperature and relative humidity on the progress of disease. Mina and Dubey 2010 also reported that maximum and minimum ambient temperature and soil temperature were positively and significantly correlated with wilt incidence. Positive correlation but non-significant effect of rainfall with leaf blight and fruit rot (incidence and intensity) development suggests that rainfall increases relative humidity but washes off the conidia and inhibits the disease development. Kumar and Sugha (2006) further observed that coefficient of multiple determination ranged from 0.82 to 0.85, resulting in 82 and 85 per cent variation in disease severity during 2001 and 2000, respectively. Our studies also indicated more than 80 per cent variation in leaf blight and fruit rot (incidence and intensity) due to a joint effect of all the weather parameters.

In present experiment it was observed that the correlation of pooled data for both the years and weather variables such as rainfall, relative humidity (morning and evening) and temperature (maximum and minimum) revealed that relative humidity (morning) had a positive and significant effect on leaf blight and fruit rot (incidence and intensity), whereas, relative humidity (evening) and temperature (maximum and minimum) had negative but significant effect on the disease development. Multiple correlation coefficients during 2007 and 2008 indicated strong relationship between leaf blight and fruit rot (incidence and intensity) and weather variables, thereby establishing that rainfall, relative humidity (morning and evening) and temperature (maximum and minimum) had a cumulative effect on the disease development and contributed more than 98.1 per cent variation in leaf blight incidence and 97.2 per cent in intensity, whereas, it contributed more than 96.9 per cent variation in fruit rot incidence and 96.6 per cent in intensity (pooled).

REFERENCES

Agrios G N. 2005. Environmental effects on the development of the infectious disease. (*in*) *Plant Pathology,* pp 251–62, 5th edn. George N Agrios (Ed). Elesvier Academic Press, Burlington, Mass, USA.

Anderson P K, Cunningham A A, Patel N G, Morales F J, Epstein P R and Daszak P. 2004. Emerging infectious diseases of plants: Pathogen pollution, climate change and agrotechnology drivers. *Trends in Ecology and Evolution* **19**: 535–44.

Annonymus. 2008. *Annual Area Production Data*. Directorate of Agriculture, Jammu and Kashmir Government, Jammu.

Chowdhury S R and Hasija S K. 1979. Pathological studies on *Phomopsis vexans* causing soft rot of brinjal fruits. *Indian Phytopathology* **32**: 495–6.

Gomez K A and Gomez A A. 1984. *Statistical Procedures for Agricultural Research*, pp 357–424, 2nd edn. Willey XVI, New York.

Horsfall J G and Barratt R W. 1945. An improved grading system for measuring plant diseases. *Phytopathology* **35**: 655.

Islam S J and Pan S. 1992. Functional relationship of *Phomopsis* leaf blight of egg plant with environmental factors and a linear model for predicting the disease. *Indian Phytopathology* **45**: 199.

Kaushal N. 1992. Studies on *Phomopsis* blight and fruit rot of brinjal. MSc thesis, CSK Himachal Pradesh Agricultural University, Palampur.

Kumar S. 1998. Epidemiology and management of *Phomopsis* disease of brinjal. Ph D thesis, CSK Himachal Pradesh Agricultural University, Palampur, pp 87.

Kumar S and Sugha S K. 2006. Role of weather variables in the development of *Phomopsis* blight of brinjal. *Plant Disease Research* **21**: 30–2.

Meehl G A, Stocker T F, Collins W D, Friedlingstein P, Gaye A T, Gregory J M, Kitoh A, Knutti R, Murphy J M, Noda A, Raper S C B, Watterson I G, Weaver A J and Zhao Z C. 2007. Global climate projections. (*in*) *Climate Change 2007*: *The Physical Science Basis.Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*, pp 749–53 Solomon S D, Manning Qin M, Chen Z, Marquis M, Averyt K B, Tignor M and Miller H L (Eds). Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

Manna B K, Jash S and Das S N. 2004. Effects of environmental factors on *Phomopsis* blight of brinjal and its management. *Annals of Plant Protection Sciences* **12**: 229–31.

Mina U and Dubey S C. 2010. Effect of environmental variables on the development of Fusarium wilt in chickpea (*Cicer arietinum*) cultivars. *Indian Journal of Agricultural Sciences* **80 (3)**: 231–4.

Panwar N S and Chand J N. 1968. Cultural characters and pathogenicity of three isolates of *Phomopsis vexans* (Sacc. & Syd.) Harter. *Indian Journal of Microbiology* **8**: 203–5.

Panwar N S, Chand J N, Singh H and Paracer C S. 1970. *Phomopsis* fruit rot of brinjal (*Solanum melongena* L.) in the Punjab; viability of the fungus and role of seeds in the disease development. *Journal of Research* **7**: 641–3.

Singh R S. 1987. *Diseases of Vegetable Crops*, pp 140–5. Oxford and IBH Publishing Co. Pvt Ltd.

Snedecor G W and Cocharn W G. 1986. *Statistical Methods*. Oxford and IBM Publishing Co., New Delhi.

Wheeler B E J. 1969. *An Introduction to Plant Disease,* pp 172–7. John Wiley, London. p 301.

Ziska L and Runion G B. 2007. Future weed, pest and disease problems for plants. (*in*) *Agroecosystems in a Changing Climate,* pp 261–87. Newton P C D , Carran R A, Edwards G R, Niklaus P A (Eds).CRC Press Boca Raton, FL.