Internat. J. Agric. Sci. Vol.3 No.2 June, 2007 : 247-251

First order auto regression and simple regression models for prediction of grape powdery mildew in Northern Karnataka, India

D.S. ASWATHA NARAYANA* AND V. B. NARGUND

Department of Plant Pathology, College of Agriculture, Bheemarayanagudi., University of Agricultural Sciences, DHARWAD (M.S.) INDIA

ABSTRACT

Phytoepidemiology has attracted people with different professional background, which deals with dynamics of plant pathogens infecting a host population. In the light above, present studies were under taken to develop prediction models for grape powdery mildew disease. The auto regression models are one of the important epidemiological tools in prediction of disease. This models had good fit for the two seasons of late *kharif* 2002 and *rabi* 2002-03 for prediction of powdery mildew one week well in advance. The equation for late *kharif* was $Y_{t+1}=1.2890\ Y_t$ with R=0.997 and for *rabi* 2002-03 was $Y_{t+1}=1.3401\ Y_t$ with R=0.994**.** However, during *rabi*, the prediction value at the end of the season was not admissible as it crossed 100 PDI. The powdery mildew occurrence was also predicted by simple regression model with an equations for late *kharif* season, 2002 and *rabi* season, 2002-03 are Y=2.01+3.44X and Y= -16.02+ 11.73X with R=0.926 and R= 0.978, respectively. By comparing the R-value it is clear that *rabi* season is suitable for powdery mildew occurrence. Therefore, both the models are good fit for powdery mildew prediction during *rabi* season than late *kharif* as it was favoured by cool and dry weather i.e, mean temperature 26.55 to 29.15^{0}C and 42 to 62 per cent relative humidity and no rainfall during *rabi* season

Key words*:* PDI, First order auto regression, Simple regression, Prediction model and *Uncinula* necator.

INTRODUCTION

Grapes (*Vitis vinifera* L.) is most important fruit crop of the world and is fairly a good source of minerals, vitamins, etc,. Grape is a temperate fruit crop, its cultivation in India is distinctly different from the cultivation elsewhere and is grown in various climatic conditions. The crop is extensively grown in Karnataka and is affected by many destructive fungal, bacterial and nematode diseases. Among these powdery mildew caused by *Uncinula necator* (Schw.) Burr. is most destructive and a limiting factor in grape cultivation resulting in shedding of blossoms in early stage and shriveling and cracking of berries during ripening stage Ghure. and Shinde(1987) and cause enormous yield loss when it attacks at early of stages crop. The disease is influenced by various environmental factors such as, temperature, relative humidity, rainfall and wind velocity. It is favoured by dry and cool weather prevailing during crop growth period. According to Rewal (1993), in South Western regions of Punjab, the maximum temperature goes beyond 35^{0}C during early berry growth period, the growth of fungus is more on the young berries than on leaves. Data on perennials are partially difficult to asses because consideration must be given to the effect of one season's disease development on future disease, in addition, the effect of disease on the current season's yield and also on long term yield potential. Powdery mildew is serious disease in vineyards of northern districts of Karnataka. Therefore, we studied the relationship between disease development and its weather parameters to develop a prediction models using "First order auto regression" and "Simple regression" so as to predict the powdery mildew occurrence one week well in advance and can plan for effective management strategies.

* Author for correspondence. Present Address : Department of Plant Pathology, College of Agriculture, U.A.S., G.K.V.K., BANGALORE (KARNATAKA) INDIA

MATERIALS AND METHODS

Studies on powdery mildew disease development were under taken at the Regional Agricultural Research Station, Raichur during late *kharif* 2002 and *rabi* 2002 – 03 on Thompson Seedless, a highly susceptible variety of grape with recommended package of practices except for the management of powdery mildew disease. Development of disease was studied in relation to previous disease intensity by using first order auto regression model and simple regression model.

The powdery mildew disease was recorded on 10 randomly selected vines by following 0-5 scale Thind *et al*. (1996) at weekly interval starting from the first appearance of disease till pruning / maturation of leaves or fruit bunches. Per cent Disease Index (PDI) was calculated as described by Wheeler(1969).

$$\text{Per cent Disease Index (PDI)} = \frac{\text{Sum of the individual disease rating}}{\text{Number of bunches or branches observed}} \times \frac{100}{\text{Maximum disease grade}}$$

Later the disease was predicted using First order auto regression model developed by Nargund (1989) and Benagi (1995)

a) First order auto regression model :

$$Y_{t+1} = aY_t + e_{t+1}$$

Where,

Y_{t+1} = Predicted PDI at time $_{t+1}$
Y_t = Observed PDI at time t
t = Time of interval in seven days
a = a parameter
e_{t+1} = Error associated with the model at time t+1

The value of 'a' was obtained with the following formula

$$a = \frac{SY_{t+1} X Y_t}{SY_t^2}$$

b) Simple regression model :

$$Y = a + bX$$

Where,

Y = Dependent variable
a = Intercept
b = Co- efficient of regression
X = Independent variable

RESULTS AND DISCUSSION

a) First order auto regression model:

The observed PDI varied from 2.16 to 21.83 and the difference in PDI was less for third and fourth week of observations during late *kharif* 2002 (Table 1).

In 2002-03 *rabi* powdery mildew development was observed in the form of a symmetric sigmoid curve. The PDI varied from 4.66 to 86.99 and the difference in PDI was less at 50th (December 10th –16th) and 51st (December 17th –23rd) meteorological weeks, but in subsequent weeks the differences were not in regular form. Based on observed PDI, the 'First order auto regression model' was employed to estimate the PDI. The auto regressive model for late *kharif* 2002 was of the form.

$$Y_{t+1} = 1.2890Y_t$$

with auto correlation co-efficient as R=0.997.

Similarly for *rabi* 2002 –2003 it was of the form.

$$Y_{t+1} = 1.3401\ Y_t$$

with auto correlation co efficient R=0.994.

Predicted powdery mildew varied from 0.00 to 25.79 PDI and 0.00 to 113.8 PDI during late *kharif* 2002 and *rabi* 2002-03, respectively. The end values of predicted PDI for *rabi* 2002-03 are not admissible as they exceeded the values of cent per cent infection. Similar, results were obtained by Nargund (1989), who reported that, the end values of predicted PDI of leaf rust of wheat were not admissible as they exceeded cent per cent infection.

Table 1 : Observed and predicted Percent Disease Index (PDI) by "First order auto regression" method of grape powdery mildew disease progression during late *kharif* 2002 and *rabi* 2002-2003.

Late *kharif* 2002				*Rabi* 2002-03			
	Per cent disease index (PDI)				Per cent disease index (PDI)		
Meteorological standard weeks	Observed (Y_t)	Predicted (Y_{t+1})	Difference ($Y_t - Y_{t+1}$)	Meteorological standard weeks	Observed (Y_t)	Predicted (Y_{t+1})	Difference ($Y_t - Y_{t+1}$)
35	2.16	-	2.16	48	4.66	-	4.66
36	12.66	2.76	9.9	49	10.33	6.24	4.09
37	13.99	16.2	-2.21	50	13.99	13.84	0.15
38	13.49	17.91	-4.42	51	19.62	18.74	0.88
39	20.15	17.21	-2.89	52	36.00	26.29	9.71
40	21.83	25.79	-3.96	1	56.00	48.24	7.76
				2	71.16	75.04	-3.88
				3	84.99	95.35	-10.36
				4	86.99	*113.8	-26.81

*Estimated values are not admissible: Since it crossed 100 Per cent disease.

Table 2 : Observed and predicted Percent Disease Index (PDI) by "Simple regression model" method of grape powdery mildew disease progression during late *kharif* 2002 and *rabi* 2002-2003.

Late *kharif* 2002				*Rabi* 2002-03			
Meteorological standard weeks (X)	Per cent disease index (PDI)			Meteorological standard weeks (X)	Per cent disease index (PDI)		
	Observed (Y)	Predicted (?)	Difference (Y –?)		Observed (Y)	Predicted (?)	Difference (Y – ?)
35(1)	2.16	5.45	-3.29	48(1)	4.66	-4.29	8.95
36(2)	12.66	8.89	3.77	49(2)	10.33	7.44	2.89
37(3)	13.99	12.33	1.66	50(3)	13.99	19.17	-5.18
38(4)	13.49	15.77	-2.28	51(4)	19.62	30.90	-11.28
39(5)	20.15	19.21	0.94	52(5)	36.00	42.63	-6.63
40(6)	21.83	22.65	-0.82	1(6)	56.00	54.36	1.64
				2(7)	71.16	66.09	5.07
				3(8)	84.99	77.82	7.17
				4(9)	86.99	89.55	-2.56

However, the results of powdery mildew during late *kharif* 2002 are in accordance with Amaresh and Nargund (2002.). The auto regression model may not fit well at very high values of PDI as observed in *rabi* 2002-03. The study reveals that, there was more powdery mildew severity on grapes during *rabi* 2002-03, where the weather was cool and dry favoured the disease development compared to late *kharif* 2002. Hence, the first order auto regressive model is more appropriate for the prediction and explaining epidemics of powdery mildew one week in advance based on the previous observed data.

b) Simple regression model :

Simple regression model is a good statistical tool to predict the disease occurrence based on PDI of previous season. Hence, the simple regression model was employed to predict the powdery mildew during late *kharif* 2002 and *rabi* 2002-03. The equation of the late *kharif* 2002 is $Y=2.01+3.44X$ with $R^2=0.926$ and $Y= -16.02+ 11.73X$ with $R^2= 0.978$ for *rabi* season, 2002-03.

During late *kharif* 2002 the predicted PDI ranged from 5.45 to 22.65 against observed PDI 2.16 to 21.83 (Table2). The observed difference is narrow and less when compared to " first order auto regression" model. The predicted values are very close to that of observed PDI and least difference were obtained at 39th meteorological week (Sept-24 to 30) followed by 37th week (Sept-10to 16) and the disease progress was slow due to heavy rain, further disease enhancement coupled with congenial temperature, relative humidity and no rainfall.

Similarly the predicted PDI during *rabi* 2002-03 ranging from 4.29 to 89.55 as against observed PDI 4.66 to 86.99. The difference between observed and predicted was very less (0.37) during 48th meteorological week (Nov-26 to 2) followed by 1st week (Jan-1 to 7) with the mean temperature (maximum and minimum) and relative humidity of 25.5, 24.60^{0}C and 53, 54 per cent respectively. Here also the observed differences were very less compared to "First order auto regression" model and are consistent. The regression co-efficient for *rabi* season is higher when compared to late *kharif* and is a function of disease progression. Therefore, both the models are good fit for powdery mildew prediction during *rabi* season than late *kharif* as it was favoured by cool and dry weather i.e, mean temperature 26.55 to 29.15^{0}C and 42 to 62 per cent relative humidity and no rainfall during *rabi* season (Table 3).

The powdery mildew has been classified as dry weather fungi Yarwood (1936). Uppal *et al*. (1931) observed that, the fungus developed over a range of atmospheric humidity (40-95%) and more number of infection points was obtained at 26 and 30^{0}C Chellemi and Marois (1991). Rawal (1986), suggested that bower training system with dense foliage that provide shade and reduces the temperature in the vine canopy, coupled with too frequent surface irrigations were found to increase the severity of disease. Powdery mildew severity more in the months of December and January (51st to 4th meteorological weeks) since the conidia production of *Uncinula necator* increased, due to the canopy temperature was decreased and climate was comparatively humid than in the months of November and February. The results are in accordance with Chavan *et al,* (1995). Both the models are well suited for the *rabi* season to predict the powdery mildew of grapes and study clearly indicates that the temperature and relative humidity are key weather factors in disease development.

Table 3 : Severity of grape powdery mildew and weekly weather data at Regional Agricultural Research Station, Raichur during 2002 – 03

Month	Week	Maxi (temp)	Min (temp)	Mean	RF (mm)	Cu RF	Rainy days	CRD	RH (I)	RH (II)	Mean	PDI
July 30/5	31	33.8	23.9	28.85	20.0	20.0	2	2	87	64	76	-
Aug. 6-12	32	29.1	21.8	25.45	79.8	99.8	5	7	90	76	83	-
Aug. 13-19	33	32.6	22.9	27.75	0.00	99.8	0	7	80	52	66	-
Aug 20-26	34	33.2	22.5	27.85	4.0	103.8	0	7	79	45	62	-
Aug 27-2	35	34.3	24.0	29.15	3.40	107.2	1	8	73	49	61	2.16
Sept 3-9	36	34.3	22.6	28.45	28.2	135.4	1	9	79	44	62	12.66
Sept 10-16	37	34.6	23.4	29.00	151.6	135.4	0	9	73	45	59	13.99
Sept 17-23	38	33.6	22.4	28.00	0.0	216.4	3	12	82	48	65	13.49
Sept 24-30	39	35.2	23.6	29.40	9.0	216.4	0	12	76	36	56	20.15
Oct 1-7	40	36.8	23.7	30.25	0.0	216.4	0	12	67	30	48	21.83
Oct 8-14	41	33.1	23.3	28.00	0.0	245.2	4	16	86	60	73	-**
Oct 15-21	42	32.9	22.6	27.75	0.0	296.8	3	19	91	51	71	-
Oct 22-28	43	32.1	20.4	26.25	0.0	396.8	0	19	87	42	65	-
Oct 29-4	44	30.9	19.5	25.20	0.0	405.8	1	20	81	45	63	-
Nov. 5-11	45	31.7	19.3	25.50	0.0	405.8	0	20	86	40	63	-
Nov 12-18	46	32.7	15.7	25.20	0.0	405.8	0	20	85	30	58	-
Nov 19-25	47	31.3	15.7	25.50	0.0	405.8	0	20	84	34	59	-
Nov. 26-2	48	33.2	15.0	25.55	0.0	405.8	0	20	78	27	53	4.66
Dec 3-9	49	31.6	16.9	23.50	0.0	405.8	0	20	82	35	59	10.33
Dec 10-16	50	31.2	15.0	24.10	0.0	405.8	0	20	82	35	59	13.99
Dec 17-23	51	32.3	14.3	24.25	0.0	405.8	0	20	80	26	53	19.62
Dec 24-31	52	31.9	17.3	23.10	0.0	405.8	0	20	79	33	56	36.00
Jan 1-7	1	31.3	18.0	24.60	0.0	405.8	0	20	75	34	54	56.00
Jan 8-14	2	30.7	19.0	24.65	2.4	405.8	0	20	71	33	52	71.16
Jan 15-21	3	30.1	16.1	24.85	0.0	405.8	0	20	75	28	51	84.99
Jab 22-28	4	34.5	18.6	26.55	0.0	405.8	0	20	62	22	42	86.99
Jan 29-4	5	34.2	19.6	26.90	0.0	405.8	0	20	64	30	47	83.33
Feb 5-11	6	33.9	19.3	26.60	0.0	405.8	0	20	73	34	53	79.66
Feb 12-18	7	32.1	21.5	28.80	0.0	408.2	0	20	71	30	51	69.32
Feb 19-25	8	35.7	21.7	28.20	0.0	408.2	0	20	63	28	46	58.99
Feb 26-4	9	37.4	22.7	30.05	0.0	408.2	0	20	57	22	40	42.16
Mar 5-11	10	37.5	22.1	29.80	0.0	408.2	0	20	45	24	34	32.49
Mar 2-18	11	36.5	22.7	29.70	0.0	408.2	0	20	70	31	51	19.99
Mar 19-25	12	37.7	23.8	30.75	0.0	408.2	0	20	58	25	41	13.34
Mar 26-1	13	29.6	24.9	27.25	0.0	408.2	0	20	45	17	31	11.33

-**: Vineyards were pruned during 41st meteorological week, CRD-Cumulative rainy days

REFERENCES

Amaresh, Y. S. and Nargund, V. B. (2002). Development of disease predication models in sunflower rust epidemics. *Indian Journal of Plant Protection*, **30(2):** 105-108, 202.

Benagi, V. I. (1995). Epidemiology and management of late leaf spot of groundnut caused by *Phaeiosariopsis personata* (Berk and curt). V. Ark. *PhD. Thesis*, University of Agricultural Sciences, Dharwad PP: 207.

Chavan, S. B., Khandge, S. V., Varshneya, M. C. and Patil, J. D. (1995). Influence of weather parameters on conidial formation in powdery mildew of grape. *Indian Phytopathology,* **48(1):** 40-44.

Chellemi, D. O. and Marois, J. J. (1991). Sporulation of *Uncinula necator* on grape leaves as influenced by temperature and cultivar. *Phytopathology,* **81(2):** 197-201.

Ghure, T. K. and Shinde, P. A. (1987). Effect of powdery mildew disease caused by *Uncinula necator* (Schew.) Burr on the quality of grape berries. *Journal of Maharastra Agriculture University,* **12(3):** 400-401.

Nargund, V. B. (1989). Epidemiology and control of leaf rust of wheat caused by *Puccinia recondita* f. sp. Tritici Rob. Ex. Desm. *Ph. D. Thesis,* University of Agricultural Sciences, Dharwad, **72:**337.

Rawal, R. D. (1986). Management of powdery mildew of grapes through the use of systemic fungicides. *Advanced Biological research*, **4:**121-127.

Rewal, H. S. (1993). Management of powdery mildew on grape in Punjab. *Maharastra Journal of Horticulture*, **7(2):** 10-12.

Thind, S. K., Kapur, S. P., Josan, J. S. and Sharma, J. N. (1996). Screening of germplasm against powdery mildew and its control. *Plant Disease Research*, **11(1):** 9-11.

Uppal, B.N., Chemma, G.S. and Kamat, M.N. (1931). Powdery mildew of the grapes and its control in Bombay.

Wheeler, B.E.J. (1969). An introduction to plant disease. John Wiley sons limited, London.pp: 301.

Yarwood, C. E. (1936). The tolerance of *Erysiphae polygoni* and other powdery mildew to low humidity, *Phytopathology*, **26:**845-849.

Received : May, 2006; Accepted : March, 2007