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Testing and validation of developed Disease prediction model of Foot rot and Leaf rot of betelvine (*Piper betel* L.) caused by *Phytophthora* sp. in three varieties of betelvine under closed conservatory condition in West Bengal

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Stepwise multiple regression analysis of per cent disease incidence of leaf and foot rot caused by *Phytophthora* sp on three different varieties of betelvine Ghanagette, Simurali Deshi and Simurali Gol Bhavna) was made by compiling the results of disease incidence during 2006-07,2007-08 and 2008-09 to find out the important meteorological parameters like Tmax, Tmin, RH max, RHmin and rainfall which were responsible for incidence of both the diseases.. The prediction equation for disease incidence which has been developed for foot rot and leaf rot of betelvine on three varieties (Ghanagette, Simurali Deshi and Simurali Gol Bhavna) were further fitted against the disease incidence of foot rot and leaf rot of betelvine in 2009-10 using the effective meteorological parameters of the same year for validation of these equations and models. The results showed poor estimated value during initial disease incidence. Among the two diseases (foot rot and leaf rot) the estimated value of leaf rot incidence was nearer to original value. It was observed that in all prediction equation like Logit, Gompertz and Percent transformation, after 10th week of observations, the estimated value was similar to that of original value. It was more validated on leaf rot disease but not in foot rot disease. Among the three varieties tested, in Ghanagette and Simurali Deshi varieties, the prediction equations which were prepared were also showed some validation in predicting the disease incidence of betelvine.

Key words: Foot rot, Leaf rot, Disease prediction model, validation

INTRODUCTION

Cultivation of betelvine is highly risky and returns are uncertain because of its proneness to several diseases, aggravated by the moist and humid conditions of the plantation, that in turn are prerequisites for good harvest. Obviously the major constraint to cultivation of betelvine is its diseases that severally damage root, foot, stem, and foliage. The serious diseases reported include a foot rot syndrome produced by a number of pathogens including *Phytophthora parasitica* var. *piperina*, *P nicotianae* var *parasitica*, species of *Rhizoctonia, Pythium* and *Sclerotium rolfsii* , and foliage diseases like leaf rot by *P. parasitica*, *P. palmivora*, leaf spot and stem anthracnose caused by *Colletorichum capsici*, bacterial leaf spot and stem rot caused by *Xanthomonas campestries* pv. *betlicola*. Among the pathogens, *Phytophthora* sp. perhaps ranks first in its destructiveness under both field and storage conditions. The extent of losses may vary from 30 – 100% in case of foot rot and 20 – 40% in case of leaf rot, leading to almost total crop failure (Maiti and Sen, 1982; Dasgupta and Sen, 1998; Dasgupta *et al.,* 2000).

The incidence, pathogenesis and control of stem rot and leaf rot of betel vine caused by *P. parasitica*

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have been studied in detail by Roy (2001), Sanyal (2002), Mahanty (2004) and under AICRP on betel vine (Anonymous, 2004,2006). Very little information have been received about epidemiology of stem rot caused by *Phytophthora parasitica*. Maiti and Sen (1982) have reported that the disease occur between June to October and reach its peak intensity during August and September. Observations made under AICRP on betelvine revealed that all the meteorological parameters like maximum and minimum temperature, maximum and minimum relative humidity and rainfall play important arole on stem rot and leaf rot of betelvine caused by *P. parasitica* (Anonymous, 2006; Dasgupta and Maiti, 2008; and Datta *et al.*, 2009). Datta *et al.*, (2009) studied the epidemiology of foot and leaf rot of betelvine considering five meteorological factors in three betelvine varieties to reveal that minimum temperature is more responsible for increase the disease intensity as well as spread of the diseases as observed in original data and also in transformation models in all the three varieties. Individually, in variety Simurali Deshi, in addition to min. temp., max. RH is also responsible for increase the disease intensity of foot rot in all the transformation models. It is also revealed that among the two transformation models Logit transformation fit best for disease prediction and it is confirmed with high R^2 value. So, it is concluded that with increase in minimum temperature (› 26.5°C) foot rot and leaf rot diseases increase significantly in case of Ghanagette and Simurali Gol Bhavna varieties whereas increase in minimum temperature and maximum relative humidity (96.5%) there is a significant increase in the intensity of leaf rot of betelvine in Simurali Deshi variety. The present investigation has been carried out to test and validate the developed Disease prediction model of Foot rot and Leaf rot of betelvine caused by *Phytophthora* sp. in three varieties of betelvine under closed conservatory condition in West Bengal.

MATERIALS AND METHODS

The varieties of betel vine used for epidemiological study were Simurali Gol Bhavna, Ghanagette and Simurali Deshi

The diseases selected for investigation of epidemiological study was foot rot and leaf rot diseases of betel vine caused by *P.parasitica*.

A '*boroj*' was selected at Mondouri Farm, in the district of , N-24 Parganas. The size of the *'boroj'* was 500 sq. ft. with length and width of 25ft and 20ft respectively.

The data on meteorological factors, like maximum temperature, minimum temperature, maximum and minimum relative humidity and total rainfall were collected from Bell's thermohygrograph situated within the *boroj*. All the data were collected daily except the rainfall data, which was collected when rain occurred. The experiment was conducted during June to November when the incidence of foot rot and leaf rot diseases due to *P. parasitica* appeared. The disease incidence was recorded at 7 days interval starting from 1st week of June to last week of November.

The foot rot due to *P. parasitica* was calculated as per cent mortality of 100 vines (approx.). The leaf rot due to *P. parasitica* was calculated as per cent disease incidence. Per cent disease incidence was calculated as per cent of leaves infected in a random sample of 500 leaves (approx.). Per cent disease incidence was calculated according to Townsend and Heuberger (1943).

Three varieties Ghanagette, Simurali Deshi and Simurali Gol Bhavna were inoculated with *Phytphthora parasitica* during end of May of each year. The intensity of diseases was recorded from 1st week of June to November at 7 days interval during 2009-10. The average weekly meteorological parameters were used for multiple regression analysis.

The results obtained were analysed by multiple regression analysis (MRA) by compiling three years data where maximum temperature, minimum temperature, maximum relative humidity, minimum relative humidity and rainfall as explanatory variables (independent) and the per cent disease incidence of foot rot and leaf rot of betelvine caused by *P. parasitica* on above three varieties as dependent variable. For comparison of transformation models on disease prediction, the per cent disease incidence of foot rot and leaf rot data were transformed to Gompertz and Logistic model and step down multiple regression analysis were done with the above independent variables. The prediction equations for disease incidence were prepared by compiling the results of disease incidence of foot rot and leaf rot of betelvine during 2006-07, 2007-08 and 2008-09 with the meteorological parameters that were further fitted against the disease incidence of foot rot and leaf rot of betelvine in current year (2009-10) using the effective meteorological parameters of current year for testing and validation of these equations and models.

RESULTS AND DISCUSSION

Five meteorological parameters like T_{max}, T_{min}, RH_{max}, RH_{min} and total rainfall played major role within the *boroj* for the growth of the plant as well as the pathogen and were considered for quantify the disease incidence. All the three popular varieties like Ghanagette, Simurali Deshi and Simurali Gol Bhavna showed differential disease reactions within the same environmental condition.

In case of variety Ghanagette, the coefficient determination (R^2) values for prediction equations were though significant in different models (Logit and Gompertz) but found very low (Table 1). The results (Table 2) showed poor estimated value during initial disease incidence. Among the two diseases (foot rot and leaf rot) the estimated value of leaf rot incidence was nearer to original value. It was observed that in all prediction equations like Logit, Gompertz and per cent transformation, after 10th week of observations, the estimated value was similar to that of original value. It was more validated on leaf rot disease but not in foot rot disease. After 16th weeks of observation it was showed that in both the diseases the estimated disease and observed diseases were similar. It was also observed that the Logit and Gompertz prediction models were best fitted to predict both the diseases. After 23rd these prediction equations were not suited up to 24th weeks of observations. The disease incidences were low at the latter part of observations as the disease fall due to change in environmental condition. Some erratic results were observed due to erratic change in environmental conditions.

The results (Table 3) showed poor estimated value during initial disease incidence in variety Simurali deshi and the coefficient determination (R^2) values (Table 1) for prediction equations were though significant in different models (Logit and Gompertz) but found very low. Among the two diseases (foot rot and leaf rot) the estimated value of leaf rot incidence was nearer to original value. It was observed that in all prediction equations per cent transformation, after 8th week of observations, the estimated value was similar to that of original value. It was more validated on leaf rot disease but not in foot rot disease. After 17th weeks of observation it showed that in both foot rot and leaf rot diseases the estimated disease and observed diseases were similar. It was also observed that the Logit and Gompertz prediction models were best fitted to predict both the diseases. The disease incidences were low at the latter part of observations as the diseases fall due to change in environmental condition.

The coefficient determination (R^2) values for prediction equations were though significant in different models but it found very low in variety Simurali Gol Bhavna (Table 1). The results (Table 4) showed poor estimated value during initial disease incidence. Among the two diseases the estimated value of leaf rot incidence was nearer to original value. It was observed that in all prediction equations like Logit, Gompertz and per cent transformation, the estimated value was similar to that of original value in 9th , 11th, 15th, 16th and 17th weeks of observations. It was more validated on leaf rot disease but not in foot rot disease. After 23rd weeks of observation it showed that in both foot rot and leaf rot diseases the estimated diseases and observed diseases were similar. The prediction equation was not suited in rest of the observations. It was also observed that the Logit and Gompertz prediction models were best fitted to predict both the diseases. The disease incidences were low at the latter part of observations as the disease falls due to change in environmental condition. Moreover, some erratic results were observed due to erratic change in environmental conditions.

It was observed that in all prediction equations, after 10th week of observations, the estimated value was similar to that of original value. It was more validated on leaf rot disease but not in foot rot disease. Among the three varieties tested, in Ghanagette and Simurali Deshi varieties, the prediction equations which were prepared were also showed some validation in predicting the disease incidence of betelvine.

The prediction equations will be best fitted if these equations were prepared by considering the other meteorological parameters like sunshine hours, vapour pressure, wind velocity and also microclimate within the plant population. Yet the prediction equations which were prepared were also showed some validation in predicting the disease incidence of betelvine.

Table 1: Comparison of different transformation models on prediction of foot rot and leaf rot disease intensity of betelvine

Model	Transformation	Fitted regression equation	R^2	Adjusted R^2	Residual SS	S.E. (est.)	Disease
Year 2006-07							
Variety Ghanagette							
Stepwise	Percent	Y = -2.24 + 0.022 max. RH** + 0.008 min. Temp*	0.51	0.47	0.04	0.002	Foot rot
		Y = -0.22 + 0.005 min RH**	0.69	0.67	0.03	0.008	Leaf rot
Stepwise	Logit	Y = -35.62 + 0.31 max. RH** + 0.12 min. Temp**	0.54	0.49	0.59	0.35	Foot rot
		Y = -18.10 + 0.13 min Temp** + 0.14 max RH**	0.76	0.74	0.26	0.07	Leaf rot
Stepwise	Gompertz	Y = -12.57 + 0.11 max RH** + 0.04 min Temp**	0.54	0.50	0.21	0.04	Foot rot
		Y = -5.74 + 0.008 min RH* + 0.03 min Temp** + 0.04 max RH*	0.78	0.75	0.10	0.01	Leaf rot
Variety Simurali Deshi							
Stepwise	Percent	Y = - 0.40 + 0.007 min RH**	0.57	0.56	0.05	0.003	Foot rot
		Y = - 0.43 + 0.008 min RH**	0.64	0.63	0.05	0.003	Leaf rot
Stepwise	Logit	Y = - 9.46 + 0.10 min RH**	0.51	0.49	0.84	0.40	Foot rot
		Y = - 29.69 + 0.24 min RH** + 0.23 max RH**	0.75	0.73	0.49	0.24	Leaf rot
Stepwise	Gompertz	Y = - 3.36 + 0.3 min RH**	0.56	0.54	0.27	0.07	Foot rot
		Y = - 3.39 + 0.02 min RH** + 0.04 min Temp**	0.71	0.68	0.20	0.04	Leaf rot
Variety Simurali Gol Bhavna							
Stepwise	Percent	Y = - 0.20 + 0.003 min RH**	0.50	0.48	0.03	0.0009	Foot rot
		Y = - 0.30 + 0.005 min RH**	0.55	0.53	0.04	0.002	Leaf rot
Stepwise	Logit	Y = - 10.33 + 0.10 min RH**	0.50	0.48	0.83	0.69	Foot rot
		Y = - 40.71 + 0.30 min Temp** + 0.32 max RH**	0.75	0.73	0.61	0.38	Leaf rot
Stepwise	Gompertz	Y = - 3.14 + 0.03 min RH**	0.52	0.49	0.23	0.52	Foot rot
		Y = - 3.39 + 0.03 min RH**	0.60	0.58	0.24	0.06	Leaf rot

Model	Transformation	Fitted regression equation	R^2	Adjusted R^2	Residual SS	S.E (est.)	Disease
Year 2007-08							
Variety Ghanagette							
Stepwise	Percent	Y = -5.04 + 3.006 min Temp*	0.12	0.07	0.03	0.0001	Foot rot
		Y = 3.916 - 0.05 max Temp* + 0.04 min Temp* - 0.03 max RH	0.27	0.17	0.16	0.027	Leaf rot
Stepwise	Logit	Y = -2.83 + 0.001 rainfall	0.10	0.03	0.45	0.20	Foot rot
		Y = -4.81 + 0.052 min RH*	0.19	0.16	1.00	1.00	Leaf rot
Stepwise	Gompertz	Y = -1.054 – 0.0005 rainfall	0.10	0.03	0.14	0.02	Foot rot
		Y = 9.71 – 0.15 max Temp* + 0.12 min Temp* - 0.08 max RH*	0.28	0.17	0.53	0.27	Leaf rot

Table contd......

Variety Simurali Deshi							
Stepwise	Percent	Y = - 0.40 + 0.001 min RH*	0.15	0.12	0.24	0.00057	Foot rot
		Y = - 0.39 + 0.03 min RH*	0.24	0.20	0.17	0.028	Leaf rot
Stepwise	Logit	Y = - 3.02 rainfall**	0.00	0.00	0.37	0.14	Foot rot
		Y = - 7.84 + 0.28 min Temp**	0.45	0.42	0.987	40.95	Leaf rot
Stepwise	Gompertz	Y = - 1.17 Rainfall**	0.00	0.00	0.17	0.01	Foot rot
		Y = - 3.00 + 0.118 min Temp**	0.33	0.30	0.52	0.27	Leaf rot
Variety Simurali Gol Bhavna							
Stepwise	Percent	Y = 0.23 - 0.0088 max Temp + 0.010 min Temp – 0.002 min RH + 0.0002 Rainfall	0.29	0.15	0.030	0.0009	Foot rot
		Y = 0.32 + 0.033 min Temp** - 0.03 max Temp*	0.40	0.33	0.114	0.013	Leaf rot
Stepwise	Logit	Y = - 1.37 – 0.07 min Temp + 0.0023 Rainfall	0.47	0.29	0.400	0.16	Foot rot
		Y = - 7.63 + 0.26 min Temp**	0.46	0.44	0.890	0.80	Leaf rot
Stepwise	Gompertz	Y = - 1.610 + 0.055 max Temp – 0.055 min Temp + 0.0016 Rainfall*	0.48	0.31	0.13	0.017	Foot rot
		Y = - 0.75 + 0.13 min Temp** - 0.088 max Temp*	0.48	0.43	0.370	0.14	Leaf rot

Year 2008-09

Variety Ghanagette

Model	Transformation	Fitted regression equation	R^2	Adjusted R^2	Residual SS	S.E (est.)	Disease
Stepwise	Percent	Y = -3.65 + 0.03 min Temp** + 0.037 max RH** - 0.004 min RH* - 0.002 Rainfall	0.51	0.41	0.081	0.006	Foot rot
		Y = -5.54 – 0.045 min Temp** + 0.059 max RH** - 0.011 min RH* - 0.002 Rainfall	0.45	0.34	0.13	0.016	Leaf rot
Stepwise	Logit	Y = -6.33 + 0.18 min Temp**	0.35	0.32	0.86	0.73	Foot rot
		Y = -42.69 + 0.31 min Temp** + 0.42 max RH** - 0.06 min RH* - 0.019 Rainfall	0.54	0.44	0.80	0.64	Leaf rot
Stepwise	Gompertz	Y = - 2.27 + 0.065 min Temp**	0.30	0.26	0.365	0.12	Foot rot
		Y = -19.84 + 0.15 min Temp* + 0. 20 max RH* - 0.039 min RH* - 0.008 Rainfall*	0.50	0.39	0.40	0.16	Leaf rot
Variety Simurali Deshi							
Stepwise	Percent	Y = - 0.41 + 0.024 min Temp**	0.39	0.36	0.10	0.01	Foot rot
		Y = - 0.37 + 0.02 min Temp*	0.25	0.21	0.14	0.02	Leaf rot
Stepwise	Logit	Y = - 6.90 + 0.21 min Temp**	0.29	0.25	0.81	0.66	Foot rot
		Y = - 9.70 + 0.32 min Temp**	0.37	0.34	1.01	1.03	Leaf rot
		Y = - 2.90 + 0.094 min Temp*	0.28	0.24	0.36	0.14	Foot rot
Stepwise	Gompertz	Y = - 3.3 + 0.1 min Temp*	0.24	0.20	0.48	0.23	Leaf rot

Table contd……

Variety Simurali Gol Bhavna

Stepwise	Percent transformation	Y = - 5.01 + 0.04 min Temp** + 0.05 max RH** - 0.007 min RH* - 0.002 Rainfall**	0.57	0.48	0.09	0.009	Foot rot
		Y = - 6.20 + 0.05 min Temp** + 0.06 max RH** - 0.01 min RH* - 0.002 Rainfall	0.46	0.35	0.14	0.020	Leaf rot
Stepwise	Logit	Y = - 36.92 + 0.30 min Temp** + 0.30 max RH** - 0.05 min RH* - 0.01 Rainfall*	0.52	0.42	0.72	0.53	Foot rot
		Y = - 4.70 + 0.14 min Temp*	0.17	0.12	1.07	1.15	Leaf rot
Stepwise	Gompertz	Y = -19.3 + 0.07 max Temp – 0.13 min Temp +0.16 RH** - 0.02 min RH – 0.0071 Rainfall*	0.55	0.42	0.33	0.10	Foot rot
		Y = - 21.31 + 0.18 min Temp** + 0.21 max RH** - 0.03 min RH* - 0.007 Rainfall	0.51	0.41	0.43	0.19	Leaf rot

Table 2: Prediction equation for validation on disease incidence (variety Ghanagette)

Weeks	Meteorological parameters					Transformation															
						Per cent				Logit				Gompertz							
	Max. Temp.	Min. Temp.	Max. RH	Min. RH	Rain Fall	Foot rot		Leaf rot		Foot rot		Leaf rot		Foot rot		Leaf rot					
						Yest	Yobs.	Yest	Yobs.	Yest	Yobs.	Yest	Yobs.	Yest	Yobs.	Yest	Yobs.				
1	35.3	26.7	88.6	64.3	23.8	12.26	0.00	29.16	3.33	6.983	0.00	18.38	3.33	9.09	0.00	25.09	3.33				
2	35.9	28.1	89.4	61.3	0.0	13.42	0.00	29.12	0.00	8.66	0.00	20.45	0.00	10.69	0.00	31.00	0.00				
3	36.9	26.7	89.5	62.2	4.5	12.31	0.00	22.21	6.67	7.046	0.00	14.28	6.67	9.158	0.00	19.6	6.67				
4	34.6	27.2	90.4	69.7	38.0	12.68	5.33	29.99	3.33	7.56	5.33	22.2	3.33	9.660	5.33	27.54	3.33				
5	32.1	26.3	94.8	80.3	113.8	11.94	5.33	28.54	3.33	6.576	5.33	28.14	3.33	8.682	5.33	27.71	3.33				
6	32.5	26.4	94.1	74.7	10.1	12.03	0.00	28.75	6.67	6.686	0.00	27.06	6.67	8.795	0.00	30.05	6.67				
7	32.4	26.6	93.6	77.6	45.7	12.20	3.33	30.50	16.67	6.910	3.33	28.24	16.67	9.022	3.33	29.73	16.67				
8	34.0	26.6	93.0	73.1	57.8	12.21	0.00	25.87	10.00	6.921	0.00	22.21	10.00	9.032	0.00	25.03	10.00				
9	33.2	25.9	97.3	80.0	164.8	11.60	0.00	19.59	13.33	6.173	0.00	22.71	13.33	8.261	0.00	21.07	13.33				
10	32.5	27.1	95.4	79.1	39.4	12.60	0.00	28.16	26.67	7.435	0.00	29.33	26.67	9.541	0.00	30.34	26.67				
11	32.7	26.0	96.0	74.4	123.8	11.70	3.33	23.92	23.33	6.286	3.33	24.99	23.33	8.380	3.33	27.50	23.33				
12	30.9	25.8	96.2	85.4	65.30	11.51	3.33	28.91	23.33	6.062	3.33	30.96	23.33	8.142	3.33	27.35	23.33				
13	31.1	25.9	95.1	82.3	86.70	11.66	3.33	30.47	13.33	6.238	3.33	30.71	13.33	8.330	3.33	29.17	13.33				
14	33.1	26.3	96.3	77.8	86.00	11.95	3.33	22.56	23.33	6.586	3.33	24.28	23.33	8.692	3.33	24.58	23.33				
15	33.5	26.4	94.9	76.1	36.00	12.00	0.00	23.88	20.00	6.646	0.00	23.21	20.00	8.754	0.00	24.33	20.00				
16	33.6	26.4	94.6	69.6	2.40	12.00	3.33	23.93	26.67	6.646	3.33	22.84	26.67	8.754	3.33	27.94	26.67				
17	31.8	25.1	97.8	84.6	76.80	10.98	6.67	21.64	23.33	5.484	6.67	25.30	23.33	7.511	6.67	21.07	23.33				
18	33.0	23.9	94.7	64.4	0.00	10.00	10.0	19.91	43.33	4.551	10.00	17.90	43.30	6.42	10.00	22.73	43.33				
19	32.7	21.5	93.7	56.2	14.30	8.07	10.0	16.89	23.33	3.128	10.00	13.26	23.30	4.58	10.00	18.51	23.33				
20	32.1	18.1	93.6	52.9	0.00	5.36	6.67	10.84	20.00	1.837	6.67	8.666	20.00	2.66	6.67	9.965	20.00				
21	32.2	21.3	93.7	59.8	0.00	7.92	6.67	18.15	30.00	3.042	6.67	13.99	30.00	4.46	6.67	17.68	30.00				
22	32.7	20.3	92.1	53.1	0.00	7.12	3.33	16.76	20.00	2.601	3.33	11.08	20.00	3.83	3.33	15.51	20.00				
23	29.0	19.0	93.7	58.5	3.80	6.12	3.33	23.54	3.33	2.134	3.33	16.93	3.33	3.12	3.33	22.10	3.33				
24	27.9	13.6	93.5	48.2	0.00	1.79	0	14.65	3.33	0.904	0.00	8.998	3.33	1.12	0.00	10.85	3.33				

Table 3: Prediction equation for validation on disease incidence (variety Simurali Deshi)

Weeks	Meteorological parameters					Per cent				Transformation Logit				Gompertz			
	Max. Temp.	Min. Temp.	Max. RH	Min. RH	Rain Fall	Foot rot		Leaf rot		Foot rot		Leaf rot		Foot rot		Leaf rot	
						Yest	Yobs	Yest	Yobs.	Yest	Yobs	Yest	Yobs	Yest	Yobs.	Yest	Yobs
1	35.3	26.7	88.6	64.3	23.8	16.15	0.00	19.95	0.00	1.975	0.00	20.37	0.00	3.99	0.00	20.15	0.00
2	35.9	28.1	89.4	61.3	0.0	18.33	0.00	22.78	6.67	3.617	0.00	28.79	6.67	6.78	0.00	25.15	6.67
3	36.9	26.7	89.5	62.2	4.5	16.24	3.33	16.08	3.33	2.455	3.33.	15.78	3.33	4.87	3.33	15.87	3.33
4	34.6	27.2	90.4	69.7	38.0	16.9	0.00	23.5	10.00	3.39	0.00	27.1	10.00	6.43	0.00	-0.32	10.00
5	32.1	26.3	94.8	80.3	113.8	15.55	0.00	26.85	3.33	6.64	0.00	29.86	3.33	10.60	0.00	28.30	3.33
6	32.5	26.4	94.1	74.7	10.1	15.72	0.00	26.23	3.33	5.89	0.00	29.15	3.33	9.754	0.00	27.62	3.33
7	32.4	26.6	93.6	77.6	45.7	16.05	0.00	27.17	3.33	5.654	0.00	31.50	3.33	9.476	0.00	29.09	3.33
8	34.0	26.6	93.0	73.1	57.8	16.06	3.33	23.00	20.00	4.983	3.33	24.59	20.00	8.646	3.33	23.77	20.00
9	33.2	25.9	97.3	80.0	164.8	14.92	3.33	22.79	20.00	9.670	3.33	22.18	20.00	13.57	3.33	22.70	20.00
10	32.5	27.1	95.4	79.1	39.4	16.78	3.33	28.24	20.00	9.257	3.33	35.15	20.00	13.23	3.33	31.06	20.00
11	32.7	26.0	96.0	74.4	123.8	15.10	0.00	24.53	26.67	7.727	0.00	25.11	26.67	11.73	0.00	24.99	26.67
12	30.9	25.8	96.2	85.4	65.30	14.74	0.00	28.21	13.33	7.607	0.00	30.47	13.33	11.61	0.00	29.458	13.33
13	31.1	25.9	95.1	82.3	86.70	15.03	3.33	28.20	20.00	6.391	3.33	31.08	20.00	10.31	3.33	29.669	20.00
14	33.1	26.3	96.3	77.8	86.00	15.57	0.00	24.26	20.00	8.904	0.00	25.59	20.00	12.88	0.00	24.989	20.00
15	33.5	26.4	94.9	76.1	36.00	15.66	3.33	23.54	23.33	6.801	3.33	24.65	23.33	10.78	3.33	24.151	23.33
16	33.6	26.4	94.6	69.6	2.40	15.66	6.67	23.26	16.67	6.461	6.67	24.23	16.67	10.40	6.67	23.809	16.67
17	31.8	25.1	97.8	84.6	76.80	13.75	6.67	24.05	23.33	8.762	6.67	21.91	23.33	12.72	6.67	23.412	23.33
18	33.0	23.9	94.7	64.4	0.00	11.92	3.33	17.39	26.67	3.258	3.33	11.80	26.67	6.157	3.33	14.611	26.67
19	32.7	21.5	93.7	56.2	14.30	8.29	10.00	10.93	33.33	1.291	10.00	5.116	33.33	2.561	10.00	7.223	33.33
20	32.1	18.1	93.6	52.9	0.00	3.21	3.33	2.14	33.33	0.457	3.33	1.518	33.33	0.700	3.33	1.775	33.33
21	32.2	21.3	93.7	59.8	0.00	8.02	3.33	11.59	30.00	1.213	3.33	5.248	30.00	2.395	3.33	7.575	30.00
22	32.7	20.3	92.1	53.1	0.00	6.52	0.00	7.37	10.00	0.640	0.00	3.236	10.00	1.117	0.00	4.476	10.00
23	29.0	19.0	93.7	58.5	3.80	4.63	3.33	12.81	10.00	0.625	3.33	4.142	10.00	1.077	3.33	7.050	10.00
24	27.9	13.6	93.5	48.2	0.00	-3.49	0.00	-0.72	3.33	0.117	0.00	0.607	3.33	0.063	0.00	0.577	3.33

Table 4: Prediction equation for validation on disease incidence (Variety Simurali Gol Bhavna)

Weeks	Meteorological parameters				Rain Fall	Percent				Transformation Logit				Gompertz			
	Max. Temp.	Min. Temp.	Max. RH	Min. RH		Foot rot		Leaf rot		Foot rot		Leaf rot		Foot rot		Leaf rot	
						Yest	Yobs.	Yest	Yobs.	Yest	Yobs.	Yest	Yobs.	Yest	Yobs.	Yest	Yobs.
1	35.3	26.7	88.6	64.3	23.8	43.87	0.00	31.60	0.00	4.74	0.00	33.99	0.00	9.51	0.00	34.52	0.00
2	35.9	28.1	89.4	61.3	0.00	46.44	0.00	32.26	3.33	5.92	0.00	38.32	3.33	11.20	0.00	36.46	3.33
3	36.9	26.7	89.5	62.2	4.5	41.58	0.00	23.76	6.67	3.21	0.00	22.46	6.67	9.58	0.00	24.89	6.67
4	34.6	27.2	90.4	69.7	38.0	46.30	0.00	32.24	3.33	6.56	0.00	36.80	3.33	10.14	0.00	35.99	3.33
5	32.1	26.3	94.8	80.3	113.8	47.77	3.33	28.40	3.33	9.42	3.33	30.20	3.33	9.05	3.33	31.30	3.33
6	32.5	26.4	94.1	74.7	10.1	47.46	3.33	29.00	3.33	8.85	3.33	31.10	3.33	9.18	3.33	31.90	3.33
7	32.4	26.6	93.6	77.6	45.7	48.16	3.33	31.20	13.30	9.59	3.33	35.10	13.30	9.43	3.33	34.90	13.3
8	34.0	26.6	93.0	73.1	57.8	45.66	0.00	26.40	6.67	6.42	0.00	27.10	6.67	9.44	0.00	28.70	6.67
9	33.2	25.9	97.3	80.0	164.8	45.08	0.00	17.60	16.7	6.48	0.00	15.90	16.70	8.58	0.00	18.50	16.70
10	32.5	27.1	95.4	79.1	39.4	49.09	6.67	28.40	10.00	10.41	6.67	31.90	10.00	10.00	6.67	31.90	10.00
11	32.7	26.0	96.0	74.4	123.8	46.20	3.33	22.80	20.00	7.64	3.33	21.90	20.00	8.72	3.33	24.30	20.00
12	30.9	25.8	96.2	85.4	65.30	48.26	0.00	27.90	6.67	10.90	0.00	29.00	6.67	8.45	0.00	30.70	6.67
13	31.1	25.9	95.1	82.3	86.70	48.37	3.33	30.20	16.70	10.84	3.33	32.60	16.60	8.66	3.33	33.40	16.70
14	33.1	26.3	96.3	77.8	86.00	46.22	0.00	21.40	13.30	7.350	0.00	20.70	13.30	9.06	0.00	22.90	13.30
15	33.5	26.4	94.9	76.1	36.00	45.82	3.33	23.40	26.70	6.838	3.33	22.90	26.60	9.13	3.33	25.10	26.70
16	33.6	26.4	94.6	69.6	2.40	45.70	6.67	23.50	33.30	6.65	6.67	23.10	33.30	9.13	6.67	25.20	33.30
17	31.8	25.1	97.8	84.6	76.80	45.40	6.67	19.00	26.70	7.55	6.67	16.70	26.60	7.75	6.67	19.70	26.70
18	33.0	23.9	94.7	64.4	0.00	40.60	3.33	17.40	33.30	4.11	3.33	13.20	33.30	6.55	3.33	16.80	33.30
19	32.7	21.5	93.7	56.2	14.30	35.30	10.00	12.80	30.00	2.36	10.0	7.92	30.00	4.55	10.00	11.10	30.00
20	32.1	18.1	93.6	52.9	0.00	28.00	3.33	3.96	33.30	1.10	3.33	3.17	33.30	2.50	3.33	4.16	33.30
21	32.2	21.3	93.7	59.8	0.00	35.60	3.33	14.10	40.00	2.54	3.33	8.52	40.00	4.42	3.33	12.30	40.00
22	32.7	20.3	92.1	53.1	0.00	32.50	0.00	12.40	20.00	1.72	0.00	6.85	20.00	3.74	0.00	10.10	20.00
23	29.0	19.0	93.7	58.5	3.80	34.98	3.33	18.40	10.00	3.16	3.33	9.63	10.00	2.99	3.33	15.10	10.00
24	27.9	13.6	93.5	48.2	0.00	23.61	0.00	5.08	3.33	0.99	0.00	2.38	3.33	0.96	0.00	3.64	3.33

The prediction equations will be best fitted if these equations were prepared by considering the other meteorological parameters like sunshine hours, vapour pressure, wind velocity and also microclimate within the plant population. Yet the prediction equations which were prepared were also showed some validation in predicting the disease incidence of betelvine.

REFERENCES

Anonymous. 2004. *Biennial Report.* All India Net Working Project on Betelvine. National Research Centre for Medicinal and Aromatic Plants, Boriavi, Anand, Gujarat, India, pp. 157.

Anonymous. 2006. *Biennial Report.* All India Net Working Project on Betelvine. National Research Centre for Medicinal and Aromatic Plants, Boriavi, Anand, Gujarat, India, pp. 168.

Dasgupta, B. and Sen, C. 1998. Loss assessment and use of chemicals in the management of *Phytophthora* root rot of betelvine. *Indian J. Mycol. Plant Pathol.* **26 :** 118.

Dasgupta,B. and Maiti,S. 2008. Research on betelvine diseases under AINP on betelvine. Proceedings Piperaceae Crops – Technologies and Future Perspectives. Indian Institute of Spices Research, Calicut, Kerala, 673012, 270-279.

Dasgupta, B., Roy, J. K. and Sen, C. 2000. Two major fungal diseases of betelvine. In : *Diseases of Plantation Crops, Spices, Betelvine and Mulberry* (Ed. M. K. Dasgupta), 133-137.

Datta,P., Dasgupta,B., Sengupta,C and Sengupta,D.K. 2009. Epidemiological studies of stem rot of betelvine caused by *Phytophthora parasitica* under closed conservatory condition in West Bengal. *Journal of Crop and Weed*,. **5 :** 258-260.

Maiti, S. and Sen, C. 1982. Effect of standard weather on three major diseases of betel vine. *Indian Phytopath.* **35** : 14-17.

Mahanty, B. 2004. *Some Biological aspects of Phytophthora sp. causing rots of Betelvine (Piper betle L.) and its management.* Ph.D. Dissertation, B.C.K.V., Mohanpur, Nadia, India.

Roy, J. 2001. *Management of Two important disease of betelvine (P. betle L.) with special emphasis on biological control.* Ph. D. Dissertation, B.C.K.V., Mohanpur, Nadia, India.

Sanyal,B. 2002. *Non target effects of pesticides on biocontrol agents effective against major fungal diseases of betelvine.* Ph.D. Dissertation, University of Kalyani, Kalyani, Nadia, India.

Townsend, G. R. and Heuberger, J. W. 1943. Methods for estimating losses caused by diseases in fungicidal treatments. *Plt. Dis. Rep.* **27** : 340-342.