Research Journal of Agriculture and Forestry Sciences _____ISSN 2320 – 6063
Vol. **5(8),** 1-5, August **(2017)** *Res. J. Agriculture and Forestry Sci.*

Epidemiological studies on downy mildew of bitter gourd caused by *Pseudoperonospora cubensis*

Kumari Manjusha[1], R.B. Kothikar[2*], Mina Koche[2] and A.N. Surpam[2]
[1]Indira Gandhi Krishi Vishwavidyalay, Raipur, CG, India
[2]Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola, MS, India
rajkumarkothikar@gmail.com

Available online at: www.isca.in
Received 15th April 2017, revised 21st July 2017, accepted 4th August 2017

Abstract

Periodical development of disease during the period revealed that, there was an increase and decrease of downy mildew disease severity from fourth October to fourth January. Disease severity gradually increases from fourth October and continued till first November (25.97 to 59.10 %), where it reached at its maximum. The rate of disease development / unit /day (r value) varied from $2.6x10^{-4}$ to $–6.82x10^{-5}$. The correlation between disease severity and environmental factors in bitter gourd indicated no definite relationship pattern. In most of the cases correlation co-efficient is negative except of relative humidity but not significant. Correlation is also positive in case of temperature difference. Maximum disease severity in first week of November is may be due to less difference in temperature and relative humidity.

Keywords: Epidemiology, Downy, Mildew, Bitter, Gourd, *Pseudoperonospora cubensis.*

Introduction

Bitter gourd / Karela (*Momordica charantia L.*) belongs to family cucurbitaceae. Bitter gourd is commonly attacked by many fungal diseases such as powdery mildew, downy mildew, anthracnose, leaf spot, wilt and charcoal rot etc. Among these, downy mildew is one of the important foliar disease of bitter gourd. Downey mildew of cucurbits was reported for the first time in 1868 from Cuba and still it is considered as one of the serious problem. The disease is prevalent in the warm temperature and tropical region in the world and is particularly destructive in north America, Europe and Asia .In India, it is present all over the country except in high altitude temperate zone in the Himalaya. The disease is more prevalent in north India. The losses are severe in bitter gourd, muskmelon, watermelon, cucumber, sponge gourd and ridge gourd but the disease is destructive on bottle gourd, pumpkin and vegetable marrow. It is more common during rainy season and it requires high humidity and cool to moderately warm temperature ranging from 12-27°C, but tolerates during hot days, although long period of dry hot weather can stifle the spread of the disease. Symptoms appear as pale green area soon become yellow in colour and angular to irregular in shape, bounded by leaf veins. The yellow spots on the upper portion of leaves appear just like indefinite mosaic pattern lesion. As the spots enlarge, a general yellowing of the leaves occurs followed by the death of the tissue. The leaves subsequently wither and die[1]. During moist weather the corresponding lower leaf surface is covered with a downy, pale gray to purple mildew. The colour of the mildew ranges from white to near black. Infected leaves generally die but may remain erect, while edges of the leaf blade curl inward. Usually, the leaves near the centre of a hill or row are infected first. The infection area spreads outward, causing defoliation and poor fruit development which reduces yield. In rainy humid weather entire vein is killed[2]. Early infection of downy mildew can cause reduction in crop yield up to 60% where as late infection is less damaging. Looking to the magnitude of disease, the role of pathogen in disease development was framed for the present study.

Materials and methods

Field experiment was carried out during Rabi season of 2006 at the horticultural farm, Indira Gandhi Krishi Vishwavidyalaya, Raipur (C.G). Raipur is situated in the mid-eastern part of Chhattisgarh state and lies at 21°16 $^{'}$N latitude and 81° 36 $^{'}$E longitude of 298.56 m from mean sea level and has sub humid agro climatic condition. The average rainfall of this region is 1200-1400 mm, out of which about 88 per cent is received during rainy season (June-September) and 8 per cent is received during winter season (October-February).

The rainfall pattern has a great variation during rainy season from year to year. May is the hottest and December is the coldest month of the year. The maximum and minimum temperature during the summer months reaches as high as 48.1^{o} C and the mercury drops to as low as 6°C during December-January. Weekly metrological parameters prevailing during the crop period (31st July 2006 to 28 February 2007) are given in Annexure-I. The Bitter gourd local cultivar "Kathiya" was used during the period of study. The Twenty days old bitter gourd plants were transplanted in the experimental plots on 13th September 2006. Planting was done at a spacing of 1.5x1 m^2 with one plant per pit.

In order to get representative samples, six plants (Net) were selected in each plot and marked with tags for studying the disease at various growth factors and the assessment of the other parameters and yield.

Six plants were selected from each plot. The disease severity was calculated in percentage.

$$\text{Disease severity/plant} = \frac{\text{Total leaf tissue damaged}}{\text{Total healthy tissue of leaf}} x100$$

Then the average percentage severity per plot was calculated. At weekly interval disease severity per plant were calculated from all the twenty plants of control in each replication and average were calculated.

The experiment was conducted under natural field condition and infection. Meteorological observations were obtained from Department of Agrometeorology, I.G.A.U., Raipur. Correlation variables between disease severity (dependent variables) and meteorological parameters (independent variables) were determined by Karl Pearson's formula and correlation co-efficient were tested individually for their significance at 5% probability level using formula.

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

Where: t = test of significance, r = correlation co-efficient, n = number of observations.

The periodical observations were recorded in control plots throughout the year from October 2006 to January 2007. Progress of the disease was recorded at seven days interval in terms of percent disease severity. Leaves of twenty plants were selected for calculation of disease severity.

The rate of disease development /unit/ day was estimated according to formula give by Vanderplank[3]. The apparent infection rate (r) for the total period was -

$$r = \frac{1}{t_2 - t_1} \log_{10} \frac{x_2(1-x_1)}{x_1(1-x_2)}$$

Where: r = rate of disease development /unit/ day, t_1 = time of first observation, t_2 = time of second observation, x_1 = disease severity at time t_1, x_2 = disease severity at time t_2.

Results and discussion

Periodical development of disease under field condition (Rate of disease development /unit/ day): Periodical development of disease during the period revealed that, there was an increase or decrease of downy mildew disease severity from fourth October to fourth January. Disease severity gradually increases from fourth October and continued till first November (25.97 to 59.10 %), where it reached at its maximum. After that there is decline in disease severity from 51.26 to 43.84%. After twenty third November there is again increase in disease severity (43.73 to 50.24%) and then sudden decrease in disease severity (50.24 to 43.84%) after 21st December. The rate of disease development / unit /day (r value) varied from $2.6x10^{-4}$ to $-6.82x10^{-5}$ (Table-1).

Table-1: Rate of disease development /unit/ day of downy mildew of bitter guard caused by *Pseudoperenospora cubensis*.

Duration	Percent disease severity	'r' value
4 October	25.97	-
11 October	39.58	$-1.25x10^{-3}$
8 October	49.584	$-1.87 x10^{-1}$
25 October	55.72	$-1.42x10^{-4}$
1 November	59.10	$-6.82x10^{-5}$
9 November	51.26	$1.611x10^{-4}$
15 November	42.34	$2.6x10^{-4}$
23 November	39.77	$9.29x10^{-5}$
30 November	43.73	$-1.49x10^{-4}$
7 December	45.95	$-3.37x10^{-4}$
14 December	47.69	$-5.58x10^{-5}$
21 December	50.24	$-6.82x10^{-5}$
28 December	47.32	$7.44x10^{-5}$
4 January	43.84	$1.05x10^{-4}$

Correlation co-efficient (r) between environmental factors and downy mildew severity on bitter gourd: The correlation between disease severity and environmental factors in bitter gourd indicated no definite relationship pattern (Table-2 and Figure-1). In most of the cases correlation co-efficient is negative except of relative humidity but not significant. Correlation is also positive in case of temperature difference. Disease severity gradually increases from fourth October and continued till first November (25.97 to 59.10 %) where it reached at its maximum. Disease severity is maximum in first week of November and then it decline. Maximum disease severity in first week of November is may be due to less difference in temperature and relative humidity.

The results are in concurrence with the findings of Reshmy Vijayaraghavan *et al.*[4] and Gandhi *et al.*[5] who reported that,

disease severity increases when maximum temperature was 32-35^{0}C, and minimum temperature was 21-25^0 C and RH 75-93%. Ullasa and Amin[6] reported that day temperature of 25-30^{0}C, night temperature of 15-21^{0}C and RH>75% favoured the infection of *Pseudoperenospora cubensis* on *Luffa acutangula*. Cheah *et al.*[7] studied epidemiology of powdery mildew of squash and no germination was observed below 15^{0}C or above 30^{0}C or at relative humidity below 94%. The first symptoms of powdery mildew appeared approximately one week after a prolonged period of continuous leaf wetness and high humidity in the summer when temperature frequently rose above 22^{0}C. Pawar and Chavan[8] reported that the powdery mildew of cucurbits increases with increase in humidity while Colusi and Holmes[9] reported fourty species in 20 genera within cucurbitaceae are known to be host and optimum temperature for sporulation requires 15^{0}C with 6 to 12 hours of available moisture.

Table-2: Correlation co-efficient (r) between environmental factors and downy mildew severity of bitter gourd.

Date	Disease severity %	Max Temp ^{0}C	Mini Temp (^{0}C)	Rainfall (mm)	Relative Humidity (%)	
					I	II
4-Oct-06	25.97	31.8	23.7	5.9	94	63
11-Oct-06	39.58	33.7	23	0	91	43
18-Oct-06	49.54	33.3	20.8	0	93	46
25-Oct-06	55.72	31.3	18.8	0	90	47
1-Nov-06	59.1	27.8	20.8	1.6	93	65
9-Nov-06	51.26	29.6	18.3	0	92	43
15-Nov-06	42.34	29.4	14.6	0	91	35
23-Nov-06	39.77	31	15.2	0	89	31
30-Nov-06	43.73	30.7	18	0	87	41
7-Dec-06	45.95	30.8	15	0	88	32
14-Dec-06	47.69	29.4	12.2	0	88	29
21-Dec-06	50.24	26.9	10.6	0	90	35
28-Dec-06	47.32	28.1	11.9	0	88	36
4-Jan-07	43.84	26.7	9.6	0	88	30
Correlation value	-	-0.36041	-0.1979	-0.5769	-0.0771	0.0032

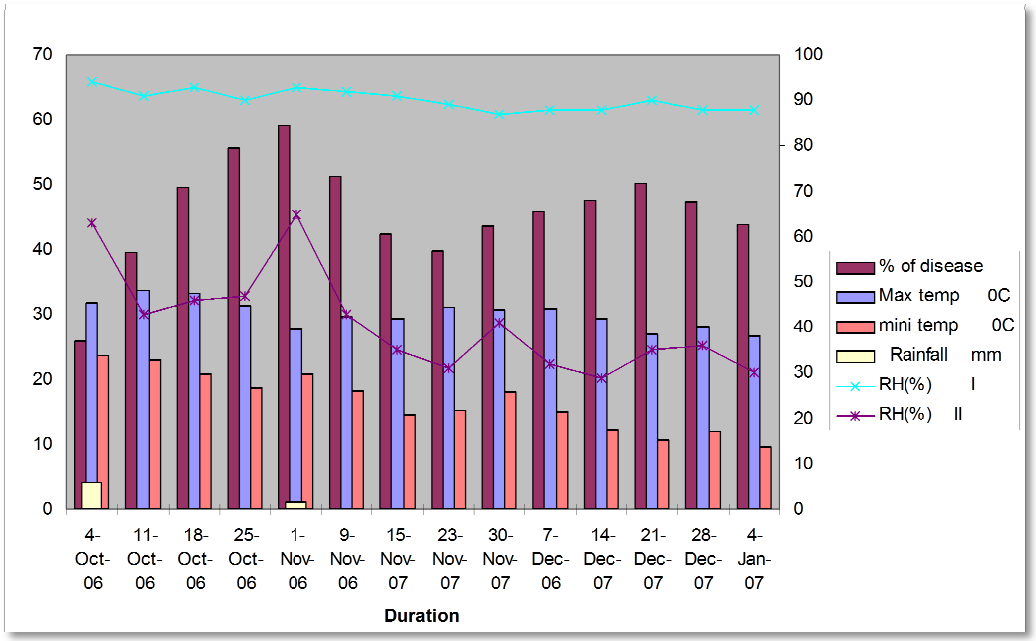

Figure-1: Co-relationship between per cent disease severity of downy mildew and weather parameters.

Conclusion

Pseudoperonospora cubensis causes downy mildew in bitter gourd. An increase and decrease of downy mildew disease severity was noticed from fourth October to fourth January. Disease severity gradually increases from fourth October and continued till first November where it reached at its maximum and maximum disease severity in first week of November was noticed and may be due to less difference in temperature and relative humidity. No definite relationship pattern was observed between disease severity and environmental factors.

Annexure-I: Weekly patterns of different meteorological parameters during 2006-2007 at Labhandi, Raipur.

Date	Max temp. (^{0}C)	Mini temp. (^{0}C)	Rainfall (mm)	Relative humidity (%)		Vapour pressure (mm)		Wind velocity (Km p h)	Evapo- ration (mm)	Sunshine (hrs)
				I	II	I	II			
Jul 2-8	30.6	25.5	55.5	85	69	22.2	21.9	12.8	4.4	2.3
09-15	32.5	26	18.1	82	62	22	20.8	13.3	5.8	2.3
16-22	28	23.8	159.2	93	84	21.6	22.5	11.9	2.4	0.3
23-29	29.7	24.1	129.1	94	77	22.3	22.8	10.5	2.8	3.1
30-05	28.9	24.2	45.3	92	79	21.8	21.9	10.8	3.3	1.3
Aug 06-12	29.5	24.2	7	89	75	21.6	22.5	11.7	4.9	6.3
13-19	29.1	24.2	266.8	93	80	22.9	23.5	11.2	3.5	2.3
20-26	29.2	24.6	30.8	93	81	22.7	22.8	9	2.6	1.9
27-02	28.4	23.7	60.1	92	75	21.5	21.9	8.4	2.4	1.8
Sept 03-09	31.3	25.1	114.4	94	71	24	23.6	5.5	3.9	7
10-16	32	24.6	72.2	94	77	24.1	23.2	3.3	3	4.9
17-23	30.9	24.4	11.6	90	70	22.4	22.6	6.6	3.8	6.7
27-30	31.5	23.1	34	90	64	27	21	4.2	4.1	7.7
Oct 01-07	31.8	23.7	5.9	94	63	23	22.1	4.4	3.5	7.7
08-14	33.7	23	0	91	43	21.1	16	2	3.9	8.6
15-21	33.3	20.8	0	93	46	19.2	16.8	2.4	4.1	9
22-28	31.3	18.8	0	90	47	16.7	14.9	2.5	4	9.3
29-04	27.8	20.8	1.6	93	65	18.5	17.4	3.6	2.3	2.8
Nov 05-11	29.6	18.3	0	92	43	15.9	13	2.7	3.1	5.6
12-18	29.4	14.6	0	91	35	13.2	10.6	2.6	3.4	9
19-25	31	15.2	0	89	31	13.2	10.1	2.1	3.3	8.4
26-02	30.7	18	0	87	41	14.8	13.1	2.3	3.5	7.2
Dec 03-09	30.8	15	0	88	32	12.5	10.3	1.9	3.4	8.3
10-16	29.4	12.2	0	88	29	10.5	8.5	2.2	3.3	9.5
17-23	26.9	10.6	0	90	35	19.4	8.8	2.4	3.1	8.1
24-31	28.1	11.9	0	88	36	10	9.8	2.2	2.7	8.1
Jan 01-07	26.7	9.6	0	88	30	8.8	7.6	2.6	3.1	8.5
08-14	28.8	10.6	0	89	32	9.3	9.1	2	3	8.3
15-21	28.8	11.5	0	83	30	9.2	8.4	2.5	3.4	7.5
22-28	29.8	10.4	0	83	22	8.5	6.6	2.2	3.8	9
29-04	31.6	15.6	0	80	32	11.5	10.5	2.2	3.9	7.1
Feb 05-11	31.3	16.4	0	85	37	12.8	12	4.5	4.6	7.6
12-18	27.6	15	22.4	87	43	12.2	10.9	4.2	4	8.2
19-25	30.4	13	0	81	21	10.3	6.9	2.9	4.9	10.2
26-04	32	16.6	0	78	27	12.4	9.2	4.7	5.9	9.6

References

1. Rai N. and Yadav D.S. (2005). Advances in Vegetable Production. Research Co Publishing, New Delhi, 325-337.
2. Badadoost M. (2001). Downy mildew of cucurbits. University of Illinois Agricultural Services, 345.
3. Plank J.E. (1963). Plant Diseases: Epidemics and Control. Academic Press, New York, 34.
4. Vijayaraghavan Reshmy, Louis Vimi, Mathew S.K., Davis Fridin, Varghese Anjaly and Dilna (2017). Planta studies on downy mildew disease of bitter gourd using fungicides and bioagents. *Int. J. Curr. Microbiol. App. Sci*., 6(3), 945-950.
5. Gandhi S.K., Maheshwari S.K. and Mehta N. (1996). Epidemiological relationship between ridge gourd downy mildew and metrological factors. *Pl. Dis. Res.,* 11(1), 62-66.
6. Ullasa B.A. and Amin K.S. (1988). Ridgegourd downy mildew epidemics in relation to fungicidal sprays and yield loss. *Mysore J. of Agril. Sci*., 22(1), 62-67.
7. Cheah L.H., Page B.B.C. and Cox J.K. (1996). Epidemiology of powdery mildew (Sphaerotheca fuliginea) of squash. Proceedings of 49th New Zealand Plant Protection Conference, 147-151.
8. Pawar V.P. and Chavan A.M. (2010). Incidence of powdery mildew on cucurbits plants and its ecofriendly management. *J. Ecobiotechnology,* 2(6), 29-43.
9. Colucci Susan J. and Holmes Gerald J. (2010). Downy mildew of cucurbits. APSnet. DOI:10.1094/PHI-I-2010-0825-01.