Journal of Agrometeorology

ISSN : 0972-1665 (print), 2583-2980 (online)
Vol No. 24(2) : 211-213 (June 2022)

https://journal.agrimetassociation.org/index.php/jam

Short Communication

Effect of meteorological variables on powdery mildew disease intensity of ber at Rahuri, Maharashtra

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The most common tropical fruit ber (*Ziziphus mauritiana*) belongs to Rhamnaceae family having 135 to 170 species (Islan and Simmons, 2006). Among them 17 are native of India (Singh *et al*., 2000). *Ziziphus mauritiana* is cultivable type in arid parts of Indian subcontinent (Sebastian and Bhandari, 1990). Recently its cultivation has been increasing very steadily in the northern, central and western states of India (Singh, 1997). In India, ber is grown 54 thousand hectare as a horticulture fruit crop with production of 606 thousand metric tons, during 2019-20 (Anon, 2021). Several biotic and abiotic stresses have been responsible for causing heavy crop losses. Horticultural crop production in India has been threatened due to various fungal, bacterial and viral diseases which cause considerable quantitative and qualitative losses to the horticultural crops. On ber, various fungal diseases have been reported *viz*., powdery mildew, sooty mold, leaf spot and rust. Among these, powdery mildew is one of the important disease, cause 50-60 percent loss in the fruit yield along with reduced market value of the produce (Jamadar *et al*., 2009). Rawal and Saxena (1996) also reported that commercially grown varieties of ber are highly susceptible to powdery mildew leading to huge qualitative and quantitative losses of about 35-45 per cent.

Realizing of this disease in causing economic losses, it was felt necessary to initiate systematic studies on different aspects of this disease. Among these aspects, environmental variables are the most crucial since they affect the pathogen, host or host pathogen interaction during pathogenesis. Weather based models have also been developed to predict the incidence and spread of disease (Pandey *et al*., 2004; Bhattiprolu and Monga, 2018; Bana *et al*., 2020). However, meagre information is available regarding the role of these environmental variables on development of ber powdery mildew. So, the present investigation was planned and executed.

Field experiments

The field experiments were conducted in the research area of All India Coordinated Research Project in Arid Zone Fruits, Mahatma Phule Krishi Vidyapeeth, Rahuri for the year 2018-19 and 2019-20. This area falls in the scarcity zone (semi arid tropics) with annual rainfall ranging between 307 to 619 mm.

The ber crop was grown by applying all recommended agronomical practices and no fungicidal sprays were given throughout the year of 2018-19 and 2019-20. The orchards of Chhuhara variety was already planted with 6 x 6 m distance in medium soil and irrigated with flood techniques. The weekly meteorological variables *viz*., temperature, relative humidity, wind speed, sunshine hours, rainfall and rainy days were collected from nearby Agrometeorological Observatory at Mahatma Phule Krishi Vidyapeeth, Rahuri and correlated with disease intensity to find out the relationship..

For disease intensity, a zig - zag route was picked across the ber variety “chhuhara” orchards so as to represent the entire orchards area and inspected randomly five plants. The appearance of the disease on ber fruits were first observed in the third week of September during both the crop season. For measuring weekly disease severity, ber fruits were observed and evaluated individually using 0-5 rating scale from 33rd SMW and continued up to 47th SMW. Disease intensity rating scale (Mckinney, 1923) of powdery mildew disease (grade 0 -5) was used viz. No infection (0), 1-10 per cent fruit area covered with pathogen (1), 11-25 per cent fruit area covered with pathogen (2), 26-50 per cent fruit area covered with pathogen (3), 51-75 per cent fruit area covered with pathogen (4) and 76-100 per cent fruit area covered with pathogen (5) was used. Further these scales were converted to per cent disease index using formula given by Wheeler (1969)

Article info - DOI: *https://doi.org/10.54386/jam.v24i2.384*
Received: 15 November 2021; Accepted: 1 March 2022; Published online: 28 May 2022

Table 1: Path coefficient analysis of various weather parameters with ber powdery mildew (Pooled data)

Parameters	Max. temp.	Min. temp.	RHmor	RHeve	Wind speed	Sunshine	Rainfall	Rainy days	Per cent disease intensity
Max. temp.	1.71	0.24	-0.02	-0.20	-1.38	-0.78	0.57	-0.44	-0.41
Min. temp.	-0.42	-0.97	0.05	0.15	1.18	0.63	-0.20	0.29	0.79**
RHmor	-0.58	-0.79	0.07	0.15	1.18	0.55	0.00	0.09	0.74**
RHeve	-1.43	-0.60	0.04	0.25	1.30	0.90	-0.64	0.62	0.57*
Wind Speed	-1.27	-0.61	0.04	0.17	1.87	0.71	-0.08	-0.15	0.74**
Sunshine	1.35	0.62	-0.04	-0.23	-1.35	-0.98	0.41	-0.28	-0.71**
Rainfall	-0.75	-0.15	-0.00	0.12	0.11	0.31	-1.30	1.44	-0.12
Rainy days	-0.48	-0.17	0.00	0.09	-0.18	0.24	-1.19	1.58	-0.02

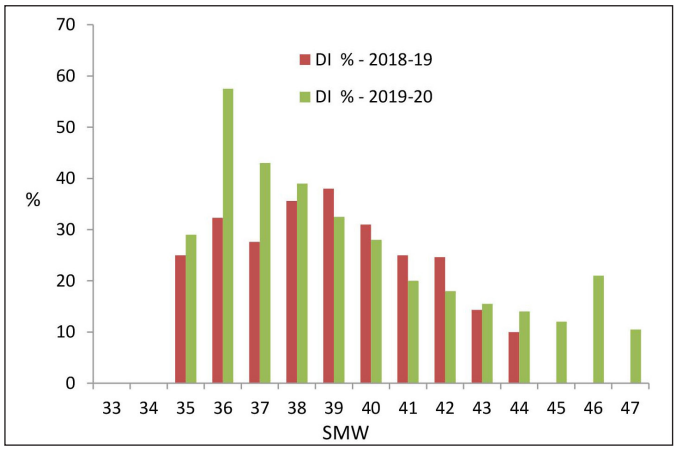

Fig. 1: Disease intensity over the growing period for both the years

$$\text{Disease Index (\%)} = \frac{\text{Sum of all numerical ratings}}{\text{Number of leaves/plants observed x Maximum rating}} \times 100$$

The intensity of powdery mildew of ber was correlated with environmental variables *viz*., temperature, relative humidity, wind velocity, sunshine hours, rainfall and rainy days with two week before disease severity. Partial regression coefficient was calculated by considering environmental variables as independent variables and disease intensity as dependent variable. The significance of partial regression coefficient was determined by "t" test. To identify direct and indirect effects through other attributes by apportioning the correlation for better interpretation of cause and effect relationship path coefficient analysis was attempted (Wright, 1921).

Powdery mildew disease intensity in ber

During the crop fruit seasons of 2018-19 and 2019-20, the powdery mildew disease intensity (DI) in ber ranged between 10-38 % with a peak in 39th SMW in 2018-19 and 10- 58% with a peak in 36th SMW during 2019-20 (Fig 1.) under prevalent congenial weather conditions during the period categorized as 3 and 4 scaled, respectively. During the crop season 2018-19, 82.6 mm rainfall with 3 rainy days were recorded with two week (33rd and 34th SMW) before disease intensity and average temperature ranged between 22.0- 27.8^{0}C with average humidity ranged between 71.5 - 80.5 per cent which was congenial condition for built up of inoculum for primary infection (25.0 %) at 35th SMW, increased up to 39th SMW (38 %) due to favourable conditions. Beyond that, due to unfavourable condition secondary infection was reduced to 10.0 per cent by 44th SMW. Similarly, during the crop season 2019-20, 1.4 mm rainfall were recorded with two week (33rd and 34th SMW) before disease intensity and average temperature ranged between 21.9 – 31.8^{0}C with average humidity ranged between 53.0-73.5 per cent which is congenial condition for built up of inoculum for primary infection (29.0 %) at 35th SMW, increased up to 36th SMW (58 %) due to favourable conditions. Beyond that, due to unfavourable condition secondary infection was reduced to 10.5 % by 47th SMW. Pandey *et al*., (2004) too reported that higher humidity (85-90%) and moderate temperature (33-34^{0}C) favourable conditions for the initiation of ber powdery mildew.

The correlation of the weather variables (Table 1) with two week before disease intensity indicated, highly significant and positive correlation of disease intensity with minimum temperature (0.79**), morning humidity (0.74**) and wind speed (0.74**) was observed at 1 per cent level of significance while, highly significant and negative correlation of disease intensity with sunshine hours (0.71**) was observed at 1 per cent level of significance. Significant positive correlation of disease intensity with evening humidity (0.57*) was observed at 5 per cent level of significance while, negative correlation of disease intensity with rainfall (-0.12), rainy days (-0.02) and maximum temperature (-0.41) observed but they were non-significant. Pandey *et al*., (2004) also reported positive correlation of ber powdery mildew intensity with minimum temperature, wind velocity while, sunshine hours had negative correlation with the disease intensity.

The data was subjected to multiple regression analysis, among the eight, five significant multiple regression coefficients were obtained for independent environmental variables *viz*., minimum temperature, morning time relative humidity, evening time relative humidity, wind speed, sunshine hours, respectively with r square value of 0.86.

For the better interpretation of cause and effect relationship path coefficient analysis was used to the direct and indirect effects through other attributes by apportioning the coefficients.

Path coefficient analysis (Table 1) revealed that maximum positive direct effect on disease intensity was exhibited by wind velocity (1.87) followed by maximum temperature (1.71) and rainy

days (1.58). However, maximum negative direct effect on disease intensity was exhibited by rainfall (-1.30) followed by sunshine hours (-0.98) and minimum temperature (-0.97). Even though minimum temperature (-0.97) had negative direct effect on disease intensity, it had highest (1.18) positive indirect effect through wind velocity, resulting positive correlation between minimum temperature and disease intensity. It was primary because of highly significant positive correlation between minimum temperature and wind velocity.

The result revealed that, maximum positive indirect effect on disease intensity was exhibited by rainfall through rainy days (1.44) followed by sunshine hours through maximum temperature (1.35) and evaporation through maximum temperature (1.33). However, maximum indirect negative effect on disease intensity was exhibited by wind velocity through maximum temperature (-1.43), followed by maximum temperature through wind velocity (-1.38) and sunshine hours through wind velocity (-1.35). Similar results were reported by Waychal (2017) and Jagtap (2017). The result may help for ber disease management advisory to be issued for farmers to control the disease.

Conflict of Interest Statement: The author (s) declares (s) that there is no conflict of interest.

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