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Epidemiological Studies of Downy Mildew Disease incited by *Peronospora arborsence* (Berk.) de Bary in Opium Poppy under Natural conditions

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ABSTRACT: Downy mildew of opium poppy is a major threat to opium cultivation in sub-tropical zone of India. Wet and humid conditions favour to pathogen *Peronospora arborescence* for rapid perpetuation in opium growing season. Therefore, epidemiological study was undertaken to investigate the factors affecting to disease developments in opium poppy crop. Downy mildew disease has appeared on opium plants in 2nd week of December with the occurrence of conducive environmental condition at eastern part of Uttar Pradesh such as minimum temperature (9.25°C), maximum temperature (22.75°C), relative humidity (91.6%) and sunshine hours (4 hrs). The disease was observed as peak in the 7th meteorological weak (2nd February) with minimum temperature (9.7°C), maximum temperature (25.6°C), relative humidity (91.15%) and sunshine hours (6.8hrs) The results of observation showed that minimum temperature was positively highly significant at establishing phase, positively significant at progressive phase and negatively highly significant at decline phase of downy mildew disease in the year 2020-21 and 2021-22. Maximum temperature was found negative significant at establishing and progressive phase however it was positively highly significant at decline phase in both the years. The minimum relative humidity was showed linear relationship at establishing and progressive phase of disease. Whereas maximum relative humidity was found positively highly significant in 2020-21 and positive significant in 2021-22 at establishing phase in case of phase (B) positive significant in 2020-21 and positively highly significant in 2021-22 in case of decline phase negatively highly significant in both year. However sunshine hour were showed negative relationship in phase (A) and (B) both year and positive relationship in phase (C) which indicating that if sunshine hours are increasing then disease incidence will be reduced.

Keywords: Downy mildew, Epidemiology, Per cent disease incidence, Temperature, Humidity and Sunshine.

INTRODUCTION

Opium poppy (*Papaver somniferum*) is a highly valuable crop grown for its alkaloid *viz*., morphine (21%), codien (2.80), thebaine (8%), dry latex, gum, wax, lactic acid (9.5%), noscopine (4.8%) etc. (Cotterill and Pascoe 1998). The opium gum was extracted from green but fully grown capsules which are used as analgesic, sedative, antitussive and antispasmodic agent in present day medicine. It is also used for preparing best known pain killer drugs from times immemorial. Besides that, opium poppy is also grown for edible seeds and seed oil. The seeds are very nutritive and contain high percentage of linoleic acid which lowers down blood cholesterol in human body system (Prasnna and Kumar 2016). Opium poppy was cultivated in 6107 hectares area with 401 tones of seed production. The average productivity of opium poppy was 66.4 kg/hectare in India during 2018-19 (Anonymous, 2019). Downy mildew is one of the most destructive diseases of opium poppy crop in the world since its first record in 1996 (Hall, 1996; Cohen, 1977). It has become prevalent in all opium growing state of India. The symptoms of downy mildew were found more or less similar to downy mildew symptoms of other plants. Downy mildew caused by *Peronospora arborescens* (Berk) de Bary produces two different types of symptoms on opium *i.e.*, systemic and non-systemic. The disease appeared from seedling to maturity stage mainly in the area of Madhya Pradesh, Uttar Pradesh

and Rajasthan. Capsule formations are adversely affected due to downy mildew disease and causing significant yield loss (Mishra *et al.,* 2013). It is spread rapidly throughout the crop under wet and humid environmental conditions. The scanty research has been conducted on the epidemiology of opium poppy downy mildew disease in India. Hence, the attempt has been made to identify the factor affecting for disease development at different phonological stages of opium poppy crop.

MATERIAL AND METHODS

The experimental site falls under sub-tropical climatic zone of Eastern part of Uttar Pradesh. The winter months prevails from November to March with mild to severe cool temperature. The severe cold was recorded in the month of December-January, Occasionally winter rains and frost was also noticed. The experiment on *Papaver somniferum* was conducted during 2020-21 and 2021-22 at Medicinal and Aromatic Plant farm, Main Horticulture Experiment Station, Acharya Narendra Deva University of Agriculture and Technology, Ayodhya. Weekly Percent disease incidence of downy mildew disease and weather data were recorded from 1st week of December to 2nd week of March in both the year. Correlation and regression coefficient between per cent disease incidence and weather parameter were calculated by followings the procedures as described by Gomez and Gomez (1984) and regression lines were developed. The percent disease incidence of each interval was calculated from the appearance of downy mildew at weekly intervals. The values of correlation coefficient vary from –1 to +1.

$$\text{Per cent Disease incidence} = \frac{\text{Number of plant infected}}{\text{Total number of plant}} \times 100$$

RESULT AND DISCUSSION

The correlation coefficient (Table 1) between percent disease incidence and weather parameters were worked out at three different phases *viz;* establishing phase (A), progressive phase (B) and decline phase (C). Downy mildew disease has appeared on opium plants in 2nd week of December with the occurrence of conducive environmental condition at eastern part of Uttar Pradesh such as minimum temperature (9.25°C), maximum temperature (22.75°C), relative humidity (91.6%) and sunshine hours (4 hrs). The disease was observed as peak in the 7th meteorological weak (2nd February) with minimum temperature (9.7°C), maximum temperature (25.6°C), relative humidity (91.15%) and sunshine hours (6.8hrs). Ankita *et al.* (2020) reported that congenial weather condition for downy mildew of onion were average mean relative humidity 52.8 per cent accompanied by cumulative rainfall (3.4mm), mean maximum temperature 22.12°C and minimum temperature 7.6°C. Spread of the disease was found to decline when relative humidity recorded 88.5%, minimum temperature 11.7 °C and 28.2 °C maximum temperatures. Minimum temperature was recorded positively highly significant at establishing phase in the year 2020-21 and 2021-22, in case of progressive phase minimum temperature was recorded positive and significant. Whereas, it was negatively and highly significant at decline phase due to increased of temperature and decreased of relative humidity. These results were similar to finding of Premila and Sophiarani (2015); Viranyi (1975). The maximum temperature was recorded negative significant in 2020-21 and negative highly significant in 2021-22 at phase (A) and (B). In case of phase (C) maximum temperature was recorded positive highly significant, which showed that if temperature was increased then percent disease incidence was decreased in the same magnitude. The minimum relative humidity was showed positive highly significant relationship at phase A and B. Whereas maximum relative humidity was found positive highly significant at phase (A) in 2020-21 and positive significant in 2021-22. Effect of vapour pressure was significant in phase A and B but it was negatively significant in decline phase. Positive response of wind speed was not recorded at phase A and B. However in decline phase it was positively significant. The sunshine hour were showed negative relationship with the incidence of downy mildew growth. It is might due to growth of fungal mycelium and disease development was highly influenced by the predisposition factors such as temperature, relative humidity and precipitation of dew on leaves during night hours (Kapoor, 1995). Disease intensity of downy mildew is depending on the length of dew deposition, leaf temperature and inoculums density of the downy mildew pathogen (Cohen *et al.,* 2017). Positive correlation was found on disease severity and leaf wetness by dew, whereas rainfall at flowering stage causes complete loss of the Isabgol crop due to rapid spread of downy mildew disease (Kapoor, 1995). Severe incidence of *Peronospora parasitica* on cabbage was recorded at 15-20°C minimum temperature by Nakov (1972), however D'ercola (1975) was reported rapid infection of *Peronospora parasitica* on cauliflower at 8-14°C minimum temperature and 90-95% relative humidity.

Table 1: Correlation and regression coefficient at different phases in between per cent disease incidence of downy mildew disease of opium poppy and meteorological factors during 2020-21 and 2021-22.

A. Establishing phase

Sr. No.	Environmental factor	Correlation coefficient		Regression coefficient R^2 value	
		2020-21	2021-22	2020-21	2021-22
1.	Minimum temperature	0.800**	0.775**	0.801**	0.724**
2.	Maximum temperature	-0.454*	-0.866**	0.353	0.856**
3.	Minimum relative humidity	0.789**	0.948**	0.697*	0.938**
4.	Maximum relative humidity	0.714**	0.512*	0.673*	0.354
5.	Total rainfall	0.00	-0.085	0.00	0.083
6.	Vapour pressure	0.855**	0.798**	0.854**	0.094
7.	Wind speed	-0.499*	-0.913**	0.498*	0.900**
8.	Sunshine	-0.310	-0.516*	0.309	0.514*
9.	**Total evaporation**	685*	0.423*	0.684*	0.380

***** Significant ******Highly Significant

B. Progress phase

Sr. No.	Environmental factor	Correlation coefficient		Regression coefficient R^2 value	
		2020-21	2021-22	2020-21	2021-22
1.	Minimum temperature	0.474*	0.660*	0.473*	0.660*
2.	Maximum temperature	-0.857**	-0.903**	0.857**	0.903**
3.	Minimum relative humidity	0.827**	0.810**	0.827**	0.809**
4.	Maximum relative humidity	0.694*	0.900**	0.694*	0.836**
5.	Total rainfall	-0.819**	0.00	0.819**	0.00
6.	Vapour pressure	0.971**	0.851**	0.971**	0.851**
7.	Wind speed	-0.531*	-0.637*	0.00	0.637*
8.	Sunshine	-0.957**	-0.965**	0.957**	0.984**
9.	Total evaporation	0.797**	0.797**	0.797**	0.797**

***** Significant ******Highly Significant

C. Decline phase

Sr. No.	Environmental factor	Correlation coefficient		Regression coefficient R^2 value	
		2020-21	2021-22	2020-21	2021-22
1.	Minimum temperature	-0.774**	-0.866**	0.773**	0.869**
2.	Maximum temperature	0.856**	0.978**	0.826**	0.977**
3.	Minimum relative humidity	0.402*	0.744**	0.402*	0.772**
4.	Maximum relative humidity	-0.900**	-0.772**	0.900**	0.772**
5.	Total rainfall	0.00	0.00	0.00	0.00
6.	Vapour pressure	-0.636*	-0.662*	0.636*	0.661*
7.	Wind speed	-0.433*	-0.107	0.432*	0.104
8.	Sunshine	0.394	0.821**	0.393*	0.821**
9.	Total evaporation	-0.662*	-0.977**	0.662*	0.977**

***** Significant ******Highly Significant

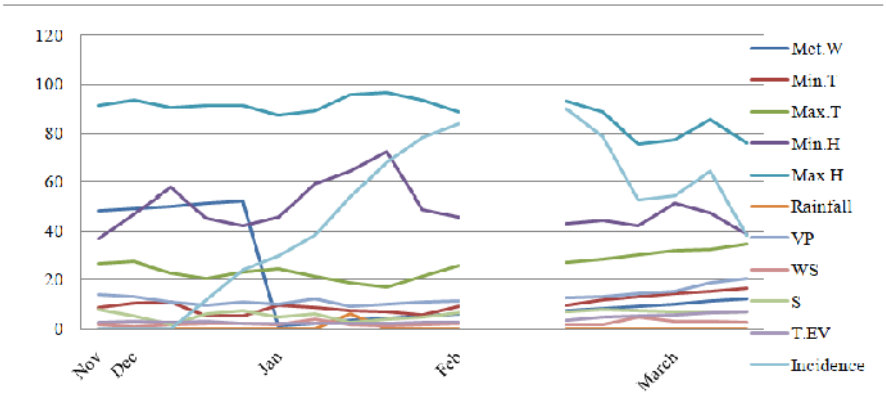

Fig. 1. Weather data vs per cent disease incidence during 2020-21.

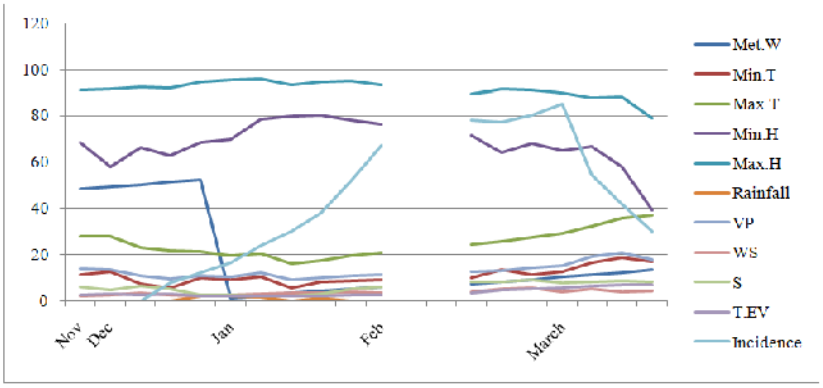

Fig. 2. Weather data vs per cent disease incidence during 2021-22.

CONCLUSION

It is concluded that percent disease incidence of downy mildew of opium poppy was recorded highest when mean atmospheric temperature was 5.0-27.2°C, relative humidity 45-93.1% with sunshine hours 2.8 hrs.

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Conflict of Interest. None.

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