Available Online at EScience Press
Plant Protection
ISSN: 2617-1287 (Online), 2617-1279 (Print)
http://esciencepress.net/journals/PP

CHARACTERIZATION OF WEATHER CONDITIONS FAVORABLE FOR POWDERY MILDEW IN PUMPKIN

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ARTICLE INFO

Article history
Received: 31st January, 2019
Revised: 19th March, 2019
Accepted: 22nd March, 2019

Keywords
Powdery mildew
Pumpkin
Epidemiology
Disease incidence

ABSTRACT

Weather variables were characterized for the powdery mildew disease caused by *Sphaerotheca fuliginea* on pumpkin crop. The relationship between airborne conidia and incidence of powdery mildew on pumpkin was studied. Disease incidence data was recorded on weekly basis and correlated with prevailing environmental conditions. All the environmental factors showed positive relationship with disease incidence except wind speed that exhibited negative correlation. There was significant increase in disease incidence with increase in maximum and minimum temperature while disease incidence was decreased with increase in wind speed. Understanding of favorable environment is helpful to use appropriate management approaches.

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INTRODUCTION

Powdery mildew disease of pumpkin is caused by an obligate, ectoparasitic fungus *Sphaerotheca fuliginea* (Kristkova et al., 2009). It is one of the major production constraints of pumpkin worldwide. Fruit quality and yield of diseased plants is drastically reduced (Choi et al., 2004). Its outbreak in Pakistan was firstly recorded in Neelam valley (Mukhtar et al., 2012). Leaves of affected plants are covered with white powdery masses of fungal spores that interrupt with photosynthetic activity contributing towards reduced biomass and yield (Seko et al., 2008). The reduction in leaf area and changes in the carbohydrate contents of infected leaves can reduce the number and size of fruits and alter their flavor, pulp thickness and amounts of total soluble solids and sugars (Queiroga et al., 2008).

Environmental factors affect infection and disease progress and also important for the development of different strategies to manage the powdery mildew fungus (Lebeda and Cohen, 2011). Temperature and humidity together creates water vapor pressure deficit (VPD) that has the greatest effect on host-parasite interactions (Jarvis et al., 2002). Precise knowledge of when to expect first appearance of disease and its subsequent progress, based on weather conditions and susceptibility of different developmental stage, would aid growers in ascertaining optimum time of fungicidal applications (Schoeman et al., 1995). Applications of forecasting models include assessing impact of host growth and environmental factors on disease development thus facilitating optimization of disease management strategies (Jeger, 1986). Symptoms appear after 3-7 days of infection if conditions are favorable. The mycelium grows rapidly during the warm summer months with an optimum temperature of about 50-90°F (Lalancette et al., 2013). High humidity favors the development of disease, but infection can occur at relative humidity as low as 50% (Bardin et al., 1999). The conidia of the fungus are spread through the air and thus can travel over great distances (Coppin et al., 2012). The mycelium can also overwinter in the buds of infected plants.

Development of epidemic involves several overlapping and repetitive infection cycles within a short spell. Statistical models aids in estimation of pathogen population and disease development process (Gururani et al., 2012). The current study was planned to find out the favorable environmental conditions for powdery mildew disease. The outcome of this experiment would be helpful for farmers in the application disease management tactics.

MATERIALS AND METHODS

The present study was conducted on an area of 54×29 square feet plot at experimental area of Department of Plant Pathology, University of Agriculture Faisalabad. For this purpose, pumpkin seeds (Mahadeev) were taken from the Vegetable Research Institute (VRI), Ayub Agricultural Research Institute (AARI), Faisalabad, and were sown in randomized complete block design (RCBD). All agronomic practices were followed recommended for better crop production.

Pathogenicity Test: Infected material was obtained from the Nuclear Institute for Agriculture and Biology (NIAB), Faisalabad. Conidia were removed from infected material by sterile brush and transferred to 100 ml distilled water containing two drops of Tween-20. Conidia were counted using a haemocytometer to give a 3×10^4 ml^{-1} conidial suspension for inoculation. The upper surface of the plants was sprayed evenly with conidial suspension with a hand sprayer.

The leaves of the inoculated plants showed typical symptoms of the disease after 5 days of inoculation in the form of white chalk dust spots on their upper surface. Diseased samples were collected to identify the pathogen. For identification and confirmation of the pathogen, slide was made by taking the spore of fungus using tape, then a drop of water was put on the slide and after that stick tape on this slide and examined under the optical microscope in Mycology Lab, Department of Plant Pathology, University of Agriculture, Faisalabad.

Data recording: Data recording was started as the disease symptoms appeared on the pumpkin plants in the form of white talcum powder like masses on both sides of leaves, petioles and stems (Seko et al., 2008). Disease incidence was calculated by using following formula:

$$\text{Disease incidence } (\%) = \frac{\text{Number of infected plants}}{\text{Total number of plants}} \times 100$$

Data of environmental conditions: The data of environmental variables including maximum temperature, minimum temperature (°C), precipitation (mm), relative humidity (%) and wind speed (km/h) were collected from the meteorological section, Department of Crop Physiology, University of Agriculture, Faisalabad (Pakistan).

Statistical analysis: The data of powdery mildew disease incidence and environmental conditions were analyzed by using statistical software IBM SPSS 22. Pearson's coefficient for disease incidence and environmental factors was used to analyze the data. The effect of different environmental variables on disease incidence was described through correlation analysis. Correlation analysis was performed to find the most suitable environmental condition for the occurrence of disease. Least significant difference (LSD) test was used to determine the comparison between environmental variables and disease incidence. The significant relationship between environment and disease was plotted graphically and their critical ranges described.

RESULTS: Disease incidence increased with a rise in temperature. Maximum disease incidence was recorded at the air temperature of 34°C (Figure 1). The relationship was explained with the help of correlation coefficient as indicted by the higher value of r = 0.94 which meant that maximum temperature significantly affected the process of disease development. The gradual increase in disease incidence was recorded with rise in temperature.

Low temperature affected the disease development process by slowing down all the steps of infection cycles. There was gradual increase in powdery mildew disease incidence with an increase in minimum temperature (Figure 2). There was a strong relationship between minimum temperature and disease incidence as indicated by high value of correlation (r = 0.90).

There was positive relation between relative humidity and disease incidence (Figure 3). High relative humidity sped up sporulation of fungus due to which there was significant increase in disease incidence with increase in relative humidity.

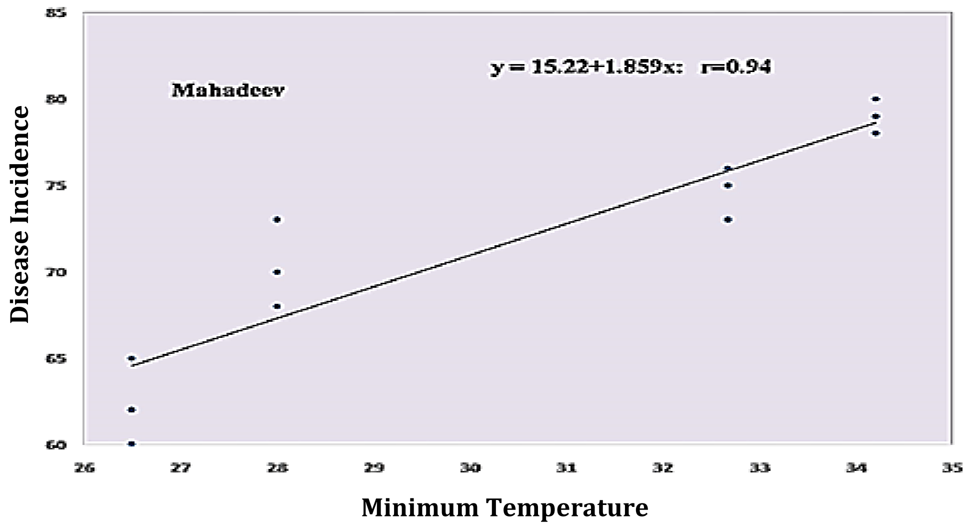

Figure 1. Relationship of maximum temperature (°C) with powdery mildew disease incidence.

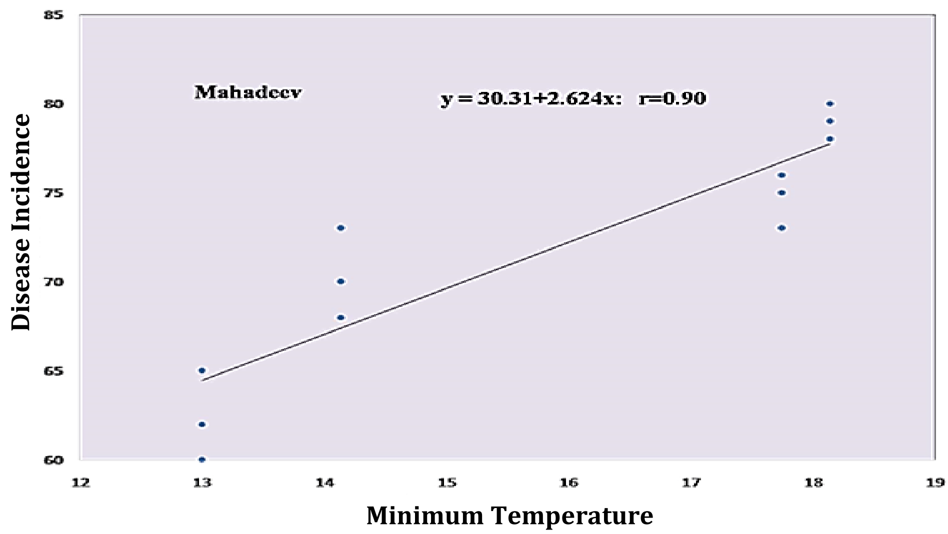

Figure 2. Relationship of minimum temperature (°C) with powdery mildew disease incidence.

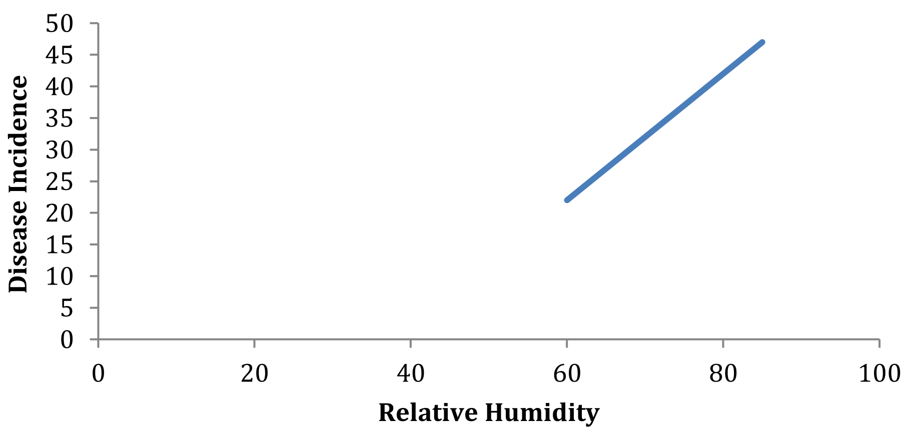

Figure 3. Relationship of relative humidity (%) with powdery mildew disease incidence.

Rainfall had positive correlation with the incidence of the disease (Figure 4). Rainfall caused increase in relative humidity that aided in disease development events and disease incidence.

The relationship of rainfall and disease incidence was 71% strong. Wind speed was negatively correlated with the powdery mildew disease incidence (Figure 5). The relationship developed by coefficient of correlation showed that disease incidence decreased with increase in wind speed.

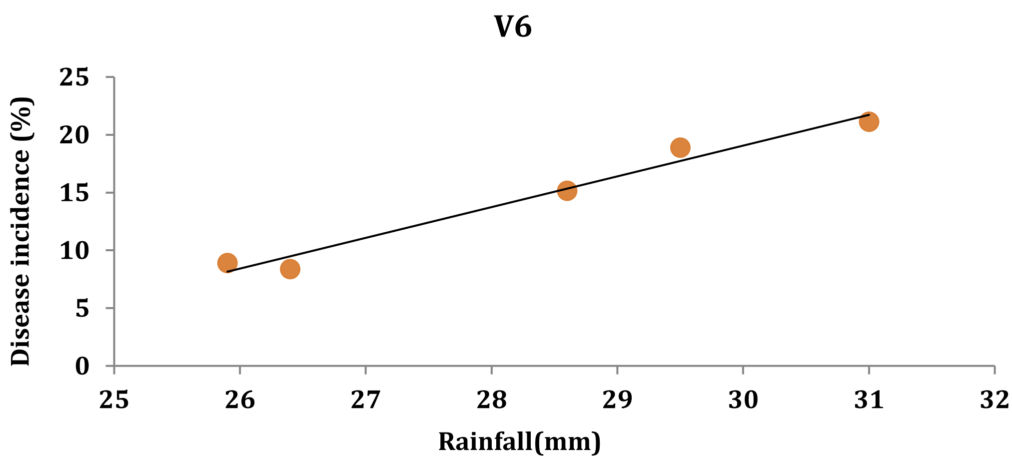

Figure 4. Relationship of rainfall with powdery mildew disease incidence.

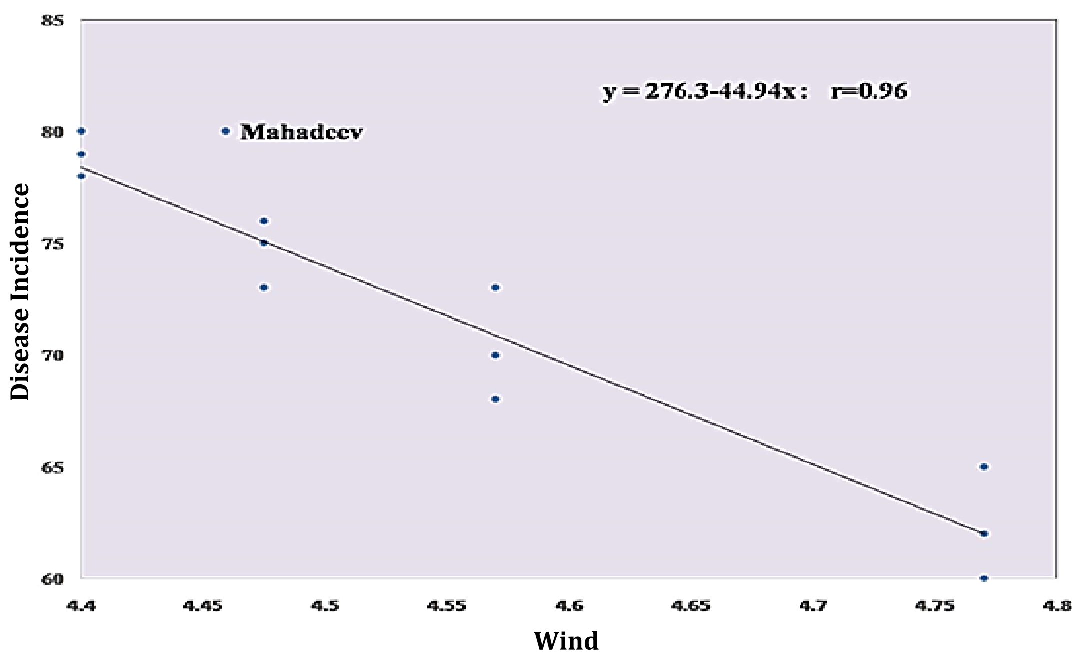

Figure 5. Relationship of wind speed (km/h) with powdery mildew disease incidence.

DISCUSSION

Sphaerotheca fuliginea the causal organism of powdery mildew has a greater diversity and ability to survive in adverse conditions due to its air born nature (Hansen, 2009). The overall correlation of powdery mildew disease incidence on pumpkin crop was significant with the maximum and minimum temperatures. These results agreed with those of Sinha et al. (2001) who studied the role of temperature and environmental factors (wind speed, relative humidity) on the development of powdery mildew disease of pumpkin and concluded that air temperature (maximum and minimum) was the most important factor in the severity of the disease. Chellemi and Marois (1991) also suggested that the minimum temperature of 8°C and maximum of 28-35°C favored powdery mildew disease occurrence. The increase in disease incidence is due to the increased activity of the pathogen such as speeding up of sporulation with rise in temperature. These results are in line with those of Sinha et al. (2005) who explained the effect of temperature on conidial germination and elongation of the germ tube. Byrne et al. (2000) stated that conidial maturation and release is enhanced at day time.

In the current study, the effect of relative humidity and rainfall was found positively correlated with powdery mildew disease. These findings are in contrast with those reported by Lebeda and Cohen (2011) who described that heavy rainfall is not favorable for the disease because it actually washes the fungal spores from plant surface. It was also stated that high relative humidity favored the spore attachment to leaf surface. Paulus (1990) concluded that rainfall decreased the conidial concentration on plant surface.

Although wind aids in the fungal spore dispersal, the correlation of increasing wind speed with disease incidence was negative. McGrath (2001) suggested that higher wind speed slowed down the process of disease development as the spores are readily dispersed from the plant surfaces. However, wind speed can contribute in the development of disease epidemics by spreading the fungal spores over longer distances. Friedrich (1995) concluded that wind speed had negative correlation with powdery mildew infection.

Characterization of favorable environmental conditions for the powdery mildew disease development is helpful in assessing the possible disease outbreak in certain prevailing weather. Evaluation of disease dynamics based upon weather conditions assists in the disease management options.

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