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Case Report

Seasonal dynamics of powdery mildew of mango and its management under subtropics

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The authors declare no conflict of interests.

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Abstract

Mango is one of the most important fruit crop in SAARC countries, which has severely been affected by powdery mildew during panicle development and fruit set stages, which in turn reduces its production and productivity. The disease is caused by *Oidium mangiferae* Berthet and is reported from more than 35 countries in the world and it may reduce yields as much as 90 per cent. It is widely distributed and can also be a major foliar disease of mango. The flowering stage, however, appears to be the most critical for infection; little infection occurs before flower opening or during fruit-set. Conidia are wind disseminated and are released on a diurnal basis. Peak spore release during 11.00 to 16.00 h, was positively correlated with temperature and negatively correlated with humidity, vapour pressure deficit and leaf wetness. The cardinal temperatures for conidium germination are 9, 32 and 23 °C. Conidia germinate at wide range of relative humidity (as low as 20%). Infection can take place within 5-7 h, and conidia are produced within 5 days of infection. Disease development occurs between 10-31 °C and 60-90% relative humidity. Infestation of the bloom clusters by powdery mildew causes flowers and young fruits to drop and direct yield loss.

Key words: Powdery mildew, mango, weather, growing degree days, management

Introduction

Powdery mildew is prevalent in all mango growing states of India (1). It usually appears every year and severity depends upon the weather conditions (2). Since, mango is the only host of *O. mangiferae*, where the fungus survives during summer and how inoculums develops during every next season, has been a matter of debate. It is thought that it perpetuates in older infected mango leaves and intact green malformed inflorescences in the form of mycelium and conidia or dormant mycelium.

Mildew fungus has been favoured by cloudy weather and heavy

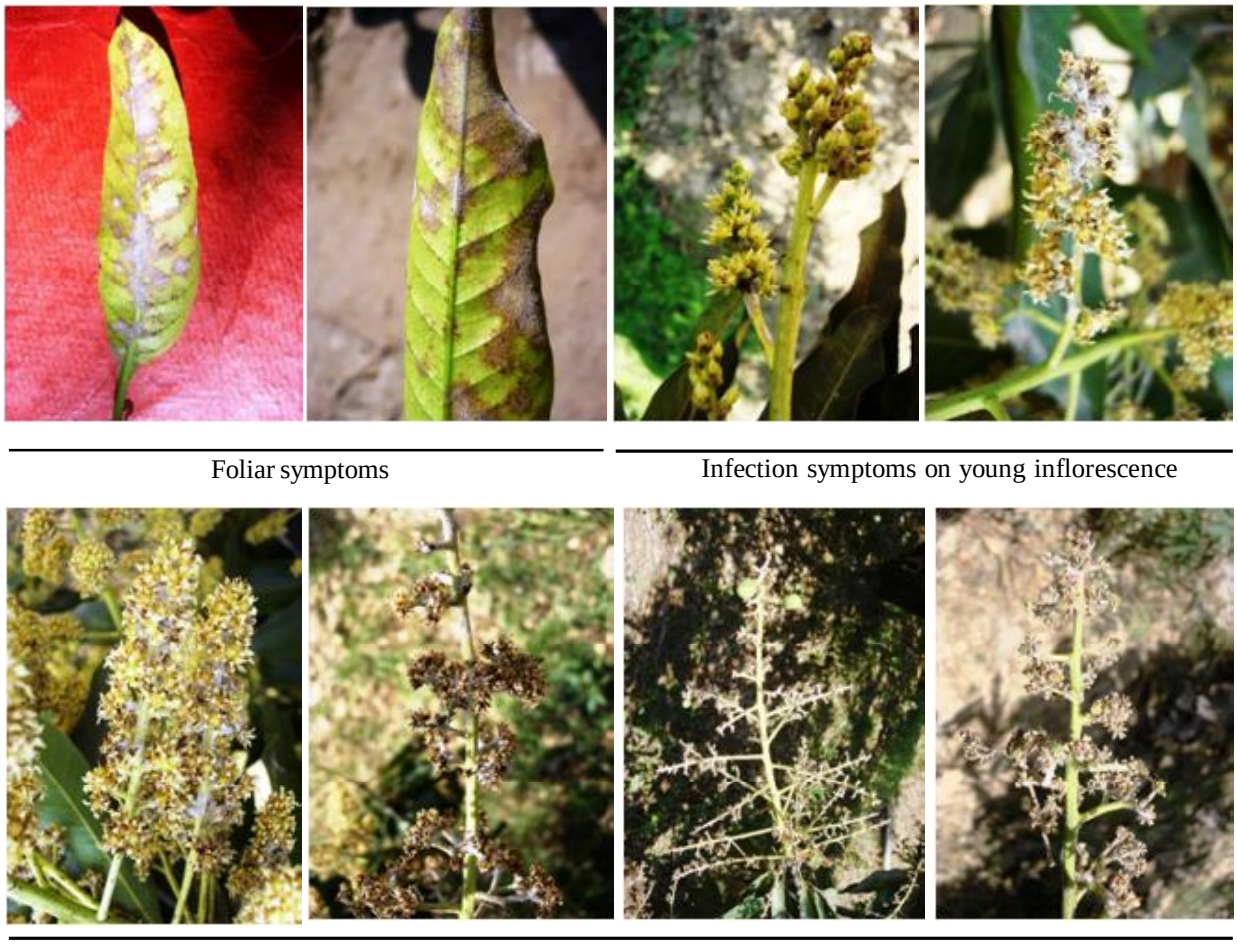

Fig 1: Symptoms of powdery mildew infection on different phenological stages

morning mists in India (3). Maximum infection of the host occurred at 26°C and 100 per cent RH. However, the fungus could cause infection at 15-32°C and 15.5-100 % RH. It was observed that atmospheric temperature was most important factor for onset and epidemic development of the disease under field conditions. The temperature range of 11-14°C (minimum) and 17-31°C (maximum) along with moderate relative humidity (64-72 per cent) was most congenial for the development of epidemic of powdery mildew of mango. Rainfall did not play any significant role on appearance and disease development, but dry weather favoured the development of the disease. Researchers from Lucknow, India suggested 35°C maximum and 15°C minimum temperatures along with <70% relative humidity for the development of powdery mildew as the most suitable ambient condition (4, 5).

Materials and Methods

In India, Uttar Pradesh being one of the major mango growing states and Malihabad mango belt of the state is popularly known for variety *Dashehari*. In order to develop weather based agro advisory for powdery mildew, the dynamics of powdery mildew were studied over different seasons and locations through roving survey of mango orchards located in 22 districts of UP and Haridwar, Uttaranchal during 2012-2014. Besides roving survey, fixed plot studies were also undertaken on trees of 20-35 years old planted at 2.5 m × 7.5 m to 10 m × 10 m for two consecutive seasons (2013 and 2014). Each orchard had at least 25 trees. Data were recorded on weekly basis from 5 trees in each orchard during 8th SMW to 16th SMW (III week of April). Disease incidence and severity was recorded from 10 panicles of each tree. Disease incidence was calculated on the basis of total number of leaves and panicles observed on a tree and the number of leaves and panicles having disease symptoms. Discussions were made using mean values per standard meteorological week. Daily weather data of temperature (maximum and minimum), relative humidity (morning and evening), rainfall, wind speed, bright sunshine hours and evaporation rates were recorded in the Agromet Observatory located within the experimental site.

Results and discussion

Roving Survey

It was noticed that weather and flowering period of mango had variations from eastern part to western region of UP state. The differences in weather parameters were noticed as maximum temperature goes beyond 35^{0}C in Lucknow (Central UP) during 20-30th March and at Saharanpur (Western UP) during 20-30th April. Hence, flowering period and disease incidence was likewise affected in two zones. Peaks of powdery mildew disease were thus observed at 13th SMW at Lucknow, 14th SMW at Aligarh, Meerut and 15-16th SMW in Muzaffarnagar, Haridwar and Saharanpur (Fig. 1). In a survey during 14th SMW of the year 2013 average incidence and severity (33.3% and 29.6 PDI) of powdery mildew were recorded in Haridwar district and 74.0% and 70.88 PDI in Barabanki and Kannauj districts during 12th and 13th SMW during 2014. Overall average incidence and severity were recorded 15.5% and 16.3% respectively during 2013 and 36.17% and 39.65 PDI respectively during 2014.

Fixed Plot Studies

The first incidence of disease on mango cv. *Dashehari* was recorded in 9th standard meteorological week (SMW) (1st week of March) in the first season (2013) while the next season (2014) it was delayed by one week (10th SMW). It increased gradually and attained a peak at 13th SMW in both the years and thereafter decreased towards the end of fruit set (Fig. 1, 2). Highest incidence and severity of powdery mildew was recorded 32.0 per cent and 41.12 PDI at Rehmankhera during 2013, and 18.0 per cent and 43.66 PDI at Meethenagar during 2014. Lowest average incidence and severity of the disease was 2.0 per cent and 13.7 PDI at Kakori during 2013 and 1.71 per cent and 10.15 PDI at Ulrapur in next season. During 13th SMW, when disease was at peak, average incidence and severity of the disease was recorded 12.2 per cent and 15.9 PDI during 2013, and 13.5 per cent and 34.01 PDI during 2014. In general, the incidence and severity were greater during 2014 as compared to 2013 mango crop season.

Disease data presented in roving survey and fixed orchards indicated wide variations among the orchards within the same agro-ecological zones. These variations are considered due to variation in disease management practices, which reiterate the need for effective agro-advisory services so that farmers could adopt the real time disease protection technologies. The difference in disease incidence during 2013 and 2014 was due to sum effect of weather variables. Sub-zero temperature during 2nd week of January followed by heavy rains during 5th to 8th SMW, high relative humidity 81.7% and lower maximum and minimum temperatures 29.6 and 9.3ÚC during 9th to 11th SMW did not allowed powdery mildew pathogen to cause epidemic during 2013. The initiation of flowering was delayed due to lower temperature in the month of January and frequent rainfall in February during 2013. All these observations indicated that incidence and severity of disease were dependent not only on weather conditions and but also on host susceptible stage. Similar observations regarding effect of weather on disease development were recorded by Gupta (4, 6) and Misra and Prakash (7). Since, ambient temperature is varying on day to day basis, its use as an independent factor for precise prediction of powdery mildew disease may be erroneous, therefore, its accumulation over time period was considered as a key component in predicting the disease dynamics. Henceforth, the heat accumulation (Growing degree days) over two seasons in a mango tree was

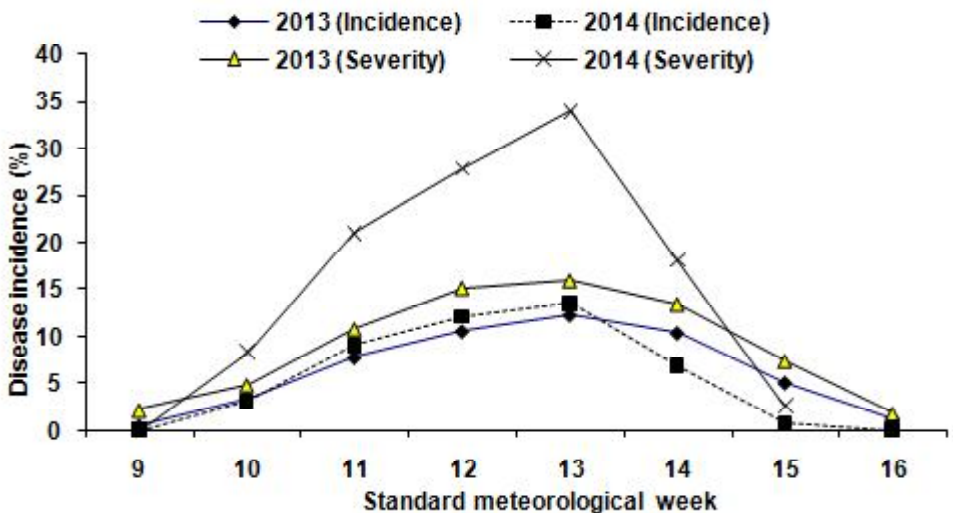

Fig 2: Incidence and severity of powdery mildew in fixed plots

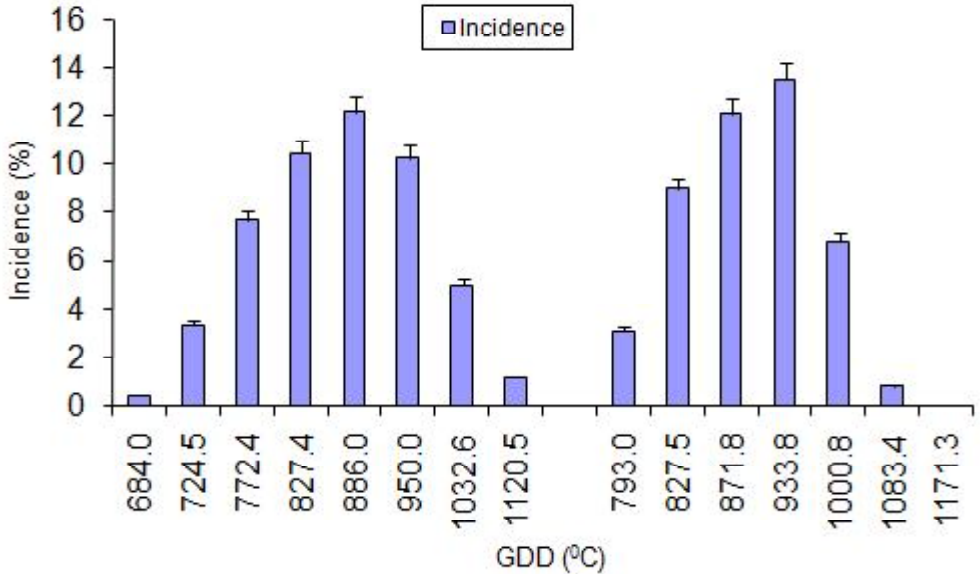

Fig 3: Incidence of powdery mildew in relation to growing degree days

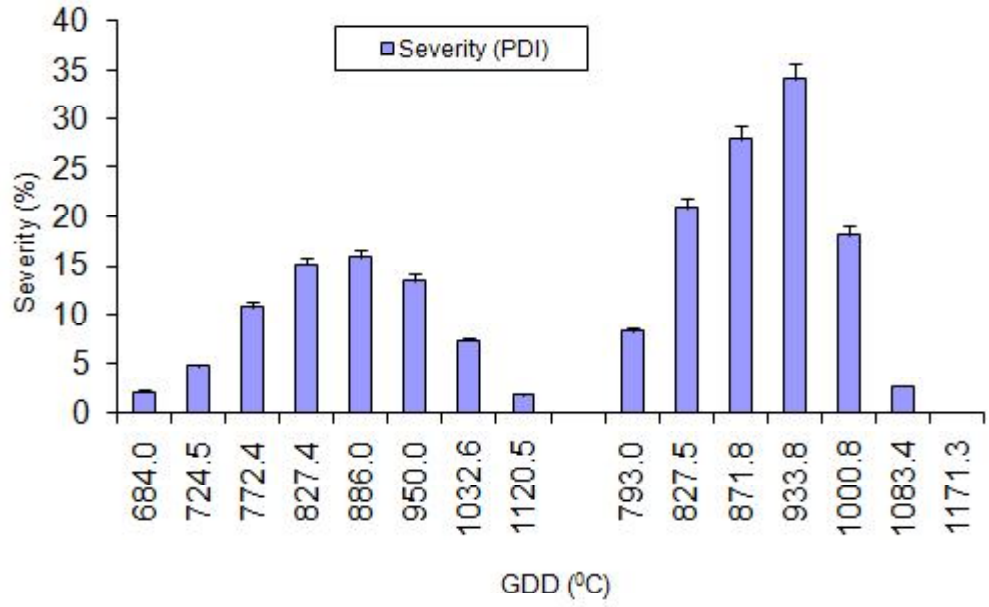

Fig 4: Severity of powdery mildew in relation to growing degree days

cumulated up to peak/maximum disease incidence and severity for generating regression based prediction and it was inferred that the maximum incidence and severity occurred at around 910 °Cd (Fig. 3, 4). The GDD could predict around 77% variations in progressive changes in powdery mildew disease incidence and severity. Therefore, use of such thermal index is more appropriate in forewarning the powdery mildew disease and its real time phenology based disease protection strategy. Findings of this study indicated that the incidence of powdery mildew is largely dependent on weather factors; therefore, GDD based agro-advisory is extremely important for cost effective management of the disease.

Management

Farmers have been practicing indiscriminate use of fungicides for management of this disease, which may lead to the problem of fungicide resistance, resurgence and residue. To get more profit, sustainable and need based interventions are required. In order to manage powdery mildew below economic threshold, farmers are advised to take up first spray with wettable sulphur 0.2 % (i.e. 2 g per litre of water) along with sticker (1 ml /liter of water) when advisory is issued or weather conditions are favourable for the development of the disease. Second spray of hexaconazole (4%) + zineb (68%) or hexaconazole (5%) @

0.1% (i.e. 1 g or ml per litre of water), should be done at 15-20 days after 1st spray, if necessary.

Conclusion

Powdery mildew is an important disease which may cause upto 90% losses. It is important because it causes the infection of inflorescences, effects fruit set and ultimately direct influence on yield. Under favourable weather conditions, it may destroy the crop within two to three days period. The growing degree day based concept could predict around 77% variations in progressive changes in powdery mildew disease incidence and severity. Therefore, use of such thermal index is more appropriate in forewarning the powdery mildew disease and its real time phenology based disease protection strategy benefited to farmers. It can easily be managed by spray with wettable sulphur 0.2 % (i.e. 2 g per litre of water) along with sticker, hexaconazole (4%) + zineb (68%) or hexaconazole (5%) @ 0.1%.

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Author contributions

Dr. P K Shukla and Dr. Gundappa designed the study, collected data, performed the experiments, Collected data from different experimental sites, analyzed the data, written the manuscript and revised. Dr. Tarun Adak analysed the data and wrote the manuscript. All authors read and approved the final manuscript.

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