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Observation on species spectrum of powdery mildew disease on cucurbits in Eastern region in Uttar Pradesh (India)

*Dr. Mohit Kumar Gupta

*Assistant Professor, Department of Botany in Dhampur Degree College, Dhampur, Bijnor, Uttar Pradesh (India)
Email: gupta.mohit891@gmail.com; Contact No. -91+7078135348

Abstract: Periodic visits were made for Observation on species spectrum of powdery mildew disease on cucurbits in Eastern region in Uttar Pradesh (India). During the phytopathological survey from September to December, 2018, powdery mildew infection on five plant species (Populus sp., Ageratum conyzoides, Quercus sp., Aegle marmelos and Zinnia elegans) was recorded. The infected plant materials, mostly leaves and stem, were collected and brought to the laboratory for further analysis. Podosphaera fuliginea (also known as Podosphaera xanthii) is a plant pathogen that causes powdery mildew on cucurbits. Podosphaera fuliginea and Erysiphe cichoracearum are the two most commonly recorded fungi causing cucurbit powdery mildew. Phyllactinia guttata is a species of fungus in the family Erysiphaceae; the anamorph of this species is Ovulariopsis moricola. A plant pathogen distributed in temperate regions, P. guttata causes a powdery mildew on leaves and stems on a broad range of host plants; many records of infection are from Corylus species, like filbert (Corylus maxima) and hazel (Corylus avellana). Erysiphe quercicola is known to infect a wide array of tropical trees as well as species of Quercus subgenera Quercus and Cyclobalanopsis.
[Gupta, K.M. **Observation on species spectrum of powdery mildew disease on cucurbits in Eastern region in Uttar Pradesh (India).** *Researcher* 2020;12(10):38-42]. ISSN 1553-9865 (print); ISSN 2163-8950 (online). http://www.sciencepub.net/researcher. 6. doi:10.7537/marsrsj121020.06.

Keywords: Species Spectrum, Powdery Mildew Disease, Cucurbits, Eastern Region

Introduction:

Powdery mildews are one of the most conspicuous parasitic fungi on plants of economic importance. Several crop plants including a number of cucurbits suffer greatly due to powdery mildews. Cucurbits are widely cultivated throughout India to be used as vegetables, ripe or raw fruits, ingradients of salad, in confectionary and for oil extraction.[1]

Powdery mildew of cucurbits is a serious disease and causes considerable loss to the crops of a number of cucurbitaceous crops grown in India. Three powdery mildews species, Sphaerotheca fullginea (Schlecht. ex Fr.) Poll., Erysiphe cichoracearum DC, ex Merat and Leveillula taurica (Lev.) Arnaud, are well established causal organisms of the disease on cucurbits on world-wide basis. Of these S, fuliginea and E. cichoracearum are more commonly encountered on cucurbits in different parts of the world; ^. fuliginea is apparently more prevalent (Khan, 1983). All the three species are reported to exist on cucurbits in India as well (Khan,1983). S.fuliginea and E. cichoracearum are known to occur on cucurbits in certain States of India like Uttar Pradesh, Madhya Pradesh, Bihar and Rajasthan (Khan et al., 1971; Khan, 1976,1977; Dave et al.,1971; Khosla et al., 1974; Siradhana and Chaudhari, 1972). In some States like Kashmir and Punjab only. fuliginea is reported to cause the disease on cucurbits (Khan et al., 1974; Jhooty, 1967). L. taurica has been reported to infect cucurbits' in Rajasthan and Karnataka (Mahrshi and Siradhana, 1980; Ullasa and Amin, 1981).[2]

Anaraorphs of S. fuliglnea and E. clchoracearum have great similarities and teleomorphs are not common. Symptoms of the disease caused by them are identical. Therefore, there has been a great deal of confusion throughout the world with regard to the identity of the causal organism of the disease. In recent past, some efforts have been made in different countries of the world including India to establish the correct identity of the species involved in the disease. Jhooty (1967) identified the cause of powdery mildew of cucurbits in Punjab on the basis of anamorph as fuliginea. Khan and Khan (1970) while studying perithecial production in cucurbit powdery mildews on cucumber and bottle-gourd cultivars in the glasshouse identified the causal organism in Uttar Pradesh as S, fuliginea. However, in a later study. Khan et al. (1971) observed that S. fuliginea was responsible mainly for the disease in nature and E. clchoracearum was confined to Coccinia cordifolla, a wild cucurbit. Siradhana and Chaudhari (1972) recorded occurrence of both the species on cucurbits in Rajasthan.[3]

Dave et al., (1971) recorded existence of both species on cucurbits in Madhya Pradesh and found

teleomorphs fuliginea on L. sicerarla (L. leucantha) and Luffa cylindrica and those of E. clchoracearum on T. dioica. From a survey conducted by Khan et al. (1974) in Kashmir, it emerged that Ss fuliginea is most prevalent species in the State and attacks a number of cucurbits like Cucurblta maxima. C. pepo, Cucumis sativus, Citrullus vulgaris and Luffa acutangula. They observed perithecia of S, fuliginea on L, leucantha at Wadura and on C, maxima in Dal Lake area. Khan (1976) after a survey in Bihar found that both species were present on cucurbits in the State. They were observed both in conidial as well as in perithecial stages. Perithecia of E. cichoracearum were found on cordifolia at Sheikhpura in Patna and of S.fuliginea on L. leucantha at Sheikhpura (Patna) and Patna city area. He further noticed that most severely affected cucurbit was L. leucantha followed by Cucurbita moschata, Cucumis melo, C. melo var. utilissimus and C, cordifolia. Sohi and Nayar (1969) reported the occurrence of fuliginea in Himachal Pradesh and observed its peritheceal stage on C. moschata. [4]

Geographic distribution

Powdery mildew occurs almost everywhere wheat is grown. It is important economically under humid rained conditions and in dry land areas when irrigation is used for production of improved cultivars with high yield potential. Powdery mildew has increased in importance in some regions because of increased application of nitrogen fertilizer, which favors the disease. The disease is important in regions where rain occurs early in the season and where temperatures are relatively cool, such as regions with maritime climates, and in cooler regions with a humid continental climate (Bennett, 1984). Powdery mildew is important in the cooler regions of China, Japan and other areas in Asia, in North and East Africa, in northern Europe and eastern North America (Roelfs, 1977; Saari and Wilcoxson, 1974). It is also important in warmer, humid regions with mild winters where wheat is planted in the autumn, such as parts of the Southern Cone of South America and the southeastern United States. In regions or seasons in which rain is frequent and heavy, the occurrence of powdery mildew may be very low because spores are washed from the leaves or they burst in water (Merchan and Kranz, 1986). [11]

Epidemiology

Powdery mildew typically begins rapid growth on the lower leaves and sheaths when plants begin to joint. It is usually the first leaf disease of the season because it is favored by temperatures between 10 and 22°C. Infection and disease development decline after flowering when temperatures increase above 25°C. Conidia are the primary inoculum source for dissemination of the fungus. They are easily dislodged from lesions by wind and rain. Production of conidia is optimal at 20°C and declines rapidly above and below that temperature (Ward and Manners, 1974). Although conidia only survive for several days, they are capable of disseminating the fungus long distances. New pustules with conidia are produced every seven to ten days at optimal conditions and provide repeating cycles of spores. Conidia germinate most rapidly at 97 to 100 percent relative humidity, but their high water content allows them to germinate when humidity declines below 50 percent. However, germ tube growth and appressorium production are greatly reduced below 92 percent relative humidity (Friedrich and Boyle, 1993). Frequent light rain removes conidia from leaves and thus reduces the number of new colonies that form. Periods of heavy rain slow the development of established pustules (Merchan and Kranz, 1986). Conidia do not germinate in free moisture, which can cause them to burst. After crop maturity, ascospores in cleistothecia serve as survival structures, but their role in initiating disease is much less important than that of the conidia in most environments. Conidia produced on grasses and volunteer wheat also maintain inoculum until wheat is planted. In autumn-sown wheat, infections that do not result in visible symptoms can maintain the fungus in leaves through the winter (Frank and Ayers, 1986). [12]

Study Area:

Eastern Uttar Pradesh: The Indian state of Uttar Pradesh borders with Nepal and the Indian states of Bihar, Jharkhand, Chhattisgarh, Madhya Pradesh, Rajasthan, Haryana, Uttarakhand, Himachal Pradesh and National Capital Territory of Delhi. The Himalayas lies in the north of the state and the Deccan Plateau is at the south. In between them, the river Ganges, Yamuna and Sarayu flow eastwards. Uttar Pradesh can be divided into two distinct regions, Southern hills and Gangetic plain. Uttar Pradesh is divided into 75 districts under 18 divisions. As of 2011, with an estimated population of 199,581,477. Uttar Pradesh is the most populous state in India. [9]

The state of Uttar Pradesh has been divided into four regions – Western, Central, Southern and Eastern. The region of eastern Uttar Pradesh comprises Bahraich, Gonda, Basti, Gorakhpur, Deoria, Ballia, Azamgarh, Faizabad, Sultanpur, Jaunpur, Ghazipur, Varanasi, Mirzapur, Allahabad and Pratapgarh districts. It covers in area of 85,803 sq/km. The region of Eastern Uttar Pradesh is located between $23^0$50` N to $28^0$25`N and $81^0$10`E to $84^0$40`E. Some of the districts comprising the region in recent past have been bifurcated into separate administrative units by creation of new districts for example: Sidharthnagar, Mau, Sonbhadra etc. The region of eastern Uttar

Pradesh districts demographic profile presents features and characteristics of population of the districts. It is focuses at analysis of inter and intra districts comparisons. It presents rural and urban segments of the population also. The share of schedule caste and schedule tribe population in total population, analysis of the population according to sex, literacy among male and female etc. Demographic profile also presents workers and non workers. Occupational profile cultivators agricultural labourers and other workers, sex ratio, etc. The data source is census 2001 Government of India. [10]

The first is the eastern tract consisting of 14 districts which are subject to periodical floods and droughts and have been classified as scarcity areas. The rainfall in the plains is heaviest in the east and decreases towards the north-west. Floods are a recurring problem in the state, causing damage to crops, life, and property. The worst floods were in 1971, when 51 of the 54 districts of the state were affected an area of nearly 52,000 square kilometres. The eastern districts are the most vulnerable to floods, the western districts slightly less and the central region markedly less. The eastern districts susceptibility to floods is ascribed, among other things, to heavy rainfall, low flat country, high subsoil water level and the silting of beds which causes river levels to rise. The problem in the western districts is mainly poor drainage caused by the obstruction of roads, railways, canals, new built-up areas etc. There is water logging in large areas. The major flood-prone rivers are the Ganges, Yamuna, Gomti, Ghaghara, Rapti, Sharda and Ramganga. The inadequate drainage capacity of the smaller western Sirsa, Kali and the Aligarh drain is also a cause of floods.

Methodology:

Periodic visits were made for Observation on species spectrum of powdery mildew disease on cucurbits in Eastern region in Uttar Pradesh (India). During the phytopathological survey from September to December, 2018, powdery mildew infection on five plant species (*Populus* sp., *Ageratum conyzoides*, *Quercus* sp., *Aegle marmelos* and *Zinnia elegans*) was recorded. The infected plant materials, mostly leaves and stem, were collected and brought to the laboratory for further analysis. The infected leaves were examined primarily with a hand-lens and then with a dissecting microscope for the presence of mildew symptoms. [8,9,10]

A piece of clear adhesive tape was placed on infected leaves, stripped off and then placed on a microscopic slide with one drop of clear distilled water. The microscopic observations were carried out for morphological characteristics of mycelia on the host, appressoria, size and shape of conidia and conidiophores and chasmothecia. Pathogenicity was confirmed for all isolates by dusting conidia on healthy plants and non-inoculated plants served as controls. Standard literature (Paul & Thakur 2006; Braun & Cook 2012) was consulted for fungal identification. [11,12]

Results and discussion:

Information about the spectrum of powdery mildew species in the Czech Republic is fragmentary. Klika compiled the first Czech monograph on powdery mildews in 1923. Twenty-five species in seven genera with morphological differences were described. They contained five species of Erysiphe (including Blumeria, Golovinomyces and Neoerysiphe); four each of Microsphaera (now E. sect. Microsphaera; only on tree hosts), Trichocladia (now E. sect. Microsphaera; two of them on tree hosts), Uncinula (now E. sect. Uncinula; only on tree hosts), Sphaerotheca (now Podosphaera sect. Sphaerotheca), three of Podosphaera sect. Podosphaera (only on tree hosts) and one of Phyllactinia (only on tree hosts). In addition, Klika cited very sporadic collections of powdery mildews by Opitz, Bubák, Kabát and Petrák in the 19th and early 20th centuries in the area of the Czech Republic. In the last 20 years, some notes on the occurrence of new powdery mildew species on trees and shrubs in the Czech Republic were published, e.g., Erysiphe azaleae on Rhododendron spp., Erysiphe palczewskii on Caragana arborescens Lam., powdery mildew on Homalocladium platycladum (F. Muell.) Meisn. and contributions to the knowledge of Erysiphe sp. on Catalpa Scopoli in Europe. In the present study following species are present:

1. Phyllactinia guttata

Phyllactinia guttata is a species of fungus in the family Erysiphaceae; the anamorph of this species is ***Ovulariopsis moricola***. A plant pathogen distributed in temperate regions, *P. guttata* causes a powdery mildew on leaves and stems on a broad range of host plants; many records of infection are from *Corylus* species, like filbert (*Corylus maxima*) and hazel (*Corylus avellana*). Once thought to be conspecific with *Phyllactinia chorisiae*, a 1997 study proved that they are in fact separate species.

Microscopically, *P. guttata* is characterized by large ascomata, long narrow pointed appendages with bulbous swellings at base, 2- or 3-spored asci with large ascospores; the ascomata also have gelatinous cells with tufts of hyphae somewhat resembling hairs. The cleistothecia are capable of dissemination and attachment to new growing surfaces by means of gelatinous penicillate cells. Originally named in 1801 as *Sclerotium erysiphe* by Christian Hendrik Persoon, the species went through a number of name changes in the 1800s. Salmon's widely used 1900 monograph on

the *Erysiphaceae* established the name as *Phyllactinia corylea* for roughly half a century, until the starting date for the naming of fungi was moved, and the name was established as *Phyllactinia guttata*.

2. *Podosphaera xanthii*

Podosphaera fuliginea (also known as *Podosphaera xanthii*) is a plant pathogen that causes powdery mildew on cucurbits. *Podosphaera fuliginea* and *Erysiphe cichoracearum* are the two most commonly recorded fungi causing cucurbit powdery mildew. In the past, *Erysiphe cichoracearum* was considered to be the primary causal organism throughout most of the world. Today, *Podosphaera fuliginea* is more commonly reported.

Powdery mildew is manifest on the plant by white powdery fungal growth on the surface of the leaf, usually both sides of the leaf show fungal growth. The host tissue is frequently stunted, distorted, discolored, and scarred. The fruit of infected plants are usually smaller and the flavor is affected negatively, as fewer sugars and solids are stored in the fruit.

3. *Erysiphe quercicola*

Erysiphe quercicola is known to infect a wide array of tropical trees as well as species of *Quercus* subgenera *Quercus* and *Cyclobalanopsis* (Baiswar et al. 2015; Cardoso et al. 2017; Cho et al. 2018; Desprez-Loustau et al. 2017; Fonseca et al. 2019; Kirschner and Liu 2014; Limkaisang et al. 2005, 2006; Siahaan et al. 2016; Takamatsu et al. 2018; Tam 2017). In Thailand, *E. quercicola* was previously reported on *Bixa orellana*, *Hevea brasiliensis*, *Mangifera indica* and *Acacia auriculaformis* (Limkaisang et al. 2005, 2006; Meeboon and Takamatsu 2016, 2017a). Powdery mildews are obligate parasites often causing significant damages to their hosts. The occurrence of *E. quercicola* in Thailand on a variety of important agricultural and horticultural plants poses a serious threat to crop production. During investigations into the diversity of powdery mildews in Thailand, the authors found the asexual morph of *E. quercicola* (*Pseudoidium* sp.) on eleven additional tropical trees. Detailed morphological descriptions and molecular analyses of *E. quercicola* on the new hosts are presented in this report.

Corresponding author:
Dr. Mohit Kumar Gupta
Assistant Professor, Department of Botany,
Dhampur Degree College,
Dhampur, Bijnor, Uttar Pradesh (India)
Contact No. -91+7078135348
Email: gupta.mohit891@gmail.com

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10/24/2020