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Pathogenic Biodiversity of powdery mildew disease on cucurbits in Rohilkhand region in Uttar Pradesh (India)

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Abstract: This study for the first time, records the occurrence of two species on cucurbits in in Rohilkhand region in Uttar Pradesh (India), a important states of Northern India and establishes their identity as Podosphaera xanthii on cultivated cucurbits and Golovinomyces cichoracearum on Coccinia cordifolia. Surveys were conducted in different localities of extensive cucurbit cultivation areas of Rohilkhand region in Uttar Pradesh (India) in second weak of April, 2018. Five to ten samples of each powdery mildew infected cucurbits were collected randomly and packed separately in polythene bags and marked to indicate the crop, location, date of collection etc. All the samples were closely examined for studying the characteristics of the symptoms on cucurbits and brought to the laboratory for the further identification. Powdery mildew species involved in the disease development were identified by using anamorph and teleomorph characters as done by Kristkova et al., (2009) and Khan and Sharma (1995). In other localities, infection was mild to moderate on Cucurbita moschata. On cucurbita maxima, Luffa cylindrica, Cucumis melo var. utilissimus, Cucumis melo var. momordica, and Cucumis sativus, infection was mild to moderate. Citrullus vulgaris var. fistulosus and Citrullus lanatus had only mild infection. Coccinia cordifolia was severely infected in Rohilkhand region in Uttar Pradesh (India), it had mild to moderate infection. C. moschata was free from infection in Rohilkhand region in Uttar Pradesh (India). L. cylindrica had no infection in Rohilkhand region in Uttar Pradesh (India). L. siceraria was found infected in every localities in all region of in Rohilkhand region in Uttar Pradesh (India). Cucumis melo was free from infection in Rohilkhand region in Uttar Pradesh (India).
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Introduction:

Powdery mildew is a common and economically important foliar disease in vegetable production throughout the world. On cucurbitaceous crops, the disease can reduce yield by decreasing fruit size, number of fruits, and length of time fruits can be harvested. Fruit quality and marketability can also be affected due to premature leaf senescence causing fruits to become exposed and more susceptible to sunburn. Additionally, powdery mildew infection can predispose cucurbit plants to other diseases. Cucurbit powdery mildew is most frequently caused by two obligate fungal pathogens, Podosphaera xanthii [(Castagne) U. Braun & Shishkoff 2000] and Golovinomyces cichoracearum [(DC.) V.P. Heluta 1988]. The most commonly identified pathogen; particularly in warmer production regions has been P. xanthii. Recently, there has been an increase in occurrence and severity of the disease in Florida, resulting in heightened concern with fungicide resistance and potentially a shift or displacement of the pathogen population. In this study, we identified and characterized single colony isolates of cucurbit powdery mildew from multiple sites, dates, and cucurbit hosts.[1]

Cucurbit powdery mildew (CPM), a disease on field and greenhouse cucurbit crops worldwide, is caused most frequently by two obligate erysiphaceous ectoparasites (Golovinomyces orontii, Podosphaera xanthii) that are highly variable in their pathogenicity and virulence. Various independent systems of CPM race determination and denomination are used worldwide, having to date been differentiated on different cultivars or lines of melon (Cucumis melo L.). We briefly review historical perspectives and the current state of understanding of the virulence variation of the two CPM pathogens at the pathogenic race level, their differentiation and their designation. Furthermore, we propose for use by the international CPM research, breeding, seed and production community new tools to enhance research, communication and management of CPM. These tools consist of five components: 1) a set of 21 differential genotypes of Cucumis melo L. for the identification of CPM races; 2) a triple-part, septet

code for meaningful, concise designation of CPM races; 3) protocols for maintaining CPM isolates and differential genotypes and for laboratory assays to examine the virulence of CPM isolates; 4) rules and principles of practical application of this system in breeding, seed production and cucurbit growing, including a proposal of a race denomination suitable for practical application; and 5) crucial activities leading to the implementation and running of new tools for CPM research and management. The five components of this package have equal importance, forming a compact system, and none of them can be omitted. [2,3]

Among the diversity in the Cucurbitaceae family, three genera are of the greatest economic significance throughout the world: Cucumis, Cucurbita and Citrullus. The major cultivated genera include: cucumber (Cucumis sativus L.), several types of melons (Cucumis L.), watermelon (Citrullus lanatus (Thunb.) Matsum. Nakai), and squash and pumpkin (Cucurbita L.) A few minor types of cultivated specialty cucurbits include chayote (Sechium edule (Jacq.) Swartz), long squash or bottle gourd (Laginaria siceraria (Mol.) Standl.), bitter melon (Momordica charantia L.), luffa sponge gourd (Luffa aegyptiaca Miller), Chinese okra or luffa ridge gourd (Luffa acutangula (L.) Roxb.), parvar or snake gourd (Tricosanthes dioica Roxb.), wax gourd (Benincasa hispida Thumb.), cassabanana (Sicana odorifera (Vell.) and tinda (Praecitrullus fistulosus Stocks). Cucurbits are among the first domesticated plant species and have varied centers of origin with representatives native to both the Western and Eastern 26 hemispheres. While Citrullus (watermelon) and Cucumis (cucumber and melon) are thought to have originated in the Eastern hemisphere, Cucurbita (pumpkin and squash) originated in the Western hemisphere. Following European contact, centers of diversity developed in Turkey (Cucurbita pepo), India and Burma (C. maxima), China and Japan (C. moschata). Cucumber originated in India; cantaloupes and melons in Africa; summer squash and butternut squash came from Mexico and Central America; winter squash from South America and watermelon from Central Africa. Cucurbits differ in their ability to tolerate cold and heat, yet all cucurbits are sensitive to frost. The vast majority of species are vining herbaceous annuals. A few cultivars produce bush-like plants and a limited number of species are woody vines in the rainforests of Australia. A small number of species are thorny shrubs and one cucurbit specie, endemic to Yemen, grows as a tree (Dendrosicyos socotranus Balf. f.). [4]

Taxonomic Classification

Cucurbitaceous crops belong to the order Cucurbitales and family Cucurbitaceae (Juss.). All the cultivated species are found in the subfamily Cucurbitoide. This plant family consists of over 100 genera and more than 800 species distributed largely in tropical and subtropical regions of the world with few representatives in temperate to cooler climates. Recent phylogenetic research by Schaefer and Renner based on molecular and morphological data, described a new classification of 95 genera and 950 to 980 species comprising the Cucurbitaceae family. [5]

Study Area:

Rohilkhand: It is a region in the northwestern part of the Uttar Pradesh state of India, centered around Bareilly and Moradabad divisions. Part of the upper Ganges Plain, the region is named after the Rohilla tribe who are Pashtun (also known as Afghan or Pathan). The region was called *Madhyadesh* in the Sanskrit epics *Mahabharata* and *Ramayana*. Rohilkhand lies on the upper Ganges alluvial plain and has an area of about 25,000 km²/10,000 square miles (in and around the Bareilly and Moradabad divisions). It is bounded by the Ganges Doab to the south and west, Uttarakhand to the north, Nepal to the east, and the Awadh region to the southeast. Rohilkhand includes the cities of Amroha, Bahjoi, Bareilly, Bijnore, Budaun, Kakrala, Khutar, Moradabad, Najibabad, Pilibhit, Rampur, and Shahjahanpur. [6,7]

Methodology:

Surveys were conducted in different localities of extensive cucurbit cultivation areas of Rohilkhand region in Uttar Pradesh (India) in second weak of April, 2018. Five to ten samples of each powdery mildew infected cucurbits were collected randomly and packed separately in polythene bags and marked to indicate the crop, location, date of collection etc. All the samples were closely examined for studying the characteristics of the symptoms on cucurbits and brought to the laboratory for the further identification. Powdery mildew species involved in the disease development were identified by using anamorph and teleomorph characters as done by Kristkova et al., (2009) and Khan and Sharma (1995). [8,9]

Since teleomorph develops rarely on cucurbits and only a few samples showed teleomorphs. Anamorph characters were largely used for determining the identity. Mode of parasitism in relation to ectophytic and endophytic nature of the mycelium, morphology of conidiophores in relation to branching, length of the conidiophores (number of cells), arrangement of conidia on conidiophores, shape of conidia, dimensions of conidia (Length and breadth), Length/Breadth (L/B) index, presence and absence of fibrosin bodies in conidia, morphology of germ tube and development of appressoria and point of origin on germ tube on conidia are anamorph characters which were used in the identity of powdery mildew species. [10]

For measuring the conidial dimensions 300 conidia selected at random from the slides prepared

from each sample were measured with the help of ocular micrometer. L/B index was determined by dividing length of a conidium with its breadth. Mean values were calculated and standard deviation was determined. For fibrosin bodies and morphology of germ tubes and development of appressoria fibrosin bodies test and germination test were conducted (Khan and Sharma, 1995). [11]

Results and discussion: The study area which included in Rohilkhand region in Uttar Pradesh (India) (a state of Northern India) showed cultivation of the cucurbits. The powdery mildew disease was wide spread appearing on all the cultivated cucurbits. No variation in symptoms was noticed. Powdery mildew species in all the samples were ectophytic. The disease intensity on the cucurbits showed a variation among the localities. The highest intensity was found on Lagenaria siceraria, being mild to severe. Cucurbita moschata was severely infected at in Rohilkhand region in Uttar Pradesh (India).

In other localities, infection was mild to moderate on Cucurbita moschata. On cucurbita maxima, Luffa cylindrica, Cucumis melo var. utilissimus, Cucumis melo var. momordica, and Cucumis sativus, infection was mild to moderate. Citrullus vulgaris var. fistulosus and Citrullus lanatus had only mild infection. Coccinia cordifolia was severely infected in Rohilkhand region in Uttar Pradesh (India), it had mild to moderate infection. C. moschata was free from infection in Rohilkhand region in Uttar Pradesh (India). L. cylindrica had no infection in Rohilkhand region in Uttar Pradesh (India). L. siceraria was found infected in every localities in all region of in Rohilkhand region in Uttar Pradesh (India). Cucumis melo was free from infection in Rohilkhand region in Uttar Pradesh (India).

Cucumis melo var. utilissimus had no infection in Rohilkhand region in Uttar Pradesh (India). Cucumis melo var. momordica was free from infection in Rohilkhand region in Uttar Pradesh (India). Cucumis sativus was found infected only in Rohilkhand region in Uttar Pradesh (India). Citrullus vulgaris var. fistulosus had infection in Rohilkhand region in Uttar Pradesh (India).

Citrullus lanatus was found infected in Rohilkhand region in Uttar Pradesh (India). Coccinia cordifolia was free from infection in Rohilkhand region in Uttar Pradesh (India). Teleomorphs was observed on L. siceraria at Sonda and on Cucumis melo at in Rohilkhand region in Uttar Pradesh (India).

Teleomorphs were greater in number on leaves than on stem. Cleistothecia were scattered to densely gregarious, 72-116µm in diameter. Appendages were variable in number and mycelioid. Each cleistothecium contained single, broadly elliptical to sub globose ascus, 53- 93×34-65µm in size. Ascospores were 8 in number, ellipsoid to nearly spherical in shape, 20-23×15-23µm in size. Based on these characters of teleomorphs the powdery mildew found on Lagenaria siceraria and Cucumis melo was identified as Podosphaera xanthii. Since the teleomorphs were present only in few samples of two cultivated cucurbits i.e. Lagenaria siceraria and Cucumis melo, in absence of teleomorphs, anamorph characters of the pathogen were used to establish the identity of the species.

The conidia from Lagenaria siceraria were 32.22×17.28µm in size, being the biggest and conidia from Cucumis melo were 26.42×14.32µm, being smallest among the conidia from the cultivated cucurbits. The conidia obtained from Coccinia cordifolia were 35.82×16.82µm in size. Length/breadth (L/B) index, calculated from the measurements of length and breadth of all conidia of each cucurbit showed more or less constant figure for cultivated cucurbits being less than 2 (mostly 1.84) while L/B index of conidia from Coccinia cordifolia was more than 2 (ie. 2.12).

The conidia obtained from cultivated cucurbits did not develop appressoria. Conidia obtained from Coccinia cordifolia imvariably formed simple germ tubes (non forked) emerging apically/ basally and subsequently produced appressoria. On the basis of anamorph and teleomorph characters powdery mildew species infecting all the cultivated cucurbits was identified as Podosphaera xanthii and Golovinomyces cichoracearum.

The identity situation of the causal species in Rohilkhand region in Uttar Pradesh (India) is similar to other states like Madhya Pradesh (Khosla et al., 1974), Uttar Pradesh (Sharma, 1973), Bihar (Khan, 1976), Tamil Nadu (Sharma and Khan, 1991) and Andhra Pradesh (Sharma and Khan, 1994), where from both Sphaerotheca fuliginea (Podosphaera xanthii) and Erysiphe cichoracearum (Golovinomyces cichoracearum) have been reported to infect cucurbits. At the same time, the dominance patterns and host speficity, Podosphaera xanthii infecting cultivated cucurbits and Golovinomyces cichoracearum generally on Coccinia cordifolia, are also comparable to other states of India. From some states like Punjab (Jhooty, 1967) and Kashmir (Khan et al., 1974), Sphaerotheca fuliginea is alone to be recorded to infect cucurbits. These two species are considered as the causal organism of the disease in different parts of the world (Lebeda et. al., 2010; Khan and Sharma, 1995).

Some old reports from India and several other countries (Lebeda et al., 2010 and Khan and Sharma, 1995) provided evidence that Erysiphe cichoracearum infects cultivated cucurbits as well. It is quite expected that this species may be attacking cultivated cucurbits in different parts of India also, there are a few reports of this effect (Khan et al., 1974; Khosla et al., 1974;

Siradhana and Chaudhari, 1972). The potential of this species to attack cucurbits in general can not be ignored and should be considered in management strategies of the disease. This study for the first time, records the occurrence of two species on cucurbits in Rohilkhand region in Uttar Pradesh (India), a important states of Northern India and establishes their identity as Podosphaera xanthii on cultivated cucurbits and Golovinomyces cichoracearum on Coccinia cordifolia.

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