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STUDIES ON THE DYNAMICS OF POWDERY MILDEWS ON CUCURBITS IN HARYANA, INDIA

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ABSTRACT

This study considered the occurrence of powdery mildew on cucurbits in Haryana and determined the identity of causal species of the disease in the state. Eleven cucurbits were found infected in one or the other locality in the study area of the state which comprised six districts located distantly. Bottle gourd (*Lagenaria siceraria*) was most severely affected crop. While *Citrullus lanatus* was least affected as comparision to other cucurbits. A wild cucurbit, *Coccinia cordifolia*, was also severely affected. Teleomorphs of the pathogen were found on *L. siceraria* and *Cucumis melo*. Utilizing anamorph and teleomorph characters, the species responsible for the disease in the state were identified as *Podosphaera xanthii* and *Golovinomyces cichoracearum*. Pathogenecity spectrum of disease in states is similar to several other states in India.

KEY WORDS: Cucurbits, *Podosphaera xanthii*, *Golovinomyces cichoracearum*, Teleomorph, anamorph

Powdery mildew is a serious disease and causes considerable loss to the number of cucurbitaceous crops grown in India. Its distribution and relative occurrence varies throughout the world. Most of the cucurbits are found susceptible to powdery mildew disease but few cucurbits are not much infected due to resistant cultivars. This disease reduced the yield of cucurbits by reducing the number and/ or size of fruit. Powdery mildew adversely affected the fruit quality. This disease is caused by three obligate biotrophic ectoparasites i.e. *Golovinomyces cichoracearum* (Syn. *Erysiphe cichoracearum*), *Podosphaera xanthii* (Syn. *Sphaerotheca fuliginea*) and *Leveillula taurica* (Khan and Sharma, 1995 and Lebeda et al., 2010). Although all these species are important in India but *G. cichoracearum* and *P. xanthii* are considered most important. Earlier reports of occurrence of powdery mildew disease on cucurbits in India indicated the occurrence of *G. cichoracearum* & *P. xanthii.* But *P. xanthii* (*S. fuliginea*) is dominant than *G.cichoracearum*. *L. taurica* has very limited economic importance.

Reports are available about the identity of powdery mildew species involved in the disease from the several states of India. These states are Madhya Pradesh (Khosla et al., 1974), Uttar Pradesh (Khan and Sharma, 1995), Bihar (Khan, 1976), Rajasthan (Siradhana and Chaudhari, 1972), Tamilnadu (Sharma and Khan, 1991) and Andhra Pradesh (Sharma and Khan, 1994) and Punjab (Jhooty, 1967), Kashmir (Khan et al., 1974). Most of these are new record reports and lack objectively in efforts to establish the identity of species on cucurbits. From other states in India, particularly Haryana of Northern India, studies on powdery mildew, in order to establish their identity, have not been undertaken. There is no such information available from Haryana. This situation prompted us to study the occurrence of powdery mildew on cucurbits and establish the identity of species causing the disease in Haryana. This study for the first time included such a large area including six districts located distantly, of Haryana state with extensive cultivation to establish the identity of causal organism causing disease on cucurbits.

MATERIALS AND METHODS

Surveys were conducted in different localities of extensive cucurbit cultivation areas of Haryana in second weak of April, 2011. 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). Since teleomorph develops rarely on cucurbits and only a few samples showed

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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.

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).

RESULTS AND DISCUSSION

The study area which included 6 districts of Haryana (a state of Northern India) showed cultivation of the cucurbits given in table -1. 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 (Table -2). The highest intensity was found on *Lagenaria siceraria*, being mild to severe. *Cucurbita moschata* was severely infected at Diwana in Panipat district. 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 Ambala and Hisar districts and in Faridabad and Palwal districts, it had mild to moderate infection (Table -2). *C. moschata* was free from infection in Hisar districts, *C. maxima* in Faridabad and Gurgaon districts. *L. cylindrica* had no infection in Hisar, Palwal and Panipat districts. *L. siceraria* was found infected in every localities in all districts except Panipat where at two lacalities i.e. Asan and Diwana, it was free from infection. *Cucumis melo* was free from infection in Gurgaon and Hisar districts. *Cucumis melo* var. *utilissimus* had no infection in Ambala and Panipat districts. *Cucumis melo* var. *momordica* was free from infection in Ambala, Faridabad and Hisar districts. *Cucumis sativus* was found infected only in Gurgaon and Palwal districts. *Citrullus vulgaris* var. *fistulosus* had infection in Ambala, Gurgaon and Panipat districts. *Citrullus lanatus* was found infected in Gurgaon and Palwal districts. *Coccinia cordifolia* was free from infection in Gurgaon district (Table -1). Teleomorphs was observed on *L. siceraria* at Sonda (Ambala district) and at Sohna (Gurgaon district) and on *Cucumis melo* at Pirthala (Palwal district). 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) (Table -4).

Fibrosin bodies were present in a high percentage

of conidia obtained from all the cultivated cucurbits but were absent from the conidia obtained from *Coccinia cordifolia*. Some conidia in samples of cultivated cucurbits did not show fibrosin bodies. Percent occurrence of fibrosin bodies in conidia in such samples ranged between 72-89. The number of fibrosin bodies per conidium ranged between 7 to 9. (Table -3). On germination, conidia from cultivated cucurbits produced simple and forked germ tubes from the side walls of the conidia. The percent germination of conidia ranged between 64 and 92. The percentage of forking of germinating conidia also varied for each cucurbit .The highest forking was marked in the germinating conidia of *Lagenaria siceraria* (66 percent) followed by *Cucurbita moschata* (54 percent). From other cucurbit percent forking ranged between 32 and 48 (Table -3).

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 of the disease in Haryana 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).

In Haryana powdery mildew was infected all cucurbits, but most often damaged *L. siceraria*, *C. melo* and *C. moschata*. The pathogen grew as a white, powdery mass on leaves, petioles and stems. The resulting decrease in photosynthesis may cause significant reduction in the quality and yield of fruit. It would be wide expected in such as wide ranging species (both geographically and in hosts) there is evidence of numerous, races, differing in minor

Table 1 : Incidence of powdery mildew on cucurbits in some districts of Haryana

Cucurbits	Incidence (%)					
	Haryana					
	Ambala	Faridabad	Gurgaon	Hisar	Palwal	Panipat
Cucurbita moschata	40.72	56.38	28.62	-	56.87	42.38
Cucurbita maxima	38.43	-	-	28.2	32.62	36.42
Luffa cylindrica	30.28	28.82	40.32	-	-	30.24
Lagenaria siceraria	78.32	72.34	68.48	80.32	83.32	60.34
Cucumis melo	58.42	54.33	-	-	63.34	30.43
Cucumis melo var. *utilissimus*	-	32.44	42.34	28.42	38.44	-
Cucumis melo var. *momordica*	-	-	30.42	-	26.42	26.38
Cucumis sativus	-	-	38.42	-	-	32.86
Citrullus vulgaris var. *fistulosus*	28.48	-	44.32	-	-	32.58
Coccinia cordifolia	52.32	74.34	-	56.80	80.37	80.34
Citrullus lanatus	-	-	16.6	-	18.7	-

- =Cucurbits not found infected

Table 2 : Severity of powdery mildew on cucurbits in some localities of Haryana

Localities	Severity										
	Cucurbits										
	Cmo	Cma	Lc	Ls	Cme	Cmeu	Cmem	Cs	Cvf	Cc	Cl
Ambala Kesri	++	+	-	++	++	-	-	-	+	++	-
Mulana	+	++	+	+++	-	-	-	-	-	+++	-
Saha	++	-	++	++	+	-	-	-	+	+++	-
Sonda	+	++	-	+++b	++	-	-	-	-	-	-
Sullar	+	-	-	++	-	-	-	-	+	+++	-
Faridabad Ballabgarh	+	-	++	++	+	+	-	-	-	++	-
Pali	+	-	-	+++	++	-	-	-	-	++	-
Surajkund	-	-	+	++	++	++	-	-	-	+	-
Gurgaon Bhaundsi	+	-	++	++	-	++	+	+	+	-	-
Kukrola	-	-	+	++	-	++	-	+	-	-	+
Manesar	-	-	+	+++	-	-	-	-	+	-	-
Sohna	+	-	++	+++b	-	-	++	++	+	-	-
Sultanpur	++	-	-	++	-	++	+	-	-	-	+
Hisar Bhada	-	+	-	++	-	+	-	-	-	++	-
Bugana	-	+	-	+++	-	-	-	-	-	+++	-
Juglan	-	-	-	+++	-	+	-	-	-	++	-
Kamri	-	+	-	++	-	+	-	-	-	++	-
Ladwa	-	-	-	+	-	+	-	-	-	+++	-
Palwal Asawta	++	+	-	+	++	++	-	-	-	++	+
Kushak	+	-	-	+++	-	-	+	-	-	++	-
Piguar	+	+	-	+	+	++	+	-	-	+++	+
Pirthala	-	+	-	+	++b	++	+	-	-	+	-
Rundhi	++	+	-	++	-	+	+	-	-	++	-
Panipat Asan	+	+	-	-	+	-	-	+	+	+	-
Diwana	+++	+	-	-	+	-	+	-	+	++	-
Israna	++	+	+	+	+	-	+	+	+	++	-
Manana	+	-	+	+	++	-	-	-	-	++	-
Naultha	-	+	-	++	-	-	+	+	+	+	-

-= No infection; + = Mild; ++ = Moderate; +++ = Severe.

b = Teleomorphs present

Cmo = *Cucurbita moschata* , Cma = *Cucurbita maxima ,* Lc = *Luffa cylindrica* , Ls = *Lagenaria siceraria* , Cme = *Cucumis melo* , Cmeu = *Cucumis melo* var. *utilissimus* , Cmem = *Cucumis melo* var. *momordica* , Cs = *Cucumis sativus* , Cc = *Coccinia cordifolia* , Cvf = *Citrullus vulgaris* var. *fistulosus* , Cl = *Citrullus lanatus*

Table 3 : Anamorph characters of powdery mildew on cucurbits in Haryana

Cucurbits	Fibrosin bodies				Germination		
	Number of Samples		Conidia with Fb %	Number of Fb / Conidium	Conidial germination (%)	Forking germ tube (%)	Appressorial development (%)
	All conidia with Fb	A few conidia without Fb					
Cucurbita moschata	14	30	82 ± 8.72	9 ± 1.87	64 ± 18.32	54 ± 8.82	—
Cucurbita maxima	4	7	85 ± 8.74	9 ± 1.78	84 ± 9.72	48 ± 8.92	—
Luffa cylindrica	16	11	83 ± 9.42	8 ± 1.57	79 ± 13.42	36 ± 4.41	—
Lagenaria siceraria	18	44	89 ± 9.93	10 ± 2.98	92 ± 7.48	66 ± 7.78	—
Cucumis melo	12	22	87 ± 8.38	9 ± 1.62	76 ± 15.12	44 ± 7.72	—
Cucumis melo var. *utilissimus*	6	11	84 ± 7.97	9 ± 1.24	70 ± 14.32	38 ± 4.98	—
Cucumis melo var. *momordica*	4	12	80 ± 7.77	9 ± 2.62	78 ± 12.32	37 ± 7.42	—
Cucumis sativus	8	14	77 ± 9.82	7 ± 1.67	70 ± 13.48	32 ± 4.42	—
Citrullus vulgaris var. *fistulosus*	4	10	74 ± 8.46	8 ± 1.62	64 ± 13.42	34 ± 4.52	—
Coccinia cordifolia	—	—	—	—	80 ± 12.77	—	74 ± 6.78
Citrullus lanatus	3	5	72 ± 8.98	7 ± 1.87	66 ± 13.42	42 ± 7.64	—

± = Standard deviation

Table 4 :Conidial dimensions of *Podosphaera xanthii* and *Golovinomyces cichoracearum* on cucurbits in Haryana

Cucurbits	Length			Breadth			L / B index
	—	n	n — 1	—	n	n — 1	
Cucurbita moschata	30.12	1.72	1.83	16.32	1.29	1.34	1.84
Cucurbita maxima	29.14	1.38	1.45	15.82	1.34	1.45	1.84
Luffa cylindrica	28.82	1.62	1.78	15.78	1.42	1.52	1.82
Lagenaria siceraria	32.22	1.78	1.84	17.28	1.38	1.45	1.86
Cucumis melo	26.42	1.68	1.72	14.32	1.45	1.52	1.84
Cucumis melo var. *utilissimus*	25.32	1.79	1.84	13.42	1.34	1.46	1.88
Cucumis melo var. *momordica*	29.82	1.68	1.74	15.34	1.29	1.34	1.94
Cucumis sativus	26.82	1.57	1.66	14.42	1.34	1.62	1.85
Citrullus vulgaris var. *fistulosus*	29.42	1.82	1.96	15.44	1.26	1.36	1.90
Coccinia cordifolia *	35.82	2.79	2.45	16.82	2.48	2.56	2.12
Citrullus lanatus	30.42	1.52	1.64	16.12	1.38	1.45	1.88

n = Standard deviation of population

n — 1 = Standard deviation of samples

* = *Golovinomyces cichoracearum*

morphological details such as conidial or ascospore size and shape and no doubt showing a degree of preference for particular host.

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 Haryana, 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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