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FULL LENGTH ARTICLE **OPEN ACCESS**

Anthracnose disease of Swiss cheese plant [*Monstera deliciosa* Liebm.] caused by *Colletotrichum* sp. from West Bengal

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ABSTRACT
Swiss cheese plant [Monstera deliciosa Liebm.] is an economically important house plant grown in the garden of Agri-Horticultural Society of India at Kolkata, West Bengal. At the study location anthracnose disease appeared regularly on the cheese plant foliage leading to devastating damage. Symptoms appeared on leaf tips as light brown necrotic areas over which dot like acervuli were scattered on lower surface bordered by dark brown smooth margins. Acervuli were black, superficial, erumpent and 253.6 – 712.3 x 222.0 – 460.5 µ in size with black, 1-3 septate, 110.0 – 175.9 x 42.8 – 69.7µ sized setae. Conidia were hyaline, single celled, cylindrical to rod shaped with rounded ends and 21.0 – 34.1 x 4.2 – 7.6 µ in size. On the peptone agar medium (PAM) identified as ideal medium for acervuli production and sporulation, the hyphae produced were hyaline, septate, diameter varied from 10.3 – 22.4 µ. Acervuli were initially hyaline, later on became pale brown to black, 540.8 – 976.1 x 329.1 – 642.1 µ in size. Setae were black, 1 – 2 septate, unbranched, 145. 8 – 245.0 x 47.4 – 69.0µ in size with pointed tips. Conidiophores were hyaline, discrete, smooth, 24.6 – 35.3 µ with rounded tips. Conidia were hyaline, 1-celled, eguttulate, cylindrical to rod shaped with rounded ends measuring 24.6 – 35.8 x 5.0 – 8.0 µ in size. Pathogenicity test of the isolated fungus had been established under laboratory condition following detached leaf technique. Previously, Colletotrichum gloeosporioides, anthracnose pathogen was reported on this plant but due to dissimilarity in size of conidia produced (i.e. larger and broader conidia than of Colletotrichum gloeosporioides), the present anthracnose pathogen has been proposed as Colletotrichum sp. from West Bengal.
Key words: Swiss cheese plant, *Monstera*, *Colletotrichum*, anthracnose, ornamental diseases.

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INTRODUCTION

Monstera is a genus of about 50 species of flowering plants in the arum family, Araceae, native to tropical regions of the Americas. *Monstera deliciosa* is recognizable by its large, glossy green leaves with deep splits and holes resembling the swiss cheese, thus the name Swiss cheese plant. Mexican breadfruit or hurricane plant are other common names. It is an epiphyte with aerial roots, able to grow up to 20m. (66 ft.) High. While they rarely flower indoors, outdoors they produce flowers that develop into edible fruit and it is said to taste like a fruit salad. It is a tropical fruit that flourishes in muggy, humid temperatures. Traditionally, several societies in Mexico and Peru use the roots as rope and basket weaving material. Medicinally, Mexicans have used root infusions to relieve arthritic pain and Martiniques use the roots to soothe snakebites. In China, parts of the *Monstera* plant remedy cough, bruises, infections and fever and Brazilians heat the leaves and mash it to cauterize wounds. It has been reported from different parts of the world including India that *Monstera* is approximately attacked by 8 fungal and few viral diseases (Table-1).Among them anthracnose disease severely infects the foliage and rapidly destroys the whole plant, making the plant less marketable by reducing their aesthetic value.

Table 1: Disease spectrum of *Monstera*

DISEASE	CAUSAL ORGANISM	REFERENCE
Fungal Diseases		
Anthracnose	*C. gloeosporioides [Glomerella cingulata]*	from Japan by Takeuchi *et al.*(2011) from Kerala (Kumari *et al.,* 1994)
Rust	*Puccinia paullula* f.sp. *monsterae*	From Australia by Shaw (1991 &1992)
Phoma leaf spot	*Phoma exigua*	Kubota *et al.* (1995)
Die back and canker	*Botryosphaeria ribis*	Punithalingam and Holliday (1973)

Macrophoma leaf-spot	*Macrophoma turconii* and *M. philodendrii*	from Chandigarh (*c.f* Sohi, 1990)
Hendersonia leaf-spot	*Hendersonia sp.*	from Chandigarh (*c.f* Sohi, 1990)
Pestalotia leaf-spot	*Pestalotia* sp.	(*c.f* Sohi, 1990)
Acrosperia leaf spot	*Acrosperia* sp.	from Allahabad (Tandon and Bilgram, 1961)
Viral disease	Brevipalpus-transmitted plant viruses (BTrV).	from Brazil by Rodrigues *et al.*(2008)

Literature suggests that the genus *Monstera* suffers from anthracnose caused by *Colletotrichum gloeosporioides*. Anthracnose disease was first reported from Hachijo Island of Tokyo Metropolis, Japan by Takeuchi *et al*. (2011).They identified the causal fungus of the disease as *Colletotrichum gloeosporioides* (Penzig) Penzig & Saccardo. They established the pathogenicity of the fungus. Anthracnose disease was also reported from Vellayani region of Kerala, India, in September 1992 and later on the pathogenicity was established by inoculation of healthy plants (Kumari *et al.,* 1994).
The condition of synergism between *Colletotrichum gloeosporioides* and *Puccinia paullula* f.sp. *monsterae* on *Monstera deliciosa* was observed by Shaw (1995). After inoculations he observed that *C. gloeosporioides [Glomerella cingulata]* gained entry into *M. deliciosa* leaves through lesions caused by *P. paullula* f.sp. *monsterae* because infection after inoculation was only obtained through rust sori and no infection resulted on unrusted leaves. No infection was obtained through wounds made by hot needles or a cold scalpel. Isolates of *G. cingulata* from fruit of avocado, mango and pawpaw as well as from *M. deliciosa* were able to colonize the leaves of *M. deliciosa* if the rust was already present. The lesion caused by rust on the host epidermis followed by possible alteration of the host cells appeared necessary for access and development of *G. cingulata*.

MATERIALS AND METHODS

A detailed study on the disease along with its causal agent had been conducted during present investigation. The diseased leaf sample of *Monstera deliciosa* grown inside and outside of the greenhouse of Agri-Horticultural society of India, Kolkata, West Bengal(located at 22˚53'N latitude and 88°33' E longitude) were collected in brown paper packets and detailed *in situ* description of symptoms were done. The severity of the foliage damage caused was assessed using the 0 - 6 scale (Table II). The percent damage caused was recorded by visual observation and scoring the plants in the greenhouse.

Table II: Descriptions of 0 – 6 disease scoring scale with respective reaction categories

Scale	Description	Reaction categories
0	No infection or 0% infection	Immune
1	1-5% leaf area /length covered by disease	Highly resistant
2	6-10% leaf area /length covered by disease	Resistant
3	11-25% leaf area /length covered by disease	Moderately resistant
4	26-50% leaf area /length covered by disease	Moderately susceptible
5	51-75% leaf area /length covered by disease	Susceptible
6	76-100% leaf area /length covered by disease	Highly susceptible

Samples kept in brown paper packets were brought to the laboratory and examined for the presence of asexual fruit bodies, acervuli. Experimental studies like isolation, purification culture, micro-photography, identification, pathogenicity testing of the isolated pathogens *etc.* were conducted following standard protocol under laboratory condition of the University, B.C.K.V. The purification of the isolated pathogen was carried out on PDA (Potato Dextrose Agar) medium but the fungus failed to produce acervuli on the medium. Thus after further studies using different media combinations it was identified that PAM (Peptone agar medium) was the ideal medium for acervuli production and sporulation of the isolated pathogen. Series of slides were prepared from culture or infected parts for morpho-metric studies of fungal spores, spore bearing and other structures. Micro-photograph of all fungal structures were taken with help of Compound microscope or Karl Zeis Phase Contrast Microscope (under 10x, 20x, 40x &100 x) and by using Canon Powers Shot A640 camera. Dimensions (*e.g.* length and breadth) of conidia, acervuli and hyphae of fungi were measured using AxioVision (Rel. 4.8) software. For pathogenicity establishment detached healthy leaves after proper cleaning with sterile distilled water and absolute alcohol, were pin pricked and artificially inoculated with fungal mat while pin pricked uninoculated (only agar bit) leaves were used as control. These were covered with transparent polythene packets for 48 hours and observed regularly till symptom development. The pathogen was re-isolated from the inoculated diseased parts of leaf and compared with the fungal culture isolated initially from diseased leaf.

RESULTS AND DISCUSSION

Anthracnose is a common disease of *Monstera*. The disease occurred almost throughout the year at the study location but severity and sporulation of the pathogen basically started from June and reached peak during September to November and thereafter, declined and continued up to the end of January. Affected leaf samples were collected from the garden during 2nd week of November, 2015. Disease severity was 50% based on 0 – 6 scale.

Symptoms of the anthracnose disease of *Monstera deliciosa*

The infection began as small, elliptical to oval brown spots with grey centres, which generally appeared close to the leaf margin. As disease progressed the leaf tip showed drying symptoms with light brown necrotic areas bordered by dark brown wavy margins. On the necrotic areas, black, erumpent, dot like acervuli appeared to be scattered on the lower surface of the leaf. Sometimes the infection may also spread to leaf sheath which turns pale yellow bearing black acervuli over it.

Pathogenicity establishment of anthracnose pathogen

Pathogenicity of the pathogen was established by inoculating detached leaf under laboratory condition. The inoculated leaf produced same symptoms as observed in field. The pathogen was re-isolated from the inoculated diseased parts of leaf and compared with the fungal culture isolated initially from diseased leaf.

Cultural characteristics of the fungus observed on various media:

On PDA medium the fungus produced cottony white mycelial growth which was slightly convex and dense. Fluffy mycelial growth covered the medium completely without any productions of fruiting bodies. On peptone agar medium, mycelial growth was limited, hyaline to white. Acervuli were produced in linear manner which were initially hyaline but turned to black finally. The acervuli number was numerous with great variation in size.

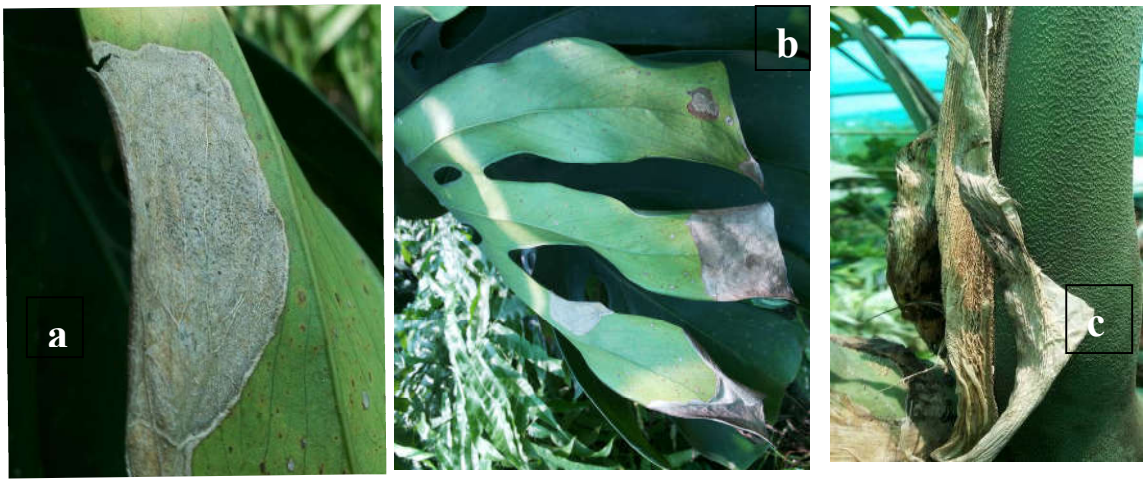

Plate 1a, b Anthracnose symptom on leaf and leaf sheath (Plate 1c) of *Monstera deliciosa*

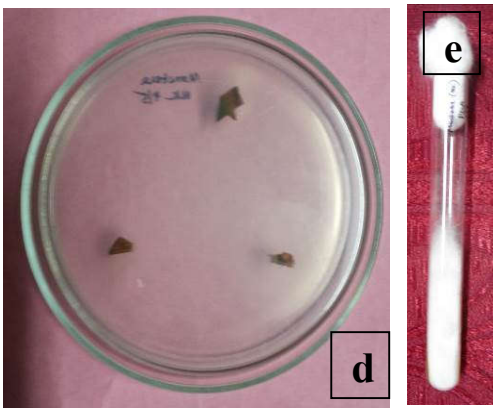

Plate 1d: *Colletotrichum* sp. isolated from infected *Monstera* leaf grown on water agar. Plate 1e: Purified culture of *Colletotrichum* sp. of *Monstera*.

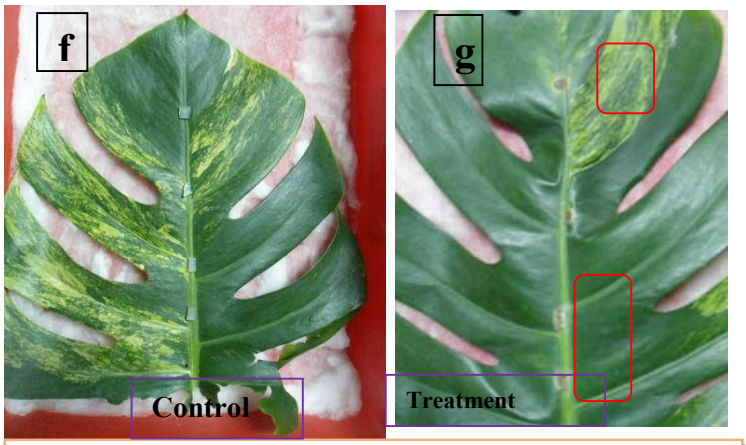

Plate 1f, g: Pathogenicity establishment of *Colletotrichum* sp. of *Monstera* under laboratory condition.

a. PDA medium **b. Peptone agar medium**

Plate 2 a, b: Cultural characteristics of *Colletotrichum* sp. of *Monstera* on different media

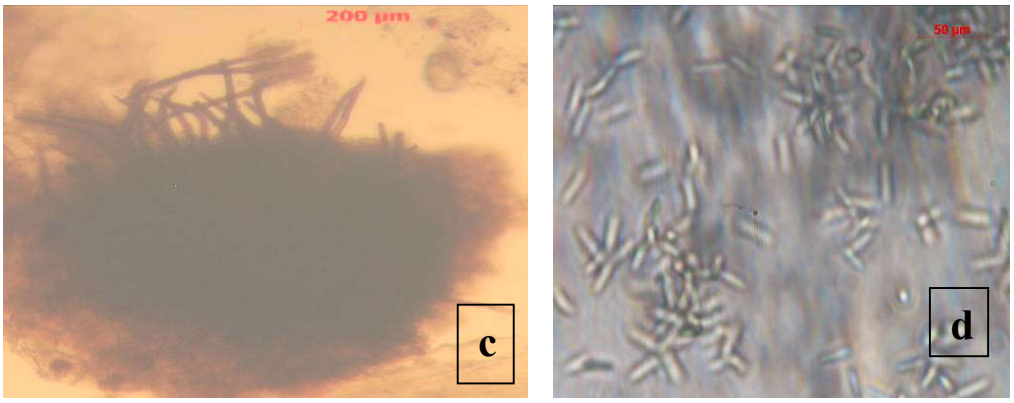

Plate 2 c, d: Microscopic view of avervuli bearing setae and conidia produced on *Monstera*

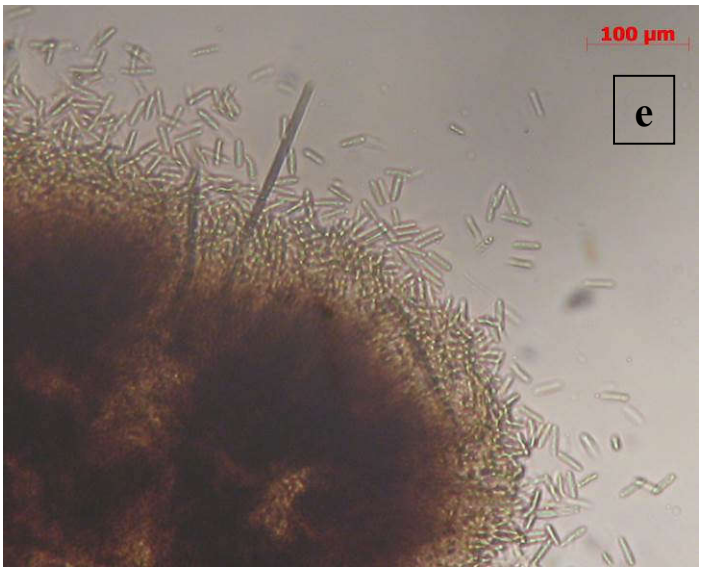

Plate 2e Microscopic view of avervuli bearing setae and conidia produced on peptone agar medium

Morpho-metrical descriptions of various structures of the pathogen obtained from *Monstera deliciosa* and on PAM:

On the host, black, dot like, numerous, superficial, erumpent acervuli were produced which were 253.6 – 712.3 (av. 464.5) x 222.0 – 460.5 (av. 380.7) µ and scattered on leaf tips. Setae were few to numerous, black, 1-3 septate, unbranched, 110.0 – 175.9(av. 138.3) x 42.8 – 69.7 (av. 55.5) µ with pointed tips. Conidia were hyaline, single celled, numerous, cylindrical to rod shaped with rounded ends and 21.0 – 34.1 (av. 28.3) x 4.2 – 7.6 (av. 6.0) µ in size.

On the medium, the hyphae produced were hyaline, thin, septate, its diameter varied from 10.3 – 22.4 (av. 15.9) µ. Acervuli were initially hyaline, later on became pale brown to black, 540.8 – 976.1 (av. 758.4) x 329.1 – 642.1 (av. 498.3) µ in size. Size of acervuli varied greatly in the peptone agar medium. Setae were few to numerous, black to dark brown, 1 – 2 septate, unbranched, 145.8 – 245.0(av. 174.1) x 47.4 – 69.0(av. 58.4) µ in size with pointed tips. Conidiophores were hyaline, discrete, smooth, 24.6 – 35.3 (av. 30.3) µ with rounded tips. Conidia were hyaline, 1-celled, smooth walled, eguttulate, cylindrical to rod shaped with rounded ends measuring 24.6 – 35.8 (av. 30.4) x 5.0 – 8.0 (av. 6.7) µ in size.

Discussion:

Anthracnose disease was first reported from Hachijo Island of Tokyo Metropolis, Japan by Takeuchi *et al*. (2011).They identified the causal fungus of the disease as *Colletotrichum gloeosporioides* (Penzig) Penzig & Saccardo. But description given by them was not accessible. However, the description of *Colletotrichum gloeosporioides* given by Saccardo (1884) is being mentioned here. He described that conidiomata were acervulus, amphigenous, mostly epiphyllous, sub-epidermal. Setae were often present on acervuli but sometimes arising alone from stomata, forming dense fascicles and bearing enteroblastic conidia apically. Conidiogenous cells were discrete, enteroblastic, phialidic, hyaline and smooth. Conidia were slimy, formed singly, cylindrical, (10 -)15 - 20(- 25) x (3 -)4 - 6 µ in size, apex obtuse, base sub-acute, aseptate, guttulate, hyaline, smooth, forming septum before germination. Appressoria with entire or sometimes slightly irregularly lobate margin were ovate, globose or ampulliform, brown to medium brown, 8 - 12 x 6 - 9 µ in size. But the conidia produced by anthracnose pathogen on *Monstera deliciosa* plant were hyaline, single celled, numerous, cylindrical to rod shaped with rounded ends and 21.0 – 34.1 (av. 28.3) x 4.2 – 7.6 (av. 5.9) µ in size and on peptone agar medium it was hyaline, 1-celled, smooth walled, eguttulate, cylindrical to rod shaped with rounded ends measuring 24.6 – 35.8 (av. 30.4) x 5.1 – 8.0 (av. 6.7) µ in size. Size of conidia produced was far larger and broader than the conidia of *Colletotrichum gloeosporioides*. It did not match with the sizes of conidia of *Collectotrichum* spp. described by Sutton (1980). So, the present anthracnose pathogen is proposed as *Colletotrichum* sp. from West Bengal.

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