



Morpho-molecular characterization of *Choanephora cucurbitarum*, causing twig blight of chilli in Karnataka

AMPLOU, M^{1*}, SAVITHA, A. S¹, AJITHKUMAR, K², RENUKA, M², YENJERAPPA, S. T³ and RAMESH, G⁴

¹Dept. Of Plant Pathology, College of Agriculture, Raichur,

²Main Agricultural Research Station, Raichur,

³College of Agriculture, Gangavathi,

⁴College of Agricultural Engineering, Raichur

*E-mail: savitha.path@gmail.com

ABSTRACT: Twig blight of chilli is a complex disease associated with multiple pathogens and has emerged as a major constraint to chilli cultivation, causing recurrent outbreaks, substantial yield losses and posing a serious threat to crop productivity. In the present investigation, a random roving survey was undertaken in major chilli-growing regions of Karnataka to assess the incidence and severity of the twig blight disease. Symptomatic plant samples were collected and subjected to isolation on potato dextrose agar. The obtained cultures were characterized based on their cultural and morphological traits. Colonies were white, submerged and exhibited rapid growth, with secondary mycelium developing within two days and the reverse side of the plate showing a pale-yellow pigmentation. Sporangiospores were brown, ellipsoidal and devoid of striations or papillae. For molecular confirmation, genomic DNA was amplified using universal primers (ITS-1 and ITS-4), yielding a ~600 bp fragment of the Internal Transcribed Spacer (ITS) region of rDNA. Sequencing and BLAST analysis against the NCBI database sequences confirmed the identity of the pathogen as *Choanephora cucurbitarum*.

Keywords: Chilli, *Choanephora cucurbitarum*, Molecular characterisation, Twig blight

INTRODUCTION

Chilli (*Capsicum annum* L.), belonging to the *Solanaceae* family, is one of the most important spice crop cultivated worldwide. It is valued for its pungency, flavour, colour and wide-ranging medicinal properties (Wahyuni *et al.*, 2013). Chilli is consumed in fresh, dried and processed forms and constitutes a vital export commodity, particularly for India.

India is the leading producer and exporter of dried chillies, contributing 35-40 per cent of global production and nearly 25 per cent of exports (Anon., 2023). In India, chilli is cultivated on 8-9 lakh hectares with a production of 1.70-2.00 million tonnes of dry chilli and 2.20-2.50 million tonnes of green chilli. In 2024-25, Karnataka reported 2.19 lakh hectares under chilli cultivation producing 3.36 lakh tonnes at an average productivity of 1.53 t ha⁻¹ (Anon., 2025). Karnataka is one of the leading chilli-producing states, with major cultivation zones in Dharwad, Haveri, Gadag, Ballari, Bagalkot, Raichur, Koppal and Chitradurga.

Chilli production and productivity are progressively declining due to a combination of insect pests, diseases

and abiotic stresses include nutrient deficiencies and drought.etc. Among the key constraints in chilli cultivation, twig blight disease caused by *Choanephora cucurbitarum* is recent concern. It is characterized by necrosis, leaf spotting, drooping of foliage and progressive twig and branch die-back, which ultimately cause plant mortality (Strouts and Winter, 2000).

Choanephora, a fungal genus in *Choanephoraceae* belongs to *Mucorales* of *Zygomycota* wherein currently, only *C. infundibulifera* and *C. cucurbitarum* were recognized, distinguished by sporangium shape and striations (Park *et al.*, 2016). They were known to cause leaf blights, leaf rots, and fruit rots on a wide range of host plants (Farr and Rossman, 2014). The twig blight disease was initially documented by Dastur (1920) in India and it became prevalent in certain monocropping areas. Siddhartha *et al* (2015) explained that twig blight/wet rot of chilli was rarely observed in the gangetic alluvial region of West Bengal up to 1995; however, since 2000, the incidence and severity of this disease has increased. They reported 12 to 30 per cent disease severity during 2006-07 to 2014-15. *Choanephora*

attacks on chillies may be exacerbated by a 20.50 per cent increase in rainfall between September and October. Today, *Choanephora* twig blight is one of the most significant biotic stresses on chillies in West Bengal. Chandrakala and Vidyasagar (2018) recorded 15 to 32 per cent *Choanephora* twig blight disease incidence in Telangana. Sangeetha *et al* (2022) observed 23 per cent twig blight incidence during 2018 in experimental plots of chilli in ICAR-IIHR-Central Horticultural Experimental Station, Odisha, India.

The disease typically began with the formation of small, localized necrotic lesions on twigs and stem and these lesions progressively enlarged and coalesced, resulting in extensive vascular necrosis. As infection advances, tissue death occurs in a top to base manner along the plant axis with typical symptom of die- back. Systemic colonization interferes with water and nutrient translocation, thereby accelerating plant decline. Interestingly, the disease remains confined to twigs and stem, with no visible symptoms observed on leaves or fruits, this may be due to high temperature. Therefore, the present study was carried out to investigate the twig blight disease associated with chilli from major chilli growing areas of Karnataka. With a detailed morpho-cultural investigations, molecular phylogenetic analysis and pathogenicity assay.

MATERIALS AND METHODS

Field survey and assessment of twig blight disease incidence and severity

An intensive roving survey was undertaken to assess the incidence and severity of twig blight of chilli in Raichur, Ballari, Gadag, Yadgir, Dharwad, Koppal and Haveri districts of Karnataka during 2024-25. In each district, two taluks and in each taluk one representative village were randomly selected. In each village one or two field were randomly surveyed. The disease severity on plant parts was recorded using a five point rating scale (0 = No infection, 1 = 0.1–5 % infection, 2 = 6–10 % infection, 3 = 11–25 % infection, 4 = 26–50 % infection and 5 = > 50 % infection) (Sharma *et al.*, 2004). Twig blight incidence was recorded by counting the number of infected plants versus total number of plants observed and expressed in per cent (Wheeler, 1969). The disease severity was calculated as per the following formula

Per cent disease index (PDI)= $\frac{\text{Sum of individual rating} \times 100}{\text{No. of plants observed} \times \text{Maximum disease grade}}$

Isolation and identification of the pathogen

The chilli plants showing typical characteristics of twig blight symptoms were collected and the pathogen was isolated by standard tissue isolation method, where the infected tissue along with some healthy tissues were cut into small bits of 0.5 to 1 cm size with the help of sterile blade. These bits were surface sterilized with one per cent sodium hypochlorite solution for 30 sec, further they were rinsed in three changes of sterile distilled water to eliminate excess sodium hypochlorite. Then they were placed on blotter or tissue paper to absorb excess water and finally kept on the PDA media containing 0.02 g l⁻¹ streptomycin in the Petri dishes. Plates were incubated for seven days at 25 ± 2°C in BOD (Espinoza *et al.*, 2009). The hyphal tip technique was used to obtain the pure culture of the isolates. The pure culture of the pathogen was maintained in PDA slants and stored at 4°C. Cultural characters (colony colour, texture, pigmentation, growth pattern, colony margin, growth rate) of the isolated fungal pathogen were recorded after 8-10 days of incubation. Further, morphological characters of the fungus such as hypha and conidia (color, shape and size) were recorded under high power objective at 40X microscopic field (Olympus, U-CMAD3 microscope).

Molecular identification of the pathogen

For molecular identification of associated pathogen, only one isolate named as CDAC-1isolate collected from Ashapura village of Raichur district was selected. The genomic DNA was isolated from 5-7 days old pure cultures using CTAB method (Moller *et al.*, 1992). The quality of genomic DNA was checked by measuring the absorbance at 260 nm using Thermo Scientific Nano Drop 1000 spectrophotometer (Thermo Scientific). The PCR reaction was carried out with a thermal cycler for amplification of internal transcribed spacer (ITS) using the primer pairs ITS1/ITS4. The 25 µl reaction mixture contained 1.0 µl of template DNA (~50ng), 12.5 µl of Taq DNA polymerase Master mix (GeNei, Bangalore), 1 µl of forward and reverse primers (10 pM each; Eurofins, Bengaluru, India) and the remaining 9 µl of nuclease-free water. The PCR conditions employed for the amplification of ITS-rDNA region which include initial denaturation at 94°C (4 min), followed by 35 cycles of denaturation (94°C for 30 sec), annealing at 48°C (1 min) and extension at 72°C (1 min) and final extension at 72°C (7 min). The amplified PCR products were visualized on 1.5 per cent agarose gel electrophoresis. Gel-purified DNA was subjected for

sequencing from both the directions in DNA sequence analyzer (ABI3730I DNA analyzer Applied Biosystems, Foster City, California). The obtained DNA sequences were compared to the nucleotide sequences in the NCBI-nBLAST database, and the closest hits was considered and included in phylogenetic tree constructions with reference sequences. The sequence was deposited in NCBI GenBank, to obtain a accession number.

Phylogenetic analysis

The consensus sequences of *C. cucurbitarum* and their closely related species were obtained from NCBI database and assembled. Initial blast results obtained from nBLAST tool were also included in the final dataset for phylogenetic tree analysis. Sequence of ITS gene was aligned using MEGA X software to perform phylogenetic analysis (Kumar *et al.*, 2018) and phylogenetic tree was constructed by using Maximum-Likelihood method. The tree was constructed with 1000 bootstrap replications and shown next to the branches. The details of reference sequences and sequences from the present investigation are depicted in the phylogenetic tree along the respective isolate/taxon details.

Pathogenicity test

Pathogenicity tests were conducted on 45 days old healthy chilli plants by using the twig inoculation method, where the tender terminal portions of the plants were carefully cut, and a T-shaped incision was made on each cut tip to facilitate pathogen entry. Mycelial discs taken from a seven-day-old actively growing fungal culture were gently inserted into these incisions. The inoculated regions were then wrapped with parafilm to secure the mycelial bits in place and to prevent contamination. To ensure a conducive micro environment for pathogen establishment, the treated whole plants were additionally covered with a polythene bag to maintain high humidity (Bhat *et al.*, 2017). For the control treatment, the same procedure was followed; however, instead of mycelial bits, sterile distilled water was applied in the T-shaped cuts. Both inoculated and control plants were maintained under glasshouse conditions, ensuring uniform temperature and humidity during the incubation period. The entire experiment was replicated three times to ensure reliability and reproducibility of the results. Plants were regularly observed for symptom development, and the pathogen was subsequently re-isolated from infected tissues to fulfil Koch's postulates.

RESULT AND DISCUSSION

Survey and collection of diseased samples

An intensive roving survey was conducted in Raichur, Ballari, Gadag, Yadgir, Dharwad, Koppal and Haveri districts of Karnataka during 2024-25. The characteristic symptom of twig blight was mainly observed as initially necrosis of twigs, later these necrotic lesions develop and progress from the tip towards down, leading to drying of twigs and finally the death of the plant (Fig.1A and B). Sangeetha *et al* (2022) found that in case of chilli, upon infection by *C. cucurbitarum*, twig blight and wet rot symptom were initially observed. On diseased leaves, a mild greyish hue resembling hot water damage first developed, and then the leaves wrinkled and dried up before spreading to twigs. Brownish spots of rot on twigs and stems, followed by die-back, are the characteristic symptoms of twig blight on infected plants. As dried twigs with copious sporulation, the infected twigs stay affixed to the plant. A closer look at the infected tissues showed opulent fungal growth with hairy, black, pin-head-like growth made up of mucoraceous fungus fruiting structures. Wet soft rot was detected on young fruits. The affected tissues exhibited collapse of epidermal and cortical layers, followed by rapid colonization of the surface with silvery conidiophores, while external vegetative mycelium was generally indistinct. Progressively, the necrotic infection advanced downwards lead to death of the invaded branches. The severity and incidence of twig blight varied from 48.45-72.85 per cent and 34.00-56.00 per cent, respectively. From two villages namely, Ashapura (Raichur district) and Aldhal (Yadgir district) twig blight incited by *C. cucurbitarum*, caused 60 and 80 per cent disease severity, respectively. The disease was favoured by prolonged leaf wetness, high relative humidity, drizzling rains, moist soil condition and wide range of temperatures (15-30 °C). As such conditions enhanced spore germination, infection efficiency and disease spread.

Choanephora blight severity was relatively low in winter (0.64-3.68 %) but increased substantially during the rainy season reaching 16.05-21.49 per cent, highlighting the strong influence of seasonal weather dynamics (Reang *et al.*, 2018). Sangeetha *et al.* (2022) reported a disease incidence of about 23.00 per cent in chilli during *Kharif* 2018, with no twig blight symptoms detected in *rabi* or summer crops, further confirming the role of climatic factors in disease manifestation. Environmental conditions such as high moisture,



Fig. 1. A and B- Symptoms of chilli twig blight in surveyed fields; C and D- Converse and inverse view of *C. cucurbitarum* on potato dextrose agar; E- Sporangiospores of *C. cucurbitarum*

prolonged leaf wetness and elevated relative humidity during monsoon periods appear to provide highly conducive conditions for rapid pathogen multiplication. Temperature regimes have also been found critical, as *C. cucurbitarum* was shown to infect both white and red quinoa panicle necks most effectively between 20-30 °C (Yin *et al.*, 2023).

Morphological and cultural identification:

The isolated pathogen from infected twigs was characterized by the following cultural and morphological characteristics. Two different isolates CDAC-1 and CDAC-2 have been obtained from chilli growing districts of Karnataka showed a unique growth characters like flat, white coloured mycelial growth diameter of 90 mm within two days and production of cottony white secondary mycelia on front view and slight yellow colour pigmentation was observed on reverse view from three days after inoculation (Fig.1 C and D). The mycelium was hyaline, branched coenocytic with a width of 2.56-2.78 μm , which produced sporangiospores in clusters at the end of branched sporangiophore. The sporangiospores were single-celled, dark brown, oval-shaped measured 17.89-18.25 \times 9.66-11.50 μm , with a smooth surface and without any papillae. Notably, zygospores were absent in CDAC-1 and CDAC-2 isolates. Rashmi *et al.* (2018) described *C. cucurbitarum*

as multi-spored, spherical sporangia (40-160 μm) that were white to yellow when young, turning pale to dark brown at maturity, with ellipsoid to broadly ellipsoid sporangiospores (16.00-20.00 \times 8.00-12.00 μm) bearing hyaline appendages. Sangeetha *et al.* (2022) also found that sporangiophores of *C. cucurbitarum* were upright with simple heads, bearing aseptate, hyaline sporangiola. Sporangiola were light to dark brown, ovoid, 11-21 μm wide and 16-32 μm high, with visible longitudinal striations. Sporangia were few to multi-spored, globular to sub-globular, measuring 68-113 μm . Sporangiospores were ellipsoid, light to dark brown, 11-25 \times 7-13 μm , with or without hyaline polar appendages.

Molecular identification

Representative one isolate *i.e.*, CDAC-1 was subjected to molecular identification at ITS-rDNA region, which were successfully amplified approximately at 600 bp and sequenced in both directions (Fig. 3). Further the sequenced data was analysed using BLASTn search from the NCBI database. These sequences showed 99.39 per cent similarity with OP811323, OQ417790, MH041502, MH041503 and MN897836 of GenBank. The sequence was deposited in NCBI GenBank with an accession number of PX331591. Kurian *et al.* (2018) carried out the molecular characterisation for species level identification and confirmation of the identity of the

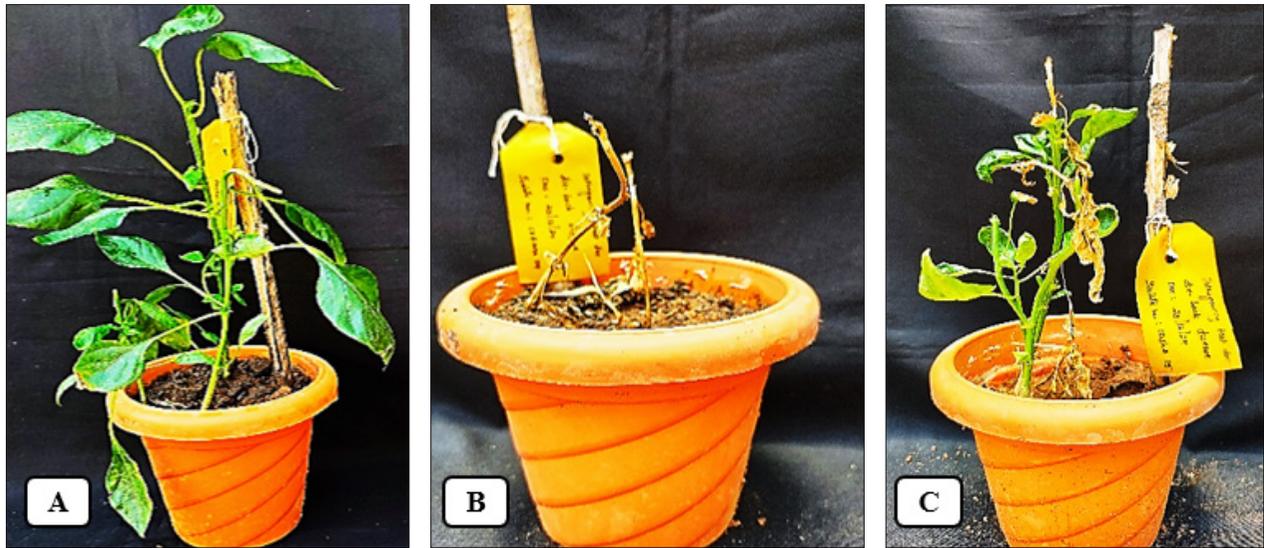


Fig. 2. Pathogenicity assay of *C. cucurbitarum* causes chilli twig blight
A. Control plant; B and C. Inoculated with CDAC-1 and CDAC-2 isolates

pathogen and it was confirmed that, the fungus causing inflorescence rot and die back of dolichos bean and the pod rot of yard long bean is *C. infundibulifera* as there was cent percent similarity between the query sequence and the sequence of *C. infundibulifera* available in the website with accession number KX980520.1. Khan *et al.* (2020) used molecular technique for identification of pathogen by using ITS primers. The PCR product of the internal transcribed spacer (ITS) region of the fungi showed nearly 650 bp size of clear band followed by sequencing of the PCR product of the fungus revealed 99.00 per cent similarity with the original sequence of *C. cucurbitarum*.

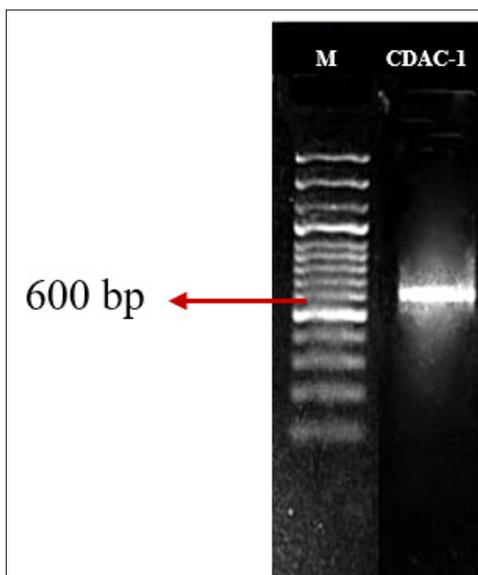


Fig. 3. Amplification of the ITS region of *C. cucurbitarum* causing chilli twig blight

Phylogenetic analysis

The dendrogram was constructed for CBS (cystathionine- β -synthase) strain of *C. cucurbitarum* and the isolate CDAC-1 (PX331591) revealed two primary clusters for *C. cucurbitarum* strains with *Aspergillus niger* as an outgroup fungus. Cluster I contains *C. cucurbitarum* CBS strains of JN206514.1, MT523842.1 and MT548497.1, which further divide into subcluster Ia (JN206514.1) and subcluster Ib (MT523842.1, MT548497.1), supported by a bootstrap value of 100. Cluster II branches into MH856564.1 (*Aspergillus niger*), *C. cucurbitarum* CDAC-1 (PX331591) isolate and CBS strains such as MH856791.1 and MT505959.1. Within cluster II, subcluster IIa comprises MH856564.1 and the CDAC-1 isolate, while subcluster IIb groups MH856791.1 and MT505959.1 with a high bootstrap value of 99, highlighting their close genetic relationship. Based on these cultural, morphological and molecular characterisations, the pathogen was identified as *C. cucurbitarum* (Fig. 4). Sangeetha *et al.* (2022) carried out phylogenetic relationship using ITS rDNA sequences revealed that the isolate *C. cucurbitarum* CHO grouped with *C. cucurbitarum*, representing a distinct separate clade as evident in the NJ tree (neighbor-joining). Garcia *et al.* (2023) conducted the evolutionary analyses by using the concatenated sequences of the ITS and LSU of *C. cucurbitarum* and other mucoralean species with the maximum likelihood method and Tamura–Nei model included in the software MEGA11. Deng *et al.* (2025) constructed the phylogenetic tree by retrieving the ITS and LSU sequences of *Choanephora* spp. from GenBank

wherein the phylogenetic analysis revealed that the five isolates clustered together with other *C. cucurbitarum* isolates within the same clade in both phylogenetic trees.

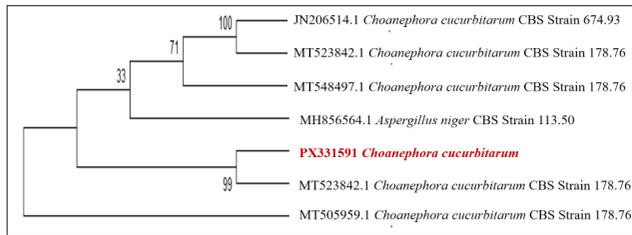


Fig. 4. Phylogenetic relationship of *C. cucurbitarum* causes twig blight of chilli with CBS reference strains based on ITS sequences

Pathogenicity test

Forty-five-days-old chilli plants inoculated with mycelial bits of the CDAC-1 and CDAC-2 isolates of *C. cucurbitarum* demonstrated characteristic symptoms of the disease. In contrast, the uninoculated plants were symptomless. The pathogen was reisolated from the affected plants, fulfilling Koch's postulates. This clearly establishes that the fungi *C. cucurbitarum* is responsible for causing twig blight in chilli plants (Fig. 2). Sangeetha *et al.* (2022) conducted the pathogenicity test of *C. cucurbitarum* in chilli by following detached leaf assay as well as on whole potted plants. The onset of lesions with pin head like sporangial growth was observed within 24-48 h of inoculation and no symptoms were observed on control leaves as recorded in case of detached leaf assay. Whereas in whole potted inoculated chilli plants, water-soaked lesions were developed within 48 h after inoculation and then rotting of flowers, growing points and fruits were observed within 4-5 days. The control plants remained unaffected.

CONCLUSION

Twig blight of chilli represents a significant threat to chilli cultivation, often leading to severe yield losses. This study aimed to identify the complex etiology of this disease. Based on cultural, morphological and molecular characterization, pathogenicity assays the pathogen was identified as *C. cucurbitarum*. Therefore, our findings conclusively demonstrate that *C. cucurbitarum* is a causal agent of the twig blight of chilli in Karnataka. Further the future line of work should focus on comprehensive survey should be conducted across major chilli growing regions of India to establish a clear picture of disease prevalence and severity at the national level. Even advanced multi gene analysis should be employed

for elucidating genetic diversity, population dynamics and virulence determinants. A major focus should be on screening chilli germplasm and hybrids under multi-location trails to develop the resistant varieties or hybrids. Lastly we can target to employ well modulated integrated disease management strategy for ecofriendly management of the disease.

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REFERENCES

- Anonymous, 2023. Agricultural and Processed Food Products Export Development Authority. <http://apeda.gov.in>.
- Anonymous, 2023. Food and Agriculture Organization of the United Nations. <https://www.fao.org/faostat>.
- Anonymous, 2025. Area, production and yield of chilli in Karnataka. <http://www.indiastat.com/>
- Bhat, H. A., Khan, N. A., Wani, S. H., Ahanger, R. A., Ahmad, K., Bhat, A. H., Dar, N. A., Mir, J. I. and Iqbal, M. 2017. Characterisation of pathogens associated with die-back and twig blight of almond (*Prunus amygdalus Batsch*). *International Journal of Fauna and Biological Studies*, **4**(3): 57-62.
- Chandrakala, J. and Vidyasagar, B. 2018. Twig blight of chilli caused by *Choanephora cucurbitarum* in Telangana, *International Journal of Pure and Applied Bioscience*, **6**(4): 521-526. doi: <http://dx.doi.org/10.18782/2320-7051.6902>
- Dastur, J. F. 1920. *Choanephora cucurbitarum*, (B. and Rav.) Thaxter, on chillies (*Capsicum* spp.). *Annals of Botany*, **34**(135): 399-403. <https://www.jstor.org/stable/43236331>
- Deng, D., Sun, S., Liu, Z., Wu, W., Duan, C. and Zhu, Z. 2025. First report of *Choanephora cucurbitarum* causing wet rot on fresh pea (*Pisum sativum*) in China. *Plant Disease*, pp.PDIS-01. <https://doi.org/10.1094/PDIS-01-25-0069-PDN>
- Espinoza, J. G., Briceno, E. X., Chavez, E. R., Urbez-T. J. R. and Latorre, B. A. 2009. *Neofusicoccum*

- spp. associated. *Plant Disease*, **93**(11): 1187-119. <https://doi.org/10.1094/PDIS-93-11-1187>
- Farr, D. F. and Rossman, A. Y. 2015. Fungal Databases. Systematic Mycology and Microbiology Laboratory, ARS, USDA.
- Garcia-Estrada, R.S., Rivera-Salas, M.M., Marquez-Zequera, I., Osuna-Garcia, L.A., Felix-Arellano, V., Castro-Alvarado, L. and Cruz-Lachica, I. 2023. First report of Cucurbita blossom blight and fruit rot caused by *Choanephora cucurbitarum* in Mexico. *Plant Disease*, **107**(9): 2872. <https://doi.org/10.1094/PDIS-04-23-0748-PDN>
- Khan, C. M. E., Saha, C. A., Alam, K., Jannatul, F. K., Asadul, I. M., Biswanath, S. and Faruk, H. M. 2020. Molecular characterization of the pathogen responsible for *Choanephora* fruit rot disease in *Momordica charantia* (L.) and establishment of its ecofriendly control measures. *GSC Biological Pharmaceutical Science*, **11**(03): 022-033. <https://doi.org/10.30574/gscbps.2020.11.3.0161>
- Kumar, S., Stecher, G., Li, M., Knyaz, C. and Tamura, K. 2018. MEGA X: Molecular evolutionary genetics analysis across computing platforms. *Molecular Biology and Evolution*, **35**: 1547-1549.
- Kurian, P. S., Anitha, P., Liji, K. O. and Davis, F. 2018. First report on incidence of inflorescence blight and pod rot (*Choanephora infundibulifera*) on dolichos bean (*Dolichos lablab*, L.) and yard long bean (*Vigna unguiculata* sub sp. *sesquipedalis*) India. *Journal of Horticultural Science*, **13**(2): 146-151.
- Moller, E. M., Bahnweg, G., Sandermann, H. and Geiger, H. H. 1992. A simple and efficient protocol for isolation of high molecular weight DNA from filamentous fungi, fruit bodies and infected plant tissues. *Nucleic Acids Research*, **20**: 6115-6116. doi: 10.1093/nar/20.22.6115
- Park, J. H., Cho, S. E., Suyama, M., Degawa, Y. and Shin, H. D. 2016. Identification and characterization of *Choanephora* spp. causing *Choanephora* flower rot on *Hibiscus syriacus*. *European Journal of Plant Pathology*, **146**(4): 949-961. <https://doi.org/10.1007/s10658-016-0972-0>
- Rashmi, C., Girija, V., Beegum, C. N., Milsha, J., Anees, M. M. and Varma, C. Y. 2018. Incidence of *Choanephora* rot on cabbage and cauliflower from Kerala. *Journal of Mycopathological Research*, **55**(4): 379-381.
- Reang, D., Khalko, S. and Roy, A. 2018. To find out the seasonal incidence of diseases in chilli at different locations of Terai zone of West Bengal. *Journal of Pharmacognosy and Phytochemistry*, **7**(5): 2799-2802.
- Sangeetha, G., Barik, U., Sahu, S. and Ponnam, N. 2022. Report on *Choanephora cucurbitarum* inciting twig blight of chilli under coastal Odisha condition in India. *Indian Phytopathology*, **75**(1): 245-249. <https://doi.org/10.1007/s42360-021-00432-1>
- Sharma, P., Kulshrestha, G., Gopal, M. and Kadu, L. N. 2004. Integrated management of chilli die-back and anthracnose in Delhi region. *Indian Phytopathology*, **57**(4): 427-434. <https://www.cabidigitallibrary.org/doi/full/10.5555/20053130101>
- Siddhartha, D., Subrata, D. and Bholanath, M. 2015. Emergence of *Choanephora cucurbitarum*, the causal agent of twig blight disease of chilli, as a major pathogen under change in climatic condition in West Bengal. *Plant Disease Research*, **30**(2): 234.
- Strouts, R. G. and Winter, T. G. 2000. Diagnosing Ill-Health in Trees. TSO publications, London. p. 322.
- Wahyuni, Y., Ballester, A. R., Sudarmonowati, E., Bino, R. J. and Bovy, A. G. 2013. Secondary metabolites of *Capsicum* species and their importance in the human diet. *Journal of Natural Products*, **76**(4): 783-793. <https://doi.org/10.1021/np300898z>
- Wheeler, R. J. 1969. An introduction to plant diseases. John Wiley and Sons Limited, London. p. 301. <https://www.cabidigitallibrary.org/doi/full/10.5555/19700305235>
- Yin, H., Tian, M., Peng, Y., Qin, N., Lü, H., Ren, L. and Zhao, X. 2023. First report on *Choanephora cucurbitarum* causing *Choanephora* rot in *Chenopodium* plants and its sensitivity to fungicide. *Journal of Fungi*, **9**(9): 881.

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