



SURVEY, PATHOGENIC VARIABILITY AND MORPHO-CULTURAL CHARACTERIZATION OF *Colletotrichum truncatum* CAUSING ANTHRACNOSE AND POD BLIGHT OF SOYBEAN IN CHHATTISGARH (INDIA)

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ABSTRACT

Colletotrichum truncatum (Schwein.), a devastating fungus causing anthracnose and pod blight of soybean, is a major threat to soybean production as it causes heavy yield loss. A roving survey across the 16 villages of six districts of Chhattisgarh, India during Kharif 2024 and 2025, covering 32 villages revealed mean percent disease index (PDI) ranged from 17.8 to 31.0%, while percent pod infection (PPI) ranged from 14.85 to 25.75%. A strong positive correlation ($r = 0.99$, $p < 0.01$) was observed between PDI and PPI across the surveyed locations. Sixteen isolates were obtained, all of which confirmed to be pathogenic with symptom appearance occurring between 10-15 days after inoculation (DAI). PDI ranged from 36.2 to 46.3%, with isolate CGCt-1 (Pathri Kalan) exhibiting the highest virulence. Eleven isolates were classified as highly virulent (PDI > 40%) and five as virulent. Cultural characterization revealed substantial phenotypic variability within isolates, with colony diameter ranging from 60.6 mm to 90.0 mm on PDA. Morphological studies revealed considerable variation in conidial dimensions ($21.9\text{-}24.8 \times 3.6\text{-}4.2 \mu\text{m}$), appressorial size ($11.0\text{-}12.8 \times 7.4\text{-}8.4 \mu\text{m}$), acervuli ($121.4\text{-}225.8 \times 180.8\text{-}295.4 \mu\text{m}$) and setae ($79.6\text{-}212.6 \times 5.0\text{-}8.4 \mu\text{m}$). The study provides baseline information on disease distribution and pathogenic variability that may be helpful in devising appropriate disease management in Chhattisgarh (India).

Keywords: Anthracnose, blight, *Colletotrichum truncatum*, disease survey, culture-morphological characterization, soybean

INTRODUCTION

Soybean (*Glycine max* L. Merrill) is one of the world's most important legume crops, providing essential proteins, oils, and carbohydrates for both human consumption and livestock feed. With global production annually exceeding 370 million metric tonnes and cultivation spanning over 120 million ha across the diverse agro-climatic zones, soybean represents a vital component of global food security and agricultural economics (FAO, 2022). Soybean's unique composition, with approximately 40% protein and 20% oil, makes it a highly versatile crop with significant value addition potential. India ranks 3rd in soybean production, after USA, and Brazil. In India, soybean is cultivated on 12.90 million ha of land with an annual production of 15.1 million metric tonnes (Ministry of Agriculture

& Farmers Welfare, 2024). Within India's agricultural landscape, Chhattisgarh state, during the year 2024-2025, had an area of 1.27 lakh ha under soybean cultivation, producing 1.18 lakh tonnes with an average productivity of 930 kg ha⁻¹.

Soybean anthracnose or pod blight is an important disease predominantly associated with *Colletotrichum truncatum*. *C. truncatum* is recognized as the principal species associated with the disease, although several other *Colletotrichum* species have also been reported on soybean (Bouffleur *et al.*, 2021). The disease occurs at different growth stages and produces characteristic symptoms, including pre- and post-emergence damping-off, dark and depressed lesions on stems, petioles and pods, and necrotic lesions on leaves. Accurate identification of *Colletotrichum* species is important because morphological characteristics alone may not always provide reliable species-level identification.

Soybean anthracnose affects all the stages of crop growth. The disease appears on leaves, fruits, pods and even on stem as black sunken lesions or reddish-brown patches. Plant may develop coloured lesions and also on the veins of lower leaves which subsequently turn black. When the pathogen infects plants at the early stages, seed formation may not occur. Early seedlings infection may lead to pre- and post-emergence damping-off and seedling blight. Pod infection is the most economically significant aspect of the disease, manifesting as sunken, dark lesions with a characteristic cracked appearance that disrupt pod integrity and seed quality (Aggarwal *et al.*, 2018).

Field surveys conducted in soybean-producing regions of India have documented disease incidence in the range of 5-35%, with significantly higher severity (10-50%) observed during seasons characterized by high humidity and moderate temperatures (Singh *et al.*, 2019; Kumar *et al.*, 2021). Confirming the etiological role of potential pathogens in disease development requires pathogenicity assessment using the established techniques based on Koch's postulates, along with cultural and morphological characterization of fungal isolates. This includes examination of growth characteristics on suitable media *viz.*, colony morphology, growth rate, pigmentation patterns, and microscopic observations of morphological features such as conidial dimensions, conidial shape, appressoria, and setae.

In India, considerable variation among *C. truncatum* isolates associated with soybean anthracnose and pod blight has been reported with respect to the cultural and morphological characteristics, including colony growth, pigmentation, sporulation, conidial characteristics and other morphological features (Nagaraj and Jahagirdar, 2014). Such variation indicates that populations of *C. truncatum* may differ phenotypically according to their geographical origin and source of isolation. More recently, studies conducted in Madhya Pradesh (India) demonstrated significant variation among *C. truncatum* isolates collected from different agro-climatic zones with respect to colony characteristics, mycelial density, radial growth and sporulation on different culture media (Khare *et al.*, 2025). Rambabu *et al.* (2025) also reported substantial cultural and morphological variability among *Colletotrichum* isolates causing soybean anthracnose/pod blight in Telangana, India. These studies emphasize that characterization of individual isolates is vital for understanding pathogen diversity and its possible implications for disease development and management. However, comprehensive information on the distribution, incidence and severity of soybean anthracnose/ pod blight and the cultural and morphological variability of *C. truncatum* isolates from major soybean-growing areas of Chhattisgarh remains limited. In particular, information on the isolates obtained from different geographical locations and diseased plant parts is inadequate. The systematic assessment of the disease and characterization of the associated pathogen are necessary to determine the current disease status and understand the variability in local *C. truncatum* populations. Such information may be useful for epidemiological studies, selection of representative isolates for molecular characterization, and the development of effective disease-management strategies. Hence, the present study was undertaken to assess the distribution, incidence, and severity of soybean anthracnose (pod blight) caused by *C. truncatum* in the major soybean-growing regions of Chhattisgarh as well as to isolate the pathogen and characterize its cultural and morphological variability.

MATERIALS AND METHODS

Survey of pod blight/anthracnose disease in major soybean growing areas of Chhattisgarh (India)

A systematic roving survey was conducted during *Kharif* seasons of 2024 and 2025 to assess the occurrence and severity of anthracnose and pod blight diseases of soybean in the major soybean-growing districts of Central Chhattisgarh Plain Zone, namely Raipur, Durg, Rajnandgaon, Bemetara, Kabirdham, and Khairagarh-Chhuikhadan-Gandai (KCG). The survey was carried out at crop maturity stage, covering 32 soybean fields distributed across 16 villages in 10 blocks of six districts. In each field, soybean plants were selected at random for disease assessment, and the observations were converted into percent disease index (PDI). Similarly, pod blight incidence was assessed approximately 15 days before harvest using a 0-5 disease rating scale, and disease intensity was calculated accordingly. Based on pod infection severity, plants were classified from immune/highly resistant (HR) to highly susceptible using PDI and percent pod infection (PPI). Plant disease reactions were classified into six categories utilizing a predefined PDI scale. The resistant groups included highly resistant (grade 0; 0-5% PDI), resistant (grade 1; 6-10% PDI), and moderately resistant (grade 3; 11-25% PDI). Conversely, plants demonstrating higher infection rates were grouped into susceptible categories: Moderately susceptible (grade 5; 26-50% PDI), susceptible (grade 7; 51-75% PDI), and highly susceptible (grade 9; 76-100% PDI). To evaluate disease reaction based on PPI, a six-level grading scale was utilized. Plants showing absolutely no infection (0% PPI) were graded as 0 and classified as immune (I). Those with infection < 1% received a grade of 1, designating them as highly resistant (HR). As the infection spread, plants were categorized as resistant (grade 2; 2-5% PPI) or moderately resistant (grade 3; 6-25% PPI). For higher severity levels, a PPI ranging from 26 to 50% corresponded to a grade of 4 and a susceptible (S) reaction. Finally, plants where pod infection exceeded 51% were assigned grade 5 and deemed highly susceptible (HS) (Mayee and Datar, 1986).

Relevant field information, in addition to disease observations, including geographical coordinates, soybean variety grown, cultivated area, previous cropping history, and soil type was documented for each survey location. Disease severity, recorded on the basis of the respective rating scales, was converted into percent disease index (PDI) using the standard formula given by Wheeler (1969). Percent pod infection (PPI) was expressed as the percentage of infected pods among the pods assessed in each field.

$$\text{PDI (\%)} = \frac{\text{Sum of numerical ratings}}{\text{Total number of leaves observed} \times \text{Maximum rating grade}} \times 100$$

$$\text{Percent pod infection (PPI\%)} = \frac{\text{Number of infection pods}}{\text{Total number of pods observed}} \times 100$$

Isolation and pathogenicity C. truncatum isolates

Diseased soybean leaves (anthracnose) and pods (blight), collected from different fields, were brought to the laboratory and thoroughly washed under running tap water. The infected tissues were blot-dried and cut into small pieces of 5 mm size containing both healthy and diseased portions. These pieces were surface sterilized with 0.1% HgCl₂ for 2 min, rinsed thrice with sterile distilled water, and blot-dried. The sterilized tissue bits were aseptically placed on PDA medium in Petri-plates and incubated at 24 ± 2°C in a BOD incubator. After 3-4 days, fungal colonies free from contamination were selected for purification by single hyphal-tip technique and sub-cultured onto PDA slants. Pure cultures were maintained on agar slants and stored under 4°C for further studies.

A total of sixteen isolates of *C. truncatum* were evaluated for their pathogenicity under pot conditions using soybean variety 'JS 335' (susceptible to anthracnose pathogen). The plants were inoculated with conidial suspension (1 × 10⁶ conidia mL⁻¹) of pathogen by spraying at 3-4 leaf stage and covered with polythene cover at night for 4 days to maintain high relative humidity (>90%) and optimum temperature (25°C). After a week's incubation, the inoculated plants were monitored for disease symptom development. For additional confirmation, the fungus was reisolated from the

affected leaf and the resulting cultures compared with the original culture and observed regularly for symptom development. Disease severity was recorded 15 days after inoculation and expressed as PDI.

Cultural and morphological characterization of *C. truncatum* isolates

This isolates were studied for their cultural characteristics like colony diameter, growth pattern and colony colour and for morphological characteristics viz., shape and size of conidia, acervuli and setae. Colony colour, margin, culture topography, zonation and growth pattern were observed visually. For morphological characters like shape and size of conidia, acervuli and setae; mount were prepared in cotton blue lactophenol. The setae and acervuli were observed at 40x magnification, while conidia under a compound microscope. The size of conidia and setae were measured using a ZEISS Primo Star compound microscope equipped with a digital camera and image analysis software.

Statistical analysis

The experimental data generated were subjected to the analysis of variance (ANOVA) to find significant differences, if any, among the treatments/isolates. The data were expressed as mean values of the replications, and means compared using the least significant difference (LSD) test at $p \leq 0.05$. Pearson's correlation coefficient (r) was calculated to assess the association among different quantitative characters. Statistical analyses were performed using OPSTAT and Microsoft Excel.

RESULTS AND DISCUSSION

Survey of anthracnose/pod blight disease in major soybean growing areas of Chhattisgarh

A roving survey across sixteen villages in Chhattisgarh during *kharif* 2024 and 2025 revealed a considerable spatial and temporal variation in anthracnose severity caused by *C. truncatum* among the surveyed locations and between the two survey years. Mean PDI ranged from 17.85 to 31.0%, while PPI ranged from 14.85 to 25.75% (Table 1). Pathri Kilan (Bemetara district) exhibited the

Table 1: Village-wise survey anthracnose/pod blight of soybean for percent disease index (PDI) and percent pod infection (PPI) in Chhattisgarh during *Kharif* season

S. No.	Villages	Blocks	Varieties	Previous crop	GPS location		2024		2025		Mean	
					Latitude	Longitude	PDI	PPI	PDI	PPI	PDI	PPI
<u>District Bemetara</u>												
1.	Pathari Kalan	Bemetara	JS 335	Chickpea	21.591396°	81.196070°	30.2	25.1	31.8	26.4	31.0	25.7
2.	Dogitarai	Saja	Local	Chickpea	21.648487°	81.321769°	28.4	23.5	29.6	24.5	29.0	24.0
3.	Thankhamria	Thankhamria	JS 335	Mustard	21.784853°	81.345214°	26.8	22.0	27.9	22.9	27.3	22.4
4.	Keshdabri	Berla	JS 20 98	Linseed	21.635982°	81.382856°	21.3	17.8	22.4	18.7	21.8	18.2
<u>District Durg</u>												
5.	Godadih	Dhmadha	JS 97 52	Mustard	21.531239°	81.244283°	20.1	16.7	21.0	17.5	20.5	17.1
<u>District Raipur</u>												
6.	IGKV	Dharsiwa	Indira Soya 9	Linseed	21.228344°	81.717138°	18.4	15.2	19.3	15.9	18.8	15.5
7.	Kharora	Tilda	JS 85 60	Maize	21.228351°	81.717157°	17.5	14.6	18.2	15.1	17.8	14.8
<u>District Rajnandgaon</u>												
8.	Haldi	Rajnandgaon	Local	Maize	21.549691°	81.053146°	24.7	20.4	25.9	21.3	25.3	20.8
9.	Dongargarh	Dongargarh	JS 335	Lathyrus	21.617065°	81.086594°	23.2	19.1	24.3	20.0	23.7	19.5
<u>District Kabirdham</u>												
10.	Kawrdha	Kawardha	Local	Chickpea	21.932076°	81.202325°	28.8	23.6	30.1	24.8	29.4	24.2
11.	Bamhan Tola	Bodla	JS 335	Chickpea	21.960736°	81.195347°	27.4	22.4	28.6	23.4	28.0	22.9
12.	Atariya	Pandariya	RSC 1172	Mungbean	21.611801°	81.065002°	26.1	21.2	27.2	22.1	26.6	21.6
13.	Sahaspur	Lohara	Local	Chickpea	21.391082°	81.043298°	24.9	20.3	26.0	21.1	25.4	20.7
<u>District Khairagarh-Chhuikhadan-Gandai (KCG)</u>												
14.	Amagaon	Khairagarh	JS 20 98	Chickpea	21.540979°	81.008961°	22.5	18.7	23.5	19.4	23.0	19.0
15.	Pendri	Chhuikhadan	JS 335	Lathyrus	21.503337°	81.274242°	20.8	17.1	21.7	17.9	21.2	17.5
16.	Birjpur	Gandai	JS 97 52	Vegetable	21.484419°	81.293001°	19.6	16.2	20.3	16.8	19.9	16.5

Crop was surveyed for the diseases at maturity, The soils in all the surveyed villages were black (Vertisols), except in villages Dogitarai, IGKV, Kharora, Pendri and Biripur which had Dosra soil (Alfisol).

highest disease severity with PDI of 31% and PPI of 25.75%, whereas Kharora (Raipur district) showed the lowest with PDI of 17.85% and PPI of 14.85%. Disease intensity increased from 2024 to 2025 across most locations, with Pathri Kilan rising from 30.2 to 31.8% (PDI) and 25.1% to 26.4% (PPI). A strong positive correlation existed between PDI and PPI ($r > 0.92$), indicating synchronous development of foliar and pod symptoms. Black soils supported higher disease intensity (mean PDI 24.83%) compared to laterite soils (mean PDI 18.50%). The susceptible variety JS 335 exhibited mean PDI of 27.35%, while Indira Soya 9 showed the lowest PDI at 18.85%. Fields with preceding chickpea crops registered the mean PDI of 26.15%, substantially higher than those with linseed predecessors (20%).

District-wise distribution of soybean anthracnose/pod blight

District-wise analysis revealed noticeable variation in anthracnose severity among the surveyed soybean-growing regions of Chhattisgarh. The highest overall disease intensity was observed in Bemetara district (27.3% PDI), closely followed by Kabirdham (27.3%), whereas the lowest disease severity was observed in Raipur (18.3% PDI). A similar trend was evident for pod infection, with Bemetara and Kabirdham showing the highest overall PPI values of 22.61 and 22.36%, respectively, while Raipur exhibited the lowest pod infection (15.2%). Across all districts, disease severity and pod infection were slightly higher during 2025 compared to 2024. The mean PDI increased from 23.14% in 2024 to 24.19% in 2025, while the corresponding PPI increased from 19.11 to 19.98%. The overall mean disease severity and pod infection across the surveyed locations were 23.67 and 19.55%, respectively (Table 2). Higher disease intensity in districts Bemetara and Kabirdham suggests that the local environmental conditions seem more favourable for disease development. Similar geographical variation in anthracnose incidence has been reported by Sharma *et al.* (2019) and Singh and Prasad (2021).

A positive relationship was observed between PDI and PPI ($r = 0.99$, $p < 0.01$; $n = 16$) indicating that severe foliar severity was associated with greater pod infection. This finding highlights the importance of early disease management to reduce disease development and potential seed-borne inoculum, as reported by Hartman *et al.* (2016). The slightly higher disease levels during 2025-26 compared to 2024-25 further suggest the persistence and accumulation of pathogen inoculum under favourable conditions.

Differences in disease severity among soybean varieties indicated the variation in host resistance, supporting the importance of resistant cultivar selection for anthracnose management. Lower disease incidence observed in some locations may also be influenced by soil type and previous cropping history. Fields following chickpea cultivation generally recorded higher disease levels, suggesting a possible role of crop residues and pathogen carry-over in disease development. Similar observations have been reported by Prasad *et al.* (2018) and Yadav *et al.* (2019).

Table 2: District-wise mean anthracnose percent disease intensity (PDI) and percent pod infection (PPI) of soybean

Districts	No. of villages	Mean PDI		Mean PPI		Overall mean PDI	Overall mean PPI
		2024	2025	2024	2025		
Bemetara	4	26.68	27.93	22.10	23.13	27.30	22.61
Kabirdham	4	26.80	27.98	21.88	22.85	27.28	22.36
Rajnandgaon	2	23.95	25.10	19.75	20.65	24.53	20.20
KCG*	3	20.97	21.83	17.33	18.03	21.40	17.68
Durg	1	20.10	21.00	16.70	17.50	20.55	17.10
Raipur	2	17.95	18.75	14.90	15.50	18.35	15.20
Grand mean	16	23.14	24.19	19.11	19.98	23.67	19.55

*KCG = Khairagarh-Chhuikhadan-Gandai

Isolation, identification and symptomatology of *C. truncatum*

The pathogenic isolates were isolated from anthracnose-infected soybean leaves and blighted pods on PDA. The fungus produced cream to blackish-grey colonies with a thin mycelial mat and little or no aerial growth. For identification, a piece of sporulating mycelium, mounted in lactophenol cotton blue was examined under a light microscope (Plate 1). The symptoms of soybean anthracnose/pod

blight were visible mostly on aerial plant parts such as leaves, petiole, stems and pods (Plate 2). Symptoms on leaves were irregular brown necrotic spots. In later stages, the necrotic spots dried up in the center leaving the spots with a shot hole appearance. Symptoms on petioles were necrotic sunken spots. As the host matured, there was a massive pathogenic attack on pods and stem. Multiple fruiting bodies (acervuli) appeared on pod in rings leading to the blackening of pods and making it unable to fill. The affected pods failed to develop any seeds or when developed, and were small and shrivelled. The primary effect of disease was the production of withered infected inferior seed.

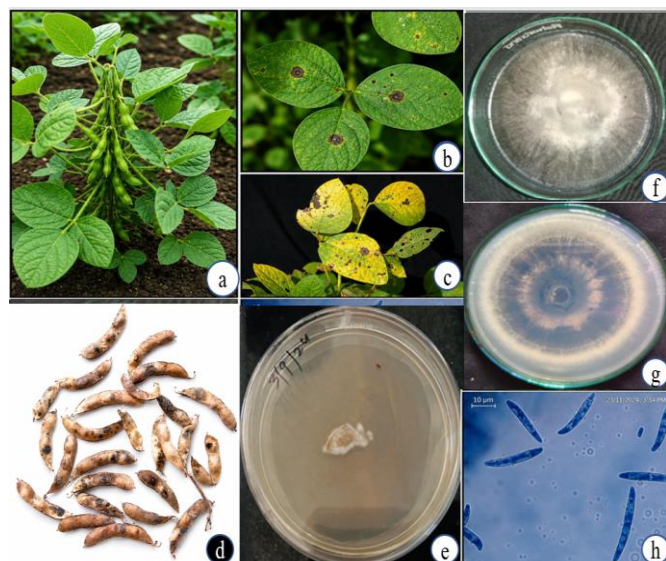


Plate 1: a) Healthy soybean, b) Early anthracnose symptoms, c) Advanced anthracnose symptoms on leaves, d) Anthracnose infected soybean pods, e) Isolation of *C. truncatum*, f) White cottony mycelial growth, g) Pigmentation, and h) Microscopic view

Pathogenicity of *C. truncatum* isolates

Pathogenicity test revealed considerable variation among the 16 *C. truncatum* isolates in terms of symptoms and disease severity on soybean. All isolates produced characteristic anthracnose symptoms, whereas no symptoms were observed in control (PDI, 0), confirming the pathogenicity of isolates. The onset of symptoms varied from 10 to 15 days after inoculation (DAI). The earliest symptom appearance was observed in CGCt-1 and CGCt-10 at 10 DAI, with PDI values of 46.3 and 45.8%, respectively. CGCt-2, CGCt-3, CGCt-11 and CGCt-12 produced symptoms at 11 DAI with PDI values of 44.7, 43.9, 44.1 and 43.2%, respectively. The remaining isolates showed symptom development between 12 and 15 DAI.

Disease severity, expressed as PDI, ranged from 30.4 to 46.3% among the isolates. CGCt-1, collected from Pathari

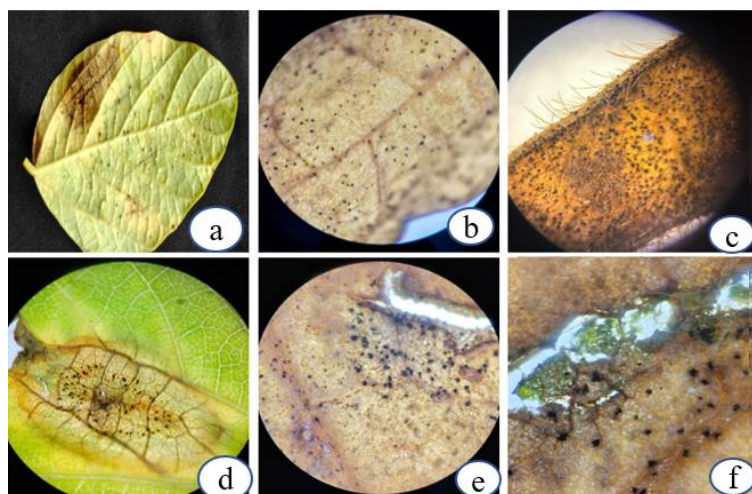


Plate 2: a & b) Necrotic lesion with visible black acervuli in backside of leaf, c) Dark setae emerging from acerulus pod, d & e) Necrotic lesion with visible black acervuli in front side leaf, and f) Close up view of acervuli and associated setae

Kalan, recorded highest PDI (46.3%), followed by CGCt-10 (45.8%), CGCt-2 (44.7%), CGCt-11 (44.1%) and CGCt-3 (43.9%). PDI values of 42.3, 41.7, 41.4, 40.6, 40.3 and 43.2% were recorded for CGCt-4, CGCt-8, CGCt-13, CGCt-5, CGCt-9 and CGCt-12, respectively. In contrast, CGCt-6, CGCt-14, CGCt-15 and CGCt-16 recorded lower PDI values of 39.3, 39.9, 37.8 and 36.2%, respectively. The lowest disease severity was observed in CGCt-7 from Kharora (30.4%), with symptoms appearing at 14 DAI. CGCt-16 exhibited latest symptom appearance (15 DAI) and recorded a PDI of 36.2%

(Table 3). The isolates differed markedly in both the speed of symptom development and disease severity, indicating considerable pathogenic variability among *C. truncatum* isolates. Pearson's correlation analysis revealed a strong and highly significant negative correlation between symptom appearance (DAI) and disease severity (PDI) ($r = -0.88, p < 0.01$). This indicated that isolates showing earlier symptom development generally produced higher disease severity, whereas isolates with delayed symptom appearance tended to exhibit lower PDI values. The significant negative relationship between DAI and PDI further supported the differences among *C. truncatum* isolates in their pathogenic behaviour and disease-causing ability. Also, similar isolate-to-isolate variation in pathogenicity was observed in soybean anthracnose where *C. truncatum* isolates differed in their ability to cause disease on soybean plants. The fungus was subsequently reisolated from the inoculated plants of the susceptible soybean cultivar 'JS 335' and exhibited characteristics similar to those of the original culture, thereby confirming the pathogenicity of the isolates. The present findings confirm considerable pathogenic variability among *C. truncatum* isolates collected from different locations.

Table 3: Pathogenicity of different isolates of *C. truncatum* on Soybean

S. No.	Isolate	Location	Symptom appearance (DAI)	PDI (%)
1.	CGCt-1	Pathari Kalan	10	46.3
2.	CGCt-2	Dogitarai	11	44.7
3.	CGCt-3	Thankhamria	11	43.9
4.	CGCt-4	Keshdabri	12	42.3
5.	CGCt-5	Godadih	13	40.6
6.	CGCt-6	IGKV	13	39.3
7.	CGCt-7	Kharora	14	30.4
8.	CGCt-8	Rajnandgaon	12	41.7
9.	CGCt-9	Dongargarh	13	40.3
10.	CGCt-10	Kawardha	10	45.8
11.	CGCt-11	Bamhan Tola	11	44.1
12.	CGCt-12	Atariya	11	43.2
13.	CGCt-13	Sahaspur	12	41.4
14.	CGCt-14	Amagaon	13	39.9
15.	CGCt-15	Pendri	14	37.8
16.	CGCt-16	Birjpur	15	36.2
	Control	Uninoculated	No symptoms	0.0

The results are in conformity with the earlier findings of Nagaraj (2013). The initial symptoms observed on leaves were dull brown lesion which later turned dark brown with necrotic and dried giving blighted appearance to seedling. Symptoms on petiole also appeared in the form of sunken necrotic spots. Re-isolation of pathogen from disease plant part revealed the fungus *C. truncatum* to be identical with the original one that was inoculated and in conformity to Akhtar and Abdul (2008), Yang and Hartman (2015), Lalhruaitluangi and Sinha (2019), and Agam *et al.* (2019).

Culturo-morphological characteristics of *C. truncatum* isolates

Cultural and morphological characterization of 16 *C. truncatum* isolates revealed considerable phenotypic variability on PDA. Colony diameter ranged from 60.6 mm in isolate CGCt-7 (Kharora) to 90.0 mm in CGCt-10 (Kawardha), with an overall mean of 80.22 mm, indicating

marked differences in growth potential among the isolates. Isolate CGCt-10 recorded maximum radial growth, closely followed by CGCt-2 (89.8 mm), whereas CGCt-7 showed the slowest growth. Considerable variation was also observed in colony pigmentation (Plate 3). The colonies appeared white (CGCt-6, CGCt-7, CGCt-14 and CGCt-16), greyish white (CGCt-1 and CGCt-5), whitish grey (CGCt-2, CGCt-11, CGCt-12 and CGCt-13), grey (CGCt-3), light grey (CGCt-4) and dull white (CGCt-8). However, all isolates produced circular colonies on PDA medium. The isolates differed in their sporulation behaviour. Four isolates *viz.*, CGCt-1, CGCt-2, CGCt-10 and CGCt-11 exhibited excellent sporulation, six isolates *viz.*, CGCt-3, CGCt-4, CGCt-8, CGCt-9, CGCt-12 and CGCt-13 showed good sporulation, while the remaining six isolates namely CGCt-5, CGCt-6, CGCt-7, CGCt-14, CGCt-15 and CGCt-16 showed moderate sporulation. These findings reveal significant cultural diversity among the isolates, suggesting the existence of considerable variability within the pathogen population across the different soybean-growing regions of Chhattisgarh.

The morphological characterization of 16 *C. truncatum* isolates revealed considerable variability in conidial, appressorial, acervular and setal dimensions (Plate 4). Conidial length varied from 21.9 μm in isolate CGCt-16 (Birjpur) to 24.8 μm in CGCt-1 (Pathari Kalan) and CGCt-2 (Dogitarai). The conidial width ranged from 3.6 μm in CGCt-7 (Kharora) to 4.2 μm in CGCt-1. The largest conidia were

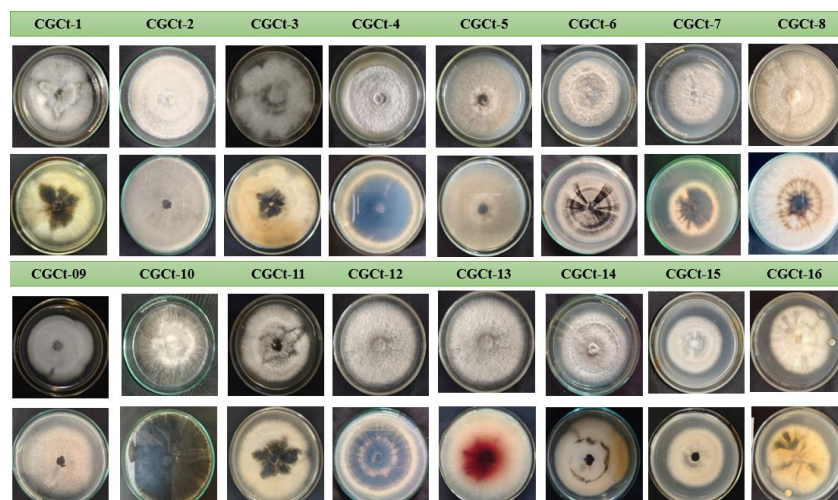


Plate 3: Cultural variation in growth and pigmentation of *C. truncatum* isolates

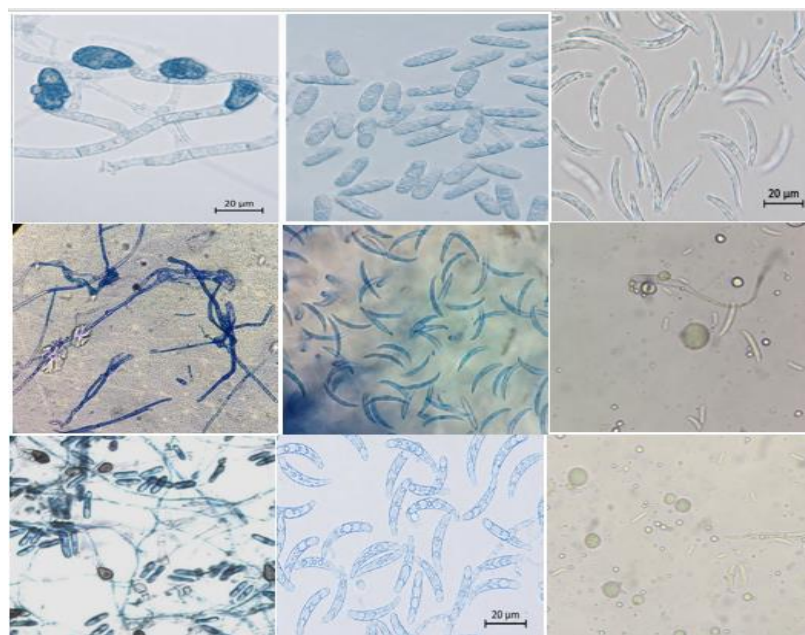


Plate 4: Morphological characteristics of conidia, germinating conidia and appressoria of *C. truncatum*

varied from 4.3 to 8.4 µm. The setae of CGCt-1 were nearly three times longer than those of CGCt-7, highlighting the pronounced morphological diversity within the pathogen population. Overall, the observed variability in reproductive and infection-related structures reflects the existence of diverse phenotypic groups of *C. truncatum* prevalent in soybean-growing areas of Chhattisgarh, India.

Significant differences were observed in colony growth, colony colour, sporulation, conidial size, appressorial dimensions, acervuli, and setae characteristics. Similar variability among *C. truncatum* isolates has been reported by Sharma *et al.* (2015) and Damm *et al.* (2009), indicating the existence of diverse pathogen populations. Variations in conidial and appressorial dimensions may influence infection efficiency and pathogenic behaviour, while differences in acervuli and setae size could affect sporulation and survival under field conditions. Similar observations have been reported by Than *et al.* (2008) and Cannon *et al.* (2012). These findings emphasize the importance of

seen in CGCt-1 (24.8 x 4.2 µm), which also exhibited excellent sporulation, indicating its high reproductive potential. Appressorial size differed among the isolates from 11.0 x 7.4 µm in CGCt-16 to 12.8 x 8.4 µm in CGCt-1 (Plate 4). Interestingly, the isolates producing larger conidia, especially CGCt-1 and CGCt-2, also formed comparatively larger appressoria, suggesting a positive relation between spore and infection structure development. Among all morphological traits, acervuli exhibited substantial variation. Acervular length ranged from 121.4 µm in CGCt-7 to 225.8 µm in CGCt-10, while width varied from 180.8 to 295.4 µm in the same isolates. The larger acervuli observed in CGCt-10, together with its rapid colony growth and excellent sporulation, indicate a highly vigorous and potentially aggressive isolate. Setae dimensions showed the highest degree of variability among the isolates. Setae length ranged from 79.6 µm in CGCt-7 to 212.6 µm in CGCt-1, whereas width

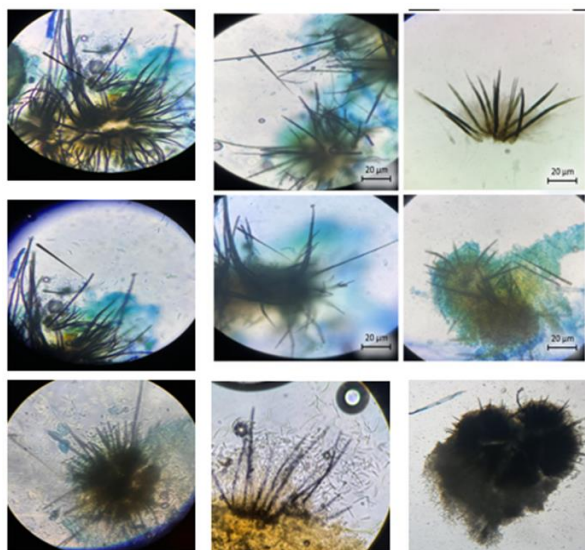


Plate 4: Microscopic morphology of acervuli and characteristic setae of *C. truncatum* isolated from soybean

continuous monitoring of pathogen populations and provide useful information for developing effective anthracnose management strategies in Soybean-growing areas of Chhattisgarh. Similar conclusions were also reported by Kumar *et al.* (2017) and Ghosh *et al.* (2019).

Conclusion: This study reveals the widespread prevalence and destructive nature of *C. truncatum* causal agent of soybean anthracnose and pod blight in soybean growing areas of Chhattisgarh. A roving survey across 16 villages showed the prevalence and disease severity in the surveyed areas. Additionally, the study demonstrated the variability among 16 isolates in conidial, appressorial, acervular and setae dimensions, whereas pathogenicity depicted 11 isolates as highly virulent and 5 as virulent isolates showing difference in aggressiveness of pathogen. Among all the characters studied setae showed highest degree of variation. The

differentiation in isolates of *C. truncatum* based on agro-ecological zone in soybean-growing regions of Chhattisgarh reflects the existence of diverse phenotypic groups in region emphasizing the need for monitoring and disease management strategies to overcome the future disease outbreaks.

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