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Cultural and Morphological Characterization of *Colletotrichum truncatum* Causing Anthracnose of Soybean on PDA

M. B. Meghana [a*], S. B. Gowdar [b], Y. S. Amaresh [a], D. S. Aswathanarayana [a] and Umesh Hiremath [c]

[a] Department of Plant Pathology, College of Agriculture, Raichur - 584 104, India.
[b] Department of Plant Pathology, College of Agriculture, Gangavathi - 583 227, India.
[c] Department of Seed Science and Technology, Seed Unit, University of Agricultural Sciences, Raichur - 584 104, Karnataka, India.

Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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Abstract

Anthracnose caused by *Colletotrichum truncatum* is a major constraint in soybean production. Understanding the pathogen's cultural and morphological variability is essential for identification and management. This study examined variability among 16 isolates (C-1 to C-16) obtained from soybean samples collected in north-eastern Karnataka. Sixteen isolates (C-1 to C-16) of *C. truncatum* obtained from soybean pod samples were characterised according to their cultural and morphological characteristics on potato dextrose agar (PDA). The colony colour was predominantly white, except for isolate C-1, which produced a creamy-white colony. White pigmentation was observed in isolates C-2, C-6, C-9, C-11, C-12, C-15 and C-16, while grey pigmentation was recorded in C-1 and C-7. Purple pigmentation was observed in C-3 and C-14, orange pigmentation in C-4, C-8 and C-13 and yellow

**Corresponding Email(s): meghanamb16114@uasraichur.edu.in;*

Contact Email(s): ampublications318@gmail.com;

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pigmentation in C-5 and C-10. Fluffy growth with a regular margin was observed in isolates C-1, C-2, C-7, C-9, C-10, C-11, C-12 and C-16. Flat growth with a regular margin was observed in C-4, C-5, C-13, C-14 and C-15, whereas C-3 and C-6 exhibited flat growth with an irregular margin. Isolate C-8 showed fluffy growth with an irregular margin. Sectoring was observed in C-3 and C-6, while the remaining 14 isolates showed no sectoring. The smallest mean conidial size was recorded in C-4 (12.54 × 3.82 µm) in terms of width, whereas C-5 recorded the greatest width (12.94 × 5.62 µm). The minimum conidial length was recorded in C-3 (11.44 µm) and the maximum in C-14 (14.20 µm). The mean conidial dimensions ranged from 11.44–14.20 × 3.82–5.62 µm. All isolates exhibited cylindrical conidia. The observed setal dimensions ranged from 45.98 to 64.68 µm in length and from 3.30 to 5.40 µm in breadth. Isolate C-9 recorded the maximum setal length (64.68 µm). The number of setae per acervulus ranged from 18 to 31; C-2 and C-3 showed the maximum (31), whereas C-10 showed the minimum (18).

Keywords: Soybean anthracnose; Colletotrichum truncatum; cultural variability; morphological characterisation; potato dextrose agar; conidial morphology.

1. Introduction

Soybean (*Glycine max* (L.) Merrill), belonging to the family Leguminaceae (subfamily Papilionaceae), is native to China and was introduced into Indian agriculture during the 1970s–80s (Toomer, 2023). Recognised globally as a major oilseed and protein crop, it is valued for its high protein content (~38 per cent), oil (~18 per cent) and diverse industrial applications ranging from biodiesel and biodegradable plastics to soy-based food products (Chauhan & Joshi, 2005; Shin *et al*., 2015). Despite its economic importance, soybean production is constrained by biotic stresses, particularly fungal diseases, which account for 6–8 per cent of the total 12–20 per cent yield loss attributed to biotic factors (Mittal *et al.,* 1993). Among these, anthracnose caused by *Colletotrichum truncatum* is one of the most destructive, with yield losses ranging from 16 to 100 per cent (Sinclair, 1992). First reported from Korea in 1917, the disease affects the crop from flowering through pod filling stages, causing brown lesions on stems, pods and petioles, premature drying and shriveled, discoloured seeds with reduced germination (Chandrasekaran & Rajappan, 2002; Khan & Sinclair, 1992; Sinclair & Backman, 1989). Seed infection levels of up to 70 per cent have been reported under favourable warm and humid conditions (Agam *et al.,* 2019). A survey of soybean-growing districts in north-eastern Karnataka also reported variation in anthracnose severity across locations (Meghana et al., 2026). A study of soybean seed-associated fungi identified *Colletotrichum truncatum* among the fungal species recovered from soybean seed samples (Gujjar et al., 2025).

The genus *Colletotrichum* is taxonomically complex and morphoculturally variable, with growth rate, colony colour, texture, margin and sporulation capacity differing widely, not only between species but also between isolates of the same species (Asalkar et al., 2019; Xiang *et al*., 2014). Accurate characterisation of these cultural and morphological attributes is fundamental to pathogen identification and isolate comparison (Kulkarni & Raja, 2019; Roja *et al*., 2022). Morphological features such as conidial shape and size, setae and number of setae per acervulus, together with cultural traits such as colony colour, pigmentation, growth type, margin and sectoring, support differentiation of *Colletotrichum* spp. and indicate the diversity of the pathogen (Damm *et al.,* 2012; Jayawardena *et al*., 2016). Recent work involving soybean-associated *Colletotrichum truncatum* isolates from different Indian growing regions has likewise documented variation in morpho-cultural characteristics (Mandloi et al., 2026). A separate investigation reported differences in the virulence of *Colletotrichum truncatum* isolates tested against soybean genotypes (Mandloi et al., 2025).

Documenting this variability among isolates from soybean seed is therefore important for their identification and comparison.

However, the cultural and morphological variation among the 16 *Colletotrichum truncatum* isolates from north-eastern Karnataka under the PDA culture conditions examined in the present study has not yet been documented systematically.

With this in view, the present investigation was undertaken to examine the cultural and morphological variability of isolates C-1 to C-16 of *Colletotrichum truncatum* with respect to conidial size and shape, setal length and number of setae per acervulus, and cultural variability on potato dextrose agar (PDA) in relation to colony colour, pigmentation, growth type, margin and sectoring.

2. Material and Methods

2.1 Survey, Collection and Isolation

A survey was conducted in the soybean-growing areas of north-eastern Karnataka to collect samples for the isolation and characterisation of *Colletotrichum truncatum*, the causal organism of soybean anthracnose.

The isolation process yielded a total of 16 fungal isolates, which were designated C-1 to C-16 according to their respective collection locations. The isolates were identified as *C. truncatum* based on their cultural and morphological characteristics. Each isolate was assigned a distinct identification code to facilitate the recording and comparison of observations. The isolates were subsequently subjected to cultural and morphological characterisation under laboratory conditions to examine the variability in their colony characteristics, conidial morphology and setal features. The collection locations corresponding to the individual isolates are presented in Tables 1 and 2.

2.2 Morphological and Cultural Characterization

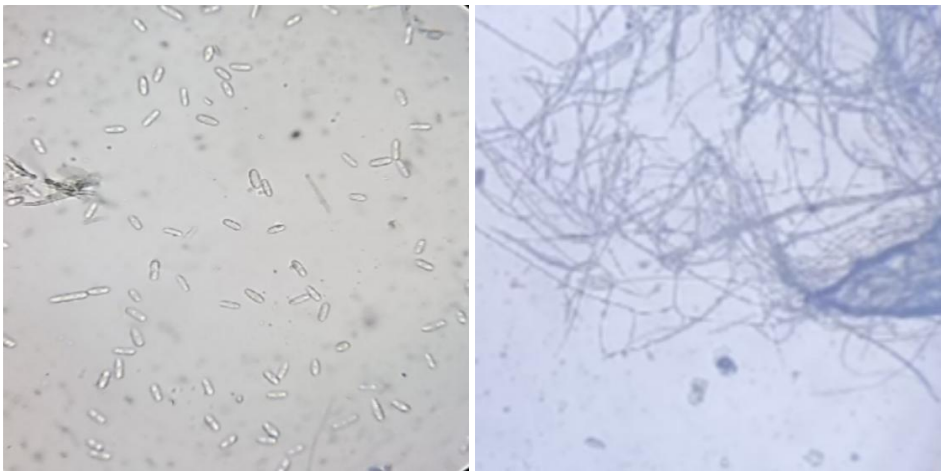
The 16 isolates of *C. truncatum* were individually grown on potato dextrose agar (PDA) medium in 90 mm Petri plates and incubated at a temperature of 27 ± 1 °C. Cultural and morphological characteristics were recorded from 7–9-day-old cultures grown

on PDA. The observations were made separately for each isolate to document differences in the characteristics expressed under the specified culture conditions.

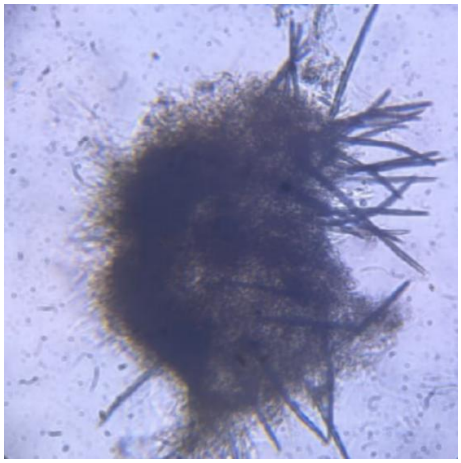
Cultural characterisation was carried out by examining colony colour, pigmentation, type of mycelial growth, colony margin and sectoring. Colony colour and pigmentation were recorded based on their visible appearance on PDA. The type of mycelial growth was characterised as fluffy or flat, while colony margins were classified as regular or irregular. The presence or absence of sectoring was also recorded for each isolate. These observations were used to compare cultural variability among the 16 isolates.

Morphological characterisation involved the examination of mycelial characteristics, conidial morphology, setal dimensions and the number of setae per acervulus. The conidia were characterised based on their shape and mean dimensions, expressed as length × width in micrometres (µm). Setal characteristics were examined in terms of their dimensions, expressed as length × breadth in micrometres (µm). In addition, the number of setae associated with each acervulus was recorded where observations were available. The morphological characteristics of the isolates, including mean conidial size, conidial shape, mean setal size and number of setae per acervulus, are presented in Table 2.

The microscopic characteristics of the pathogen, including conidia, mycelium and acervuli, are illustrated in Plate 1 at 40× magnification. The recorded cultural and morphological characteristics were compared across the isolates to assess the extent of variability in *C. truncatum* under the PDA culture conditions used in the investigation.



a) Conidia (40X) **b) Mycelium (40X)**



c) Avervulus (40X)

Plate 1. Morphological characteristics of *Colletotrichum truncatum*

3. Results and Discussion

Sixteen isolates (C-1 to C-16) of *Colletotrichum truncatum* obtained from soybean pod samples were characterised based on their cultural and morphological characteristics on potato dextrose agar (PDA).

3.1 Cultural Characterization of *Colletotrichum truncatum*

Considerable variation was observed among the isolates with respect to colony colour, pigmentation, type of growth, sectoring and conidial dimensions. The colony colour was predominantly white, except for isolate C-1, which produced a creamy-white colony. The pigmentation of the isolates varied considerably and included grey, white, purple, orange and yellow pigmentation. White pigmentation was observed in isolates C-2, C-6, C-9, C-11, C-12, C-15 and C-16, while grey pigmentation was recorded in C-1 and C-7. Purple pigmentation was observed in C-3 and C-14, orange pigmentation in C-4, C-8 and C-13 and yellow pigmentation in C-5 and C-10 (Table 1, Plates 2a and 2b). Similarly, Nagaraj and Jahagirdar (2014) recorded distinct variation in colony colour among 11 isolates of *C. truncatum* collected from different soybean-growing regions of India. The colony colour varied from cottony white to dark grey, with individual isolates producing white, light grey, grey, dark grey and creamy yellow colonies. Khare *et al*. (2025) observed that the isolates exhibited differences in colony pigmentation and colour, along with variation in colony texture and mycelial density.

Table 1. Cultural characteristics of *Colletotrichum truncatum* isolates

Sl. No.	Isolate	Place	Colony colour	Pigmentation	Type of growth	Sectoring
1	C-1	Yedlapur	Creamy white	Grey	Fluffy with regular margin	Absent
2	C-2	Dhanura	White	White	Fluffy with regular margin	Absent
3	C-3	Markhal	White	Purple	Flat with irregular margin	Present
4	C-4	Janwada	White	Orange	Flat with regular margin	Absent
5	C-5	Keroor	White	yellow	Flat with regular margin	Absent
6	C-6	Balur	White	White	Flat with irregular margin	Present
7	C-7	Hallikhed K	White	Grey	Fluffy with regular margin	Absent
8	C-8	Mustapur	White	Orange	Fluffy with irregular margin	Absent
9	C-9	Koutha B	White	White	Fluffy with regular margin	Absent
10	C-10	kotgyal	White	Yellow	Fluffy with regular margin	Absent
11	C-11	Suntnoor	White	White	Fluffy with regular margin	Absent
12	C-12	Ladchincholi	White	White	Fluffy with regular margin	Absent
13	C-13	Madur	White	Orange	Flat with regular margin	Absent
14	C-14	Bhankur	White	Purple	Flat with regular margin	Absent
15	C-15	Savalgi	White	White	Flat with regular margin	Absent
16	C-16	KVK, Kalaburagi	White	White	Fluffy with regular margin	Absent

Variation was also observed in the type of colony growth. Fluffy growth with a regular margin was the most common cultural characteristic and was observed in isolates C-1, C-2, C-7, C-9, C-10, C-11, C-12 and C-16. Flat growth with a regular margin was observed in C-4, C-5, C-13, C-14 and C-15, whereas C-3 and C-6 exhibited flat growth with an irregular margin. Isolate C-8 showed fluffy growth with an irregular margin. Sectoring was observed in two isolates, C-3 and C-6, while the remaining 14 isolates showed no sectoring (Table 1, Plate 2a). The isolates exhibited differences in the type of mycelial growth on PDA, ranging from sparse to dense and compact or cottony growth. Similar variation in colony morphology and mycelial characteristics among *Colletotrichum* spp. was reported by Damm *et al*. (2012) and Jayawardena *et al*. (2016), who emphasised colony texture, aerial mycelium, pigmentation and growth characteristics as useful phenotypic traits for preliminary characterization of the genus. A study on *C. truncatum* isolates from Hyderabad and Palampur, India, reported clear differences in the type of mycelial growth on PDA. The Hyderabad isolates showed dark olive colonies with dense mycelial growth and abundant acervuli (+++), whereas some showed slow mycelial growth with sparse acervuli (++). The Palampur isolates produced light olive to yellowish brown colonies, with slow growth and sparse acervuli (Pandey *et al*., 2021).

3.2 Morphological Characterization of *Colletotrichum truncatum*

The mycelium was septate and hyaline, producing oblong, unicellular, hyaline conidia containing an oil globule. The setae were dark brown to black and hair-like structures arising from the acervuli. Mean conidial size also varied among the isolates. The smallest mean conidial size was recorded in C-4 (12.54 × 3.82 µm) in terms of width, whereas C-5 recorded the maximum width (12.94 × 5.62 µm). Considering conidial length, the minimum was recorded in C-3 (11.44 µm), whereas the maximum was observed in C-14 (14.20 µm). The isolates exhibited differences in conidial size; however, the measurements showed only a limited degree of variation, reflecting close morphological similarity among the isolates. Overall, the mean conidial dimensions ranged from 11.44–14.20 × 3.82–5.62 µm. All isolates exhibited cylindrical conidia. Variation was also observed in setae and their numbers per acervulus; setal dimensions ranged from 45.98 to 64.68 µm in length and from 3.30 to 5.40 µm in breadth. Among these, C-9 showed the maximum setal length (64.68 µm) followed by C-2 (63.20 µm). The number of setae per acervulus ranged from 18 to 31; C-2 and C-3 showed the maximum number (31), followed by C-1 (28). The minimum was observed in C-10 (18). The observed variation in conidial characteristics indicated considerable morphological variability among the *Colletotrichum truncatum* isolates obtained from the soybean samples (Table 2). Similarly, Jagtap and Sontakke (2009) reported that setae length ranged from 166.65 µm in the most variable isolate (Ct-1) to 44.36 µm in the least variable isolate (Ct-6), while setal width ranged narrowly between 4.92 and 5.50 µm across isolates. Liu et al. (2018) characterised *Colletotrichum* species associated with rubber tree anthracnose. For *Colletotrichum siamense*, the conidia measured 7.00 – 13.00 × 2.50 – 4.00 µm, with a mean of 10.00 ± 1.40 × 3.60 ± 0.40 µm. The colonies on PDA were 75.00 – 85.00 mm after seven days, with white to dark grey cottony aerial mycelium and orange conidiomata. Rambabu *et al*. (2025) described that the pathogen produces single-celled, hyaline conidia that are cylindrical to dumbbell-shaped with rounded ends and mean conidial dimensions ranging from 24.25 – 28.95 × 3.15 –4.10 µm among 27 *Colletotrichum* isolates.

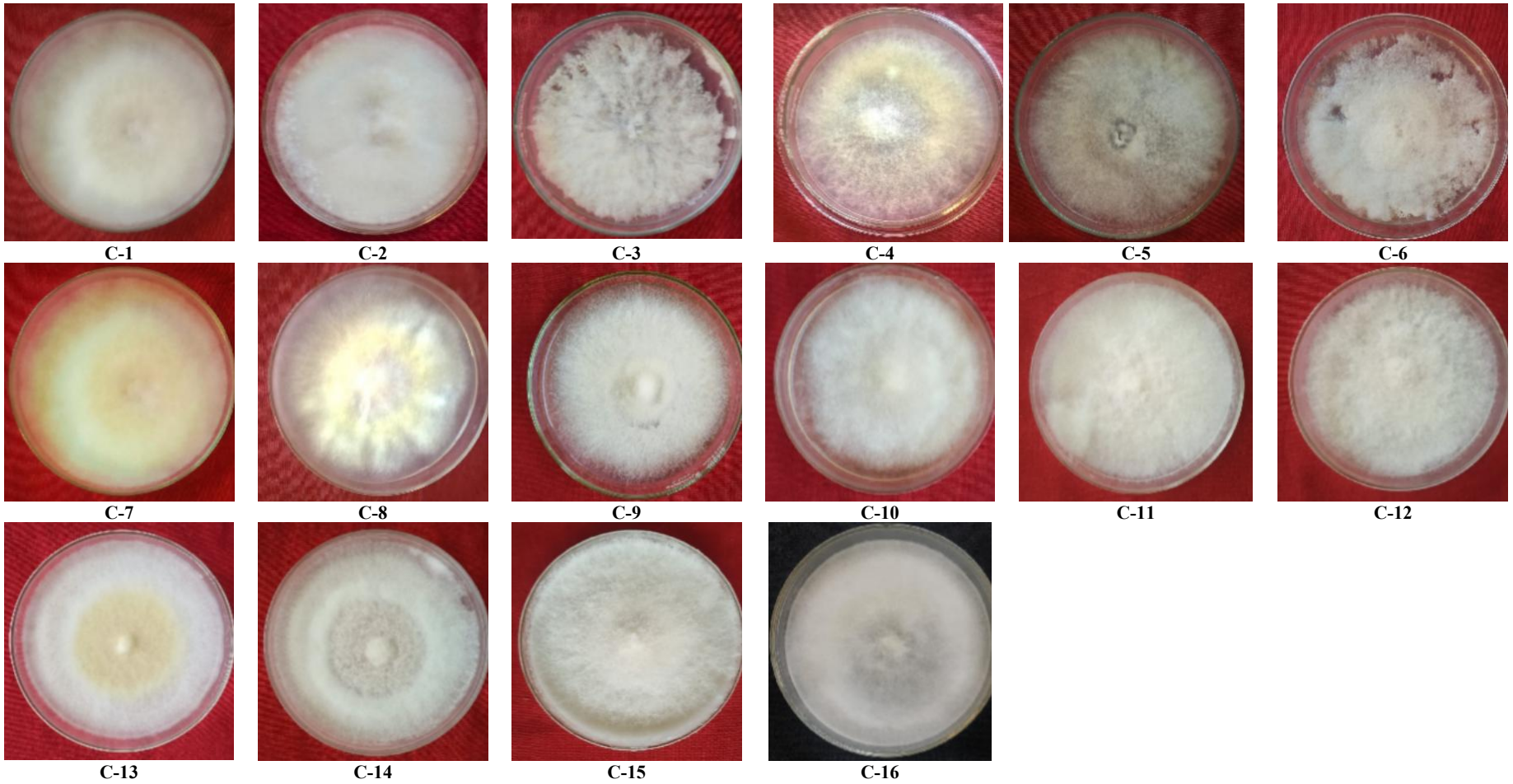


Plate 2a. Converse view of *Colletotrichum truncatum* isolates on potato dextrose agar

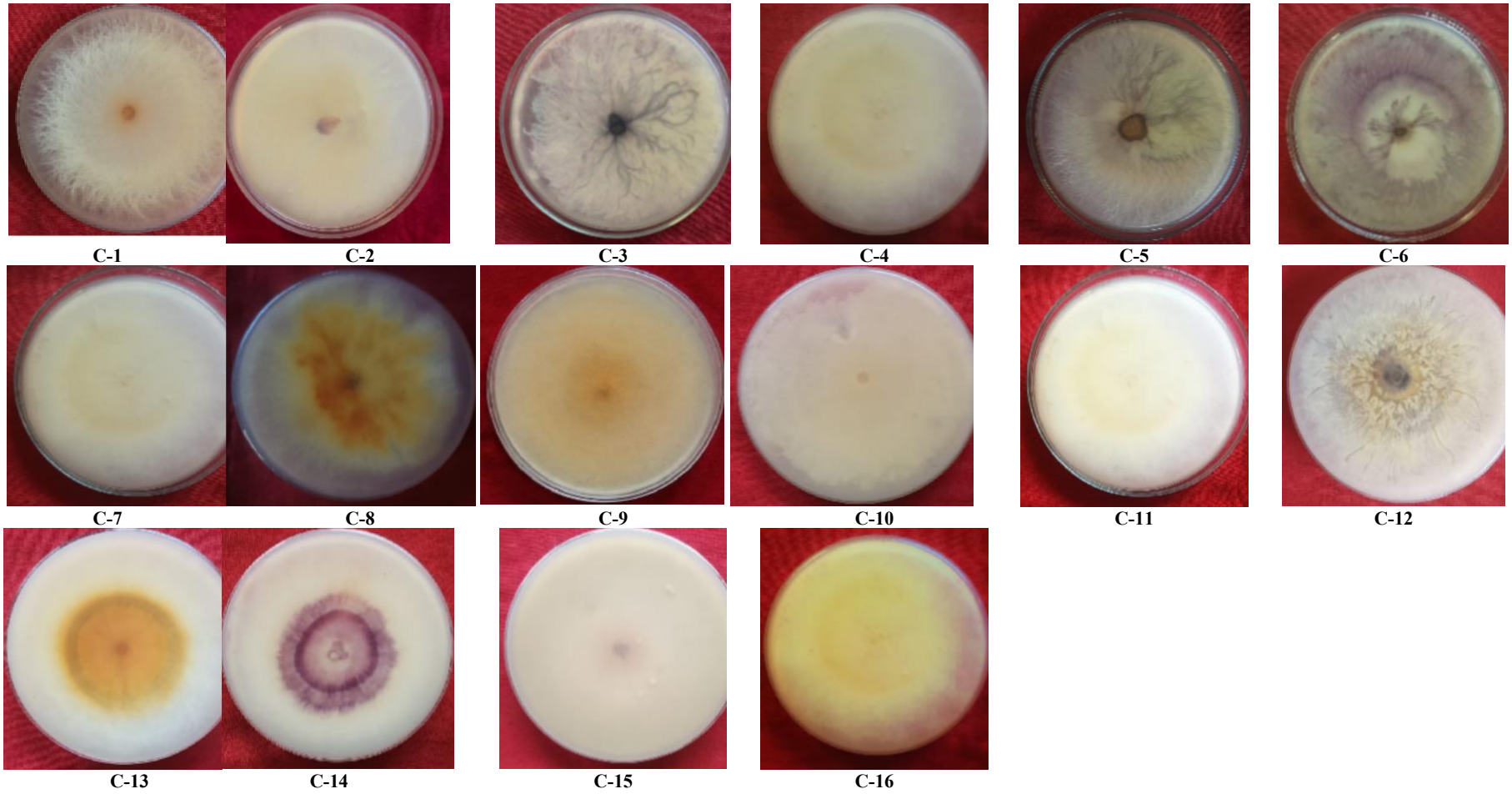


Plate 2b. Inverse view of *Colletotrichum truncatum* isolates on potato dextrose agar

Table 2. Morphological characteristics of *Colletotrichum truncatum* isolates

Sl. No.	Isolate	Place	Mean conidial size (µm)	Shape of conidia	Mean setae size (µm)	Number of setae per acervulus
1	C-1	Yedlapur	11.46 × 4.53	Cylindrical	54.56×3.30	28
2	C-2	Dhanura	12.32 × 4.50	Cylindrical	63.20×4.50	31
3	C-3	Markhal	11.44 × 4.37	Cylindrical	52.22×5.40	31
4	C-4	Janwada	12.54 × 3.82	Cylindrical	-	-
5	C-5	Keroor	12.94 × 5.62	Cylindrical	45.98×4.78	25
6	C-6	Balur	12.86 × 4.32	Cylindrical	-	-
7	C-7	Hallikhed K	13.25 × 4.92	Cylindrical	58.76×4.84	25
8	C-8	Mustapur	13.85 × 5.13	Cylindrical	-	-
9	C-9	Koutha B	12.66 × 4.63	Cylindrical	64.68×5.06	27
10	C-10	Kotgyal	12.86 × 4.12	Cylindrical	56.86×4.78	18
11	C-11	Suntnoor	13.63 × 4.98	Cylindrical	-	-
12	C-12	Ladchincholi	13.86 × 4.64	Cylindrical	-	-
13	C-13	Madur	12.72 × 5.46	Cylindrical	48.76×4.86	21
14	C-14	Bhankur	14.20 × 4.86	Cylindrical	-	-
15	C-15	Savalgi	12.75 × 4.96	Cylindrical	46.89×5.04	25
16	C-16	KVK, Kalaburagi	12.76 × 4.54	Cylindrical	52.78×4.62	23

4. Conclusion

The examination of 16 *Colletotrichum truncatum* isolates on potato dextrose agar documented differences in colony appearance and selected morphological characteristics. Colony colour was predominantly white, apart from the creamy-white colony of C-1, whereas pigmentation included white, grey, purple, orange and yellow. The isolates also differed in growth type and colony margin. Fluffy growth with a regular margin was most frequent, and sectoring was restricted to C-3 and C-6. All 16 isolates produced cylindrical conidia; their mean lengths ranged from 11.44 to 14.20 µm and their mean widths from 3.82 to 5.62 µm. Among isolates with setal measurements, the recorded length range was 45.98–64.68 µm, while counts varied from 18 to 31 setae per acervulus. These findings provide a comparative description of the isolates under the culture conditions examined. The variation was more conspicuous in pigmentation and colony growth characteristics than in conidial dimensions. The recorded cultural and microscopic traits can assist the comparison of isolates in subsequent studies, while conclusions about their behaviour beyond the conditions studied require separate investigation.

5. Limitations

The study characterised 16 isolates using cultural and morphological observations on potato dextrose agar under a single stated incubation temperature. The findings therefore describe variation under these laboratory conditions rather than across different media or environments. Setal measurements and counts were not reported for six isolates in Table 2, limiting comparisons for these traits. The manuscript does not report molecular characterisation, comparative pathogenicity testing or field-based assessment of the isolates; consequently, the observed cultural differences cannot establish differences in aggressiveness or disease-management response.

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Declaration of AI Use

This manuscript was prepared through the intellectual contributions of the author(s) to the study design, data analysis, interpretation of results, and scholarly content. ChatGPT, Claude and Perplexity were used solely to assist with grammatical refinement and reference formatting during manuscript revision. The author(s) accept full responsibility for the accuracy, integrity, and final content of the manuscript.

Competing Interests

Authors have declared that no competing interests exist.

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