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Cultural variability of *Macrophomina phaseolina* causing dry root rot in groundnut

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Abstract

Macrophomina phaseolina is a destructive soilborne pathogen causing dry root rot in groundnut, and its variability has important implications for disease management. The present study was conducted to assess the cultural variability of *M. phaseolina* isolates associated with dry root rot in groundnut and to determine the influence of different solid media on mycelial growth and sclerotial production. Cultural studies were carried out on Potato Dextrose Agar, Czapek's Dox Agar, Oatmeal Agar, and Richards Agar. The results revealed that the mycelial growth, sclerotia initiation and sclerotial production on all the media tested showed significant variations among the *M. phaseolina* isolates. Potato Dextrose Agar supported the maximum mycelial growth and sclerotial production, followed by Oatmeal Agar and Czapek's Dox Agar, whereas Richards Agar recorded comparatively poor growth.

Keywords: *Macrophomina phaseolina*, groundnut, dry root rot, cultural variability, sclerotial production

Introduction

Groundnut (*Arachis hypogaea* L.) is an economically important legume and oilseed crop cultivated widely in tropical and sub-tropical regions for its high oil, protein and nutritional valve (Ganesh *et al*., 2023) [12]. Its production is severely affected by several diseases, among which dry root rot caused by *Macrophomina phaseolina* is one of the most important soilborne diseases in groundnut growing regions. It is a destructive necrotrophic pathogen with a wide host range, survives in soil and crop residues through microsclerotia that remain viable for long periods even in the absence of a host (Marquez *et al*., 2021) [11]. In groundnut, the pathogen infects roots and colour region, symptoms appear as brown colour lesions at soil level, root decay, bark shredding, dropping of foliage, wilting, death of plant and black microsclerotia are seen at infected tissues (Jayasimha *et al*., 2021) [8]. The importance of dry root rot has increased in recent years because the pathogen responds strongly to changing climatic conditions, especially prolonged dry spells, rising temperature, inconsistent rainfall, and moisture stress favour infection and disease development. As a result, the disease is now regarded as an emerging threat to groundnut production, particularly in areas with rainfed cultivation (Pamala *et al*., 2023) [12].

The *M. phaseolina* exhibits considerable variability in cultural and pathogenic characters viz., colony colour, growth rate, sclerotial production, growth pattern, and aggressiveness (Kaur *et al*., 2012) [10]. Studies on groundnut isolates have reported distinct groups ranging from weakly to aggressively pathogenic, demonstrating the existence of considerable biological diversity within the species (Gade *et al*. 2018) [2]. Such variability makes the disease more difficult to manage because isolates may respond differently to host resistance, environmental conditions, and control measures (Sharma *et al*., 2012) [15]. Cultural characterization is an essential step in understanding the biology of *M. phaseolina*. It helps identify optimum growth conditions and media preferences, which are useful for isolating, maintaining, and comparing different strains. (Iqbal and Mukhtar, 2014) [7]. Earlier reports indicated that the pathogen grows well on Potato Dextrose Agar and showed optimum growth around 30°C in various crops (Ashraf *et al*. 2015; Gowdra *et al*., 2015; Gaikwad and Rajurkar, 2018; Satpathi and Gohel, 2018) [1, 3, 6, 14]. The few studies on cultural variability of *M. phaseolina* isolates in groundnut were reported. Therefore, the present study was undertaken to cultural variability of *M. phaseolina* causing dry root rot in groundnut.

Materials and Methods

Isolation and identification of dry root rot pathogen

For isolation of pathogen, groundnut plants showing typical symptoms of dry root rot were collected during survey for disease incidence in groundnut growing areas of Southern India *viz.* Andhra Pradesh, Telangana, Karnataka, and Tamil Nadu (Pamala *et al*., 2023) [12], samples were placed in labelled paper bags and brought to lab. The pathogen *M. phaseolina* was isolated from the infected root portion using the tissue segment method on potato dextrose agar (PDA) medium. The root pieces of about 1 cm were cut with a sterilized blade, surface sterilized in 1% sodium hypochlorite for 45 seconds, washed three times with sterile distilled water, and then plated on Petri dish containing PDA. The plates were incubated at 28 ± 2°C and observed periodically for the growth.

Cultural variability of *M. phaseolina* isolates on different solid media

The cultural variability of *M. phaseolina* isolates on different solid media was determined by using potato dextrose agar (PDA), czapek's dox agar (CDA) (HiMEDIA), oatmeal agar (OMA) (HiMEDIA) and Richard's agar (RA) (HiMEDIA). The respective solid media were prepared and poured @ 15 ml into 90 mm diameter Petri dishes (Gaikwad and Rajurkar, 2018) [3]. The mycelial discs of 5 mm diameter were cut from the edge of

a three-day-old culture and transferred aseptically to Petri dishes amended with a fore mentioned respective media. These petri dishes were then incubated at 28 ± 2°C, and each isolate was replicated thrice for each solid media.
Observations were recorded at 12 hrs intervals to assess growth rate and the time required for sclerotial initiation. Slides were prepared from seven-days-old culture to count the number of sclerotia per 10X microscopic field using a Q-capture image analyser. Sclerotia production was categorized into five types based on the number of sclerotia present in the 10X microscopic field (Table 1).

Table 1: Categorization of *M. phaseolina* isolates of groundnut (Dry root rot) based on the production capacity of sclerotial bodies under *in-vitro* conditions.

S. No.	Rate of sclerotial formation	No. of sclerotia / 10X microscopic field	Category
1	No Sclerotial formation	0	-
2	Poor	1-10	+
3	Moderate	11-20	++
4	Good	21-30	+++
5	Excellent	>30	++++

Statistical analysis
The experiment was laid out in a completely randomized design (CRD) with three replications. The data were statistically analysed using R software version 4.1.0. Data were subjected to analysis of variance (ANOVA) at a significant level and critical difference (CD).

Results and Discussion
Isolation and identification of dry root rot pathogen
The pathogen *M. phaseolina* was isolated from infected Plant samples on PDA, and after 2-3 days of incubation, grey to black culture with aerial mycelium was observed. The cultures were purified using the hyphal tip method. Microscopic examination confirmed the isolates as *M. phaseolina* by using Olympus BX 53 microscope equipped with a digital camera DP 72 (Olympus) observed hyphal characters like right-angle branching of hyphae, constriction near the branching point, and the presence of microsclerotia in all isolates (Figure 1). The isolates were designated as GRb01 to GRb60 for further studies.

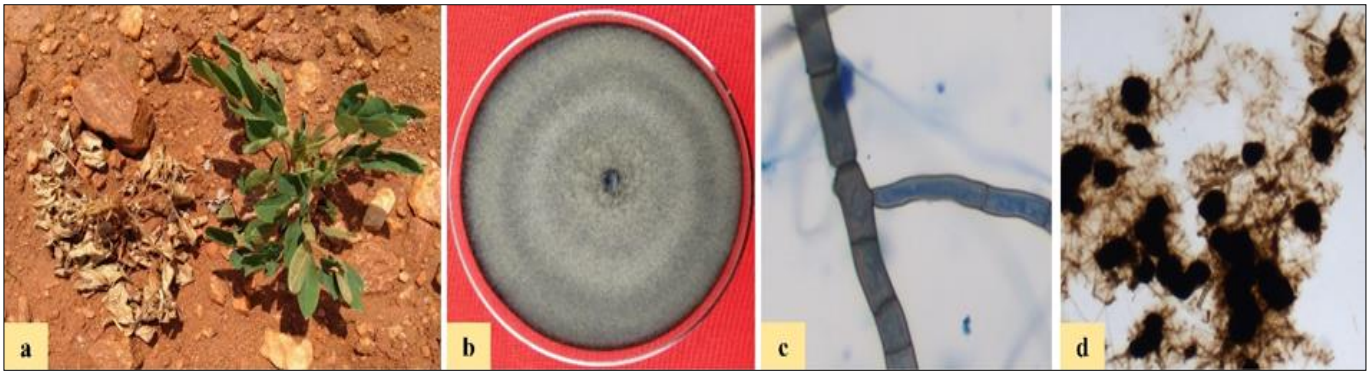

Fig 1: (a) field symptoms of dry root rot disease of groundnut (diseased plant and healthy plant) (b) grey to black culture colour (c) microscopic characteristics like, right angle hyphal branching and constriction near the point of branching and (d) presence of microsclerotia.

Cultural variability of *M. phaseolina* isolates on different solid media
The isolates of *M. phaseolina* showed significant variation in mycelial growth and sclerotium production on the four-culture media tested (Table 2).

Mycelial growth
The average mycelial growth of *M. phaseolina* on different Solid media significantly varied among the isolates (Table 2 and Figure 2). The results revealed that the highest average mycelial radial growth rate of isolates was 8.5 cm at three days after inoculation was observed in PDA, followed by OMA (8.1 cm), CDA (7.8 cm) and RA (6.8 cm) (Figure 3). In PDA, growth rate per day ranges from 1.2 to 3.2 cm, followed by OMA, CDA and RA with 0.6 to 3.1 cm, 0.8 to 3.1 cm and 0.8 to 2.8 cm, respectively.

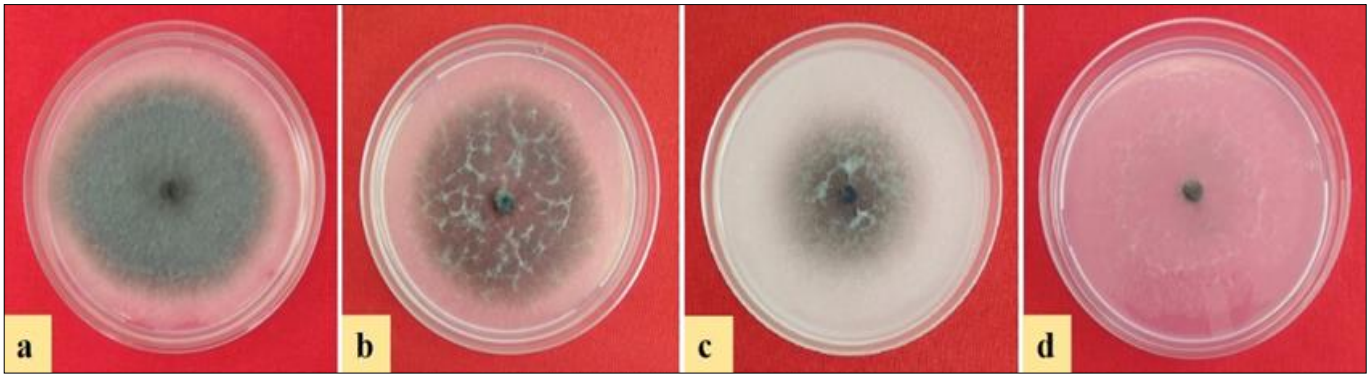

Fig 2: Cultural variability of *M. phaseolina* isolates in different solid media a) PDA b) CDA c) OMA d) RA

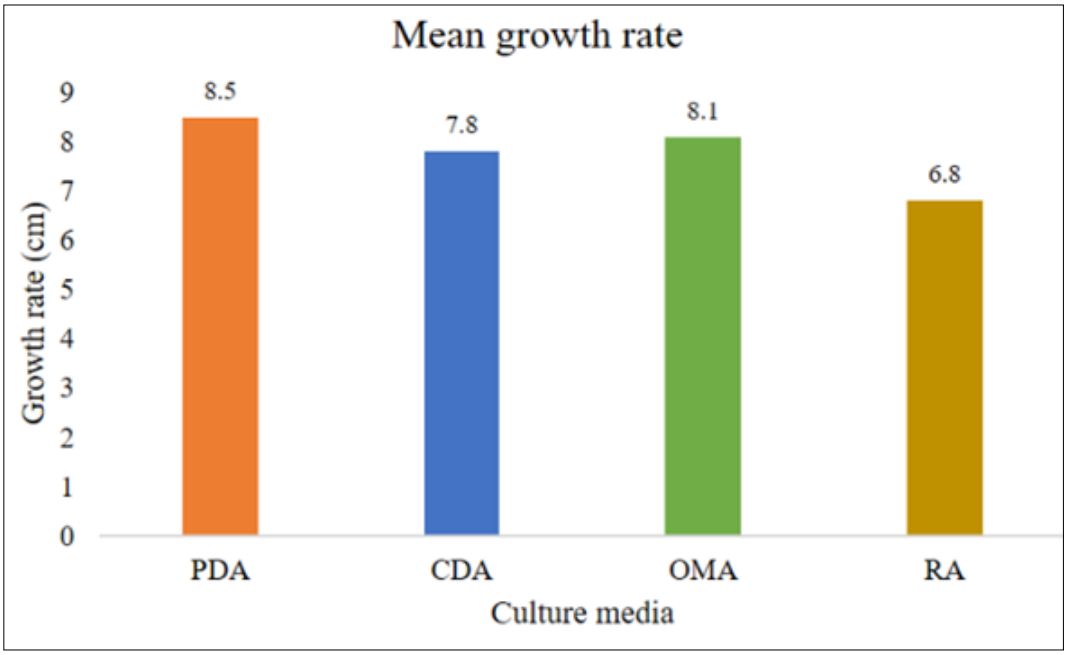

Fig 3: Mean growth rate of *M. phaseolina* isolates on different solid media

Sclerotial initiation and production

On PDA, the time taken for sclerotial initiation varied from 36 to 84 hrs, and the average of all isolates was 54.6 hrs. Sclerotial production ranged from excellent to good. Similarly, on CDA, the time taken for sclerotial initiation varied from 48 to 120 hrs, and the average of all isolates was 68.2 hrs. Excellent to moderate production of sclerotia was observed in all the isolates. On OMA, Sclerotial initiation time ranged from 48 to 120 hrs, and the average of all isolates are 69.6 hrs. Sclerotial production varied from excellent to moderate. The average time taken to sclerotial initiation of all the isolates is 86.8 hrs and Sclerotial initiation time ranges from 60 to 120 hrs. Sclerotial production varies from excellent to poor (Table 2 and Figure 4).

The results showed that both mycelial growth and sclerotial production were significantly affected by the nutrient composition of the culture media. PDA supported the faster mycelial growth and earlier sclerotial production than the other culture media. Similar findings have been reported earlier (Ashraf *et al*., 2015; Gowdra *et al*., 2015; Gaikwad and Rajurkar, 2018; Satpathi and Gohel, 2018) [1, 3, 6, 14], Where PDA was suitable medium for growth and biomass production of the groundnut root rot pathogen, followed by CDA. The nutrient compositions in culture media may be attributed to the pathogen's mycelial growth and sclerotial production. Sclerotial initiation occurred earlier on PDA and was delayed on RA, showing that nutrient composition strongly affected survival structure formation. Because sclerotia are the main long-term survival units of *M. phaseolina* (Jehani *et al*., 2016; Premalatha *et al*., 2020; Geetha et al., 2025) [5, 9, 13].

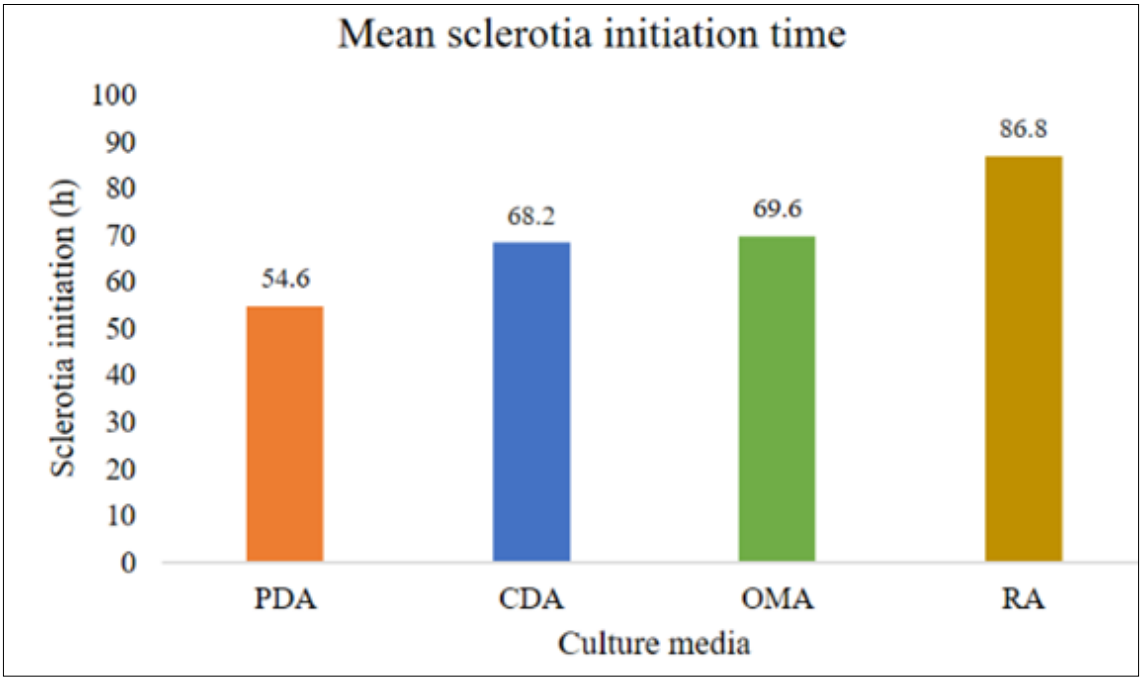

Fig 4: Mean sclerotia initiation time of *M. phaseolina* isolates on different solid media

Table 2: Cultural variability of *M. phaseolina* (groundnut dry root rot) collected from Southern India and assessed on different culture media

Isolate	PDA			CDA			OMA			RA		
	Growth rate (cm) at 72 hrs*	Sclerotia initiation (hrs)	Sclerotial Production **	Growth rate (cm) at 72 hrs	Sclerotia initiation (hrs)	Sclerotial Production	Growth rate (cm) at 72 hrs	Sclerotia initiation (hrs)	Sclerotial Production	Growth rate (cm) at 72 hrs	Sclerotia initiation (hrs)	Sclerotial Production
GRb01	9.0	48	++++	8.1	60	+++	9.0	48	++++	7.4	72	+++
GRb02	9.0	48	++++	9.0	48	++++	9.0	72	+++	7.9	72	+++
GRb03	9.0	60	+++	7.9	60	++++	9.0	60	+++	7.4	72	+++
GRb04	6.6	84	++++	4.3	108	++	5.7	96	++	4.6	120	+
GRb05	6.5	72	++++	4.0	96	++	4.9	108	++	4.9	108	+
GRb06	9.0	48	++++	9.0	48	++++	8.2	72	+++	6.8	96	++
GRb07	9.0	48	++++	9.0	48	++++	7.9	84	+++	6.9	96	++
GRb08	9.0	48	++++	9.0	48	++++	9.0	72	+++	8.0	60	++++
GRb09	5.7	72	+++	2.1	108	++	4.7	120	+	2.9	120	+
GRb10	9.0	60	++++	7.8	60	++++	9.0	60	++++	6.8	84	++++
GRb11	9.0	48	++++	9.0	60	++++	9.0	60	++++	7.9	72	+++
GRb12	7.9	60	+++	7.8	60	+++	9.0	60	++++	6.9	84	++
GRb13	7.3	48	++++	6.1	60	++++	4.7	84	+++	6.3	96	++
GRb14	9.0	48	++++	7.1	96	++++	9.0	48	++++	9.0	48	++++
GRb15	9.0	48	++++	8.2	60	++++	9.0	72	+++	7.0	72	+++
GRb16	7.7	60	+++	5.9	96	++	7.5	84	+++	3.7	120	+
GRb17	7.4	72	+++	5.9	108	++	5.7	96	++	5.0	108	++
GRb18	9.0	36	++++	9.0	48	++++	9.0	60	++++	7.6	72	+++
GRb19	9.0	48	++++	9.0	48	++++	8.4	72	+++	7.9	72	++
GRb20	9.0	48	++++	9.0	48	++++	9.0	60	++++	8.0	72	+++
GRb21	8.0	48	++++	7.4	72	+++	9.0	72	+++	6.6	96	+++
GRb22	9.0	48	++++	9.0	60	++++	8.3	84	+++	7.2	84	+++
GRb23	4.9	72	+++	2.9	108	++	5.5	108	++	3.7	120	+++
GRb24	9.0	36	++++	9.0	48	++++	9.0	60	+++	8.0	60	++++
GRb25	9.0	48	++++	9.0	60	++++	8.0	84	+++	7.8	72	+++
GRb26	9.0	48	++++	8.3	60	++++	6.9	84	+++	7.5	72	+++
GRb27	9.0	60	++++	7.3	84	+++	9.0	60	++++	7.1	84	++
GRb28	7.7	60	+++	7.4	48	++++	7.4	84	+++	7.7	72	++
GRb29	9.0	48	++++	9.0	60	++++	7.4	84	+++	6.4	96	+
GRb30	9.0	48	++++	9.0	48	++++	8.3	72	+++	7.4	84	+++

GRb31	9.0	48	++++	9.0	48	++++	8.6	84	+++	7.3	84	++
GRb32	7.7	60	++++	7.5	84	++++	8.0	84	+++	6.9	96	+++
GRb33	8.2	60	+++	7.5	96	++	8.4	72	+++	6.0	108	++
GRb34	9.0	48	++++	9.0	48	++++	7.8	72	+++	7.7	72	+++
GRb35	8.3	60	++++	7.6	96	++	8.1	84	+++	5.8	108	++
GRb36	8.3	60	+++	8.5	60	++++	8.0	72	+++	6.4	96	++
GRb37	9.0	48	++++	9.0	60	++++	8.5	72	+++	7.1	84	++
GRb38	9.0	60	++++	7.5	84	++++	8.3	72	+++	6.5	96	+++
GRb39	9.0	60	++++	9.0	60	++++	9.0	60	++++	7.4	84	+++
GRb40	9.0	48	++++	9.0	60	++++	8.3	60	+++	8.0	72	+++
GRb41	8.0	60	++++	8.5	72	++++	8.1	84	+++	7.5	84	+++
GRb42	9.0	36	++++	9.0	36	++++	8.6	60	++++	8.1	72	++
GRb43	9.0	84	++++	3.6	108	++	5.4	96	++	5.0	108	+
GRb44	9.0	60	++++	9.0	60	++++	8.7	48	++++	7.1	84	++
GRb45	9.0	60	++++	8.4	60	++++	8.7	72	+++	6.5	96	++
GRb46	4.3	72	+++	7.2	60	+++	8.3	60	+++	4.2	108	++
GRb47	9.0	48	++++	9.0	60	++++	9.0	48	++++	7.6	84	+++
GRb48	9.0	48	++++	8.6	60	++++	9.0	48	++++	7.0	84	++
GRb49	9.0	48	++++	8.2	60	++++	9.0	60	+++	7.7	72	+++
GRb50	7.9	60	++++	7.8	60	++++	9.0	72	+++	6.6	84	++
GRb51	9.0	48	+++	9.0	60	++++	8.3	84	+++	7.5	84	++
GRb52	9.0	48	++++	8.5	60	++++	9.0	48	++++	8.0	72	+++
GRb53	9.0	60	++++	7.8	72	+++	9.0	72	++++	6.7	96	+++
GRb54	9.0	60	+++	8.2	72	+++	9.0	72	+++	6.7	96	++
GRb55	9.0	48	++++	8.1	60	++++	9.0	60	+++	7.2	84	+++
GRb56	9.0	60	++++	8.2	60	++++	9.0	72	+++	6.8	96	++
GRb57	9.0	48	++++	7.8	84	+++	9.0	60	++++	7.3	84	+++
GRb58	9.0	60	++++	7.6	72	+++	9.0	60	+++	6.9	108	++
GRb59	9.0	36	++++	9.0	36	++++	9.0	72	+++	8.4	60	++++
GRb60	8.4	60	+++	7.7	72	+++	9.0	60	++++	7.4	96	++
Mean	8.5	54.6		7.8	68.2		8.1	69.6		6.8	86.8	
Sem	0.33			0.41			0.29			0.26		
CD (0.01)	0.94			1.15			0.82			0.74		
CV%	0.83			1.02			0.73			0.65		

Note: + = Poor, ++ = Moderate, +++ = Good, ++++ = Excellent. * mean of three replications ** number sclerotia/ 10X microscopic field

Conclusion

In the present study, the cultural variability of *M. phaseolina* isolates on different solid media revealed that the considerable variation was observed among the isolates in colony growth, sclerotial initiation, and sclerotial production on all media tested. Potato Dextrose Agar supported the maximum mycelial growth and sclerotial production, followed by Oatmeal Agar and Czapek's Dox Agar, whereas Richards Agar recorded comparatively poor growth. The study revealed significant cultural diversity among *M. phaseolina* isolates, indicating variability in their biological behaviour.

References

1. Ashraf W, Sahi ST, Haq I, Ahmed S. Morphological and Pathogenic Variability among *Macrophomina phaseolina* Isolates Associated with Maize *Zea mays* in Punjab-Pakistan. International Journal of Agriculture and Biology,2015:17(5):1037-1042.
2. Gade RM, Belkar YK, Ingle YV. Morphological and Pathogenic Variability among *Rhizoctonia bataticola* Isolates Associated with Soybean (*Glycine max* L.) from India. International Journal of Current Microbiology and Applied Sciences,2018:7(1):2575-2588.
3. Gaikwad SN, Rajurkar SK. Cultural Studies of *Macrophomina phaseolina* Causing Root Rot Disease of Groundnut *Arachis hypogaea* L. International Journal of Academic Research and Development,2018:3(5):105-108.
4. Ganesh T, Vemana K, Reddy BVB, Venkateswarlu NC, Vidhya AS, Devi RSJ, et al. Pathogenic Variability of *Rhizoctonia bataticola* and *Sclerotium rolfsii* Isolates of Groundnut *Arachis hypogeae* L. in Andhra Pradesh. Biological Forum An International Journal,2023:15(8):352-358.
5. Geetha CR, Latake SB, Gaikwad RT, Navale AM, Randive YK, Karande SA, et al. Cultural and Physiological Studies against *Macrophomina phaseolina* Inciting Dry Root Rot Disease in Soybean. Plant Archives,2025:25(2):176-180.
6. Gowdra N, Muhammad S, Pavithra S, Suresh SR. Morphological Variability of *Macrophomina phaseolina* (Tassi) Goid, Causal Agent of Dry Root Rot Disease of Chickpea (*Cicer arietinum* L.). International Journal of Plant Protection,2015:8(1):69-72.
7. Iqbal U, Mukhtar T. Morphological and Pathogenic Variability among *Macrophomina phaseolina* Isolates Associated with Mungbean *Vigna radiata* L. Wilczek from Pakistan. The Scientific World Journal,2014:2014:1-9.
8. Jayasimha PP, Jayalakshmi RS, Vemana K, Naidu GM, Varshney RK, Sudini HK. Pathogenicity of *Rhizoctonia bataticola* Isolates Collected from Southern India and Screening of Groundnut Genotypes for Resistance to Dry Root Rot in Field Conditions. Biological Forum – An International Journal,2021:13(4):980-987.
9. Jehani MD, Chaudhari DPA. Evaluation of Different Synthetic and Semi-synthetic Media for the Growth and Sclerotial Formation of *Macrophomina phaseolina* (Tassi) Goid. Advances in Life Sciences,2016:5(18):7414-7418.
10. Kaur S, Dhillon GS, Brar SK, Vallad GE, Chand R, Chauhan VB. Emerging Phytopathogen *Macrophomina phaseolina* Biology, Economic Importance and Current Diagnostic Trends. Critical Reviews in Microbiology,2012:38(2):136-151.
11. Marquez N, Giachero ML, Declerck S, Ducasse DA. *Macrophomina phaseolina*: General Characteristics of Pathogenicity and Methods of Control. Frontiers in Plant Science,2021:12:1-16.
12. Pamala PJ, Jayalakshmi RS, Vemana K, Naidu GM, Varshney RK, Sudini HK. Prevalence of Groundnut Dry Root Rot *Macrophomina phaseolina* Tassi Goid. and Its Pathogenic Variability in Southern India. Frontiers in Fungal Biology,2023:4:1-16.
13. Premalatha K, Oviya R, Kannan R, Sabarinathan KG, Ramamoorthy V. Isolation and Evaluation of Various Isolates of *Macrophomina phaseolina* Causing Dry Root Rot of Sesame. International Journal of Current Microbiology and Applied Sciences,2020:9(7):728-734.
14. Satpathi AK, Gohel NM. Cultural and Morphological Variability among the Isolates of *Macrophomina phaseolina* Tassi Goid. Causing Stem and Root Rot of Sesame *Sesamum indicum* L. International Journal of Chemical Studies,2018:6(6):2890-2893.
15. Sharma M, Ghosh R, Krishnan RR, Nagamangala UN, Chamarthi SK, Varshney RK, et al. Molecular and Morphological Diversity in *Rhizoctonia bataticola* Isolates Causing Dry Root Rot of Chickpea (*Cicer arietinum* L.) in India. African Journal of Biotechnology,2012:11(37):8949-8959.