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Studies on isolation, identification and pathogenicity of *Macrophomina phaseolina* causing dry root rot of mungbean

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Abstract

Dry root rot caused by *Macrophomina phaseolina* is an important soil-borne disease of mungbean, particularly under high-temperature and moisture-deficit conditions. The present investigation was undertaken to isolate, identify and establish the pathogenicity of the pathogen associated with dry root rot of mungbean in Junagadh district. Diseased mungbean plants exhibiting characteristic dry root rot symptoms were collected from different fields and the pathogen was isolated from infected root tissues on Potato Dextrose Agar (PDA) medium under aseptic conditions. The isolate was purified and identified based on its cultural and morphological characteristics, including abundant mycelial growth and formation of characteristic black microsclerotia. Infected plants exhibited rusty-brown discoloration and decay of roots, shredding of the root cortex, followed by leaf drooping, sudden wilting and complete drying of plants. Pathogenicity was confirmed under glasshouse conditions using mungbean, where typical symptoms developed 30–35 days after inoculation. Re-isolation of the pathogen from artificially infected plants and comparison with the original culture confirmed *M. phaseolina* as the causal agent of dry root rot of mungbean.

Keywords: *Macrophomina phaseolina*, dry root rot, mungbean, pathogenicity

1. Introduction

Pulses constitute an important component of the human diet, particularly in India, where they are commonly consumed in combination with cereals to provide a nutritionally complementary source of high-quality plant protein (Ali and Sen Gupta, 2012; Calles *et al.*, 2019; Ramya *et al.*, 2026) ^[1, 4, 21]. In addition to their nutritional importance, pulse crops contribute significantly to sustainable agricultural production through biological nitrogen fixation, improvement of soil fertility and their adaptability to low-input production systems. Recognizing their importance for food and nutritional security, the United Nations General Assembly declared 2016 as the “International Year of Pulses” to promote their contribution to sustainable food systems and human health (Khan, 2016) ^[10].

Mungbean [*Vigna radiata* (L.) Wilczek], commonly known as green gram, is one of the important grain legumes cultivated extensively in India and other parts of Asia, particularly Southeast and East Asia (Lambrides and Godwin, 2017) ^[15]. It belongs to the family Leguminosae and is valued for its high nutritional quality, short crop duration, low input requirement and adaptability to diverse agro-climatic conditions. The crop is considered to have originated in the Indian subcontinent, where it was domesticated several centuries ago (Vavilov, 1926) ^[27]. Mungbean is predominantly adapted to tropical and subtropical environments and can be cultivated over a relatively wide range of latitudes provided temperatures remain above approximately 15 °C (Lawn, 1983; Imrie *et al.*, 1981) ^[16, 9]. Its short duration and suitability for inclusion in different cropping systems make it an important crop for enhancing cropping intensity and farm productivity.

Despite these advantages, mungbean productivity is constrained by several biotic and abiotic stresses. Among the biotic constraints, insect pests and diseases are particularly important because they can cause considerable reductions in plant growth, yield and seed quality.

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Mungbean is affected by a number of economically important diseases, including mungbean yellow mosaic virus, *Cercospora* leaf spot, powdery mildew, anthracnose, web blight, bacterial blight and dry root rot (Khattak *et al.*, 2000; Lal, 1987; Pandey *et al.*, 2018; Roy *et al.*, 2023) ^[12, 14, 19, 22]. The severity and distribution of these diseases vary with cultivar, environmental conditions and pathogen prevalence, thereby posing a major challenge to stable mungbean production.

Among the soil-borne diseases, dry root rot (DRR) caused by *Macrophomina phaseolina* (Tassi) Goid is an important and destructive disease of mungbean. The disease has been reported from several major mungbean-growing regions and is capable of causing substantial yield losses under favorable environmental conditions (Allen *et al.*, 2017; Pandey *et al.*, 2020) ^[2, 18]. *Macrophomina phaseolina* is a soil- and seed-borne necrotrophic pathogen with a broad host range and remarkable survival ability in soil. The pathogen produces microsclerotia that enable it to persist in crop residues and soil for extended periods, making its management particularly difficult (Pandey *et al.*, 2021) ^[20].

Dry root rot symptoms generally begin with root infection and progressive rotting of the root system, followed by black discoloration of affected tissues, yellowing and wilting of plants, and, in severe cases, complete plant death (Khan *et al.*, 2017) ^[11]. Disease development is strongly influenced by environmental conditions, with high temperature and low soil moisture favoring disease development and increasing disease severity (Saleh *et al.*, 2010) ^[23]. The pathogen can spread through infested soil, infected plant debris and seed, resulting in the establishment and persistence of inoculum within cropping systems. Consequently, the disease can become particularly severe under warm and moisture-deficit conditions.

The management of dry root rot is challenging because of the persistent nature of the pathogen, its soil-borne habit and the influence of environmental factors on disease development. Although fungicides, biological control agents and other management practices have been investigated for the suppression of *M. phaseolina*, effective and sustainable management requires a better understanding of the pathogen, its variability, disease development and response to different management approaches. Therefore, comprehensive studies on the occurrence, isolation, identification, pathogenicity, cultural and morphological variability, host-pathogen interactions and management of *M. phaseolina* are essential for developing effective strategies against mungbean dry root rot.

In view of the increasing importance of dry root rot as a constraint to mungbean production, the present study was undertaken to investigate the prevalence, characterization and pathogenicity of *M. phaseolina* associated with dry root rot of mungbean and to evaluate suitable management strategies, including fungicides and other potential disease management approaches, for effective suppression of the pathogen and disease.

2. Materials and Methods

2.1 Isolation and purification of pathogen

The fungus was isolated from root tissues of mungbean plants exhibiting characteristic disease symptoms. A standard tissue isolation technique was employed for pathogen isolation following the procedure described by Tuite (1969), as outlined below:

2.1.1 Isolation procedure

Freshly infected root tissues of mungbean plants exhibiting

typical root rot symptoms were selected for pathogen isolation. The infected tissues were cut into small segments ensuring that each segment contained both infected and healthy portions and placed in sterile Petri plates. The tissue pieces were surface-sterilized using 1 per cent sodium hypochlorite (NaClO) solution for approximately one minute. The sterilized tissues were then rinsed thoroughly with sterile distilled water in two successive washes to remove any residual disinfectant. Hands were disinfected with rectified spirit and the working surface of the inoculation chamber was cleaned using a cotton swab soaked in rectified spirit. PDA medium (20 ml per plate) was poured into sterilized Petri plates under aseptic conditions and allowed to solidify. Four surface-sterilized tissue pieces were aseptically placed at equal distances on each PDA plate. The plates were incubated in an inverted position at $28 \pm 1^\circ\text{C}$ and observed after 2–3 days for fungal growth. Actively growing hyphal tips were aseptically excised and transferred to PDA slants for purification and maintenance of the fungal isolates.

2.1.2 Purification of fungus by single hyphal tip method

A mycelial suspension of the fungus was prepared in sterile distilled water. Approximately 20 ml of melted 2 per cent agar (maintained at $40\text{--}45^\circ\text{C}$) was poured into sterile Petri plates. The plates were inoculated with a loopful of the mycelial suspension and gently rotated to ensure uniform spreading. After solidification of the medium, a single emerging hyphal tip was identified and marked using a glass marking pencil under an inverted position. The selected hyphal tip was aseptically transferred onto PDA slants. The inoculated slants were incubated at $28 \pm 2^\circ\text{C}$ in a B.O.D. incubator until visible growth was obtained. The resulted culture was confirmed as pure and used for further experimental work. To maintain culture viability and prevent contamination, the pure isolate was periodically sub-cultured on PDA slants at 15-day intervals.

2.2 Identification of fungus

The colony appearance of *M. phaseolina* in culture varies from black to brown or gray, gradually darkening as the culture ages. The fungus produces abundant aerial mycelium, with microsclerotia embedded within the hyphae or aggregated on the agar surface, forming smooth and distinct structures. The hyphae are septate and initially hyaline, later became honey-brown to black. Numerous dark brown to black microsclerotia were visible, particularly on the reverse side of the culture plate. The vegetative mycelium was characterized by monilid or barrel-shaped cells and the presence of septa near branching points. Hyphal branching typically occurred at right angles to the parent hyphae, although acute-angle branching may also observed (Dhingra and Sinclair, 1977) ^[6]. Microsclerotia develop through the aggregation of melanized hyphal cells and generally consisted of 50–200 cells. They are black and their size varied between 50–150 μm depending on the host and the culture medium (Short and Wyllie, 1978) ^[25].

2.3 Pathogenicity test

Pathogenicity was confirmed under net house conditions by artificial inoculation of *M. phaseolina* using the susceptible mungbean cultivar JG-37, following standard inoculation procedures based on Koch's postulates. Soil and earthen pots were sterilized. For each pathogenicity method, five pots were used and an additional set of five pots filled only with sterilized soil served as the uninoculated control. Representative isolates of the pathogen were utilized for the pathogenicity tests.

2.4 Seed inoculation

Ten apparently healthy, surface-sterilized seeds were each rolled over seven day-old cultures of *M. phaseolina* grown on PDA in Petri plates to ensure proper inoculation. The inoculated seeds were then sown into earthen pots contained sterilized soil at the rate of 10 seeds per pot. Surface-sterilized, uninoculated healthy seeds served as the control. All pots were maintained in the net house and irrigated as required. Seed germination was recorded one week after sowing, while disease incidence was assessed 15 days after germination.

2.5 Soil inoculation

Pathogenicity was confirmed using the sick pot technique described by Nene *et al.* (1981) [17]. Autoclaved soil was filled into 30 cm earthen pots (3 kg per pot) and inoculated separately with *M. phaseolina* grown on sorghum sand medium (SSM). The SSM was prepared by mixing 100 g sorghum grain flour, 50 g sand and 50 ml distilled water in 250 ml conical flasks, plugging with cotton, wrapping with aluminum foil and sterilizing at 15 psi for 1 h for three consecutive days. The sterilized medium was then inoculated with 5 mm mycelial discs of *M. phaseolina* and incubated at 25-30 °C in a B.O.D. incubator. The flasks were shaken on alternate days to ensure uniform fungal colonization. The colonized SSM was mixed with sterilized soil at 5 per cent (w/w) following Haware (1980) [7]. Soil without inoculum served as the control. Seeds of the susceptible mungbean variety JG -37 were sown in the inoculated pots and maintained under controlled conditions. The pots were kept in the net house and irrigated as required. Initial seedling emergence was recorded and root rot incidence was assessed weekly, beginning 15 days after germination. Control plants grown in uninoculated soil remained symptomless. The pathogen was successfully re-isolated from infected seedlings showing characteristic root rot symptoms using a standard tissue isolation technique. The identity of the re-isolated fungus was confirmed based on its morphological characteristics and compared with the original culture on PDA slants, thereby satisfying Koch's postulates.

2.6 Symptomology: Visual and microscopic examinations of root rot-infected samples were performed to confirm the presence of the pathogen. Characteristic signs and symptoms on mungbean roots under natural field conditions were carefully observed and recorded.

3. Results and Discussion

3.1 Isolation and identification of the dry root rot pathogen

Mungbean plants exhibiting characteristic symptoms of dry root rot were collected from different fields of Junagadh district. The infected plant samples were carefully brought to the Department of Plant Pathology for further investigation. The pathogen was isolated from the diseased root tissues on Potato Dextrose Agar (PDA) medium under aseptic conditions and subsequently purified through the single-spore isolation technique to obtain a pure culture.

The purified fungal isolate was examined microscopically for identification based on its morphological characteristics, including the nature of the mycelium and the formation of sclerotia. The infected plants exhibited typical dry root rot symptoms such as drooping of petioles and leaflets, yellowing and wilting of foliage and the presence of numerous black, scattered sclerotial bodies on the root and collar regions during the early stages of infection.

3.2 Symptomatology of dry root rot in mungbean

The characteristic symptoms of dry root rot observed in mungbean plants are presented in Plate.1, which served as the basis for identifying diseased plants under field conditions. The disease is predominantly favoured by high temperature and moisture-deficit conditions, making it more severe during periods of heat and drought stress.

The life cycle of the pathogen comprises four distinct phases: (i) germination, (ii) penetration, (iii) parasitic and (iv) saprophytic phases. During the initial stage of infection, the affected plants exhibited a rusty-brown discoloration of the root system, which gradually progressed to root decay. As the disease advanced, necrotic lesions developed on the infected root tissues, accompanied by the formation of numerous minute black sclerotia. The infected plants showed drooping of leaves and petioles, followed by sudden wilting and complete drying.

The pathogen initially invaded and colonized the living root tissues and subsequently entered the saprophytic phase, during which it degraded the host cells, resulted in extensive tissue necrosis and characteristic black discoloration of the roots. The deterioration of root tissues reduced their structural integrity, impaired the uptake and translocation of water and nutrients and ultimately arrested plant growth. Severe infection leads to premature drying and death of the plants, resulted in considerable yield losses.

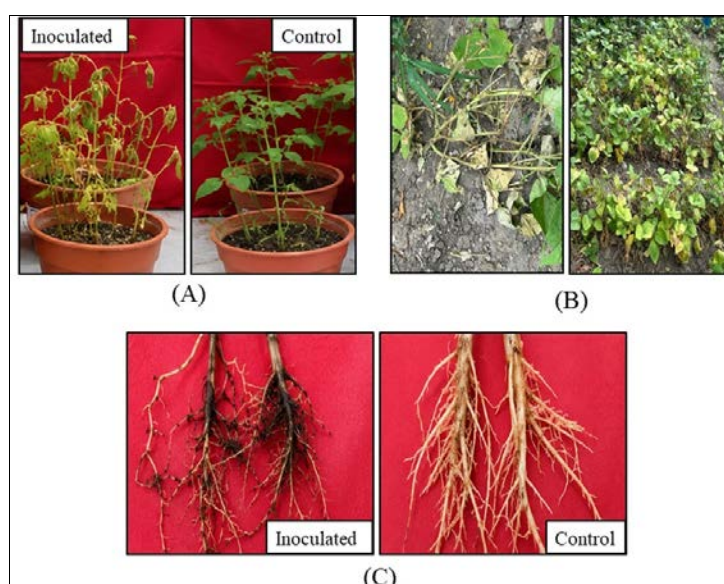


Plate 1: Symptomology of *M.phaseolina* on mungbean (A) Treated and Control treatments in pots, (B) Field view of dry root rot disease incidence, (C) Root systems *M. phaseolina* inoculated and control plants

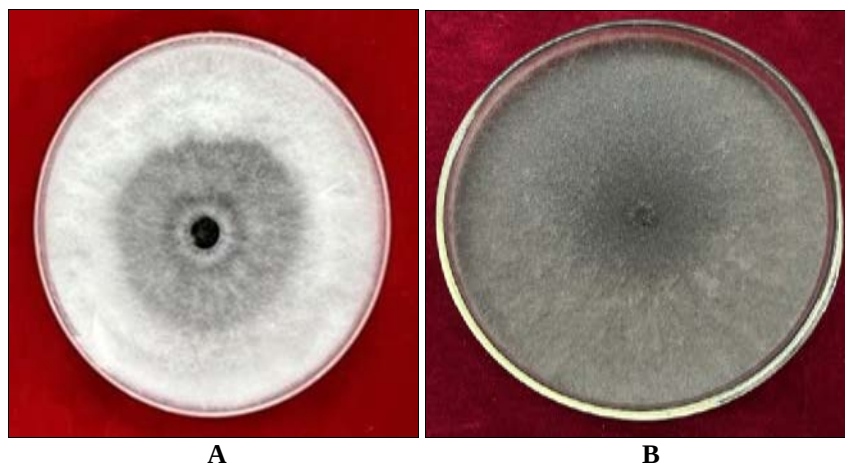


Plate 2: Morphological characteristics of *Macrophomina phaseolina* causing dry root rot of mungbean (A) Pure culture (B) Old culture, 10 day old at 10X

3.3 Pathogenicity test

The pathogenicity of the isolated *Macrophomina phaseolina* was evaluated under glasshouse conditions following the inoculation procedure described in Section 2.5. Typical dry root rot symptoms were observed on mungbean plants 30-35 days after inoculation, thereby confirming the virulence of the pathogen.

The infected plants initially exhibited rusty-brown discoloration of the secondary roots, followed by shredding of the cortex region of the tap root. As the disease progressed, necrotic lesions developed on the affected root tissues along with the formation of numerous minute black sclerotia. These symptoms ultimately resulted in sudden wilting and drying of the plants. Microscopic examination of the infected roots revealed abundant microsclerotia characteristic of *M. phaseolina*.

To fulfill Koch's postulates, the pathogen was re-isolated from the artificially infected plants grown under glasshouse conditions and cultured on Potato Dextrose Agar (PDA) medium. The cultural and morphological characteristics of the re-isolated fungus were identical to those of the original isolate, thereby confirming that *M. phaseolina* was the causal agent of dry root rot in mungbean (Plate.2).

Discussion

The present findings are in agreement with those of Lakhra *et al.* (2018)^[13], who successfully isolated, purified, identified and confirmed the pathogenicity of fungal species associated with infected plant tissues using similar morphological and cultural characteristics.

The symptoms observed in the present investigation are in close agreement with the findings of Choudhary *et al.* (2011)^[5], who reported wilting of plants at advanced stages of infection followed by complete plant mortality. Similarly, Basandrai *et al.* (2021) documented that the dry root rot pathogen causes both pre-emergence and post-emergence mortality in mungbean seedlings as well as mature plants under field conditions.

The present findings are in close agreement with the earlier reports of Higuera (1991)^[8], who evaluated different inoculation techniques for establishing the pathogenicity of *Macrophomina phaseolina* in cowpea. Among the inoculation methods tested, soil-borne inoculum multiplied on rice seeds was found to be highly effective in establishing infection and producing characteristic disease symptoms. The higher effectiveness of the soil-based inoculation method could be attributed to the direct placement of the pathogen inoculum in the rhizosphere, thereby providing greater opportunity for the pathogen to come into contact with susceptible roots and establish infection. The

development of distinct root rot symptoms following soil inoculation further demonstrated the ability of *M. phaseolina* to infect the host through the root zone and subsequently cause disease.

Similarly, Satish (1993)^[24] reported successful induction of charcoal rot (dry root rot) and root rot symptoms in jojoba through soil inoculation with *M. phaseolina* using a seed-cum-soil incorporation technique. The successful development of disease following incorporation of pathogen-infested inoculum into the soil highlights the importance of soil as a primary reservoir and source of inoculum for *M. phaseolina*. The pathogen is capable of surviving in soil and plant debris for prolonged periods, primarily through the formation of microsclerotia, which serve as important survival structures and facilitate subsequent infection of susceptible plants.

The results of the present study, together with these earlier observations, demonstrate that soil-based inoculation techniques are reliable for establishing *M. phaseolina* infection under controlled experimental conditions. The consistent development of typical dry root rot symptoms following inoculation also confirms the pathogenic nature of the isolates used in the present investigation. Moreover, the effectiveness of soil inoculation emphasizes the importance of the rhizosphere and soil-borne inoculum in the disease cycle of *M. phaseolina*. Thus, the present findings corroborate previous reports and provide further evidence that incorporation of pathogen-infested substrate into the soil can be effectively employed for pathogenicity testing and for evaluating the disease-causing ability of *M. phaseolina* isolates under experimental conditions.

Conclusion

The present investigation confirmed *Macrophomina phaseolina* as the causal agent of dry root rot of mungbean in the surveyed fields of Junagadh district. Diseased plants exhibited characteristic symptoms, including leaf and petiole drooping, yellowing and wilting, rusty-brown root discoloration, root decay, cortical shredding and formation of numerous black microsclerotia on infected root and collar regions. The pathogen was successfully isolated from infected root tissues on Potato Dextrose Agar, purified and identified based on its cultural and morphological characteristics, particularly abundant mycelial growth and characteristic black microsclerotia. The disease was observed to be favoured by high-temperature and moisture-deficit conditions.

Pathogenicity tests under glasshouse conditions confirmed the disease-causing ability of the isolate, with typical symptoms

appearing 30–35 days after inoculation. Re-isolation of the pathogen from artificially infected plants and comparison with the original culture confirmed the identity of *M. phaseolina*, thereby fulfilling Koch's postulates. Overall, the findings provide a reliable basis for further studies on the epidemiology, variability and effective management of dry root rot of mungbean.

References

1. Ali M, Gupta S. Carrying capacity of Indian agriculture: pulse crops. *Current Science*. 2012;4(2):874–881.
2. Allen TW, Bradley CA, Sisson AJ, Byamukama E, Chilvers MI, Coker CM, et al. Soybean yield loss estimates due to diseases in the United States and Ontario, Canada. *Plant Health Progress*. 2017;18(1):19–27.
3. Basandrai AK, Basandrai D, Sharma BK. Dry root rot of mungbean caused by *Macrophomina phaseolina*: symptomatology and disease management. *Indian Phytopathology*. 2021;74:749–758.
4. Calles T, Xipsiti M, del Castello R. Legacy of the international year of pulses. *Environmental Earth Sciences*. 2019;78(5):1–8.
5. Choudhary RG, Jain RK, Mathur K. Dry root rot of mungbean caused by *Macrophomina phaseolina* in Rajasthan. *Indian Phytopathology*. 2011;64:284–286.
6. Dhingra OD, Sinclair JB. Influence of soil environment on survival of *Macrophomina phaseolina* in soil. *Phytopathology*. 1977;67:1198–1201.
7. Haware MP. Techniques for inoculation of chickpea with *Macrophomina phaseolina*. In: *Proceedings of the International Workshop on Chickpea Improvement*. Hyderabad: ICRISAT; 1980. p. 10–11.
8. Higuera G. Evaluation of inoculation techniques for screening cowpea against *Macrophomina phaseolina*. *Plant Disease*. 1991;75:1033–1036.
9. Imrie BC, Drake DW, DeLacy IH, Byth DE. Analysis of genotypic and environmental variation in international mungbean trials. *Euphytica*. 1981;30(2):301–311.
10. Khan SA. Reflecting on the International Year of Light and light-based technologies. *Current Science*. 2016;111(4):627–631.
11. Khan SN, Abid M, Javaid A. Genetic diversity among isolates of *Macrophomina phaseolina* revealed by RAPD markers. *Pakistan Journal of Phytopathology*. 2017;29(1):27–36.
12. Khattak GSS, Haq MA, Ashraf M, McNeilly T. Genetic basis of variation for flag leaf area and other related traits in mungbean. *Journal of Genetics and Breeding*. 2000;54(4):285–292.
13. Lakhra H, Choudhary DK, Jat BL. Cultural and morphological characterization of *Macrophomina phaseolina* from chickpea. *Journal of Plant Disease Protection*. 2018;125(4):419–424.
14. Lal SS. A review of insect pests of mungbean and their control in India. *Tropical Pest Management*. 1987;33(1):87–103.
15. Lambrides CJ, Godwin ID. Mungbean. In: *Genome mapping and molecular breeding in plants*. Vol. 3, Pulses, sugar and tuber crops. Springer; 2017. p. 69–90.
16. Lawn RJ. Response of four grain legumes to water stress in south-eastern Queensland. *Australian Journal of Agricultural Research*. 1983;34(5):481–501.
17. Nene YL, Haware MP, Reddy MV. Chickpea diseases: resistance-screening techniques. *ICRISAT Information Bulletin No. 28*. Patancheru: International Crops Research Institute for the Semi-Arid Tropics; 1981. p. 28–29.
18. Pandey AK, Burlakoti RR, Rathore A, Nair RM. Morphological and molecular characterization of *Macrophomina phaseolina* isolated from three legume crops and evaluation of mungbean genotypes for resistance to dry root rot. *Crop Protection*. 2020;127:104962.
19. Pandey AK, Nair RM, Sharma M, Pande S. Review on diseases and disease management of mungbean. *Journal of Food Legumes*. 2018;31(2):1–22.
20. Pandey AK, Yee M, Win MM, Lwin HMM, Adapala G, Rathore A, et al. Identification of new sources of resistance to dry root rot caused by *Macrophomina phaseolina* isolates from India and Myanmar in a mungbean mini-core collection. *Crop Protection*. 2021;143:105569.
21. Ramya A, Venu E, Eden K, Prasanna Kumari V, Srinivas Prasad M. Enzymatic antioxidant responses in resistant and susceptible rice genotypes due to blast infection. *International Journal of Advanced Biochemistry Research*. 2026;10(3S):1006–1012.
22. Roy B, Venu E, Kumar S, Dubey S, Lakshman D, Mandal B, et al. Leaf curl epidemic risk in chilli as a consequence of vector migration rate and contact rate dynamics: a critical guide to management. *Viruses*. 2023;15(4):854.
23. Saleh AA, Ahmed HU, Todd TC, Travers SE, Zeller KA, Leslie JF, et al. Relatedness of *Macrophomina phaseolina* isolates from tallgrass prairie, maize, soybean and sorghum. *Molecular Ecology*. 2010;19(1):79–91.
24. Satish D. Studies on dry root rot of greengram caused by *Macrophomina phaseolina* [MSc thesis]. Dharwad: University of Agricultural Sciences; 1993.
25. Short GE, Wyllie TD. Biological control of *Macrophomina phaseolina* with *Bacillus subtilis*. *Phytopathology*. 1978;68:1297–1302.
26. Tuitt J. *Plant pathological methods: fungi and bacteria*. Minneapolis (MN): Burgess Publishing Company; 1969. p. 239.
27. Vavilov NI. Centers of origin of cultivated plants. *Institute of Applied Botany and Plant Breeding*. 1926;16(2):121–129.