STM JOURNALS

International Journal of
Fungi

Volume 1, Issue 2, 2024
July–December
DOI (Journal): 10.37591/IJF

https://journals.stmjournals.com/ijf

Review IJF

Causes and Measures to Control Root Rot Fungus in Mulberry Ecosystem

K. Ramya Harika[1,*], Tejashree P.[2], Karthick Mani Bharathi B.[3], Susikaran S.[4], Vasanth V.[3]

Abstract

Root rot is a severe plant disease caused by various soil-borne fungi, including Phytophthora sp., Pythium sp., Rhizoctonia sp., Fusarium sp., and Armillaria sp. These pathogens attack plant roots, leading to decay, stunted growth, wilting, yellowing leaves, and plant death. Root rot typically develops in waterlogged soils with poor drainage, as these conditions create an environment favorable for fungal growth. Factors such as warm temperatures, compacted soil, improper watering practices, and plant stress (due to nutrient imbalances, mechanical injury, or weakened immunity) also contribute to the spread of root rot. Symptoms of root rot include root discoloration, a foul odor from decaying roots, and poor plant growth. Control measures focus on prevention through cultural, biological, and chemical strategies. Important cultural techniques include proper soil management and proper drainage. Crop rotation and the use of resistant plant varieties. Biological controls such as beneficial fungi (e.g., mycorrhizae) and antagonistic microbes (e.g., Trichoderma sp.) can help suppress fungal pathogens. Chemical treatments, including fungicides and soil fumigation, are used sparingly as a last resort. An integrated approach combining cultural, biological, and chemical methods is essential for long-term management of roots rot, thus ensuring the health and productivity of crops and plants.

Keywords: Bio-control, host resistance, ipm, management, root rot fungus, symptoms

INTRODUCTION

Mulberry (*Morus* spp.) is an economically significant plant widely cultivated for its leaves, which are the primary food source for silkworms, and its fruits, which have culinary and medicinal uses [1]. However, the productivity of mulberry crops is often severely threatened by root rot diseases primarily caused by various soil-borne fungal pathogens such as *Fusarium spp.*, *Rhizoctonia solani*, and *Lasiodiplodia theobromae*. These pathogens induce significant economic losses and hinder the sustainable cultivation of mulberry, necessitating an understanding of the causes of root rot and effective management strategies to control these diseases [2].

Root rot infection can occur for many reasons. Including both biotic and abiotic stresses. Bionically, fungi are the primary agents responsible for root rot. *Fusarium solani*, for example, is known to infect the root system of mulberry, thus leading to severe wilting and plant death [3]. Other pathogens like *Rhizoctonia solani* and *Lasiodiplodia theobromae* exacerbate the issue, particularly under conducive environmental conditions, such as excessive soil moisture, poor drainage, and high humidity [4]. These fungi thrive in warm, moist environments, thus allowing them to invade and colonize root tissues, resulting in necrosis and subsequent decline of the plant [5].

***Author for Correspondence**
K. Ramya Harika
E-mail: kamaramyaharika4444@gmail.com

[1]Teaching Assistant, Sri Swaminathan Polytechnic of Agriculture, Guntur, Andhra Pradesh, India
[2]Research Scholar, Department of Genetics and Plant Breeding, SV Agricultural College, Tirupati, Andhra Pradesh, India
[3,5]Student, Department of Sericulture, Forest College and Research Institute, Tamil Nadu Agricultural University, Mettupalayam, Tamil Nadu, India
[4]Assistant Professor, Directorate of Open and Distance Learning, Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu, India

Received Date: October 10, 2024
Accepted Date: October 13, 2024
Published Date: October 22, 2024

Citation: K. Ramya Harika, Tejashree P., Karthick Mani Bharathi B., Susikaran S., Vasanth V. Causes and Measures to Control Root Rot Fungus in Mulberry Ecosystem. International Journal of Fungi. 2024; 1(2): 36–41p.

Abiotic factors also contribute to the onset of root rot diseases. Soil quality, including pH, nutrient availability, and organic matter content, significantly influences the susceptibility of mulberry to fungal infections [6]. Soils that are poorly drained or have high compaction levels can create anaerobic conditions that promote the proliferation of pathogenic fungi. Additionally, environmental stresses such as drought or excessive rainfall can weaken plants, thus making them more susceptible to infections [7].

Control measures for root rot in mulberry involve an integrated approach thereby combining cultural, biological, and chemical methods to effectively manage disease incidence and severity [8]. One of the fundamental cultural practices is the implementation of proper irrigation management to avoid waterlogging, which creates a favorable environment for root rot pathogens. Enhancing soil drainage and incorporating organic matter can improve soil structure and aeration, thus reducing pathogen prevalence [9].

Biological control agents including beneficial microorganisms such as *Trichoderma spp.* have gained attention as an effective alternative to chemical fungicides. These agents can inhibit the growth of root rot pathogens through various mechanisms, including competition for nutrients, production of antifungal metabolites, and parasitism. Additionally, employing resistant mulberry varieties can be a long-term strategy to mitigate root rot, as these cultivars possess inherent traits that enhance their resilience against fungal infections [10].

Chemical control measures such as the application of fungicides can provide immediate relief from severe infections; however, they should be used judiciously and as part of an integrated disease management strategy. Fungicides can effectively suppress pathogen populations, but their overuse can lead to resistance development, thus making it crucial to combine chemical treatments with other control measures [11]. Root rot is a serious threat to mulberry cultivation, which affects productivity and quality. Understanding the multifaceted causes of these diseases, alongside implementing an integrated approach that encompasses cultural, biological, and chemical management strategies, is vital for sustainable mulberry production. Continued research into the epidemiology of root rot pathogens and the development of resilient cultivars will be instrumental in securing the future of mulberry cultivation and its associated industries [12].

CAUSES OF ROOT ROT

The primary cause of root rot is fungal infection, but this infection is facilitated by several contributing factors that create an environment conducive to fungal growth.

Fungal Pathogens

Different species of fungi cause root rot with each exhibiting slightly different characteristics:

- *Phytophthora sp.* is known to affect many plant species, including fruit trees, ornamental plants, and vegetables. *Phytophthora cinnamomi* is a notorious pathogen causing root rot in avocados, eucalyptus, and other plant species. It prospers well in waterlogged and poorly drained soils.
- *Pythium sp.:* These fungi primarily attack seedlings and plants under stress. They produce motile spores (zoospores) that are capable of swimming in water, thus making *Pythium* sp. infections more common in overly wet soils [13].
- *Rhizoctonia solani:* A common soil pathogen, *Rhizoctonia sp.* can affect a broad spectrum of crops, particularly in warm and humid climates. It is known to cause damping off in seedlings and root rot in older plants [4].
- *Fusarium sp.:* A genus that includes both root and vascular wilt pathogens. *Fusarium oxysporum* is well known for causing root rot and wilt in various vegetable crops, including tomatoes and cucurbits.
- *Armillaria sp.*: Commonly known as the “honey fungus” this fungus is more frequently found in forest and woodland ecosystems. It infects a wide variety of woody plants and trees thus often leading to root and collar rot [14].

Environmental Conditions

The occurrence and severity of root rot are significantly influenced by environmental conditions. The following factors are

- *Waterlogged soils:* Excessive soil moisture is one of the most important factors in the development of root rot. Many root rot fungi, such as *Pythium sp*. and *Phytophthora sp.,* produce swimming spores that thrive in water-saturated environments. Poor drainage, overwatering, and compacted soils that do not allow for proper air exchange exacerbate the problem.
- *Temperature:* Warm, humid conditions are ideal for fungal proliferation. For instance, *Rhizoctonia sp.* prefers warm temperatures, which is why it is common in tropical and subtropical regions. However, certain fungi, such as *Pythium sp.*, thrive in cooler soils, particularly during the early stages of plant growth [15].
- *Soil pH and composition:* Acidic or alkaline soils can influence the growth of different fungal pathogens. Some species of fungi, such as *Fusarium sp.,* tend to proliferate more in alkaline soils, while others may prefer acidic conditions.
- *Soil structure:* Compacted soils with poor aeration reduce the oxygen available to plant roots, making them more susceptible to fungal infections. Sandy soils, which drain too quickly, may not retain enough moisture for healthy root development, while heavy clay soils may hold excessive moisture, thereby promoting fungal growth [16].

Plant Stress Factors

Plants under stress are more vulnerable to root rot infections. Stress factors include.

- *Over- or under-watering:* Both excessive and insufficient watering can weaken a plant's root system, thus making it more prone to infection. Over-watering creates anaerobic conditions in the soil, thereby favoring root rot fungi, while drought-stressed plants may have weakened defense mechanisms.
- *Poor nutrient management:* Nutrient deficiencies or imbalances (especially of nitrogen, phosphorus, and potassium) can weaken the immune system of plants, thereby rendering them more susceptible to root rot infections. Conversely, overfertilization can damage root systems, thus leaving them vulnerable to fungal attacks [17].
- *Mechanical injury:* Damage to plant roots from cultivation, transplanting, or pests such as nematodes can create entry points for fungal pathogens.
- *Host susceptibility:* Some plant species and cultivars are more susceptible to specific root rot pathogens than others due to genetic factors [18].

SYMPTOMS OF ROOT ROT

Root rot often goes unnoticed in the early stages, as the symptoms below ground are not visible until substantial damage has occurred. Common symptoms include:

- *Wilting and yellowing of leaves:* Affected plants often appear water-stressed, even when the soil is moist. Leaves may turn yellow and eventually drop [19].
- *Stunted growth:* As the roots deteriorate, plants are unable to take up water and nutrients efficiently, thus leading to stunted growth [16].
- *Discoloration and root decay:* Infected roots can turn brown, black, and mushy. Healthy roots may be densely white or pale in comparison**.**
- *Foul smell:* A distinct foul odor may emanate from the roots or surrounding soil, particularly in the case of severe infections [20].
- *Stem root and damping off:* In seedlings, damping off is a common symptom where young plants collapse and die shortly after germination due to root and stem infections.
- *Death of plant:* In severe cases, root rot leads to the death of the plant as the root system becomes too compromised to sustain the plant’s water and nutrient needs [21].

MEASURES TO CONTROL ROOT ROT FUNGUS

Effective control of root rot involves an integrated approach combining cultural, biological, and chemical measures. Prevention is key, as treatment options are limited once the disease becomes established [13].

Cultural Practices

Adopting good cultural practices can significantly reduce the risk of root rot infections.

- *Soil management:* Ensure proper drainage in soils to prevent waterlogging. Raised beds, mounds, and drainage systems can help control water flow and limit the danger of fungal infection. Avoid compacting the soil through overtillage or heavy foot traffic.
- *Water management:* Drip irrigation systems, which deliver water directly to the root zone, can help reduce excess moisture in the soil. Ensure the soil has adequate drying time between successive watering schedules to discourage fungal growth [4].
- *Crop rotation:* Crop rotation helps prevent fungal buildup in the soil through crop succession. To reduce the risk of disease avoid growing weakened plants in the same area each season.
- *Soil improvement:* Adding organic matter such as compost or well-rotted manure. Can increase soil structure and drainage. As well as promoting beneficial bacteria that compete with root rot fungi.
- *Use resistant varieties:* Choose plant varieties that are resistant or resistant to root rot. Breeding programs have developed cultivars with improved resistance to certain fungi, such as *Phytophthora sp.* resistant avocados and *Fusarium sp.* resistant tomatoes (Yu et al., 2016).
- *Sanitation:* Clean and disinfect tools, pots, and gardening equipment. To prevent the spread of fungal spores. Disinfect greenhouse benches and surfaces to prevent the spread of fungi to seedlings and potted plants [15].

Biological Control

Biological control using natural organisms to stop root rot. This method is environmentally friendly and can be highly effective when used as part of an integrated pest management strategy.

- *Mycorrhizal fungi:* Mycorrhizal fungi are helper fungi that form a symbiotic relationship with plant roots. Increase nutrient absorption and act as a shield to protect against harmful fungi. Inoculating soil or plant roots with mycorrhizal fungi can improve plant health and reduce the risk of root rot [8].
- *Antagonistic microbes:* Certain bacteria and fungi such as *Trichoderma sp.* and *Bacillus subtilis sp.*, are known to suppress root rot pathogens by competing for resources or by producing antibiotics that inhibit fungal growth. These biological agents can be applied to soil or as seed treatments [9].

Chemical Control

Chemical control options, while effective, should be used as a last resort due to the potential for environmental harm and the development of resistant fungal strains. Some commonly used fungicides include:

- *Fungicides for soil drench:* Products containing active ingredients such as mefenoxam, phosphonates, or copper-based fungicides can be applied as soil drenches to control root rot pathogens. These fungicides are particularly effective against *Phytophthora sp.* and *Pythium sp.* [2].
- *Seed treatments:* Seeds can be treated with fungicides or biological agents to protect young plants from early root infections. These treatments are commonly used in commercial agriculture to prevent damping off and early root rot.
- *Fumigation:* In some cases, soil fumigation may be necessary to reduce high levels of pathogenic fungi in the soil. However, this method is expensive, labor-intensive and can have negative effects on soil health and biodiversity [21].

INTEGRATED PEST MANAGEMENT (IPM) FOR ROOT ROT CONTROL

Long-term control of root rot requires an integrated approach. IPM strategies include the following:

- *Monitoring and early detection:* Check plants regularly for signs of root rot. Especially in humid or wet conditions. Early detection allows for rapid action to limit the spread of disease [19].

- *Use of resistant varieties and crop rotation:* Selecting resistant plant varieties and practicing crop rotation can minimize the risk of infection.
- *Biological controls:* Introduce beneficial microbes or mycorrhizal fungi to promote plant health and suppress pathogens [22].
- *Proper water management:* Water plants efficiently to avoid waterlogging and create an environment that discourages fungal growth.
- *Judicious use of chemicals:* Use chemical controls sparingly and only when necessary to prevent the development of resistant fungal strains and reduce environmental impact [20].

CONCLUSION

Root rot fungus is a significant threat to plants across various agricultural, horticultural, and forest ecosystems, caused by soil-borne pathogens like *Phytophthora sp.*, *Pythium sp.*, *Fusarium sp.*, and *Rhizoctonia* sp. These fungi attack the roots, causing rot and affecting the plant's ability to absorb water and nutrients, which results in stunted growth, wilting, and, in many cases, plant death. The disease is triggered by a combination of environmental factors such as waterlogged soils, poor drainage, and compacted soil, along with plant stress from improper watering, nutrient imbalances, and physical damage. Effective control of root rot requires a comprehensive, integrated approach. Preventive cultural practices, including proper water management thereby improving soil structure and using resistant plant varieties, play a key role in reducing disease risk. Biological control methods like introducing beneficial microbes and mycorrhizal fungi offer sustainable options for suppressing pathogenic fungi in the soil. Chemical fungicides may be used as a last option, but their application should be cautious to prevent environmental harm and resistance development. Ultimately, prevention through good soil and water management along with early detection is the most effective strategy. By combining cultural, biological, and limited chemical controls, root rot can be managed, thus preserving plant health and ensuring productivity in agricultural and natural systems.

REFERENCES

1. Kulshrestha S, Seth CA, Sharma M, Sharma A, Mahajan R, Chauhan A. Biology and control of Rosellinia necatrix causing white root rot disease: a review. J Pure Appl Microbiol. 2014;8(3):1803–1814.
2. Sayfullaev AA, Normatov BI, Bobomurodov MK, Normatov RJ. Types of fungal diseases of Mulberry. Acad Globe. 2021;2(6):357983. doi:10.17605/OSF.IO/X4GCU.
3. Ghosh SK, Banerjee S, Pal S, Sur PK. Present status of fungal diseases, crop loss and crop protection of mulberry plants. J Environ Sociobiol. 2016;13:169–180.
4. Arunakumar GS, Gnanesh BN. Evaluation of artificial inoculation methods to determine resistance reaction to dry root rot and black root rot disease in mulberry (Morus spp.). Arch Phytopathol Plant Prot. 2023;56(1):49–65. doi:10.1080/03235408.2023.2170692.
5. Bharathi KM, Susikaran S, Vijay S, Vasanth V, et al. A comparative biochemical study of mulberry (Morus spp.) mini clones over conventional stem cuttings. Int J Plant Soil Sci. 2024;36(5):975–983. doi:10.9734/ijpss/2024/v36i54593.
6. Arunakumar GS, NR NP, Arya NR, Monika BM, Sherpa DC, Anupama C, Suresh A, Kammar S, Supriya M, Sruthi S, Gnanesh BN. Diversity of fungal pathogens in leaf spot disease of Indian mulberry and its management. Heliyon. 2023;9(11):e21750. doi:10.1016/j.heliyon.2023.e21750.
7. Bharathi KM, Susikaran S, Parthiban KT, Vasanth V, Vijay S. Influence of different transplanting days on yield attributes of mini clones under field conditions for Morus indica (V1). Madras Agric J. 2024;111(3):1–7. doi:10.29321/MAJ.10.001099.
8. Maji MD, Chattopadhyay S, Kumar P, Saratchandra B. In vitro screening of some plant extracts against fungal pathogens of mulberry (Morus spp.). Arch Phytopathol Plant Prot. 2005;38(3):157–164. doi:10.1080/03235400500094290.
9. Baruah JP, Borthakur I. Infectious disease (fungal, bacterial, viral and nematodal) of mulberry plant and its control measure: a review. Int J Plant Soil Sci. 2021;33(18):110–116. doi:10.9734/IJPSS/2021/v33i1830581.

10. Gnanesh BN, Tejaswi A, Arunakumar GS, Supriya M, Manojkumar HB, Tewary P. Molecular phylogeny, identification and pathogenicity of Rhizopus oryzae associated with root rot of mulberry in India. J Appl Microbiol. 2021;131(1):360–374. doi:10.1111/jam.14959.
11. Nguyen DT, Hieu NC, Hung NV, Thao HT, Keswani C, Van Toan P, et al. Biological control of fusarium root rot of Indian mulberry (Morinda officinalis How.) with consortia of agriculturally important microorganisms in Viet Nam. Chem Biol Technol Agric. 2019;6:1–1. doi:10.1186/s40538-019-0168-x.
12. Wang GF, Xie GL, Zhu B, Huang JS, Liu B, Kawicha P, et al. Identification and characterization of the Enterobacter complex causing mulberry (Morus alba) wilt disease in China. Eur J Plant Pathol. 2010;126:465–478. doi:10.1007/s10658-009-9552-x.
13. Naik VN, Sharma DD, Govindaiah G. Incidence and intensity of root disease complex due to nematode and soil borne fungal pathogens in Mulberry (Morus alba L.). Int J Ind Entomol. 2008;16(2):49–56.
14. Sharma DD, Naik VN, Chowdary NB, Mala VR. Soil borne diseases of mulberry and their management. Int J Ind Entomol. 2003;7(2):93–106.
15. Sowmya P, Naik VN, Sivaprasad V, Naik VG. Characterization and correlation of pathogenicity of Botryodiplodia theobromae isolates, the causal agent of black root rot of mulberry (Morus spp.). Arch Phytopathol Plant Prot. 2018;51(19–20):1022–1038. doi:10.1080/03235408.2018.1544192.
16. Xie HH, Wei JG, Liu F, Pan XH, Yang XB. First report of mulberry root rot caused by Lasiodiplodia theobromae in China. Plant Dis. 2014;98(11):1581–1589. doi:10.1094/PDIS-03-14-0261-PDN.
17. Yu C, Hu X, Deng W, Li Y, Han G, Ye C. Soil fungal community comparison of different mulberry genotypes and the relationship with mulberry fruit sclerotiniosis. Sci Rep. 2016;6(1):28365. doi:10.1038/srep28365.
18. Beevi ND, Qadri SMH. Biological control of mulberry root rot disease (Fusarium spp) with antagonistic microorganisms. J Biopestic. 2010;3(1):90–92.
19. Arunakumar GS, Revanna S, Kumar V, Yadav VK, Sivaprasad V. Studies on scanning electron microscopy and fungal association with root knot nematode in major mulberry growing areas of Southern Karnataka. J Entomol Zool Stud. 2018;6(4):511–518.
20. Arunakumar GS, Gnanesh BN, Tejaswi A, Supriya M, Manojkumar HB, Devi SS. Characterization and pathogenicity of Lasiodiplodia theobromae causing black root rot and identification of novel sources of resistance in mulberry collections. Plant Pathol J. 2022;38(4):272–286. doi:10.5423/PPJ.OA.01.2022.0005.
21. Dar GH, Beig MA, Ahanger FA, Ganai NA, Ahangar MA. Management of root rot caused by Rhizoctonia solani and Fusarium oxysporum in blue pine (Pinus wallichiana) through use of fungal antagonists. Asian J Plant Pathol. 2011;5(2):62–67. doi:10.3923/ajppaj.2011.
22. Bharathi KM, Susikaran S, Parthiban KT, Vasanth V. Effect of auxins on biochemical composition of apical cuttings of mulberry (Morus indica L.) using mini clonal technology. Int J Zool Appl Biosci. 2024;9(3):40–45. doi:10.55126/ijzab.2024.v09.i03.007.

