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Bio-control Practices in Managing Rhizome Rot of Zinger: A Comprehensive Review

Dr. V.R.S. Rathore

Head, Department of Plant Pathology, Faculty of Agriculture, Govt. College, Uniara, Tonk

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Address for Correspondence: Dr. V.R.S. Rathore (rathore.vrs1965@gmail.com)
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Abstract

This article discussed approximately the bio-control practices provide a sustainable and effective method to coping with rhizome rot of ginger, by incorporating useful micro- organism, fungi, and amendment in soil environment strategies, so that possibility lessen to reliance on chemical insecticides. Enhancement in ginger production due to biocontrol management practices, continued research and development on ginger rhizome rot by biocontrol technique will pave the method for more reliable and widely followed bio-manipulate process to control the disease.

Keywords: Rhizome, ginger production, biocontrol, sustainable management

Introduction:

Ginger's leafy stems reach a height of approximately one meter, or three feet. The leaves emerge from sheaths enveloping the stem and are elongated, alternating in two vertical rows, ranging in length from 15 to 30 cm (6 to 12 inches). The blooms are comprised of overlapping green bracts, which may have a yellow tinge, and are arranged in dense cone-like spikes measuring 2.5 cm (1 inch) thick and 5 to 8 cm (2 to 3 inches) long. A single little purple and yellow-green blossom is enclosed by each bract.

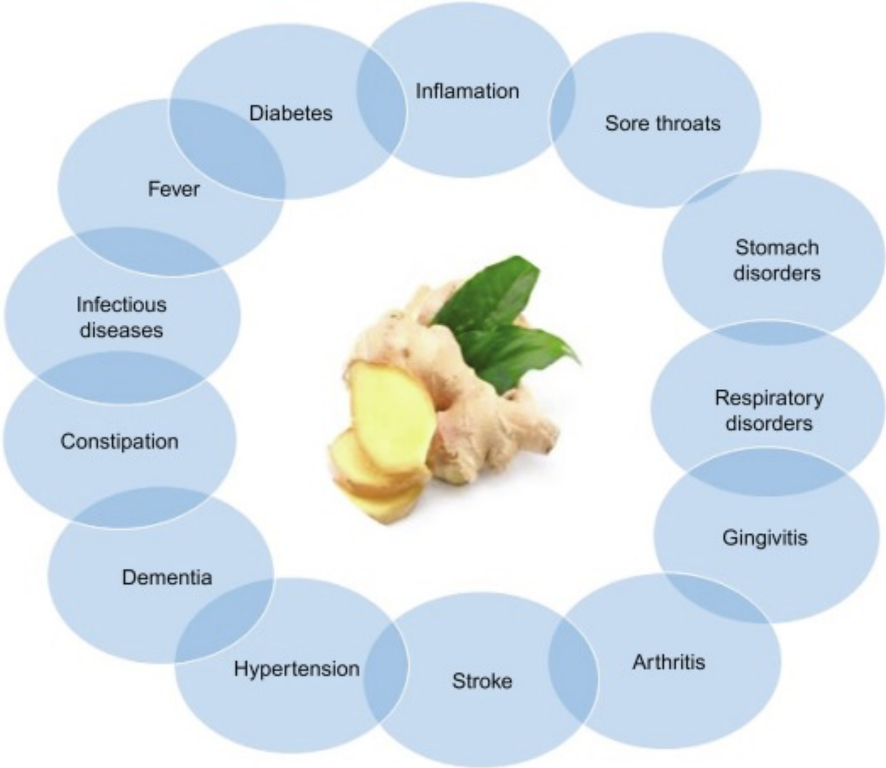
Ginger (*Zingiber officinale*) is essential crop with good sized monetary and medicinal value. However, its production is significantly low with rhizome rot infestation, due to pathogens like *Pythium myriotylum, Pythium aphanidermatum., Fusarium oxysporium* and *Rhizoctonia solani*. Traditional use of chemical control methods to manage the rhizome rot of ginger imposes environmental hazards and health risks, resulting in the need for sustainable biocontrol practices of rhizome rot of ginger.

History

Zingiber, the general term for ginger, is taken from the Greek word “zingiberis”, which itself is derived from the Sanskrit name “singabera” for the spices. Ginger has long been used in India and China, and by the first century CE, traders had brought ginger to the Mediterranean region. In England, it was well-known by the eleventh century. Soon after the conquest, the Spaniards introduced ginger to the West Indies and Mexico, and by 1547, ginger was being shipped from Santiago to Spain.

Significance

The spice, which is often ground and dried, has a somewhat sharp flavor and is used to flavor pickles, ginger ale, breads, sauces, and curry meals. Green ginger, the fresh rhizome, is used in cooking. Boiling in syrup is one way to preserve peeled rhizomes. Ginger slices are consumed as a palate cleanser in Japan and other countries in between meals. Medical practitioners use ginger to alleviate colic and gas. About 2% of essential oil is found in ginger; zingiberene and zingerone are the spice's primary constituents and pungent principles, respectively. Rhizomes are used to extract oil, which is then used in the food and fragrance sectors.



The health benefits associated with the consumption of ginger are given in Fig.1.

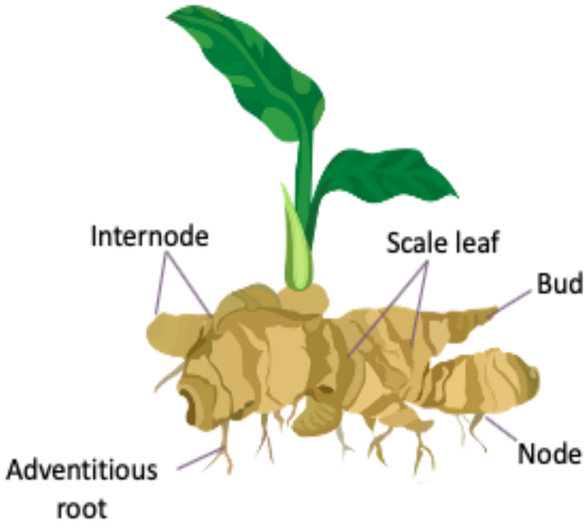


Fig.1.Ginger rhizome

Pathogens Causing Rhizome Rot

Rhizome root in ginger is primarily caused by several soil-borne pathogens:

1. *Pythium myriotylum, Pythium aphanidermatum*: These oomycetes caused rhizome rot, thriving in wet conditions, and responsible for tremendous yield losses.
2. **Fusarium spp**: *Fusarium oxysporum* and *Fusarium solani* are acknowledged to cause wilting and decay in ginger which decrease yield of ginger rhizomes.
3. **Rhizoctonia solani**: This fungus causes damping-off in seedlings and root rot in mature flora, known to negative plant status quo and yield reduction.

Bio-control Agents

Beneficial Bacteria

1. ***Bacillus spp***.: Bacillus subtilis and Bacillus amyloliquefaciens produce antibiotics and lipopeptides that inhibit pathogen boom.

They also set off systemic resistance in plants.

2. ***Pseudomonas spp***.: Pseudomonas fluorescens and Pseudomonas putida are recognised for his or her manufacturing of siderophores, antibiotics, and enzymes that degrade fungal mobile partitions. They additionally promote plant boom through hormone manufacturing.

Biocontrol agents

1. ***Trichoderma spp***.: *Trichoderma harzianum* and *Trichoderma viride* are broadly used biocontrol substrates. They act via mycoparasitism, competition, suppression and the manufacturing of antifungal volatile and nonvolatile compounds.
2. ***Gliocladium spp***.: *Gliocladium virens* (now referred to as *Trichoderma virens*) produces antibiotics and competes with pathogens for space and vitamins, efficiently controlling soil-borne diseases.
3. **Mycorrhizal Fungi (Arbuscular Mycorrhizal Fungi (AMF)**: AMF, such as Glomus spp., form symbiotic relationships with ginger rhizomes roots, enhancing nutrient uptake and inducing systemic resistance against pathogens. They also improve soil structure and health, creating a less favorable environment for pathogens.

Mechanisms of Bio-control

Antibiosis

Antibiosis involves the production of antimicrobial compounds by biocontrol agents that inhibit pathogen growth. For instance, *Bacillus spp*. produce antibiotics like iturins and fengycins, which disrupt fungal cell membranes.

Competition

Biocontrol agents compete with pathogens for space, nutrients, and other resources. This mechanism is particularly effective in the rhizosphere, where beneficial microbes suppressed pathogens, thereby reducing their population and impact.

Mycoparasitism

Mycoparasitism involves direct attack on pathogenic fungi by biocontrol agents. *Trichoderma spp*. are known for their mycoparasitic activity, where they coil around pathogen hyphae, penetrate them, and release enzymes that degrade fungal cell walls.

Induced Systemic Resistance (ISR)

Some biocontrol agents induce systemic resistance in plants, making them more resilient to pathogen attacks. This involves the activation of plant defense mechanisms, such as the production of pathogenesis-related proteins and phytoalexins. *Bacillus* and Pseudomonas spp. are known to trigger ISR in ginger.

Integrated Biocontrol Strategies

Combining multiple biocontrol agents and practices can enhance efficacy. Integrated approaches may include the use of microbial consortia, organic amendments, and cultural practices to create a holistic disease management strategy.

1. **Microbial Consortia**: Using a combination of beneficial bacteria and fungi can provide a broader spectrum of protection against pathogens. For example, combining *Bacillus spp*. with *Trichoderma spp*. can exploit their complementary mechanisms of action .
2. **Organic Amendments**: Adding organic matter, such as compost or green manure, can enhance soil health and microbial diversity, indirectly suppressing pathogens. Organic amendments also improve soil structure and water-holding capacity, creating a less favorable environment for pathogens .
3. **Cultural Practices**: Crop rotation, proper drainage, and sanitation can reduce the incidence of rhizome rot. These practices help in minimizing the pathogen load in the soil and improving plant health, making them less susceptible to infections .

Challenges and Future Directions

Despite the potential of bio-control agents of rhizome rot of ginger, there are challenges in their application:

1. **Consistency and Reliability**: The efficacy of bio-control agents can vary due to environmental conditions, soil type, and

pathogen variability as temperature is very high in summers in Rajasthan.

2. **Formulation and Delivery**: Developing effective formulations and delivery systems for biocontrol agents is crucial for their success. This includes ensuring the viability and stability of the agents during storage and application.

3. **Regulatory and Adoption Issues**: Regulatory approvals and farmer adoption of biocontrol practices can be challenging. There is a need for policies that support the use of biocontrol agents and educate farmers on their benefits and usage.

Conclusion

Biocontrol practices in rhizome rot of ginger offer a sustainable and effective approach to managing the disease. By leveraging beneficial biocontrol fungi and integrated strategies like amendments etc., it is possible to reduce reliance on chemical pesticides and enhance ginger production by reducing incidence of rhizome rot of ginger and increasing the production level by developing tolerance and resistance in ginger rhizomes. Continued research and development in this field will pave the way for more reliable and widely adopted biocontrol solutions.

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