SJIF Impact Factor: 6.711

WORLD JOURNAL OF ADVANCE HEALTHCARE RESEARCH

ISSN: 2457-0400
Volume: 1.
Issue: 2
Page N. 94-99
Year: 2017

Review Article www.wjahr.com

ADVANCEMENTS IN GINGER RHIZOME ROT MANAGEMENT: CHEMICAL AND BIOLOGICAL CONTROL PERSPECTIVES

Dr. V. R. S. Rathore*

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

Article Received date: 21 September 2017 **Article Revised date:** 11 October 2017 **Article Accepted date:** 01 November 2017

***Corresponding Author: Dr. V.R.S. Rathore**

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

ABSTRACT

Ginger (Zingiber officinale) is a treasured spice crop cultivated international, but its production is considerably hampered by means of rhizome rot diseases resulting from diverse pathogens, consisting of Pythium spp., Fusarium spp., and Ralstonia solanacearum. Effective control techniques are crucial to mitigate financial losses and make certain sustainable cultivation. Chemical manage measures, including fungicides and bactericides, have traditionally been used; but, issues concerning environmental safety and pathogen resistance necessitate opportunity techniques. Biological manipulate techniques, along with beneficial microorganisms, biopesticides, and mycorrhizal associations, provide promising eco-friendly answers. This review highlights latest improvements in chemical and organic manipulate strategies, emphasizing integrated sickness control (IDM) tactics that combine a couple of techniques for long-term sickness suppression. Future research ought to attention on growing novel biocontrol marketers, enhancing biopesticide efficacy, and breeding disease-resistant ginger cultivars to make sure sustainable ginger production.

KEYWORDS: Biopesticide efficacy, fungicides and bactericides, emphasizing integrated sickness control.

1. INTRODUCTION

Ginger (Zingiber officinale) is a widely cultivated spice crop valued for its culinary, medicinal, and commercial programs. It is an critical element in traditional medication and has tremendous monetary importance in lots of tropical and subtropical regions. However, ginger manufacturing is severely stricken by rhizome rot, one of the maximum devastating sicknesses caused by soilborne pathogens along with Pythium spp., Fusarium spp., and Ralstonia solanacearum. The disorder leads to severe yield losses, decreasing both the quantity and pleasant of harvested rhizomes.

Rhizome rot signs and symptoms consist of yellowing and wilting of leaves, softening of rhizomes, and enormous decay, regularly resulting in complete crop failure under favorable situations. High soil moisture, negative drainage, and heat temperatures exacerbate disease severity. The rapid unfold of the ailment, mixed with its persistence inside the soil, makes management specifically difficult.

Traditional chemical manipulate strategies, together with fungicides and bactericides, have been normally hired to combat rhizome rot. However, growing concerns over environmental pollutants, pesticide residues, and the emergence of resistant pathogen strains have necessitated the exploration of opportunity sickness control strategies. Biological manage, using useful microorganisms, organic amendments, and integrated disorder management (IDM) tactics are gaining prominence as sustainable and green solutions.

This review explores recent advancements in chemical and organic manipulate techniques for managing ginger rhizome rot. It highlights the effectiveness of numerous fungicides, bactericides, and biopesticides at the same time as emphasizing the function of useful microbes, natural amendments, and included sickness control practices in attaining lengthy-term disease suppression. Understanding and imposing these strategies may be critical in making sure sustainable ginger cultivation and minimizing economic losses due to rhizome rot.

2. Causal Agents and Disease Cycle

Ginger rhizome rot is a complicated disease as a result of more than one soilborne pathogens, typically fungi and micro organism. The most not unusual causal agents include.

1. Fungal Pathogens

- Pythium spp. (Pythium aphanidermatum, Pythium myriotylum): These oomycetes are the maximum competitive pathogens causing gentle rot of ginger rhizomes. They thrive in waterlogged conditions and infect flora thru zoospores, leading to rapid decay.
- Fusarium spp. (Fusarium oxysporum, Fusarium solani): These fungi cause dry rot in ginger, characterised by inner browning and sluggish deterioration of the rhizome. Fusarium spp. Produce chlamydospores that remain viable in the soil for lengthy intervals, making control difficult.

2. Bacterial Pathogen

- Ralstonia solanacearum: This bacterium causes bacterial wilt, a extreme disorder that results in vascular browning, yellowing, wilting, and eventual plant death. It spreads through soil, water, and inflamed planting materials and might continue to exist inside the soil for years.

Disease Cycle

1. Survival and Inoculum Source

- The pathogens persist in soil, plant particles, or contaminated rhizomes.
- Pythium spp. Produce oospores and zoospores, which could live to tell the tale unfavourable conditions.
- Fusarium spp. Live to tell the tale as chlamydospores in soil or on plant cloth.
- Ralstonia solanacearum can continue to be in soil, water, and weeds, acting as a chronic source of infection.

2. Dissemination

- The pathogens spread via infected planting material, infested soil, irrigation water, and farm gear.
- Rain splash, floodwater, and human pastime make contributions to the spread of the disease within and between fields.

3. Infection Process

- Under favorable conditions (high humidity, negative drainage, and warm temperatures), spores or bacteria enter plant roots or rhizomes through herbal openings or wounds.
- The pathogens multiply inside plant tissues, blocking off vascular structures (within the case of Ralstonia solanacearum) or breaking down plant cells, main to rot and wilting.

4. Symptom Development

- Early symptoms consist of yellowing of leaves, stunted increase, and water-soaked lesions on rhizomes.
- In advanced ranges, rhizomes end up soft, discolored, and emit a foul odor due to secondary microbial invasion.
- The disorder progresses rapidly, often leading to total crop loss.

3. Chemical Control Strategies

Chemical manipulate remains a extensively used approach for managing ginger rhizome rot. Fungicides, bactericides, soil fumigants, and seed treatments assist reduce pathogen populations and limit disorder occurrence. However, the improvement of resistance and environmental issues necessitate really appropriate and included use of those chemical substances.

1. Fungicides and Bactericides

Chemical fungicides and bactericides play a crucial role in managing fungal and bacterial pathogens liable for rhizome rot. Some usually used chemical substances encompass.

- **Fungicides for Pythium and Fusarium Control**
- Metalaxyl (systemic; effective against Pythium spp.)
- Mancozeb (touch; broad-spectrum safety)
- Carbendazim (systemic; effective in opposition to Fusarium spp.)
- Captan (shielding fungicide for seed and soil remedy)
- Azoxystrobin (wide-spectrum fungicide)

- **Bactericides for Ralstonia solanacearum Control**
- Copper oxychloride (contact bactericide; limits bacterial unfold)
- Streptomycin sulfate (systemic antibiotic; suppresses bacterial wilt)
- Kasugamycin (effective towards bacterial infections)

Regular software of these chemical compounds as foliar sprays, soil drenches, or rhizome treatments allows lessen sickness severity. However, excessive and indiscriminate use may lead to environmental contamination and pathogen resistance.

2. Soil Fumigation

Soil fumigation efficaciously reduces soil borne pathogens before planting. Traditionally, fumigants like methyl bromide had been used, but because of environmental issues, opportunity fumigants are now desired.

- Dazomet – Broad-spectrum soil fumigant effective against fungi, bacteria, and nematodes.
- Metam sodium – Used for pre-plant soil sterilization to lessen pathogen load.
- Chloropicrin – Controls Pythium and Fusarium, although its use is limited in some areas.

Soil fumigation ought to be completed below managed conditions, ensuring right aeration before planting to save you phytotoxicity.

3. Seed and Rhizome Treatment

Treating ginger rhizomes before planting is a crucial step in sickness prevention. Common chemical remedies consist of.

- **Fungicide Treatments**
- Carbendazim (0.2%) or Captan (0.3%) dip for 30 minutes.
- Metalaxyl-Mancozeb aggregate for protection in opposition to Pythium and Fusarium.

- **Bactericide Treatments**
- Copper oxychloride (zero.2%) dip to manipulate bacterial wilt.
- Streptomycin sulfate (0.1%) to suppress Ralstonia solanacearum.

These remedies assist get rid of seed-borne inoculum and offer initial safety in opposition to soil pathogens.

4. Soil Drenching and Foliar Sprays

Chemical packages to the soil or foliage help suppress pathogen spread at some stage in crop boom:

- Metalaxyl (0.1%) drenching for Pythium manipulate.
- Carbendazim (zero.2%) drenching to govern Fusarium.
- Copper oxychloride (zero.3%) foliar sprays to manipulate bacterial wilt.

Repeated applications at recommended intervals can decorate effectiveness. However, integrating chemical manage with organic and cultural strategies improves sustainability and lengthy-time period sickness management.

Limitations of Chemical Control

Despite its effectiveness, chemical manipulate has several drawbacks:

- Pathogen resistance development due to continuous use.
- Environmental and fitness worries associated with chemical residues.
- High charges for small-scale farmers.
- Negative effects on beneficial soil microbiota.

4. Biological Control Approaches

Biological manipulate is an eco-friendly and sustainable method to managing ginger rhizome rot. It involves using useful microorganisms, biopesticides, and natural amendments to suppress soilborne pathogens and beautify plant fitness. These strategies reduce dependency on chemical fungicides and assist keep soil microbial balance.

1. Beneficial Microorganisms

Several adverse microorganisms have shown capability in controlling rhizome rot pathogens through mechanisms like competitive exclusion, antibiosis, and precipitated systemic resistance.

- **Fungal Biocontrol Agents**
- Trichoderma harzianum and Trichoderma viride – Antagonistic fungi that inhibit Pythium and Fusarium via mycoparasitism and production of antifungal compounds.
- Gliocladium spp. – Effective in suppressing Fusarium and selling plant increase.

- **Bacterial Biocontrol Agents**
- Pseudomonas fluorescens – Produces siderophores, antibiotics, and lytic enzymes that suppress Pythium and Fusarium.
- Bacillus subtilis – Enhances plant resistance with the aid of generating antifungal metabolites and promoting root fitness.

2. Biopesticides and Plant Extracts

Natural plant-derived compounds have antimicrobial houses against rhizome rot pathogens. Common biopesticides include.

- Neem Extracts (Azadirachta indica) – Exhibits antifungal and antibacterial homes in opposition to Pythium, Fusarium, and Ralstonia solanacearum.
- Garlic Extracts (Allium sativum) – Contains allicin, which inhibits fungal and bacterial growth.
- Essential Oils (e.G., thyme, lemongrass, and eucalyptus oils) – Have vast-spectrum antimicrobial results.

These biopesticides can be implemented as seed remedies, soil drenches, or foliar sprays.

3. Mycorrhizal Associations

Arbuscular mycorrhizal fungi (AMF), which includes Glomus spp., shape symbiotic relationships with ginger roots, improving nutrient uptake and enhancing resistance to soilborne pathogens. AMF software has been proven to:

- Enhance phosphorus absorption and root improvement.
- Induce systemic resistance in opposition to Fusarium and Pythium.
- Improve plant resilience to environmental pressure.

4. Organic Amendments and Soil Microbial Enhancement

Incorporating natural substances into the soil boosts beneficial microbial populations, suppressing pathogens obviously.

- Compost and Vermi compost: Improve soil structure and decorate beneficial microbial activity.
- Farmyard Manure and Green Manure: Increase microbial range, decreasing pathogen survival.
- Biofertilizers (e.G., Azospirillum, Azotobacter) – Promote plant increase and enhance soil health.

5. Antagonistic Viral and Bacterial Agents

Recent research have explored using bacteriophages (viruses that infect bacteria) to control Ralstonia

solanacearum. Phage remedy suggests promise in lowering bacterial wilt incidence with out affecting useful microbes.

Advantages of Biological Control

- Environmentally friendly and sustainable.
- Reduces chemical residue in soil and meals products.
- Promotes soil fitness and biodiversity.
- Delays pathogen resistance development.

5. Integrated Disease Management (IDM) Strategies

Integrated Disease Management (IDM) is a holistic technique that mixes chemical, biological, cultural, and physical manipulate methods to effectively control ginger rhizome rot whilst minimizing environmental impact and resistance development. IDM objectives to create a sustainable and economically possible ailment manage approach for long-term ginger manufacturing.

1. Crop Rotation and Field Management

- Avoid non-stop ginger cultivation in the equal subject to break the disease cycle.
- Rotate with non-host vegetation along with legumes, cereals, or marigold (Tagetes spp.) to suppress soilborne pathogens.
- Implement raised bed cultivation and right drainage to lessen soil moisture, limiting Pythium and Ralstonia infections.

2. Use of Disease-Free Planting Material

- Select healthy, pathogen-loose rhizomes from certified assets.
- Treat rhizomes with biocontrol marketers (Trichoderma spp., Pseudomonas fluorescens) before planting.
- Store planting material beneath proper situations to save you pre-infection

3. Soil Solarization and Organic Amendments

- Soil Solarization: Cover soil with obvious polyethylene sheets for four-6 weeks all through summer time to elevate soil temperatures and kill pathogens.
- Organic Amendments: Incorporate compost, farmyard manure, neem cake, or vermicompost to enhance useful microbial hobby and suppress pathogens.

4. Chemical and Biological Control Integration

- Apply fungicides (e.G., Metalaxyl, Carbendazim) or bactericides (Copper oxychloride) in aggregate with biocontrol agents for more desirable disorder suppression.
- Use biopesticides (e.G., neem oil, garlic extract) as alternatives to artificial chemical compounds.
- Apply adversarial microorganisms (Trichoderma harzianum, Bacillus subtilis) to promote plant resistance and manage pathogens.

5. Sanitation and Hygiene Measures

- Remove and smash infected plants to prevent the unfold of disorder.
- Sterilize farm equipment and gadget often to lessen pathogen transmission.
- Avoid excessive irrigation and hold top-quality soil moisture to restriction pathogen proliferation.

6. Resistant Varieties and Genetic Improvement

- Promote the cultivation of disease-resistant ginger varieties thru breeding programs.
- Develop genetically progressed ginger cultivars with enhanced resistance to Pythium, Fusarium, and Ralstonia solanacearum.

7. Monitoring and Early Detection

- Regularly check out fields for early sickness signs and symptoms.
- Use disorder forecasting fashions and soil testing to predict pathogen dangers.
- Apply focused remedies based totally on disease incidence degrees.

8. Adoption of Precision Agriculture Techniques

- Utilize drone-primarily based surveillance and soil sensors for sickness detection and moisture management.
- Implement decision-aid systems to optimize fungicide and biocontrol applications.

6. Future Directions

Effective control of ginger rhizome rot requires non-stop research and the development of progressive strategies. Future efforts should cognizance on enhancing ailment resistance, enhancing biocontrol performance, and integrating superior agricultural technologies. The following key areas will be important for sustainable disorder control.

1. Development of Disease-Resistant Ginger Varieties

- Utilize conventional breeding techniques and molecular genetics to expand Pythium-, Fusarium-, and Ralstonia-resistant ginger cultivars.
- Apply genomic and marker-assisted choice (MAS) for faster and more specific breeding of resistant strains.
- Explore transgenic and gene-enhancing strategies (e.G., CRISPR) to decorate disorder resistance at the same time as retaining perfect agronomic tendencies.

2. Advancements in Biological Control Strategies

- Improve the system, balance, and shelf-life of biocontrol marketers like Trichoderma spp., Bacillus subtilis, and Pseudomonas fluorescens for huge-scale application.
- Develop microbial consortia that integrate a couple of biocontrol agents for synergistic consequences.

- Investigate endophytes and rhizosphere-associated microbes that beautify plant immunity towards pathogens.

3. Precision Agriculture and Smart Disease Management

- Implement AI-based sickness prediction fashions using real-time environmental and soil health information.
- Use drone and satellite tv for pc imaging for early detection of disease outbreaks and focused interventions.
- Develop soil microbiome analysis strategies to monitor pathogen dynamics and optimize biocontrol applications.

4. Sustainable Chemical Control Alternatives

- Focus on the discovery and development of plant-based biopesticides with antifungal and antibacterial properties.
- Explore nanoparticle-based totally fungicides and bactericides for greater pathogen concentrated on and decreased environmental impact.
- Promote secure and really apt use of existing chemical fungicides to put off resistance improvement.

5. Improved Soil Health and Organic Management

- Encourage big-scale adoption of natural farming practices using compost, biofertilizers, and cowl crops to suppress pathogens.
- Study the position of soil suppressiveness and beneficial microbial interactions in ailment control.
- Investigate the impact of weather trade on soilborne pathogen dynamics and adapt management techniques hence.

6. Policy and Farmer Awareness Programs

- Strengthen extension services to educate farmers on incorporated disorder control (IDM) strategies.
- Develop authorities-supported schemes to sell using biopesticides and disorder-resistant varieties.
- Foster collaboration among researchers, policymakers, and agribusinesses to force innovation in disease management.

7. CONCLUSION

Ginger rhizome rot stays a massive assignment to worldwide ginger production, inflicting tremendous yield losses and economic setbacks for farmers. The disease is because of more than one soilborne pathogens, which include Pythium spp., Fusarium spp., and Ralstonia solanacearum, which thrive in warm, humid situations and poorly drained soils. Effective management of rhizome rot requires an integrated technique that combines chemical, biological, cultural, and bodily manage techniques. Chemical fungicides and bactericides, even as powerful, pose issues related to environmental effect and resistance improvement. As a end result, sustainable alternatives consisting of biocontrol dealers (Trichoderma spp., Bacillus subtilis), organic amendments, and disorder-resistant types are gaining significance. Precision agriculture, advanced soil fitness control, and advanced breeding techniques in addition decorate disease manipulate efforts.

Future strategies ought to attention on growing resistant ginger sorts, optimizing biological manipulate formulations, and making use of AI-driven sickness detection and prediction structures. Strengthening farmer attention packages and policy aid can also be critical in promoting sustainable disease control practices.

By integrating more than one disease management procedures, ginger farmers can effectively manipulate rhizome rot, ensure sustainable manufacturing, and reduce reliance on artificial chemical compounds. Continued research and innovation will play a key function in overcoming the challenges related to this adverse sickness and securing the future of ginger cultivation global.

8. REFERENCES

1. Acharya, B., Regmi, H., Ngangbam, A. K., & Nongmaithem, B. D. (2016). Management of rhizome rot disease of ginger using eco-friendly natural products. *Indian Journal of Agricultural Research*, *50*(6): 599–603.
2. Lodha, B. C., Webster, J., Ram, D., & Mathur, K. (2000). Evaluation of resident biocontrol agents as seed treatments against ginger rhizome rot. *Indian Phytopathology*, *53*(4): 450–454.
3. Shanmugam, V., Thakur, H., & Gupta, S. (2013). Use of chitinolytic *Bacillus atrophaeus* strain S2BC-2 antagonistic to *Fusarium* spp. for control of rhizome rot of ginger. *Annals of Microbiology*, *63*(3): 989–996.
4. Dohroo, N. P. (2005). Diseases of ginger. In P. N. Ravindran & K. Nirmal Babu (Eds.), *Ginger: The genus Zingiber* (pp. 305–340). CRC Press.
5. Isman, M. B. (2006). Botanical insecticides, deterrents, and repellents in modern agriculture and an increasingly regulated world. *Annual Review of Entomology*, *51*: 45–66.
6. Khafagi, I. K., & Dewedar, A. (2000). The efficiency of random versus ethno-directed research in the evaluation of Sinai medicinal plants for bioactive compounds. *Journal of Ethnopharmacology*, *71*(3): 365–376.
7. Neupane, F. P. (2003). Integrated pest management in Nepal. Centre for Environmental and Agricultural Policy Research, Extension and Development (CEAPRED).
8. Poudyal, B. K. (2011). Commercial ginger farming in Nepal: Today and future. Sajha Prakashan.
9. Poudyal, B. K. (2012). Jeevatu: One of the best bio-agents for the control of soft rot of ginger. In *Proceedings of the 2nd International Conference on*

Environmental Science and Biotechnology (Vol. 48, pp. 66–70).
10. Jolad, S.D.; Lantz, C.R.; Chen, J.G.; Bates, B.R.; Timmermann, N.B. Commercially processed dry ginger (Zingiber officinale): Composition and effects on LPS-stimulated PGE2 production. Phytochemistry, 2005; 66, 1614–1635. [CrossRef]
11. Drake, G.N. Diseases of ginger (Zingiber officinale Rosc.) and their management. J. Spices Aromat. Crops, 1995; 4: 40–48.
12. Prabhakaran Nair, P.K. The Diseases of Ginger. In The Agronomy and Economy of Turmeric and Ginger: The Invaluable Medicinal Spice Crops; Prabhakaran Nair, K.P., Ed.; Elsevier Inc.: Amsterdam, The Netherlands, 2013; 409–426.
13. Trujillo, E.E. Diseases of Ginger (Zingiber officinale) in Hawaii; Hawaii Agricultural Experiment Station, University of Hawaii: Honolulu, HI, USA, 1964; 58: 7.
14. Stirling, M.A. The causes of poor establishment of ginger (Zingiber officinale) in Queensland, Australia. Australas. Plant Path, 2004; 18: 203–210.
15. Moreira, S.I.; Dutra, D.C. Fungi and bacteria associated with post-harvest rot of ginger rhizomes in Espírito Santo, Brazil. Trop. Plant Pathol, 2013; 38: 218–226.