

Article

Rice Plant Parasitic Nematodes and Measures to Combat them

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ABSTRACT: This article investigates rice plant parasite nematodes and how to resist them. Rice parasitic nematodes may be handled using a variety of integrated techniques. These include the use of resistant rice cultivars, crop rotation and diversification, soil solarization, biofumigation, chemical nematicides, biological control, soil amendments, trap cropping, precision farming methods, and integrated pest management. Breeding initiatives introduce resistant cultivars, but crop rotation disturbs worm life cycles and lowers population densities. Biofumigation produces chemicals that reduce nematode populations. Chemical nematicides are employed selectively, although their usage is weighed against possible environmental and health hazards. Biological control employs natural enemies, whereas organic additions promote soil health.

Keywords: rice plant, parasite nematodes, rice cultivars, crop rotation, soil solarization, diversification, biofumigation, chemical nematicides, biological control, soil amendments, trap cropping, precision farming methods, integrated pest management

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1. Introduction

The study of rice parasitic nematodes would fall under the field of plant pathology, specifically within the subfield of nematology. Nematology is the scientific study of nematodes, also known as roundworms, which include those that are parasitic to plants. Understanding the types of nematodes that affect rice plants, their life cycles, modes of infection, and methods of control are all important aspects of research within this field.

Rice parasitic nematodes play several significant roles in science, particularly in the fields of agriculture, plant pathology, and nematology:

Impact on Rice Production: Rice is one of the world's most important food crops, feeding billions of people globally. Parasitic nematodes that infest rice plants can cause significant yield losses by damaging roots, reducing nutrient uptake, and making plants more susceptible to other stresses.

Research Model: Rice parasitic nematodes serve as important model organisms for studying plant-nematode interactions. Researchers study the molecular mechanisms of nematode infection, host responses to nematode attacks, and the development of resistance in rice varieties.

Biological Control Studies: Scientists explore various methods to control rice parasitic nematodes, including biological control agents such as predatory nematodes, fungi, bacteria, and other organisms. Understanding the ecological interactions between nematodes and their natural enemies aids in developing sustainable management strategies.

Genetic Resistance: Identifying and breeding rice varieties with resistance to parasitic nematodes is a key focus of research. Genetic resistance can significantly reduce the need for chemical nematicides, thereby promoting environmentally friendly and economically viable pest management practices.

Crop Protection: Understanding the distribution, prevalence, and life cycles of rice parasitic nematodes helps farmers implement appropriate management practices to protect their crops. This includes techniques such as crop rotation, soil amendments, and planting resistant varieties.

Environmental Impact: Research on rice parasitic nematodes contributes to understanding their impact on soil health, ecosystem dynamics, and overall agricultural sustainability. Managing nematode populations effectively can minimize environmental damage associated with chemical control methods.

Overall, the study of rice parasitic nematodes is essential for safeguarding rice production, ensuring food security, and promoting sustainable agricultural practices in regions where rice is a staple crop.

2. Literature Review

Many scientists have studied rice parasitic nematodes over the years, contributing to our understanding of their biology, ecology, and management. Some notable scientists and researchers in this field include:

Dr. Robin M. Giblin-Davis: An eminent nematologist who has extensively researched plant-parasitic nematodes, including those affecting rice crops.

Dr. Roland N. Perry: A leading expert in nematology who has conducted research on various plant-parasitic nematodes, including those infesting rice plants.

Dr. Renato N. Inserra: Renowned for his work on nematode biology and control strategies, including studies relevant to rice parasitic nematodes.

Dr. Terry L. Kirkpatrick: Known for his contributions to nematology, particularly in the area of nematode ecology and management in agricultural systems, including rice fields.

Dr. Edward C. McGawley: A researcher who has focused on nematology and plant pathology, with studies encompassing the management of nematode pests in rice and other crops.

Dr. Weimin Ye: Recognized for his research on plant-parasitic nematodes and their interaction with crops, including studies on rice nematodes and their management.

Dr. Ramesh Y. Singh: Notable for his research on nematode management in agriculture, including studies on rice parasitic nematodes and integrated pest management strategies.

These scientists, among many others, have made significant contributions to the understanding of rice parasitic nematodes, ranging from their biology and ecology to the

development of effective management practices for mitigating their impact on rice production.

In Uzbekistan, E.A. Kholmurodov, B.S. Nasirov, B.S. Boltaev, M. Tojjeva, B.K. Mukhammadiev, R.D. Mominova, Sh.A. Makhmudova, and M.M. Abzalova studied nematodes, mites, rodents, and measures to control them and conducted research.

Scientists Sh.G.Hodjaev, E.A.Kholmurodov studied and analyzed "Fundamentals of entomology, crop protection and agrotoxicology".

3. Results and Discussion

Rice parasitic nematodes can cause significant damage to rice crops, leading to yield losses and economic impact for farmers. The most common types of nematodes affecting rice include root-knot nematodes (*Meloidogyne* spp.), cyst nematodes (*Heterodera* spp.), and root lesion nematodes (*Pratylenchus* spp.). Here are some measures to combat them:

- 1) Crop Rotation: Rotating rice with non-host crops can help break the nematode life cycle by depriving them of a suitable host. Selecting crops that are not susceptible to the same nematode species can reduce nematode populations in the soil.
- 2) Resistant Varieties: Planting rice varieties that have been bred for resistance or tolerance to specific nematode species can be an effective strategy. These varieties can withstand nematode infestations to some extent, reducing yield losses.
- 3) Soil Solarization: Solarization involves covering the soil with clear plastic sheets during the hot summer months to raise soil temperatures and kill nematodes and other soilborne pathogens. This method is effective in reducing nematode populations but requires careful management to avoid adverse effects on soil health.
- 4) Biocontrol Agents: Certain beneficial organisms, such as nematophagous fungi and bacteria, prey on nematodes and can help suppress their populations. Incorporating these organisms into the soil through biocontrol products or organic amendments can provide natural control of nematodes.
- 5) Nematicides: Chemical nematicides can be applied to the soil to kill nematodes or suppress their activity. However, the use of nematicides should be approached cautiously due to potential environmental and health risks, as well as the development of nematode resistance to these chemicals.
- 6) Soil Amendments: Organic amendments such as compost, manure, or green manures can improve soil health and increase microbial activity, which can indirectly suppress nematode populations. Amendments high in carbon can also help reduce nematode populations by altering soil conditions.
- 7) Practicing good sanitation by removing crop residues and weed hosts can help prevent
- 8) Crop Sanitation: nematode buildup in the soil. Infected plant material should be promptly removed and destroyed to prevent the spread of nematodes.
- 9) Integrated Pest Management (IPM): Adopting an integrated approach that combines multiple control methods, such as crop rotation, resistant varieties, biological control, and cultural practices, can provide effective and sustainable management of nematode pests while minimizing environmental impact.

It's essential to monitor nematode populations regularly through soil sampling and analysis to assess the effectiveness of control measures and adjust management strategies

as needed. Additionally, maintaining overall soil health and promoting biodiversity in agricultural ecosystems can contribute to the natural suppression of nematode populations.

Rice parasitic nematodes are a group of microscopic roundworms that can infest rice plants, causing damage to their roots and reducing overall plant health and productivity. Several species of nematodes can affect rice, including:

- 1) Root-knot nematodes (*Meloidogyne* spp.): These nematodes invade rice roots, causing the formation of characteristic galls or knots on the roots. Infected plants may exhibit stunted growth, reduced tillering, and yellowing of leaves.
- 2) Cyst nematodes (*Heterodera* spp. and *Globodera* spp.): Cyst nematodes infect rice roots and form cysts containing eggs. As the cysts mature, they release juveniles that infect nearby rice plants, leading to root damage and reduced nutrient uptake.
- 3) Rice root nematodes (*Hirschmanniella* spp.): These nematodes feed on rice roots, causing root lesions and impairing the plant's ability to absorb water and nutrients. Infected plants may exhibit symptoms such as wilting, yellowing, and reduced yield.
- 4) Lesion nematodes (*Pratylenchus* spp.): Lesion nematodes feed on rice roots, causing necrotic lesions and reducing root function. Severe infestations can lead to reduced plant vigor, poor growth, and yield loss.

Rice parasitic nematodes can be particularly problematic in areas with warm and moist soil conditions, where they can multiply rapidly and cause significant damage to rice crops. Effective management strategies, including crop rotation, the use of nematode-resistant varieties, soil solarization, and biological control, are important for mitigating nematode damage and maintaining healthy rice production systems. Regular monitoring and early detection of nematode infestations are also essential for implementing timely control measures and minimizing yield losses.

Rice parasitic nematodes can indeed pose significant challenges to rice production in Uzbekistan, as they do in many other rice-growing regions around the world. Some of the key nematode species affecting rice in Uzbekistan include:

- 1) Rice Root-Knot Nematode (*Meloidogyne* spp.): This nematode species can cause root galling, stunting, and yield loss in rice plants.
- 2) Rice Cyst Nematode (*Heterodera sacchari*): It forms cysts on the roots of rice plants, leading to reduced nutrient uptake and yield losses.
- 3) Rice Stem Nematode (*Ditylenchus* spp.): This nematode primarily affects the stem and leaf tissues of rice plants, causing symptoms such as stunting, wilting, and chlorosis.
- 4) Rice Spiral Nematode (*Helicotylenchus* spp.): These nematodes can cause root damage, leading to reduced water and nutrient uptake by rice plants.

By adopting an integrated approach to nematode management, farmers in Uzbekistan can mitigate the impact of rice parasitic nematodes on their crops and sustainably improve rice production. Additionally, ongoing research and extension efforts can provide farmers with updated information and innovative solutions for nematode control.

In Uzbekistan, researchers and scientists are actively involved in studying rice parasitic nematodes and implementing measures to combat them. Here are some key aspects of their work:

- 1) **Research and Identification:** Scientists conduct extensive research to identify the species of nematodes affecting rice crops in Uzbekistan. This involves field surveys, laboratory analysis, and collaboration with international experts to accurately identify the nematode species and understand their biology and behavior.
- 2) **Impact Assessment:** Researchers assess the economic and agronomic impact of nematode infestations on rice production in Uzbekistan. This involves field trials, yield assessments, and monitoring of crop health to quantify the losses caused by nematodes.
- 3) **Development of Resistant Varieties:** Plant breeding programs focus on developing rice varieties with resistance or tolerance to nematode infestations. Scientists use traditional breeding techniques as well as molecular markers to introduce nematode resistance genes into high-yielding rice cultivars suitable for Uzbekistan's agro-climatic conditions.
- 4) **Integrated Pest Management (IPM):** Scientists promote the adoption of IPM strategies among rice farmers to manage nematode infestations effectively. This includes a combination of cultural, biological, and chemical control methods tailored to the local context. Farmers are trained in crop rotation, soil management, use of resistant varieties, and judicious application of nematicides to minimize nematode damage while ensuring sustainable rice production.
- 5) **Soil Health Management:** Researchers emphasize the importance of maintaining soil health to suppress nematode populations naturally. Practices such as organic amendments, cover cropping, and crop diversification help improve soil structure, enhance beneficial microbial activity and reduce nematode pressure over time.
- 6) **Capacity Building and Extension Services:** Scientists collaborate with agricultural extension agencies to disseminate knowledge and best practices for nematode management to rice farmers across Uzbekistan. Training workshops, demonstration plots, and extension materials are used to educate farmers on nematode identification, monitoring, and control strategies.
- 7) **Monitoring and Surveillance:** Continuous monitoring and surveillance programs are established to track nematode populations and their distribution in rice-growing areas of Uzbekistan. This information is used to develop early warning systems and decision-support tools to help farmers implement timely control measures.
- 8) **International Collaboration:** Uzbekistan scientists collaborate with international research institutions, universities, and organizations working on nematode management in rice crops. This collaboration facilitates knowledge exchange, technology transfer, and access to resources and expertise to enhance nematode control efforts in Uzbekistan.

4. Conclusion

Learning to combat rice parasitic nematodes is crucial for protecting crop yield, ensuring food security, promoting sustainability, maintaining economic stability, adapting to climate change, enhancing resilience to pest pressure, and fostering knowledge sharing and collaboration among farmers, scientists, extension services, and policymakers. These measures help farmers maximize yields, maintain food security,

minimize financial risks, and mitigate the impacts of climate change on rice production. By implementing effective management techniques, farmers can minimize the impact of nematode infestations on their crops and contribute to the overall agricultural community.

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