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Emerging of Major Diseases Caused by Plant Parasitic Nematode on Rice in India: Losses and Management Strategies

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Abstract

More than 200 species and 35 different genera of PPNs are reported to be found in rice areas. But only a few are considered significantly important pests of rice. There are several PPNs infesting rice, but some of them, like white tip nematodes (***Aphelenchoides besseyi***), rice root-knot (***Meloidogyne graminicola***), rice root (***Hirschmanniella*** spp.), rice stem (***Ditylenchus Augustus),*** and rice cyst (***Heterodera oryzicola***) nematodes, are economically most essential. Furthermore, a number of nematode species economically affect rice harvests grown in a variety of rice varieties.

Key words: Nematodes, Disease, Rice, PPNs and Root knot .

Introduction

Rice is an important food grain for more than half of the world population. Plant parasitic nematodes (PPNs) have been adapted to each rice cultivation system with both foliar and root parasites. More than 200 species and 35 different genera of PPNs are reported to be found in rice areas. But only a few are considered significantly important pests of rice. There are several PPNs infesting rice, but some of them, like white tip nematodes (***Aphelenchoides besseyi***), rice root-knot (***Meloidogyne graminicola***), rice root (***Hirschmanniella*** spp.), rice stem (***Ditylenchus Augustus),*** and rice cyst (***Heterodera oryzicola***) nematodes, are economically most essential. Furthermore, a number of nematode species economically affect rice harvests grown in a variety of rice varieties. The rice root-knot nematode is one of the important emerging worms that could be harmful to rice growing in India. From currently available sources, the distribution, host range, disease symptoms, interaction with other disease-causing pathogens of rice and management options of major nematode pests of rice are reviewed. The yield loss potential of major phytonematodes in rice is known from

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different countries, but the extent of losses is dependent on the crop variety, season, land quality, and cultivation practices assumed by the growers. Plant parasitic nematodes are present in all types of rice ecosystems but depend on the ecosystem due to species and species diversity. Further studies on developing precise distribution areas of important nematode species infecting rice; creation of consciousness among farmers and extension workers about nematode pests; development of locally feasible, low-cost and sustainable nematode management methods; development of sustainable rice-based cropping systems with due consideration to susceptibility/tolerance/resistance of the component crops to rice nematodes; exploiting the antagonistic potential of fungal and bacterial bio-agents for nematode management and developing effective low-cost delivery systems for these microbes; and incorporation of resistance into agronomically superior cultivars using conventional breeding and biotechnological/transgenic approaches.

Rice Root-Knot Nematode (*Meloidogyne graminicola*)

The rice root-knot nematode (*Meloidogyne graminicola*), a motile endoparasite of rice root, is a well-known nematode pest of highland rice. In West Bengal boro and kharif nurseries, it is primarily found on sandy loam soils or, more recently, in alluvial soils. It also poses a serious threat in other rice-growing regions of India. It is a suitable method for transplanting rice grown in areas where severe waterlogging is a problem. There is a sizable population of *M. graminicola* in Assam, West Bengal, Gujarat, Orissa, Karnataka, Tripura, and other areas of India that grow rice.

It is not necessary to pay attention to the above-ground symptoms, such as yellowing of leaves, plant dwarfism, small fruit size and low fruit set, flowering which is delayed by 15-20 days, plants making minimum tiller work, etc. At the root tip of rice plants, nematodes have a tendency to promote connection and have a recognizable "hook-shaped" or "ring-like" shape. Nematode galls cause lateral rootlets and root hairs to multiply. In rice, M. graminicola is known to be capable of causing losses of up to 64 per cent of crop production in severe cases and between 16 and 32 percent in upper paddy (Phukan 1995) at Simurali in the Nadia district of West Bengal. After the rice is harvested, the eggs of the nematode remain in the soil during this period and continue to breed on various weeds. The female of the nematode often hides inside the root tissue, laying the eggs, and once the pupal stage juveniles emerge, they return to the roots of the same plant to spread the infection. This

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nematode completes its life cycle in rice in about 19 days at temperatures ranging from 22 to 29 °C.

Management

Utilizing fallow land, ideally for two seasons, or rotating non-nutritive crops like peanuts, mustard, black gramme, and potatoes, among others, can help reduce the population of the rice root-knot nematode.

- Using resistant genotypes like ARC-12620, INRC-2002, and CR-94-CCRP-51, which have shown resistance against *M. graminicola*, may be advantageous for paddy regions impacted by *M. graminicola.*
- The nematode population is decreased in nursery beds treated with carbofuran at a rate of 0.3 g a.i./m2 and 1 kg a.i./ha after 40 days of transplanting.
- After soaking rice seeds in a solution containing 0.1 percent carbosulfan for 12 hours, rice yield increased and the root gall of rice root-knot nematodes was significantly reduced.
- The nematode population can be reduced by adding 20 g/m2 of the bio-agent Pseudomonas fluorescens to nursery beds.

Rice Root Nematode (*Hirschmanniella* spp.)

A plant parasitic nematode has been found in all the Asian countries listed below: Myanmar, India, Pakistan, Bangladesh, Sri Lanka, Nepal, Thailand, Vietnam, Indonesia, Philippines, China, Korea, and Japan. The rice root nematode is a migratory endoparasite of roots that mostly lives in soils used for rice cultivation *(Hirschmanniella* spp.). Nematode species accounted for up to 19 per cent of the rice crop yield in West Bengal (Ahmad et al. 1984). Two species of nematodes, Hirschmanella oryzae and H. mucronata, are commercially important and widely distributed in the rice-growing regions of India, although it is unlikely that *H. gracilis* will be found. Adult and juvenile stage nematodes fully penetrate the roots and later create channels or holes in the roots by feeding on the cortical cells. Sometimes, food can continue to go into the central circulatory system. On infected roots, water-soaked brown lesions are clearly visible, most of which are spindle-shaped. The physiological mechanisms of sick plants are disturbed, which slows down plant development. The signs of gene realization include leaf chlorosis, limited tillage, delayed blooming and fruiting, as well as retarded plant development.

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Hirschmanniella species have been found to be more common when rice is actively developing. The population of this nematode increases after rice is transplanted for up to 80 days before declining when the rice roots begin to rot. Rice root nematodes are more common in thick soils and soils with poor drainage. It can survive in both cold and hot temperatures in northern India, ranging from 8-12 °C in December to January to 35-45 °C in the evenings of May to June.

Symptoms

- Roots that have been infected appear discolored and hollow in places.
- Feeding has a negative impact on how well nutrients and water are absorbed.
- Patches of plants display stunted development.
- Reduced prices on tillers

Management

Direct seeding of rice has been found to be more vulnerable to attack by this nematode compared to transplanted crop (Singh and Jain 1995).

Cultural Practices

- Early rice planting should take place in June or the middle of July. Organic adaptations like mustard cake or neem cake should be utilized with 200-250 kg/ha.
- Balanced NPK fertilization.
- Throughout the Rabi season, rotating crops including wheat, linseed, potatoes, cauliflower, mustard, and grains should be performed.
- Deep ploughing the field in the summer eliminates the second stage of nematode eggs and juveniles.
- Use disease-free cultivars of paddy, such as TKM-9, CR-142-3-2, CR-52, N-136, and W-136.
- The plant Sesbania rostrata can be used as a trap crop for *H. oryzae.*
- 1.0 kg a.i./ha of carbofuran 3G or phorate 10G is administered to the nursery bed, and then 1.0 kg a.i./h applications are made at 7 days and 50 days after transplanting.
- Using *Pseudomonas fluorescens* as a soil application at 2.5 kg/ha in the main field, seed treatment at 10g/kg, and seedling root dipping at 1.5kg/ha.

White Tip Nematodes (*Aphelenchoides besseyi*)

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The nematode that infects the leaves and buds of the plant, called *Aphelenchoides besseyi* is a specialized parasite that infects many parts of its natural host, the rice-growing region. Despite the fact that this nematode prefers rice as a host plant, it can also infect other plant species such as tubers, onions, soybeans, sugarcane, oats, millets, orchids, etc. According to Dastur, the "white tip" on the rice leaf is the most recognizable disease symptom, which gives this worm its common name, "white tip nematode," which first appeared in India on rice from Madhya Pradesh and Central Provinces in India. However, in other states such as Gujarat, Tamil Nadu, Madhya Pradesh, Andhra Pradesh, and West Bengal, this rice nematode is found to be high in these. The nematode is also widespread in West Bengal and poses a significant problem in rice fields. Nematodes often result in a yield reduction of 10 to 60%. It is possible to quickly determine whether rice seeds contain nematodes. The leaves of the plant have tips up to 5 cm long, which turn pale yellow or white during the tillage stage, first showing symptoms in the field, followed by dry leaves. These symptoms only last for a short time in the plant. The usually bent end of the flag leaf prevents the formation of panicles. Infected inflorescences are thinner and lighter than healthy inflorescences. *A. Besseyi* grows to adulthood under the husk of a paddy kernel but does not survive in the soil. Other alternative hosts or infected seeds help the nematode survive until the next crop. In rice, they typically spend the first three years in a coiled anhydrobiotic state between the lemma and the pelaea. A nematode infection by which *A. Besseyi* can spread quickly is rice seed. Additionally, flood water or irrigation water can spread it. The female nematode lays eggs on rice plants. Each stage of nematode development can be observed in rice plants.

Management

Rice nematode management strategies include using healthy, nematode-free seedlings and soaking the seeds before sowing, followed by hot water treatment at 52–54 °C for 10–15 minutes. Infected seed can also be made nematode-free using a simple method that involves spreading rice grains on a concrete floor for at least four-six hours each day in direct sunlight on a hot summer day. It is also suggested to apply carbosulfan 25EC at 0.2 percent for 12 hours to the seeds. Spraying of standing crops with Monocrotophos, Cartap Hydrochloride, Oxamyl, and Benomyl at least twice at an interval of 15 days will help in controlling white

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tip disease affecting rice. This nematode is one of the most dangerous pests of rice and bananas in Kerala. Apart from this, infections have been reported in Goa and Karnataka.

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