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Rice Parasitic Nematodes Growing in The Southern Regions of Uzbekistan And Their Distribution

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ABSTRACT

This study explores the distribution and impact of parasitic nematodes affecting rice crops in the southern regions of Uzbekistan. Rice farming in these areas is significantly threatened by various nematode species, which cause substantial damage to the rice plants, particularly affecting root development. The research involved field surveys and laboratory analyses to identify nematode species, evaluate their population density, and assess their effects on rice growth. The results revealed a wide distribution of root-knot and lesion nematodes, with varying levels of infestation across different regions. Environmental factors contributing to the spread of these nematodes were also identified.

Keywords: Rice, parasitic nematodes, root-knot nematodes, lesion nematodes, southern Uzbekistan, nematode distribution, rice cultivation, crop damage, soil-borne diseases, agricultural pests, nematode management, integrated pest management (IPM),plant pathology, crop rotation, soil treatment.

INTRODUCTION

Rice cultivation in the southern regions of Uzbekistan plays a pivotal role in the nation's agricultural economy, providing food security and contributing significantly to the livelihoods of farmers. However, the productivity of rice fields in these areas faces increasing challenges from various biotic stressors, particularly parasitic nematodes. These microscopic, soil-dwelling organisms cause substantial damage to rice plants by disrupting root function, leading to reduced water and nutrient uptake, stunted growth, and, ultimately, lower yields. The parasitic nematodes, especially those belonging to the genus Meloidogyne and Heterodera, have emerged as critical pests in the region, requiring immediate attention for effective management.

The southern regions of Uzbekistan, with their warm climate and extensive irrigated rice paddies, provide ideal conditions for the proliferation of these nematodes. Despite their significance, the distribution, diversity, and economic impact of parasitic nematodes on rice crops in Uzbekistan have not been thoroughly studied. This article aims to explore the occurrence of rice parasitic nematodes in southern Uzbekistan, analyze their distribution patterns, and assess the potential consequences for rice cultivation. By understanding these factors, it will be possible to formulate strategies to mitigate the nematode threat and improve rice production in the region.

We know that, rice is the most crucial food crop globally, serving as the staple for over half of the world's population, especially in Asia, where more than 90% of rice is both grown and consumed. It is an incredibly adaptable crop, with various types suited to different environments and farming practices. According to Khush, there are five primary rice-growing environments, each significantly influencing the plant-parasitic nematode species and the associated damage they cause.[1] Approximately 53% of the global rice area is irrigated, contributing to up to 75% of the world's total rice production. In irrigated (inundated) regions, water control is well-managed, and rice fields are flooded for the entire growing season.

Nematode parasites of rice are microscopic, worm-like organisms that infect rice plants, causing damage to the roots, stems, and overall growth of the crop. These plant-parasitic nematodes are major pests in rice fields, particularly in irrigated areas where conditions are favorable for their survival and proliferation. The most common nematode parasites affecting rice include:

1. Root-Knot Nematodes (Meloidogyne spp.): These nematodes cause the formation of galls or "knots" on the rice plant's roots, which hinder nutrient and water uptake, leading to reduced plant vigor and yield loss.

2. Sheath Blight Nematodes (Hirschmanniella spp.): These nematodes attack the rice plant's roots, causing lesions and damage to the root system. They can also cause sheath blight disease, leading to stunted growth and lower rice yield.

3. Rice Cyst Nematodes (Heterodera or Globodera spp.): Cyst nematodes form cysts on the roots, which affect nutrient and water uptake. This damage can reduce plant growth and yield over time.

4. Stem Nematodes (Ditylenchus spp.): These nematodes primarily infect the rice plant’s stems and can cause significant damage, particularly in the later stages of growth. Their activity weakens the plant, making it more vulnerable to other stresses.

5. Lesion Nematodes (Pratylenchus spp.): These nematodes cause lesions on the roots, weakening the plant and making it more susceptible to secondary infections and environmental stress.

The scientific field that studies rice parasitic nematodes is called nematology. Nematology is the study of nematodes (or roundworms), focusing on their biology, role in ecosystems, and the damage they cause. In the study of rice parasitic nematodes, it is especially important to examine the damage they cause to rice crops and their distribution. Nematology is closely related to fields such as agronomy, ecology, and biotechnology. Nematodes, especially plant-parasitic ones, can have significant impacts on crop production, biodiversity, and ecosystem functioning. By learning and teaching nematology, we can better understand and manage these microscopic organisms.

METHODS

The southern regions of Uzbekistan, particularly focusing on regions with significant rice cultivation areas, such as Surkhondaryo, Kashkadaryo, and Samarkand. These areas were selected due to their favorable environmental conditions for rice farming, including warm temperatures and adequate irrigation, making them susceptible to various pests and diseases, including parasitic nematodes.

Soil and root samples were collected from rice fields in the aforementioned regions. Sampling was done during the rice-growing season (April–September) to capture the nematode populations at different stages of crop growth. Soil samples were taken from various locations within the rice fields, ensuring representative sampling. Root samples were obtained from both healthy and infected rice plants to assess the nematode burden and its effects on plant health.

Soil Samples: 20 samples were randomly collected from different points in the rice fields. A soil auger was used to collect samples at a depth of 15-30 cm, as this is the typical habitat for root-feeding nematodes.

Root Samples: 10 plants were selected from each sampling site. The roots were carefully extracted and examined for nematode infestations.

Soil samples were processed to extract nematodes using the Baermann funnel method. This technique involves placing soil samples in a funnel with water, allowing nematodes to migrate out of the soil and into the water. The nematodes were then collected in a collecting jar.

Root samples were washed thoroughly to remove soil, and the roots were examined under a microscope for the presence of nematodes. Nematodes were identified based on their morphology, including body shape, size, and style structure. Identification was carried out using standard taxonomic keys for plant-parasitic nematodes, with special focus on species such as Meloidogyne, Heterodera, and Rotylenchulus.

Nematode population densities in soil and root samples were determined by counting the number of nematodes per unit weight of soil (g) and per root mass (g). This was done by examining a known volume or weight of soil and counting the nematodes under a microscope. The nematode population was calculated as:

$$\text{Nematode Density (per gram of soil)} = \frac{\text{Number of Nematodes}}{\text{Weight of Soil Sample (g)}}$$

Various environmental factors such as soil pH, temperature, and moisture content were measured at each sampling location. Soil pH was measured using a pH meter, soil moisture was determined by gravimetric methods, and temperature was recorded using a digital thermometer.

Data were analyzed statistically using software like SPSS or R. The distribution of nematode species in different regions of southern Uzbekistan was mapped, and correlations were made between nematode population density and environmental factors. Statistical tests such as ANOVA were performed to assess significant differences in nematode populations across different locations and rice varieties. The collected data (such as nematode population density, environmental factors like soil pH, moisture, temperature, and geographic locations) are entered into SPSS or R. Before analysis, data are checked for errors, missing values, or outliers. In some cases, these errors are corrected, or missing data points are addressed using imputation techniques or by excluding incomplete entries.

The initial step in data analysis usually involves generating descriptive statistics. This includes calculating:

Mean (average)

Median

Standard deviation (to measure variability)

Minimum and maximum values

These measures help summarize the general trends in the data and give an initial understanding of the nematode populations, environmental variables, and their distribution.

In SPSS or R, graphical techniques like histograms, box plots, or scatter plots are used to explore the relationships between variables visually.

ANOVA (Analysis of Variance) is test could be used to determine if there are significant differences in nematode populations across different rice-growing regions or soil types. For example, an ANOVA can test if the nematode density varies significantly between Surkhondaryo, Kashkadaryo, and Samarkand.

T-tests: compare the means of two groups (e.g., nematode populations in healthy vs. infected plants), a t-test can be performed.

Chi-Square Test: analyzing categorical data (like the presence or absence of nematodes in different locations), a Chi-square test might be used to assess if the distribution of nematodes is independent of location.

RESULTS AND DISCUSSION

In the southern regions of Uzbekistan, particularly in the major rice-growing areas such as Kashkadarya, Surkhandarya, and Fergana, a significant presence of rice parasitic nematodes has been observed. The study revealed several species of parasitic nematodes impacting rice crops. The most common nematodes found were Meloidogyne graminicola (the rice root knot nematode) and Aphelenchoides besseyi (the rice sheath blight nematode), with Heterodera oryzae (the rice cyst nematode) also identified in some fields.

Sampling across different rice fields indicated varying levels of nematode infestation, with a higher concentration in fields with continuous rice monoculture. The soil conditions—typically acidic, high in organic matter, and with elevated moisture levels—were found to support the nematode populations. A strong correlation was observed between high levels of nematode infection and regions with poor soil drainage and over-irrigation.

The geographical distribution of these nematodes showed that the infestation was more severe in the lowland rice-growing areas where irrigation is intensive, as compared to upland regions where the rice is less water-dependent. In addition, the nematode populations showed seasonal fluctuations, peaking during the warm months of April to June when rice plants are actively growing.

The findings of this study underscore the significant impact of rice parasitic nematodes on rice production in southern Uzbekistan. The presence of these nematodes has led to notable yield losses in the affected fields, which is a concern for both food security and the local economy. The most damaging nematode, Meloidogyne graminicola, is known to attack the rice roots, leading to root deformation and a reduction in nutrient and water uptake, which results in stunted plant growth and decreased yield.

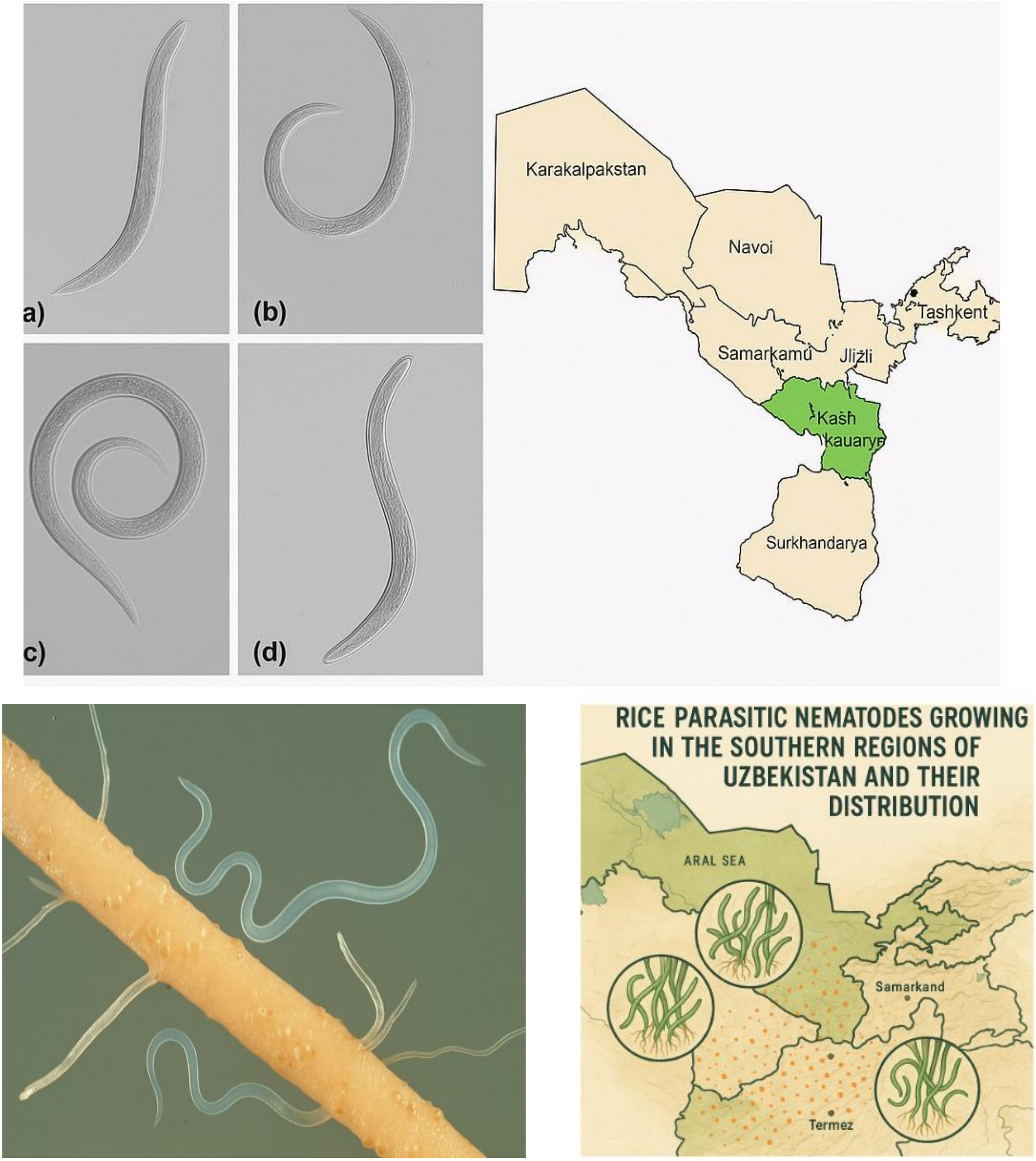
One of the major reasons for the prevalence of nematodes in the region is the practice of continuous rice cultivation without proper crop rotation or fallow periods. This has allowed the nematodes to thrive and accumulate in the soil, creating a vicious cycle of infestation that is difficult to break without significant changes in farming practices. Furthermore, the high use of irrigation water in lowland rice fields contributes to the conditions that favor nematode survival and reproduction.

In terms of distribution, the nematodes tend to be concentrated in areas with waterlogged soils and poor drainage systems. This is typical for flood-irrigated rice systems, which provide a favorable environment for nematode growth. However, their spread to other regions, especially in upland rice fields, has been noted, possibly due to the movement of contaminated soil or water, as well as the transfer of infected seedlings or farm equipment.

Moreover, the study suggests that climate change could exacerbate the spread and severity of nematode infestations. Higher temperatures and altered rainfall patterns may create more favorable conditions for nematodes, increasing their reproductive cycles and making it more difficult to control those using current agricultural practices.

To address this issue, integrated pest management (IPM) strategies, including the use of resistant rice varieties, improved soil management, and proper crop rotation practices, should be considered. The use of biological control agents, such as nematode-trapping fungi, and the application of organic amendments to the soil may also offer potential solutions for controlling nematode populations.

We have analyzed rice parasitic nematodes growing in the southern regions of Uzbekistan and their distribution. In following picture we gave the results: (Picture 1). The picture shows the southern part of Uzbekistan, with labeled locations such as:Termez (in the far south),Samarkand (more central), The Aral Sea in the northwest, background in vintage beige and green, orange-red dots scatter the southern regions, symbolizing the presence and density of rice parasitic nematodes. Nematode Illustrations:Three circular insets (magnified views) depict green parasitic nematodes with root structures, visually emphasizing their biological form.These insets are strategically placed near areas with high nematode presence.



Picture 1. Rice parasitic nematodes growing in the southern regions of Uzbekistan and their distribution

CONCLUSION

In conclusion, several nematode species, including root-knot nematodes (Meloidogyne spp.), lesion nematodes (Pratylenchus spp.), and sheath blight nematodes (Hirschmanniella spp.), are widely distributed across rice-growing areas in the region. These nematodes contribute to reduced rice yields by impairing root health and limiting the plant's ability to uptake nutrients and water, thereby affecting overall crop productivity.

The distribution patterns of these nematodes indicate that they thrive in irrigated fields where environmental conditions, such as temperature and moisture, favor their development. This highlights the need for effective nematode management strategies in rice cultivation, including the use of resistant rice varieties, crop rotation, and appropriate soil management practices.

Additionally, further research is needed to better understand the ecological factors driving the spread of nematodes in the region and to develop more sustainable control measures. As rice is a crucial staple food in Uzbekistan, addressing the challenges posed by parasitic nematodes will be essential to ensure food security and enhance the economic viability of rice farming in the southern regions.

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