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# Effect of 11 years long term manorial practices on nematode population and diversity in rice agroecosystem

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**Abstract**
Rice-rice is an important production system for eastern India. Soil organisms play important role in the functioning of rice field ecosystem. Fertilizer and manures directly or indirectly influence soil biota particularly faunal community and their functioning. The present investigation was undertaken to study nematode population and diversity under the influence of long term fertilizer experiment conducted on an acidic sandy loam Inceptisols of Bhubaneswar with eight numbers of manurial treatments. Nematode population and diversity studies were made on soils of pre planting, tillering and flowering stages of *kharif* 2017 taking treatment combinations of balanced nutrition (100%NPK), super optimal dose of balanced nutrition, secondary and micronutrient, organic manure (FYM) and soil conditioner (lime). The plant parasitic nematode population varied from 64 to 324/ 200 g soil. FYM @ 5t/ha and lime @ 1t/ha significantly reduced the parasitic nematode population at all growth stages of rice. Three parasitic nematode species i.e. *Hirschmanniella oryzae, Helicotylenchus abunaamai, Tylenchorhynchus mashhoodi* were identified to be present in the rice field irrespective of rice growth stages.

**Keywords:** Long term, rice, nematode population, diversity

## Introduction
A major global challenge in the coming years will be to ensure food security and to feed the increasing human population. Nowhere will the need to sustainably increase agricultural productivity in line with increasing demand be more pertinent than in resource poor areas of the world, especially India, where populations are most rapidly expanding. Plant protection is important worldwide for the production of rice because pathogens, including plant-parasitic nematodes, can be a major cause of reductions in rice yield and quality. Many nematode species have been reported being associated with rice but relatively few are considered of economic importance (Bridge *et al.* 2005) [2]. A good knowledge of the population dynamics of a pathogen on a host plant in a specific environment may assist in making management decisions and in the more accurate timing of the application of a pathogen management practice (Trudgill and Phillips 1997) [14].

## Materials and Methods
The long-term fertilizer experiment of All India Coordinated Research Project (AICRP) of ICAR at OUAT, Bhubaneswar, India (20°17′ N, 85°49′ E and 30 m above mean sea level) since 2005-06 was selected for this study. The location of the experimental site is characterized as sub humid subtropical climate with dry season from October to June and wet season from July to September. The soil of the experimental site was sandy loam in texture, acidic (pH 5.8) and udic Ustochrept type. Rice cultivar Swarna (MTU 7029) was grown under flooded condition in *kharif* season of every year. Seven treatments *viz*., 100% NPK at 80:40:40 kg $ha^{-1}$ of $N:P_2O_5:K_2O$ in the form of DAP, urea and MOP; 150% NPK; 100% NPK +Zn; 100% NPK + Zn + S,, Zn as Zinc oxide solution @0.4% for seedling root dip and S as Gypsum @30kg $ha^{-1}$; 100% NPK+ FYM; 100% NPK + Lime + FYM, FYM at 5 t $ha^{-1}$ Lime as $CaCO_3$ @ 1t $ha^{-1}$ and an unfertilized control were evaluated for the study. Nitrogen was applied in three splits *i.e.* 25% as basal, 50% at 18 days after transplanting and 25% at panicle initiation stage. Total P was applied as basal and K was applied 50% as basal and 50% at panicle initiation stage. Rice seedlings were transplanted at a spacing of 20 cm × 10 cm with 2-3 seedlings per hill. Necessary intercultural, water management and plant protection measures were undertaken in general until the crop was matured for harvesting. The experiment was laid out in randomized block design (RBD) and replicated in quadruplicate.
Surface soil samples (0-15 cm depth) were collected during before planting, maximum tillering and flowering stage in *kharif* 2017. Later, these samples were pooled to

draw a representative sample of 200 g of soil. The soil samples were processed on the same day or kept in the refrigerator at $4^0$C for a couple of days. Samples were transported to the laboratory right after sampling and nematode extraction was processed on the same day of sampling. Nematodes from the soil samples were extracted by using modified Cobb's (1918) [4] Sieving and Decantation (gravity) method. The day after the extraction, the number of nematodes recovered from the samples was counted. The population densities of nematodes were expressed per 200 ml soil. The collected nematodes were killed and fixed by the method given by Seinhorst, 1966 [11]. The morphological details were examined under microscope and the nematodes were identified up to species level. All the data were subjected to statistical analysis as per the methods suggested by Gomez and Gomez (1984) [6] at 5% significance level and various relationships are established.

## Results and Discussions

**Table 1:** Effect of manurial treatments on Plant parasitic nematode population at different growth stages of rice (number/200 gm soil)

| Treatment | Pre-planting stage | Maximum tillering stage | Flowering stage |
|---|---|---|---|
| 100%NPK | 223 | 216 | 229 |
| 150%NPK | 209 | 217 | 278 |
| 100%NPK+Zn | 185 | 213 | 231 |
| 100%NPK+S+Zn | 92 | 116 | 131 |
| 100%NPK+FYM | 83 | 176 | 90 |
| 100%NPK+Lime | 140 | 144 | 195 |
| 100%NPK+LIME+FYM | 64 | 152 | 79 |
| Control | 118 | 124 | 145 |
| CD (P=0.05) | 19.57 | 19.79 | 27.39 |

Result presented in table 1 showed that in FYM treated plot, parasitic nematodes are less in number than that of non FYM amended treatments. In the plots treated with FYM recorded lowest plant parasitic nematode population in both the seasons which may be due to competition for food among different nematode communities. Plant-parasitic nematodes generally occur in poly specific communities, including predacious and free-living nematodes. Following the addition of organic and inorganic fertilizers to soil, populations of predatory nematode which predates on parasitic nematode may increase (Guiran *et al*., 1990) [7] causing less population of plant-parasitic nematodes (Tomerlin and Smart, 1969) [13]. The addition of organic amendments may also be directly toxic to plant-parasitic nematodes as organic materials releases various organic acid, phenolic compounds on decomposition (Akhtar and Alam, 1993) [1].

At pre-planting stage Nematode population varied from a lowest of 64/ 200g of soil measured in 100%NPK+Lime+FYM plot to 223/ 200g soil in 100%NPK treatment. Application of recommended dose of fertilizer increased the population by 88.9% over control. Availability of readily available nitrogen source results in the production of new tissues and saps, and can extend the vegetative state and increase the number of feeding sites in the roots, encouraging nematode attack (Ferraz *et al*., 2010) [5]. There was a decrease in population in secondary and micronutrient applied plots. Due to zinc deficiency, the accumulation of free amino acids and amides occurs as a result of protein synthase inhibition boosting the quantity of these amino acids in root exudates (Cakmak and Marschner, 1988) [3]. Since nematodes are attracted by exudates, the higher root exudation in plants deficient in zinc can attract these parasites and, therefore, speed up the infection process (Streeter *et al*., 2001) [12]. Application of Lime decreased the population by 37.2% over 100% NPK treatment. A long-term liming experiment found that mean total number of nematodes increased by 48.6% from soil pH (1 M KCl) 4.0 to 5.4, but decreased by 12.4% from 5.4 to 6.1 with a greater decrease in plant parasites (Korthals *et al.* 1996) [8]. Another possible reason for declining numbers of nematodes was associated with the increased ingestion of nematodes by earthworm after applying lime (Raty and Huhta, 2003) [10].

At maximum tillering stage, the population is slightly higher in most of the treatments. Mean value of all treatments showed 14.66% increase over the population before transplanting stage.

A general trend of population was seen at maximum tillering stage and a lower population in FYM, sulphur and lime applied treatments were observed. At flowering stage, the population was further increased by 6.97% over maximum tillering stage. Nematode total abundance was highest at the flowering stage over pre-planting and maximum tillering stage. This result is similar with maunga *et al.* (2013) [9] who observed that highest peak was in flowering stage. At this stage population ranges from a lowest of 79 in 100%NPK+Lime+FYM to a highest of 278 in 150%NPK treatment. There was a decrease in the number by 65.5% in 100%NPK+Lime+FYM over the optimum fertilized treatment (100%NPK).

Study on species identification showed abundance of 3 parasitic nematodes *Hirschmanniella oryzae*, *Helicotylenchus abunaamai*, *Tylenchorhynchus mashhoodi* at preplanting, tillering and flowering stages of rice growth. Figure 1 showed that *Hirschmanniella oryzae* is more abudance than *Helicotylenchus abunaamai*, *Tylenchorhynchus mashhoodi* and highest abundance is observed during tillering stage.

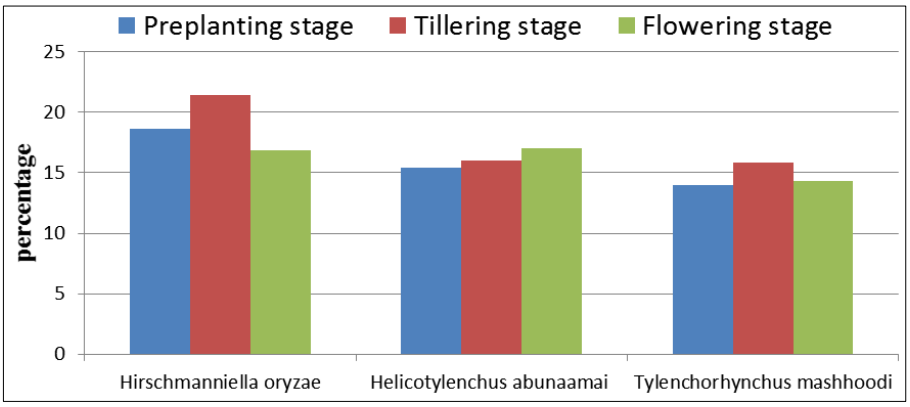


**Fig 1:** Relative abundance of different species of nematodes found in experimental field

## Conclusion

Our findings clearly indicated that Plant parasitic nematodes were influenced by manurial treatments. FYM application at 5t/ha decreased the population by 47 %. Lime application at 1t /ha decreased the population by 28.2%. S and Zn decreased the population. There was 22.8% increase in population from pre-planting to flowering and 6.7% from tillering to flowering stage. Three plant parasitic nematodes *Hirschmanniella oryzae*, *Helicotylenchus abunaamai*, *Tylenchorhynchus mashhoodi* were identified to be present in soil irrespective of manurial treatment and season. *Hirschmanniella oryzae* was most abundance among all three species with percentage mean abundance of 18.9%.

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