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# Study on Soil Microfauna (Nematodes) in the Agroecosystem of Siwan, Bihar

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**Abstract**

The percentage wise middle range of nematode distribution is ranged between 07-35%. The minimum contribution was showed by *Meloidogyne incognita* (07%) and the highest percentage (35%) was shared by *Heterodera* species. Now percentage wise distribution of nematode at site – 2 of the lowland area of Pachrukhi block, Siwan (2017-18) constitute the highest number of percentage (88%) of *Meloidogyne* species in the upper layer of the soil.

**Keywords:** Soil Microfauna, Nematodes, Agroecosystem, Soil Health.

## Introduction

Nevertheless, analyzing how soil functions as a habitat is a more recent emphasis, including the way organisms create their habitats and live in them. Soil scientists have described the vertical and sometimes horizontal gradation of soil horizons via a wide variety of soil classification systems. Soil physicists have provided detailed descriptions of the solid and porous phases in their attempts to model soil hydric processes. Agronomists and ecologists have detailed how soils can provide nutrients and a physical substrate for plant growth. There is an extensive body of literature that details the biological, physical, and chemical transformations that occur during soil organic matter decomposition. Adaptation to living in soils has generated a wide range of life-forms and specific biological traits. Understanding these adaptations requires a holistic view of the nature of soils, linking physical, chemical, and biological processes and trying to understand what being a bacterium or a collembolan in this environment actually entails. The understanding of these adaptations is a mandatory step before conceptual models of soil as a habitat are developed within different environmental contexts, or before intuitive theory is. For example, there is considerable recent interest in stoichiometry and the ecological consequences of differences between supplies of soil nutrients and the needs of living organisms for these nutrients. Soil is a refuge for a large number of very old (in evolutionary terms) taxa and an environment with a large, enigmatic, biodiversity. Soil porosity does not seem to exhibit a continuous distribution pattern across. The whole range of size classes; distribution is rather discontinuous and seemingly follows a fractal pattern, with concentration of porosities at discrete scales. Three pore classes may be defined according to their sizes, the associated matric potential, and the subsequent force to be applied to extract water molecules held by surface tension forces: micro-, meso-, and macropores. Micropores are textural pores of a size below 0.15 µm. They correspond to the spaces accumulated among soil particles and retain water at potentials of less than −1.5 MPa (i.e. beyond the limit where plants can extract water). Macropores comprise the large-sized soil porosity from which water drains almost freely for as long as the connectedness of pores allows. They are rather diverse in origin, having been created by physical or biological processes. The formation of cracks by the physical retraction of drying or thawing soils is a rather frequent process that creates physical macropores. On average, 90% of all primary production returns to the soil after the death of plants or plant organs. Dead soil microbes and fauna also follow the same pattern. Soils and their litter layers are therefore environments with potential high resource availability.

The physically protected fraction is only accessible to soil organisms if aggregates are broken down; furthermore, a rather large energetic investment is required to use organic matter that only comprises a limited proportion (Ca. 5% in favorable cases) of the aggregates. The third is a chemically-protected pool generally equivalent to the amount of the physically protected pool comprising recalcitrant humic compounds with a very long turnover time (800–1200 years). This OM stays when soils have been highly degraded by, for example, intensive agriculture practices with intensive tillage, limited return of organic residues and soil maintained bare for several months each year. In the example of the Martinique vertisol, this pool would essentially comprise Cleft after 15 years of market gardening plus 4 years with no plant cover,

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39% of total SOM in this case Much soil ecology experimentation has actually been based on laboratory or small-scale field experiments (micro/mesocosms) since natural field observations and experimental designs, generally time consuming and costly, hardly provided conditions to test a single effect in isolation by an experimentation. These approaches provided a great deal of interesting results.

**Review of Literature**

Soil health, and soil resilience are being used more frequently and with greater urgency in connection with strategies to protect our global environment. The needs to improve our quality of life and protect many scarce natural resources are forcing society to recognize the importance of their soil resource. Soil quality is frequently over-looked in a society that places more emphasis on water and air quality, likely because these resources have a more apparent connection to human health and existence.

However, soil quality and land management both have a direct influence on water and atmospheric quality and, by extension, to human and animal health. Soil is a vital resource for producing the food and fiber needed to support an increasing world population (Papendick & Parr, 1992) [13]. While seemingly a straight-forward concept, soil quality has been difficult to define and more difficult to quantify. Many feel that soil quality cannot be defined for a complex system as diverse and dynamic as soils. "Quality" and "soil quality" are seen by some to have infinite meanings and basically are indefinable. Others, however, have taken on the challenge of converting a subjective term such as "soil quality" into an objective characterizable term. The definition of soil quality (and some may argue soil) is controlled by a multitude of variables. Additionally, not all involved accept the same terminology. Soil quality and soil health are often considered to have the same meaning. The term soil health is often preferred to soil quality by farmers, while scientists relate the term "soil health" to the status of various biological properties in the soil. Soils serve as a medium for the global cycle of nutrients and energy. The soil plays an ecological role in the purification, detox Low microbial respiration could indicate the presences of pollutants such as fungicides or other pesticides. Soil microbes perform many beneficial functions as well as some detrimental impacts. The impact of soil biota is complex and difficult considering the same activity may be positive or negative depending on its location in the soil profile. Soil respiration and other microbial indicators need to be interpreted with respect to the specific function carried out by the soil microorganisms.

Siwan is a land locked district of Bihar State. It has Sadar block on its north side at one end while the other end is connected to the Gopalganj district. The three districts like Siwan, Gopalganj and Chapra lie in the same commissionary called Saran. It is one of the oldest commissionary in Bihar province and one played pivotal role in the several independence movements.

The Siwan areas are full of plains and fertile soil mostly prepared by holy river Ganga. Several million years ago still today, the geographical areas is dominated by sandy soils which have low water holding capacity but exhibits very fertile in productivity.

**Materials and Methods**

Three sites were selected in each location in Siwan and Pachrukhi block representing areas of dense crops of wheat and rice (with flood and drought disturbance); indicative of biological soil diversity because the areas are covered by grass and crops only and bare soils on the paths. The sampling sites in each area were inside an area of less than 100 square meters. Samplings in Siwan were done across 24 months (two cycle of January, March, April, May, June, September, October, November and December) At each sampling event and site, three cores were collected and pooled, resulting in a total of 24 soil samples for Siwan and Pachrukhi.. The collection of samples followed the protocol described by Davies, *et al*. (2003). In brief, a tube was introduced in the first 5 cm of soil and this core was packed into a plastic bag after removing roots and soil from the samples. Samples were brought to the lab for processing within 3d. One portion of the samples was used to determine the soil characteristics.

**Results**

As far as the Nematodes in the different crop lands are concerned, their density varies according to the several changes and the depth of the soil. There were seven species identified altogether from the different crop fields of Pachrukhi block and Siwan sadar as well. The distribution and abundance of nematodes also varies from upper layer to lower layer. The site of the upland area of the Pachrukhi block (2017) the maximum number of nematodes are found at the upper surface of the crop land areas. At site I, from upland area of the Pachrukhi block, the maximum number of *M. incognita* is found. Whose distribution from upper (0-5 cm), middle (5-10cm) and lower surface (10-15 cm) are 60%, 30% and 10% comparatively. Site I also depicts that there was maximum distribution of the nematodes in the upper layer, while minimum number of nematodes were found in lower surface of the soil (10-15 cm). The *pratylenchus* spp. contains minimum number at upper layer, while it is found in large number in lower (10-15 cm) surface of the soil. The nematode population are several years from the same site depicts that the *M. incognita* was found maximum at the surface level while *Heterodera* species found in the minimum amount at the upper surface. Moderate distribution of Nematode is found in the middle region of the upland area of Pachrukhi block (2018-19). The maximum range of distribution is ranged between 15-20 ind of nematodes in the lower surface region of the crop. At site I of the lowland area of the Pachrukhi block during 2017-18, the nematode species *M. incognita* contains its upper, middle and lower layer of distribution is 88 ind, 10 individual and 02 individual respectively. Again at the site I of low land area of the pachrukhi block showed highest nematode density at upper surface. Here, the *Heterodera* species found in minimum number i.e. 71 at upper surface, and its maximum number is found in lower surface i.e. 10 individual. The *Xiphinema* species showed its lowest density i.e. 1 in lower surface of the crop land area showed its ranges between 12 to40 individuals in the middle layer of the crop. The lower number of nematode is found is *Tylenchorhynchus* species, while *Helicotylenchus* species contains 40 indv. During the second year cycle (2018-19) there is marked variation in the density of nematode species in the different Zones of crop land area. In the second annual cycle, *Heterodera* species is found in maximum number in the upper surface of the lowland area of the Pachrukhi block, while the *Pratylenchus* species was found in the minimum number at the lower surface of the crop land. Hence, one thing is important that there is marked variation in the distribution density of nematodes at upper and lower surface of crop land area. At site 2 of the upland cropland area of Pachrukhi block, the *Tylenchorhynchus*

species was most abundant on the upper surface of the crop land (0-5 cm), while the *Pratylenchus* species was found in minimum number in the lower (10-15 cm) straight of the crop soil with the percentage sharing is only 3. The middle range of nematode distribution was found between 12-26 percent of individual nematodes. *Rotylenchulus* species was more abundant (26 percent) in the middle part of the crop soil while, the minimum percentage (12%) was contributed by T*ylenchorhynchus* SP. Similarly, in the sewed annual cycle of the crop land area of the Pachrukhi block (2017-18) at site 2, the *Meloidogyne incognita* constitute the maximum percentage (90%) at the upper layer of the crop sample. The lower soil sample from the same site contains highest percentage species distribution (15%) by *Xiphinema* species.

The percentage wise middle range of nematode distribution is ranged between 07-35%. The minimum contribution was showed by *Meloidogyne incognita* (07%) and the highest percentage (35%) was shared by *Heterodera* species. Now percentage wise distribution of nematode at site – 2 of the lowland area of Pachrukhi block, Siwan (2017-18) constitute the highest number of percentage (88%) of *Meloidogyne* species in the upper layer of the soil. While *Heterodera* SP constitute the lowest percentage (60%) at the upper layer of the soil sample. The lower surface layer exihibits maximum percentage (12%) by *Tylenchorhynchus* species, while minimum percentage was shared by *Meloidogyne incognita* species. The range of nematode percentage distribution in the middle layer of the soil sample varies from 8-35% with lowest percentage shared by *Meloidogyne incognita* and highest by Heterodera species. During the second annual cycle of the percentage distribution of the nematodes at the lowland area of Pachrukhi block (2018-19) the *Meloidogyne incognita* showed the maximum percentage (92%) at upper surface of the crop land. While, the minimum percentage of nematode (70%) was showed by the species i.e. *Heterodera* species and *Pratylenchus* species. The lower surface of the same crop land constitute maximum percentage of nematode is *Rotylenchulus* species (10%). While, 1% is shared by *Tylenchorhynchus* species. The *Tylenchorhynchus* species was maximum at upper layer. The nematode percentage distribution in the middle range varies from 06-25% with minimum shared by *Meloidogyne incognita* and maximum by *Heterodera* species. Now, the percentage wise nematode distribution in the upland area of Siwan (at site I, 2017-18) showed maximum percentage (80%) shared by *Meloidogyne* species and minimum (50%) by *Pratylenchus* species. The lower surface constitute 29% of highest value by *Rotylenchulus* species while minimum percentage was shared *Meloidogyne* species. Now, If we explaining the percentage of nematodes from upland area of Siwan Sadar, Siwan during 2018-19 at site I, the highest percentage of nematodes at the upper surface was observed of the *Helicotylenchus* species and *Tylenchorhynchus* species both show 70% percentage. At the middle layer, the dominant species was Heterodera species (30) and found with least percentage at the middle layer is (22). *Xiphinema* species and *Pratylenchus* species both have 23% showing. At the lower surface of the soil, the minimum percentage of nematode was shared by *Heterodera* species, its distribution percentage was 04%. Similarly from the lowland area of Siwan sadar (2017-18) at site I, *M. incognita* showed maximum percentage (85%) at the upper layer from the same site, the middle layer contributes *Heterodera* SP with maximum percentage (35%) and the lower most soil surface of the same crop land area beard *Heterodera* species*, M. incognita* and *Pratylenchus* species (all shared 5%). The maximum percentage at lower surface was shared by *R. reniformis* and *Tylenchorhynchus* species with 10% sharing. As far as the low land area of Siwan sadar, during 2018-19 at site I, the maximum number of nematode percentage was shared by *M. incognita* (82%) while minimum number of nematode percentage was shared at the upper surface was shared by *Heterodera* species (65%). The nematode percentage at the middle layer, the maximum percentage were shared by *Heterodera* species and *Helicotylenchus* species both were shared 25% contribution. The lower percentage distribution was made by *M. incognita (*10%). At the lower surface, the maximum percentage was shared by *R. reniformis* and *Heterodera* species both have 10% sharing. Here, from the same layer, the minimum percentage was shared *by pratylenchus* species (3%). Now, the percentage wise distribution of nematodes from upland area of Siwan sadar during 2017-18 (at Site-2), the maximum distribution percentage of nematode at the upper layer of the soil crop was shared by *Tylenchorhynchu*s species (89%) and the lower percentage was shared by *Heterodera* species (52%). At the middle surface, the highest number of nematode percentage was shared by *Xiphinema* species (34%), while the layer % was shared by *Tylenchorhynchus* species (26%) and minimum percentage was shared by *Tylenchorhynchus* species (1%). Hence, the percentage wise distribution of nematodes from upland area of Siwan Sadar during 2017-18 (at Site-2) contains the highest percentage of *M. incognita* (81%) at the upper surface of the soil crop while the minimum percentage distribution at the same surface shared by *R. reniformis* and *Helicotylenchus* species (both have 65% distribution sharing). As far as the middle surface is concerned, the maximum percentage was shared by *Helicotylenchus* species with 30% sharing and the minimum percentage was contributed by the *M. incognita* species with only 10% sharing. Now, the lower most layer of the same crop land, contributed maximum distribution percentage of *R. reniformis* only 10% sharing while the minimum percentage distribution was shared by *Helicotylenchus* species. Again, the nematodes percentage distribution from lowland area of Siwan Sadar during 2017-18 (Site-2), showed maximum distribution of percentage at upper surface layer was *M. incognita* (90%) and minimum nematode sharing was made by *Heterodera species* (54%). Here, the middle part of crop soil maximum nematode percentage was shared by *Heterodera* species (35%) and minimum percentage distribution was shared *by Helicotylenchus* species and *M. incognita* (both have 8% sharing.) Now the lower surface of the crop land soil contains maximum percentage of nematode of *Helicotylenchus* species (12%) and minimum percentage of *M. incognita* and *Pratylenchus* species both have 3% and 3% sharing respectively. At last, the percentage wise distribution of nematodes from low land area of Siwan Sadar, during 2018-19 (Site-2). Showed maximum number of nematode percentage was shared by *M. incognita* (88%) and minimum percentage was shared by *R. reniformis* (56%) at the upper surface layer of the soil. The middle layer of the soil contains maximum nematode percentage of *Heterodera* species (31%) and minimum *M. incognita* with 06%. The lower surface of the soil contains *R. reniformis* as the highest percentage distribution (14%) and the lowest was shared by *Heterodera* species (01%).

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