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Effect of soil temperature and moisture on population dynamics of phytonematodes infesting sugarcane

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Abstract

In India, phytonematodes are reported to cause about 10-40 %yield loss in sugarcane. In India, Uttar Pradesh is the major sugarcane growing state, contributing about 48% of the area and 40% of the production. The present study was undertaken to record biodiversity, to correlate the soil major edaphic factors (temperature & moisture). The study was also centered on to reveal the edaphic factors affecting sex ratio fluctuation of the dominant phytonematodes. Soil temperature, which changes constantly, is a major factor influencing nematode development. Temperature is an important environmental factor for organisms. Different organisms have their own optimal temperatures for normal activities and high and low temperature limits they can tolerate. Diurnal fluctuations in temperature vary in extent and depend upon soil type, texture, moisture, atmospheric conditions, latitude, elevation, season and soil cover. Cool climate species often develop slowly in winter and become more active when temperatures rise in spring season and in this season plant parasitic nematodes population decrease. Moisture plays an important role in the movement of the soil organism. The findings indicated that during winter period when moisture and humidity is high in soil environment conditions. Populations of plant parasitic nematodes were highest in this season.

Key words: dominant phytonematodes, Diurnal fluctuations, disease complex, Saccharum officinerum, temporal dynamics

Introduction

Sugarcane is the World's major cash crops providing about 75% of the sugar harvested for human consumption (FAO 2004). FAO estimates it was cultivated on about 23.8 million hectares, with a worldwide harvest of 1.69 billion tones. India was the second largest producers with 277,750,000 tones than Brazil. Plant parasitic nematodes are obligate parasites, which depend on living plant hosts for the food necessary to develop, mature and reproduce. In the absence of a host plant, nematodes die after the stored food in its body has been depleted. Most plant parasitic nematodes probably do not survive for more than 12 to 18 months and many do not survive the first 6 months. Conditions of low temperature, dry soil and slow root growth are factors that could contribute to low nematode activity.Large and consistent yield responses were obtained when nematode populations were reduced by soil fumigation, crop rotation and fallowing. Lesion nematode (*Pratylenchus Zeae*) is probably the most important in the community of plant parasitic nematodes found in sugarcane fields.At present 48 genera and 310 species of endo and ecto parasitic nematodes species have been reported to be associated with rhizosphere soil and root of various crops a including sugarcane (Cadet and Spaull, 2005). Species of five genera namely Pratylenchus, Hoplolaimus, Helicotylenchus, Tylenchorhynchus and Meloidogyne is listed as major plant parasitic nematodes with wide distribution and common occurrence in soil of India. A disease complex, known as stubble decline, is responsible for reductions in the ratooning ability of the crop. At present eleven genera of plant parasitic nematodes have been reported in Uttar Pradesh associated with sugarcane crop. The report from surroundings of lakes of Udaipur and Sitamata Wild Life Sanctuary, Rajasthan, twelve species of nematodes belonging to order Tylenchida (six species) and Dorylaimida (six species) under nine genera of nine families were reported from India. Plant parasitic nematodes have a sensitive relationship with their environment and they respond to the spatial and temporal dynamics of resources and stressors in soil habitats.

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Resources are the sources of nutrition and characteristic of the habitat that enable phytonematodes to survive and reproduce whereas stressors tie nematode biodiversity to fundamental attributes of ecosystems, the plants and microorganisms in a habitat upon which nematodes feed, natural and anthropogenic disturbances, physical and chemical properties of soil and climate. These attributes individually and collectively influence the structure and function of nematode biodiversity.

Material and Methods

Meerut division is an administrative geographical unit of Uttar Pradesh state, India. The division consists of three tahseel i.e. Meerut, Sardhana and Mawana. Western Uttar Pradesh is known for its cereal production and also extensively known for sugarcane (*Saccharum officinerum)*, cultivation Extensive survey was conducted throught the Meerut districts to collect soil & root sample from sugarcane fields in the Western Uttar Pradesh. The soil samples were processed for isolation of phytonematodes by Cobb's sieving and Decanting method (Goodey, 1963). The major edaphic factors were measured on the spot and in the laboratory. Soil temperature was measured on the spot at each depth and distance with the help of dial thermometer in both summer and winter season. Soil moisture was measured with the help of a portable moisture meter with the dry and wet weight method. Data was analyzed with the help of SPSS (21version) software and biostatistical tools were applied between the major edaphic factors and nematode population to find out the correlation coefficient.

Results and Discussion

The present study was carried out in Meerut Districts of Western Uttar Pradesh where sugarcane was extensively grown. Sugarcane is the main cash crop of this region. Extensive survey was conducted throught the Meerut districts to collect soil & root sample from sugarcane fields in the Western Uttar Pradesh. Soil samples were collected randomly, from September 2013 to March 2015, for the distribution pattern with various factors of some dominant ectoparasitic and endoparasitic Tylenchids. Although over 4,100 species of plant-parasitic nematodes have been identified (Decraemer and Hunt 2006), new species are continually being described. However, the plant parasitic nematodes of economic importance can be grouped into relatively restricted specialized groups that either cause direct damage to their host or act as virus vectors. More than 275 species of 48 genera of plant parasitic nematodes have been recorded from the roots and rhizosphere of sugarcane. The most economically important nematodes are root lesion nematode (*Pratylenchus spp*.), stunt nematode (*Tylenchorhynchus spp*.), root-knot nematode (*Meloidogyne spp*.) and stubby root nematode (*Paratrichodorus spp*.). Temperature is an important environmental factor for various phytonematodes. Different nematodes have their own optimal temperatures for normal activities and high and low temperature limits they can tolerate. The present study indicated the marked decrease in population of nematodes in high temperature ((44^oC-46^oC) during summer season (such as May, June.) whereas an increase of population of nematodes were revealed in early and mid of winter season (18^0C - 27^0C). About 27^0C to 34^0C is suitable temperature for survival of phytonematodes. (Table no. 1). Population of *Hoplolaimus spp* was observed in all season, maximum population of *Hoplolaimus spp* were observed in the month of September and March. Soil temperature was measured on the spot at each depth and distance with the help of dial thermometer. Survey of soil edaphic factors especially, temperature were recorded data in summer and winter season. Maximum temperature (44^oC-46^oC) show in June and July (2013-2015) and minimum temperature (4^oC-12^oC) show in December and January (2013-2015). The highest population of nematodes were recorded in February to March and September to November and lowest population of nematodes in June to August. (Table-1). The observations revealed that highly significant positive correlations with soil moisture and total population of plant parasitic nematodes at 10-15cm depths during 2013-15. The observations of the effect of moisture infesting sugarcane fields were recorded as: The 24 months study revealed that highly positive correlations with population of plant parasitic nematodes infesting the sugarcane fields during 2013-15(Table-6-7, Fig.2) the positive influence of moisture was observed ($r = .487$; P <

Table-1. Month wise population dynamics of Plant parasitic Nematodes infesting sugarcane crop.

Serial No.	Months	Temperature (^{0}c)	No. of population of nematodes/500gm
1	**May**	39.93±3.08 (36.22-44.03)	1143.60±223.09 (890-1446)
2	**June**	44.01±3.47 40.22-48.44)	999.20±90.89 (873-1120)
3	**September**	35.38±1.73 (33.01-37.33)	2271.60±232.11 (1975-2528)
4	**October**	25.69±1.18 (24.01-27.22)	1280±149.71 (1098-1470)
5	**November**	22.03±,1.37 (20.33-24.03)	1919±542.13 (1008-2374)
6	**December**	17.87±2.02 (15.33-20.03)	819.20±218.69 (586-1105)
7	**January**	11.31±3.22 (8-15.33)	1367±150.28 (1165-1531)
8	**February**	23.85±1.96 (21.01-26.02)	1860±59.82 (1765-1931)
9	**March**	30.50±2.05 (28.09-33.06)	774.80±163.83 (565-980)
10	**April**	32.67±3.57 (29.02-38.45)	1919±542.13 (1008-2374)

Table -13. Functional linear regression depicting correlation of soil edaphic factor with plant parasitic nematodes with host (sugarcane) during 2013-2015.

Serial no.	Soil edaphic factor	2013-2014	2014-2015
1.	Temperature	Y= 1099.12+12.02 r =0.397; P <0.029	Y= 842+13.26 r =0.360; P <0.10
2.	Moisture	Y = 1437.75+ 192.81 r = 0.487; P <0.405	Y = 964.26+25.81 r = 0.445; P <0.001

.0.03) and (r =0.445; P < 0.001) from the sugarcane during 2013-15.(figure-1) The investigation of seasonal fluctuations in the population of phytonematodes can be correlated with the earlier workers (Norton, 1978; Ross, 1962; Wallace, 1971; Siddiqi *et al.,* 1973; Prasad and Chawla, 1965; Khan *et al.*, 1971; Malhotra and Chaubey, 1990). The present study can also be correlated with work of minimum population during the dry season and maximum population of phytonematodes during the early winter season. Temperature was a majorenvironmental factor influencing the behavior of the plant parasitic nematodes. Soil temperature was the most constantly changing factors that nematode encounters. The diurnal fluctuations vary greatly depending on the atmospheric conditions, season of the year and the other factors. Such fluctuations might be due to differences in soil texture was identified as clay loam in which sand percent was determined 60%. Soil with high sand content.

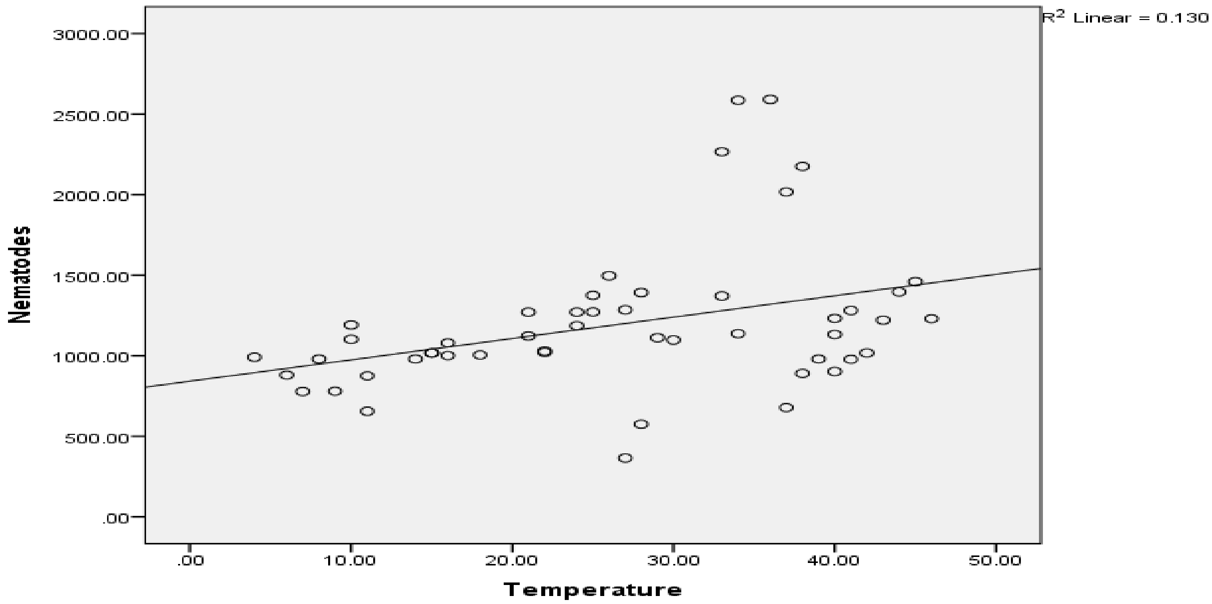

Fig.1- Interrelationship of plant parasitic nematodes with temperature around sugarcane fields during 2013-2015

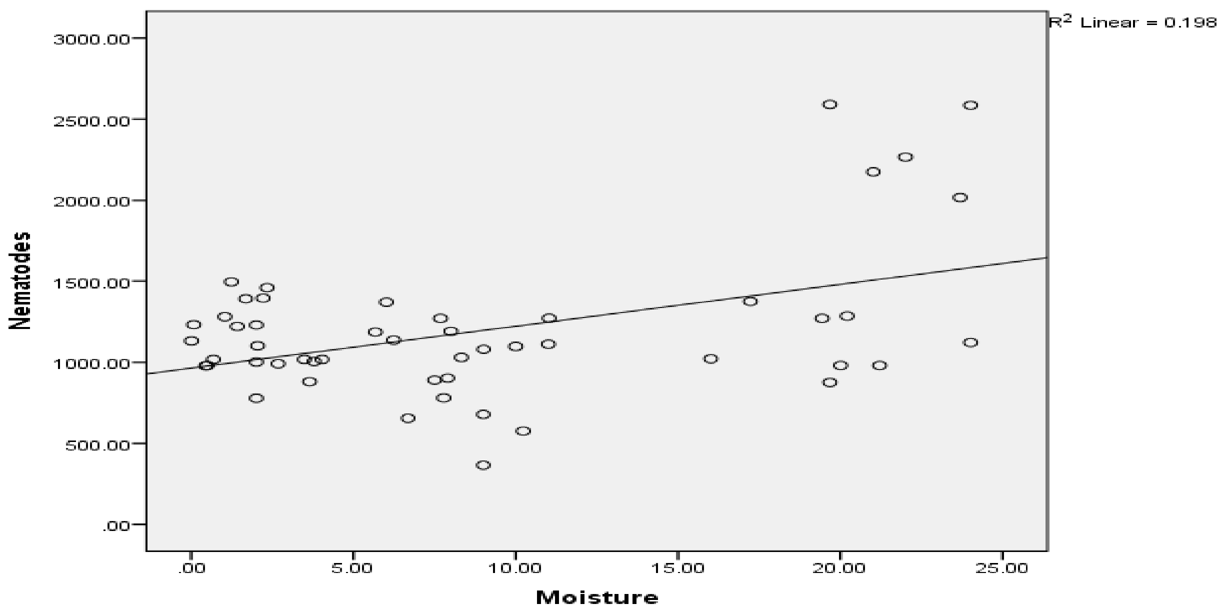

Fig.2- Interrelationship of plant parasitic nematodes with moisture around sugarcane fields during 2013-2015

Blair and Stirling (2007) where they observed nematodes. The investigation of seasonal fluctuations in the population of phytonematodes can be correlated with the earlier workers (Barker, 1969; Oka, 2007; Tsai, 2008; Prasad and Ganguly, 1998). Present observations of the study showed the relationship between the nematode population levels and the soil type. Comparatively higher number of nematodes was observed in sandy soils than in other types of soil. Sandy soils provide better aeration and better porosity for nematode migration which leads rapid multiplication

(Wallace, 1971). Many other workers (Dick 1958; Williams, 1969; Hu & Chu, 1964) also observed that the population of nematodes was generally larger in sandy and light soils than in other soil types. The present study showed positive correlations of phytonematodes with soil moisture which can also correlated with the work of some nematologists (Anita & Chaubey, 2003; Chaubey, 1994; Das and Mishra, 1982; Norton, 1978; Brodie, 1976; Siddiqui et, al., 1973).

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