Correlation of population of plant nematodes and soil temperature in *Mangifera indica*

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Received 16 Sep 2022; Accepted 22 Oct 2022; Published 11 Nov 2022

Abstract

Most of the studies have been conducted on the vertical distribution of migratory ecto and semi endoparasites than with any other groups of nematodes. From the various experiments, it has been found that the population density of nematodes was greatest in top 30 cm of soil and generally declined to 30-60 cm depths. It has been also demonstrated that nematodes distribution often is correlated with root distribution. In some cases (Rhodopholus similes) it has been observed that the nematode population increased with the deeper strata of soil. Temperature is one of the important edaphic factors that acts as a stimulus of vertical distribution. We have seen that nematodes do have different levels of temperature preference and that there is undoubtedly active migration under some circumstances. It is often stated that nematodes move downward in winter "to get away from cold" but assuming that there is considerable vertical migration at least more than we know about how much due to temperature changes and how much to other factors. But now a days it is possible to find out the precise role of one specific factor out of various edaphic factors through using various statistical tools like multivariate analyses and ANOVA. Ecological study of plant parasitic nematodes plays an important role in minimizing the infestation of almost all the parasitic forms of Phyto nematodes. The nematode population size depends on action and reaction of edaphic factors including the host plant itself. Analysis of relationship between variation in soil parameters and the irregular pattern should lead to an improved understanding of how these organisms interact with the soil environment. In the present work the population density of major parasitic Phyto nematodes was studied in respect of soil edaphic factors. Soil samples were collected from three vertical depths (0.0-20.0 cm; 20.01- 40.0 cm 40.01- 60.0 cm) and three horizontal distances (30 cm; 60 cm; and 90 cm) from the stem of the host i. e., mango (*Mangifera indica*). Functional linear relationships confirmed inverse relationship with soil temperature with that of the total nemic population. Few positive thermo -response were observed at 40.01-60.0 cm vertical depth (P<0.20) at 30 cm distance.

Keywords: phyto-nematodes, soil temperature, *Mangifera indica*, edaphic factor

Introduction

The nematode population attained will depend on many factors, but the environment, including the host is the most important. All most all the edaphic factors viz., soil temperature, moisture, pH, organic matter, soil humus, amino acids, nitrogen, phosphorus, calcium, potash and other micro and macro nutrients of plants by an important role in population fluctuations of the nematodes. The Phyto nematodes have patchy distribution in infested field. Analysis of relationships between variation in soil parameters and the irregular pattern should lead to an improved understanding of how these organisms interact with the soil environment. Population density of nematode represents a response to the soil environment. Soil micro-sites with varying physical and chemical parameters have different effects on the nematode or host plant. The nematodes population is induced by the action of soil edaphic factors. Temperature affects nematode activities such as hatching, reproduction, movement, development and survival on one side and also affects the host plant on another side.

Materials and Methods

Soil samples were collected randomly from the orchard of mango (*Mangifera indica*) from 20 km away from the center of the Meerut city. Two plots of 3 hectare each were selected for uniformity of ectoparasites established around the root zones of mango. The age of the plants were about five years further the plots were subdivided into micro-plots to avoid the sampling errors. Sampling was done fortnightly with the help of auger at three vertical depths (0.0- 20.0 cm; 20.01 - 40.0 cm and 40.01 – 60.0 cm) and at three horizontal distances (30 cm; 60 cm and 90 cm) from the stem of plants. A total of 216 soil samples were collected from September 2001 to February 2002. Five samples of each were mixed together for making one sample.

Soil sample was stored in polythene bags to prevent loss of moisture and labelled properly. The collected soil samples were analyzed and examined within a day or two as far as possible. The other soil sample were kept at 15 ℃ for further analysis of edaphic factors.

Soil samples, each 250 ml in volume, work processed for nematode by Cobb's shifting and gravity method (Cobb, 1918) [3]. For this the soil was placed in bucket, filled with water and agitated the content for homogenous suspension. Suspension was allowed to settle down. The nematodes were floated on the upper surface of the suspension. The suspension was passed through a series of sieves i.e., 60, 100, 200, 350 meshes. The residue of each of the sieves was condensed and poured into 250 ml beaker through cotton sieve containing tissue paper. The bottom of the cotton sieve remained in contact with water and kept for overnight. To estimate the population density of various nematodes the content of the beaker was finally passed through 350 meshes to reduce the quantity (up to 10 ml), poured into counting dish and the nematodes were counted under the binocular microscope. Total numbers of nematodes were counted genera wise. Genera wise nematodes were then picked with the help of needle made by a fine wire mounted on a small, thin wooden holder. The different types of nematodes recovered from the soil samples were mounted and recorded by genera and species.

Soil temperature

On the spot soil temperature at each depth was taken by thermometer from which samples were collected, the recorded data are presented as:

Mangifera indica-

Vertical depth 0.0 – 20.0 cm (Table-1); 20.01 – 40.0 cm (Table-2) and 40.01 – 60.0 cm (Table-3) up to 90 cm horizontal distances.

Statistical analyses

Coefficient of Correlation, Standard Deviation, Standard Error and Functional Linear Regression analysis of the data were done with the help of computer using SPSS- 7.5 software.

The identification of Phyto-nematodes was done with the help of Keys and was further confirmed from Indian Agricultural Research Institute, New Delhi. The worms thus collected and identified whose distribution was considered significant from ecological point of view, were:

1. *Hoplolaimus indicus*
2. *Helicotylenchus indicus*
3. *Tylenchorhynchus brevilineatus*

Results

In the six months study it was observed that the role of soil temperature played an important role in minimizing the population of parasitic phytonematodes at almost all the vertical depth and horizontal distances around the root zones of the plants i.e., mango. Functional linear regression trend confirmed inverse relationship with total nemic population under M. indica. Whereas the positive thermo-response was observed at 40.01- 60.0 cm vertical depths and at 30 cm ($P < 0.025$), 60 cm ($P < 0.40$) and 90 cm ($P < 0.40$) horizontal distances around root zones of mango plants. Functional linear regression depicting correlation between edaphic factors and total nemic population against both the plants has been presented in Table-4.

Table 1: Mean monthly data of population and edaphic factors at 0.0-20.0 cm vertical depth up to 90 cm horizontal distances around root zones at M. indica at Meerut

Years	Months	Populations (X 100)	Temperature (ºC)
2001	September	9.3±0.03 (2-19)	29.67±1.04 (25-32)
	October	57.67±0.06 (9-79)	25.3±0.01 (25-26)
	November	11.2±1.04 (8-15)	19.7±0.59 (19-21)
	December	19.3±1.01 (13-27)	14.6±1.04 (14-16)
2002	January	29.6±1,01 (5-49)	16±1.05 (15-18)
	February	24.3±1.01 (24-29)	23.3 ±0.05 (23-24)

Table 2: Mean monthly data of population and edaphic factors at 20.01-40.0 cm vertical depth up to 90 cm horizontal distances around root zones at M. indica at Meerut

Years	Months	Populations (X 100)	Temperature (ºC)
2001	September	9.33±1.01 (2-13)	33.67±1.69 (31-38)
	October	29.33±1.05 (4-60)	25.67±1.03 (24-31)
	November	6.33±0.05 (3-8)	20 ± 1.07 (19-21)
	December	16.67 ± 1.07 (15-17)	14.61 ± 0.39 (14-15)
2002	January	28.67 ± 1.32 (5-51)	16.33±1.02 (16-17)
	February	17 ± 2.39 (7-32)	23.67±1.58 (23-24)

Table 3: Mean monthly data of population and edaphic factors at 40.01-60.0 cm vertical depth up to 90 cm horizontal distances around root zones at M. indica at Meerut

Years	Months	Populations (X 100)	Temperature (ºC)
2001	September	15.33 ±1.01 (5 -27)	34.5±1.04 (31-39)
	October	18.67±1.00 (3 -39)	25.3±1.04 (25 -26)
	November	5.33 ± 0.05 (2 -9)	22.4 ± 1.01 (20-25)
	December	13.33±1.01 (6 -24)	14.67±0.02 (14-15)
2002	January	13.6±1.04 (5 -26)	16.3 ± 0.83 (16-17)
	February	20.3 ± 1.00 (18 -40)	23.3 ±1.00 (23-24)

Table 4: Functional linear regression depicting correlation of soil temperature with total nemic population under M. indica

Distance/Depth	*M. indica*
H= 30 cm	
V= 0.0-20.0 cm	Y = 59.0825-1.1843X
	r = -0.34 P < 0.4
V= 20.01-40.0 cm	Y =83.0018-1.9517X
	r = -0.50 P < 0.10
V= 40.01-60.0 cm	Y = -55.0398+1.6703
	r = 0.69 P < 0.025
H= 60 cm	
V= 0.0-20.0 cm	Y = 61.1472-1.785X
	r = -0.30 P < 0.40
V= 20.01-40.0 cm	Y = 43.1833-1.0875X
	r = -0.30 P < 0.40
V= 40.01-60.0 cm	Y = -53.0328+2.0081X
	r = 0.43 P < 0.40
H= 90 cm	
V= 0.0-20.0 cm	Y = 68.1833-1.1839X
	r = -0.53 P < 0.40
V= 20.01-40.0 cm	Y = 51.2836-0.9882X
	r = -0.30 P < 0.40
V= 40.01-60.0 cm	Y = -28.6248+0.4580X
	r = 0.30 P < 0.40

H = Horizontal distance from host plants, V = Vertical depths

Discussion

The October month appeared to be the most favourable for the increasing the nemic population in the soil around the root system of mango at Meerut. The high peak of total nematodes was in the month of October. The closest finding to the author's work appeared to be the October November peak demonstrated by *Hoplolaimus indicus* and *Tylenchorhynchus brassicae* under *Rosa indica, Nyctanthes arbotristis, Bougainvillea spectobitis* and *Tabernanontane coronaria* in Aligarh (Khan, Rehman, Saxena and Khan, 1980) [5]. The total warm under mango declined significantly (r=-0.50; P<0.10; Table-4) against increasing moisture content at 20.01-40.0 cm vertical depth and at 30 cm horizontal distance from the same host plants.

This is indeed noteworthy that although population increased by the total number of nematodes against temperature and their inverse relationship with moisture were apparently abnormal, yet at time both the condition co-occurred simultaneously at the same side and at the same time. This observation conclusively indicated that besides temperature and moisture retain other community interactions or physiological interactions played a significant role in the dynamics of infestation by the total nematodes. It is noted from the results that all the studied nematodes do best at temperature between 16 ŒC to 25 ŒC. This may account for the general severity of infections in the months of October and November.

The trends of distribution of most of the nematodes under soil of M. indica at Meerut indicated affinity to offset of rains. This indicates that the greatest developmental activities of nematodes and the peak total population density during this period when moisture played significantly dominant role than temperature on population dynamics of Phyto nematodes. The peak population density during the winter months was noticeably declined and reached a minimum in February (when the temperature decreased) in other month and moisture increased. Thus, nematode population density increased around the root system of M. indica in the month of January and December respectively. It might be expected that the nematodes reproduce best at different temperatures and thus play a decline deciding role either in increasing or decreasing the population. Bird (1974) [1] reported that exposing eggs of *Meloidogyne javonica* to 46 ŒC for 10 minutes suppressed embryogenesis and hatching. Therefore, in the present study the low population density during the month of September and October can be correlated with the work of Bird (1974) [1].

Nematodes are subjected to a wide range of temperature. Temperature near the soil surface may fluctuate greatly. Nicholas (1975) [8], Norton (1978) [9] and Chaubey and Dwivedi (1992) [2] have reviewed the thermophilic/thermophobic response of nematodes. Temperature has shown to effect rate of development (Smolik, 1982) [12], generation time (Huang and Lin, 1972) [4], egg production and hatching (Van Hoof, 1976 [13]; Laybourn, 1979 [6]), sex ratio (Marques and Huang, 1986) [7], movement (Proctor, 1987) [10] and infectivity (Wallace, 1969 [14]; Rebois, 1973 [11]).

Conclusions

Ecological study of plant parasitic nematodes can play an important role in minimizing the infestation of almost all the parasitic forms of Phyto nematodes.

Acknowledgements

I am extremely thankful to the principal and head to Zoology Department of CCS University, Meerut for providing necessary facilities and field studies. The authors wish to thank Dr A. K. Choubey for useful discussions on this work.

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