Impact of Soil abiotic factors on population fluctuation of soil and plant parasitic nematodes associated with mulberry, *Morus alba* L. from Gangapur, Aurangabad (M.S), India

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ABSTRACT

Mulberry, *Morus alba* L. Family – Moraceae, an economically important tree in sericulture, was selected to study the effect of soil abiotic factor on the population of soil and plant parasitic nematodes. The soil samples were collected from the Mulberry garden from Gangapur, Aurangabad. The population was investigated at 10-15 cm depths. The result shows that, there is variation in nematode count and it is due to the effect of temperature, soil moisture and pH during the study. It was observed that soil abiotic factors have a direct effect on the nematode population. The largest nematode population was observed when the percent soil moisture was high. Both soil temperature and soil moisture were equally important. The soil pH also affected indirectly the nematode population densities.

Keywords: Mulberry, Soil moisture, Temperature, pH, Nematode population.

INTRODUCTION

Mulberry (*Morus* spp.) is an important commercial crop grown extensively both in tropical and temperate countries of the world. India is the second largest producer of silk in the world and accounts for 16 per cent of the global production. The major constraint in the cultivation of mulberry and production of quality mulberry leaves is the attack of the pests and diseases including plant parasitic nematodes. The plant parasitic nematodes have wide range of host plants and cause economic damage to many agricultural crops. Paraphrasing some of his earlier concepts, poetically described the importance of nematodes thus: “If all the other matter of the universe could be magically swept away and we could then, as disembodied spirits, revisit these scenes we should find them still recognizable ...... We could recognize lakes, rivers, and oceans by the nemas particular to them. So, too, we could recognize the soil and tell where there had been one kind of soil and where another. Several plants in parasitic nematodes species belonging to different genera have been encountered in the rhizosphere soil of mulberry gardens. Mulberry being a perennial crop, the nematode readily perpetuate and spread entire root system to cause rotening and decaying of roots. The root knot nematode, Dagger nematode and Spiral nematode which cause significant losses in mulberry production [1].

About 42 species belonging to 24 genera are associated with mulberry in different mulberry growing regions of the world. The severity of attack and damage depends on the soil and climatic conditions of different areas. The plant parasitic nematodes *Meloidogyne incognita* [2], *M. javanica* [3], *M. arenaria* [4], *Xiphinema index* [5], *X.
meovuittenezi [6], X. basiri [7], Helicotylenchus digitiformis [8], Rotylenchus reniformis [9], Hoplolaimus seinhorsti [10], Longidorus martini [11] and Pratylenchus sp. [12] are frequently associated with mulberry.

The nematode populations change in response to the pressure and challenges imposed by external factors, and so they develop a structure and show properties of growth to such factors as rainfall, temperature, soil type and host plant and to show precisely how each factor affects biological processes [13]. In general, most of the information in the literature deals with the relation between soil type and densities of nematode species on banana [14], [15] and [16]. But it is a rare study that correlates soil variables to the nematode community structure. There are several references from various countries on the influence of soil condition on animal activity. Taking nematodes as a distinct group, there is some evidence that different preferences as regards soil type [17]. Nielsen (1949) [18] has described the distribution of soil nematode in some soil types and concluded that food, water and aeration are important factors governing their distribution. He expresses the view that pore size is unimportant in nematode distribution.

The present investigation study shows that, there is variation in nematode count and it is due to the effect of Soil temperature, Soil moisture and Soil pH during the study.

MATERIALS AND METHODS

Soil sample collection and nematode extraction for count: The soil samples were collected from the Mulberry garden from different Gangapur tehsil of Aurangabad Districts. In various soil variables such as Temperature, pH and Soil moisture are noted at time of soil sampling take place. The soil samples for this study were collected from mulberry farm of various farmers during 2009-2011. Two hundred cubic centimeter of soil were sampled at depth 0-15 cm. Soil samples from various farm were pooled, thoroughly mixed before taken 200 cm

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of the representative sample for nematode extraction using Cobbs sieving and decanting method with Baermann techniques. The sample method is very simple i.e. pooled two samples from random sampling method from collection site of mulberry garden and further procedure as above. Then note down their mean value as nematode count.

Preservation and mounting of nematode: Batches of the extracted nematodes were inactivated in water bath at 60-70 °C, fixed in FA 4:1 fixative cleared in a glycerol-ethanol solution by slow evaporation of the ethanol and stored in anhydrous glycerol. Microscopic examination and photographing of the nematodes was done in glycerol mounts.

Estimation of soil abiotic factors of mulberry field: A portion of soil samples, collected from mulberry selected for ecological studies was kept separate to estimate the soil abiotic factors like soil moisture, pH and temperature. The methods of estimation as follows:

Preparation of soil for testing: The soil samples were thoroughly air dried under shade, grinded into fine particles, and was passed through 2mm pore size sieve. The soils were stored in containers with label of locality and month of collection for subsequent analysis.

Estimation of Soil Temperature: Soil temperature was recorded every month from Mar.2009- Apr. 2011 from mulberry field at the time of collecting soil samples between 11 AM to 12 PM with the help of soil thermometer. The thermometer was pushed into soil at least up to 10 cm depth keeping there until a constant temperature was reached and the temperature was reached and the temperature was recorded.

Estimation Soil pH: With the help of soil pH meter the pH of soil is note on the field during the soil samples collection time.

Estimation Soil moisture: Weighing 10 gm of soil then take it in the oven at temperature around 105°C overnight and re-weight.

Soil moisture (%) = \[
\frac{\text{Wet soil weight (gm) - Dry soil weight (gm)}}{\text{Dry soil weight (gm)}} \times 100
\]
RESULTS AND DISCUSSION

1. Population fluctuation of the nematode orders Dorylaimida, Tylenchida, Mononchida and nematodes of other orders in mulberry garden of Gangapur tehsils.

In Gangapur tehsil mulberry garden, the maximum total population abundance, i.e., the totality of all (Juveniles and adults) Dorylaimids, Tylenchids, Mononchids and other nematodes, was observed in month of August among all twenty-four months of observations, the mean of total population being 332 / 250 gm of soil in August 2009, 434 in August 2010. The minimum total population was recorded in the month of May 2010-11, the mean population being 45 and 35 (Figure No. 1).

The maximum population of Tylenchida was noticed in August 2009 (117 / 250 gm of soil respectively) and August 2010 (165). Tylenchids were counted minimum in March, April and May 2010-11, being 15 and 26, 20 and 20, 17 and 12 respectively. Like-wise, the mean population abundance of Dorylaimida was observed to be the highest in the month of August in two consecutive years (125 in 2009 and 172 in 2010). The mean population of Dorylaimida was counted lowest in March, April and May 2010-11, being 18 and 31, 26 and 28, 15 and 14 respectively. The distinct population peak of Mononchida was well pronounced in August 2009-10 (54 and 52 respectively). It remained distinctly minimum in February, March, April and May 2010-11, being 15 and 12, 11 and 10, 12 and 9, 9 and 5 respectively. The highest population of nematodes belonging to other orders, i.e. of ‘other nematodes’ was encountered in August 2009 is 36 and August 2010 is 45. The least population was recorded in February, March, April and May 2010-11, being 10 and 9, 8 and 7, 10 and 5, 4 and 4 respectively. The data regarding the monthly population fluctuation of Tylenchida, Dorylaimida, Mononchida and other nematodes in Gangapur mulberry garden is shown in Figure No. 1.

In the present observation, the total population of all the nematode orders started up coming from the month of June for the years under study and maintained high population abundance up to the month of January, reaching its highest in the month of September. In the year 2009 as well as 2010 – 11, the population started declining notably in February to May followed by June- July. The seasonal variations in the population of plant and soil nematodes discussed by many scientists like [19-29]. Population dynamics of plant parasitic nematodes associated with mulberry in Egypt by [30] revealed that Seasonal fluctuation of plant parasitic nematodes associated with mulberry showed a peak of *Rotylenchulus reniformis* in March and August and population of *Paratylenchus* sp., showed a peak in January, May and July.

Gantait *et al.*, (2006) [31] shows very much close findings of Monthly population fluctuation of four plant parasitic nematodes, *Rotylenchulus reniformis*, *orhynchus coffeae*, *Helicotylenchus crenacauda* and *Hoplolaimus indicus* associated with banana plantation (*Musa paradisiaca* cv ‘Kanthali’), *Tylench* was studied in Paschim Medinipur District, West Bengal, India, during March 2004 to February 2005. All the four species reached at peak in August, then declined till January. In March, a second but smaller peak was seen, followed by a decline till June. Thus, a bimodal population fluctuation has been observed in all the cases.

The population of the ‘other nematodes’ fluctuated throughout the year shows maximum in month of august and September during 2009-10. There was no remarkable variation in occurrence of the “other nematodes” population in present study. They maintain high build up in their population from august to December in two years observation. Drastic decline was observed in March, April and May 2010-11. The similar results were observed by [32] in paddy crops for two years.

2. Correlation and Regression analyses of the nematode orders Dorylaimida and Tylenchida in mulberry garden of Gangapur tehsils.

In Gangapur mulberry garden, the population of different genera of Dorylaimida and Tylenchida have negative impact of temperature on their population growth (correlation coefficient (r) lies between (-) 0.653 to (-) 0.788 for different genera, *P* ≤ 0.05). On the contrary, pH of soil also affected the population of all the genera having negative impact on their population growth [correlation coefficient (r) lies between (-) 0.664 to (-) 0.782 for different genera, *P* ≤ 0.05]. The population growths of Dorylaimids were positively correlated with the moisture content of the soil at a significant level [correlation coefficient (r) lies between (+) 0.755 to (+) 0.846 for different genera, *P* ≤ 0.05]

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whereas, the tylenchid population showed significant relationship [r ranges between (+) 0.745 to (+) 0.795, P ≤ 0.05].

The data regarding the mean population of tylenchid and Dorylaimid genera and the estimated monthly mean value of soil abiotic factors in Gangapur tehsil mulberry garden are shown in Table No. 1 and in Figure No. 2, 3, 4 and 5 respectively.

Table: 1. Correlation coefficients (r) between nematode genera and different soil abiotic factors in Gangapur Mulberry garden

<table>
<thead>
<tr>
<th>Genera</th>
<th>Temperature (°C)</th>
<th>Moisture (%)</th>
<th>pH</th>
</tr>
</thead>
<tbody>
<tr>
<td>Meloidogyne</td>
<td>-0.676*</td>
<td>0.745*</td>
<td>-0.782*</td>
</tr>
<tr>
<td>Helicotylenchus</td>
<td>-0.690*</td>
<td>0.795*</td>
<td>-0.668*</td>
</tr>
<tr>
<td>Pratylenchus</td>
<td>-0.698*</td>
<td>0.792*</td>
<td>-0.679*</td>
</tr>
<tr>
<td>Eudorylaimus</td>
<td>-0.748*</td>
<td>0.775*</td>
<td>-0.689*</td>
</tr>
<tr>
<td>Mesodorylaimus</td>
<td>-0.788*</td>
<td>0.780*</td>
<td>-0.708*</td>
</tr>
<tr>
<td>Aporcelaimellus</td>
<td>-0.666*</td>
<td>0.755*</td>
<td>-0.664*</td>
</tr>
<tr>
<td>Discolaimus</td>
<td>-0.786*</td>
<td>0.846*</td>
<td>-0.674*</td>
</tr>
<tr>
<td>Xiphinema</td>
<td>-0.653*</td>
<td>0.780*</td>
<td>-0.685*</td>
</tr>
</tbody>
</table>

Figure: 1. Month wise man population (adults and juveniles) of Tylenchida, Dorylaimida, Mononchida and other nematodes / 250 gm of soil in mulberry garden in Gangapur tehsil.

In all the mulberry garden under study shows that the population of all Dorylaimids and tylenchids were negatively correlated with soil temperature having significance in Gangapur tehsils. The populations of different genera of Dorylaimida and Tylenchida have negative impact of temperature on their population growth (P ≤ 0.05). The Meloidogyne, Pratylenchus and Xiphinema genus having (P ≤ 0.05) which does not show significance. But other genera i.e. Helicotylenchus, Eudorylaimus, Mesodorylaimus and Discolaimus having (P<0.02) which shows significant correlation coefficient (r) values. The results shows similar with [30] revealed that Seasonal fluctuation of plant parasitic nematodes associated with mulberry showed a peak of Rotylenchulus reniformis in March and August which was negatively correlated (r = 0.03) with the prevalent soil temperature. Population of Paratylenchus sp., showed a peak in January, May and July which was negatively correlated (r = 0.01) with the soil temperature. [31] has made an attempt to correlate the population change of the species with soil factors like...
temperature, moisture, pH, and organic carbon content. Temperature, moisture and organic carbon showed positive correlation with the population whereas pH showed negative correlation. This study shows opposite results of our findings.

Soil moisture is one of the major factors in regulating the nematode population being related mainly to rainfall of a particular area. In the present study, significant population growth of Dorylaimids occurred with the increasing moisture content of the soil (P<0.05). Khan and Sharma (1990) [33] observed no considerable role of moisture on some nematode species having negative correlation with population build-up in apple orchard which contradicts the present observation in its extreme. On the other hand a positive correlation was observed between certain genera and rainfall in pastures [34], which helped to maintain a consistent increase in plant feeders with increasing soil water in prairie system [35] and that of omnivores and predators in an irrigated orchard [36]. Griffin et al. (1996) [37] concluded that the positive relationship exists between high soil water and maximum population densities of *Tylenchorhynchus acutoides*. But in the present investigation although the population of tylenchids was highest during monsoon, still they showed no significant correlation with soil moisture (P>0.10).

Figure: 2. Linear regression of Tylenchida population (genus *Meloidogyne* and *Helicotylenchus*) in relation with soil abiotic factors (as mentioned on X-axis) in Gangapur mulberry field.
Fig: 3. Linear regression of Tylenchid and Dorylaimid population (genus Pratylenchus and Eudorylaimus) in relation with soil abiotic factors (as mentioned on X- axis) in Gangapur mulberry field.
Fig: 4. Linear regression of Dorylaimid population (genus Mesodorylaimus and Aporcelaimellus) in relation with soil abiotic factors (as mentioned on X- axis) in Gangapur mulberry field.
Fig: 5. Linear regression of Dorylaimid population (genus Discolaimus and Xiphinema) in relation with soil abiotic factors (as mentioned on X- axis) in Gangapur mulberry field.
CONCLUSION

1. Soil abiotic factors like temperature, moisture and pH were also observed during the same period and were recorded and the values of temperature for correlation coefficient (r) lies between (-) 0.198 to (-) 0.483 for different genera, P ≤ 0.05). Moisture content of the soil at a significant level (correlation coefficient (r) lies between (+) 0.755 to (+) 0.846 for different genera, P ≤ 0.05) whereas pH of soil also affected the population of all the genera having negative impact on their population growth (correlation coefficient (r) lies between (-) 0.664 to (-) 0.782 for different genera, P ≤ 0.05).

2. Monthly population fluctuation of the nematodes belonging to orders Dorylaimida, Tylenchida, Mononchida and nematodes belonging to the other orders were studied.

3. In general, populations of all orders of nematodes were highest during rainy season (June-Oct.) and remained comparatively lower in winter and summer season.

4. The available Tylenchids, Dorylaimids and Mononchids genera were correlated to three soil abiotic factors mentioned above along with linear regression analyses.

5. These effects of soil abiotic factors on nematode population. Soil temperature and pH shows and negative correlation on nematode population. Soil moisture was positively correlated (P ≤0.005) with the population of different genera for all six mulberry gardens.

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