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Effect of soil abiotic factors on population of *Helicotylenchus* steiner, 1945 associated with mulberry, *Morus alba* L. from Gangapur, Aurangabad (M.S), India

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Abstract

Mulberry is an important source of food for the silkworm Bombyx mori L, and it is grown in the sericulture industry all over the world. Plant parasitic nematodes have a negative impact on mulberry leaf quality and quantity. So, in the present study, the effect of soil abiotic factor changes on the population levels of *Helicotylenchus* Steiner, 1945 in Mulberry, Morus alba L. field and also analyze the Correlation coefficients (r) from Gangapur, Aurangabad District Mulberry garden.

Keywords: *Helicotylenchus*, soil abiotic factors, *Bombyx mori* L., Gangapur

Introduction

Sericulture is one of the most important agricultural industries in India, earning around Rs. 1137.44 crores in foreign currency per year in 2019-20 and employing over 9.18 million people in 2018-19. (Central silk board, 2021) [2]. Sericulture is the process of breeding silkworms for the purpose of producing silk on either mulberry or non-mulberry plants. India has surpassed China in silk production and is currently the world's second largest economy. Agriculture and agro-based sectors are crucial for emerging countries like India to improve their rural economies. Villages are looking for alternative rural industries, one of which is sericulture, due to limited land availability, low monetary returns, and agriculture being limited to one or two seasons per year. It's a small-scale agro-based business that employs a lot of women in rural areas to rear silk worms while the men work in the fields. Thanks to the innovation of new methods by research institutions in mulberry cultivation and silkworm handling among sericulturists, the industry is now performed as a significant vocation and a substantial cash crop in the region. Sericulture is a low-investment, high-output occupation that delivers both jobs and earnings. It is a recreation-oriented small-scale farming sector. The business has a lot of job-creating potential, especially in rural and semi-urban areas (Benchamin and Jolly, 1986) [1].

Mulberry is commercially essential for silk production, which is dependent on the quality and quantity of the leaves, which are prone to infection by nematodes, fungi, virus, bacteria, insects, and other pathogens. These diseases are the cause of a significant reduction in mulberry leaves production and nutritional value. The health of the silkworms is directly related to the quality of the leaves fed to them, and as a result, the cocoon yield is lowered. The recurrent loss in leaf yield is due to a lack of study on the frequency of various illnesses and epidemics (Powell, 1971; Sengupta *et al.*1990; Teotia and Sen S.K, 1994; Datta *et al.*, 1997; Datta, 2007; Datta and Datta, 2008) [18, 22, 25, 4, 6, 5]. The study focused on nematodes connected with mulberry plants, the most common of which belonged to the Hoplolaimidae family. Helicotylenchus spp., Rotylenchus sp., and Scutellonema sp. were the spiral nematode species found. The family's population behaviour in relationship to soil physicochemical factors is also taken into account. (Loukrakpam Bina and Naorem Mohilal, 2020) [16].

The invasion of pests and diseases, particularly plant parasitic nematodes, is a serious restraint in mulberry cultivation and the production of high-quality mulberry leaves. In diverse mulberry-growing countries around the world, some 42 species of nematodes belonging to 24 genera are associated with mulberry (Swamy, B. C. N. and H. C. Govindu (1965) [24]. The severity of the attack and the damage it causes is determined by the soil and climatic conditions in each place. Because nematodes live in the soil microenvironment, soil parameters such as temperature, moisture, and pH have an impact on them, even when it comes to worm population management. The impact of pH and salt content on the survival of several nematodes is studied by Jairajpuri et al. (1974) [12]. Rao and Swarup (1975) [20] reportable the factors those have an effect on the coffee, population development and survivality of *Helicotylenchus dihystera*. Shukla *et al.* (1986) [23] studied the population dynamics of *Helicotylenchus* associated with soil temperature and moisture. Kamra and Sharma (2000) record the distribution

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of some plant parasitic nematodes in several states of Asian nation relying upon the temperature. Influence of soil temperature, Moisture and pH on nematodes in numerous fruit orchards are studied by Dwivedi *et al.* (1987) [9], Dwivedi, Malhotra and Mishra (1987) [8], Khan and Sharma (1990) [13].

Material and methods

Collecting soil samples and extracting nematodes for counting

Soil samples were taken from various Mulberry gardens in the Gangapur tehsil of the Aurangabad district. During the study period, soil samples were gathered from several farmers' mulberry farms. Cobbs sieve and decanting method with Baermann procedures were used to collect about 200 cm^3 of soil sample for nematode extraction.

Nematode preservation and mounting

The nematodes were removed and inactivated in a water bath at 60-70°C, then fixed in FA 4:1 fixative, cleaned in a glycerol-ethanol solution, and kept in anhydrous glycerol. Glycerol mounts were used for microscopic investigation and photography of the nematodes.

Estimation of soil abiotic factors from mulberry

Soil samples from a mulberry field were maintained separate to determine soil abiotic variables such as soil moisture, pH, and temperature for ecological studies. The following are the estimating methods:

Preparation of soil for testing

The soil sample is air dried and grinded into fine particles is passed through 2mm pore size sieve. The soils were stored in laboratory with label of locality and month of collection.

Estimation of Soil Temperature

Soil temperature was recorded every month during the study from mulberry field at the time of collecting soil samples between 11 AM to 12 PM with the help of soil thermometer.

Estimation of Soil pH

The pH of soil is note on the field with the help of soil pH meter during the soil samples collection.

Estimation Soil moisture

Weight about 10 gm of soil and then take it in the oven at 105°C overnight and re-weight.

$$\text{Soil moisture (\%)} = \frac{\text{Wet soil weight (gm) - Dry soil weight (gm)}}{\text{Dry soil weight (gm)}} \times 100$$

Results and Discussion

The During 24 months of observations, the mulberry garden in Gangapur tehsil of Aurangabad district observed the highest population of all (juveniles and adults) Helicotylenchus sp. The total population was around 51/ 250 mg of soil in September 2009 and 81/ 250 gm of soil in September 2010. The lowest population was recorded in April and May 2010-11, with populations of around 13 and 8, respectively, and 9 and 5. Figure No. 1 shows the monthly fluctuations in the population levels of Helicotylenchus sp. nematodes in the Gangapur tehsil mulberry garden.

Helicotylenchus sp. population levels changed in June, July, August, and September, when soil temperature, moisture, and pH were in the 25-28°C, 26-36 %, and 6.2-6.5 respectively. They are at their lowest number in March, April, and May, when the soil factor is between 29 and 34 °C, 8-14 percent, and 6.6-6.8 %, respectively (Figure. 1). In the remaining months, despite the presence of comparably lower temperatures and moisture with higher pH, the population fluctuated without any increase or decline. According to Debabrata et al., 2008 [7], peak Helicotylenchus population density occurred in June and July when soil temperature, moisture, and pH were between 31-36°C, 15-30%, and 5.6-5.8 respectively. They reach at the lowest level of their abundance in September, April and May when the soil factors ranged between 31 to 37°C, 11.2 to 27.5% and 5.7 to 6.2 respectively.

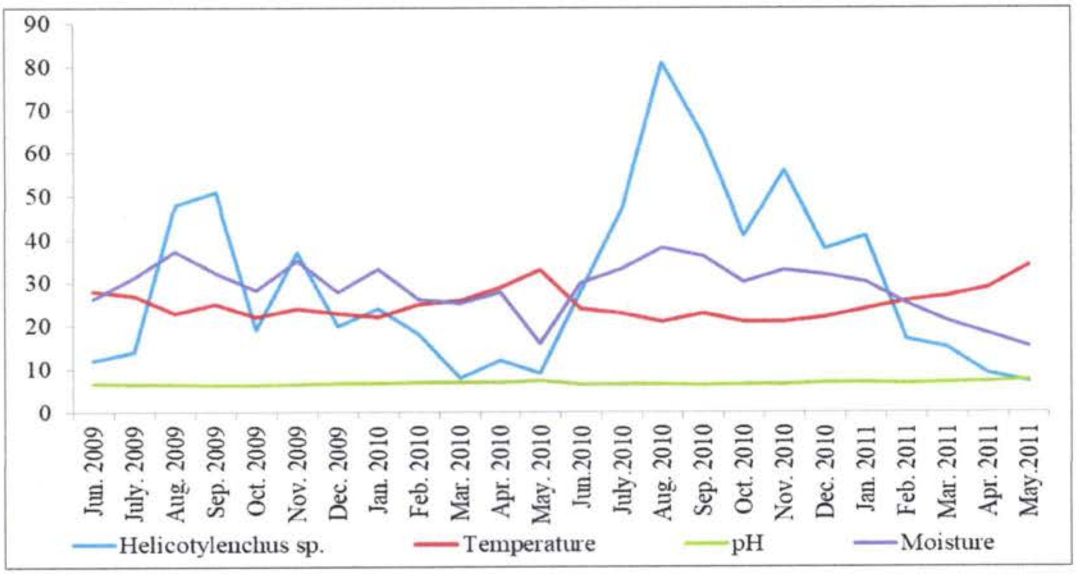
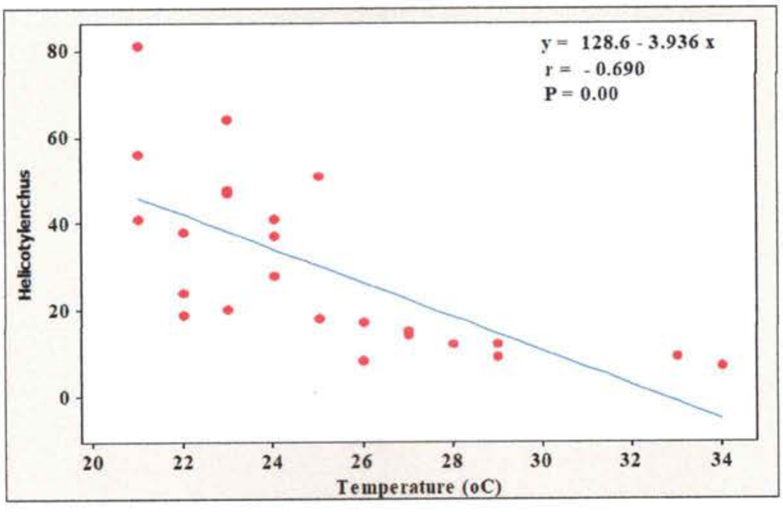


Fig 1: In a mulberry garden in Gangapur tehsil of Aurangabad District, mean population size (adults and juveniles) of each Helicotylenchus sp. / 250 gm in relation to Soil abiotic factors.

Das et al., (1984) [3] found that the adults and larval populations in soil report fluctuate nearly in the same fashion from June to September and November to January in an increased trend that shows both peaks, but they also noted a low level of the adults and larval population from February to May. Because high population density was seen at optimum temperature and high moisture % in the current study, Khan et al., (1971) [15] also reported the optimum temperature of 25°C. for nematode population growth. Ramana et al. (1978) [19] also found that in monsoon locations, 21-26 °C or lower soil temperature is favourable for lance nematode, which contradicts the current study.

Gantait et al., (2006) [10] has study on 4 plant parasitic nematodes *Rotylenchulus reniformis, Orhynchus coffeae, Helicotylenchus crenacauda* and *Hoplolaimus indicus* associated with banana plantation to correlate the population change of the species with soil factors like temperature, moisture, pH, and organic carbon content which show positive correlation with the population and pH showed negative correlation. Rogovska *et al.*, (2009) [21] study show soybean yield and soybean cyst nematode densities related to soil pH, the result shows that the relative yield declined with increases pH than resistant cultivators. The soybean cyst nematode population densities were more strongly related to soil pH. Soil pH seems here to have a less effect on *H. multicinctus* and *M. incognita*, though as reported by Norton (1979) [17], numerous data suggest that soil pH unless at an extreme low or high level has no adverse effect on nematodes. Jairajpuri *et al.*, (1974) [12] observed that *Hoplolaimus indicus* and *Helicotylenchus indicus* have a wide range of optimum pH (5.8- 9) for survivality, which is conformity with present study.

The relationship of *Helicotylenchus* sp. with soil abiotic factors represented with correlation coefficient (r) during study period i.e. ($r = -0.690$; $P=0.00$), ($r = 0.795$; $P= 0.00$), ($r = -0.668$, $P= 0.00$) respectively (Figure No. 2 - 4). Loukrakpam Bina and Naorem Mohilal (2020) [16] has analyse correlation co-efficient between the nematodes and the environmental parameters taken into consideration in the study showed that there was significant positive correlation (significant at 95% level of significance and above) with soil pH but in our findings has significant negative correlation between nematode population and soil pH.



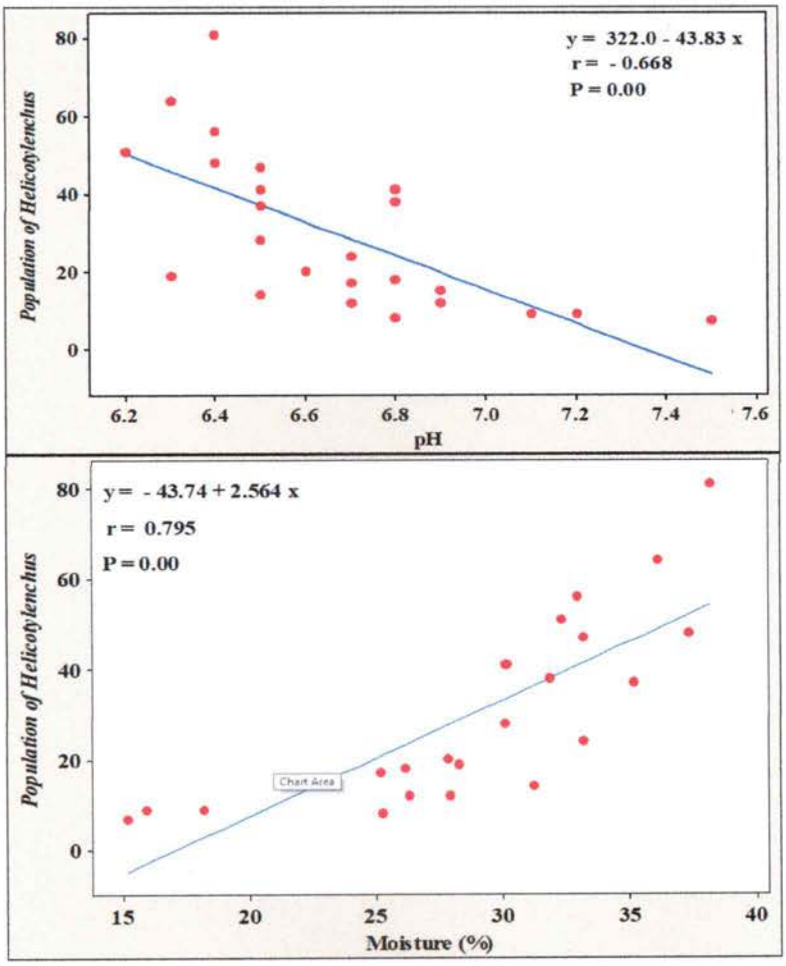


Fig 2-4: At Gangapur tehsil in Aurangabad District Mulberry Garden, correlation coefficients (r) between Mean population Helicotylenchus sp. and soil abiotic variables (* Significant correlation 0.05).

The correlation coefficient (r) shows a negative relationship between the population of Helicotylenchus spp. (Figure No. 2 - 4) and soil temperature and pH, which can be represented by the following regression equations over the study period: Y = -3.936X + 128.6 (r = -0.690; P=0.00) and Y = 2.564 X - 43.74 (r = -0.668, P=0.00) over the study period. On the other hand, the following regression equations with sufficient correlation can be used to indicate a positive relationship seen between the population and soil moisture: Y = -43.83X + 322.0 (r = 0.795; P= 0.00). Youssef (1998) [26] finds that the seasonal fluctuation of Rotylenchus reniformis associated with mulberry is negatively correlated (r = 0.03) with the prevalent soil temperature, and that the population of Paratylenchus sp. has a peak in January, May, and July that is negatively correlated (r = 0.01) with soil temperature. Ghosh and Manna *et al.*, (2008) show that the soil moisture has positive correlation with the nematode population even in continuous follow period of paddy crop field to frequent rainfall in West Bengal. Debabrata *et al.*, 2008 [7] shows the relationship of *Helicotylenchus* with soil temperature, moisture and pH can be represented by the following regression equations in the total period of study: Y = -0.0162X + 31.421 (r = -0.155; P > 0.10), Y = 0.0328X + 14.828 (r = 0.188; P> 0.10) and Y = -0.0025X + 6.2528 (r = -0.33; P > 0.10) respectively.

Conclusion

1. To determine the seasonal occurrence of Helicotylenchus spp., a research was done to record the Helicotylenchus species fauna available from mulberry fields in Gangapur, Aurangabad district (M.S.) India.
2. Helicotylenchus spp. populations were maximum during the rainy season (June-October) and remained significantly lower during the winter and summer seasons.
3. The population of Helicotylenchus spp. is affected by abiotic factors in the soil. The population of Helicotylenchus spp. is negatively correlated with soil temperature and pH. In mulberry gardens, soil moisture was found to be positively linked (P 0.005) with the population of Helicotylenchus spp.
4. The population of Helicotylenchus spp. was associated with the three soil abiotic parameters listed above, as well as linear regression analysis.

5. In a realistic and honest manner, we must acknowledge that the growth/decline of the overall population of nematodes in a natural ecosystem is driven by the interaction of all possible biotic variables between the soil and nematode populations. It would be nearly impossible to test the efficacy of a biotic component in the population in this situation.

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