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THE EFFECT OF SOIL TEMPERATURE AND OF INFESTATION BY *PRATYLENCHUS LOOSI* ON THE GROWTH AND NUTRIENT STATUS OF A SUSCEPTIBLE AND TOLERANT VARIETY OF YOUNG TEA (*CAMELLIA SINENSIS* L.)

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Soil temperatures ranging from 18-24°C were found to be the optimal for the rapid build up of populations of *Pratylenchus loosi* Loof in both susceptible and tolerant clones of young tea. Pathogenic effects were evident only in this temperature range and this was observed only in respect of the susceptible clone, TRI 2024. Nitrogen and magnesium metabolism were found to be significantly affected by the pathogenicity of *P. loosi*. Total nitrogen was found to accumulate with infestation while magnesium was found to be significantly reduced. The tolerant clone TRI 2142 did not show such changes even at the optimal temperature range for the rapid buildup of the eelworm population. Maximum shoot growth of plants was found to occur at 30°C and the least growth at 12°C. Both the soil temperatures tested (12°C and 30°C) were found to be unfavourable for the increase of the nematode population.

INTRODUCTION

Pratylenchus loosi Loof is a pest of tea in Sri Lanka at altitudes of 900-1800 m (Hutchinson & Vythilingam 1963). The results of critical studies by growing plants at four different temperatures in controlled environment chambers have shown that the population of *P. loosi* rapidly increases between 15.6-21°C, whereas it declines rapidly at the lower extreme of 11.5°C and at the higher extreme of 28°C (Sivapalan 1969). The altitude distribution pattern of the incidence of *P. loosi* appears to be a function of soil temperature (Sivapalan 1972). The present investigation was undertaken to study the possible effects of soil temperature and nematode pathogenicity on the growth and nutrient status of a susceptible and a tolerant tea clone.

MATERIALS AND METHODS

Thermostatically-controlled constant temperature tanks measuring 2 x 1 m and 30 cm in depth were used as water baths to heat soil contained in clay pots, 15 cm in diameter. The temperature of the water in the respective tanks was maintained by a thermostatically-controlled 3 KW imersion heater fitted horizontally, 5 cm from the bottom at the centre of the tank. To maintain even temperatures throughout the tank, water was circulated very rapidly at intervals by a Steuarts Turner No. 10 centrifual pump mounted on the under side of each tank. It was possible to maintain the required temperatures within $\pm$ 1°C. The tanks were set up in a glass house.

Nursery soil, fumigated with methyl bromide at 0.5 Kg per 2.7 m^3, mixed in the proportion of three parts gravel and one part clay soil, was used. Seven-months-old plants of uniform size of the tea clone TRI 2142 and TRI 2024 were transplanted into the pots and were kept in the glass house for a period of two weeks before transferring them to the respective temperature tanks (Fig. 1). A total of 36 potted plants

(18 each of clone TRI2142 and TRI 2024) were transferred to each of four temperature tanks maintained at 12, 18, 24 and 30°C respectively. After these plants had remained in the temperature tanks for a period of three months, half of them were inoculated with a suspension of 3000 nematodes (*P. loosi*). The treatments in the respective temperature tanks were arranged in a randomized block design. Following inoculation the plants were maintained for a further period of 12 months, at the end of which period they were removed for assessments. Fertilizer applications were made at fortnightly intervals using solutions of T 65 (Tolhurst 1961) at the following rates. Increasing concentrations of fertilizer solutions were applied at the rate of 7, 14, 21, 28, 35 and 42 g/100 plants, for periods of one month each respectively. Beyond the 6th month a common fertilizer solution at 49 g/100 plants was supplied.

At the end of 15 months, the plants were removed for analysis. The plants were individually removed from the pots with special attention being paid to recover all roots from each pot. Fresh weights of shoot and root were determined and the third and fourth leaf of the each plant was removed for mineral analysis. Root samples were processed for recovering nematodes using the method described by Hutchinson (1962).

Total nitrogen was determined by the Kjeldahl method. Phosphorus was determined by the vanado molybdophosphoric yellow colour method. Potassium and calcium were determined by flame photometry using an Eel Flame Photometer. Manganese was determined by the periodate oxidation method (Jackson 1958). Magnesium was determined by the titan yellow method (Chenery 1964).

RESULTS AND DISCUSSION

The analysis of mean shoot and root weight of plants at the different temperatures and the nematode population counts in roots at these respective temperatures are given in Table 1.

TABLE 1 — *Mean shoot and root weights and numbers of nematodes present in roots of two clones grown in soil maintained at four different temperatures*

Mean shoot and root weight and nematode count in roots (log)

Temperature (°C)	Shoot weight (g)	Root weight (g)	Nemas g^{-1} root (log n)
12	57.67	75.40	1.91
18	57.43	52.66	2.38
24	65.99	46.78	2.44
30	79.95	67.57	2.24
LSD (P=0.05)	9.47	9.17	0.06

A definite influence of soil temperature on the growth performance of young tea was observed in this experiment. There was, however, no significant interaction between clones and soil temperatures in respect of overall growth. In general the mean fortnightly height increments of clone TRI 2142 at all tested temperatures were found to be greater than for clone TRI 2024.

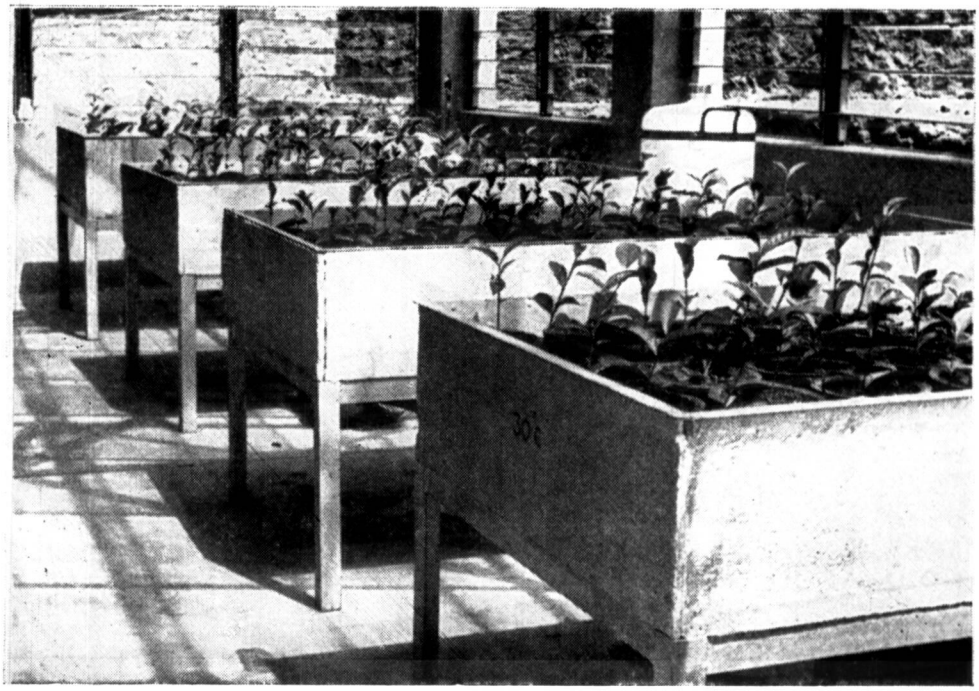

FIG. 1—*Temperature tanks containing potted plants set up in the glasshouse*

The highest shoot growth was observed at 30°C. This was followed by the growth at 24°C which was higher than that at 18° and 12°C. The higher temperatures of 24° and 30°C, therefore, seem to favour shoot growth. Root growth, however, at 18 and 24°C was significantly less than that at 12° and 30°C. The nematode build up at 24°C was significantly higher than that at all the other temperatures tested. Although the nematode population at 18°C was significantly lower than at 24°C this was significantly higher than that at both 12° and 30°C. The high nematode population at 18° and 24°C seems to have significantly suppressed root growth at these two temperatures, and it is on account of nematode pathogenicity at these temperature that the overall root growth at 18° and 24° appears to be significantly lower than that at 12° and 30°C.

Effects of temperature on nematode population in different clones

The results of the interaction of clones and temperature in terms of nematode counts in roots are presented in Table 2.

TABLE 2 — *Nematodes present in roots of two clones at different temperatures*

		Mean nematode count g^{-1} root (log)			
Clones	Temperature (°C)	12	18	24	30
TRI 2024		1.98	2.42	2.33	2.20
TRI 2142		1.84	2.33	2.56	2.28
LSD (P=0.05)				0.08	

As seen from Table 2 the susceptible clone TRI 2024 supported the highest nematode population at a temperature of 18°C. The nematode-tolerant clone TRI 2142, on the other hand, supported a high population of nematodes at 24°C. This population was significantly higher than that at all the other temperatures. The nematode population at 12° and 30°C respectively was, however, significantly lower than at 18° and 24°C in both susceptible and tolerant clones. Temperatures of 18° and 24°C, therefore, seem to be the favourable temperature for nematode population build up in both clones.

The nematode population supported by the tolerant clone at 24°C was significantly higher than even the highest population supported by the susceptible clone at 18°C. This finding substantiates the earlier observation of good tolerance of TRI 2142 to nematode infestation (Kerr & Vythilingam, 1967). In the case of the susceptible clone it is very likely that the initial higher population could have declined with increasing root damage, which seems to have been replenished adequately by compensatory root growth in the tolerant clone TRI 2142. The steady regrowth of roots in the tolerant clone appears to have supported a higher population than that supported by the inadequately replenished damaged roots of the susceptible clone at the time of the termination of this experiment.

Effects of infestation on shoot and root growth

The mean shoot and root weights of the respective clones of uninoculated and infested plants are presented in Table 3.

TABLE 3 — *Mean shoot and root weights of two clones grown in soil infested with P. loosi and uninoculated soil*

	Mean shoot and root weight (g)			
	SHOOT		ROOT	
Clones	2024	2142	2024	2142
Control	74.25	71.48	64.70	68.90
Infested	49.13	66.19	47.20	61.60
LSD (P=0.05)	9.47		NS	

Despite the fact that both tea clones supported a high population of nematodes, overall nematode pathogenicity was evident in the form of reduced shoot weight only in the susceptible clone TRI 2024 as seen in Table 3. Nematode pathogenicity, however, as a function of the reduction in root weight was seen only at 18° and 24°C (Table 4). No significant effects were observed at 12° and 30°C.

TABLE 4 — *Mean shoot and root weights of two clones grown in soil infested with P. loosi and uninoculated soil maintained at four different temperatures*

Treatment	Shoot weight				Root weight			
Temperature (°C)	12	18	24	30	12	18	24	30
Control	60.9	65.6	80.2	84.7	79.6	64.7	56.9	60.0
Infested	54.4	49.2	51.8	75.2	71.2	40.6	36.3	69.1
LSD (P=0.05)	NS				12.9			

The high nematode counts at 18°C and 24°C (Table 2) and the overall significant reduction of root growth at these two temperatures (Table 1) support the earlier field and experimental observations that the largest increase in nematode numbers was around 1200 m elevation, where the soil temperature is around 15-18°C (Hutchinson & Vythilingam 1963) and that rapid nematode population increase have been recorded around 15°C and 21°C (Sivapalan 1972).

Effects of temperature on the nutrient status in leaf samples

The results of mineral analysis of leaf samples of plants at the tested temperatures are presented in Table 5.

TABLE 5 — *Mean assessments of nutrients in leaf samples from plants maintained at four different soil temperatures*

Temperature (°C)	Nutrient content (% dry matter)		
	N	K	Ca
12	2.96	1.58	0.58
18	3.21	1.56	0.54
24	3.26	1.39	0.49
30	3.03	1.52	0.41
LSD (P=0.05)	0.22	0.12	0.06

Leaf analysis revealed a significantly high total nitrogen content at 24°C which was closely followed by that at 18°C. The total nitrogen content was significantly higher in the infested plants at 18 and 24°C as compared with the uninoculated plants at these two temperatures as shown in Table 6.

TABLE 6 — *Mean percentage nitrogen in leaf samples in infested and uninoculated plants maintained at four different soil temperatures*

Treatment	Mean % N in dried leaf samples			
Temperature (°C)	12	18	24	30
Control	2.95	2.98	2.94	3.03
Infested	2.98	3.45	3.58	3.02
LSD (P=0(05)		0.32		

A significant accumulation of total nitrogen was seen only in the nematode-susceptible clone whereas no significant increase was observed in the nematode-tolerant clone as shown in Table 7.

TABLE 7 — *Mean percentage nitrogen in leaf samples in the susceptible and tolerant clones*

Clones	Mean % N in dried leaf samples	
	Control	Infested
TRI 2024	2.83	3.34
TRI 2142	3.12	3.17
LSD (P=0.05)	0.22	

There is therefore a significant accumulation of total nitrogen with nematode injury as shown by the responses of the susceptible and the tolerant clone.

Although there was no overall difference in the total magnesium content in leaves at the different temperatures, a significant reduction in magnesium content was seen in the infested plants at 18° and 24°C as seen in Table 8.

TABLE 8 — *Mean percentage magnesium in leaf samples of infested and uninoculated plants*

Temperature	Mean % Mg in dried leaf samples	
	Control	Infested
18°C	0.28	0.23
24°C	0.27	0.23
LSD (P=0.05)	0.03	

The reduction in magnesium content, however, is seen only in the nematode-susceptible clone whereas in the nematode-tolerant clone there was no difference.

TABLE 9 — *Mean percentage magnesium in leaf samples in the susceptible and tolerant clones*

	Mean % Mg in dried leaf samples	
Clones	Control	Infested
TRI 2024	0.26	0.21
TRI 2142	0.27	0.28
LSD (P=0.05)	0.02	

This finding seems to support the general observation of chlorotic symptoms in leaves of plants with high nematode infestation (Gadd and Loos, 1946).

For the nutrients P, K, Ca and Mn no significant differences were observed in respect of interactions between clones, temperature, and infestation. However the Ca content in the leaves was found to steadily decrease with increase in temperature. Nitrogen and magnesium metabolism seem to be significantly affected as a consequence of pathogenicity brought about by *P. loosi*. In the case of the nematode-tolerant clone TRI 2142 no such symptoms were evident.

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