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EFFECT OF ENVIRONMENT ON POPULATION DYNAMICS OF PLANT PARASITIC NEMATODES AND CONSEQUENT PATHOGENICITY TO TEA

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When the soil from the rhizosphere of tea plants from any part of the world is examined, one would encounter several species of plant-parasitic nematodes (Table 1). Among them, those which cause concern are the ones which bring about economic damage to tea.

The presence of these pathogenic species, however, as in the case of any other pests, would cause alarm, only if they are present in sufficient numbers above the established damage thereshold level. Nevertheless, when these species are detected in any location, a close vigilance needs to be maintained to ensure that the population does not build up to levels that can cause economic damage and also to avoid the spread to other areas hitherto uninfested.

The factors generally limiting nematode reproduction and survival and establishment in a given specific location is known to be very much dependent on the soil environment, which can be divided into two factors: (1) Physical; (2) Biotic.

TABLE 1 - DISTRIBUTION OF NEMATODES KNOWN/SUSPECTED TO BE PATHOGENIC TO TEA

Nematode species	Argentina	Australia	E. Africa	S. Africa	Malawi	Zimbabwe	Kenya	Bangladesh	China	Indonesia	N.E. India	S. India	Japan	Malaysia	Pakistan	Sri Lanka	Taiwan
Pratylenchus loosi								+	+		+		+			+	
Pratylenchus brachyurus		+			+						+						
Radopholus similis				+		+			+	+						+	
Meloidogyne javanica		+	+		+	+			+	+	+	+				+	
Meloidogyne incognita	+	+			+	+	+	+	+	+	+		+			+	
Meloidogyne arenaria					+	+			+							+	
Meloidogyne hapla						+					+						
Meloidogyne brevicauda											+	+				+	
Meloidogyne thamesi									+								
Hemicriconemoides kanayaensis									+				+				+
Rotylenchulus reniformis					+	+					+					+	
Rotylenchus sp.			+	+		+					+						
Helicotylenchus sp.			+		+	+		+			+	+			+	+	
Helicotylenchus erythrinae									+		+		+			+	+
Helicotylenchus dihystera		+									+		+			+	
Hoplolaimus sp.			+		+						+				+	+	
Paratylenchus curvitatus											+		+			+	
Xiphinema sp.			+	+	+	+		+			+		+	+	+		

The physical factors include the non-living components of the soil, such as soil moisture, soil type and texture, pH, nutrient status, as well as the above-ground characteristics that affect the soil micro-environment, including rainfall intensity and distribution, sunshine hours, wind speed and the slope and geographic aspect of the land.

The biotic factors include: food supply (presence or absence of suitable host plants), root exudates and/or presence of toxic compounds in associated plants (diversionary hosts and trap crops), presence of competitive nematodes, predators and parasites (predatory nematodes, nematode-trapping fungi, soil arthropods - mites and tardigrades, as well as parasitic bacteria and protozoa) which suppress the population of the target nematode.

Thus the ecological niche occupied by any plant parasitic nematode is subject to a highly complex interaction which determine the establishment of a particular species, in a given location.

A detailed study of the population dynamics of the different species of pathogenic nematodes and their consequent damage to tea under the different environmental conditions has helped to better understand the behaviour of the pest thus enabling us to be able to provide appropriate recommendations to suit the particular species and location.

PHYSICAL FACTORS

Effect of climate

Soil moisture and temperature have a major impact on the reproductive and survival rates of plant-parasitic nematodes and are thus responsible for the regional variations of the presence and population levels of the different species of plant-parasitic nematodes.

In Sri Lanka, where there are wide variations in climate in the different tea-growing areas, a good correlation exists between such differences in climate and the occurrence or absence of specific species of parasitic nematodes e.g. although the broad classification of tea growing areas is simply based on the altitude of the location of factories as high, mid and low, there are distinct and marked variations in the climate, within each such classified area.

Surveys and experiments carried out under controlled conditions to-date, have shown that both *Pratylenchus loosi* and *Radopholus similis,* need moist soil conditions continuously, for survival and build-up of populations. The soil temperature range for the optimal reproductive rate of *P. loosi* is between 18 - 24°C, whilst *R. similis* requires warmer soil temperatures, in the range of 24 - 30°C. Although *Rotylenchulus reniformis* also favours similar warmer temperatures as *R. similis* unlike the former, it is able to survive in soils subject to comparatively longer periods of dryness, as is encountered in the drier parts of Uva, whilst in the Deniyaya, Morawakka areas where the rainfall is well distributed we encounter *R. similis*.

Effect of soil types

Soil type and texture have a very significant influence on the reproductive rate and the population dynamics of plant parasitic nematodes and pathogenicity to tea. In a given type of soil of a specific texture, the damage threshold level of a specific species would be quite different to that in a different soil type or texture. Each species of nematode has its own requirement. Some species prefer sandy soils, whilst others would prefer clayey soils.

Earlier studies have revealed that the greatest build-up of *P. loosi* and the largest amount of damage to tea occurs in clay-loams, whilst the lowest reproductive rate was observed in gravelly soils and the least damage to tea in sandy soils. A similar experiment carried out under controlled conditions to study the influence of soil types on *R. similis* (sandy, gravelly, clayey and loams), revealed a heavy build-up in population in the susceptible clone (TRI 2025) growing in sandy and gravelly soils.

BIOTIC FACTORS

Food source

The source of food for plant parasitic nematodes are the tissues of the host plant. In the presence of a suitable host, the population builds up causing damage resulting from a series of interactions between the nematode and the plant, beginning first with attraction towards the growing tissue, cell penetration and/or movement through the tissue, feeding, and reproduction. These damaging activity invariably lead to a retardation in growth and the ultimate lowering of yield.

In the case of tea nematodes, the main host is the tea plant, with the associated susceptible plant species serving as secondary hosts. Therefore, one of the most important strategy within an integrated programme of nematode pest management in tea is to grow only the nematode-tolerant or resistant tea cultivars and also by discouraging the growing of plant species that could serve as good alternate hosts. On the other hand, there are many plant species that have been evaluated to be having nematicidal properties. These plant species would serve as useful trap crops to grow in the tea field to reduce soil populations, provided they do not compete with tea. Some of these trap crops screened by us include *Eragrostis curvula* (African love grass), *Vetiveria zizanoides* (Vetiver), *Cassia spectabilis, Vinca rosea,* Tagetes sp, *Azadirachta indica* (Neem), Ricinus communis, (Castor) *Tithonia* (wild sun flower), *Calliandra calothyrsus,* etc.

Influence of soil micro/meso fauna and flora

Under field conditions, all plant-parasitic nematodes occur as polyspecific communities interacting amongst themselves, as well as with other micro-flora and fauna, thus influencing the population dynamics of each other, with the consequent overall influence on the host plant. This natural balance established in the micro environment within the rhizosphere, gets positively or negatively affected (in terms of the benefit to the main crop), by the various field practices adopted in the crop environment.

One of the positive ways by which plant parasitic nematodes are maintained below damage threshold level, is by increasing the populations of natural enemies of nematodes, such as mites and tardigrades, earthworms, nematode-trapping fungi, predatory nematodes, parasitic bacteria and protozoa, as well as by bringing about competition between nematode species for specific feeding sites.

One of the important means of achieving this is by amending the soil through the incorporation of various organic matter, such as plant residues (including refuse tea. oil cakes of Neem, castor, Mahuva, Karanj) and farmyard manure (poultry manure).

The use of certain chemicals, on the other hand, could be detrimental by killing these beneficial organisms, thus upsetting the ecological balance and causing a build-up in the pathogenic species.

Since plant pathogenic nematodes are very tiny and invisible to the naked eye they go often unrecognized until the damage to plant has been very severe. However, these very minute organisms are very sensitive to the changes in the environment in the micro and macro level and under suitable environmental conditions in the presence of a good host will build-up to a level above the economic damage threshold level to cause severe damage to the plant.