DEVELOPMENTS IN THE CONTROL OF THE MEADOW NEMATODE

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Although a number of other nematodes have been found in or around the roots of tea, the root-lesion or "meadow" nematode has long been recognized as the most important species. This nematode at first was known by the rather complicated name of *Anguillulina pratensis* de Man. In succeeding years, its name changed to *Pratylenchus pratensis* de Man and then to *Pratylenchus coffeae* Zimmermann. It is now known as *Pratylenchus loosi* Loof—both in recognition of the fact that as a species it differs from *Pratylenchus coffeae*, and as a tribute to the work of Mr Clive Loos whom most of you will recall as one of my predecessors at the Institute.

Now, what is a nematode? I dare say that most of you have never seen one, and that perhaps half of my audience does not even believe in them! Although nematodes can be viewed to best advantage in a living state and through a low-power microscope, some idea of their size and shape may be gained through photographs.

Plate 1 shows an adult female of the meadow nematode in comparison with a human hair. Although it is visible to the unaided eye, its light colour makes it difficult to see unless a microscope is used.

The head end of the meadow nematode is also shown in Plate 1, and is typical of plant parasitic nematodes. A hollow stylet, very much resembling a hypodermic needle, can be thrust from the mouth opening into a plant root. This stylet is connected with a strong, muscular pumping apparatus that allows the nematode to withdraw the liquid contents of plant cells as food. The digestive fluids that the nematode pours into the cells through this stylet, and the bacteria and fungi that can enter the openings made by the stylet, are the principal reasons for injury to plant roots. In addition, a number of nematodes actually enter the roots and make their way through the plant tissue, carrying bacteria and other organisms with them. The meadow nematode is one of these.

Injury caused to tea by the meadow nematode (Plate 2) can easily be confused with that caused by other conditions or pests that prevent uptake of water and fertilizers into the leaves. Such conditions include insufficient manuring, underlying slab rock, or water-logged soil. Pests that also produce similar effects include *Poria* fungus, and the Shot-hole Borer. The meadow nematode gradually destroys the root system of the tea plant, by attack on both the feeder roots and the large storage roots. Under conditions otherwise favourable to growth, infested tea may show no sign of injury. However, if the bushes are exposed to other adverse conditions, such as prolonged dry weather, the leaves turn yellow and defoliation occurs.

Plate 2 also shows a storage root of tea from which the outer bark has been scraped to reveal the dark area or "lesion" in the cortex where several hundred meadow nematodes are feeding. Such lesions can eventually expand to girdle large roots and thereby kill the portions beyond the lesion.

This meadow nematode causes losses to Ceylon tea that are not precisely known, but must involve several million rupees per annum. Our programme for control of this pest can be outlined under four headings: 1. study of its distribution; 2. protection of plants in the nursery; 3. recovery of infested tea in the field; 4. selection and testing of clones for replanting that are either resistant to or tolerant of the nematode.

A study of the distribution of the meadow nematode is important in determining whether or not low-country and mid-country estates need to be concerned with using resistant or tolerant clones for replanting, and also whether or not meadow nematode can be blamed for weak tea in these areas. In our laboratory we have a map of the planting districts of Ceylon, whereon are marked all estates from which soil samples have been received over the past 18 years. Dark pins indicate estates where meadow nematode has either not been found, or where it has been found in only small numbers. Light coloured pins indicate estates where large numbers of the meadow nematode have been found. In most cases, these are associated with obvious injury to the tea. From this map, it appears that large numbers of the nematode have usually been found only on estates above 4,000 ft. elevation. However, we are testing this by setting out infested plants in jungle areas at 8 elevations from near sea-level to above 7,000 ft. The plants will be examined at intervals to determine whether or not the nematodes fail to maintain themselves at lower elevations. If this experiment shows that the meadow nematode cannot survive in numbers in the low-country or mid-country, these areas will not need to be concerned about its control.

The second part of our programme is concerned with keeping meadow nematodes out of tea nurseries, since infested nursery plants are the best means for spreading the nematode around an estate. Fumigation of the striking beds before setting out cuttings, and of soil to be used for basketing, has already been shown to be a necessary and effective practice. However, no method has been demonstrated for ridding nursery plants of the nematode once they have become infested. As the result of an experiment wherein various pesticides were drenched into infested nursery beds, we have *preliminary* evidence, however, that the nematode can be completely eliminated without harm to the plants, and that the plants will recover normal growth. Further experiments are in progress.

The third part of our programme is concerned with measures to reduce the number of meadow nematodes in mature tea. For this, we are testing the effect of adding large amounts of composted cattle manure, and the effect of inter-planting marigolds with tea after pruning.

In theory, the addition of compost could either reduce the numbers of meadow nematodes by multiplying their enemies, or increase their numbers by producing a large number of new roots for them to feed upon. It may seem strange that compost might multiply the enemies of the meadow nematode, and therefore an explanation may be in order. There are basically three different types of nematodes in the soil: those that feed on bacteria and possibly directly on organic matter; those that feed on other nematodes; and those that feed on plant roots. Addition of compost should increase the number of those nematodes feeding on bacteria or organic matter. An increase in these so-called saprophagous nematodes should provide more food for the predaceous types feeding on other nematodes. These in turn, should also feed upon the plant parasitic nematodes. Unfortunately, we have not yet demonstrated these last two possibilities. With an application of 20 tons of compost raked over ground that had just been deep forked, we found a rapid but temporary increase in the numbers of those nematodes feeding on bacteria or organic matter. There was, however, no accompanying increase in predaceous nematodes, or decrease in the meadow nematode.

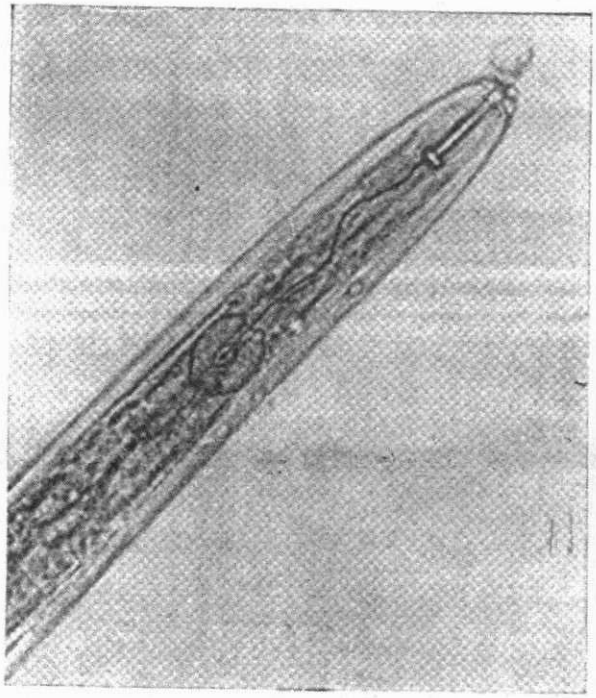
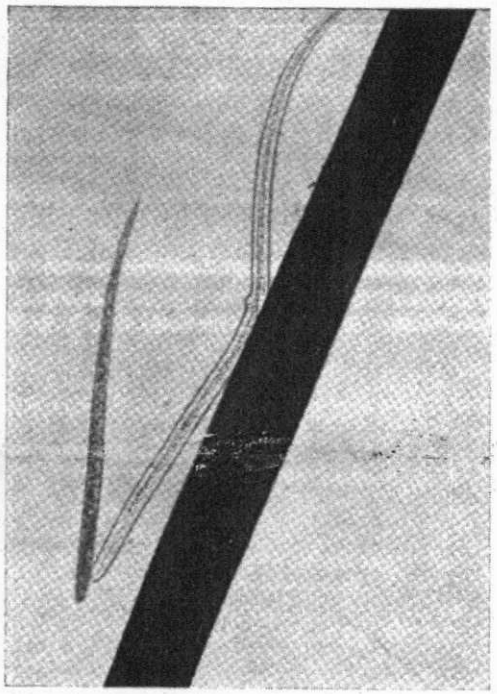


Plate 1. *The root-lesion or Meadow Nematode, Pratylenchus loosi* Head end much enlarged, showing the hollow stylet with which the nematode punctures plant roots.



Adult female, alongside a human hair. A smaller, saprophagous nematode is seen at the left.

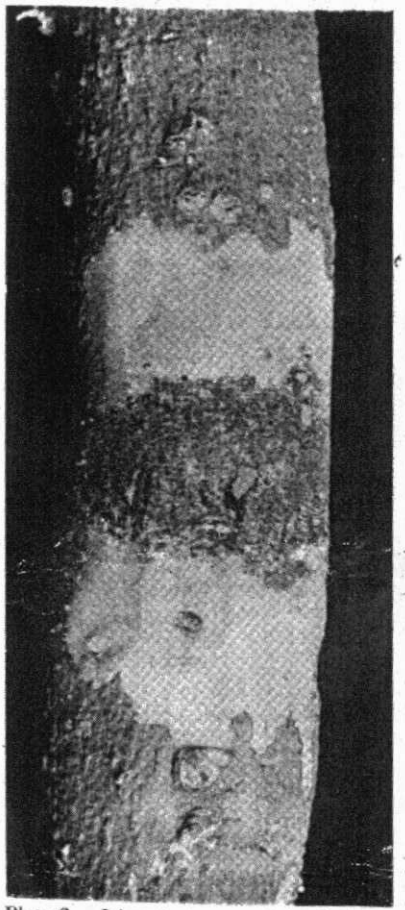
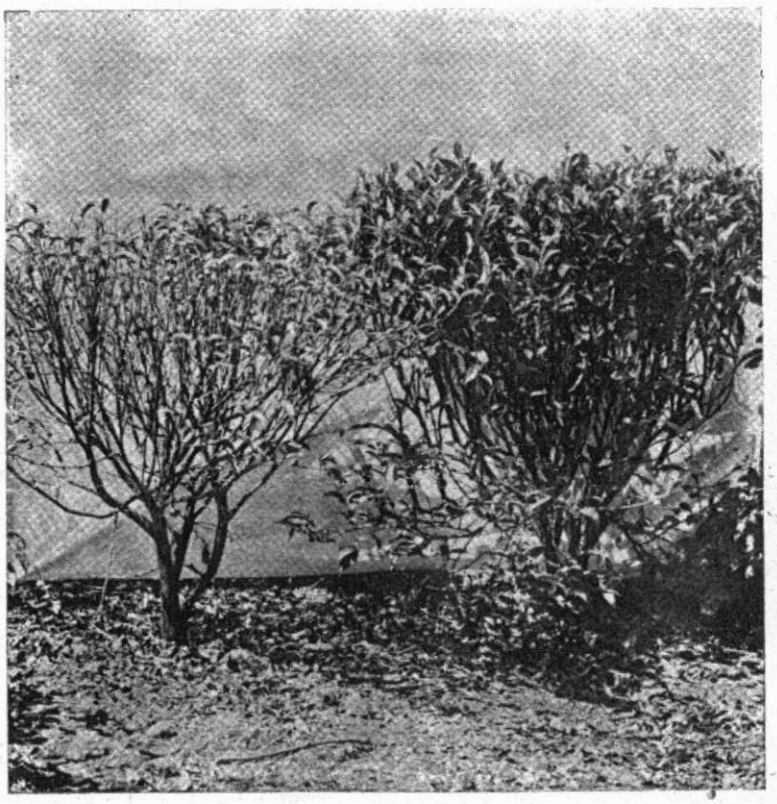


Plate 2. *Injury to tea caused by P. loosi.* Dark lesion in cortex of storage root, exposed by cutting away the bark.



Defoliation of mature bush.

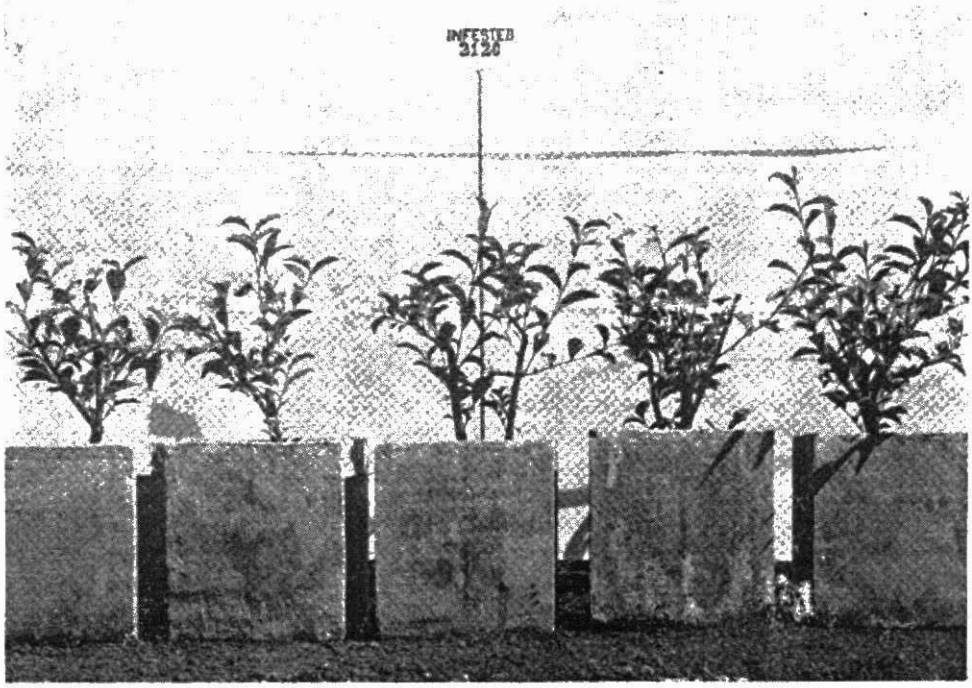
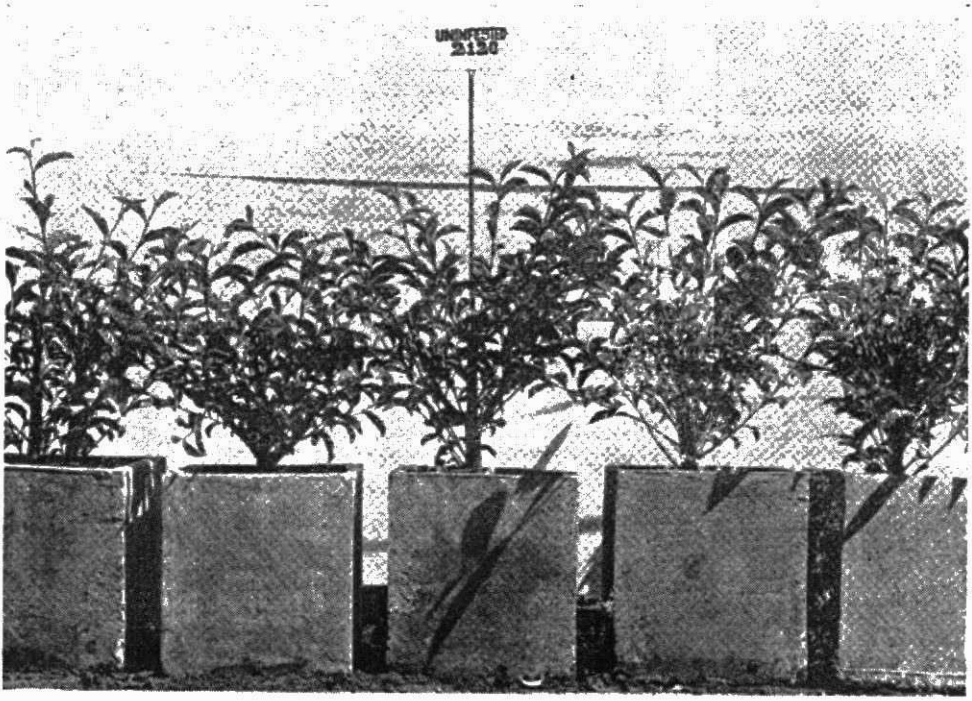


Plate 3. *Susceptible clone TRI* 2120, showing effect of 5 years' infestation with *P. loosi*.



Compared with uninfested controls.

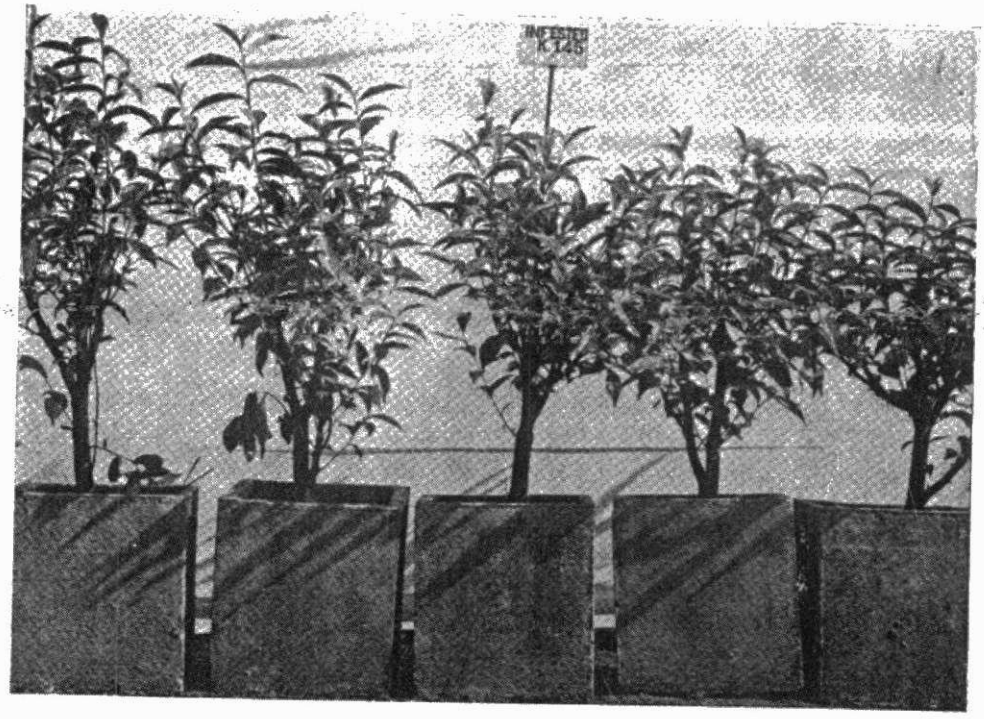
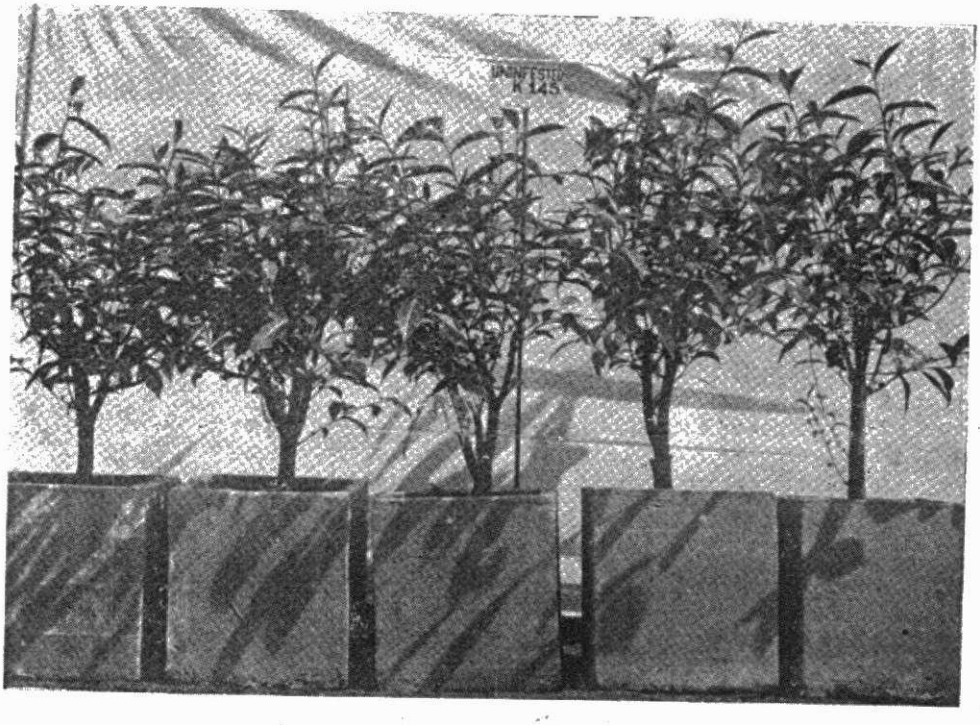


Plate 4. *Tolerant clone Kirkoswald* 145, showing effect of 5 years' infestation with *P. loosi*



Compared with uninfested controls.

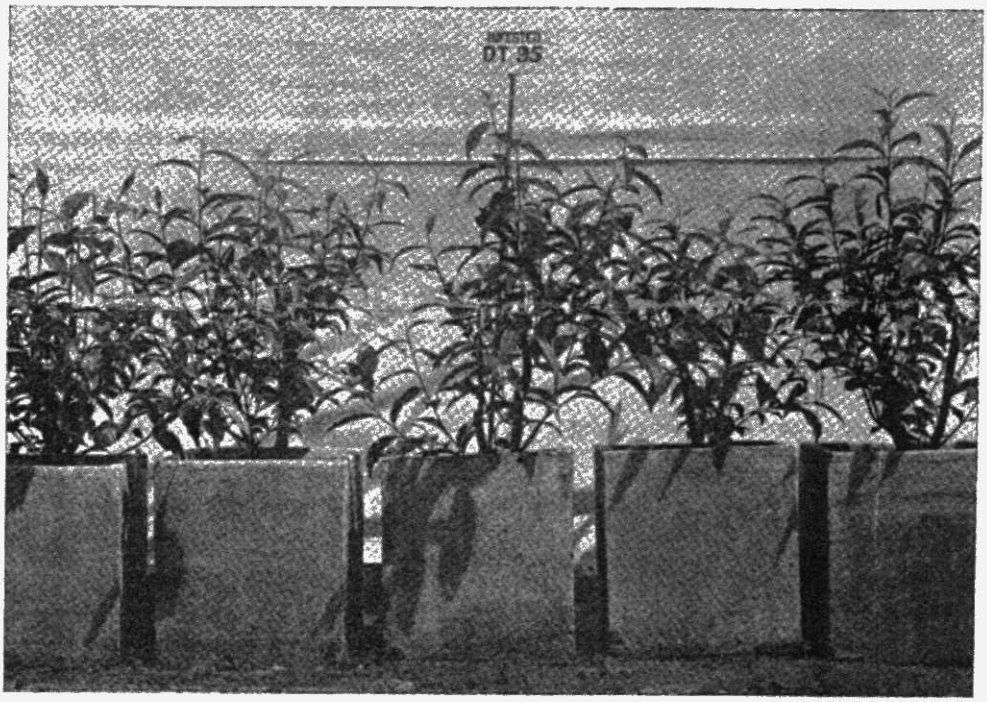
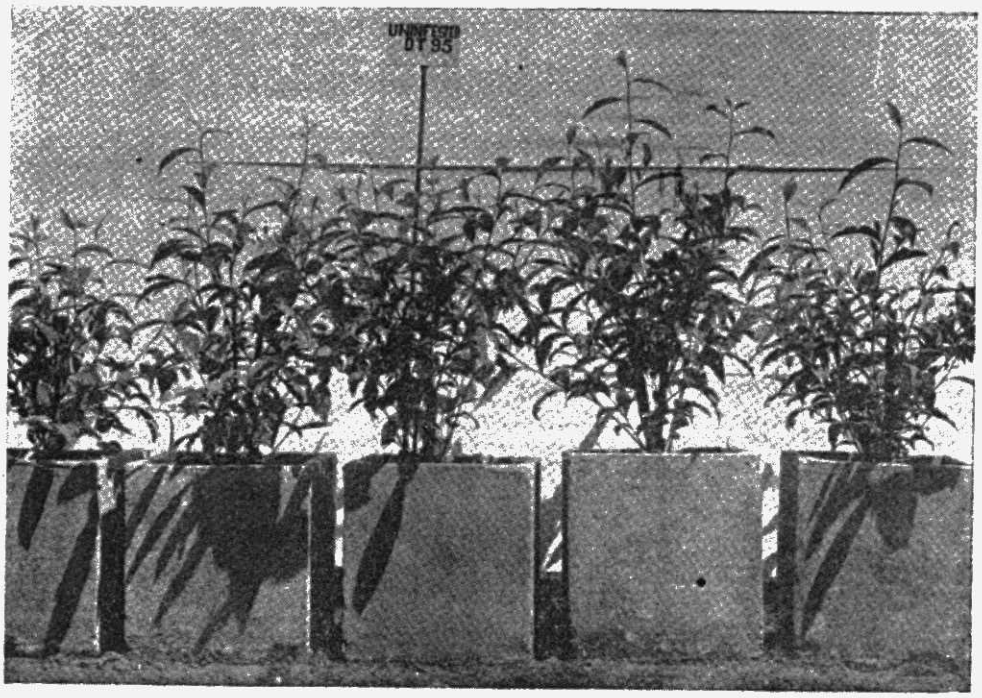


Plate 5. *Resistant clone Drayton* 95, showing effect of 5 years' infestation with *P. loosi*



Compared with uninfested controls.

Interplanting marigold in mature tea after pruning is probably a more practical measure for most planters, since there seems to be an almost unlimited supply of marigold seed available, compared with a very limited supply of cattle manure. In spot checks on four estates, we have found that tea with marigold has less meadow nematode than adjacent tea without marigold. These results, as well as those obtained previously by Dr Visser, have encouraged us to go forward with an expanded programme on marigold, both in the field and in the laboratory.

Both compost and marigolds appear to produce a definite improvement in the growth of tea and, in the case of marigold, we are planning yield trials to estimate this improvement more accurately.

The final part of our programme is concerned with testing and further selection of clones that are either resistant to or tolerant of the meadow nematode, for use in replanting.

The tests of clones in pots, begun by Mr Loos and continued by Dr Visser, has just been concluded. It has revealed three basic types of clones: susceptible, tolerant, and resistant.

Plate 3 shows plants of the susceptible clone TRI 2120. These plants in common with all others in the pot tests have been pruned three times during five years. Note that growth of the infested plants has been retarded by the nematodes in comparison with the uninfested plants.

Shown in Plate 4 are infested and uninfested plants of clone Kirkoswald 145. The infested plants have made good growth even though the nematodes are present in large numbers. Therefore we say that this clone is tolerant.

Plate 5 shows infested and uninfested plants of clone Drayton 95. The infested plants have made just as good growth as the healthy plants, but the reason is that the nematodes have not been able to increase in numbers. Therefore we say that such a clone is resistant.

Only one source of the meadow nematode was used for these experiments. But we have evidence that populations of meadow nematodes from different sources will affect a given clone differently, so we are now testing our most resistant clones against populations from 25 different estates. The results of this test will help us to select those clones most likely to do well on *any* infested estate. In the meantime, we are setting out plants of clones that so far appear to be resistant or tolerant, to provide an adequate number of cuttings for replanting infested areas.

A further part of this programme is concerned with making new selections from estates. We have in mind about 30 such selections, which will be tested against 25 populations of the nematode for resistance. A rapid method should enable testing of all these clones within 18 months.

A final part of this programme is concerned with the reasons why clones are resistant. We have already found that clones TRI 2135 and Drayton 95 can resist the entry of certain populations of the meadow nematode. Other possibilities for resistance include clones that can prevent maturity or normal fertility of the nematodes.

To review, the four approaches being made for control of the meadow nematode in tea are concerned with: 1. determining distribution; 2. elimination in the roots of nursery plants; 3. lowering numbers in the roots of mature tea; and 4. selection and evaluation of clones that are resistant or tolerant. There are good reasons to be hopeful for success in all these departments.

References

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Question No. 68.—Anon.

Do you advise lopping marigolds or allowing them to flower, with particular reference to possible competition with the tea in dry weather?

Dr Hutchinson: This question concerns the lopping of marigolds to protect the tea from competition during dry weather. In the absence of exact knowledge we would say: Yes, lop the marigolds at about two feet high. If you lop them much lower, re-growth will be poor. But there is also the question of the stage of marigold growth at which it exerts its effect on the eelworm. We are currently experimenting with this. It may be that it needs to mature in order to produce its greatest effect on the eelworm. Further, some people might want the marigold to mature in order to obtain seed. But remember that once it has flowered and seeded, then there is no point in lopping it, because it will not then re-grow. Lopping must be done before any extensive flowering has occurred, if you are to get additional growth.

Question No. 69.—Anon.

Is it better to use organic or inorganic manures on tea suffering from Meadow Eelworm?

Dr Hutchinson: If we are thinking in terms of blood meal as the organic manure, provided they have the same analysis as an inorganic manure, there is very little to choose between them, because the amount of "Sterameal" would not be great enough to contribute any real addition of organic matter to the soil. If we are thinking of compost in addition to inorganic manures, then many planters believe that it helps. We are hoping to obtain specific yield records on this matter, so that we will not have to rely on what may well be correct results but which at present lack adequate figures. Speaking about the question of manuring and eelworm, it has been found in the United States and elsewhere that increasing the potash manuring of perennial trees does increase their tolerance to meadow eelworms, and we are contemplating an experiment along these lines.