FURTHER DEVELOPMENTS IN THE CONTROL OF MEADOW NEMATODE

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On the occasion of the 1961 Conference, I described four principal approaches to control of the meadow nematode, *Pratylenchus loosi* Loof (Hutchinson 1961).

1. Study of its distribution in tea soils.
2. Planting of marigold.
3. Selection of resistant and tolerant clones.
4. Use of chemical drenches to eliminate nematodes from the roots of nursery plants.

The Nematology Division has now made real progress in all but the last of these approaches.

Distribution of the meadow nematode

As is well known, effective measures for the control of any pest require detailed knowledge of its distribution. The paper published in the *Tea Quarterly* for June (Hutchinson and Vythilingam 1963) summarizes our knowledge in this respect for the meadow nematode. It is now evident that all estates above 3,000 feet elevation in the zone receiving the South-West Monsoon, should bear in mind the problem of preventing injury due to this pest, particularly in view of the increased planting of susceptible clonal tea.

Planting of marigold

We can now state that marigold is showing its usefulness as a means of increasing yield of infected tea. However, it can only be used where the tea cover is incomplete otherwise it will not receive sufficient sunlight to permit vigorous growth. *Plate 1* shows such a planting of marigold within established clonal tea infected by the nematode.

A summary of its mode of action may help to explain how marigold is useful in this way. Briefly, the nematodes are attracted to marigold roots as they are to tea roots. Once inside the marigold roots, however, they are destroyed within a week's time by chemical substances. Roots of marigold in all stages of vigorous vegetative growth are effective in this way. Roots of plants in full bloom or past bloom appear to be less effective.

The above action is, however, only one of several desirable properties of marigold. The plants do not compete unduly with established tea for moisture or fertilizer. They provide a soil cover that helps to prevent erosion. They propagate readily from seeds or from branches buried in soil. They do not influence the quality of tea produced from bushes with which they are grown. Taken together, these properties make fully practicable the use of marigold for control of this nematode in plantings of mature tea, provided that the yield of tea is increased sufficiently to cover costs.

The three experiments were started immediately after pruning, and the results of each are for the first year of the new cycle. After the prunings were removed marigold was seeded at ½ inch depth, in rows 1 foot apart. The estimated cost includes that of preparing the soil, seeding 10 lbs per acre, and lopping to delay flowering. Seed was estimated to cost Rs. 2/50 per acre if grown, harvested, cleaned, and stored on the estate where used.

A significant yield increase of 7% was obtained on Derryclare Estate (I), and a similar, but non-significant, increase was obtained on Logie Estate (II). Yields of untreated plots differed widely, 430 and 1,300 lbs respectively for the two estates. On St Coombs (III) clonal tea (TRI 2024) yielding 960 lbs was used, and the 15% increase in yield makes this the most promising of the experiments. Costs for the 2nd and 3rd years of the cycle may be assumed to be negligible, since the marigold readily self seeds. Further experiments are needed to confirm these findings, but it already seems reasonable to be optimistic about sowing marigold in certain areas.

Now, a word concerning the availability and care of marigold seed. At St Coombs, there are at present some 8 acres of marigolds, seed from which will be available to the Industry at a reasonable price. This seed should be stored in the factory furnace room; otherwise it may lose its powers of germination within 6 months (Hutchinson 1964). Where marigold is grown on your own estates, it should be regularly harvested as it matures, cleaned immediately, and then dried in the furnace room, since sun-drying tends to decrease germination.

I will conclude this report on margiold by noting that its use is envisioned to improve old infected tea prior to replanting with desirable clones, although it may also prove to be a means of rehabilitating old plantings to a point where a complete cover of tea can be maintained. A further use is in interplanting with Guatemala grass, to provide early cover of soil during the rehabilitation period. It is not intended, however, that marigold of itself be considered as a rehabilitation crop, since its root system is much too shallow for this purpose. Neither is marigold intended for interplanting with newly-established tea, because of competition for water and fertilizer.

It will be of interest to you that this is apparently the first instance in which the planting of marigold has been a practicable means for control of a plant parasitic nematode, and you should be aware that this happy state of affairs is due primarily to the interest of Dr T. Visser, former Plant Physiologist of the Institute, who introduced the idea from Holland, and who conducted the first experiments in Ceylon (Visser and Vythilingam 1959).

TABLE 1.—*Economics of interplanting Marigold in Nematode-Infested Tea.*
(*1st Year after pruning*).

Experiment	Cost	Gross Returns	Est. Profit
I (Seedling)	53/-	64/-	11/-
II (Seedling)	53/-	156/-	103/-
III (Clone)	53/-	290/-	237/-

Selection of resistant and tolerant clones

Perhaps the most important stage so far in our attempts to control the meadow nematode by selecting resistant and tolerant clones, was the announcement in December, 1962 that cuttings of clone TRI 2142 were available from the Institute. (This clone was selected by Mr G.B. Portsmouth in 1950, on St Coombs, primarily for its blister-blight resistance and vigour: Ed.). Response from the Industry has been so considerable that several hundred thousand cuttings, purchased from St Coombs and other estates, have already been set out. Clone TRI 2142 is still the best clone of which we are aware, for use in replanting areas that have been or are likely to become infested by the nematode. Its level of tolerance is high. Its quality is very good. It seems to yield well, and is quite resistant to blister blight. With this clone as a standard, we will have considerable difficulty in selecting others.

However, TRI 2142 is by no means the only clone that is promising, and in *Table* 2 data for additional clones are presented. These clones are virtually the sole survivors of an intensive selection process that was initiated as long ago as 1939, by the late Dr Gadd at Drayton Estate. This work, continued by Mr Loos, and later by Dr Visser, provided us with material from which a more intensive selection could be made. Particular mention should at this time be made of the work at Mooloya Estate, Hewaheta, and the constant and enthusiastic co-operation of its Superintendent, Mr Jack Ritchie, over a period of no less than nine years.

TABLE 2.—*Performance of selected clones. The highly Susceptible clone TRI* 2024 *is used as a standard for comparison.*

Clone	Quality	Yield	Rooting	Performance in Infested Soil
2142	A 1	Very Good	Good	Excellent
DT 95	B	Average	Good	Excellent
MO 146	B	Average	Good	Very Good
DK 1	B	Average	Very Good	Good
MO 116	A 2	Good	Good	Good
DT 1	A 1	Good	Very Good	Average
2024	A 2	Excellent	Excellent	Very Poor

Now, a word about this selection process. Initially, bushes showing vigorous growth, either during the cycle, or in recovery from pruning, were selected from infested areas. Soil examinations were then made, and bushes having meadow nematode in the immediate vicinity of the roots were propagated for further testing. Bushes apparently not exposed to infection were discarded at this stage. The successful selections were then set out in infested soil, either at the estate where selected, or at St. Coombs, or both. They were then further selected for good growth in infested soil, and many were also evaluated for quality. The best were then tested in pots of soil infested with the nematodes (Hutchinson 1961). Further tests were made at Mooloya and St. Coombs, using small plots of infested soil, with the object of devising a means of testing clones on a continuous basis. The present method is shown in Plate 2. You will note that a bed of prepared soil some 40 feet long and 6 feet wide is made within a boundary of cement blocks, and is separated into two sections by means of a thin barrier placed deeply into the ground. The soil contains meadow nematodes from approximately 25 locations, and one of the two sections has been fumigated to kill the nematodes. Within a border of edge plants not included in the test, 1 year-old plants of 18 clones are set out at random. This test is replicated at three additional sites nearby. After approximately one year, growth on both sides of the barrier is compared, and those clones showing the least reduction of growth in the infested soil are considered for recommendation to the Industry. Plate 3 shows, closer at hand, the great differences in growth that can result.

It is evident that the method just described is an extreme test, providing conditions far more severe than would be encountered in the field. The plants are young, and they are immediately exposed to a high concentration of nematodes from many different sources. However, while failure to grow well under such conditions should not disqualify a clone, it is well to remember that if a clone *can* withstand such treatment when young, it will probably survive any infection by nematodes in the field, and is therefore more likely to be reliable on a long-term basis.

Clones performing well in the above test are then rechecked for rooting ability and quality. Yield, however, is not considered to be as critical a factor in selection. Naturally, low-yielding clones would be eliminated. However, clones having but an average yield are still acceptable. This is because they may sometimes be closely planted, to provide a yield approaching that of high-yielding clones. Clone Drayton 95 is probably a very good example of such a clone. An upright grower, it has only average yield. However, it is markedly resistant to the nematode, and is perhaps the most reliable clone that we now possess for vigorous growth in infested soils.

While selected clones are primarily intended for replanting on estates having a known problem of meadow nematode, they should not be neglected by other estates above 3000 feet elevation, in the zone receiving the South-West Monsoon. Even if such an estate is not known to be infested, planting tolerant and resistant clones can be an insurance against the possibility of future spread of the nematode, or against its presence in sufficiently low numbers to have escaped detection. When replanting, it would be well to begin with the highest fields. Otherwise, new clearings can be infected by nematodes moving down-slope in soil and water.

Two more observations are in order before concluding a discussion of the selection of clones. The first concerns the large number of seedlings that must be dealt with initially, and the second relates to the small number of clones that eventually survive testing. For example, from perhaps 500 acres of seedling tea on Mooloya Estate, approximately 600 plants were initially selected. Of these, only 3 or 4 can now be recommended to the Industry.

There are several reasons for this. Subsequent soil examinations showed that many of the 600 seedlings apparently had not been exposed to nematode attack. Of those growing in infested soil, some were actually neither tolerant nor resistant, deriving their increased vigour in the field from special advantages of soil or light. Some proved to be resistant to or tolerant of only one or two populations of the nematode. Others were poor rooters, or were unduly susceptible to blister blight or other diseases. Still others produced tea of poor quality. Based on similar experience with some 200 selections each from Drayton and Diyanilakele Estates, we can assume that only half of one percent of seedlings selected from infected tea will eventually prove suitable.

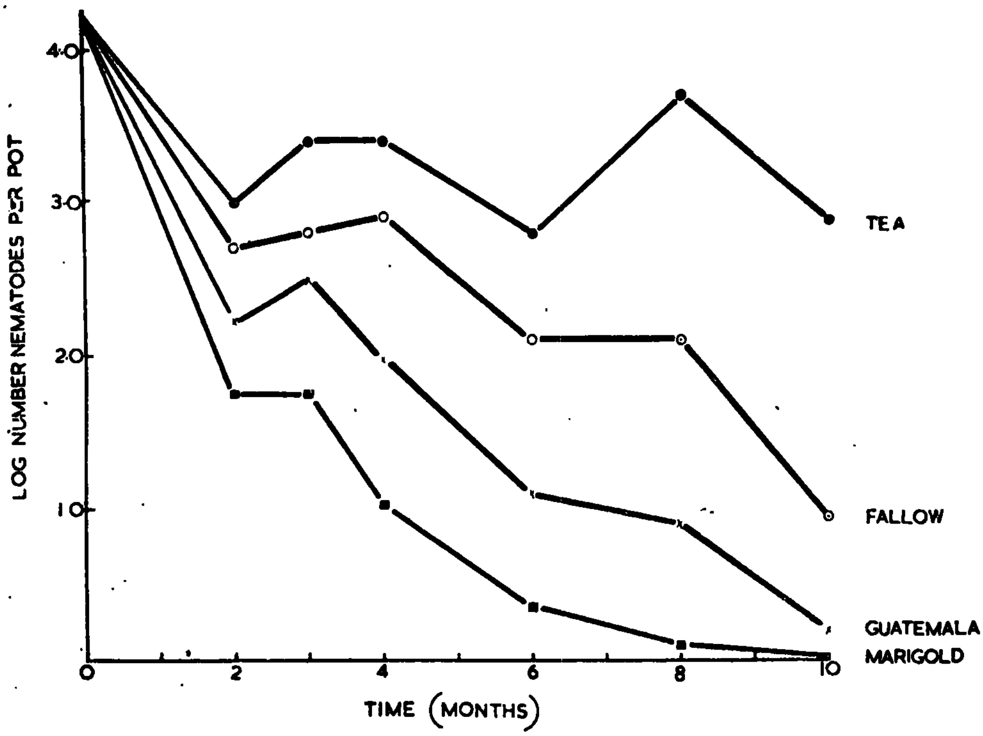
The process of selection from seedling tea must therefore continue apace if the Industry is to have an adequate number of clones for the future. This aspect assumes particular importance at a time when many of the infested fields from which such selection can be made are being considered for uprooting. Some additional selection has already been carried out at Derryclare and Wootton Estates, but much remains to be done, in cooperation between the Institute and the estates having meadow nematode as a problem.

Nursery practice

A summary of this aspect of nematode control has already been presented by Dr. Kerr in the September issue of the Tea Quarterly (Kerr 1963). To this summary can be added the fact that, to date, no chemical drench has been found that will completely eliminate nematodes from the roots of infected nursery plants. Moreover, the most promising materials in this regard are so highly toxic to mammals that it would seem unwise to entrust their use to unskilled nursery labourers. Emphasis, therefore, is now being placed on means of preventing nematode infection of cuttings that are being rooted in bags of fumigated soil.

Rehabilitation of infested soil

A fifth major aspect of meadow nematode control concerns the rehabilitation of infested soil that is to be replanted. As indicated in a previous article (Hutchinson 1962), Guatemala grass seems to be reliably immune to the meadow nematode. Even so, nematodes can survive in its presence for periods longer than 10 months. This result is shown in *Figure 1*. The experiment concerned was one in which tea, marigold, and Guatemala grass, respectively, were grown in pots of infested soil. A fourth series of pots was left unplanted, and was thereafter carefully weeded. At monthly intervals, the plants were uprooted, and healthy tea plants, clone TRI 2024, were planted in the appropriate pots of all four series. These were left for three months, at which time their roots were examined for nematodes; this method being a far more sensitive check on the survival of the nematodes in the soil than examination of the soil itself.



As all pots were kept moist, it is assumed that the nematodes continued active, and were expending energy which they could only replenish in the pots containing the tea roots. It is therefore remarkable that they survived so well in fallow soil. A further point of interest is that the roots of Guatemala grass may, like those of marigold, be toxic to the nematodes. In any event, the practical advice to be given is that the rehabilitation period cannot be less than one year if nematodes are to be eliminated.

There is also a very real danger of further survival of nematodes in roots of old tea, or perhaps in the roots of weeds. The roots of old tea are never completely removed from the soil, and weeds can usually establish themselves in stands of Guatemala grass. Under practical field conditions, therefore, it is yet to be determined by experiments whether 18 months or even 2 years will be sufficient for elimination of the nematodes. However, we can say without question that the uprooting of old tea should be carried out as thoroughly as possible, in accordance with instructions of the Tea Replanting Subsidy Scheme, viz. "Every effort should be made to remove all the roots in order to minimize the dangers from any root disease prevalent in the old tea. Any roots showing signs of disease should be burnt on the spot." (Mahadeva 1963). To carry out the uprooting of infected tea in a careless manner is poor economy, and it may result in the reduced growth of subsequent plantings.

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