REPLANTING EELWORM INFESTED AREAS

A. Kerr & M. K. Vythilingam

Results of recent experiments indicate that numbers of the meadow or root-lesion eelworm, *Pratylenchus loosi* Loof, fall rapidly during the rehabilitation period. The death rate is logarithmic and because of this, the 'half-life' concept can be applied to *P. loosi* in the same way as it is commonly applied to loss of radiation from radioactive particles. In a rehabilitation experiment on St Coombs the half-life was 1.6 months; in other words, nematode numbers decreased by half every 1.6 months. Experimental results from other estates suggest that this death rate is relatively constant for different soils in different localities. If old tea has been uprooted effectively, a rehabilitation period of 18 months is more than adequate to reduce nematode numbers to a very low level.

Little information is available on the build-up of *P. loosi* after clonal tea is planted, but results of a pot experiment indicate that the increase in numbers is markedly different in different soils. Evidence is accumulating that the main danger to new clearings is from infection in the nursery.

Many planters and planting companies have expressed grave concern at replanting tea that is heavily infected with eelworm. "What is the point of spending a lot of money on uprooting, rehabilitating and replanting an area if the new clearing is going to be re-infected ? " This is a common and very pertinent question and it is the object of this paper to present evidence to show that such areas can be very successfully replanted, if simple precautions are taken.

Methods

Soil sampling

Soil samples were taken at a depth of 0-9 inches with a soil auger. Each soil sample consisted of ten auger samples, each of approximately 200 g, taken at random. The soil was thoroughly mixed by hand and duplicate 100 g sub-samples were processed to extract eelworms.

Extraction of eelworms from soil

A modified Baermann funnel technique was used for all extractions. The method was the same as that described by Hutchinson & Vythilingam (1963a) except that a nylon-cotton wool nematode filter* was used instead of a thin layer of sand.

Extraction of eelworms from roots

Nematodes were extracted from roots by the method described by Hutchinson and Vythilingam (1963b).

Rehabilitation experiments and observations

The first experiment was originally designed to determine if growing one crop of potatoes during the rehabilitation period influenced the number of eelworms surviving. Eelworm infected tea on St Coombs was uprooted and eight plots, 30' × 20' were marked out. Two soil samples were taken from each plot immediately after

*Manufactured by Brocades-Stheeman & Pharmacia, Holland.

uprooting and then at monthly intervals. Guatemala grass was planted in four plots chosen at random and potatoes in the other four. The potato crop was harvested 3 months later and Guatemala grass planted. As there was no significant difference in the number of eelworms as a result of treatment, data from all eight plots were combined. Figure 1 shows the survival of eelworms with time.

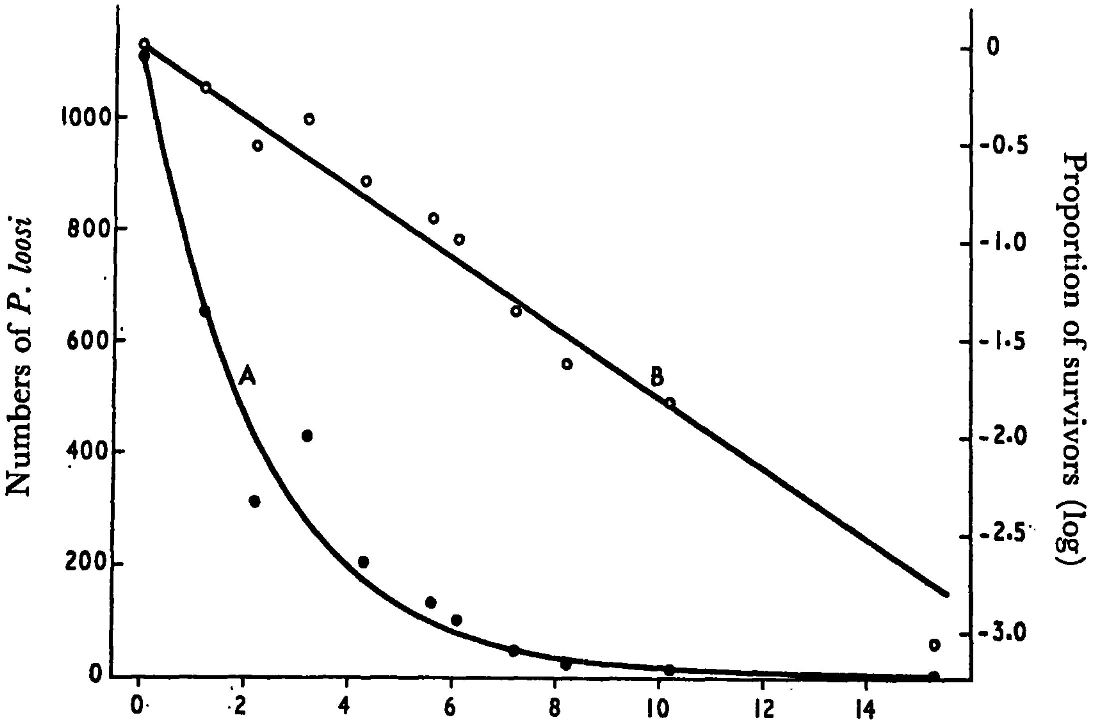

FIGURE 1—*Survival of* P. loosi *over the rehabilitation period—A: number of* P. loosi *extracted from 32 soil samples, each of 100 g—B: logarithm of proportion of survivors*

There is a very rapid drop in the number of *P. loosi* over the first few months, followed by a much slower decrease. The form of graph A is a typical logarithmic curve and can be readily converted to a straight line. If, instead of plotting the actual numbers, we determine the proportion of survivors and convert to logarithms we get a straight line relationship with time (graph B). This can be defined by the equation $\log(I/I_0) = 2.3\, rt$ where I_0 = number of *P. loosi* immediately after uprooting and I = number of *P. loosi* after t months ; r = death rate of *P. loosi* and is always negative. Using the data from the experiment the equation becomes

$$\log(I/I_0) = -0.185\, t \qquad (1)$$

We can use this equation to calculate the half-life of an organism (Yarwood & Sylvester 1959). In this case $I/I_0 = \frac{1}{2}$, the logarithm of which is -0.301 and by substituting this in Equation 1 we can calculate, t, the time taken for eelworm numbers to be reduced by half. Doing this we get $-0.301 = -0.185\, t$ and therefore $t = 1.6$.

Perhaps some planters will have forgotten their elementary mathematics and so we shall explain what this means in practical terms. It means that irrespective of the number of eelworms present when tea is uprooted, the number will be reduced by half every 1.6 months. For example, if there are 512 eelworms per 100 g soil at uprooting (very heavy infestation) there will be 256 after 1.6 months, 128 after 3.2 months, 64 after 4.8 months, 32 after 6.4 months, 16 after 8.0 months, 8 after 9.6 months, 4 after 11.2 months, 2 after 12.8 months and 1 after 14.4 months. If we assume that a safe level of infestation for a new clearing before planting is less than one eelworm per 100 g soil, a rehabilitation period of 15 months will achieve this. If, however, the population of eelworms at uprooting is 32 per 100 g soil the required reduction in numbers will be achieved within 8 to 9 months.

These examples are based entirely on data collected from an experiment on St Coombs and it would be interesting to know if the population decrease is similar in other soils and in different localities. The decrease in numbers of *P. loosi* over part of the rehabilitation period has been measured on five other estates. Results are shown in Table 1 along with the predicted number of *P. loosi* at the second sampling, calculated from Equation 1.

TABLE 1—*Survival of* P. loosi *during the rehabilitation period*

Estate	months between 1st & 2nd sampling (t)	No of *P. loosi* per 100 g soil At uprooting (I_o)	At 2nd sampling (I) Measured	Predicted from equation 1
Drayton	6.4	105.5	6.4	6.6
Eildon Hall	6.2	62.4	0.8	4.2
Kirimetiya	8.6	12.8	1.6	0.3
Leangawella	7.3	17.3	0.2	0.7
Palmerston	6.0	67.0	13.8	5.0

It will be seen that the measured and the predicted numbers agree quite closely. It is interesting that on Palmerston, where the measured number of eelworms was appreciably higher than the predicted number, the planting of Guatemala grass had been delayed and growth was sparse at the time of sampling. In a pot experiment, Kerr (1964) reported that eelworm numbers declined more rapidly in soil under Guatemala grass then they did in fallow soil and this may be the reason for the slower death rate on this estate. Although more data are desirable, it would appear that the death rate of nematodes during the rehabilitation period is similar in different soils in different localities.

One factor that may increase the survival of eelworms over the rehabilitation period is the method of uprooting. On many estates we have visited, old tea is removed by chopping, rather than by uprooting and a considerable number of large roots are left in the soil. These large roots die very slowly and in some cases may even produce new shoots. We have extracted high numbers of *P. loosi* from such roots 18 months after the old tea was uprooted. **It is clear that every effort should be made to remove all large roots, and we strongly recommend winching to uproot the old tea.**

Eelworm infestation of the nursery

Evidence is accumulating that serious infestation of new clearings usually originates in the nursery. There have been several cases recently of nursery plants, submitted to the Institute for diagnosis, having heavy eelworm infection. Because of this, a survey of estate nurseries has been started, and although far from complete, the results to date are of interest. Of eleven nurseries sampled in the NE monsoon area, only four were free of eelworm, four others had light infestation and the remaining three had moderate infestation. Forty-four other estate nurseries will be sampled over the next few months and when completed, a full report will be published, but we anticipate that a fair percentage of the nurseries will be infested. This is a most unsatisfactory state of affairs because eelworm infestation of nurseries can be readily and cheaply controlled by fumigating the soil with DD. Detailed instructions for nursery fumigation were given by Kerr (1963) and will not be repeated here. One aspect of nursery fumigation must be mentioned however. Many estates fumigate the soil for bagging, but after the bags are filled, they are placed in nursery beds, the soil of which has not been fumigated. The same nursery site may have been used for several years and the chance of infestation is very high. Eelworms can readily move from the bed soil into the bags and infect the young cuttings. **We must state most emphatically that the whole nursery should be fumigated before cuttings are introduced and this should be repeated every year.**

Eelworm infestation of new clearings

We have seen that the normal rehabilitation period of 18-24 months is more than adequate to reduce eelworm numbers to a very low level; if proper precautions have been taken in the nursery, healthy cuttings should be available for planting in the field. What are the chances of reinfestation from neighbouring tea? We know that under their own volition, eelworms spread very slowly in soil, but can be carried rapidly and for long distances in water or by soil movement. If infected tea is situated above a new clearing, drains should be dug to prevent water running off the infested area into the new clearing; a 5 ft strip of Guatemala grass or Mana grass should be planted on both sides of the drains to prevent soil movement.

Although rehabilitation reduces the number of *P. loosi* in soil to a very low level, there might still be some eelworms left even after two years. How quickly do numbers increase after replanting? We have very little information on this, but results, of a recent pot experiment are of considerable interest.

Soils were collected from eight estates, placed in pots (15 pots for each soil) and left fallow for several months to reduce eelworm numbers. Before planting clone DT 1 in all the pots, no *P. loosi* could be detected in seven of the eight soils and only very few in the last one. After planting, the same number of *P. loosi* was added to every pot and infection of the roots was measured 8, 12 and 16 months later. There was a significant difference ($P<0.001$) in the levels of infection of plants in the different soils. Results for three of the soils are illustrated in Figure 2.

Various physical and chemical properties of the eight soils were determined by the Agricultural Chemistry Division, but there was no obvious explanation for the marked difference in behaviour of *P. loosi* in the different soils. It is always dangerous to predict from results of a pot experiment, what will happen in the field, but it seems likely that eelworm numbers might build up much more rapidly in some soils than in others.

Numbers of *P. loosi* in soil after replanting are being followed on five estates. There was very low infestation (less than 1 per 100 g soil) on all estates at time of planting and this has not increased on any estate in 12 months. This may be because soil samples are taken from between the rows, and plant roots have not yet extended to the sampling sites. Further measurements will be made every six months.

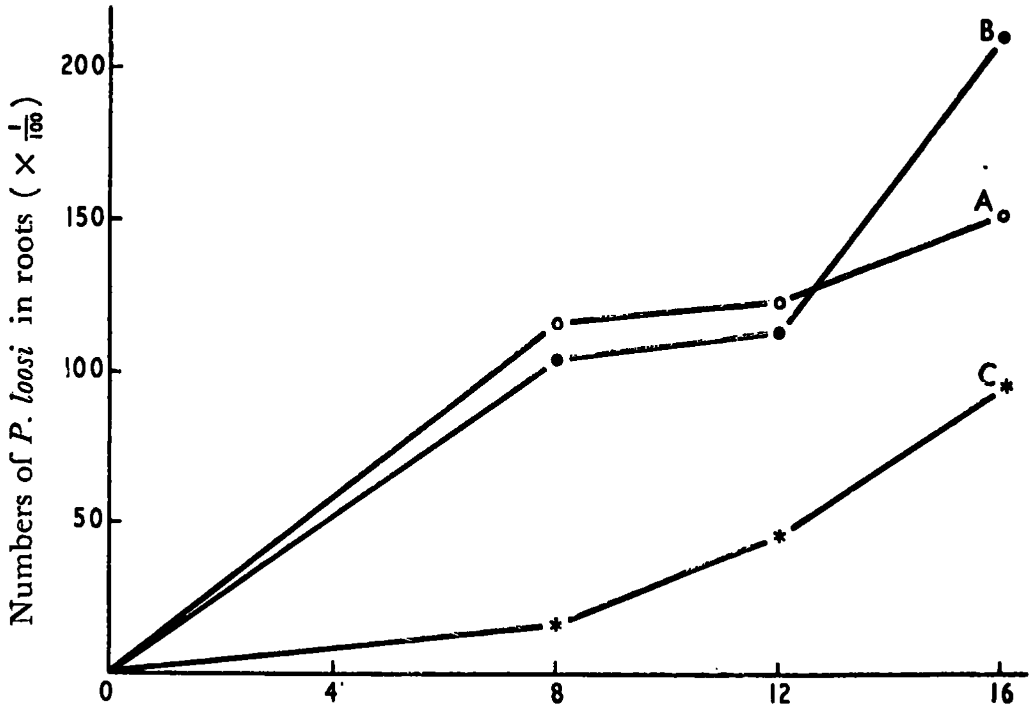

FIGURE 2—*Increase in number of* P. loosi *in roots of clone DT 1 growing in different soils—Mean number of* P. loosi *per plant—A : Drayton, B : St Coombs, C : Wootton*

Circumstantial evidence indicates that if a new clearing becomes well established, it can tolerate quite heavy reinfestation which may develop over the years. This applies even to a very susceptible clone like TRI 2024, but to be on the safe side, it is probably better to plant more resistant clones. These are, in approximate order of resistance, DT 95, TRI 2142, MO 146, MO 116, DUN 7, DT 1, DK 1, TRI 2025, K 145, DK 8 and KEN 16/3. These clones are recommended for your consideration, *but it must be emphasized that we do not have enough field experience of many of them to recommend them without qualification.* TRI 2025 and K 145 are the exceptions, because both are well proven clones.

Whenever *P. loosi* is present, either in new clearings or in old seedling tea, there is a constant battle between the plants and the eelworms. If the plants can produce new roots faster than the eelworms can damage them, the plants will continue to grow and appear healthy even though crop might be slightly reduced. If, however, eelworm damage to roots exceeds the rate of production of new roots, top growth will not be maintained and yields will fall. We have frequently observed that any set-back to the plants as a reslult of over-cropping, under-manuring, heavy pruning, severe drought *etc*, may change the balance in favour of the eelworms. Soil conditions may also affect the balance; eelworm damage is often more severe in light gravelly soils or in heavy poorly drained soils, probably because root production is restricted. Everything should be done to maintain plant vigour.

Acknowledgements

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