Paper 12

POTATO CYST NEMATODE IN NEW ZEALAND

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INTRODUCTION

There are two species of potato cyst nematode in New Zealand. *Globodera pallida* was first found in New Zealand at Pukekohe in 1972 (Dale, 1972) and *Globodera rostochiensis* was found in Canterbury in 1975.

Research into this problem was undertaken by the nematology group of DSIR, at Pukekohe in 1974 and subsequently at Lincoln in 1976. Regional research plots were also established in the peat soils of Marshlands (Canterbury) and the early cropping areas of Outram near Dunedin.

Research has been directed into the specific areas of chemical control and biological studies, with the aim of producing management strategies for the control of the pest.

CHEMICAL CONTROL

A number of fumigants and nematicides have been evaluated over a range of geographical locations and soil types. Rates of materials used and methods of incorporation have been established and the most cost effective material selected. The soil fumigants dichloropropane-dichloropropene (D-D) and dichloropropene (Telone II) at 250-500 l/ha applied twice, gave 70-90% kill, Dazomet (Basamid) a granular fumigant, broadcast and incorporated at 350 kg/ha gave a similar level of control, but the cost per hectare was greater than with D-D or Telone II.

The principal advantage of fumigation is that it kills a large proportion of the population and thus reduces the risk of spread to other areas. Nematicides, on the other hand, protect the crop by disorientating and killing the hatched nematode larvae as they move through the soil in search of the developing crop roots. In spite of this effect, a small number of larvae find the potato root and a low multiplication rate of the nematode population occurs. Depending on the material and the soil type this multiplication rate varies from 0.9 to 7 times. An untreated crop will allow a multiplication of between 20-50 times. The highest multiplication rate occurs in peat soils.

The main advantage of nematicides is that they hold the multiplication rate of nematodes down while allowing a susceptible potato crop to be grown.

The oxime carbamates (Temik and Vydate), when applied as granules at 5 kg ai/ha broadcast and rotovated into the soil prior to potato planting, give the required level of control. Fenaminaphos (Nemacur) as a 40% emulsifiable concentrate has been granted provisional B registration. This material, when applied at 20 1/ha as a post planting spray and subsequently incorporated by moulding, shows promise but needs more extensive evaluation.

BIOLOGICAL STUDIES

Biological studies were undertaken to answer specific questions and research was directed to four major areas — rate of nematode buildup, crop loss assessment, rate of nematode decline and distribution of species and their pathotypes.

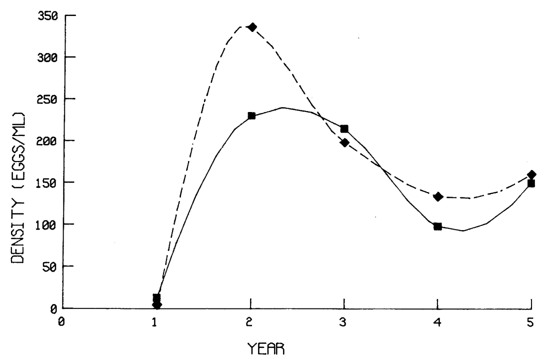

Figure 1: Rate of build up of two species of potato cyst nematode in Canterbury with continuous cropping of potatoes.
RO_4 = G. *rostochiensis* (Diamonds)
Pa_3 = G. *palida* (Squares)

Rate of nematode build up

Potatoes were planted every year in experimental plots of evenly infested silt soils. The results of this experiment in Canterbury are shown in Figure 1. There was a rapid buildup in egg/ml of soil for both *G. rostochiensis* and *G. palida*, throughout the three years of the trials with a maximum of 350 and 250 egg/ml for *G. rostochiensis* and *G. pallida* respectively. This density was not sustainable and the populations subsequently declined to an equilibrium density between 100 and 150 eggs/ml. There was a significant ($P < .005$) difference in the multiplication rate of the two species in Canterbury, with *G. rostochiensis* having a higher rate of increase.

The effect of rotation on the buildup of nematodes was examined by Foot *et al.* (1980) at Pukekohe. they found a similar rate of increase to that found in Canterbury, when potatoes were repeatedly planted (Figure 2), but no increase in nematode numbers occured if potatoes were planted only once every four years.

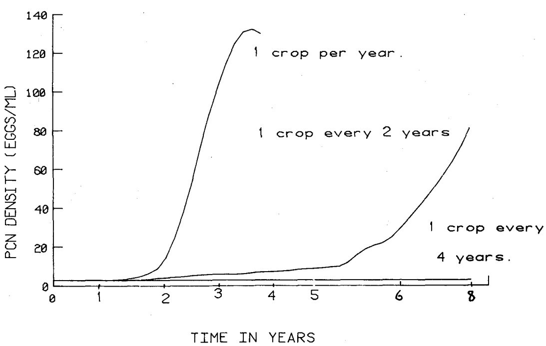

Figure 2: Rate of potato cyst nematode build up under Pukekohe conditions.

Crop loss assessment

Potato cyst nematode does cause yield loss under New Zealand conditions. Wood and Foot (1977) found that yield reductions of 10-58% resulted when potatoes were grown in soil infested with 20-90 eggs/g soil. Under Canterbury conditions (Figure 3) yield losses of up to 95% of table grade potatoes have been recorded. Yield loss became significant ($P < .005$) when the density of eggs exceeded 10/ml of soil which is well below the density of 40-50

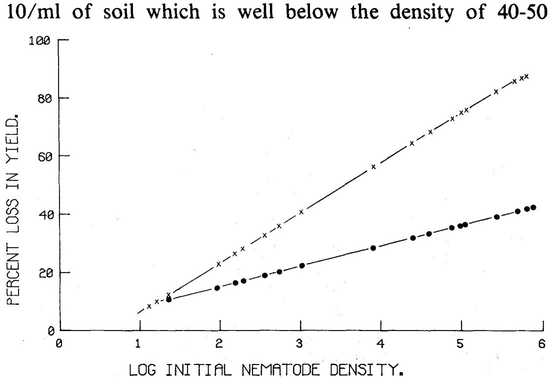

Figure 3: Percent loss in yield with increasing potato cyst nematode density in Canterbury trials. (Crosses represent table size grade) (Dots represent seed size grade)

eggs/ml soil when above ground symptoms are obvious (Wood and Foot 1977). When this level of 40-50 egg/ml soil is reached, infested plants appear spindly with smaller leaves, the stems are often shorter and chlorosis is often present later in the season. Infested plants die down earlier than non infested plants. Both *G. rostochiensis* and *G. pallida* produce the same symptoms and affect plant yield in the same way.

Rate of nematode decline

In the absence of a supporting host, the number of larvae in a dormant cyst declines (Figure 4). The rate of decline varies with soil type and location. Also, populations that are subject to regular changes in soil temperature and moisture have the greatest rate of decline. In the Pukekohe situation, Foot *et al.* (1980) measured a population decrease of up to 70% per year, but in the Canterbury silts and peats there was only a decrease of 45%. Changes in the rate of decrease were observed for the different species, soil types and the length of time the population has been deprived of a host.

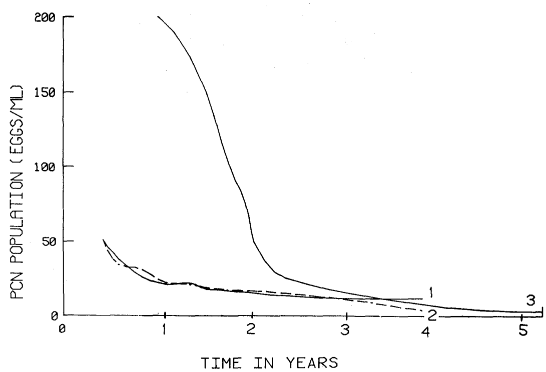

Figure 4: Rate of decline in a potato cyst nematode population from three locations
1 = silt loam Canterbury
2 = peat Canterbury
3 = loam Pukekohe (after Foot *et al* 1980)

The presence of self set potatoes following a crop of potatoes is the most significant impediment to natural decreases in nematode density. Foot *et al.* (1980) showed that a nematode population will slowly increase on self sets, and hence recommended that all practical steps be taken to remove self sets during the period between potato crops.

Distribution of species and their pathotypes

Both *G. rostochiensis* and *G. pallida* are present in New Zealand. In the North Island at Pukekohe, where *G. pallida* predominates, pathotypes Pa_2 and Pa_3 have been detected. Pa_2 is the major pathotype in this area. A single population of *G. rostochiensis* pathotype Ro_1 has been recorded. No other populations have been found in the North Island.

In the South Island, two commercial areas and a number of isolated domestic gardens have been infested. The silt and peat areas around Christchurch are extensively infested with both species, but *G. rostochiensis* predominates. The major pathotype is Ro_4, but populations of Ro_1 have been recorded. *G. pallida* is present in large areas and the only pathotype found to date has been Pa_3. The Christchurch area also has sites where both species are present as mixtures.

In the early potato producing areas of Outram and Port Chalmers, near Dunedin, *G. rostochiensis* pathotype Ro_1 predominates. A single population of *G. pallida* also has been found. A number of home gardens in the Port Chalmers area are infested with both *G. pallida* and *G. rostochiensis*. Other home gardens in Palmerston, Alexandra and Invercargill are known to be infested.

Knowledge of the species distribution in New Zealand is important as it determines which potato cyst nematode resistant potato cultivars can be grown. There are a large number of potato cultivars resistant to *G. rostochiensis* which are very effective at reducing nematode levels. Unfortunately, *G. pallida* is not controlled by the same cultivars and should a *G. rostochiensis* resistant cultivar be planted in a *G. pallida* infested field, the nematode would reproduce as readily as on the susceptible Ilam Hardy.

Also, information on the pathotypes present within each nematode species is essential for the potato breeder. Parental material used in breeding programmes has differing levels of resistance to each pathotype, and it is important that the highest level of resistance is incorporated in any new potato cultivar produced.

BREEDING FOR RESISTANCE

Potatoes resistant to potato cyst nematode are the best long term solution to potato cyst nematode control and we have been fortunate in having a wide range of *G. rostochiensis* resistant cultivars to evaluate. For *G. pallida* the plant breeders of Crop Research Division, DSIR have produced some very promising cultivars with a high level of resistance and these should be available for evaluation in the near future. The long term aim of the breeding programme is to produce potato cultivars which contain resistance to both species of potato cyst nematode. The breeding programme is outlined in more detail in the paper by Genet and Anderson in this publication.

It must be pointed out that the availability of resistant cultivars does not permit a grower to reduce his rotation. The repeated use of resistant cultivars increases the likelihood of the resistance breaking down, as nematodes which survive on a resistant cultivar will buildup and ultimately damage the crop.

However, under a 4 year rotation it is unlikely that a resistant population of nematodes will build up. (Jones and Kempton, 1978).

MANAGEMENT STRATEGIES

Using the information obtained from the research programmes, management strategies for each affected area have been developed. The four major management tools available are:

- Fumigation
- Rotation
- Nematicides
- Resistant cultivars

Each region has different management requirements for potato growing and hence require different management strategies. The strategies used at Pukekohe and Outram illustrate the range of approaches available.

Pukekohe

Large areas of volcanic clay loam, on which early potatoes have been grown, were infested. All nematode populations were *G. pallida*, pathotypes Pa_2 and Pa_3. All areas of infestation were initially fumigated by Ministry of Agriculture and Fisheries and an enforced four year rotation established. No Solaneaceous crops were allowed to be grown for three consecutive years; during this time a natural population decline of 70% per annum reduced the level of nematodes. At the end of this period, the grower applied to the MAF to replant potatoes and a soil sample was taken. If there were no viable eggs detected, a crop of nematode susceptible potatoes could be planted with an acceptable nematicide. Nematicides are very effective in restricting the level of nematode multiplication to 0.9 to 3 times. After this crop the land is again retired for a further three years. Unfortunately, there are no *G. pallida* resistant cultivars available yet, hence the use of nematicides and enforced crop rotation is the only available means of control.

Outram

Potato cyst nematode was found on a number of small holdings producing mainly early potatoes on mineral soil. All but one population was *G. rostochiensis*, pathotype Ro_1. A four year rotation was enforced on each farm and nematicides used with the susceptible local cultivar on a quarter of the property. In this soil type, the nematicide reduced multiplication to 1 time. A large number of *G. rostochiensis* resistant potato cultivars were assembled and evaluated in the area and compared with the existing cultivar. Growers selected the best cultivar, Maris Anchor, and this has been accepted by growers, the market, and consumers. Demand for seed potatoes of Maris Anchor at present exceeds supply. Because of other agronomic advantages it is also being grown by potato growers not affected by potato cyst nematode. This has the effect of lowering nematode numbers in areas of infestations that have not yet been detected by normal survey methods, and this should assist in a better long term control of potato cyst nematode in the district.

Christchurch peat soils

Management strategies for nematode control on peat soils are not as effective as on mineral silt soils, especially when *G. pallida* is present. The management of these areas is under review.

CONCLUSION

Research on the two species of potato cyst nematode carried out over the last 10 years has resulted in recommendation of the use of the nematicides Temik and Vydate as successful control measures. The understanding of the biology of both species, such as the rate of increase and decrease under various cropping rotations, has led to the formulation of a 4 year potato cropping rotation. This rotation, coupled with the use of nematicides has resulted in an overall decrease in the nematode population. Different management strategies are needed for the different areas and soil types in New Zealand. Peat soils in Canterbury present the greatest management problem and research in this soil type is continuing.

Our research programme continues to investigate better methods of nematode control and population decline by using combinations of nematicides, crop rotation and resistant potato cultivars.

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