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HOST RESISTANCE TO THE POTATO CYST NEMATODE

J.G.C. SPIERS

Crop Research Division, DSIR, Christchurch

Summary

Two field trials were carried out to assess the control of a light infestation of the golden cyst nematode (*Globodera rostochiensis*)* by the resistant potato (*Solanum tuberosum*) cultivar 'Maris Court', in comparison with its natural increase in association with the susceptible cultivar 'Ilam Hardy'. In both trials the number of nematode eggs declined under 'Maris Court', by an average of 50% in a peat soil and to zero in a silt soil. In contrast the nematode population increased under 'Ilam Hardy', by 8 times in peat and by 23 times in silt. The precautions to be taken in growing resistant cultivars are discussed.

INTRODUCTION

Two species of potato cyst nematode, the golden and the white (*G. pallida*), parasitise the potato plant. Their host range is limited to members of the family Solanaceae e.g. tomato (*Lycopersicon esculentum*), poroporo (*S. aviculare*), black nightshade (*S. nigrum*) and hairy nightshade (*S. sarachoides*). The two species can be distinguished by the colour of the developing cyst and by minor morphological differences.

Resistance in the potato was found in the semi-domesticated sub-species *andigena*, and in several wild species from South America (Ellenby 1948). Breeding for resistance began in Europe over twenty years ago (Huijsman 1955) and many cultivars resistant to the golden cyst nematode are now available. Eight pathotypes or races are known, five of them within the golden cyst nematode and three of them within the white cyst nematode (Anonymous 1976). Most of the resistant cultivars available at present are resistant only to the commonest pathotype (RO₁) of the golden cyst nematode.

Cultivars resistant to the white cyst nematode have taken longer to develop because it was not realised until the mid-sixties that this nematode was a separate species.

This paper reports the results of two trials comparing the effect of a resistant and a susceptible cultivar on a population of the golden cyst nematode.

METHODS

The resistant cultivar used was 'Maris Court', developed by the Cambridge Plant Breeding Institute in England. This cultivar was imported into New Zealand in 1972. The susceptible cultivar was 'Ilam Hardy', widely grown in New Zealand.

* The generic name has been changed recently from *Heterodera* to *Globodera* (Mulvey and Stone 1976).

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The first trial was planted within a quarantine block in the Marshland district of Christchurch. The soil had a high organic content and had been infected with golden cyst nematode prior to a crop of 'Ilam Hardy' the previous year. Soil sampling carried out before the area was artificially infected indicated that viable nematode cysts were absent. Two plots of 120 'Ilam Hardy' tubers and two plots of 60 'Maris Court' tubers were planted on 25 November 1976. There were five rows in each plot. Two plots similar in area to the 'Ilam Hardy' plots were left fallow and were maintained free of volunteer potatoes and weeds.

Samples of soil were collected using a soil corer. Two cores, approximately 2.5 cm dia. x 20 cm deep were taken per row before planting. Harvesting was carried out by machine on 31 March 1977 (18 weeks) and soil cores were taken afterwards. This time 10 cores per row were taken in the 'Ilam Hardy' and fallow plots and five in the 'Maris Court' plots. The cores were pooled within rows, to form 30 composite samples.

The second trial was planted in the high-security quarantine block at the Lincoln Station on 16 December 1976. The soil, a well-drained silt and spray irrigation was used during dry periods. Each tuber was planted with a small quantity of infected soil containing an average of 102 cysts which had been obtained from the Marshland site. Two plots of 'Ilam Hardy' and two of 'Maris Court' were each planted with 80 tubers in five rows. This trial was harvested by hand on 12 May 1977 (21 weeks) and composite samples of 10 cores per row were taken in each plot.

For cyst extraction 100 g soil samples were taken from the air-dried pre-plant cores from the Marshland site. The initial infection level at Lincoln was determined by extracting cysts from 12 randomly chosen soil inoculations which had been made up as extras. The post-harvest composite core samples from both sites were thoroughly mixed and two sub-samples of 100 g were taken from each composite sample. The samples were dried at room temperature and the cysts were separated from the soil by flotation using a Fenwick can (Fenwick 1940). The cysts in each sample were crushed in water in a tissue grinder. The eggs and larvae were counted in a sub-sample of this solution using a McMaster slide, and the total in the sample, and hence the plot, was estimated.

For convenience the word eggs will be used to refer to both eggs and larvae in a sample.

RESULTS AND DISCUSSION

Trial 1 Marshland, peat soil

The mean numbers of eggs per plots are shown in Table 1. This trial was severely waterlogged, plot 1 being the worst affected. The number of eggs increased in the 'Ilam Hardy' plots but decreased in the 'Maris Court' plots. Plot 3 ('Maris Court') decreased by 66% but plot 6 ('Maris Court') decreased by only 40%, which is a smaller decrease than would be expected from other studies. Howard (1972)

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and Hijink (1972) quote decreases of 50-70% and 80% respectively. There is considerable variation between replicate plots and also between rows within plots. Part of this variation can be attributed to soil sampling. The apparent increase under fallow in plot 2 is adequately explained by the lack of precision in the method of pre-plant sampling. This probably also explains the smaller decrease in plot 6. It is possible that other pathotypes of the golden cyst nematode or a low level of the white cyst nematode are present, which could multiply on 'Maris Court', but none were detected in Trial 2, which was infected from the Marshland site.

TABLE 1: Average number of eggs and larvae per gram of soil ($\pm$ s.e.) from the Marshland and Lincoln trial plots

PLOT	Trial 1 (Marshland)		Trial 2 (Lincoln)	
	1	4	A	C
<i>'Ilam Hardy'</i>				
pre-plant	8.2 $\pm$ 3.4	5.2 $\pm$ 2.2	3.4 $\pm$ 0.2	3.4 $\pm$ 0.2
post-harvest	37.0 $\pm$ 16.4	57.2 $\pm$ 22.6	77.5 $\pm$ 21.3	84.7 $\pm$ 12.2
multiplication rate	x 4.5	x 11	x 22.8	x 24.9
PLOT	3	6	B	D
<i>'Maris Court'</i>				
pre-plant	5.5 $\pm$ 2.7	6.3 $\pm$ 2.2	3.4 $\pm$ 0.2	3.4 $\pm$ 0.2
post-harvest	1.9 $\pm$ 1.3	3.7 $\pm$ 1.2	0.0	0.0
multiplication rate	x 0.3	x 0.6	—	—
PLOT	2	5		
<i>Fallow</i>				
pre-plant	3.3 $\pm$ 1.3	3.7 $\pm$ 0.8		
post-harvest	4.5 $\pm$ 1.4	2.5 $\pm$ 0.6		
multiplication rate	x 1.4	x 0.7		

Trial 2 Lincoln, silt soil

The average number of eggs in each plant inoculation was 10190. In terms of eggs per gram of soil this is approximately 3.4/g, taking the weight of the soil in the rhizosphere of the potato plant as 3 kg. The average numbers of eggs per plot are shown in Table 1. In the 'Ilam Hardy' plots there was a 23-fold increase, to 80 eggs/g, of soil. Although the 'Maris Court' plots had contained on average 8,000 cysts each, 10 sub-samples from 50 soil cores per plot taken at harvest recorded only three cysts from each plot and all of these were empty. In contrast the numbers of cysts recovered from the 'Ilam Hardy' plots after harvest were 258 and 319, 90% of which were full. In comparison with the trial at Marshland, these results show a clear and dramatic difference between potato varieties.

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IMPLICATIONS AND CONCLUSION

These results are very encouraging for the control of the golden cyst nematode. For a suitable resistant cultivar to be grown commercially it is necessary to identify which nematode species is present and what the pathotype is. It is likely that some nematode infestations will be mixtures of both species or that the species will occur separately within the same paddock or at least on the same farm. However this may not pose serious problems because other investigations (Huijsman 1961; Cole and Howard 1962) have suggested that where an initial heavy population contains less than 1% white cyst nematode it would take four crops of the resistant cultivar to eliminate the golden nematode. It is not known whether the level of the white cyst nematode reached after this time would appreciably affect yields. Jones *et al* (1967) suggested that by alternating resistant and susceptible cultivars in a three course rotation where initially there is 1% white cyst nematode in the population, it is likely that the nematode levels would remain at a stable low level for 30-40 years, and perhaps indefinitely.

It is concluded that once the distribution of the two nematode species has been determined, resistant cultivars will provide a cheap and effective means of control when used in conjunction with short rotations and nematostats. The past performance of resistant cultivars in other countries has been encouraging. There has been no instance reported where a nematode population has changed or mutated to overcome the resistance in the potato. The fact that the nematode is confined to the soil and is relatively immobile would suggest that resistance of the type used here can be exploited with confidence.

ACKNOWLEDGEMENTS

I am grateful to L.M. Rankin for her technical assistance and helpful comments.

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