Proceedings *of the New Zealand Grassland Association 47: 267-271 (1986)*

A SURVEY OF ROOT KNOT AND CLOVER CYST NEMATODES IN DRY HILL COUNTRY

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Abstract

Clover cyst nematode *(Heterodera* trifolii Goffart, 1932) and root knot nematode *(Meloidogyne* spp.) were found throughout summer-dry hill country in the North Island. Clover cyst nematode was found at 50% of sites in the corresponding South Island hill country regions sampled but no root knot nematode was found at South Island sites. The implication for white clover breeding programmes is discussed.

Keywords: Pasture, dry hill country, clover cyst nematode, root knot nematode, *Heterodera trifolii, Meloidogyne* sp., white clover, *Trifolium repens.*

INTRODUCTION

White clover *(Trifolium repens* L.) production in New Zealand is affected by two main nematode pests, root knot nematode *(Meloidogyne* spp.) and clover cyst nematode *(Heterodera trifolii* Goffart, 1932) (Yeates 1977; Yeates et al. 1977). Two broad surveys have shown the extensive distribution of these root parasites (Yeates 1975; Skipp & Christensen 1983) on high fertility ryegrass/white clover pastures. Little is known about the nematode status of low fertility hill country.

Older white clover cultivars, such as 'Grasslands Huia', have a broad genetic base and were intended for use throughout New Zealand, but the failure of Huia to persist in hill country pastures (Forde and Suckling 1977; Charlton 1984) has shown the need for cultivars better adapted to this environment. Since 'Grasslands Tahora' white clover was placed on the Acceptable Herbage Cultivars List in 1982 for use in moist hill country, plant breeders at Palmerston North have started a programme to breed a more persistent and productive cultivar for summer-dry hill country pastures. To help determine priorities for plant breeding objectives, a survey was made of the incidence of root knot and clover cyst nematodes in this class of land.

METHODS

Sampling strategy

The zone to be sampled was defined as hill country in permanent pasture under normal to intensive grazing management which is dry in summer (>50mm average annual soil moisture deficit). This included much of the East Coast hill country of the North Island, Taupo, Marlborough, North Canterbury and Central Otago. Five samples were also taken from lowland Canterbury as a comparison. White clover plants were collected in late autumn/early winter from 62 sites within these regions as the plants were recovering from the severe drought of 1982/83. The population at each site was sampled by taking 30 plants at approximately 10m spacings along a transect. Plants were collected using a 50mm soil corer and taken with soil to Palmerston North.

Nematode extraction

Soil shaken from white clover plants in the laboratory was combined for each site, sieved through a 5mm x 14mm expanded mesh sieve and mixed.

(a) Root knot Half of the soil was mixed with an equal volume of sterilised sand and placed in 3 to 5 pots each containing one tomato (Lycopersicon *esculentum* Mill. cv. "Beefsteak") seedling. The seedlings were placed in a glasshouse where air tempera-

tures ranged from 19-25°C. After 6 weeks the tomato roots were washed free of soil and assessed for root knot galls. Up to 10 galls per site were later checked for root knot nematode females. Sites with no tomato roots forming galls were further checked by examination of finely chopped and sieved roots using the method of Coolen and d'Herde (1972) with a 38 μm sieve for the final capture.

Root knot females were not identified to species level and are referred to as Meloidogyne spp. Several species of root knot are known to occur in New Zealand, but only M. *hapla* has been recorded on *T. repens* (Dale 1975; C.J. Barber pers. comm.).

(b) Clouer cyst The other half of the soil was air dried and a 100 cc aliquot elutriated with water (Wood and Foot 1977) and debris caught on 600 μ m and 180 μ m sieves. The 180 μm sievings were washed onto filter paper and examined microscopically for H. *trifolii* cysts.

TABLE 1: Localities sampled and occurrence of root knot (*Meloidogyne* spp.) and clover cyst (*Heterodera trifolii*, Goffart, 1932) nematodes.

District and locality	Map Reference	Annual soil moisture deficit (mm) (Coulter 1973)	Nematodes	Annual clovers
SOUTHERN HAWKE'S BAY				
Horoeka	N 150 670242	50	rk, cc[1]	2,3,5,6[2]
Pukewhinau	N 154 650170	50	rk, cc	1,3,5
Pongaroa	N 154 682069	50	rk, cc	2,3,5
Akitio	N 154 834115	50	rk, cc	2,5
Okarae	N 150 635473	50	rk, cc	3,5
Te Uri	N 150 821474	50	rk, cc	2,3,5,6
Te Uri	N 150 820449	50	rk, cc	1,2,3,5
Ti Tree Point	N 150 874246	50	rk, cc	3,5
Weber	N 150 754288	50	rk, cc	2,3,5
Weber	N 150 740290	50	cc	2,3,5
WAIROA				
Putre	N 105 520081	50	rk, cc	2,3,5
Mahia Penin.	N 116 243844	100	rk, cc	2,3,4,5
GISBORNE				
Muriwai	N 107 295297	100	rk	2,5,6
Mangatoitoi	N 097 165445	50	rk, cc	2
HAWKE'S BAY				
Porongahau	N 151 003425	100	rk, cc	3,4,5
Porongahau	N 151 980312	100	rk, cc	3,4,5
Blackhead	N 151 123498	100	cc	2,3,5
Pourerere	N 146 252673	100	rk, cc	1,2,3,5
Elsthorpe	N 141 262860	100	cc	3,4,5
Rissington	N 124 169438	50	rk, cc	3,4,5
Dartmoor	N 124 117408	50	cc	3,5
Ruakawa	N 134 103158	100	CC	2,3,5,6
Maraekakaho	N 134 955132	50	cc	2
WAIRARAPA				
Tinui	N 159 545711	50	rk, cc	1,3,4,5
Tinui	N 159 610770	50	cc	3,4,5
Castlepoint	N 159 656687	100	rk, cc	2,4,5
Waiteko	N 159 525608	50	rk, cc	3,4,5
Maungaraki	N 162 184324	50	rk, cc	3,4,5,6
Summerhill	N 166 205285	100	rk, cc	3,4,5,6
Martinborough	N 162 014325	100	rk, cc	3,5
Ponatahi	N 161977345	100	cc	2,4,5
Martinborough	N 162 033307	100	cc	1,2,3,4,5
Martinborough	N 166 036286	100	rk, cc	2,5

TAUPO				
Wairakei	N 094 593484	50	rk, cc'	1,3,5[2]
Wairakei	N 094 621443	50	rk, cc	3
Taupo	N 094 510462	50	rk, cc	3
Taupo	N 093 448447	50	rk, cc	3
CANTERBURY				
Burnham	S 083 7 17449	100	cc	2,3,5
Greendale	S 083 582528	100	CC	3,5
Burnham	S 083 703414	100	cc	2,5
Darfield	S 075 560620	100	cc	3,5
Kirwee	S 083 618588	100		3,5
NORTH CANTERBURY				
Hawarden	S 060 898365	50		1,4,5
Hawarden	S 061010280	100	cc	1,2,4,5
Hawarden	S 061 994227	100	cc	1,2,5
Ethelton	S 062 402364	100	cc	1,2,4,5
Cheviot	S 062 383402	100	cc	1,3,5
Cheviot	S 062 494458	100	cc	1,3,5
MARLBOROUGH				
Wairau Valley	S 028 826900	100	CC	1,2,5
Waihopai Valley	S 028 074895	100	cc	1,2,3,5
Upper Awatere Valley	S 035 847495	100		1,2,4
Upper Awatere Valley	s 035 915531	100	cc	1,5
Wither Hills	S 028 240856	100		1,4,5
Wither Hills	S 028 203831	100		1,4,5
Wither Hills	S 028 165820	100		1,4,5
Grassmere	S 029 410759	200		2,5
CENTRAL OTAGO				
Maniototo	S 135 969640	200	cc	3,5
Maniototo	S 135 970640	200	cc	3,5
Maniototo	S 134 648672	200		3.5
Alexandra	S 134 320560	200		3'
MacKenzie Basin	S 116 643310	200		1,3
Middlemarch	S 154 920070	50		3

[1] rk — root knot nematode, cc — clover cyst nematode

[2] 1 — *T. striatum*
2 *T. glomeratum*
3 — *T. dubium*
4 — *T. micranthum*
5 *T. subterraneum*
6 — *T. cernuum*

RESULTS AND DISCUSSION

Both root knot and clover cyst nematodes were widely distributed throughout the dry hill country surveyed (Table 1). In previous surveys (Yeates 1975; Skipp and Christensen 1983) only a few sites were sampled within the hill country areas listed above. Yeates (1975) found root knot only in pastures in warm (mean annual temperature over 12°C), moist (mean annual rainfall over 1000mm) climates. He considered that these conditions were essential for the survival of *Meloidogyne* in pastures and suggested that the absence of M. *hapla* from a Masterton site was caused by drought (Yeates 1973). A dominant feature of the soils on the dry hill country we sampled is the soil moisture deficit in summer (Table 1). Yet, 28 of the 37 North Island sites samples had root knot (Table 1), and other workers (Peacock 1957; Wallace 1963) have reported that root knot nematode can survive such conditions.

Root knot has been found in the South Island (Skipp and Christensen 1983) but did not occur in any of our samples. Skipp and Christensen (1983) found root knot in the Nelson region and in Westland, areas which are warmer and wetter than the South

Island areas sampled in this survey. Root knot has also been found in irrigated horticultural areas of mid Canterbury (unpubl. data). Only limited temperature data are available for *M. hapla* and these may not apply to the New Zealand pathotype(s). However, *M. hapla* is known to have a higher temperature optimum than clover cyst nematode (Oostenbrink 1967; Bird and Wallace 1966) and this may explain the contrast in distributions in the South Island. The possibility that root knot nematode has not yet been introduced to all those South Island sites where it was found absent is unlikely. The main dispersion method is mechanical and the sites where root knot was not found are not exempt from stock and vehicle movements from areas where root knot nematode is located.

The distribution of root knot nematode has probably been influenced by alternative host plants. Suckling clover (Trifolium dubium Sibth.) and lesser suckling clover (Trifolium micranfhum Viv.) are widespread in both islands and collected plants were frequently found to be galled in our North Island samples. This finding prompted the host range testing of the other *clovers* and weeds found in dry hill country. Preliminary results (Mercer, unpubl.) show that of the 6 annual clovers listed in Table 1, only striated clover *(Trifolium* striafum L.) is not a host to M. *hapla*. Scotch thistle (Cirsium *vulgare* (Savi) Ten.) and Californian thistle (Cirsium aruense (L.) Scop.) were found to be hosts of *M. hapla* but the nematode failed to reproduce on hawkbit *(Leontodon* taraxacoides (Vill.) Merat), curled dock (Rumex *crispus* L.), broad-leaved dock *(Rumex obtusifolius* L.) and narrow-leaved plantain *(Plantago lanceolata* L.).

The clover cyst nematode, *H.* trifolii, was extensively distributed in the dry hill country of both Islands (Table 1), with only one of the 37 North Island sites and 10 of the 20 South Island hill country sites having no cysts in the samples. Of the South Island sites with no cysts detected, the Wither Hills, Grassmere and Harwarden sites had few white clover plants but alternative hosts were present (Table 1). Although first recorded in 1963 (Grandison 1963) its wide distribution indicates that this parasite has had a long association with white clover in New Zealand. Its spread has probably been influenced by its wide host range among weeds and clovers common in summer-dry hill country pastures. Docks (Rumex spp) have been reported as hosts in New Zealand (Dale 1972; Healy et *al.* 1972) and in other countries (Winslow 1954; Gerdemann and Linford 1953). Other potential host plants found in the areas sampled were subterranean clover (Trifolium subterranean L.), clustered clover *(Trifolium glomeratum* L.), suckling clover and chickweed *(Stellaria media* (L.) Vill.). *Since* these have been recorded as hosts for H. trifolii overseas (Norton and Isely 1967; Winslow 1954) but not in New Zealand, host range testing is in progress. Preliminary results (Mercer, unpubl.) show that the widespread clustered clover, suckling clover, lesser suckling clover, subterranean clover and drooping flowered clover (Trifolium *cernuum* Brot.) are hosts of H. trifolii. The distribution of alternate hosts shows that a source of inoculum capable of parasitising oversown white clover could exist in all dry hill country areas (Table 1).

With the survey showing that both root knot and clover cyst nematodes are widespread in North Island dry hill country, any white clover bred for this area should be resistant or tolerant to both nematodes. However, if a separate regional selection is required for South Island dry hill and high country then it is probably necessary to consider only clover cyst nematode. Further nematode population studies are needed to ascertain the status of clover cyst nematode as a pest in this environment, particularly in the South Island where the nematode was found less frequently. The selection of white clover genotypes for drought tolerance should be concomitant with selection for nematode resistance with screenings being carried out at dry hill country sites where the relevant species of nematode are resident.

Acknowledgments

The authors wish to thank R. Barker, M. Sangrauber and M.L. Ridge for assistance with processing samples; thanks are due to G.R. Cousins, many farmers and MAF officers for assistance in the field.

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