EFFECTS OF SOIL TREATMENTS ON GROWTH AND ROOT PATHOGEN STATUS OF PASTURE PLANTS

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Establishment and growth of pasture plants are often adversely affected by root pathogens. In North Island pastures, control of plant parasitic nematodes has been shown to increase nitrogen fixation in white clover (*Trifolium repens* L.) by at least 50% (Watson *et al.* 1985). Nematode damage often leads to invasion of roots by fungal pathogens exacerbating the losses which commonly occur in young seedlings (Falloon 1985). A pot experiment was designed to evaluate the effects of nematodes and other pathogens on the growth of white clover and ryegrass, and also the extent of root colonisation by fungi.

The soil used was Horotiu sandy loam, a typic vitrandept, collected in Hamilton. The experiment consisted of four treatments; untreated soil, soil frozen (-20°C for 7 days) to eliminate most plant parasitic nematodes, chloroform-fumigated soil and fumigated soil re-inoculated with a 5 g layer of soil which had been frozen for 7 days. Ryegrass and clover seeds were planted and the pots were maintained at 20°C in a constant environment room with 16 h light and 8 h dark periods. One ml of a suspension of *Rhizobium trifolii* containing approximately 10^7 cells/ml was added to the soil at the base of each clover seedling after 7 days. Pots were watered regularly and each pot also received 10 ml of 1/2 strength nutrient solution (Smith *et al.* 1983) once a week. After approximately 6 weeks, harvesting of the plants commenced. Pots were grouped into ten replicates, each containing 12 pots. These 12 pots were comprised of four pots of untreated soil and two pots each of the other treatments, all randomly selected. Harvesting was done over 22 days. One complete replicate was harvested in 1 day. Measurements made included wet weight of roots and shoots, dry weight of shoots, number of nematodes in the roots and types of fungi. To evaluate fungal colonisation, roots were surface-sterilised with saturated calcium hypochlorite for 5 min and rinsed in several changes of sterile distilled water. The roots were then cut into segments (about 1 cm length) and approximately 16 root segments per treatment were plated on potato dextrose agar (PDA) containing aureomycin. Plates were incubated at room temperature.

Means of wet weight of whole plants and shoot dry weight of ryegrass and clover were lower ($P<0.05$) in plants grown in untreated soil than in plants grown in frozen, fumigated or fumigated-inoculated soil (Table 1). The mean weight of clover plants grown in frozen soil was lower ($P<0.05$) than those from the two fumigated treatments and there was also a statistically significant difference between the fumigated and fumigated-inoculated treatments. The re-introduction of microorganisms inhibitory to clover growth with the addition of nematode depleted but unsterile soil into the fumigated-inoculated treatment may account for this (Suslow and Schroth 1982).

The presence of the nematodes *Heterodera trifolii* and *Meloidogyne hapla* probably accounted for the severe stunting of clover plants in untreated soil. Freezing of soil can almost eliminate plant parasitic nematodes (Watson, unpublished). However, in the present work, cyst nematodes (*H. trifolii*) were found in clover plants grown in the frozen treatment. There were no cyst or root knot nematodes in the fumigated-inoculated treatments although the latter pots had a layer of frozen soil placed on top of fumigated soil. Initially the cyst nematode numbers may have been

severely reduced due to freezing. During the trial, a few of the surviving *H. trifolii* may have invaded clover roots in the frozen treatment but these numbers were low.

TABLE 1: Mean weights and nematode status of ryegrass and white clover plants grown in untreated and treated soils.

		Untreated	Frozen	Fumigated	Fum-Inoc	SED[1]
Ryegrass	Plant wet wg (g)	3.84	6.47	6.83	7.1	0.43
	Shoot dry wt (g)	0.33	0.62	0.93	0.85	0.052
Clover	Plant wet wt (g)	0.11	1.07	1.86	1.33	0.19
	Shoot dry wt (g)	0.012	0.092	0.225	0.162	0.025
Nematode status[2]	*Meloidogyne hapla*	+	—	—	—	—
	Heterodera trifolii	+	+	—	—	—

[1] SED All the treatments were different ($P<0.05$)from the untreated control.
[2] Presence or absence of the nematodes in the roots of white clover.

TABLE 2: Occurrence of two root pathogenic fungi, *Fusarium oxysporum* and *Codinaea fertilis*, among treatments expressed as a percentage of the total number of isolates of each species (*F. oxysporum* = 100; *C. fertilis* = 55).

	F. oxysporum		*C. fertilis*	
Treatment	Clover	Ryegrass	Clover	Ryegrass
Untreated	12 (6)[1]	5 (3**)	56 (9)	29 (8)
Frozen	10 (4)	19 (6*)	11 (3**)	2 (1**)
Fumigated	5 (3)	8 (4**)	0 (0**)	0 (0**)
Fumigated-inoculated	9 (6)	32 (10)	2 (1**)	0 (0**)

[1] Figures in parentheses show the number of replicates (total number = 10) yielding one or more cultures of the pathogen *Fusarium oxysporum*; clover, no significant difference: ryegrass, fumigated-inoculated treatment significantly different from the rest, *C. fertilis*; untreated different from other three treatments for both plants (** significant at 1%; * significant at 5%).

A total of 468 isolates of fungi were recovered from the 1266 root segments cultured. Known root pathogens isolated included *Fusarium* spp., *Codinaea fertilis* Hughes and Kendrick, *Cylindrocarpon destructans* (Zinnsmeister) Scholten and *Cylindrocladium scoparium* Morgan. Table 2 shows the occurrence of the two most common pathogens, *F. oxysporum* Schlecht and *C. fertilis,* in all treatments. The greatest numbers of *C. fertilis* were isolated from clover and ryegrass roots from untreated soil (56% and 29% of isolates respectively). The higher numbers of fungal isolates obtained from these samples may be due to nematode damage to roots of clover and ryegrass allowing access of the pathogen into roots, and/or decrease of *C. fertilis* populations in frozen soil as a direct result of freezing. Skipp and Christensen (1981) observed an increase in fungal attack in roots of white clover seedlings which contained *Heterodera* larvae. Greatest numbers of *F. oxysporum* were found in all the

treatments which included fumigated soil, possibly from contamination during the trial. Greatest numbers were found in ryegrass roots from fumigated-inoculated soil. This indicates that the *F. oxysporum* is able to colonise ryegrass and clover roots in the absence of nematode damage. *Fusarium oxysporum* has been shown to proliferate rapidly and destroy roots of *Trifolium subterraneum* in soil relatively free from other competing fungi, but in natural soil the fungus was relatively benign (Pung *et al.* 1992).

The presence of nematodes appears to have severely reduced the growth of clover plants in soil. There was no direct indication that the root pathogenic fungi, in the absence of nematodes, cause significant damage to ryegrass or clover plants.

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