INDICATORS OF PATHOGEN POTENTIAL OF PASTURE SOILS

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ABSTRACT

A simple pot test was used to indicate the combined effects of several pathogens common in pasture soils (plant parasitic nematodes and pathogenic fungi e.g. *Pythium* spp.) by comparing the dry weight yields of clover seedlings grown in untreated soil with those from soil treated in a microwave oven. Response to microwave treatment, expressed as a "Soil Pathogenicity Index", was greater with soil from old pasture or from areas in 2 year old pasture plots showing poor regrowth after grazing of white clover (*Trifolium repens* L) or Caucasian clover (*T. ambiguum* Bieb.), than from soil from new pasture or areas in the 2 year old plots with vigorous clover regrowth.

KEYWORDS

Soilborne pathogens, nematodes, seedling vigour, white clover, Caucasian clover

INTRODUCTION

Soilborne pathogenic nematodes, fungi and bacteria can be major biological constraints to productivity of pasture and forage crop plants (Skipp and Watson, 1996; Mercer and Watson, 1996) through their adverse effects on seedling establishment, persistence, drought tolerance, regrowth after grazing, N-fixation, and/or efficiency of fertilizer use. However, it has been difficult to define and quantify losses because damage frequently results from complex interactions among several soilborne pathogens (Skipp and Watson, 1996). Current attempts to develop bioindicators of 'soil quality' to monitor changes in the sustainability of farming systems (Pankhurst, 1994) have largely ignored the impact of plant pathogens. Cook (1994) has advocated measurement of increases in plant growth resulting from disinfestation of soil (e.g. by heat sterilization or chemical fumigation) for field-scale detection of effects of soilborne pathogens. This paper describes the use of simple pot tests which indicate 'pathogen potential' of soils by comparison of seedling growth in untreated soil and in soil treated with microwave (MW) radiation.

METHODS

Core samples of a light volcanic ash soil (Paengaroa Shallow Sand, a typic Hapludand) were obtained from a dairy farm near Te Puke, North Island, New Zealand which had shown declining milk yields associated with poor performance of white clover (*Trifolium repens* L) (Watson *et al.* 1994). Pot experiments were conducted using soil from pastures containing perennial ryegrass (*Lolium perenne* L) and white clover or Caucasian clover (*T. ambiguum* Bieb.). Samples were taken from areas showing differences in plant vigour as follows: (a) 'New pasture' (first year pasture with cv. Kopu white clover); (b) 'Old pasture' (>10 years, local white clover ecotype); (c) 'High vigour white clover' (from areas in a second year pasture after maize cropping within patches showing good regrowth of cv Kopu white clover after grazing); (d)'Low vigour white clover' (as 'c' showing poor regrowth); (e) 'High vigour Caucasian clover' (as 'c' from pasture containing cv Endura Caucasian clover); (f) 'Low vigour Caucasian clover'. Soil was air dried, crushed and sieved (9 mm). Bulk soil from each category was placed in 1 kg quantities in 2 polyethylene bags and moistened to 40% water holding capacity (WHC). One bag of each category was untreated and the other treated in a 650 watt microwave oven for 3 min at full power (Nan *et al*. 1991). Cool soil (150g) was placed in 65mm diam. unperforated plastic cups, sown with 20 seeds of white clover (cv. Huia) or Caucasian clover (cv. KZ1) and covered with 20g of the same soil. Five replicate pots of treated and untreated soil were prepared per soil category. Pots were maintained at 80% WHC and 20°C in temperature-controlled water baths in the glasshouse for 2 months. Shoot dry weight (DW) data were analysed by 2 way ANOVA and the influence of soilborne pathogens expressed as "Soil Pathogenicity Index" (SPI) = 1 - (DW shoots from untreated soil/DW shoots from MW treated soil).

RESULTS AND DISCUSSION

More ($P<0.01$) white clover seedlings established in pots of MW treated soil (76%) than in untreated soil (65%), whereas establishment of Caucasian clover was not affected by MW treatment. The mean DW of shoots of seedlings grown in untreated soil from new pasture was greater than that of seedlings in untreated old pasture soil (Table 1), while the shoot DW of white clover and Caucasian clover seedlings from their respective 'high' and 'low' vigour soils did not differ significantly.

Microwave-treated soil yielded greater seedling DW than untreated soil for each of the six soils tested (Table 1). However, the percent increase in response to MW treatment (and the SPI) was greater for the old pasture and 'low vigour' soil than for the new pasture and 'high vigour' soil. Roots of seedlings washed from MW treated soil were white and lacked symptoms of pathogen damage while roots from untreated soil bore root galls caused by *Meloidogyne* spp. nematodes, cysts of *Heterodera trifolii* Goffart and dark fungal root lesions. Pathogenic fungi isolated from lesioned roots included *Codinaea fertilis* Hughes & Kendrick, *Pythium* spp., *Fusarium* spp. and dark sterile forms.

The SPI provides an indication of the potential effects of the combined natural inoculum of pathogens in a particular soil in terms of growth depression relative to an arbitrary optimum value defined by growth in soil rendered 'pathogen-free' by microwave radiation. In the absence of any substantial inter-plant competition, the index will reflect the additive effects of pathogens which reduce plant numbers by killing seedlings (e.g. *Pythium* spp.) and those which reduce seedling vigour (e.g. nematodes). The effects of these two types of pathogens can be differentiated using separate indices for effects on seedling number and of dry weight per plant. Use of soil treatments more selective in their action than MW treatment (e.g. soil freezing, nematicides and fungicides), coupled with the use of root examination and fungal isolation techniques, can help further differentiate the influence of different pathogens (Skipp and Watson 1996). Since nematode and fungal pathogens which invade seedling roots affect plant growth long after establishment, particularly during periods of rapid root initiation and growth, the use of such indicators are applicable to mature permanent pastures.

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Table 1
Mean shoot dry weight per pot, % increase in shoot DW resulting from MW treatment, and soil pathogen index (SPI) of seedlings grown in untreated and treated soil from new (first year) and old pasture (>10 years), and high and low vigour patches in second year pasture containing white or Caucasian clover.

Source of Soil		Untreated		MW-treated	% Increase	SPI
		White clover seedlings				
New pasture		0.477		0.583	22.2	0.18
Old pasture		0.263		0.631	139.9	0.58
High vigour white clover		0.421		0.745	76.7	0.43
Low vigour white clover		0.317		0.696	119.6	0.54
LSD	(P<0.05)		0.106			
	(P<0.01)		0.143			
		Caucasian clover seedlings				
High vigour Caucasian clover		0.356		0.505	41.9	0.30
Low vigour Caucasian clover		0.304		0.615	102.3	0.51
LSD	(P<0.05)		0.106			
	(P<0.01)		0.142			