Numbers of nematodes and microbial activity of soils under a range of pastures in northern New South Wales

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Nematodes are non-segmented worms typically 10-20 μm in diameter and 0.5-3 mm in length. Most attention in agriculture has been directed towards a few root-feeding species that are responsible for plant diseases, but ecologists are more interested in the diversity of soil nematodes and the beneficial role they play in soil (Yeates and Bongers 1999). A large variety of free-living nematodes function at several levels of the soil food web, feeding on bacteria, fungi, protozoa, algae, other nematodes and a variety of other soil organisms.

Nematodes are important in mineralising, or releasing, nutrients in plant-available forms. They are useful indicators of soil health because of their diversity and role in many functions at different levels of the soil food web (Neher 2001). Another useful indicator of nutrient turnover in soil is microbial activity, which can be estimated by measuring the activity of various soil enzymes (Nannipieri 1994). Since little is known about these parameters in soils that are used for pasture production, this paper reports preliminary observations on nematode communities and soil microbial activity in pasture soils of northern NSW.

Methods

Twenty paddocks on producer's properties in the districts of Nundle, Tamworth, Somerton, Manilla, Barraba, Bingara, Bundarra, and Armidale were sampled in spring 2003 as part of a survey to identify soil biological constraints to pasture production in northern NSW. Target species in the survey were phalaris, lucerne and subterranean clover, with the latter being sampled in both native and sown perennial grass pastures. In each paddock, 3 locations were selected (~5 by 5 m) and pasture herbage mass and species composition was estimated from 10 quadrats (40 by 40 cm) using calibrated BOTANAL procedures. Soil samples were also collected to a depth of 15 cm in 25 cores (5 cm diameter) at each location. Soil samples from individual cores at each location were mixed and bulked (with large roots and stones being removed) giving a total of 60 samples (20 paddocks by 3 locations). A subsample of 1250 g of fresh soil was used for nematode community analysis and to determine microbial activity.

Nematodes were extracted from 200 mL soil samples using a standard tray extraction technique and total numbers of free-living nematodes were counted. Plant-parasitic nematodes were identified to genus level and counted. Samples were processed and stored for further identification. Microbial activity was determined by measuring the rate of hydrolysis of fluorescein diacetate (FDA, Schnürer and Rosswall 1982).

Results and Discussion

Numbers of free-living nematodes varied considerably among the paddocks sampled. Some of this variation was probably related to soil type, soil moisture content and plant health, but pasture species also appeared to have an impact. Numbers of free-living nematodes were generally lower in paddocks sown to lucerne than in those with phalaris or subterranean clover (Table 1). For phalaris or subterranean clover pastures, free-living nematode numbers were consistently highest for heavy textured podsol and red basalt derived soils south of Armidale (mean values of around 3600 nematodes/200 ml soil), compared with lighter textured soils and those at lower elevations (1800 nematodes/200 mL soil).

The most common plant-parasitic nematode was lesion nematode (*Pratylenchus* spp.), which was found in 18 of the 20 paddocks. Generally populations were low, but 5 paddocks and all 3 pasture species had moderate to high nematode populations in some samples. It is likely that 4 or 5 *Pratylenchus* species were present, with some individual samples containing at least 3 species. Lesion nematodes are recognised pests of some pasture species, and in New

Table 1. Number of free-living nematodes (mean ± standard error, n=60) for 3 pasture types sampled in northern NSW in September 2003

Pasture species	No. of paddocks	No. free-living nematodes per 200 ml soil	Microbial activity (µg FDA/g/min.)
Lucerne	6	1303 ± 195	0.553 ± 0.069
Subterranean clover	8	2198 ± 275	1.376 ± 0.162
Phalaris	6	2424 ± 231	1.787 ± 0.137

Zealand, growth responses in ryegrass pastures are obtained when this nematode is controlled (Cook and Yeates 1993).

Root-knot nematode (*Meloidogyne* spp.) was found in 2 paddocks. At one site, there was considerable variation in nematode numbers across the paddock. Subterranean clover plants were later collected from the location with the highest nematode counts and heavy galling was observed on some parts of the root system. This nematode attacks a wide range of pasture species and is an important pest of lucerne and clovers (Cook and Yeates 1993). Cyst nematode (*Heterodera* spp.) was associated with phalaris (1 paddock) and subterranean clover (2 paddocks). Further taxonomic work will be needed to identify the nematode species involved, but it is likely that cyst nematode is economically important where it occurs. Several cyst nematode species are known pathogens of pasture grasses and legumes (Cook and Yeates 1993).

Pin nematode (*Paratylenchus* spp.) was common, and high numbers occurred in several paddocks. However, this nematode is usually considered a minor pathogen. Stunt nematodes (*Tylenchorhynchus* spp. and *Merlinius* spp.), spiral nematodes (*Rotylenchus* spp. and *Helicotylenchus* spp.) and stubby root nematodes (*Paratrichodorus* spp.) were found in several paddocks, but numbers were relatively low and it is unlikely that they were causing major problems. An unidentified nematode found in one paddock requires further investigation. Only second-stage juveniles were recovered from soil, indicating that the nematode is probably a sedentary endoparasite and may therefore be relatively pathogenic.

Microbial activity varied considerably among paddocks and locations within paddocks, but was generally lowest in paddocks sown to lucerne (Table 1). Again, for phalaris or subterranean clover pastures, microbial activity was highest for heavy textured podsol and red basalt derived soils south of Armidale (mean values of around 2.1 µg FDA/g/minute), compared with lighter textured soils and those at lower elevations (about 1.3 µg FDA/g/minute).

Soils with high numbers of free-living nematodes tended to have high microbial activity, but the relationship was not strong ($R^2 = 0.15$). Both numbers of free-living nematodes and soil microbial activity were poorly correlated with herbage mass of the target species. Interestingly, the biological status of soils under lucerne, that often have a long history of cropping and disturbance, was poorer than for those under phalaris or subterranean clover. Also, in northern NSW lucerne pastures typically have a shorter stand-life (generally <6 years) compared with generally more persistent phalaris and subterranean clover pastures.

These results indicated that soil biotic constraints to pasture production were present in perennial pastures in northern NSW. Several sites were infested with nematodes that are known pathogens of crop and pasture plants.

Counts of free-living nematodes and measurements of microbial activity suggested that soil health may be poor in some pasture soils, particularly those sown to lucerne. Eight of the 60 samples had very low microbial activity readings (<0.5 µg FDA/g/min.), with most of these paddocks and locations being on the North-West Slopes on red chromosol and brown vertosol soils. On the other hand, several paddocks had high numbers of free-living nematodes, low numbers of plant-parasitic nematodes and high microbial activity, which suggested reasonably good soil health.

Work currently in progress will provide a clearer picture of the soil health status of pasture soils in northern NSW. The free-living nematodes found in each sample will be identified, and the indices derived will provide a good indication of the condition of the soil food web (Ferris *et al.* 2001). Bioassays which compare plant growth in heated and non-heated soils are also being carried out, and these results should indicate whether nematodes and other root pathogens are affecting pasture production.

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