Effects of Fumigation and Soil Amendments On Nematode-Feeding Groups in Cereal Growing Soils

Aim: To quantify the effects of nematode feeding groups in Western Australian soils on crop performance.

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Background: Little is known of the impact of broadacre management practices on the different nematode feeding groups within soil in Western Australia. This research investigated the response of nematode functional groups and the soil microbial biomass (i.e. mass of living microbes in soil) to commercial products designed to either attack pathogenic nematodes or enhance overall soil biological fertility.

Trial Details:

Plot size and replication	2m x 10m * 3 replications
Soil type	Clay loam
Sowing date	27th May
Conditions at sowing	Good Soil Moisture
Machinery	FlexiCoil Bar
Seeding rate	Bonnie Rock 70 kg/ha
Fertiliser	Maximal fertiliser application to remove any nutrient limitations
Herbicides and Insecticides	27 May: 1.2L Glyphosate, 250mL Ester, 1g Ally 17th June: 150g Diuron, 300mL MCPA-amine
Paddock History	2002 = Wheat, 2001 = Wheat, 2000 = Chick pea

Site selection:

Trials were located in the northern (low rainfall, Latham) and southern (high rainfall, Jerramungup) grain-growing regions of Western Australia. Site locations were chosen based on an initial screen of sites for high levels of *Pratylenchus neglectus* using the PredictaB ™ DNA disease diagnostic service.

Soil Treatment

At both sites, methyl bromide was applied to the fumigated plots 2 weeks prior to seeding. Fumigation with methyl bromide is <u>not</u> a practical management practice for broadacre farming but does provide a research treatment where we expect maximal kill of the nematodes and other soil biology. At the Latham site products were applied to the surface of the soil using low-pressure spray equipment a few days after sowing. At the Jerramungup site products were applied 3 hours prior to seeding to the surface of the soil using watering cans.

1. Control.
2. Methyl bromide (at a rate of 1 kg per 10 m^2) was pumped across the soil surface under plastic covering that was left for 24 hr prior to removal.
3. A talc based formulation containing 100 million spores per gram of *Trichoderma harzianum, T. lignorum, Gliocladium virens* and *Bacillus subtilis*. was applied as a solution with 1kg talc per ha.
4. Beneficial mix of microorganisms applied with a food source after being incubated for 24 hours (Commercial formulation of undisclosed composition)
5. Predatory fungi formulation consisted of a 5kg talc applied as a solution. Contained 1 x 10 exp9 CFU per gram of *Arthrobotrys oligospora, A. conoidus, Paecilomyces fumosoroseus, P. lilacinus*, and *Verticillium chlamydosporium* .
6. Food source developed to support microbial populations and obtained as a commercial formulation with an undisclosed microbial food preparation,.

Extraction of nematodes. Soil was collected at the time of sowing, 8 weeks after sowing and at anthesis. Numbers of nematodes were counted and placed into one of five functional feeding groups based on the morphology of the oesophageal region: bacterial feeder (BF), predator (P), omnivore (O), fungal feeding/plant associate (FF) and plant parasite (PP). The counts were adjusted to nematodes / g dry weight of soil and the omnivores and predators combined into one group. The genera within each feeding group were identified and sites compared.

Results:

General Information

The genera within the different feeding groups (omnivores, bacterial feeders and fungal feeders) varied between sites (data not presented). Nematode counts also varied significantly between sampling times, with numbers of all feeding groups significantly higher at anthesis, compared with samples taken 8 weeks after sowing (data not presented). Significant differences were not observed for treatments in the total number of nematodes. However, treatment effects were evident in the numbers of plant parasitic nematodes (Table 1), with fumigation causing a significant decrease in numbers. Supplying a readily utilisable food source at this site also resulted in a trend towards higher levels of plant parasitic nematodes (principally *Pratylenchus neglectus* (95 – 100% of total plant parasitic nematodes)).

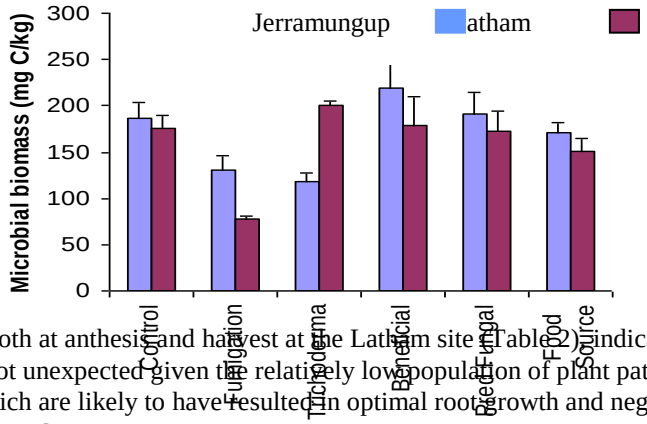
Table 1: Numbers of plant parasitic and total nematodes extracted from soil from the Latham fumigation trial at anthesis (Nematodes / dry g soil). Within columns, numbers with the same letters were not significantly different (P>0.05). PP = plant parasites, TOT = total nematodes.

Treatment	PP	TOT
Control	18.5 a	40.6 a
Fumigation	0.2 b	13.4 a
Food Source	35.0 a	53.5 a
Beneficial Fungi and Bacteria (added with food source)	4.8 ab	20.0 a
Trichoderma	11.4 a	37.2 a
Predatory Fungi	10.6 a	24.8 a
P value	0.025	0.163

The microbial biomass was significantly lower in the fumigation treatment at both sites at anthesis indicating that the microbial population had not recovered from the effect of methyl bromide 12 weeks after fumigation in these soils (Fig. 1). Application of microbial mixes and/or a food source did change microbial biomass.

There were differences between nematode feeding groups from soil and the root of plants (rhizosphere) at the Jerramungup site when soil and plants were sampled at anthesis (Table 2). When soil from the rhizosphere was sampled, the numbers of bacterial feeders, fungal feeders, plant parasites and total nematodes differed with treatments. The fumigation treatment had significantly lower numbers of nematodes. The trend was then for the control to have the next highest with the other treatments having significantly higher numbers.

Figure 1: Microbial biomass (mg C kg^{-1} soil) values for the Latham and Jerramungup bulk soil samples taken at anthesis



Plant biomass responses measured both at anthesis and harvest at the Latham site (Table 2) indicate no significant effect of treatments on crop growth. This is not unexpected given the relatively low population of plant pathogenic nematodes and the good seasonal conditions experienced, which are likely to have resulted in optimal root growth and negated the impact of nematodes and other pathogens on crop growth and production.

Results from these trials indicate that differences occur in the levels of nematodes from all feeding groups between sampling times (data not presented). The effect of treatments on nematode populations however, appeared to become less apparent in the soil as the season progressed. However, where soil from the rhizosphere was sampled, treatment effects appeared to persist throughout the season, particularly for the fumigation treatment, causing significant reductions in all feeding groups except omnivores/predators.

Table 2. Plant biomass (t/ha) of wheat cv 'Bonnie Rock' measured at anthesis and physiological maturity.

Treatment	Plant biomass at anthesis (t/ha)	Plant biomass at harvest (t/ha)
Control	6.12	8.04
Fumigation	7.19	8.59
Food Source	5.51	7.86
Beneficial Fungi and Bacteria (added with food source)	5.89	7.31
Trichoderma	6.10	8.77
Predatory Fungi	6.31	7.85
LSD (P=0.005)	*1.64*	*1.38*

Summary:

- The soil treatments investigated at these sites are considered to be ineffective for broad acre farming.
- Changes to nematode composition and microbial biomass were small and did not result in plant biomass production.
- Improvements in the effectiveness of the soil treatments may occur when applied as seed dressings; this is currently being evaluated.

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