THE EFFECT OF GREEN MANURE CROPS ON PLANT PARASITIC NEMATODES IN THE SOUTH AFRICAN SUGAR INDUSTRY

S D BERRY and E J WISEMAN

South African Sugar Association Experiment Station
P/Bag X02, Mount Edgecombe, 4300, South Africa
E-mail: shaunber@sugar.org.za *and* jean.wiseman@sugar.org.za

Abstract

Plant parasitic nematodes, *Meloidogyne javanica* in particular, cause significant yield losses in sugarcane crops in South Africa. The chemicals at present available for nematode control are expensive and potentially detrimental to the environment. It has been reported that various types of crops reduce the numbers of plant parasitic nematodes. Seven green manure crops (sunn hemp, marigold, oats, dolichos beans, velvet beans, forage peanuts and cowpeas), as well as tomato and sugarcane variety N12, were evaluated in a glasshouse trial to assess their susceptibility to *M. javanica*, as well as their influence on other nematode populations. Initial results indicate resistance of forage peanuts, marigolds and sunn hemp to *M. javanica*. Cowpeas, dolichos beans and tomato were particularly good hosts. The host status of velvet beans and sugarcane variety N12 differed in inoculated and naturally infested soils. Numbers of *Xiphinema elongatum* were not affected by any of these crops. Forage peanuts and sunn hemp increased the free-living nematode populations more so than did the other crops.

Keywords: nematodes, *Meloidogyne javanica,* green manure crops, host status

Introduction

Sugarcane is grown predominantly as a monoculture system in the South African sugar industry. This form of agriculture can result in the build-up of pests and diseases, and lead to a decline in soil health and productivity (Garside *et al.,* 1997). The use of green manure crops has been shown to maintain or improve soil organic matter (Moody *et al.,* 1999; Dunn, 2002), and in some cases reduce plant parasitic nematode populations (McSorley, 1999; Pankhurst *et al.,* 1999). Soil organic matter improves the soil environment in which the roots grow, as well as reducing the sensitivity of plants to nematode injury (Dunn, 2002).

Root-knot nematodes (*Meloidogyne* spp) are economically the most important plant parasitic nematodes in tropical and subtropical agriculture (Sasser, 1979). Root-knot, lesion (*Pratylenchus*) and dagger (*Xiphinema*) nematodes are important growth constraints to sugarcane grown in sandy soils in South Africa (Spaull and Cadet, 1990). Due to the wide host range of many of these nematodes, it is important to investigate the host susceptibility of potential cover and green manure crops before their widespread adoption.

Materials and Methods

Two pot experiments were conducted in the glasshouse at the South African Sugar Association Experiment Station (SASEX). A sandy soil with 6% clay was collected from a site known to be infested with nematodes. For the first experiment, the soil was sterilised and then inoculated with 500 second stage juveniles of *Meloidogyne javanica*. In the second experiment, the soil was left unaltered. Sunn hemp (*Crotolaria juncea*), marigold (*Tagetes* sp.), oats (*Avena sativa*), dolichos beans (*Dolichos lablab*), velvet beans (*Mucuna deeringiana*), forage peanuts (*Arachis hypogaea*) and cowpeas (*Vigna unguiculata*) were sown in 2-litre pots, with five replicates of each. For comparison, sugarcane variety N12 and tomato (*Lycopersicum esculentum*. Heinz 1370) were also included in the tests.

After three months all the pots were harvested. Soil was removed for nematode extraction and enumeration. Roots were collected, weighed, rated according to the number of galls and endoparasitic nematodes were extracted. Nematode data were transformed to $\log_{10}(x+1)$ and the resistance status of the plant determined by calculating their Rf values (Rf = Pf (final population density)/Pi (initial population density). The significance of the results were analysed by ANOVA (Statview software package).

Results and Discussion

Crops with Rf values >1 are described as good hosts, those with values of 0.1 to 1 are poor hosts and crops with values of 0 to 0.1 are non-hosts (Fortnum *et al.,* 2001). Of the seven green manure crops tested, two (cowpeas and dolichos beans) were good hosts for *M. javanica* and would not be recommended for planting in sandy soils, particularly in fields with a history of nematode damage (Tables 1 and 2). Velvet beans were rated as a poor host in the inoculated, sterile soil, but as a good host in the natural soil; the converse was true for sugarcane variety N12. These results were in agreement with those from a similar experiment performed in natural soil but harvested one month earlier (results not shown). This suggests that testing potential crops for their resistance to nematodes should be done in both inoculated, sterile soil and naturally infested soil, to take into account the impact of the microflora on plant-nematode interactions.

Sunn hemp, marigolds and forage peanuts reduced the numbers of *M. javanica* in both experiments and could be used as nematode-suppressive green manure crops in sandy soils. Peanuts and sunn hemp increased the number of free-living nematodes more so than did the other crops (Tables 1 and 2). Sunn hemp would be an ideal green manure crop on sandy soils as it provides nitrogen, is highly resistant to root-knot nematodes and increases the number of free-living nematodes. However, none of the crops tested had an effect on the numbers of *X. elongatum,* which is a pest of sugarcane on a wider range of soils than where *Meloidogyne* occurs (Spaull, 1981). Also, none of the crops influenced the numbers of *Pratylenchus zeae* (data not shown).

These results generally complement those of other researchers (Bridge, 1987; Minton and Baujard, 1990; McSorley, 1999; Ploeg, 1999; van Biljon and Meyer, 2000) although where contradictions occur they may be due to the differences in susceptibility between cultivars (McSorley and Dickson, 1995). Cropping or intercropping green manure and cover crops in the sugarcane agricultural system is an effective way of improving the environment for the cane plant, provided the selected crops do not, at the same time, encourage plant pathogenic nematode populations.

Table 1. Experiment 1: Numbers of second stage juveniles of *Meloidogyne javanica*, reproduction factors and galling index of nine crops grown in inoculated sterile soil.

Crop	Pi	Pf (soil)	Pf (roots)	Rf (soil+roots)	Gall index*	Root-knot status
Cowpea	500	8320 a	162540 a	**341.72 a**	4 (81-100)	
Tomato	500	1370 b	6928 b	**16.59 b**	5 (>100)	
Dolichos	500	912 b	6882 b	**15.58 bc**	5 (>100)	good host
N12	500	140 c	4390 b	**9.05 c**	3 (61-80)	
Oats	500	138 c	1247 b	**2.77 c**	0 (0)	
Velvet beans	500	36 d	18 c	0.10 d	0 (0)	poor host
Peanuts	500	0 e	17 c	0.03 d	0 (0)	
Marigolds	500	2 e	8 c	0.02 d	0 (0)	non-host
Sunn hemp	500	0 e	2 c	0.004 d	0 (0)	

*Gall index calculated on a scale of 0-5, where 0=0-20 galls; 1=21-40 galls, 2=41-60 galls, 3=61-80 galls, 4=81-100 galls and 5=>100 galls.
($P<0.0001$ for all comparisons)
Data was transformed to $\log_{10}(x+1)$ for statistical analysis; however, actual numbers are depicted here for ease of reading.

Table 2. Experiment 2: Numbers of second stage juveniles of *Meloidogyne javanica*, total numbers of *Xiphinema elongatum* and free-living nematodes, and reproduction factors on nine crops grown in naturally infested soil.

Crop	*Meloidogyne*				*Xiphinema*			Free-living nematodes		
	Pi	Pf (soil)	Pf (roots)	Rf (soil+roots)	Pi	Pf	Rf	Pi	Pf	Rf
Tomato	24	92 a	3204 a	**137.35 a**	88	32 a	0.36 a	320	540 b	1.68 b
Cowpea	24	2 b	1505 ab	**62.78 ab**	88	62 a	0.70 a	320	680 b	2.13 b
Dolichos	24	10 b	958 b	**40.33 b**	88	14 a	0.15 a	320	560 b	1.75 b
Velvet beans	24	6 b	309 b	**13.11 b**	88	82 a	0.93 a	320	640 b	2.00 b
Oats	24	0 b	28 c	1.15 c	88	58 a	0.65 a	320	720 b	2.25 b
N12	24	2 b	17 c	0.78 c	88	90 a	1.02 a	320	560 b	1.75 b
Peanuts	24	0 b	0 c	0 c	88	28 a	0.31 a	320	1140 a	**3.56 a**
Marigolds	24	0 b	0 c	0 c	88	50 a	0.56 a	320	880 ab	**2.75 ab**
Sunn hemp	24	0 b	0 c	0 c	88	10 a	0.11 a	320	1140 a	**3.56 a**
	$P < 0.0001$				$P = 0.099$			$P = 0.0008$		

REFERENCES

Bridge J (1987). Control strategies in subsistence agriculture. pp 389-420 In: RH Brown and BR Kerry (Eds). *Principles and Practice of Nematode Control in Crops*. Academic Press, Sydney, Australia.

Dunn RA (2002). Organic matter, green manures and cover crops for nematode management. University of Florida, Institute of Food and Agricultural Services, (www.ifas.ufl.edu/).

Fortnum BA, Lewis SA and Johnson AW (2001). Crop rotation and nematicides for management of mixed populations of *Meloidogyne* spp. on tobacco. *J Nematol* 33(4S): 318-324.

Garside AL, Smith MA, Chapman LS, Hurney AP and Magarey RC (1997). The yield plateau in the Australian sugar industry: 1970-1990. pp 103-124 In: BA Keating and JR Wilson (Eds). *Intensive Sugarcane Production: Meeting the Challenges Beyond 2000*. CAB International, Wallingford, UK.

McSorley R and Dickson DW (1995). Effect of tropical rotation crops on *Meloidogyne incognita* and other plant-parasitic nematodes. *J Nematol* 27(4S): 535-544.

McSorley R (1999). Host suitability of potential cover crops for root-knot nematodes. *J Nematol* 31(4S): 619-623.

Minton NA and Baujard P (1990). Nematode parasites of peanuts. pp 285-320 In: M Luc, RA Sikora and J Bridge (Eds). *Plant Parasitic Nematodes in Subtropical and Tropical Agriculture*. CAB International, Wallingford, UK.

Moody PW, Bramley RGV, Skjemstad JO, Garside AL and Bell AL (1999). The effects of fallow and break crops on the quantity and quality of soil organic matter in cane soils. *Proc Aust Soc Sug Cane Technol* 21: 87-91.

Pankhurst CE, Magarey RC, Stirling GR, Holt GA and Brown JD (1999). Rotation-induced changes in soil biological properties and their effect on yield decline in sugarcane. *Proc Aust Soc Sug Cane Technol* 21: 79-86.

Ploeg AT (1999). Greenhouse studies on the effect of marigolds (*Tagetes* spp.) on four *Meloidogyne* species. *J Nematol* 31(1): 62-69.

Sasser JN (1979). Economic importance of *Meloidogyne* in tropical countries. pp 256-268 In: F Lamberti and CE Taylor (Eds). *Root-knot Nematodes (Meloidogyne species): Systematics, Biology and Control.* Academic Press, London, UK.

Spaull VW (1981). Nematodes associated with sugarcane in South Africa. *Phytophyl* 13: 175-179.

Spaull VW and Cadet P (1990). Nematode parasites of sugarcane. pp 461-491 In: M Luc, RA Sikora and J Bridge (Eds). *Plant Parasitic Nematodes in Subtropical and Tropical Agriculture*. CAB International, Wallingford, UK.

van Biljon ER and Meyer AJ (2000). Reproduction of *Pratylenchus zeae* and *P. delattrei* on crops resistant to *Meloidogyne javanica* and *M. incognita* races 2 and 4. *Afr Pl Prot* 6: 43-45.