The effects of biofumigants on the survival of *Meloidogyne javanica* in field soil

PW17001 Final report Appendix 14 Integrated pest management of nematodes in sweetpotato

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The Department of Agriculture and Fisheries proudly acknowledges all First Nations peoples (Aboriginal peoples and Torres Strait Islanders) and the Traditional Owners and Custodians of the country on which we live and work. We acknowledge their continuing connection to land, waters and culture and commit to ongoing reconciliation. We pay our respect to their Elders past, present and emerging.

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Summary

Meloidogyne javanica, a root-knot nematode (RKN), poses a significant challenge to the Australian sweetpotato industry, causing considerable yield losses and economic hardships for growers. Conventional control methods like chemical nematicides, while effective, raise environmental concerns, prompting the search for sustainable alternatives like biofumigants. Biofumigation, involving brassica plants rich in glucosinolates, has emerged as a potential control strategy utilising the pesticidal and nematicidal properties of glucosinolate derivatives. This study aims to assess the impact of biofumigants on nematode survival in a highly controlled setting, informing future investigations.

Red ferrosol soil from the Redlands Research Station, Brisbane, was treated with ground vegetative matter of brassica cultivars Caliente (Indian mustard), Nemat (Rocket), Terranova radish (Radish) and Capppucchino (Ethiopian mustard). Treatments were mixed in calculated amounts based on pot volume and average dry weight in a field environment before incorporation. A ground oats treatment was added to the experiment to simulate organic matter treatment without a biofumigation effect, and a Nil control without the addition of vegetative matter was included. Pots were then inoculated with live juvenile RKN and the soil surface left sealed or unsealed for 72 hours after which live nematodes were extracted over four days.

Indian Mustard (cv. Caliente) showed significant potential in reducing RKN numbers. Further trials, especially in pot and field settings, are recommended to confirm the practical application of biofumigants in nematode management.

Outcomes

While further analysis is required, results of this small study indicate that Indian Mustard has the potential to reduced RKN numbers significantly. Other brassica treatments may also have a similar if lesser affect when the vegetative matter is well sealed in the soil. Progress to pot and/or field trials are recommended to determine the feasibility and practical application of this process.

Introduction

The management of soil-borne pathogens and pests remains a critical challenge to the Australian sweetpotato industry. Among these, a root-knot nematode (RKN) species (*Meloidogyne javanica*) stands out as a formidable adversary, inflicting substantial yield losses with negative economic implications for sweetpotato growers. Traditional control methods, such as chemical nematicides, have shown efficacy, but concerns about environmental impact, residue buildup, development of nematode resistance and biodegradation have prompted a search for sustainable alternatives. This pursuit has led to the exploration of biofumigants, a group of naturally occurring compounds with soil-borne pest and pathogen suppressive properties.

Biofumigation involves the incorporation of brassica plants, particularly members of the mustard family (*Brassicaceae*), into soil. These plants contain glucosinolates, sulphur-containing compounds, which, when hydrolysed by enzymes upon tissue disruption, release isothiocyanates and other volatile compounds with proven pesticidal and nematicidal properties. The ability of biofumigants to suppress soil-borne pests and pathogens, including nematodes, shows promise as a potential alternative for conventional nematicides.

This small study aims to evaluate the impact of biofumigants on nematode survival in a tightly controlled environment, to ascertain the efficacy of certain biofumigants for further expanded study.

Methodology

Red ferrosol soil was collected from a stockpile located at Redland Research Station in Brisbane, sieved to approximately 5 mm, and mixed to ensure a homogeneous soil. 200 g was oven dried at 70°C to determine moisture content (18.25%). A subsample was processed for nematode extraction. No RKN was detected, although very low numbers of other plant parasites were present.

Cultures of *Meloidogyne javanica* maintained in a glasshouse on tomato (cv. Tiny Tim) and eggs were obtained for use as inoculum by soaking roots in NaOCl (0.5% available chlorine) for five minutes, retrieving eggs on a 38 µm sieve by washing thoroughly with water. Eggs were placed in a hatching tray for three days, then juvenile RKN numbers were quantified. Inoculum density was quantified to 2420 juveniles per ml. Low numbers of nematode eggs were also present.

Soil (2400 ml) was placed into multiple large ziplock bags (Figures 1 and 2). This was sufficient soil for five replicates of each biofumigant, and a sealed and non-sealed treatment to replicate recommended vs non-recommend post incorporation practice. No organic matter was added to the Nil control treatments.

Image 1 Left, ground vegetative matter. Right, ground vegetative matter mixed with soil.

Dried, ground vegetative matter was mixed in each bag in the following amounts, calculated on volume of the pot, and average dry weight in a field environment prior to incorporation (Table 1). Oats weights were calculated just prior to seed head development.

Table 1 Weight of biofumigants added, related to average dry weight in a field environment.

Treatment	10 cm pot (g/pot)	Volume of soil (ml)	Biofumigant needed (g)	Average dry weight (t/ha)
Caliente (Indian mustard,	2.06	2400	24.69	12.4
Nemat (*Eruca sativa*)	1.73	2400	20.70	10.4
Terranova radish (*Raphanus*	1.48	2400	17.78	8.93
Cappucchino (Ethiopian mustard,	3.03	2400	36.37	18.27
Oats (*Avena sativa*)	2.2	2400	26.40	13.3
Nil	0	0	0	0

The biofumigants and organic matter were mixed thoroughly in the bags, then 200 ml of each mix was transferred into 250 ml screw-top containers (Figure 3). In the sealed treatments, the soil was lightly compressed. Conical holes were made in the soil at varied depths (Figure 4), a total of one millilitre (2420 RKN juveniles) of the nematode inoculum was added, and the holes were lightly covered by scratching over adjacent soil. The sealed treatments were misted with three sprays of water and the lids loosely placed on top of the containers. The unsealed treatments were not sprayed, and the lids were loosely placed on top of the containers (Figure 5). The experiment was incubated at room temperature (22°C – 24°C) for 72 hrs. After incubation, all soil was individually removed from each container and extracted over four days using a Whitehead tray (Whitehead AG *et al.,* 1965) - a modified Baermann funnel technique - after which the solution was poured over a 38 µm sieve. Root-knot nematodes and free-living nematodes (FLN) were quantified.

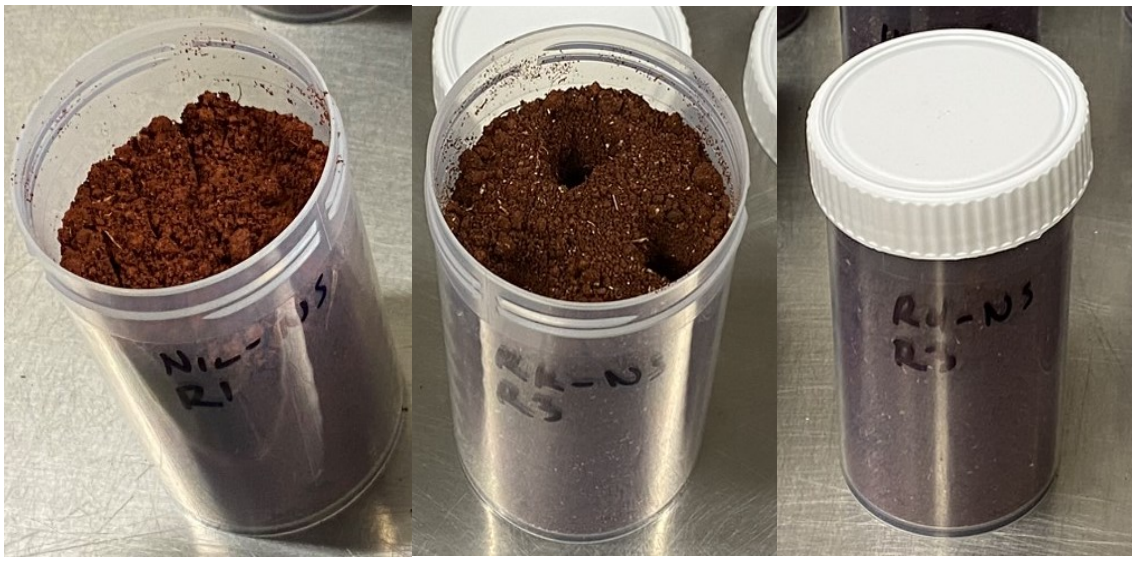

Image 2 Left, 200 ml of soil. Centre, Nematode inoculation. Right, Incubation.

Results

Table 2 Total root-knot and free-living nematodes recovered after treatments applied for 72 hours.

Sealed Treatments		Total RKN	Total FLN
Ethiopian mustard	R1	1250	673
	R2	1080	565
	R3	910	750
	R4	675	655
	R5	1085	770
Indian mustard	R1	48	68
	R2	90	78
	R3	34	36
	R4	51	49
	R5	52	39
Radish	R1	557	6620
	R2	477	9140
	R3	320	5420
	R4	687	7740
	R5	464	5020
Rocket	R1	858	515
	R2	850	353
	R3	484	545
	R4	825	650
	R5	660	408
Oats	R1	1030	640
	R2	1080	536
	R3	1165	610
	R4	1290	720
	R5	935	640
Nil	R1	1020	363
	R2	780	397
	R3	1140	780
	R4	775	404
	R5	1210	484

Not Sealed		Total RKN	Total FLN
Ethiopian mustard	R1	1480	452
	R2	805	530
	R3	535	350
	R4	428	565
	R5	81	440
Indian mustard	R1	43	97
	R2	169	155
	R3	202	169
	R4	83	78
	R5	77	121
Radish	R1	1480	8000
	R2	1470	5520
	R3	1440	6160
	R4	1180	6720
	R5	1020	7520
Rocket	R1	1170	363
	R2	1110	512
	R3	1180	505
	R4	1190	224
	R5	1310	510
Oats	R1	1070	900
	R2	1350	960
	R3	1300	690
	R4	973	833
	R5	1070	990
Nil	R1	1230	1240
	R2	1280	730
	R3	1200	1100
	R4	1055	570
	R5	940	640

Preliminary analysis suggests that Indian Mustard (cv. Caliente) has a significant effect on the reduction of both RKN and total FLN numbers in both the sealed and non-sealed treatments. Very low numbers were observed in all Indian Mustard treatments. Radish and rocket sealed treatments, while not as effective, showed some effect (Figure 1).

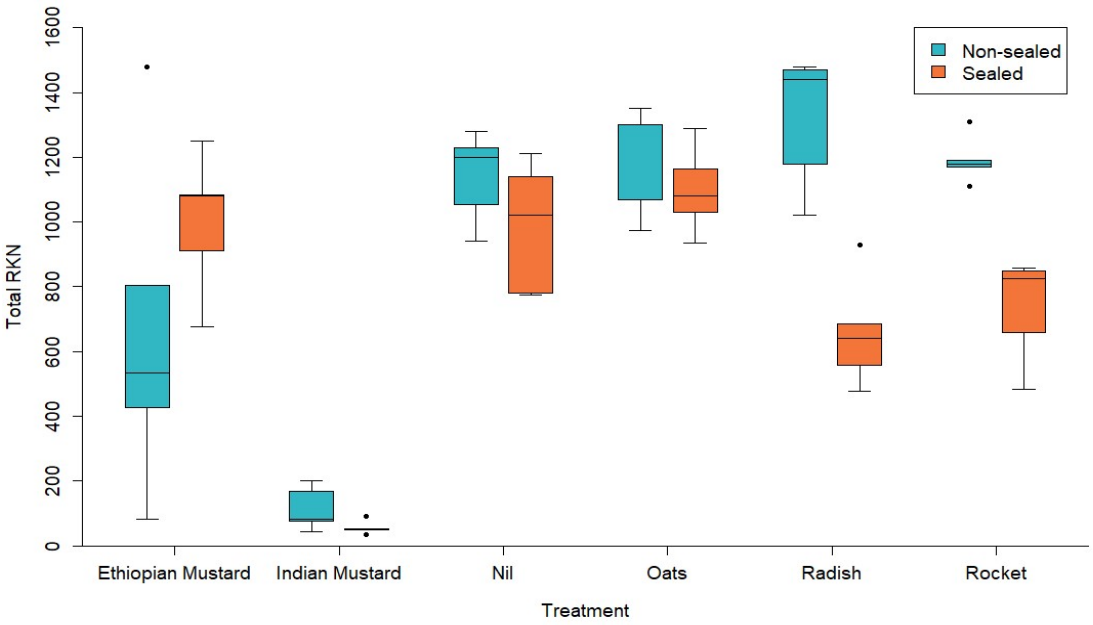

Figure 1 Total root-knot nematodes recovered after treatments applied for 72 hours.

All treatments had low numbers of total FLN, except for both radish treatments, in which total FLN numbers were elevated. While not segregated into trophic groups, the majority appeared to be bacterivores. The reason for this is unknown (Figure 7).

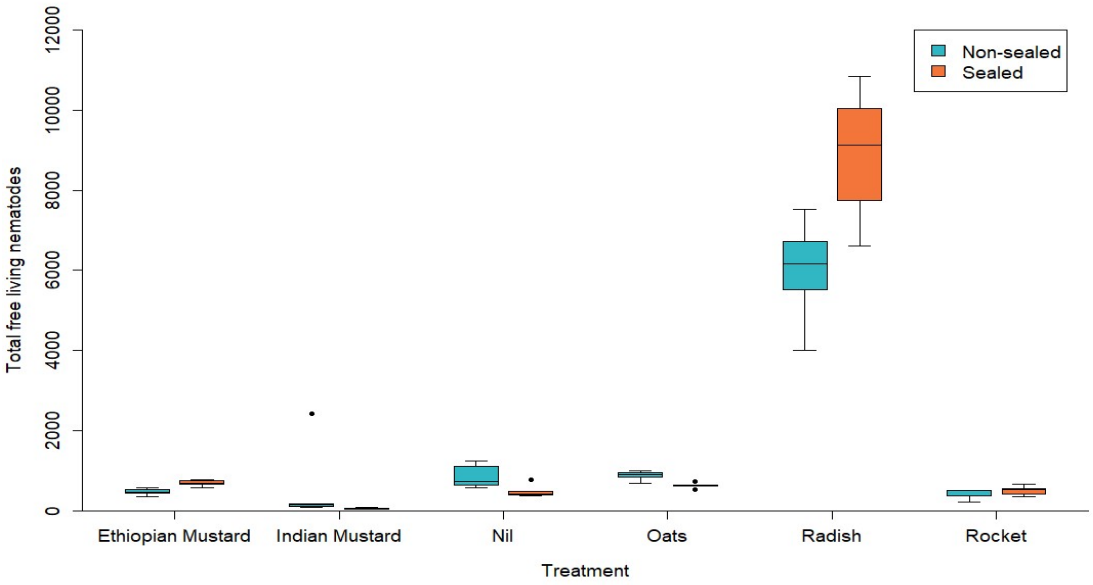

Figure 2 Total free-living nematodes recovered after treatments applied for 72 hours.

Conclusion

While further analysis is required, results of this small study indicate that Indian Mustard has the potential to reduced RKN numbers significantly. Other brassica treatments may also have a similar if lesser affect when the vegetative matter is well sealed in the soil. Progress to pot and/or field trials are recommended to determine the feasibility and practical application of this process.