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Control of Nematode pests of Okra (*Abelmoschus esculentus* L. Moench) using two plant materials and carbofuran

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Abstract

Screen house and field experiments were conducted at the University of Ilorin to investigate the comparative effects of amending the soil with air-dried leaves of brimstone (Morinda lucida) and basil (Ocimum gratissimum) and treating the soil with carbofuran (furadan) on the nematode pests, growth and yield of okra (Abelmoschus esculentus). The plant amendments were used at the rates of 0.5, 1.0 and 1.5 t/ha while carbofuran was applied at the rate of 1.5 kg a.i/ha. The results that were obtained from the field experiment showed that the effects of 1.0 and 1.5 t/ha of M. lucida and 1.5 t/ha of O. gratissimum did not differ significantly from that of 1.5 kg a.i/ha of carbofuran. In the screenhouse, there was no significant difference in the effects of all the rates of the test plant leaves and carbofuran. In both the screenhouse and field experiments, all the treatments (with the exception of 0.5 t/ha of basil in the field experiment) significantly improved ($p \leq 0.05$) the growth (plant height, number of leaves and branches and shoot weight) and yield (number and weight of fruits) of okra and significantly reduced ($p \leq 0.05$) soil and root nematode populations when compared with the untreated control. This study shows that amending plant–parasitic nematode-infested soils with air-dried leaves of brimstone and basil at the rates of 0.5, 1.0, and 1.5 t/ha; and 1.0 and 1.5 t/ha respectively will control the nematodes and improve the growth and yield of okra on such soils.

Introduction

Okra, *Abelmoschus esculentus* L. (Moench) is of a major economic importance for millions of people in Nigeria where the pods are used for thickening and flavouring stews and soups because of the high mucilaginous content. Okra is a rich source of many nutrients including vitamins C and B_6, folic acid and fibre (Zook, 2006).

The superior fibre found in okra helps to stabilize blood sugar as it curbs the rate at which sugar is absorbed from the intestinal tract. The fibre also absorbs water and ensures bulk in stool thereby preventing and improving constipation. The mucilage does not only bind cholesterol but also binds bile acid carrying toxin dumped into it by the filtering liver. The stem and mature pods produce a fibre which is used in making paper textile (Kuchare and Hotchmuth, 2003).

The yield of okra is low in Nigeria partly as a result of attack from pests and pathogens including plant–parasitic nematodes. There is need for control using plant materials which are generally safe for the environment and humans (Chitwood, 2002).

This study was therefore embarked on to study the effects (in comparison to that of a standard synthetic nematicide carbofuran) of two plant materials, *Ocimum gratissimum* and brimstone, *Morinda lucida* used as soil amendments in the control of nematodes pests of okra and consequent effects on growth and yield of treated okra.

Materials and Methods

Screenhouse experiment

Sandy loam soil was steam pasteurized using the method described by Gautam and Goswami (2002) and thereafter allowed to cool. Forty 10-litre size experimental pots were each filled with 10kg of the pasteurized soil and arranged on stands in the screen house. The treatment materials comprised ground air-dried leaves of basil and brimstone and carbofuran (furadan) 3G. The treatments were applied separately to the soil at the rates equivalent to 0.5t, 1.0t and 1.5t of each of basil and brimstone while carbofuran was applied at the rate equivalent to 1.5 kg a.i/ha. A set of five pots were left untreated which served as the control. Three seeds of okra variety Clemson spineless were sown into each pot. A week after planting, the seedlings were thinned leaving the most vigorous plant per pot. 1000 freshly extracted (Southey, 1986) root-knot nematode juveniles were introduced into the soil at the base of each seedling after thinning.

Field experiment

A piece of land with known record of nematode infestation measuring approximately 2,000m^2 on the Teaching and Research Farm of the University of Ilorin at Bolorunduro, was ploughed, harrowed and ridged.

The land was divided into four (4) blocks and 32 plots with alleys measuring 1m and 0.5m separating two blocks and two plots respectively. The treatments which comprised 0.5t, 1.0t and 1.5t/ha of each of ground air-dried leaves of basil and brimstone and 1.5 kg a.i/ha of carbofuran were separately incorporated into the soil while there was an untreated control. The design of the experiment was a randomized complete block of eight treatments replicated four times. Seeds of okra variety Clemson spineless were sown at a spacing of 60 cm on the ridges at the rate of 3 seeds/hole.

Data collection

Data collection in both the screenhouse and field experiments commenced at two weeks after planting on plant height and number of leaves/plant at weekly intervals, number of branches/plant, days to 50% flowering, shoot weight, fruit number, fruit weight, root gall index using a scale of 0-5 described by Taylor and Sasser (1978), nematode populations in the soil and okra roots at harvest using the method described by Southey (1986). Data were subjected to ANOVA and where appropriate the means were separated using Duncan's Multiple Range Test.

Results and Discussion

In the screen house, all the treated plants were significantly taller than the control though at 2 WAP (Weeks after planting) okra plants that were sown in the soil treated with 0.5 t each of basil and brimstone did not differ significantly from the control (Table 1). There was no significant difference in the number of leaves among the treatments at 2 WAP but as from 3 WAP to 6 WAP treated plants had significantly ($p<0.05$) higher number of leaves than the control plants. In most cases the effects of basil and brimstone used as soil amendments particularly at the higher doses did not differ significantly from that of the carbofuran treatment.

There was no significance difference in the number of branches/plant. Dry shoot weight, number of fruits and weight of fruits were significantly improved by all the treatments when compared with the control (Table 2). The treatments significantly reduced the root gall index, root and soil nematode population as compared with the untreated control.

Table 3 shows that treatment with 1.0 and 1.5 t/ha of brimstone and 1.5 t/ha of basil did not significantly differ from treatments with 1.5 kg a.i/ha of carbofuran in most cases.

Plant height and number of leaves/plant were significantly improved by the two higher doses of the test plant as compared with the control while the lowest concentration of basil did not differ from the control in most cases.

The number of branches was significantly improved by the higher doses of the test materials and carbofuran when compared with the control while there was no significant difference in the number of days to 50% flowering (Table 4). Dry shoot weight, number and weight of fruits were significantly higher in all the treated plants (except in plants treated with 0.5 t/ha and of basil) than in the control while plants treated with 1.5 t/ha of basil and 1.0 t and 1.5 t/ha of brimstone did not differ from those treated with carbofuran. The treatments except 0.5 t/ha of basil significantly reduced root gall index and nematode populations in the root and soil.

The observed nematicidal effect of the plants materials and consequent improvement in okra growth and yield might be due to the presence tannins, methy anthraquinones and heterosides (Oliver-Bever, 1986; Patience, 2006) in brimstone and essential oils such as eugenol and thymol which possess antibacterial and antiprotozoa properties in basil (Sofowora, 1970). Adeyemo and Oyedunmade (2006) and Olabiyi *et al.* (2008) reported the presence of flavonoids and saponnis in brimstone and basil leaves. Since the deductions from the study emphasize the efficacy of plant materials (especially basil and brimstone) as being toxic to plant parasitic nematodes, optimum rates of 0.5 – 1.5kg/ha of brimstone and 1.0 – 1.5kg/ha of basil are therefore suggested for application in nematode infested fields in order to avoid the attendant problems associated with synthetic nematicides.

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Table 1: Effects of treatments on mean plant height and number of leaves of *nematode-infected* okra in the screenhouse

Treatment	Rate	Plant height (cm)					Number of leaves / plant				
		2WAP*	3WAP	4WAP	5WAP	6WAP	2WAP	3WAP	4WAP	5WAP	6WAP
Ocimum	0.5t/ha	5.2^{ab}	8.1^{ab}	14.7^{bc}	20.5^{b}	27.6^{ab}	4.4	7.4^{abc}	12.4^{a}	15.4^{b}	15.4^{b}
gratissimu	1.0 t/ha	5.8^{a}	8.2^{ab}	15.0^{b}	22.3^{ab}	28.5^{ab}	4.9	8.6^{a}	12.5^{a}	15.7^{ab}	16.0^{ab}
m	1.5 t/ha	5.8^{a}	10.3^{a}	17.3^{ab}	24.0^{ab}	29.4^{ab}	5.3	8.5^{ab}	12.0^{a}	15.6^{ab}	16.0^{ab}
Morinda	0.5 t/ha	5.6^{ab}	7.9^{b}	17.1^{b}	22.1^{b}	25.4^{ab}	4.4	8.6^{a}	12.5^{a}	16.0^{ab}	16.5^{ab}
lucida	1.0 t/ha	6.2^{a}	9.1^{a}	17.4^{ab}	24.1^{ab}	27.6^{ab}	4.4	8.8^{a}	13.4^{a}	17.0^{ab}	17.1^{a}
	1.5 t/ha	7.0^{a}	10.4^{a}	20.9^{a}	25.2^{ab}	29.4^{ab}	4.9	9.4^{a}	14.8^{a}	17.3^{ab}	17.5^{a}
Furadan	1.5 kg a.i/ha	6.6^{a}	10.5^{a}	22.6^{a}	30.1^{a}	34.0^{a}	5.9	10.1^{a}	14.6^{a}	18.0^{a}	19.0^{a}
Control	0 t/ha 0 kg a.i/ha	4.0^{b}	6.1^{c}	12.8^{c}	16.7^{c}	20.1^{c}	4.3	5.6^{c}	8.4^{b}	10.4^{c}	10.4^{c}
	SE	0.31	0.64	1.75	2.34	2.38	N.S	0.63	0.86	0.69	0.67

Means in the same column followed by different letters are significantly different at $P \leq 0.05$ according to Duncan's Multiple Range Test.

*NS = Not significant

WAP = Weeks After Planting

Table 2: Effects of treatments on mean number of branches, days to 50% flowering, shoot weight, number of fruits, weight of fruits, root gall, index and nematodes population in the soil and root of nematode-infected okra in the screenhouse.

Treatment	Rate	Number of branches/plant	Days to 50% flowering	Dry shoot weight (g)	Number of fruits	Weight of fruit (g)	Root gall index	Root nematode population	Soil nematode population
Neem	0.5 vbo	2.0a	54.0a	13.5a	2.8a	160a	2.1a	8.7a	30.5a
[illegible]	1.0 vbo	2.5a	51.3a	15.5a	3.5a	139ab	1.5a	8.3a	22.1a
	1.5 vbo	2.5a	48.2a	18.5a	3.5a	203a	1.0a	6.9a	20.1a
Neem/ash	0.5 vbo	2.1a	51.3a	15.9a	3.6a	125ab	1.7a	7.9a	18.5a
Neem/	1.0 vbo	3.0a	50.7a	17.0a	3.9a	201a	1.3a	5.1a	20.8a
	1.5 vbo	3.2a	50.1a	18.7a	4.4a	240a	1.0a	4.8a	15.5a
Carbofuran	1.5 kg a.i/ha	3.5a	45.6a	24.0a	4.4a	261a	0.8a	2.4a	12.6a
Control	0 vbo	0.5a	55.1a	9.6a	1.9a	82a	4.4a	25.9a	196.9a
	0 kg a.i/ha								
	SE	0.11	3.51	0.79	0.18	1.73	0.85	0.38	5.71

Means in the same column followed by different letters are significantly different at P ≤ 0.05 according to Ducan's Multiple Range Test.

Table 3: Effects of treatments on mean plant height and number of leaves of nematode - infected okra on the field.

Treatment	Rate	Plant height (cm)					Number of leaves / plant				
		2WAP*	3WAP	4WAP	5WAP	6WAP	2WAP	3WAP	4WAP	5WAP	6WAP
Ocimum gratissimum	0.5t/ha	7.7^{ab}	12.1^{d}	18.0^{c}	25.1^{c}	26.8^{c}	5.6	12.1^{cd}	17.5^{cd}	21.5^{cd}	22.8^{c}
	1.0 t/ha	8.9^{a}	14.8^{cd}	23.1^{c}	30.7^{b}	32.5^{b}	6.2	15.5^{b}	23.4^{b}	26.7	28.2^{b}
	1.5 t/ha	9.1^{a}	20.3^{ab}	29.6^{ab}	38.2^{a}	39.7^{a}	6.8	21.8^{a}	25.5^{ab}	34.6^{ab}	35.9^{ab}
Morinda Lucida	0.5 t/ha	8.6^{a}	16.5^{bc}	26.6^{bc}	32.8^{b}	33.1^{b}	6.9	13.6^{bc}	20.5^{bc}	24.6^{c}	28.1^{b}
	1.0 t/ha	10.7^{a}	20.3^{ab}	31.5^{a}	36.5^{ab}	38.5^{a}	7.5	19.2^{ab}	25.7^{a}	30.3^{b}	34.5^{ab}
	1.5 t/ha	11.5^{a}	21.7^{a}	33.3^{a}	39.2^{a}	39.6^{a}	7.1	22.5^{a}	27.6^{a}	33.8^{a}	38.2^{a}
Furadan	1.5 kg a.i/ha	11.8^{a}	24.2^{a}	34.6^{a}	40.4^{a}	41.0^{a}	7.9	25.7^{a}	30.2^{a}	35.3^{a}	39.5^{a}
Control	0 t/ha 0 kg a.i/ha	5.1^{b}	11.1^{d}	15.9^{d}	20.0^{d}	20.5^{d}	4.2	11.4^{d}	15.3^{d}	20.1^{d}	20.1^{c}
	SE	2.61	4.12	5.20	3.91	5.67	*NS	2.12	5.26	6.10	4.59

Means in the same column followed by different letters are significantly different at $P \leq 0.05$ according to Duncan's Multiple Range Test.

* NS = Not significant

* WAP = Weeks After Planting

Table 4: Effects of treatments on mean number of branches, days to 50% flowering, shoot weight and number of fruits, weight of fruits, root gall, index and nematodes population in the soil and root of nematode-infected okra on the field

Treatment	Rate	Number of branches/ plant	Days to 50% flowering	Dry shoot weight (g)	Number of fruits	Weight of fruits (g)	Root gall index	Root nematode population	Soil nematode population
Ocimum gratissimum	0.5t/ha	1.9^{ab}	56.0	22.5^{bc}	6.0^{bc}	43.1^{d}	2.8^{ab}	12.9^{bc}	70.5^{bc}
	1.0 t/ha	3.1^{ab}	53.3	22.6^{bc}	6.8^{b}	46.3^{cd}	2.2^{a}	7.0^{ab}	21.0^{a}
	1.5 t/ha	3.7^{a}	53.5	26.1^{a}	7.5^{a}	56.7^{ab}	2.0^{a}	5.5^{a}	18.5^{a}
Morinda Lucida	0.5 t/ha	2.9^{ab}	53.8	23.9^{b}	7.0^{b}	50.5^{bc}	2.2^{a}	8.7^{b}	23.5^{a}
	1.0 t/ha	3.5^{a}	54.8	26.2^{a}	7.2^{ab}	57.1^{ab}	2.2^{a}	6.1^{a}	16.8^{a}
	1.5 t/ha	3.7^{a}	53.2	27.4^{a}	8.0^{a}	59.1^{a}	1.5^{a}	4.2^{a}	10.5^{a}
Furadan	1.5 kg a.i/ha	4.5^{a}	51.8	30.2^{a}	8.8^{a}	64.7^{a}	1.2^{a}	3.7^{a}	10.1^{a}
Control	0 t/ha 0 kg a.i/ha	1.7^{b}	55.7	20.6^{c}	5.3^{c}	40.9^{d}	3.3^{b}	15.8^{c}	108.5^{c}
	SE	0.34	*NS	1.37	0.09	3.51	0.08	2.01	18.01

Means in the same column followed by different letters are significantly different at $P \leq 0.05$ according to Duncan's Multiple Range Test.

*NS = Not significant

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