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Short communication

COMPARATIVE PERFORMANCES OF CARBOFURAN AND PLANT EXTRACTS IN THE CONTROL OF ROOT-KNOT NEMATODE ON PEPPER

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ABSTRACT: A field trial was carried out to compare the effectiveness of carbofuran and plant extracts from the roots of rattle weed and nitta plants in root-knot nematode control. Carbofuran was applied at 1.5 and 2.5 kg a.i/ha while plant extracts were applied at 25, 50, 75, and 100% concentrations. An experimental plot where neither carbofuran nor plant extracts was applied served as the control treatment. Both carbofuran and plant extracts significantly reduced the soil population of root-knot nematode and galling on the root of pepper, and also improved growth and yield of pepper. Pepper plants treated with carbofuran and 100% concentration of the plant extracts gave the best control of the root-knot nematode.

Key words/phrases: Carbofuran, control, rattle and nitta plants, root-knot nematode

INTRODUCTION

Pepper, *Capsicum annuum*, is an important crop of high economic and nutritional importance in Nigeria. Erinle (1989) reported that Nigeria is the largest producer of pepper in Africa (50% production) and was rated second in the world in 1979 (Yamaguchi, 1982). It is an important soup ingredient that supplies essential nutrients that may not be present in staple food items.

Root-knot nematodes, *Meloidogyne* species have been identified as economic pathogens of vegetables (Waliullah, 1992; Yousef and S'Jacob, 1994; Olabiyi and Ndana, 2003; Olabiyi, 2004). Root-knot nematodes are recognised on plants by the presence of galls on the plant roots. Above ground symptoms include stunting, chlorosis, wilting and early senescence (Richard and Nicola, 1990).

Between 1999 and 2003, severe root-knot nematode infections, which caused complete crop (100%) loss on some pepper plants, were observed in the Horticultural garden of the Osun State College of Education, Ila-Orangun, Nigeria. As a result of the field root-knot nematode population reaching an epidemic level, an attempt was made to control the root-knot nematode disease on pepper in 2004.

In the time past, chemical nematicides (carbofuran, vertimec, vydate oxamy, ethoprop, cadusafos, fenamiphos and aldicard) had been in use by numerous farmers. Restriction on the importation of chemical through the international market made chemical nematicide to be scarce and expensive, even beyond the reach of poor resource farmers in Nigeria. Moreover, the hazard effects of chemical nematicide on both target and non-target organisms, and also on the environment (as pollutant) had brought much discouragement to many Nigerian farmers.

Several investigators (Pandey, 1990; Abid and Maqbool, 1991; D' Abbaddo and Sasanelli, 1999; Olabiyi and Ndana, 2003; Olabiyi, 2004) have carried out studies on the use of plant materials as alternative control measure against plant parasitic nematodes.

In Nigeria, efforts are being geared toward the search for plant materials that could be used in the control of root-knot nematode pathogenic organism on the economic food crops. In this present study, attempts were made to compare the performances of carbofuran with that of extracts from the roots of rattle weed and nitta plants in the control of root-knot nematode disease on pepper.

MATERIALS AND METHODS

A field experiment was carried out during the 2004-cropping season at the Horticultural garden of the Osun state College of Education, Ila-Orangun, Nigeria. The experimental site soil type was sand-loam (55% sand, 16% clay and 29% silt) with pH 5.8. Two levels (1.5 and 2.5 kg a.i/ha) of carbofuran (Furadan (R) 5G and four concentrations (25, 50, 75, and 100%) each of aqueous and methanol extracts of rattle weed and nitta root were tested for the control of root-knot nematode, *Meloidogne incognita,* on pepper, *Capsicum annuum*. An experimental plot where

neither carbofuran nor plant extracts (0% treatment concentration) was applied served as control. The experiment was laid out as a randomized complete block design. There were 4 blocks with 1 m alleyway left in-between the blocks. Each block was sub-divided into 35 treatment plots with each plot having a size of 5 m (length) by 1 m (breath) and alleyway of 0.5 m in-between one plot and the other. Each treatment was replicated 4 times.

Pre-planting soil samples (zigzag form) were taken and assessed for nematode occurrence and abundance following the Southey (1986). Pepper seeds (cv.DT95/422) were bought from National Horticultural Research Institute (NIHORT), Ibadan, Nigeria. Five hundred pepper seedlings were raised in the nursery and transplanted at four weeks old at a spacing of 60 cm by 60 cm apart. The synthetic nematicide, carbofuran and plant extracts were applied close to pepper roots, 1 cm away from plant base and 5 cm into the soil, at 2 weeks after transplanting. Fertilizer N:P:K (15:15:15) was applied at the rate of 5 g per plant at 3 weeks after transplanting. Manual weeding was done at 4-week intervals during the period of the field experiment.

Plant heights, number of leaves per plant, number of fruits per plant and fruit weight per plant were recorded. Post-harvest soil samples (zigzag form) were taken for nematode population assessment. Root gall indices were scored as used by Sasser *et al.* (1984) on a scale of 0-5, where 0 = no galls; 1 = 1%-2% galls; 2 = 3%-10% galls; 4 = 31%-100% galls and 5 = more than 100% galls. All data were subjected to analysis of variance and means were partitioned using Tukey-Kramer's highest significant difference at the 5% probability level (SAS, 1997 statistical package).

RESULTS AND DISSUSSION

The effects of different treatments of carbofuran and plant extracts on the plant height of pepper are presented in Table 1. It was observed that plant height at 10 weeks after transplanting (WAT) did not vary significantly ($P<0.05$) among the treatments. Pepper plants treated with 100% concentrations of the test plants and carbofuran (1.5 and 2.5 kg a.i/ha) grew significant taller at 12 WAT and 14 WAT than pepper plants treated with lower test plant extract concentrations and the control experiment.

Comparative effects of carbofuran and plant extracts on the average number of leaves of pepper infected with *M. incognita* are presented in Table 1. No significant differences between the number of leaves on pepper plants occurred at 10 WAT. However, significant differences became prominent on number of leaves at 12 and 14 WAT. It was observed that the number of leaves of pepper plants at either 12 WAT or 14 WAT were significantly higher in pepper plants treated with either carbofuran or 100% concentration of the plant extracts than in pepper plants treated with lower test plant extract concentration. The control treatment had the least number of leaves per pepper plant.

These findings are in agreement with investigations of Abid and Maqbool (1991) and Oyedunmade *et al.* (2001). These authors reported that carbofuran and plant extracts significantly increased vegetative growth (plant height and number of leaves per plant) of tomato, egg plant, okra and soyabeans.

Number of fruit and fruit weight per plant were significantly higher in pepper plants that were treated with carbofuran than other treatments (Table 2). It was observed that the 100% plant extracts in most cases resulted in higher number of fruit and fruit weight per plant than pepper plants treated with lower test plant extract concentrations. Pepper plants that did not receive any treatment had the least number of fruit and lowest fruit weight amongst all the treatments. Oyedunmade *et al*. (2001) reported that 100% neem leaf extract and carbofuran, singly and in combination, significantly increased number of fruits and fruit weight per okra plant.

Table 2 also shows that carbofuran and 100% concentration of the plant extracts significantly reduced the soil root-knot nematode population and consequently root galls as compared with lower plant extracts and the control. Olabiyi (2004) reported that the roots of rattle weed and nitta plants contained saponins which are nematoxic. In an *in vitro* experiment carried out with the use of saponins on eggs and juveniles of root-knot nematode, it was shown that saponins were inhibitory to root knot nematodes (Olabiyi, 2004). Oyedunmade *et al.* (2001) reported a significant reduction in root gall index and soil root knot nematode population as a result of a Vertimec (R) and plant material applied to root knot nematode infested soil grown with soyabean.

It could be concluded from this study that roots of rattle weed and nitta appear to hold promise as nematicidal plants and their effectiveness on the control of root-knot nematode at 100% concentration are at par with carbofuran.

Table 1. Comparative effects of carbofuran and plant extracts on the mean plant height (cm) and number of leaves of pepper infected with *Meloidogyne incognita* at 10,12, 14 weeks after transplanting (WAT).

Treatment	Concentrations (%)	Mean plant height (cm)			Mean number of leaves		
		10 WAT	12 WAT	14 WAT	10 WAT	12 WAT	14 WAT
Aqueous extract of rattle weed leaf	25	5.3	7.3b	10.0c	5.5	9.5 bc	15.8 c
	50	5.5	7.5b	10.7c	6.8	11.0b	17.3c
	75	5.5	8.4b	12.7c	6.3	11.3b	18.5c
	100	5.6	10.6a	7.2a	7.3	13.3a	23.3b
Methanol extract of rattle weed leaf	25	5.2	7.3b	10.1c	5.3	0.0c	15.0c
	50	5.3	7.7b	10.7c	6.0	11.5b	17.5c
	75	5.5	8.3b	12.5c	6.8	12.8b	19.3bc
	100	5.6	10.7a	18.0a	7.8	14.8a	22.3b
Aqueous extract of rattle weed root	25	5.3	7.2b	10.1c	5.5	10.0c	14.3c
	50	5.4	7.9b	10.6c	6.0	12.0b	17.8c
	75	5.3	10.4b	12.5c	7.0	13.3a	19.8bc
	100	5.8	17.4a	18.2a	7.8	14.5a	22.8b
Methanol extract of rattle weed root	25	5.3	7.2b	10.1c	5.3	10.3c	15.8c
	50	5.5	7.7b	11.4c	5.5	11.5b	17.5c
	75	5.5	9.4b	12.2c	5.8	11.8b	18.5c
	100	5.6	10.6a	18.2a	6.8	13.0a	23.5b
Aqueous extract of nitta leaf	25	5.3	7.2b	10.3c	6.0	8.9c	16.5c
	50	5.3	7.1b	10.6c	7.0	10.3c	17.0c
	75	5.4	9.5b	13.1c	7.0	10.3c	21.0bc
	100	5.5	11.0a	17.2a	7.3	12.0b	21.5bc
Methanol extract of nitta leaf	25	5.3	7.4b	11.1c	5.5	8.8c	15.8c
	50	5.4	7.8b	12.5c	5.5	9.8bc	17.0c
	75	5.3	7.8b	13.6c	6.3	10.5c	19.0bc
	100	5.3	10.6a	16.3ab	7.3	12.0b	28.3a
Aqueous extract of nitta root	25	5.2	7.2b	10.7c	6.5	9.3bc	15.5c
	50	5.5	7.3b	11.0c	5.0	9.8bc	18.0c
	75	5.5	8.3b	12.3c	5.5	11.0b	19.5bc
	100	5.7	10.7a	16.2ab	6.3	12.0b	24.5b
Methanol extract of nitta root	25	5.2	7.8b	11.7c	6.3	9.3bc	17.5c
	50	5.5	8.3b	12.1c	5.5	10.3c	18.8c
	75	5.6	8.9b	13.5c	6.0	11.0b	20.0bc
	100	5.5	10.9a	15.0a	6.0	11.0b	20.0bc
Carbofuran	1.5kg a.i/ha	5.6	11.2a	17.5a	7.3	14.8a	30.1a
	2.5 kg a.i/ha	5.5	11.6a	19.1a	7.8	14.9a	30.6a
Control	0	5.2	5.8c	9.2d	5.0	7.0d	10.8d
		NS			NS		

WAT = Weeks after transplanting; NS = Not significant; Numbers with same letter in the column are not significantly different. The means were partitioned using Tukey-Kramer Highest Significant Difference at 5% probability level.

Table 2: Comparative effects of carbofuran and plant extracts on the mean number of fruit and fresh fruit weight (g) per plant, and soil nematode population (200 g soil) and root gall index of pepper infected with *Meloidogyne incognita*.

Treatment	Concentrations (%)	Number of fruit/plant	Fresh fruit weight (g)/plant	Initial *M. incognita* population	Final *M. incognita* population	Gall index
Aqueous extract of rattle weed leaf	25	18.8d	62.3d	1298	600d	2.4c
	50	18.8d	68.0d	1300	565d	1.6c
	75	22.0c	96.8c	1310	388ab	0.4a
	100	22.0c	108.5c	1310	335a	0.1a
Methanol extract of rattle weed leaf	25	18.0d	66.0d	1298	520c	2.3c
	50	20.0d	68.8d	1299	511c	1.4b
	75	20.8d	96.5c	1310	330a	0.5a
	100	24.8c	108.0b	1308	298a	0.3a
Aqueous extract of rattle weed root	25	18.8d	64.5d	1298	521c	2.3c
	50	20.8c	66.8d	1298	488bc	1.3b
	75	22.8c	96.8c	1305	315a	0.1a
	100	24.0c	110.8b	1300	280a	0.1a
Methanol extract of rattle weed root	25	18.5d	66.3d	1302	525c	2.4c
	50	18.8d	66.5d	1305	490bc	0.8b
	75	22.5c	94.8c	1298	337a	0.2a
	100	26.3b	108.5b	1298	341a	0.1a
Aqueous extract of nitta leaf	25	20.3d	64.0d	1310	489bc	3.0d
	50	22.0c	76.5d	1305	497bc	1.3b
	75	22.8c	110.0b	1307	348a	0.5a
	100	26.8b	130.3a	1308	32a	0.2a

Table 2. Contd.

Treatment	Concentrations (%)	Number of fruit/plant	Fresh fruit weight (g)/plant	Initial *M. incognita* population	Final *M. incognita* population	Gall index
Methanol extract of nitta leaf	25	20.0d	62.9d	1304	570d	2.3c
	50	20.5d	72.3d	1305	497bc	1.1b
	75	22.3c	108.0b	1299	405b	0.6ab
	100	28.0a	128.0a	1298	328a	0.3a
Aqueous extract of nitta root	25	18.8d	64.0d	1310	558d	2.3c
	50	20.3d	66.3d	1308	507c	1.5b
	75	22.3c	96.5c	1309	340a	0.2a
	100	22.5c	108.8b	1305	331a	0.1a
Methanol extract of nitta root	25	18.8d	65.8d	1303	564d	2.2c
	50	18.5d	94.3c	1306	510c	1.1b
	75	22.0c	106.3b	1305	337a	0.2a
	100	26.5a	130.9a	1298	315a	0.3a
Carbofuran	1.5kg a.i/ha	32.5a	131.3a	1306	248a	0.0a
	2.5 kg a.i/ha	34.5a	54.9e	1305	8529e	4.6e
Control	0	14.3e		NS		

Numbers with same letter in the column are not significantly different. The means were partitioned using Tukey-Kramer Highest Significant Difference at 5% probability level.

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