Efficacy of *Cleome viscosa* L. against *Meloidogyne incognita* Infestation in Okra (*Abelmoschus esculentus* L.)

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Abstract

A field experiment was conducted to assess the efficacy of dried powder of *Cleome viscosa* against nematode, *Meloidogyne incognita* infecting okra (var. Arka Anamika). Soil was treated with dried plant material at 50, 100, and 250 g plot^{-1} (1 × 1m) and carbofuran 3G was used as farmers practice. All the treatments of *C. viscosa* were found to be effective in increasing the plant growth parameters of okra such as height of plants, number of leaves and number of fruits and in reducing the root galling by the nematodes. Increase in growth parameters and reduction in root galling was directly related to the dose of plant powder. Increase in plant growth parameters and yield were also significantly higher in treatments with dried plant powder compared to Carbofuran 3G. Treatment with 250 g powder plot^{-1} was highly effective in managing the root knot nematode infestation and in increasing the yield of okra. However, percentage increase in yield from 50 g powder treated plants to 100 g powder treated plants was more compared to the increase in yield from 100 g powder treated plants to 250 g treated plants. Application of dried plant powder was superior to Carbofuran at 3 kg ai ha^{-1} which recorded only 10.08% increase in yield over control. Weight and length of fruits also recorded significant increase in the treatments over control. Percentage increase in the weight of fruits in *C. viscosa* 50 g treated plants was 24.32% and carbofuran 3G treated plants were 24.43% over control. *C. viscosa* 250 g treatments gave 61.76 % increase in weight of fruits over control. Gall formation was reduced in the roots of okra when treated with plant powder. Treatments with 250 g of the plant powders were free from galls. The plant powders at 50 and 100 g showed a gall index of two while in carbofuran 3G treated plants it was one.

Keywords: root-knot nematodes, carbofuran, weeds, pesticides

Introduction

Root-knot nematodes of the genus *Meloidogyne* (Nematoda: Heteroderidae) constitute a major group of plant parasitic nematodes, causing substantial reduction in yield and quality to a wide variety of economically important crops. They are a tremendous threat to crop production worldwide (Sasser, 1980; Sasser and Freckman, 1987). *Meloidogyne incognita* is the most widespread and commonly encountered species in tropical and subtropical regions.

Management of agricultural pests using chemicals is a predominant strategy for many years. High cost of synthetic chemical pesticides and its hazardous effects on the environment and non target organisms leads to the use of natural products for the management of agricultural pests of national importance. Plant world is a rich source of bio chemicals and hence may provide a best alternative for synthetic pesticides. A number of plants and plant products have been reported to possess pesticidal activities. Green manures from a number of plants were reported to be effective in the management of plant parasitic nematodes (Ajith and Sheela, 1996; Sipes and Arakaki, 1997).

Cleome viscosa L. (Capparidaceae) is an annual aromatic herb, locally abundant as a naturalized weed. Williams et al. (2003) reported that organic extract from *C. viscosa* was toxic to *M. incognita* and it contains compounds with antimicrobial and insecticidal activities. Singh and West (1991) reported that aqueous extract of seeds of *C. viscosa* is found non toxic when given orally and intraperitoneally to rats, mice and guinea pigs. The main constituents from the aerial parts were monoterpene hydrocarbons and some oxygenated derivatives (Olatungi et al., 2005) which were not toxic to humans and other vertebrates. The plant was found highly nematicidal both in fresh and dried states in laboratory conditions and hence an attempt was made to study the efficacy of dried powder of *Cleome viscosa* in the management of root knot nematode infestation in okra under field conditions.

Materials and Methods

Chemicals and Reagents

Cleome viscosa was collected from fields of Central Tuber Crops Research Institute, Thiruvananthapuram. The collected plants were chopped into small pieces using Chaff cutter and dried in shade. Dried materials were powdered using Powdering mill and stored in plastic containers at room temperature (28±2°C).

Efficacy of the powdered plant material was tested against root knot nematode infestation in okra. Three different doses (50, 100 and 250 g plot^{-1}) of the dried plant powders were mixed with soil. One × 1 m plots with nematode infested soil were selected for the study. For comparison of the results Carbofuran 3G was also used. Each treatment has three replications. Nematode infected plots without treatment served as controls. After one week okra seeds (var. Arka-Anamika) were sown in each plot. Plants were thinned after one week retaining four healthy plants in each plot. Observations were recorded on the biometric parameters (height of plants, number of leaves etc.) from one week after planting. Yield in terms of number of fruits were recorded. Weight and length of fruits were also recorded on each harvest. Plants were uprooted after three months and the weight and length of roots were recorded. Gall index was recorded following 0-5 index developed by Taylor and Sasser (1978).

Results and Discussion

Amendment with plant powder was effective in reducing the root- knot nematode infection in okra roots. Of the three concentrations tested 250 g plot^{-1} was found most effective. Amendment of soil with the plant powder also increased the plant growth parameters such as height of plants, number of leaves and number of fruits. The results are in confirmation with

Ramakrishnan et al. (1999) who reported that cassava leaf and tuber rind applied as soil amendments at 100 or 50 g plot^{-1} significantly reduced *Meloidogyne incognita* population, and improved plant growth parameters of okra in pot experiments. A significant increase in the plant growth parameters of rice (var. Jaya), and a reduction in nematode (*Meloidogyne graminicola)* infestation was observed in plots amended with the chopped botanicals of *Polygonum hydropiper*, neem seed, *Ageratum* sp., *Mikania* sp., rice straw and water hyacinth (Das et al., 1999). Chopped leaves of many weeds successfully suppressed the population of plant parasitic nematodes and improved plant growth (Alam, 1987).Green and dry manuring of plant parts has been practiced as a method for the control of plant parasitic nematodes (Osman et al., 1989). Castillo (1985) reported reduction in *Rotylenchulus reniformis* population in the pots where fresh leaves of *Asystacia gangetica, Polytrias amaura, Gliricidia sepium* and *Leucaena leucocephala* were added. Organic extract of *C. viscosa* was reported to be moderately toxic to larval *M. incognita* at 500 ppm (Williams et al., 2003).

Number of leaves of okra showed significant differences among treatments (Table 1). At 15 days of planting, there was a significant difference in the number of leaves between the treatments and control. In Carbofuran 3G treated plants the number of leaves was five and it showed significant difference from the control plants. Maximum number of leaves was present in 250 g powder treated plants followed by 100 g powder treated.

Between Carbofuran 3 G and 50 g powder treated plants no significant difference in number of leaves was observed. Mulching of green leaves of *Pongamia* and neem in the soil significantly reduced the incidence of root-knot nematodes and increased the plant growth as well as leaf yield in mulberry (Govindaiah et al., 1989). Chopped leaves of *Gliricidia maculata* as green manure was found to reduce the population of *Radopholus similis* and promote growth of black pepper under pot conditions (Jasy and Koshy, 1992).

Height of the plants also showed significant differences among treatments and control (Table 2). At 7 days after planting there was no significant difference in plant height. After one month the height of the plants in 250 g powder treated plot was 42.95 cm whereas in control it was 26.29 cm. In Carbofuran 3G treated plants the height was 31.12 cm. Yield of the plants was also affected by the treatments. Number of fruits and weight of fruits are maximum in 250 g powder treated plants (Table 3). An increase of 49.35% in yield was obtained in 250 g powder treated plants over control. In Carbofuran 3G treated plants 10.08% increase in yield was obtained. Weight of the fruits showed an increase of 61.76% over control in 250 g powder treated plants. In 100 g and 50 g powder treated ones it was 46.3% and 24.32% respectively. The result is in confirmation with Ajith and Sheela (1996) who reported that addition of chopped green leaves of neem and *Eupatorium* at 15 t ha^{-1} effectively reduced plant parasitic nematodes of okra and cowpea and subsequently increased crop yield during rainy and summer seasons.

Table 1 Effect of different treatments on the number of leaves of Okra at different intervals.

Treatment	No. of leaves at different intervals (DAP- Days after planting)				
	7	15	22	30	37
C. viscosa 50 g	3.00	4.67	6.00	12.33	13.00
C. viscosa 100 g	3.00	5.33	6.33	14.33	16.33
C. viscosa 250 g	3.00	5.67	6.67	16.00	19.33
Carbofuran 3G	3.00	5.00	6.00	12.00	13.67
Control	3.00	4.33	5.33	10.33	12.00
P < 0.05[1/]	ns	*	*	*	*

[1/] ns = Not significant; * = Significant at P<0.05.

Table 2 Effect of different treatments on the height of okra at different intervals.

Treatment	Height of plants at days after planting (cm)								
	7	15	22	30	37	42	50	55	62
C. viscosa 50 g	7.00	16.17	22.28	33.27	52.17	60.27	74.79	106.87	116.77
C. viscosa 100 g	7.33	17.67	23.03	35.54	65.28	80.81	85.09	119.46	126.09
C. viscosa 250 g	7.67	20.17	28.54	42.95	77.89	86.90	100.29	131.00	136.03
Carbofuran 3G	7.00	14.58	20.94	31.12	46.42	60.72	70.47	103.77	111.72
Control	7.00	12.58	17.74	26.29	42.04	54.19	62.27	100.47	102.05
P < 0.05[1/]	ns	*	*	*	*	*	*	*	*

[1/] ns = Not significant; * = Significant at P<0.05.

Carbofuran 3G treated plants recorded an increase of 24.43%. Length of the fruits also recorded an increase in the treatments compared to control (Table 4). Maximum length of fruits was obtained in 250 g powder treated plants followed by 100g powder treated and Carbofuran 3G treated. Treatment with plant powder was also effective in increasing the length and weight of roots (Figure 1). Maximum root length and weight were recorded by 250 g powder treated plants followed by Carbofuran 3G treated plants. The use of organic mulches for managing nematodes has been widely studied and there are various examples of plant debris having beneficial effects on plant growth (Muller and Gooch, 1982). Addition of organic matter was shown to increase soil microbial activity (Widmer and Abawi, 2000) that may have a direct effect on plant parasitic nematode populations (Kloepper et al., 1991).

Gall formation due to the nematodes in the roots of okra was reduced by the treatments. In control plants a gall index of three was recorded (Figure 2). Gall index was reduced to zero when 250 g powder was treated. In 50 and 100g treated plants it was two and in Carbofuran treated plants a gall index of one was observed. The inference drawn from the present investigation that in the dried plant powder treated plants, the root-knot nematode infestation was reduced. The plant powder may acted against the nematodes by means of some active principles absorbed by roots or by way of some chemical reactions triggered by these chemicals (Bunt, 1975), causing tolerance of cells against the invasion and development of the nematodes (Bell, 1981; Tiyagi and Alam, 1995).

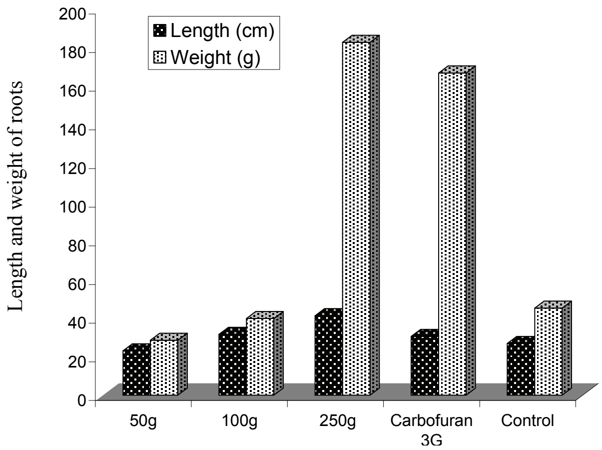

Figure 1 Effect of different doses of plant powder and carbofuran on the weight and length of roots of okra.

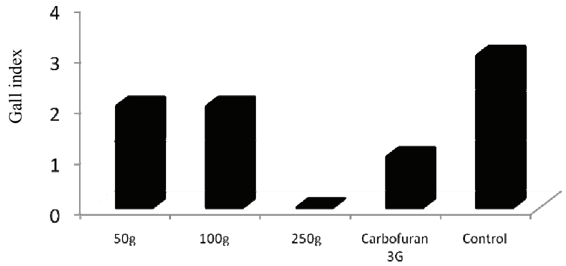

Figure 2 Effect of different doses of plant powder and carbofuran on the gall formation in the roots of okra.

Table 3 Effect of different treatments on the yield of okra.

Treatment	Total fruit		Increasing over control	
	Number (no. plot^{-1})	Weight (g)	Number (---- % -----)	Weight
C.viscosa 50 g	29.34	79.94	9.10	24.32
C.viscosa 100 g	38.32	112.66	30.40	46.30
C.viscosa 250 g	52.66	158.20	49.35	61.76
Carbofuran 3G	29.66	80.06	10.08	24.43
Control	26.67	60.50	-	-
$P < 0.05$[1/]	*	*		

[1/] * = Significant at P<0.05.

Table 4 Effect of different treatments on the length of fruits of Okra at different intervals.

Treatment	Length of fruits at days after planting (cm)							
	37	42	50	55	60	66	74	78
C. viscosa 50 g	14.74	15.27	14.20	13.73	15.73	14.40	15.67	14.87
C. viscosa 100 g	17.20	16.17	15.30	15.93	15.17	15.73	16.07	15.87
C. viscosa 250 g	18.60	16.53	16.10	15.87	16.47	16.90	16.93	16.67
Carbofuran 3G	12.48	15.93	15.20	14.07	12.93	15	14.73	15.40
Control	11.98	13.57	12.93	13.20	12.87	13.20	14.07	13.07
$P < 0.05$[1/]	*	*	*	*	*	*	*	*

[1/] * = Significant at P<0.05.

The plant powder treated plants also showed increased plant growth parameters and yield. This may be due to increased soil fertility. Ramesh et al. (2008) reported that the regular application of organics in amounts sufficient to meet the nutrients of crops, not only result in increasing crop yield but also improve soil fertility and organic matter contents. As the plant is found as a weed all over the plains of India and throughout the tropics of the world (Prajapati et al., 2003; Mali and Ravindra, 2010) it is easily available and could be used for the management of plant parasitic nematodes. Thus, from the present study it appears that the dried powder of *C. viscosa* may be a best substitute for chemical nematicides in managing the root – knot nematode infestation.

Conclusions

The aim of the present study was to investigate whether the dried plant materials are effective in managing the root - knot nematode infestation in field conditions. Dried powder of *Cleome viscosa* at 250 g $plot^{-1}$ was highly effective in suppressing the root knot nematode infestation in okra. This is better than even Carbofuran 3G. Increase in plant growth parameters and yield were also significantly higher in treatments with dried plant powder even compared to Carbofuran 3G. Addition of the plant material to the soil may increase the organic matter favouring growth of the plants and may also increase the water holding capacity of the soil. The plant powder is non toxic to humans and other non target organisms it could substitute Carbofuran 3G for the control of root-knot nematode infestation.

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