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COMPARATIVE EFFECTS OF NEEM (*AZADIRACHTA INDICA*) EXTRACTS AND KARATE (LAMBDACYHALOTHRIN) IN THE CONTROL OF THE ROOT KNOT NEMATODE (*MELOIDOGYNE INCOGNITA*) ON *CELOSIA ARGENTEA*

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ABSTRACT
In order to compare the effects of lambdacyhalothrin, a synthetic pyrethriods and neem (Azadirachta indica) extracts in the control of the root knot nematode of Celosia argentea, two weeks old plants of C. argentea were inoculated with 7,000 eggs of Meloidogyne incognita. Seven days after inoculation, the plants were treated with two concentrations of lambdacyhalothrin at 6,000ppm and 3,000ppm and neem oil extract at 2.14 ml/kg and 4.28ml/kg of soil. Untreated nematode-inoculated C. argentea plants served as negative control while uninoculated C. argentea plants served as positive control. Three weeks after inoculation and subsequently till the 8th week, data were collected on growth parameters such as stem height, number of leaves and yield parameters such as fresh shoot weight, fresh root weight, and root galling indices. There were significant differences between the untreated-nematode inoculated plants and all the other treatments for both the growth and yield parameters except the mean galling indices. Although neem oil at 2.14 ml/kg of soil consistently gave the highest means for leaf number, there were no significant differences between the means for stem height even though untreated-nematode inoculated plants had the lowest values. There was also no significant difference between Lambdacyhalothrin-treated plants at both 6000ppm and 3000ppm for all the parameters considered. Thus, neem oil at 2.14 ml/kg of soil is recommended as an alternaive for Lambdacyhalothrin at 6000ppm and 3000ppm concentrations in the control of root knot nematode of C. argentea since the leaf is the most important part and in view of its environmental friendliness.

Keywords: Neem extracts, lambdacyhalothrin, *Meloidogyne incognita*, *Celosia argentea*

INTRODUCTION

Celosia argentea is an annual herbaceous vegetable of the family *Amaranthaceae*. It has its origin in West Africa, where it can be found as a weed in open disturbed places (Omueti, 1980). In south-western Nigeria, it is known as *sokoyokoto* (Yoruba). The leaves when boiled, along with the young shoots can be used in soups and stews. The seeds are used as a remedy against diarrhea. The crop is highly susceptible to nematodes, which is the main limiting factor to its production (Schippers, 2000; Chweya and Eyzaguirre, 1999). Intensive production of the vegetable is therefore often accompanied with frequent spraying of pesticides to improve its cosmetic value thereby increasing profits (Deang, 1991).

Nematodes are the most important pests of vegetables in the tropics and of all the nematode species, the southern root knot nematode (*Meloidogyne incognita*) is the most common.

Studies have shown that because of the root knot nematodes, it is very difficult and sometimes impossible to grow important vegetables such as okra, *Celosia*, tomato etc in the tropics (Caveness and Wilson, 1975). Hussey (1985) also reported that the root knot nematodes are the most destructive group of nematodes known at present in Nigeria. Attack by the root knot nematode renders the plant vulnerable to secondary infections caused by bacteria and fungi. The symptoms shown by plants to attack by *Meloidogyne* sp. are characterized by numerous swellings or galls on roots of host plants, disruption of water and nutrient uptake, stunted growth, patchiness and chlorosis (Hussey (1985). The different control measures often adopted to control these root knot nematodes on vegetables are; biological control, use of resistant varieties, crop rotation, improved cultural practices and the use of chemical pesticides (nematicides). Chemical control method has been found to be one of the most effective ways of controlling the root knot nematodes. One of such synthetic pyrethroids that have been used in the control of root knot nematodes is Lamdacyhalothrin, which was introduced into the Nigerian market in 1984 (ICI, 1984). However, they have received series of criticisms due to their roles in many environmental hazards and their high toxicity, pollution (abuse), actions on target and non-target organisms and the problem of persistence in the environment. Thus, the naturally occurring pesticides have assumed importance because they are easily bio-degradable, less toxic to mammals and generally less persistent unlike the chemical pesticides (Areekul, 1985).

Azadirachta indica (neem) is a native of India but now found throughout West Africa where in treating malaria in man. The tree is a fast growing, sclerophyllous tree; it grows well in climates from semi-arid to semi- humid and will even thrive in places with less than 500mm of rain per year. The effective ingredients are present in all parts of the tree but are mostly concentrated in the seeds. The oil content of the seed is 35-45%. The Neem has broad range action and is used as insecticides, repellants, antifeedants, growth-inhibitor, fungicides and as a nematicide (van Latum, 1985). Egunjobi and Afolami (1975) reported over 80% increase in yield of maize using water extracts from neem leaves as a soil drench on maize field infested with *Pratylenchus brachyurus*. They suggested that the extracts were probably systemic in function. This study was therefore set up to compare the nematicidal potentials of lambdacyhalothrin (synthetic pyrethroid) and Neem extracts on the growth and performance of *C. argentea*.

MATERIALS AND METHODS

Planting: Top soil was collected at a fallow bush behind the Department of Crop Protection and Environmental Biology, University of Ibadan, Ibadan, Nigeria. The soil was steam sterilized at 160°C for four hours, allowed to cool and stored. Seeds of *C. argentea* were collected from the National Institute for Horticultural Research and Training (NIHORT), Ibadan and were planted in 7kg pots and later thinned to one healthy plant per pot. The design used was a randomized complete block design of six treatments replicated eight times. The treatments are the uninoculated *Celosia* plant, nematode-inoculated *Celosia* plants, nematode-inoculated *Celosia* plant treated with lambdacyhalothrin at 6,000ppm, nematode-inoculated *Celosia* plant treated with lambdacyhalothrin at 3,000ppm, nematode-inoculated *Celosia* plant treated with neem oil at 4.28ml/kg of soil, and nematode-inoculated *Celosia* plant treated with neem oil at 2.14ml/kg of soil.

Preparation of plant extracts and inocula: Neem seeds were collected from a tree in the department of Chemistry, University of Ibadan and its oil was extracted using soxhlet extraction with N-Hexane. Solution concentrations of 6,000ppm and 3,000ppm were prepared by diluting 6ml and 3ml of karate in 1,000mls of water respectively. Extraction method used was the Hussey and Barker (1973) method of collecting inocula for *Meloidogyne* species. Eggs of *M. incognita* were sourced from roots of *C. argentea* which were washed in running tap water and chopped into smaller pieces of about 1-2cm length before transferred into a conical flask. After this, 0.35% sodium hypochlorite (NaOCl) was added to the nematode solution and shaken for 5 minutes and then rinsed over two 200 mesh sieves to collect the large plant debris. The filtrate was then passed through a 500 mesh sieve to collect the eggs. Water was added continuously to the sieve containing the egg. The resultant solution was then diluted with distilled water to 1litre mark in a 1litre beaker. Nematode egg population was estimated by counting four samples of 2ml each from the nematode solution using a Doncaster counting dish and a tally counter under a light microscope.

Nematode inoculation: Two weeks after planting, *Celosia* plants were inoculated with 7,000 nematode eggs with the exception of the controls. These eggs were added to the soil at the base of each plant root with aid of a 5ml hypodermic syringe after properly homogenizing the inoculums in the beaker to uniformly expose the nematode eggs. A week after inoculation, the various treatments were applied to the plants. Data collected on growth and yield parameters were pooled before subjecting to analysis of variance (ANOVA) using GENSTAT and means were separated using the least significant difference at 5% level of probability (LSD).

RESULTS

Three weeks after planting (WAP), plants treated with neem oil at 2.14mg/kg of soil gave the highest mean number of leaves while the nematode-inoculated plants gave the lowest. This trend was also observed till eight weeks after planting. There were no significant differences at three and four weeks after planting. At five to eight weeks after planting, mean number of leaves varied significantly among the treatments with the nematode-inoculated plant being significantly ($p<0.05$)lower than others. However, at six weeks after planting, nematode-inoculated plants were not significantly ($p<0.05$) different from the nematode-inoculated *Celosia* plant treated with neem oil at 4.28ml/kg soil while at seven weeks after planting, it was not also different from the nematode-inoculated *Celosia* plant treated with lambdacyhalothrin at 3000ppm and the nematode-inoculated *Celosia* plant treated with neem oil at 4.28ml/kg soil (Table1). The mean stem height of *Celosia* plants for the duration of this experiment did not show any significant ($p<0.05$) differences among the treatments (Table 2).

Plate 1: Severely galled root of nematode-inoculated *Celosia argentea* plant

Table 1. Effect of lambdacyhalothrin and neem oil on mean number of *Celosia argentea* leaves

Treatment	Weeks after planting					
	3	4	5	6	7	8
T_0	17.75	34.60	61.80	81.40	100.00	120.0
T_1	15.13	32.20	43.00	55.00	71.50	86.40
T_2	18.38	35.50	62.90	74.60	96.10	130.60
T_3	19.62	38.10	63.20	79.40	89.80	130.10
T_4	16.50	34.50	61.60	73.00	86.80	109.40
T_5	20.12	39.00	71.60	86.80	103.90	130.80
$LSD_{0.05}$	**NS**	**NS**	**14.48**	**18.24**	**19.87**	**17.92**

T_0: Uninoculated *Celosia* plant; T_1: Nematode-Inoculated *Celosia* plants; T_2: Nematode-inoculated *Celosia* plant treated with Lambdacyhalothrin at 6000ppm; T_3: Nematode-inoculated *Celosia* plant treated with Lambdacyhalothrin at 3000ppm; T_4: Nematode-inoculated *Celosia* plant treated with Neem oil at 4.28ml/kg application rate; T_5: Nematode-inoculated *Celosia* plant treated with Neem oil at 2.14ml/kg application rate.and NS: Non-Significant

Table 2. Effect of lambdacyhalothrin and neem oil on mean stem height of *Celosia argentea* plants

Treatment	Weeks after planting					
	3	4	5	6	7	8
T_0	7.88	12.50	20.55	33.40	50.90	59.60
T_1	7.81	12.44	16.88	25.00	34.90	54.70
T_2	8.44	12.31	20.00	30.70	46.20	56.30
T_3	7.81	13.56	21.53	33.00	48.70	56.40
T_4	7.56	12.65	20.12	31.10	46.90	60.30
T_5	7.62	12.94	20.45	31.70	50.70	60.90
$LSD_{0.05}$	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**

T_0: Uninoculated *Celosia* plant; T_1: Nematode-Inoculated *Celosia* plants; T_2: Nematode-inoculated *Celosia* plant treated with Lambdacyhalothrin at 6000ppm; T_3: Nematode-inoculated *Celosia* plant treated with Lambdacyhalothrin at 3000ppm; T_4: Nematode-inoculated *Celosia* plant treated with Neem oil at 4.28ml/kg application rate; T_5: Nematode-inoculated *Celosia* plant treated with Neem oil at 2.14ml/kg application rate.NS: non-Significant

Table 3: Effect of lambdacyhalothrin and neem oil on mean galling indices of *Celosia argentea*

Treatment	Mean Galling Indices
T_0	1
T_1	5
T_2	3
T_3	3
T_4	2
T_5	2

T_0: Uninoculated *Celosia* plant; T_1: Nematode-Inoculated *Celosia* plants; T_2: Nematode-inoculated *Celosia* plant treated with Lambdacyhalothrin at 6000ppm; T_3: Nematode-inoculated *Celosia* plant treated with Lambdacyhalothrin at 3000ppm; T_4: Nematode-inoculated *Celosia* plant treated with Neem oil at 4.28ml/kg application rate; T_5: Nematode-inoculated *Celosia* plant treated with Neem oil at 2.14ml/kg application rate.

Table 4: Effect of lambdacyhalothrin and neem oil on fresh shoot and fresh root weight of *Celosia argentea*

Treatment	Fresh Root Weight (g)	Fresh Shoot Weight (g)
T_0	18.29	44.84
T_1	25.26	36.13
T_2	21.98	40.58
T_3	20.19	45.44
T_4	23.16	41.50
T_5	18.40	44.97
$LSD_{0.05}$	2.498	4.351

T_0: Uninoculated *Celosia* plant; T_1: Nematode-Inoculated *Celosia* plants; T_2: Nematode-inoculated *Celosia* plant treated with Lambdacyhalothrin at 6000ppm; T_3: Nematode-inoculated *Celosia* plant treated with Lambdacyhalothrin at 3000ppm; T_4: Nematode-inoculated *Celosia* plant treated with Neem oil at 4.28ml/kg application rate; T_5: Nematode-inoculated *Celosia* plant treated with Neem oil at 2.14ml/kg application rate.

Mean galling indices on *Celosia* plants after harvesting are shown in Table 3. The nematode-inoculated plants had the highest mean galling indices of 5 (severe galling) which was followed by the lambdacyhalothrin treated plants at 6,000ppm and 3,000ppm that had mean galling indices of 3 (mild galling). Nematode-inoculated *Celosia* plant treated with neem oil at 4.28ml/kg soil and 2.14mg/kg soil both had mean galling indices of 2 (slight galling). The uninoculated *Celosia* plants had mean galling indices of 1 (no galling damage).

Yield components shows that the nematode-inoculated *Celosia* plant treated with neem oil at 2.14mg/kg soil gave the highest fresh shoot weight (44.97g) followed by the uninoculated plants (44.84g). The nematode inoculated plants had the least fresh shoot weight (36.13g) which was significantly different from the remaining treatments. The nematode-inoculated *Celosia* plants treated with lambdacyhalothrin at 6,000ppm and 3,000ppm showed significant difference between each other (Table 4). Nematode-inoculated plants had the highest fresh root weight of 25.26g which was significantly different from the remaining treatments while the uninoculated plants (18.29g) had the lowest fresh weight (Table 4).

DISCUSSION

The effectiveness of lambdacyhalothrin was compared with neem oil for the suppression of root knot nematode disease caused by *M. incognita* on *C. argentea*. In this study, significant reduction in growth and yield of *Celosia* was observed but was more pronounced in the uninoculated control. Odeyemi (2004) and Odeyemi and Afolami (2008) have reported stunted growth, root galling, fewer pods and significant reduction in yield as main symptoms of *M. incognita* infection on host crop. Lambdacyhalothrin applied at the recommended rates of 6,000 and 3,000 ppm showed satisfactory control of root knot nematode on *C. argentea*, thus affirming Fadina and Adesiyan (1997) who had reported, with discernable evidence some of the pyrethroids' effects on the various life stages of *M. incognita*. However *Celosia* plants treated with lambdacyhalothrin at 6,000ppm showed a characteristic phytotoxic symptom. Fadina and Adesiyan (1997) had that lambdacyhalothrin used as soil drench on soyabean was phytotoxic. This however contradicts reports by Imperial Chemical Industries (1984) that lambdacyhalothrin is not toxic to vegetables at the recommended dose of

6,000ppm. In addition, neem oil may be effective in the control of root knot nematode disease of *Celosia* plants and this agrees with the work of Egunjobi and Larinde (1978) who reported that extracts from neem leaves contain substances toxic to root knot nematodes. Adegbite and Adesiyan (2005) also reported that 100% concentration of neem root extracts caused larval mortality of root knot nematodes *in vitro*. They concluded that it could be due to the inhibitory effect of the extract and that the inhibitory effect might be due to the chemicals present in the extract that possess ovicival and larvicidal properties. Neem extracts contained alkaloids, flavonoids, saponives, amides including benzamide and ketones that singly and in combination inhibited hatching or caused arrested development of *Meloidogyne* species (Chitwood, 2002).

From this study, lambdacyhalothrin, 6,000ppm and 3,000ppm and neem oil at 2.14ml/kg soil and 4.28ml/kg soil are effective in the control of root knot nematode disease of *C. argentea* due to their inhibitory effects on the growth and development of the root knot nematodes on the crop. However, neem oil at 2.14ml/kg of soil is recommended to vegetable growers as it increased the yield (leaf number) of *C. argentea* significantly. If lambdacyhalothrin is to be used at all, the 3,000ppm application rate is advisable, albeit considering the environmental implication. The future looks bright for identifying new classes of pesticides from natural plants to replace the dangerous synthetic and expensive chemicals used at present (Adegbite and Adesiyan, 2005).

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