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# Resistance to Meloidogyne Incognita Attack Discovered in Some Common Ornamentals and the Plants Nematicidal Potentials in Celosia Agentea

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**Abstract:** ***Root knot nematodes are found worldwide and are known to affect over 2000 species of plants including various vegetable and crop species. Chemical control of root knot nematodes, highly effective but leads to environmental hazard because of the high toxicity and persistence of the nematicides. It is therefore part of the efforts to come up with suitable organic, human and environmental friendly alternatives that led to this investigation into the pathogenicity of the nematode on some common ornamental plants and the nematicidal potentials of their leaves in celosia argentea. The plants are: Dieffenbachia bowmanii, Philodendron selleoum andMoringaoleifera. The inoculation of nematode eggs carried out on each of the plants revealed no significant defect on the plants. Their leaves were then collected, shade dried and prepared into powders following standard procedures. The leaves powder of Tageteserecta (beingnematicidal) was also prepared and used as one of the checks. The plants powders were incorporated into the soil at the rates of 5 g/kg and 10 g/kg soils at 2 weeks before transplanting of the Celosia seedlings. Carbofuran was applied at 5 g/kg soil. The 4 x 2 factorial experiment was arranged in completely randomized design (CRD) and the data analysed .The plants leaves powder exhibited significant effects on the nematodes population.***

**Keywords:** Resistance, *Meloidogyne incognita* (Root knot nematode), Ornamentals, Nematicidal

## 1. Introduction

*Dieffenbachia* and *Philodendron* species are commonly found in homes, offices, and waiting rooms (Jennifer *et al.*, 2006).Dieffenbachia gets the nicknames “Dumb Cane” and “Mother in Law Plant” as a result of the effects of the milky sap it contains. If ingested it causes a burning sensation in the mouth, swells the tongue, and paralyzes the vocal cords, literally taking one’s voice away. It has the same effects on cats and dogs, so it’s important to keep this plant out of reach. The sap can also cause mild skin irritation so be sure to wash hands after handling (Susan, 2008). Dieffenbachiaspp and Philodendron plants contain insoluble crystals of calcium oxalates called raphite(Peterson *et al.*, 2006 and Poppenga, 2002).

*Moringaoleifera* is the best known of the thirteen species of the genus *Moringa*. This fast-growing ornamental tree is also grown for human food, medicine, dye, fodder and water clarification. *M. oleifera* is known by several names in different countries, but it is popularly called the "drumstick tree" for its pods resembling drumsticks and the "horseradish tree" for the flavour of its roots (Mosquin, 2008).

Marigold (*Tagetes* spp.), which is a popular bedding plant, can be used as a cover crop. Marigold produces a substance called ***alpha-terthienyl***, which can aid in the reduction of root-knot nematodes and other disease promoting organisms, such as fungi, bacteria, insects and some viruses (Soule, 1993).There are only a few plants that have been found to produce substances known to be detrimental to nematodes. Marigold,asparagus, pangola grass,neem and castor bean, produce substances in their roots that are toxic to at least one or more kinds of nematodes (Overstreet *et al*., 2017). Marigolds are known to be particularly effective against root-knot nematode. However, most of the effects of marigolds are not from these natural nematicides but the plants acting as a trap crop. The nematode enters roots of the plant but is unable to develop further in its life cycle or may be actively killed by the plant when it attempts to feed. (Overstreet, *et al*., 2017)

**Nematodes - Host Status**

Each specie ofnematodes has certain plants it can feed and reproduce on and others it cannot. The ability of a plant to support reproduction of nematodes is referred to as host status. If a particular specie of nematode is unable to reproduce on a crop, the nematode numbers will decline as nematodes die. A susceptible plant is one on which the nematode population will increase. A resistant plant is one on which the nematode population will decrease. An intermediate plant is one on which the nematode population will remain stable or be unpredictable.

Susceptibility of marigolds depends on the marigold species and variety or cultivar, as well as the species of nematode. Varieties designated **“resistant”** could be used as cover crops to suppress that nematode. Varieties designated **“susceptible**” can increase population levels of the nematode and actually make the problem worse. It is probably safest to avoid varieties termed “**intermediate”** in their response, since these can be unpredictable.

**Useful Benefits of Celosia**

Various parts of *Celosia agentea* are used in different countries of the world as follows: The young inflorescence of *C.cargentea* are eaten as a potherb in Kenya, the liquid extract from the leaves and flowers is used by the Masai as a body wash for convalescents, the whole plant is used as an antidote for snakebites and the roots in the treatment of colic, gonorrhoea and eczema. In Ethiopia and DR Congo the seeds are used as medicine for diarrhoea, the flowers are used to treat dysentery and muscle problems. In China and Japan, the leaves are used as medicine in the treatment of infected sores, wounds and skin eruptions. The seed extracts are also used as a therapeutic drug for eye and hepatic diseases. In India, the leaves mixed with honey are applied to inflated areas or abscesses, and the seeds are widely used for the treatment of diabetes mellitus. In South-East Asia, the flowers are used as medicine for dysentery, haemoptysis and menstruation problems. The flower and seed are astringent, haemostatic, ophthalmic, parasiticidal and poultice. It is used in the treatment of bloody stool, haemorrhoid bleeding, uterine bleeding, leucorrhoea and diarrhoea. As a parasiticide, it is very effective against *Trichomonas*, a 20% extract can cause the *Trichomonas*to disappear in 15 minutes. The seed is hypotensive and ophthalmic. It is used in the treatment of bloodshot eyes, blurring of vision, cataracts and hypertension. The seed also has an antibacterial action, inhibiting the growth of *Pseudomonas* (Kuntze, 2012).

**Susceptiblility of Celosia to Root knot nematodes**

Denton (2004) reported that *Celosia argentea*is highly susceptible to root-knot nematodes (*Meloidogyne* spp.) causing galls on roots, unthrifty growth, small and chocolate-coloured leaves as well as reductions in yield of up to 40%. It is therefore recommended that celosia should not be grown continuously nor be followed by other crops that are susceptible to root-knot nematodes such as okra, gboma eggplant, Jew's mallow, lettuce or tomato.

Variation in degree of susceptibility to root-knot nematodes exists among cultivars, but no resistant cultivars have been reported. However, the application of much organic manure reduces the nematode population, as well as annual flooding. Nematicidal activities of plants materials have been reported to vary from plant to plant. This variation has also been attributed to differences in chemical compositions and concentration of the toxic compounds present in different plants (Olabiyi, 2004; Oladoye*et al.*, 2007).

Botanical insecticides or pesticides have long been touted as attractive alternatives to synthetic chemical for pest management because botanicals reputedly pose little threat to the environment or to human health (Murray, 2005). Botanicals are all plant extracts, plant volatiles, and natural oils which exhibit pest control activities (Jones, 2002). Therefore, this investigation was to evaluate the nemato-toxicities or nematicidal potentials of four horticultural plant leaf powders on the root-knot nematode infecting *siaargentea*. Two of these are known to be highly poisonous ornamental plants containing high level of calcium*Celo* oxalates. In the case of the remaining two, *Moringaoleifera* is known to be highly medicinal while*Tageteerecta* is nematicidal when intercropped with nematode susceptible crops.

## 2. Materials and Methods

The investigation was conducted during both the dry and wet seasons of 2011 and 2012 respectively, at one of the green (screen) houses of the National Horticultural Research Institute (NIHORT), Jericho Idi – Ishin, Ibadan.

The investigation was divided into four (4) different experiments which include:

1) Effects of different nematodes levels on *Moringaoleifera*
2) Effects of different nematodes levels on *Dieffenbachia bowmanii*
3) Effects of different nematode levels on *Philodendron selleoum*
4) Evaluation of the potency of the different ornamentals (*Moringaoleifera*, *Dieffenbachia bowmanii*,*Philodendron selleoum and Tageteserecta* in controlling *Meloidogyne incognita* in *Celosia argentea*.

**Soil Sterilization**

Rich top soil from the jungle was collected from the nursery site of the floriculture programme of the National Horticultural Research Institute, Jericho, Ibadan. The soil was sterilized at 80 $^{0}$C for 20 minutes (Ononuju*et al*., 2011). A method referred to as heat dry method.

The sterilized soil was cooled, and 5kg was put each into different 96 polythene bags and arranged in completely randomised designed (CRD) with four (4) replicates, for the *Moringaoleifera* experiment.

**Experiment 1**

*Moringaoleifera* seeds were sown into 96 polythene pots at two seeds per pot and later thinned to one per pot. There were four (4) plants and pots per plot. The pots were arranged in completely randomized design (CRD). Inoculation of 1000 eggs / 10ml, 1500eggs / 15ml and 2000 eggs/ 20ml of *Meloidogyne incognita*was carried out at about 8 weeks after sowing .

The data collection on growth indices were at inoculation. Destructive sampling was done at intervals of 6 weeks.

**Experiment II**

Dieffenbachia was propagated by stem cutting. The planting materials had equal number of buds, each containing 3 buds. The planting materials were sterilized with hypochlorite solution prior to planting. The stem cutting were planted into 32 polythene pots, 2 pots per plot and arranged in completely randomized design (CRD) in the green house. Inoculation was not done until about seven (7) weeks after planting when there were about 80 % leaves sprouts. The treatments applied were One thousand (1000) eggs; One thousand five hundred eggs, two thousand eggs and no eggs were applied to control.

The data collected were plant height, number of leaves, leaf area and number of galls on root. All data were subjected to descriptive statistics and ANOVA.

**Experiment III**
The procedures for this experiment were the same with those of the Dieffenbachia experiment except that the inoculation commenced about 8 weeks after planting. The treatment applied was also the same. Destructive sampling was done at the end of the experiment. All data were then subjected to statistical analysis

**Experiment IV:**
Evaluation of effectiveness of four (4) botanicals in the control of meloidogyne incognita in celossia.

*Celosia argentea* seedlings from sterilized trays of soil were transplanted into sixty (60) polythene pots of sterilized top soil. There were ten (10) plots in a replicate of three (3). Two pots per plot and two (2) plants per plot. The treatments were six in all four (4) botanicals, carbofuran and the control.

Each botanical was shade-dried, ground and applied into their respective pots, two weeks before transplanting. Inoculation of two thousand eggs into each of the sixty (60) pots was done two days after transplanting. Growth indices considered in data collection were, plant height, number of leaves, leaf area, stem girth, biomass weight and Gall Index (G.I). The destructive sampling was done at intervals of four weeks.

Nematodes from 100ml soil from each pot were extracted by cobbs sieving method for estimating nematode population.

All data were then subjected to statistical analysis (SAS was used).

## 3. Results and Discussion

Table 1, shows the Dieffenbachia growth indices; the plant heights, number of leaves and the leaf areas. The leaf areas did not show any significant difference throughout the period of the investigation. The plant heights too followed the same trend with some exceptions, so also the number of leaves.

When the nematode population and eggs were examined (Table 2), treatments with 1000 and 1500 eggs showed increase in nematode population but there was a reduction in nematode population in the treatment with 2000eggs.It is obvious from the table that there is no significant difference between the treatments, but there is, when compared with the control treatment, except for treatment 3(i.e. 2000 eggs) and the control. In the case of eggs, there is no significant difference between treatments that received 1500 and 2000 eggs but there is between 1000 eggs treated plots and the control.

The number of leaves of Philodendron showed no significant difference throughout the period of the investigation except during the period before the first data (Table 3). The leaf areas too showed no significant difference throughout the investigation period.

There was no significant difference in mean plant heights of Philodendron at week 4 but in the 5$^{th}$ week a significant reduction in plant height was observed.

Table 5 shows the means for Moringa plant heights throughout the period of data collection. There were no significant differences ($p < 0.05$) observed when compared with the plant height of the control.

The number of leaves, shows similar responses to the varying levels of the inocula except for the 7$^{th}$, 8$^{th}$ and 9$^{th}$ weeks. What might be responsible for this exception was the fact that Moringa is a tropical tree which has a mechanism by which it tolerates water stress or drought as observed in the course of this investigation, and this is by shedding its leaves in order to reduce evapo-transpiration.

There were no significant differences also in the stem girth taken from the 7$^{th}$ week to the end of the experiment. *M. oleifera* is known to be planted for its fruits, leaves, stem and root. Therefore, destructive samplings were carried out twice, both at 7$^{th}$ week of data collection and at the 10$^{th}$ week to have the fresh and dry biomass weighed. When the data were subjected to statistical analysis, there were no significant differences between the biomas of inoculated plants and that of the control ($p < 0.05$) (Table 6).

The moringa roots were examined for galls but there were none visible while the roots of *Celosiaargentea* planted as test plants produced galls. The gall index for the moringa plant was therefore zero (0).

The moringa roots when examined sensorily had this menthol-like odour. The **Polyelectrolyte** known to be present in moringa has the tendency to produce positive charges which like magnet can attract the negative charges of particles (such as clay, silk, bacteria, germs and other toxic particles in water) (Mesfin, 2008)

There was no significant difference in the effects of the botanicals on the plants heights and the number of leaves except in the seventh week. Significant difference was observed when level 2(i.e. 10g/kg soil) of both moringa and dieffenbachia were compared with the control (Table 7). The leaf areas too showed no significant differences in responses to the botanicals except between level 1(5g/kg soil) and 2(10g/kg soil) of marigold.The trend of development of the celosia plants can be seen to be consistent with the report of Ridge(1991), that, the number of leaves produced by a plant is directly proportional to photosynthate produced, and also the higher leaf area in plants can be obtained as a result of high rate of photosynthesis with resultant increase in carbohydrate production and hence increases in leaves size.

The responses of *Celosia argentea* biomass to treatments of the botanicals against root-knot nematodes did not show significant difference between the effects of Marigold at 5 g/kg soil and 10 g/kg soil. Also, there was no significant difference between Moringa and Dieffenbachia at the two levels but Philodendron gave significant difference between the two levels of application.

**Table 1:** Effect of Nematode inoculation on Dieffenbachia Plant Height (cm), Number of leaves and leaf areas.

| | 3WAS | | | 6WAS | | | 9WAS | | | 12WAS | | | 15WAS | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Inoculum | PH | NL | LA | PH | NL | LA | PH | NL | LA | PH | NL | LA | PH | NL | LA |
| 1000 eggs | 16.70$^{a}$ | 6.00$^{a}$ | 80.80$^{a}$ | 24.95$^{a}$ | 8.5$^{a}$ | 123.30$^{a}$ | 27.05$^{ab}$ | 11.25$^{a}$ | 233.25$^{a}$ | 31.50$^{a}$ | 11.50$^{a}$ | 212.08$^{a}$ | 34.32$^{a}$ | 12.25$^{a}$ | 207.78$^{a}$ |
| 1500 eggs | 16.85$^{a}$ | 5.50$^{a}$ | 109.65$^{a}$ | 20.35$^{b}$ | 7.00$^{a}$ | 158.25$^{a}$ | 22.45$^{b}$ | 9.25$^{b}$ | 202.43$^{a}$ | 27.37$^{a}$ | 9.75$^{ab}$ | 232.65$^{a}$ | 32.80$^{a}$ | 11.25$^{ab}$ | 189.48$^{a}$ |
| 2000 eggs | 20.80$^{a}$ | 3.25$^{b}$ | 83.33$^{a}$ | 24.47$^{ab}$ | 4.50b | 122.43$^{a}$ | 26.57$^{ab}$ | 6.75$^{b}$ | 200.05$^{a}$ | 27.25$^{a}$ | 7.50$^{b}$ | 189.58$^{a}$ | 30.50$^{a}$ | 8.00$^{b}$ | 190.03$^{a}$ |
| Control | 23.28$^{a}$ | 5.00$^{a}$ | 85.85$^{a}$ | 27.25$^{a}$ | 7.25$^{a}$ | 123.20$^{a}$ | 29.35$^{a}$ | 9.25$^{ab}$ | 193.20$^{a}$ | 30.87$^{a}$ | 8.75$^{ab}$ | 193.40$^{a}$ | 33.32$^{a}$ | 11.25$^{ab}$ | 203.85$^{a}$ |

Means with the same alphabets in the same column are not significantly different ($P < 0.05$)

LEGEND: PH – Plant Height (cm)
NL – Number of Leaves
LA – Leaf Areas
WAS – Weeks After Sprouting

**Table 2:** Effects of Dieffenbachia on *M. incognita* population and eggs

| Treatments | Population/200ml soil | Eggs/40ml water |
|---|---|---|
| 1,000 eggs | 3150.00 a | 60.00 a |
| 1,500 eggs | 1950.00 a | 20.00 ab |
| 2,000 eggs | 1440.00 ab | 3.00 b |
| Control | 0.00 b | 0..00 b |
| LSD | 1930.00 | 50.34 |

Means with the same alphabets in the same column are not significantly different ($P < 0.05$)

**Table 3:** Effect of Nematode inoculation on Philodendron Plant Height (cm), Number of leaves and leaf areas.

| | 3WAS | | 6WAS | | 9WAS | | 12WAS | | | 15WAS | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Inoculum** | NL | LA | NL | LA | NL | LA | PH | NL | LA | PH | NL | LA |
| **1000 eggs** | 2.00$^{b}$ | 21.1 a | 3.00 a | 24.8 a | 3.00 a | 32.2 a | 8.15 a | 6.75 a | 31.0 a | 12.00 b | 10.25 a | 27.1 a |
| **1500 eggs** | 4.00$^{a}$ | 24.1 a | 6.50 a | 27.7 a | 5.75 a | 31.4 a | 9.95 a | 7.75 a | 32.2 a | 12.50 ab | 11.75 a | 34.1 a |
| **2000 eggs** | 4.00$^{a}$ | 24.8 a | 6.00 a | 39.4 a | 4.50 a | 42.3 a | 9.75 a | 8.25 a | 35.1 a | 11.80 b | 10.25 a | 39.1 a |
| **Control** | 3.25$^{ab}$ | 33.1 a | 6.00 a | 39.7 a | 4.50 a | 49.2 a | 11.95 a | 11.50 a | 38.5 a | 17.50 a | 16.00 a | 40.7 a |

Means with the same alphabets in the same column are not significantly different ($P < 0.05$)

LEGEND: PH – Plant Height (cm)
NL – Number of Leaves
LA – Leaf Areas
WAS – Weeks After Sprouting

**Table 4:** Effects of Philodendron on *M. incognita* population and eggs

| Treatments | Population/200ml soil | Eggs/40ml water |
|---|---|---|
| 1,000 eggs | 1020.00 a | 120.00 b |
| 1,500 eggs | 600.00 a | 640.00 a |
| 2,000 eggs | 1750.00 a | 280.00 ab |
| Control | 0.00 a | 0..00 b |
| LSD | 2014.40 | 383.00 |

Means with the same alphabets in the same column are not significantly different ($P < 0.05$)

**Table 5:** Effect of Nematode inoculation on Moringa Plant Height (cm), Number of leaves and leaf areas.

| | 2WAS | | 4WAS | | 6WAS | | 8WAS | | | 10WAS | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Inoculum** | PH | NL | PH | NL | PH | NL | PH | NL | SG | PH | NL | SG |
| **1000 eggs** | 31.05 | 70.50 | 57.33 | 185.00 | 85.68 | 272.00 | 98.20 | 297.00 | 1.34 | 108.88 | 299.50 | 1.85 |
| **1500 eggs** | 30.28 | 72.50 | 52.75 | 186.75 | 76.88 | 287.00 | 90.13 | 366.88 | 1.59 | 102.30 | 273.00 | 2.05 |
| **2000 eggs** | 32.75 | 66.50 | 55.78 | 155.25 | 83.40 | 209.75 | 98.33 | 286.75 | 1.26 | 105.45 | 221.50 | 1.95 |
| **Control** | 33.10 | 68.00 | 54.80 | 200.75 | 78.35 | 207.25 | 92.28 | 443.50 | 1.46 | 98.08 | 352.25 | 2.11 |
| **LSD** | **3.68** | **11.91** | **10.96** | **60.16** | **19.98** | **99.27** | **19.83** | **108.76** | **0.33** | **17.96** | **132.50** | **0.24** |

Means with the same alphabets in the same column are not significantly different ($P < 0.05$)
LEGEND: PH – Plant Height (cm)
NL – Number of Leaves
SG – Stem Girth
WAS – Weeks After Sowing

**Table 6:** Effects of Nematode Levels on Moringa Biomass

| Treatments | FSW (g) 1 | DSW (g) 1 | FRW (g) 1 | DRW (g) 1 | FSW (g) 2 | DSW (g) 2 | FRW (g) 2 | DRW (g) 2 |
|---|---|---|---|---|---|---|---|---|
| 1,000 eggs | 8.45 | 1.18 | 4.48 | 0.85 | 9.99 | 5.27 | 9.41 | 5.22 |
| 1,500 eggs | 6.28 | 1.35 | 4.53 | 0.90 | 10.01 | 6.6 | 9.41 | 5.92 |
| 2,000 eggs | 8.08 | 1.30 | 6.90 | 3.33 | 10.94 | 6.59 | 8.24 | 5.11 |
| Control | 8.58 | 1.55 | 5.3 | 0.85 | 8.54 | 6.25 | 8.83 | 5.36 |
| **LSD** | **4.13** | **0.47** | **4.12** | **3.93** | **3.83** | **1.95** | **4.15** | **1.78** |

**Legend:**
1----First destructive sampling data
2--- Second destructive sampling data

**Table 7:** Celosia Growth Parameters in response to the Botanicals for Nematode Control

| BOTANICALS | LEVEL | MEAN GROWTH INDICES | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | PLANT HEIGHT | | | NUMBER OF LEAVES | | | LEAF AREA | | | BIOMASS | | | |
| | | 3 WAP | 5 WAP | 7 WAP | 3 WAP | 5 WAP | 7 WAP | 3 WAP | 5 WAP | 7 WAP | FSW(g) | DSW(g) | FRW(g) | DRW(g) |
| MARIGOLD | 1 (10 g/2 kg) | 21.83 | 30.90 | 53.70 | 17.00 | 20.00 | 27.30 | 21.70 | 26.70 | 43.30 | 13.30bcd | 1.04abc | 1.61bcd | 0.24b |
| | 2 (20 g/2 kg) | 21.87 | 33.30 | 48.80 | 17.00 | 22.70 | 38.00 | 25.50 | 42.80 | 50.40 | 18.80bc | 1.48ab | 2.57abcd | 0.49ab |
| MORINGA | 1 (10 g/2 kg) | 24.10 | 31.70 | 54.70 | 21.67 | 24.00 | 39.00 | 27.30 | 31.30 | 45.70 | 14.40bcd | 0.82bc | 2.17bcd | 0.30b |
| | 2 (20 g/2 kg) | 21.03 | 35.00 | 60.30 | 17.33 | 22.37 | 39.70 | 21.10 | 34.10 | 55.30 | 10.60cd | 0.87abc | 0.66d | 0.26b |
| DIFFENBACHIA | 1 (10 g/2 kg) | 21.80 | 32.20 | 54.20 | 17.67 | 20.30 | 33.30 | 21.80 | 29.90 | 52.60 | 7.90d | 0.58c | 0.83d | 0.15b |
| | 2 (20 g/2 kg) | 26.70 | 37.80 | 60.00 | 18.00 | 20.00 | 25.70 | 22.10 | 31.00 | 48.70 | 15.50bcd | 1.10abc | 3.51abc | 0.55ab |
| PHILODENDRON | 1 (10 g/2 kg) | 18.73 | 30.50 | 54.20 | 16.00 | 21.00 | 29.00 | 17.40 | 28.20 | 46.20 | 14.10bcd | 0.37c | 0.92cd | 0.13b |
| | 2 (20 g/2 kg) | 22.20 | 31.20 | 55.00 | 20.00 | 24.00 | 39.00 | 22.10 | 31.90 | 46.80 | 36.20a | 1.52ab | 3.98ab | 0.28b |
| CARBOFURAN | 1 (10 g 2 kg) | 21.87 | 31.90 | 54.50 | 20.67 | 26.00 | 38.30 | 20.00 | 28.10 | 41.20 | 11.20cd | 0.78bc | 1.38bcd | 0.21b |
| CONTROL | 1 (10 g/2 kg) | 22.37 | 30.70 | 44.80 | 20.33 | 22.70 | 27.00 | 22.80 | 29.80 | 47.00 | 22.40b | 1.73a | 4.86a | 0.75a |
| LSD | | 5.60 | 9.36 | 14.70 | 5.18 | 6.83 | 18.57 | 7.99 | 14.32 | 12.32 | 10.70 | 0.89 | 2.64 | 0.43 |

Legend:
WAP - Weeks after planting
FSH – Fresh shoot weight
DSH – Dry shoot weight
FRW – Fresh root weight
DRW – Dry root weight

**Table 8:** Gall Index, Nematode Population and Logarithms.

| BOTANICALS | LEVELS | GI | NP | LNP | LGI |
|---|---|---|---|---|---|
| MARIGOLD | 1 (10 g/2 kg) | 0 | 0 | 1 | 1 |
| | 2 (20 g/2 kg) | 0 | 0 | | |
| MORINGA | 1 (10 g/2 kg) | 0 | 0 | 1 | 1 |
| | 2 (20 g/2 kg) | 0 | 0 | | |
| DIFFENBACHIA | 1 (10 g/2 kg) | 0 | 0 | 1 | 1 |
| | 2 (20 g/2 kg) | 0 | 0 | | |
| PHILODENDRON | 1 (10 g/2 kg) | 0 | 0 | 1 | 1 |
| | 2 (20 g/2 kg) | 0 | 0 | | |
| CARBOFURAN | 1 (10 g 2 kg) | 0 | 0 | 1 | 1 |
| CONTROL | 1 (10 g/2 kg) | 1 | 2,648 | 2,648 | 100 |
| LSD | | | | 0 | 0 |

**Legend:**
GI – Gall Index
NP – Nematode Population
LNP – Log. of Nematode Population
LGI – Log. of Gall Index

The comparism of the biomass responsesto carbofuran treatment and control showed no significant difference, but significant difference was observed inthe responses to the four botanical treatments except for the second level of philodendron.

As for the dry shoot weights there is significant difference between the responses to carbofuran treatments and the control. On the contrast, significant differences were observed between all the botanicals and the carbofuran treatments.

There is no significant difference between the fresh root weight responses to marigold and moringa treatments. There are no significant differences in between the responses to dieffenbachia and philodendron of the same levels. There was a significant difference observed between carbofuran and the control. Fresh root weights responses showed no significant to the botanicals and the synthetic carbofuran. This followed the same trend with the dry root weights, that is, no significant difference was observed when compared with dry root weight responses to carbofuran.

Table 8 shows the root-knot population and the gall index in *Celosia agentea*. There was no significant difference observed between the botanicals effects while there is significant difference when the botanicals effects were compared to that of the untreated control.

All the bio-preparations were found to prevent the gall formation in roots as compared to the untreated control from week 1 to 7. Contrast analysis indicated that all the four botanicals performed very well in preventing root galling compared to the control.

Infected roots in the control had more tiny knots but not stunted. Once the root was infected with the nematode more fibrous roots emerged and give hairy appearance.

The active ingredients such as the polyelectrolytes (water-soluble proteins, which carry a positive charge released through gradual decomposition of the moringa leaves acting like magnets and attracting the predominantly negatively particles (such as clay, silk, bacteria, and other toxic particles (Mesfin, 2010).

According to Peterson *et al*., (2006) *Dieffenbachia* spp. contain insoluble crystals of calcium oxalates called raphites which are poisonous to both dogs ,cats and man etc.

Flavonoids are also contained in marigold. The presence of these compounds and their concentration in the soil might be lethal to the nematodes and thereby suppressed nematode populations throughout the experimental period. Therefore, the four botanicals treatments demonstrated better nematode suppression towards the end of the growing period of celosia.

## 4. Conclusion

It can be concluded that all the ornamental plants powders (i.e. the botanicals) effectively controlled the nematodes. Any of them can be made use offor the control of nematodes in large hectares of land or they can be combined in a situation whereby one is not adequately available. For most of the botanicals, level 2 (20g / 2kg soil performed better in figures i.e. 20, 000kg or 20 tons / ha than level 1 (which is10g/2kg or 10 tons / ha).

Inferences can also be drawn from the results of this investigation that Moringa, Dieffenbachia and Philodendron plants can be tolerant or restistant to root knot nematode.

## 5. Recommendation

The botanicals, though, effectively controlled root galls formation in the Celosia roots as indicated in the results. There should therefore be further studies on both sensory evaluation of the vegetable, as well as the determination of level of Calcium oxalates (known to be poisonous) in the vegetable (celosia). The level of alpha tertianyl (which is also described as one of the most toxic naturally occurring compound) should also not be left out. This is because the absorption of the active ingredients in each of the botanicals is a possibility. The tests will therefore, show whether the celosia is safe for human consumption. All the growth indices considered showed no significant differences in their responses to the various levels of the inocula and especially when also compared with the respective control treatments.

Moringa, which is known for its medicinal values can be recommended for growing in areas where there is high infestation of root knot nematodes. It is also advisable that it can be introduced into crop rotation in order to manage root knot nematode (*Meloidogyne incognita*)

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