



*Full Length Research Paper*

## TOXICITY OF THE CONSTITUENTS OF *PARINARI POLYANDRA* ON *MELOIDOGYNE INCOGNITA* INFECTING *CELOSIA ARGENTEA*

\*<sup>1</sup>O.A. Fabiyi, <sup>2</sup>G.A. Olatunji and <sup>3</sup>T.I. Olabiyi

<sup>1</sup>Dept. of Crop Protection, University of Ilorin, Ilorin, Nigeria.

<sup>2</sup> Industrial Chemistry Dept, University of Ilorin

<sup>3</sup> Ladoko Akintola University of Technology. P.M.B 4000, Ogbomoso, Nigeria.

\*Corresponding author: [fabiyitoyinike@hotmail.com](mailto:fabiyitoyinike@hotmail.com)

Mobile: 23407064356721

---

### ABSTRACT

*Parinari polyandra* fractions were tested for their nematicidal potential in the screenhouse on *Meloidogyne incognita* (Kofoid & White) Chitwood infecting *Celosia argentea*. A factorial design incorporated into randomised complete block design was employed. *P. polyandra* ethanol fractions were significantly ( $p < 0.05$ ) more effective and compared with the standard synthetic nematicide than dichloromethane fractions and the aqueous extract. There was improved yield and vegetative production in plants treated with the highest concentration (15mg/mL) of fractions as opposed to the untreated control plants. Spectroscopic results revealed the presence of carboxylic acids, aldehyde, phenols, alpha, beta unsaturated ketones and esters in the fractions. Fractions from the bark of *Parinari polyandra* can serve as an alternative to the toxic synthetic nematicides to reduce environmental pollution.

**Key words:** *Parinari polyandra*, *Celosia argentea*, *Meloidogyne incognita*, spectroscopy

---

### INTRODUCTION

*Celosia argentea* is an important vegetable that is cultivated on a large scale in Nigeria (Denton, 2004). It is a vegetable of high economic value, particularly in the dry season, and commands market prices similar to those

of amaranth (*Amaranthus cruentus* L.).

In Nigeria, young celosia plants are sold in small bundles (0.5–1.0 kg) in main and small street markets (Denton, 2004).

It is a dark green leafy vegetable with a high content of micronutrients, comparable with amaranth (*Amaranthus*

*cruentus*). Young leaves harvested 5–7 weeks after sowing have the best nutritional value and are especially rich in Fe, vitamin A and C. The leaves contain phytic acid (120 mg/100g) and oxalic acid (20 mg/100g). Root knot nematodes (*Meloidogyne* spp) are capable of reproducing on several plants (Sasser and Freckman, 1987). The symptoms of nematode infection are the formation of root galls which results in limited growth, reduced nutrient and water uptake, wilting, weak and poor yielding plants (Abad *et al.*, 2003). *Celosia argentea* is highly susceptible to root-knot nematodes, *Meloidogyne* spp (McSorley and Frederick, 1994), causing galls on roots, unthrifty growth, small and chocolate-coloured leaves as well as reductions in yield of up to 40%. The increased production of this vegetable is constrained by nematode infection which consequently resulted in indiscriminate use of synthetic nematicides to reduce nematode population. The attendant consequence of this is serious environmental pollution which necessitated the need for alternative methods of nematode control. In view of this the bark of *Parinari polyandra* reputed for high content of bioactive chemical constituents was evaluated for possible nematicidal potential.

## MATERIALS AND METHODS

*Parinari polyandra* stem bark was collected from the University of Ilorin campus. The stem bark was air dried in the laboratory for two weeks to reduce the moisture content, after which it was divided into three equal parts (910g each) for extraction. Each part was extracted separately in ethanol

(EtOH), dichloromethane (DCM) and water (H<sub>2</sub>O). After two weeks the ethanol and dichloromethane extracts were decanted, filtered and concentrated, while the aqueous extract was allowed to evaporate to dryness at 37°C. The organic solvent extracts were chromatographed over silica gel 100-120 mesh grade. This afforded twenty four (24) fractions from the ethanol and dichloromethane extracts. These fractions were combined on the basis of retention factors as indicated on the T.L.C (thin layer chromatographic) plate, and a total of nine fractions were left. A fraction each was selected from ethanol and dichloromethane extract on the basis of quantity and polarity.

## Spectroscopic Measurements

Ultra violet-visible (U.V) of two fractions were taken on Du 730 Life Science U.V/Vis spectrophotometer Beckman Coulter, at the Chemistry Department University of Ilorin, while the Infra-red (IR) spectra of the fraction were recorded on SHIMADZU 8400s FTIR (Fourier Transform) spectrophotometer at the Chemistry Department, Redeemer's University Mowe, Ogun state Nigeria.

## Planting operations

Fertile soil was collected by scrapping the top soil. This was pasteurized using a drum at 60°C for 4hours. Thereafter it was distributed into 48 plastic buckets of 5liter capacity at 3kg in each bucket. The pots were arranged in a randomized complete block design and raised above ground level to avoid microbial contamination. *Celosia argentea* seeds were sown at a depth of

0.4cm, germination of seeds started on the fourth day, and the plants were thinned down to a plant per pot after 14days. Carbofuran 3G bought in Ilorin metropolis was applied at 0.3, 0.5 and 0.7kg/a.i/ha this was equivalent to 0.015, 0.025 and 0.035g per 3kilogram soil, while the fractions were applied at 5mg, 10mg and 15mg. Each of this was dissolved in 25mL of a non-ionic surfactant to achieve total solubility and was later sprinkled around the plant in banded form.

### Nematicidal test

*Meloidogyne incognita* race II were collected from the galled roots of *Celosia argentea*, raised at IITA, Ibadan Nigeria. The galled roots were washed free of soil particles and chopped into tiny pieces. These were incorporated into the pasteurized soil to build up the population of *M. incognita* and to serve as inoculums in the experimental pot. Three weeks after inoculation, soil samples were taken for initial nematode population count before planting. An overall average of 216 nematodes was counted in the forty eight pots.

**Phytochemical analysis:** The crude extract and fractions were tested for phytochemicals such as phenols, alkaloids, flavonoids, anthraquinones, terpenoids and steroids.

**Statistical Analysis:** All data collected were subjected to analysis of variance (ANOVA) and significant means separated with the Duncan's multiple range test.

## RESULTS

The result of the phytochemical screening confirmed the presence of secondary metabolites such as phenols, terpenoids, alkaloids, flavonoids and saponins in all the fractions, while anthraquinones and terpenoids were absent in the crude extracts.

### Spectroscopy result

U.V spectra of *Parinari polyandra* fraction absorbed at  $\lambda$  max 298. This may be for a  $\alpha$ .  $\beta$  unsaturated ketone with diverse substituent's. The infra-red spectra revealed six major peaks in the range of 600-1500 and 2800-3400  $\text{cm}^{-1}$ . The *Parinari* ethanol fraction had an OH vibration at 3421 $\text{cm}^{-1}$ . A carbonyl functional group at 1635 $\text{cm}^{-1}$ . C=C of aromatic rings at 1541 and 1458 $\text{cm}^{-1}$ . The C-O of acids is indicated by the frequency at 1076 and 1045 $\text{cm}^{-1}$ . Dichloromethane fraction showed an OH vibrating frequency at 3450 $\text{cm}^{-1}$ , aliphatic C-H stretching at 2955 $\text{cm}^{-1}$ , 2924 and 2854 $\text{cm}^{-1}$ . The peak at 1685 $\text{cm}^{-1}$  indicates the presence of carboxylic acid while 1637 $\text{cm}^{-1}$  and 1508 $\text{cm}^{-1}$  registered the C=C stretching of aromatic compounds. 1460 and 1377 $\text{cm}^{-1}$  is the C-H of alkyl groups. The bands at 1165 and 1033 $\text{cm}^{-1}$  depicts the C-O of esters and phenols.

### Screenhouse/Growth characters

The application of fractions from *Parinari polyandra* significantly ( $p < 0.05$ ) improved plant growth and the yield of treated *Celosia argentea* compared with the untreated inoculated plants (Tables 1-3). Greatest increase in yield occurred in carbofuran (CBFN) and

ethanol fraction (PAPO/EtOH) treatment, the dichloromethane fraction was however not as effective as the ethanol fraction, while plants treated with the aqueous extract had significantly ( $P<0.05$ ) lower yield. The level of application was also significant on the yield of treated plants, as plants treated with the highest level (15mg/mL) produced higher number of leaves, number of branches and plant height.

### Population Density

The different treatments significantly reduced the incidence of *Meloidogyne incognita* on *Celosia argentea* plants. In all treatments, nematode population density drastically declined compared with control (0). Maximum reduction in population was observed in plants treated with ethanol fraction and carbofuran, while the highest population of nematodes was registered in the untreated plants. Treatment with aqueous extract however had the least effect on the population density of *M. incognita*.

### DISCUSSION

The presence of phytochemicals such as alkaloids, anthraquinones, terpenoids, flavonoids, glycosides, saponin and phenolic compounds have been established in *Parinari polyandra* extracts. Vongtau *et al.*, (2004) in their research confirmed the presence of flavonoids, phenols, saponin and glycosides in the methanol extract of the stem bark of *P. polyandra*. Ighodaro *et al.*, (2012) also established the presence

of secondary metabolites in the seeds of *P. polyandra*.

Plant extracts have been tested and proved to serve as an effective alternative in the control of plant parasitic nematodes, most especially *Meloidogyne incognita*. Extracts of *Azadirachta indica* seeds have been reported to be excellent inhibitors of egg-hatch in *H. sacchari* (Salawu, 1992), while Fatoki and Fawole (1999) found ethanol extracts of *A. indica* leaves at 40,000mg/kg to significantly inhibit egg hatch of *M. incognita* and induce mortality of the second stage juveniles. Upadhyay *et al.*, (2003) in their research reported 100% mortality of *M. incognita* using extracts of leaves of *Allium cepa*, *Solanum nigrum*, and seeds of *Azadirachta indica*. Similarly, *Chenopodium album*, *Ocimum sanctum*, *Datura fastuosa*, *Digeria arvensis*, *S. nigrum* and *A. indica* caused 90% mortality of *Heterodera cajani* (Upadhyay *et al.*, 2003).

In another study, Adegbite (2011) found *A. indica* leaf extract to be a very effective inhibitor of *M. incognita* egg hatch, followed by *Chromolaena odorata*, *Nicotiana tabacum*, *Carica papaya*, *Cannabis sativa*, and *Cassia alata*. The effects of plant extracts against root knot nematode *Meloidogyne incognita* was also investigated by Sajid *et al.*, 2011, they observed a reduced population of *M. incognita* juveniles, females and egg masses in the root and soil of tomato plants treated with chillies onions and neem extracts. Trifonova and Atanasov (2011) also confirmed the effectiveness of five plant extracts on the growth of potato and population density

of potato cyst nematode *Globodera rostochiensis*. Extracts of *Nicotiana tabacum* at 0.5% and *Veratrum album* 1.0% were the most effective in reducing disease incidence to 77.8%.

The nematicidal activity exhibited by the constituents of *Parinari polyandra* could be attributed to the synergistic effect of the various compounds in the fractions as seen in the result of the infrared and U.V spectroscopy result. The decrease in

population of *Meloidogyne incognita* and also their absence in some of the pots treated with higher concentration of the plant extract are also responsible for the improved vegetative growth of *Celosia argentea* demonstrated by the result of this research. Specific isolation and characterisation of the individual compounds which are responsible for the observed nematicidal activity in *P. polyandra* is however suggested.

**Table 1: Effect of treatment and level of application of *Parinari polyandra* fractions, aqueous extract and carbofuran on plant height of *Celosia argentea*.**

| Treatments            | 4 <sup>th</sup><br>WAP | 5 <sup>th</sup><br>WAP | 6 <sup>th</sup><br>WAP | 7 <sup>th</sup><br>WAP | 8 <sup>th</sup><br>WAP | 9 <sup>th</sup><br>WAP | 10 <sup>th</sup><br>WAP | 11 <sup>th</sup><br>WAP | 12 <sup>th</sup><br>WAP |
|-----------------------|------------------------|------------------------|------------------------|------------------------|------------------------|------------------------|-------------------------|-------------------------|-------------------------|
| CBFN                  | 8.91 <sup>a</sup>      | 12.01 <sup>a</sup>     | 17.12 <sup>a</sup>     | 21.07 <sup>a</sup>     | 27.05 <sup>a</sup>     | 30.25 <sup>a</sup>     | 35.23 <sup>a</sup>      | 39.71 <sup>a</sup>      | 39.71 <sup>a</sup>      |
| PAPO/DCM              | 7.03 <sup>b</sup>      | 9.21 <sup>b</sup>      | 13.04 <sup>b</sup>     | 17.31 <sup>b</sup>     | 22.36 <sup>b</sup>     | 26.28 <sup>b</sup>     | 30.12 <sup>b</sup>      | 33.07 <sup>b</sup>      | 33.07 <sup>b</sup>      |
| PAPO/EtOH             | 9.01 <sup>a</sup>      | 11.70 <sup>a</sup>     | 16.81 <sup>a</sup>     | 20.63 <sup>a</sup>     | 26.85 <sup>a</sup>     | 30.11 <sup>a</sup>     | 35.48 <sup>a</sup>      | 39.49 <sup>a</sup>      | 39.49 <sup>b</sup>      |
| PAPO/H <sub>2</sub> O | 4.30 <sup>c</sup>      | 7.20 <sup>c</sup>      | 9.14 <sup>c</sup>      | 14.28 <sup>c</sup>     | 19.23 <sup>c</sup>     | 22.30 <sup>c</sup>     | 25.10 <sup>c</sup>      | 28.20 <sup>c</sup>      | 28.20 <sup>c</sup>      |
| S.E.M                 | 0.06                   | 0.06                   | 0.07                   | 0.07                   | 0.06                   | 0.05                   | 0.06                    | 0.06                    | 0.06                    |
| Level mg/mL           |                        |                        |                        |                        |                        |                        |                         |                         |                         |
| 0                     | 1.07 <sup>d</sup>      | 2.07 <sup>d</sup>      | 4.11 <sup>d</sup>      | 6.21 <sup>d</sup>      | 9.13 <sup>d</sup>      | 11.20 <sup>d</sup>     | 13.10 <sup>d</sup>      | 16.18 <sup>d</sup>      | 16.18 <sup>d</sup>      |
| 5                     | 3.08 <sup>c</sup>      | 4.11 <sup>c</sup>      | 7.00 <sup>c</sup>      | 9.03 <sup>c</sup>      | 14.05 <sup>c</sup>     | 16.01 <sup>c</sup>     | 18.13 <sup>c</sup>      | 22.27 <sup>c</sup>      | 22.27 <sup>c</sup>      |
| 10                    | 5.02 <sup>b</sup>      | 6.13 <sup>b</sup>      | 10.00 <sup>b</sup>     | 12.10 <sup>b</sup>     | 17.00 <sup>b</sup>     | 19.21 <sup>b</sup>     | 21.22 <sup>b</sup>      | 27.14 <sup>b</sup>      | 27.14 <sup>b</sup>      |
| 15                    | 7.30 <sup>a</sup>      | 9.12 <sup>a</sup>      | 12.14 <sup>a</sup>     | 16.00 <sup>a</sup>     | 20.14 <sup>a</sup>     | 23.08 <sup>a</sup>     | 26.09 <sup>a</sup>      | 31.16 <sup>a</sup>      | 31.16 <sup>a</sup>      |
| S.E.M                 | 0.06                   | 0.06                   | 0.07                   | 0.07                   | 0.06                   | 0.05                   | 0.06                    | 0.06                    | 0.06                    |

Means in a segment of a given column followed by the same letter are not significantly different at  $p < 0.05$  using the new Duncan's multiple range test

**Table 2: Effect of treatment and level of application of *Parinari polyandra* fractions, aqueous extract and carbofuran on number of leaves of *Celosia argentea*.**

| Treatment             | 4 <sup>th</sup><br>WAP | 5 <sup>th</sup><br>WAP | 6 <sup>th</sup><br>WAP | 7 <sup>th</sup><br>WAP | 8 <sup>th</sup><br>WAP | 9 <sup>th</sup><br>WAP | 10 <sup>th</sup><br>WAP | 11 <sup>th</sup><br>WAP |
|-----------------------|------------------------|------------------------|------------------------|------------------------|------------------------|------------------------|-------------------------|-------------------------|
| CBFN                  | 14.21 <sup>a</sup>     | 27.04 <sup>a</sup>     | 34.15 <sup>a</sup>     | 40.20 <sup>a</sup>     | 45.11 <sup>a</sup>     | 49.23 <sup>a</sup>     | 55.13 <sup>a</sup>      | 58.14 <sup>a</sup>      |
| PAPO/DCM              | 11.15 <sup>b</sup>     | 22.18 <sup>b</sup>     | 30.18 <sup>b</sup>     | 34.09 <sup>b</sup>     | 36.04 <sup>b</sup>     | 42.15 <sup>b</sup>     | 47.20 <sup>b</sup>      | 52.40 <sup>b</sup>      |
| PAPO/EtOH             | 14.04 <sup>a</sup>     | 27.15 <sup>a</sup>     | 34.11 <sup>a</sup>     | 39.91 <sup>a</sup>     | 44.85 <sup>a</sup>     | 48.70 <sup>a</sup>     | 54.91 <sup>a</sup>      | 57.79 <sup>a</sup>      |
| PAPO/H <sub>2</sub> O | 8.12 <sup>c</sup>      | 15.12 <sup>c</sup>     | 22.31 <sup>c</sup>     | 27.10 <sup>c</sup>     | 31.16 <sup>c</sup>     | 35.14 <sup>c</sup>     | 40.30 <sup>c</sup>      | 44.08 <sup>c</sup>      |
| S.E.M                 | 0.22                   | 0.22                   | 0.24                   | 0.20                   | 0.15                   | 0.17                   | 0.17                    | 0.16                    |
| Level mg/mL           |                        |                        |                        |                        |                        |                        |                         |                         |
| 0                     | 4.00 <sup>d</sup>      | 5.12 <sup>d</sup>      | 9.00 <sup>d</sup>      | 11.06 <sup>d</sup>     | 13.00 <sup>d</sup>     | 15.18 <sup>d</sup>     | 18.05 <sup>d</sup>      | 22.11 <sup>d</sup>      |
| 5                     | 6.04 <sup>c</sup>      | 8.00 <sup>c</sup>      | 13.03 <sup>c</sup>     | 14.19 <sup>c</sup>     | 16.20 <sup>c</sup>     | 21.10 <sup>c</sup>     | 24.17 <sup>c</sup>      | 29.12 <sup>c</sup>      |
| 10                    | 9.18 <sup>b</sup>      | 11.21 <sup>b</sup>     | 18.10 <sup>b</sup>     | 20.00 <sup>b</sup>     | 25.07 <sup>b</sup>     | 29.24 <sup>b</sup>     | 31.01 <sup>b</sup>      | 35.09 <sup>b</sup>      |
| 15                    | 12.07 <sup>a</sup>     | 16.15 <sup>a</sup>     | 22.16 <sup>a</sup>     | 26.15 <sup>a</sup>     | 30.01 <sup>a</sup>     | 34.11 <sup>a</sup>     | 39.19 <sup>a</sup>      | 43.00 <sup>a</sup>      |
| S.E.M                 | 0.23                   | 0.25                   | 0.24                   | 0.20                   | 0.17                   | 0.17                   | 0.15                    | 0.16                    |

Means in a segment of a given column followed by the same letter are not significantly different at  $p < 0.05$  using the new Duncan's multiple range test

**Table 3: Effect of treatment and level of application of *Parinari polyandra* fractions, aqueous extract and carbofuran on number of branches of *Celosia argentea*.**

| Treatments            | 6 <sup>th</sup> WAP | 7 <sup>th</sup> WAP | 8 <sup>th</sup> WAP | 9 <sup>th</sup> WAP | 10 <sup>th</sup> WAP | 11 <sup>th</sup> WAP | 12 <sup>th</sup> WAP |
|-----------------------|---------------------|---------------------|---------------------|---------------------|----------------------|----------------------|----------------------|
| CBFN                  | 2.3 <sup>a</sup>    | 3.9 <sup>a</sup>    | 6.6 <sup>a</sup>    | 8.1 <sup>a</sup>    | 11.4 <sup>a</sup>    | 13.3 <sup>a</sup>    | 13.3 <sup>a</sup>    |
| PAPO/DCM              | 2.0 <sup>ab</sup>   | 3.0 <sup>ab</sup>   | 4.0 <sup>b</sup>    | 5.7 <sup>c</sup>    | 8.0 <sup>c</sup>     | 10.0 <sup>b</sup>    | 10.0 <sup>b</sup>    |
| PAPO/EtOH             | 2.2 <sup>a</sup>    | 3.6 <sup>a</sup>    | 6.4 <sup>a</sup>    | 7.8 <sup>b</sup>    | 11.0 <sup>b</sup>    | 13.0 <sup>a</sup>    | 13.0 <sup>a</sup>    |
| PAPO/H <sub>2</sub> O | 0.5 <sup>c</sup>    | 1.5 <sup>c</sup>    | 2.5 <sup>c</sup>    | 4.0 <sup>d</sup>    | 5.3 <sup>d</sup>     | 7.3 <sup>c</sup>     | 7.3 <sup>c</sup>     |
| S.E.M                 | 0.13                | 0.09                | 0.10                | 0.09                | 0.15                 | 0.14                 | 0.14                 |
| Level<br>mg/mL        |                     |                     |                     |                     |                      |                      |                      |
| 0                     | 0.0 <sup>d</sup>    | 0.4 <sup>d</sup>    | 1.6 <sup>d</sup>    | 1.9 <sup>d</sup>    | 2.4 <sup>d</sup>     | 3.2 <sup>d</sup>     | 3.2 <sup>d</sup>     |
| 5                     | 0.1 <sup>c</sup>    | 1.5 <sup>c</sup>    | 2.0 <sup>c</sup>    | 2.7 <sup>c</sup>    | 4.5 <sup>c</sup>     | 6.6 <sup>c</sup>     | 6.6 <sup>c</sup>     |
| 10                    | 0.5 <sup>b</sup>    | 2.0 <sup>b</sup>    | 3.5 <sup>b</sup>    | 5.0 <sup>b</sup>    | 7.2 <sup>b</sup>     | 9.5 <sup>b</sup>     | 9.5 <sup>b</sup>     |
| 15                    | 1.5 <sup>a</sup>    | 3.0 <sup>a</sup>    | 5.3 <sup>a</sup>    | 7.8 <sup>a</sup>    | 10.5 <sup>a</sup>    | 12.2 <sup>a</sup>    | 12.2 <sup>a</sup>    |
| S.E.M                 | 0.13                | 0.09                | 0.09                | 0.10                | 0.09                 | 0.14                 | 0.14                 |

Means in a segment of a given column followed by the same letter are not significantly different at  $p < 0.05$  using the new Duncan's multiple range test

**Table 4: Effect of treatment and level of application of *Parinari polyandra* fractions, aqueous extract and carbofuran on yield attributes of *Celosia argentea*.**

| Treatments            | Shoot weight       | Root weight       | Nematode population in 200g soil | Nematode population in 10g root | Gall rating      |
|-----------------------|--------------------|-------------------|----------------------------------|---------------------------------|------------------|
| CBFN                  | 103.0 <sup>a</sup> | 49.6 <sup>a</sup> | 0.0 <sup>a</sup>                 | 0.0 <sup>a</sup>                | 0.0 <sup>a</sup> |
| PAPO/DCM              | 82.7 <sup>b</sup>  | 30.0 <sup>b</sup> | 11.3 <sup>b</sup>                | 4.0 <sup>b</sup>                | 0.0 <sup>a</sup> |
| PAPO/EtOH             | 102.6 <sup>a</sup> | 50.0 <sup>a</sup> | 0.0 <sup>a</sup>                 | 0.0 <sup>a</sup>                | 0.0 <sup>a</sup> |
| PAPO/H <sub>2</sub> O | 63.3 <sup>c</sup>  | 18.0 <sup>c</sup> | 45.4 <sup>c</sup>                | 23.0 <sup>c</sup>               | 1.7 <sup>b</sup> |
| S.E.M                 |                    |                   |                                  |                                 |                  |
| Level mg/mL           |                    |                   |                                  |                                 |                  |
| 0                     | 22.0 <sup>d</sup>  | 5.5 <sup>d</sup>  | 224.0 <sup>d</sup>               | 69.4 <sup>d</sup>               | 5.0 <sup>c</sup> |
| 5                     | 44.4 <sup>c</sup>  | 10.4 <sup>c</sup> | 14.0 <sup>c</sup>                | 2.9 <sup>c</sup>                | 1.2 <sup>b</sup> |
| 10                    | 79.8 <sup>b</sup>  | 17.8 <sup>b</sup> | 4.1 <sup>b</sup>                 | 1.6 <sup>b</sup>                | 0.0 <sup>a</sup> |
| 15                    | 100.5 <sup>a</sup> | 26.0 <sup>a</sup> | 00.0 <sup>a</sup>                | 44.5 <sup>a</sup>               | 0.0 <sup>a</sup> |
| S.E.M                 | 0.45               | 0.37              | 8.85                             | 1.16                            | 0.00             |

Means in a segment of a given column followed by the same letter are not significantly different at  $p < 0.05$  using the new Duncan's multiple range test

## REFERENCES

- Adegbite, A.A. (2011). Effects of Some Indigenous Plant Extracts as Inhibitors of Egg Hatch in Root-knot Nematode (*Meloidogyne incognita* race 2). *American Journal of Experimental Agriculture* 1(3): 96-100.
- Abad, P., Favory B., Rosso, M. and Castagnone-Sereno, P. (2003). Root-knot nematode parasitism and host response: molecular basis of a sophisticated interaction. *Molecul. Pathol.* 4:217-224.
- Denton, O.A., (2004). *Celosia argentea* L. In: Grubben, G.J.H. & Denton, O.A. (Editors). PROTA 2: Vegetables/Légumes. [CD-Rom]. PROTA, Wageningen, Netherlands.
- Fatoki, O.K. and B. Fawole (1999). *In Vitro* toxicity of some selected plant extracts on eggs and second-stage juveniles of *Meloidogyne incognita*. *African Journal of Plant Protection.* 9:83-92.
- Ighodaro, O. M., Omole, J.O., Adejuwon, A .O. and Odunaiya, A. A (2012). Effects of *Parinari polyandra* seed extract on blood glucose level and biochemical indices in Wister rats. *International Journal of Diabetes Research.* 1(4):68-72.
- Mcsorley, R. and Frederick, J.J. (1994). Response of some common annual bedding plants to three species of *Meloidogyne*. *Supplement to Journal of Nematology.* 26(4S): 773-777.
- Salawu, E.O. (1992). Preliminary studies on the effectiveness of indigenous medicinal plant extracts as inhibitors of egg-hatching of *Heterodera sacchari*, a sugarcane cyst nematode in Nigeria. 193-197, in: Proceedings of the first Regional Symposium on the Biology and Control of Nematode pests of food crops in Africa. B. Fawole, O.A. Egunjobi, S.O. Adesiyun, J.O. Babatola, A.A. Idowu (Eds.). His will Info Resources Management Limited, Ibadan.
- Sasser, J.N. and Freckman D.W. (1987). A world perspective on nematology. The role of society. In Vista in Nematology. (Eds.): J. A. Veech and D. W. Dickerson. Hyattsville. Society of Nematologist. 7-14.
- Trifonova, Z. and Atanasov, A. (2011). Control of potato cyst nematode *Globodera rostochiensis* with some plant extracts and neem products. *Bulg. J. Agric. Sci.* 17:623-627.
- Upadhyay, K.D., Dwivedi, K. and Uttam, S. K. (2003). Effect of some Plant Extracts on the mortality and hatching of *Meloidogyne incognita* and *Heterodera cajani* infesting Pigeon pea. *Nematol. Medit.* 31: 29-31.
- Vongtau, H.O., Abbah, J., Ngazal, I.E., Kunle, O.F., Chindo, B.A., Otsapa, P. A. and Gamaniel, K.S. (2004). Anti-noceptive and anti-inflammatory activities of methanolic extract of *Parinari polyandra* stem bark in rats and mice. *J. Ethnopharmacol.* 92: 317-324.