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# Effects of water extracts of Africanmarigold (*Tagetes erecta*) on the egg hatch and juvenile survival of the root knot nematode (*Meloidogyne species*).

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**Abstract**
*Root knot nematodes (Meloidogyne species) are devastating pestsin the tropics and are known to infect a wide variety of crops causing economic damage to these crops.Field experiments were carried out to generate the materials used in this laboratory experiment to investigate the effects of water extracts (50% fresh weight of plant part: water volume solution) of the African marigold Tagetes erecta on the egg hatch and juvenile survival of the root knot nematode. The research design used for the study was the Completely Randomized Design (CRD) with five treatments(leaf, stem, root, flower extracts and control), and five replications per treatment making a total of 25 treatments The set up was observed for five conservative days with data obtained squared root transformedand subjected to analysis of variance. Although some studies have shown a nematicidal action in the root of the African marigold, the current study also observed a nematicidal action in the leaf, stem and the flower extracts as well. Again it was discovered that egg hatchability was suppressed in the leaf, stem, flower and root extracts as compared with the control in that order. Besides, the study also observed a reduction in the surviving population of the juveniles in the leaf, root, stem and flower extracts as compared with the control in that order. The study recommends that African marigold (Tagetes erecta) water extract should be used by farmers for nematode control.*

***Keywords:*** *Effects; Extracts; African marigold; Root knot nematode; Egg hatch; Juveniles*

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## I. Introduction

Nematodes are, in general eel-shaped, with smooth, unsegmented bodies, without legs or other appendages. The females of some species, however, become swollen at maturity and have pear-shaped or spherical bodies (Agrios, 1988). Nematodes that are parasitic on plants belong to the order *Tylenchidaea* of the phylum *Nematoda* and have a buccal stylet, which allows them to pierce the cell wall of plants and absorb the cell content (Messiean, 1994). Plant parasitic nematodes are potentially serious constraints to crop productivity(Sasser and Carter, 1985) The estimated overall average annual yield loss of the world's major agricultural crops including maize, cassava, rice and vegetables due to damage by plant parasitic nematodes was reported to be 12.3%(Sasser, 1993). The monetary losses due to nematodes on twenty-one (21) crops were estimated at seventy-seven billion dollars annually (Sasser, 1993)

A world-widesurvey (Sasser and Freckman, l987) showed the ten (10) most important genera of plant parasitic nematodes (in order of importance) to be *Meloidogyne* (root knot nematode),*Pratylenchus* (root lesion nematode), *Heterodera* (cyst nematode), *Ditylenchus* (stem nematode), *Globodera* (cyst nematode), *Tylenchus* (citrus nematode),*Xiphinema* (dagger nematode), *Radopholus* (burrowing nematode), *Rotylenchulus* (spiral nematode) and*Helicotylenchus* (spiral nematode). Root knot nematodes are widely distributed geographically, are adapted to a very wide range of hosts and are generally recognized as causing more economic damage to food crops than any other single group of plant parasitic nematodes (Sasser and Carter, 1985)

Taxonomically, the root knot nematode *Meloidogyne* species belong to the family*Meloidogynidae* in the super-family *Tylenchidaea*of the order *Tylenchidaea*. The family is characterised by marked sexual dimorphism (Adesiyan, Caveness and Fawole, l990). Root knot nematodes are major pests in the tropical, sub-tropical and Mediterranean regions, infecting a wide variety of crops and causing economic damage than any single group of plant parasitic nematodes (Mai, 1985). Purseglove (1984) reported that, the root knot nematodes can cause serious damage to agricultural crops. Nwauzor and Fawole (1982) also reported that root knot nematodes are probably the major obstacle to the production of sufficient food and fibre crops in many developing nations including Ghana. Luc, Sikora and Bridge (1990) observed the root knot nematodes as cosmopolitan in distribution attacking crops and many weed species.Duponnois (1995) also described plant

parasitic nematodes as cosmopolitan and a major pest to crop production with the*Meloidogyne* species particularly identified as serious on vegetables.

Fifty species of *Meloidogyne* have been described (Jepson, 1987). Out of these, four (4) species namely; *M.incognita*,*M. javanica, M. arenaria,* and *M. hapla* are of economic importance in agriculture. Misari (1992) identified *Meloidogyne incognita* as one of the most devastating species causing damage to almost all crops. Among the root knot nematodes, *Meloidogyne javanica* is the most widely distributed (Sasser, 1980).Dropkin (1980) reported that *Meloidogyne* species are sedentary endoparasites which cause conspicuous root galls and growth reduction of tops in many host plants especially vegetables. Although root galls in crops can be attributed to fungal attacks, as in the case of clubroot, most are due to attacks by the *Meloidogyne* species (Messiean, 1994)

The root development of plants attacked by root knot nematodes is reduced and the photosynthates utilised for gall development. Besides, an infected plant shows nutrient deficiency symptoms, and poor yield. The damage can be aggravated by the parasite's interaction with other microorganisms such as fungi and bacteria. If the crops are manured and well irrigated, they appear to give normal yield but yields are, in effect, (15-30%) lower than they should (Messiean, 1994).

Crops form the world's main source of food; they are susceptible to diseases caused by pathogens including nematodes. It becomes obvious that control of the root knot nematode is vital for the growth of agriculture. Among the various methods available for controlling root knot nematodes are prevention of spread, crop rotation, flooding, chemical control and the use of antagonistic crops (Adesiyan *et al*, 1990) Crop rotation is difficult and sometimes an impossible task due to the wide host range of the root knot nematodes (Netscher and Sikora, 1990).

Harvey (1988) reported of non-readily availability of nematicides commonly used in the control of nematodes which are again found to be environmentally unfriendly. Furthermore, non - fumigant nematicides are not effective against eggs and in most cases they do not kill the juveniles at the concentrations now being recommended for use. Nematicides are also very expensive. For example, in the United States of America, growers spend more than hundred million dollars every year on nematicides. The use of synthetic nematicides is also associated with many hazards to human health, toxic residues in food and other produce. Coupled with these are their effects on non-target organisms.

Neher(l968) noted that, concern for the environmental and safety hazards associated with chemical nematicides has spurred research on alternative control strategies for plant parasitic nematodes. One alternative method is the use of certain non-host or intercrop plants that exude nematicidal substances into the soil.

**Research Objective**

The main objective of this study was to assess the effectiveness of the African marigold (*Tagetes erecta*) in controlling the root-knot nematode *Meloidogyne species* in crop production

Specifically, the study sought to investigate the effects of water extracts (50% fresh weight of plant part (leaf, root, stem and flower): water volume solution) of the African marigold (*Tagetes erecta*) onthe egg hatch and juvenile survival of the root knot nematode (*Meloidogyne* species).

**Research question**

What are the effects of the water extracts of the African marigold on the egg hatch and the juvenile survival of the root knot nematodes?

## II. Literature review

**Plant Parasitic Nematodes in General**

The life histories of most plant parasitic nematodes are generally, similar. Eggs hatch into juveniles, whose appearance and structure are usually similar to those of the adult nematode. Juveniles grow in size, and each juvenile stage is terminated by a moult. All nematodes have four juvenile stages, with the first moult usually occurring in the egg. After the final moult the nematodes produce fertile eggs either after mating with a male or, in the absence of males, parthenogenetically, or can produce the sperm herself.

A life cycle from egg to egg may be completed within three (3) or four (4) weeks under optimum environmental, especially temperature, conditions but will take longer in cooler temperatures. In some species of nematodes, the first or second juvenile stages cannot infect plants and depend for their metabolic functions on the energy stored in the eggs. When the infective stages are reached, however, they must feed on a prone host or starve to death. Absence of a suitable host may result in the death of all individuals of certain nematode species within a few months, but in other species the juvenile stages within a few months may dry up and remain quiescent, or the egg may remain dormant in the soil for years (Agrios, 1988).

**Root Knot Nematodes**

Infective juveniles(J2) penetrate roots at the tip in the zone of elongation behind the tip. They break into epidermal cells and usually move through the cortex and pericycle tissues. In addition, side roots may be initiated from galls. The nematodes enlarge to a sausage shape while vascular cells are transformed into giant transfer cells upon which the parasites feed. The swollen second-stage juvenile stops feeding, undergoes 3 moults in the course of a few days, and becomes an adult male or female.

The male is elongated and vermiform. It leaves the root, mates and can be found free in the soil or in proximity to adult females. The female swells into a characteristic shape with a narrow mobile head and a swollen immobile posterior. Eggs are deposited into a gelatinous egg sac behind the female, usually at root surface (Figure 1 below). The life cycle takes 3-4 weeks in favourable hosts in warm soil (25—30) °C. Eggs in egg masses survive moisture stress, and infected roots may retain reproducing nematodes for long periods after harvest. Some species reproduce by Parthenogenesis while others do not (Dropkin 1980),

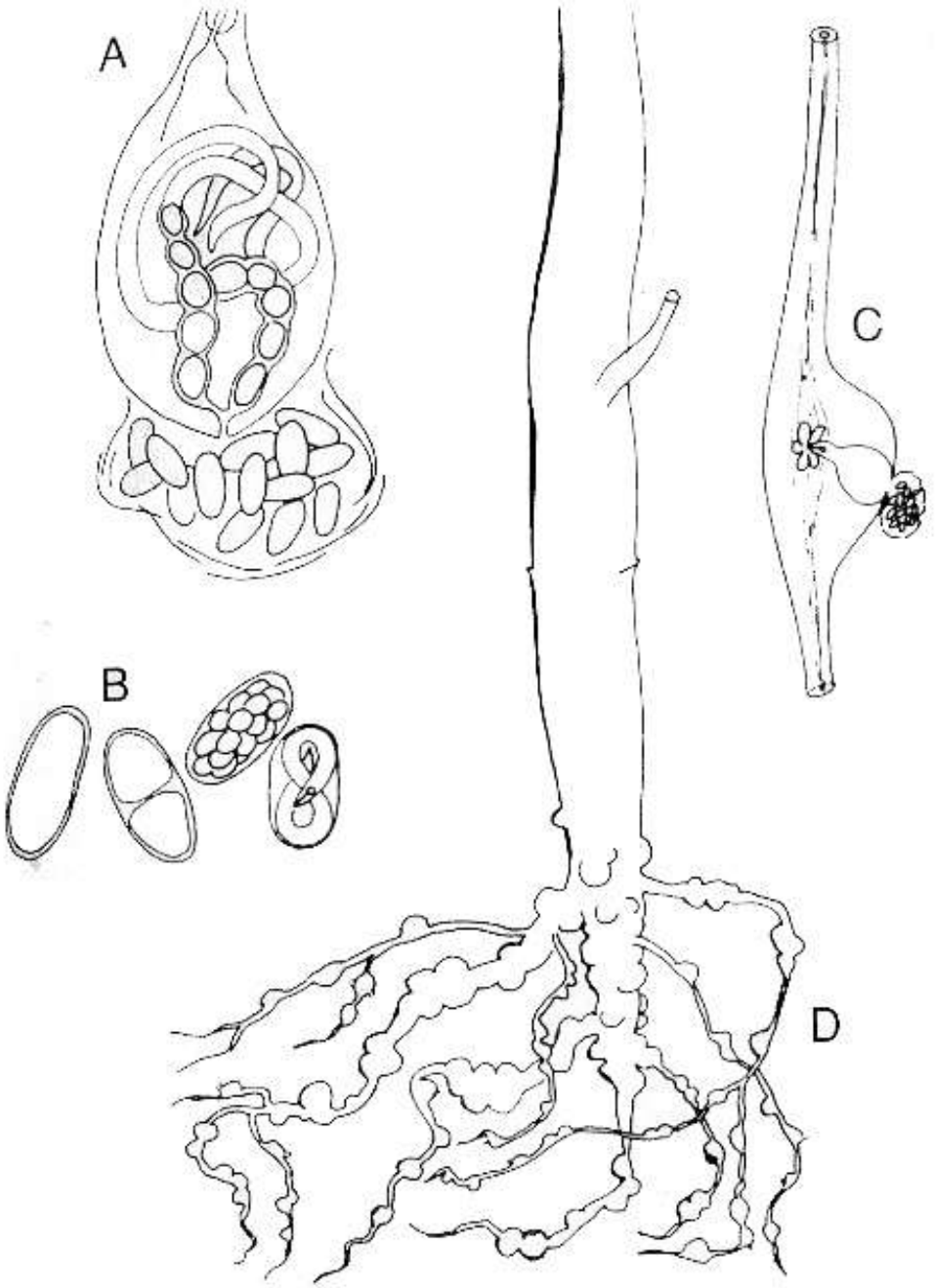


**Fig 1** Rock knot nematode (*Meloidogyne* spp).

A female and mass of eggs
B eggs at different stages of incubation
C diagrammatic cross-section of a gall
D galls on root of infected plant

**Botany of African marigold *(Tagetes erecta)***

*Tagetes erecta* (African marigold) belongs to the plant family composite. It is a native of Mexico. It is a popular, erect, spreading plant, with finely divided leaves, which reaches a height of (2.5) to (3) feet. It produces showy cream, orange or yellow flowers. The flowers are in large heads about two (2) to three (3) inches across. It is suitable as a bedding and a pot plant. It makes lovely cutflowers, although the flowers have a rather unpleasant scent. It is propagated by seeds which are sowneighteen (18) inches apart.

**Uses in Nematode Control**

Several plants have demonstrated to contain chemicals in their roots that are antagonistic to phytonematodes. The Mexican marigold, *Tagetes patula* and others of the genus have been studied extensively. Winton (1969) re-examined some of the effects of *Tagetes* species in controlling root knot nematodes. He suggested that the nematicidal principle is made up of several components in addition to thiophenes and that their concentrations vary between *Tagetes* species. The effect seems to be strongest for end parasitic root knot nematodes.

Many reports have it that different *Tagetes* species produce more or less of the nematicidal compound $\alpha$ - terthienyl (Miller and Ahrens, 1969; Hackney and Dickerson, 1975; Varma, 1978). Kanagy and Kaya (1996) observed (1%) aqueous root extract of *Tagetes patula cav.*Lemon-drop had no impact on thechemotaxisof *Steinernemacarpocapsae*compared with the control while the synthetic $\alpha$ - terthienyl at concentrations of twenty (20) and forty (40) ppm significantly reduced the number of nematodes that infected insect host. However, Mckenry and Kaku (1988) found nematicidal activity in extracts of *Tagetes tennifolia* cav. at (1.8%)

Messiaen (1994) reported that species of *Tagetes,* which exude nematicidal soil toxins, have been grown together with vegetables, as a control strategy in India. Ward (1981) also reported that, some plant species including tangerine, marigold (*Tagetes patula*) and sesame (*Sesamumindicum*) are known to produce toxic root exudates to root knot nematodes; and these have been used with limited success by intercropping with root knot susceptible crops. Yeates (l987) also observed low rate of galling, low nematodes densities and better plant growth which was attributed to the nematicidal effects of the root exudates of the *Tagetes minuta*. Furthermore, he reported that nematode control by non- host plant has been attributed to their nematicidal root exudates which are toxic, and also disrupt female taxis to roots •or male taxis to females. Mexican marigold (*Tagetes minuta)*suppressed plant parasitic nematodes in their use in intercropping systems (Hackney and Dickerson, 1975; Siddiqui and Alam, 1987; Yeates, 1987)

Gommers and Bakker (1988) reported that the roots of the marigolds and some related plants produce the nematicidal Compound α—terthienyl, known to be exuded into the rhizosphere. In an experimental setting, the cover cropping of*Tagetes* species and incorporation of their residues into the soil were found to be suppressive for *Meloidogyne incognita*on pepper (Zavaleta - Mejia, *et al* 1993) (Miller and Ahrens, 1969) and a variety of plant parasitic nematodes on tomatoes (Good *et al*, 1965).

Caswell *et al*, (l991a) reported a reduction in *Rotylenchusreniformis*, numbers in soils planted to *Tagetes patula* L., significantly greater than that of a fallow treatment. Many reports (Adenij*iet al*, 1971, and Mai, 1968) showed that antagonistic crops such as African marigold (*Tagetes* species), *Crotalaria* species and *Cynodon* species have been also used to control root knot nematodes. It has been postulated that these crops produce root exudates that contain nematicidal substances.

Oostenbrink*et al*, (1957) tested 16 varieties of *Tagetes patula* and *Tagetes erecta* placed between the rows or around other plants. They found that all varieties suppressed the populations of *pratylenchus* in the roots of other plants as well as in the soil, resulting in a better growth of perennials in the second year of the succeeding crop. The *Tagetes* species was suggested to have nematicidal action.

## III. Methodology

**Experimental Design and Treatment**

The Completely Randomized Design (CRD) with five treatments and five replications was employed. The design was selected for its comparative characteristics of simplicity, uniformity and its ease to work with. The five treatments used were as follows;

Treatment 1 (T1) ____ Control
Treatment 2 (T2) ____ Leaf extract

Treatment 3 (T3) ____ Root extract
Treatment 4 (T4) ____ Stem extract
Treatment 5 (T5) ____ Flower extract

**Materials used in the Study**

Materials used in the study include, petri-dishes, pipettes, measuring cylinders, round bottom flasks, glass blocks, plastic containers and a stereo microscope. Laboratory facilities at the Departments of Plant Pathology and Nematology of the faculty of Agriculture at the University of Science and Technology, Kumasi were used for this study.

**Analysis of Data**

All data obtained in this study were squared root transformed and subjected to Analysis of Variance (Gomez and Gomez, 1984), and where necessary treatment means were separated using the Duncan's multiple range test.

**Results**

**Raising of the African marigold**

Seeds of the African marigold were obtained from the department of horticulture of the University of Science and Technology, Kumasi. A viability test was carried out on the seeds by plating (20) seeds each in 5 petri dishes lined with filter paper moistened with water. This was to determine the seed rate. The seeds were planted on a piece of land at the Department of Agricultural Education of the University of Education, Winneba, Mampong Ashanti. The necessary cultural operation including weeding were carried out as required. The fully grown plant parts (roots, leaves, stems, and flowers) were used for making the extracts which were used for the study.

**Rearing and the Multiplication of Root Knot Nematodes**

Root knot nematode-galled Cabbage roots were collected from infested farms and chopped into smaller portions. These were incorporated into sandy loam soil in which cabbage were growing, Watering and fertilization were carried out as necessary. This was to rear and multiply the root knot nematodes in order to ensure enough of the nematodes which were used for the study.

**Sterilization of Glass Wares / Plastics**

Glasswares and plastic materials such as petri-dish, pipettes and measuring cylinders used in this study were washed thoroughly with detergent and brush, rinsed first with tap water and then with distilled water

**Test Nematode and Its extraction**

The root knot nematode *(Meloidogyne* species) inocula used in the study originated from the Department of Agricultural Education of the University of Education, Winneba, Mampong Ashanti. Heavily galled cabbage plants were uprooted carefully from the farm and taken to the laboratory in polythene bags. Eggs were extracted from the infected (galled) cabbage roots using (0.5%) Sodium hypochlorite (NaOCl) solution as described by Hussey and Barker (1973). The roots were gently washed under a jet of water to remove debris and soil particles. The galled roots were cut into (2-5) cm segments and placed in clean empty jam jars and enough (0.5%) of sodium hypochlorite added just to cover the roots. This is to release the egg masses from the gelatinous matrix inside which they are contained. The entire mixture was shaken vigorously for (3) minutes. The egg suspension in the sodium hypochlorite solution was quickly poured into a 200µm mesh sieve nested in a 500$\mu$m mesh sieve to collect the free eggs. The 500$\mu$m mesh sieve with eggs was quickly placed under a stream of cold water to remove residual sodium hypochlorite. The trap eggs were then washed with water into a beaker to settle. With the aid of a stereo microscope, a pipette and a counting dish, the number of eggs in the egg suspension was determined and standardized at 60 eggs per ml of the egg suspension.

**Preparation of the Water Extract of the African marigold (*Tagetes* erecta).**

The African marigold used in the study was obtained from the marigold field of the Department of Agricultural Education of the University of Education, Winneba, Mampong Ashanti. Fifty (50) g each of the stem, flowers, leaves, and the roots of the *Tagetes erecta* were weighed out separately.

Each weighed plant part was cut into smaller pieces and soaked in l000ml of boiling water in a beaker for 24 hours after which the resultant extract was filtered with filter paper into another beaker. The filtrate which was 5% fresh weight of plant part: water volume solution was labelled and stored in the refrigerator prior to use.

**Egg Hatch Test**

The test was carried out in a set of twenty-five (25) petri dishes arranged on a bench in the laboratory. One ml of the egg suspension containing sixty(60) freshly extracted eggs from the standardised egg suspension per unit volume was put in each of the petri dishes.

To each of them were added (20) ml of the extracts of the different plant parts while distilled water only was used for the control experiment. Each set up was replicated five (5) times. The petri dishes were partially covered to reduce evaporation rate while still providing entry of oxygen for respiration.

The effect of the extracts on the eggs were assessed by observing and counting the number of the vermiform second stage juveniles (J2) emerging from the eggs under the stereo microscope. A daily observation was made for 5 consecutive days.

**Juvenile Mortality Test**

The freshly extracted eggs were incubated in the laboratory at room temperature to hatch out the second stage juveniles from them. Twenty (20) freshly hatched juveniles were transferred to each of a set of 25 petri dishes arranged on a bench in the laboratory. Twenty (20) ml of each of the extract type were added to the petri dishes. Water was used for the control while each set up was replicated five (5) times. The number of dead juveniles was counted and recorded daily for 5 consecutive days.

**Effects of Marigold Extracts on *Meloidogyne* egg hatch**

A significant difference was observed in the mean percentage egg hatch of the root knot nematodes brought about by the various treatments for four (4) consecutive days starting from Day two (2) to Day five (5) (Table 1 below). However, there was no significant difference among the treatments for Day 1. The mean percentage egg hatch for Day 2 in the control was significantly higher than that for the leaf, root, stem, and the flower extracts. However, there was no significant difference between mean percentage egg hatch among the leaf, stem and the flower extracts.

Significant ($\rho$ = 0.05) difference in mean percentage egg hatch was observed on the Day 3 between the control and the other treatments (leaf, stem, root, and the flower extracts).

The highest egg hatch of 24.4% was obtained for the control while the other treatments had relatively lower mean percentage (leaf extract 4.4%, Root extract 5.0%, Stem extract 5.0%, and flower extract 1.6%) egg hatch.

A significant difference was observed between the control and the other treatments (leaf, root, stem, and the flower extracts) for Day 4 as the control recorded the highest mean percentage egg hatch (49.4%). The leaf, root and stemextracts also had a significantly higher mean percentage egg hatch than the flower extract which resulted in the lowest mean percentage egg hatch of (10.6%). However, the leaf (17.7%), root (17.2%), and stem (17.2%) extracts did not differ significantly among themselves.

Significant ($\rho$ = 0.05) difference was observed in mean percentage egg hatch of the root knot nematode for Day 5. The control treatment differed significantly from the leaf, stem, root, and the flower extracts. The highest mean percentage egg hatch (7l.6%) was obtained for the control while the leaf, root, stem and the flower extracts had relatively lower percentage (19.4%) egg hatch.

Similarly, as observed in Day 4 the leaf, root, and the stem extracts had a significantly higher mean percentage egg hatch than the flower extract which resulted in the lowest mean percentage egg hatch. However, the leaf (29.5%), root (27.2%) and the stem (28.3%) extracts did not differ significantly among themselves.

**Table 1: Effects of marigold Extracts on root knot nematode (*Meloidogyne species*) Egg Hatch**

| Treatment | Mean percentages (%) of egg hatch for 5 consecutive days | | | | |
|---|---|---|---|---|---|
| | Day 1 | Day 2 | Day 3 | Day 4 | Day 5 |
| Control (T1) | 0 | 11.1a* | 24.4a | 49.4a | 71.6a |
| Leaf Extract (T2) | 0 | 1.1b | 4.4b | 17.7b | 29.5b |
| Root Extract (T3) | 0 | 1.1b | 5.0b | 17.2b | 27.2b |
| Stem Extract (T4) | 0 | 0.5b | 5.0b | 17.2b | 28.3b |
| Flower Extract (T5) | 0 | 0.0b | 1.6b | 10.6c | 19.4c |

** NS = not significant

* Means with different letters are significantly different at (p = 0.05) according to Duncan's multiple Range Test.

**Effects of African marigold extracts onroot knot nematodes (*Meloidogyne species)* Juvenile Mortality**

The results that were obtained for the effects of the various marigold extracts on the juvenile mortality of the root knot nematodes are shown in Table 2 below. A significant difference ($\rho$ = 0.05) was observed in

juvenile mortality of the root knot nematodes among the various treatments (control, leaf, root, and stem extracts) for the five consecutive days.

From Table 2 for Day 1, the leaf (13.35%), root (15.0%) and the stem (15.0%) extracts recorded a higher mean juvenile mortality than the flower (5.0%) extract and the control (0.0%), though the mean percentage juvenile mortality in the flower extract (5.0%) was significantly higher than the control (0.0%). In fact, the control recorded no juvenile mortality for the first two consecutive days of the setup. Theleaf, rootand the stem extracts recorded a significantly higher mean percentage juvenile mortality than the flower (8.3%) extract and the control (0.0%) for Day 2. Similar to what was observed for Day 1, the mean percentage juvenile mortality in the flower extract (8.3%) was significantly higher than the control (0.0%). There was no significant difference among the leaf (43.3%), root (48.3%), and the stem (46.6%) extracts.

From Table 2 for Day 3, the leaf, root and the stem extracts obtained a higher mean percentage juvenile mortality of the root knot nematodes than the flower extract and the control, with the leaf extract recording the highest mean percentage juvenile mortality of (76.6%) and the control the least mean percentage juvenile mortality of (6.6%). The flower extract (28.3%) also differed significantly from the control. However, there was no significant difference among the leaf (76.6%), root (75.0%) and the stem (75.0%)extracts. Significant difference was also observed among the treatments for Day 4. The leaf, root and the stem extracts differed significantly from the flower extracts and the control. However, the mean percentage juvenile mortality in the flower extract (60%) was significantly higher than the control (11.6%). The leaf (90%), root (86.6%), and the stem (88.3%) extracts did not differ significantly among themselves.

Similarly, from Table 2 for Day 5, the leaf, root, and the stem extracts obtained a higher mean percentage juvenile mortality than the flower extract and the control. However, there was no significant difference among the leaf, root, and the stem extracts. The leaf extract recorded the highest mean percentage juvenile mortality of 100% followed by the root extract (98.5%), the stem extract (95%) and the flower extract (73.5%) while the control recorded the least mean percentage juvenile mortality of 15. The flower extract recorded a significantly higher percentage juvenile mortality from the control.

**Table 2: Effects of African marigold Extracts on Juvenile Mortality of the Root Knot Nematodes (*Meloidogyne* species)**

| Treatment | Mean percentages juvenile mortality for 5 consecutive days | | | | |
|---|---|---|---|---|---|
| | Day 1 | Day 2 | Day 3 | Day 4 | Day 5 |
| Control (T1) | 0.0c* | 0.0c | 6.6c | 11.6c | 15.0c |
| Leaf Extract (T2) | 13.3a | 43.3a | 76.6a | 90.0a | 100.0a |
| Root Extract (T3) | 15.0a | 48.3b | 75.0a | 86.6a | 98.5a |
| Stem Extract (T4) | 15.0a | 46.6a | 75.0a | 88.3a | 95.0a |
| Flower Extract (T5) | 5.0b | 8.3b | 28.3b | 60.0b | 73.5b |

* Means with different letters are significantly different at ($\rho$ = 0.05) according to Duncan's multiple Range Test.

## IV. Discussion

Various marigold extracts had a significant effect on the egg hatch and juvenile mortality of the root knot nematode *(Meloidoqyne* species). The controlled had significant highest mean percentage egg hatch because no marigold extract was applied. Marigold extract treatments resulted in lower mean percentage egg hatched when compared with the controlled. The controlled recorded the least mean percentage juvenile mortality when compared with the marigold extract treatments. The flower extract treatment resulted in a lower juvenile mortality than the other marigold treatments.

These observations indicated that there is a nematicidal component in the various marigold water extracts which is capable of preventing the root knot nematode, particularly the infective juvenile, population build—up by disrupting eggs hatched and juvenile survival. This supports the findings by Messiean(1994), Miller and Ahrens (l969), Hackney and Dickerson (l975), that species of *Tagetes* had nematicidal action on the root knot nematodes (*Meloidogyne* species) in soil planted with them.

Research carried out by Mckenry and Kaku (1988) also confirmed a nematicidal activity in a 1.8% extract of *Tagetes tennifolia* Cav. Besides, Oduor-Owino, *et al* (l996), similarly observed that *Tagetes minuta* L. and other antagonistic plants stimulated egg parasitism of the *Meloidogyne javanica* by the fungus *Paecilomyceslilacinus* (Thom) Samson. However, Kanagy and Kaya (1996) reported that 1% aqueous extract (root fresh weight: water volume solution) of *Tagetes patula* L. cv lemon drop had no impact on either chemotaxis and infectivity of *Steinernema carpocapsae* and *s. glaseri* respectively through a sound column

compared with the control while the synthetic α-terthienyl at concentrations of 20 and 40 ppm significantly reduced the number of nematodes that infected insect host.

Odour-Owino, *et al* (1996) also reported that galling index and the population of nematode juveniles were lower at (P=0.05) in soils treated with aldicarb or planted with *Tagetes minuta* and other antagonistic plants. This was confirmed as the researcher also observed a reduction in the surviving (live) population of the juveniles of root knot nematodes in the leaf, root, stem and the flower extracts in agreement with the findings from the investigations made by Zavaleta - Meijia*et al,* (1993) that the marigold extracts have a nematicidal effect.

The nematicidal active principle in marigold has been reported to be concentrated in the root (Winoto, 1969). The findings from this current study supports this assertion and also indicated a nematicidal activity in the leaf, shoot, and the flower extracts as well

**The following were the findings of the study**

- The treatments showed no impact on the egg hatch of the root knot nematode on day one of treatment application.
- The study revealed a nematicidal activity in the leaf, root, stem and flower extracts of the African marigold.
- Egg hatchability was suppressed in the leaf, stem, flower and the root extracts as compared with the control in that order
- A reduction in the surviving population of juveniles was observed in the leaf, root, stem and flower extracts as compared with the controlled in that order.
- The varied degrees to which the treatments inhibited egg hatch and enhanced juvenile mortality suggest that the leaf, root, stem, and flower extracts have different inhibitory potency
- Although some studies have showed a nematicidal action in the root of the African marigold, the current study observed a nematicidal action in the leaf, stem and the flower as well.

## V. Conclusion

From the findings of study, it can be concluded that African marigold water extracts has effect on the root knot nematode by suppressing the egg hatch and enhancing juvenile mortality. Based on the conclusion from the study, it is recommended that African marigold (*Tagetes erecta*) water extracts should be used by farmers for nematode control. Farmers should intercrop with the African marigold on their farms to suppress the activities of root knot nematodes

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