

INFECTIVITY OF *MELOIDOGYNE* SPECIES ON SOYBEAN (*GLYCINE MAX* L.) UNDER DIFFERENT COMMERCIAL INORGANIC INSECTICIDES.

OGWULUMBA S.I., ARIRI F.C. AND OKON D.N.

DEPARTMENT OF CROP PRODUCTION TECHNOLOGY, FEDERAL COLLEGE OF AGRICULTURE
ISHIAGU, EBONYI STATE, NIGERIA.
EMAIL: SOLOOGWULU@GMAIL.COM

ABSTRACT

Soybean is one of the important leguminous crops growing in various parts of Nigeria. Its cultivation is challenged seriously by root knot nematodes. This experiment was designed to investigate the efficacies of some commercial insecticides in controlling root knot nematodes infecting soybean in 2020 and 2021. The commercial insecticides used according to manufacturers specifications were; Worm force at 33kg/ha (carbofuran), Mite force at 500ml/ha (Abamectin and Acetamprid), Clofos at 2.5kg/ha (Chlorpyrifos) and Control (no pesticide). The insecticides were randomly fitted in to randomized complete block design (RCBD) replicated three times. Data were collected on plant height (cm) and number of leaves at 3,6, and 9 weeks after planting, number of pods, weight (kg) of pods, number of galled roots, number of galls per root (gall index) and nematode population per 100g soil. Data collected were averaged over the two years and subjected to analysis of variance with significant treatment means separated using least significant difference at 5% level of probability. Results showed that that application of the insecticides significantly ($P<0.05$) reduced the number of galled roots, number of galls per root and nematode population per 100 g soil while the plant height across the weeks, number of leaves at 3 weeks after planting, number and weight of pods at harvest were significantly ($P<0.05$) enhanced when compared with the control plots. Worm force (carbofuran) however performed better than other insecticides and control and it is therefore recommended to farmers.

Key words: commercial insecticides; root knot nematode; control; infectivity

INTRODUCTION

Soybean (*Glycine max* L.) is a leguminous vegetable of the pea family; *Leguminosae*, that grows in tropical, sub-tropical and temperate climates. Soybean is among the major industrial and food crops grown in every continent (Gibson and Benson, 2005). The crop can be successfully grown in many states in Nigeria using low agricultural input. Gai, (2000) stated that it is an important cash crop in the legume family giving relatively high returns for a limited land area and is well adapted to the hot semi-arid condition characterizing many of the regions where it is grown.

Soybean (*Glycine max* L.) ranks as the third most important oil food grain legumes after cow pea and groundnut in the developing countries especially in the tropical northern parts and to a limited extent in the southern part of Nigeria, where it is mainly grown both at the subsistence and commercial levels. Soybean requires few inputs for its production and it increase soil fertility by fixing nitrogen (that is, legume feature), making it an approximate choice in the low input agricultural systems that are prevalent among many small-scale farmers in Africa especially Nigeria (FAO, 2009).

Natarajan *et al.* (2006) , Ogwulumba and Okonta (2015) reported that the major problem of soybean is pests and diseases which do not only cause low yield but also discourage most farmers from cultivating the crop. One of the major limiting factors to the profitable soybean production is the damage caused by plant- parasitic nematodes especially *Meloidogyne* species (Ogwulumba and Okonta, 2015; Mousai; 2012). The most predominant species of root nematode are *M. javanica*, *Meloidogyne incognita* and *M. arenaria*. They are notoriously difficult to control because of their wide host range and high rates of reproduction (Khan *et al.*; 2003). *Meloidogyne* species causes severe yields losses of more than 90% in high population (Abad *et al.*, 2008; Nicol *et al.*, 2011). This is mainly as a result of root deformation which diminishes their function and predisposes plants to pathogens. It affects crops directly and indirectly by their function with various soil borne fungi, bacteria and viruses (Khan *et al.*; 2008). The extent of damage is influenced by the cultivar, nematode species, level of soil infestation and environment. Root knot nematodes infect roots of soybean plants resulting in considerable yield losses, which are usually associated with conspicuous galls that disrupt water and nutrient uptake (Caveness *et al.*, 2000).

The objective of this study was to assess the infectivity of *Meloidogyne* species on soybean under different commercial inorganic insecticides. The research sought to evaluate the nematicidal potentials of the commercial insecticides against *Meloidogyne* species attacking soybean in Ishiagu.

MATERIALS AND METHODS

Site description

The experiment was conducted at the research and teaching farm of Federal College of Agriculture Ishiagu, Ebonyi State during the 2020 and 2021 cropping seasons. The study area lies within latitude 05° 56' N and longitude 07° 04' E in the derived savannah zone of the Southeastern Nigeria. The area is an ultisol and has a mean annual temperature of about 30°C, rainfall of 1350 mm with relative humidity of 88% (Nwite *et al*; 2008).

Experimental Materials and Source

The commercial inorganic insecticides used were: Mite force, Worm force and Clofos. Susceptible local soybean variety seeds were obtained from the local farmers.

Experiment Design and Layout.

The treatments used were the commercial insecticides with the untreated plots serving as control. The experimental design was Randomized Complete Block Design (RCBD) with the three treatments and the control replicated three times. The experimental area in each year was 7 m x 10.5 m (73.5 m²). The total area was divided into three blocks containing four plots each. Twelve (12) plots measuring 1 m X 2 m were constructed in each area. The row distance between blocks was 1m spacing and 0.5m spacing between plots.

Treatment Allocation

The various pesticides were used according to manufacturer's specifications thus.

Treatment1 = Worm force at 33kg/ha (0.0066g/plot size (carbofuran))

Treatment 2 = Mite force at 500ml - hectare (0.01ml/ plot size) (Abamectin and Acetamprid)

Treatment 3 = Clofos at 2.5kg per hectare (0.005g/plot size) (Chlorpyrifos)

Treatment 4 = Control (no pesticide)

Planting/Sowing

The soybean seeds were sown directly into the field, at a spacing of 50 cm by 50 cm on the bed at the rate of two seeds per hole which were thinned down to one, two weeks after germination. This gave eight (8) stands per plot and a projected plant population of 40,000 stands per hectare.

Weeding

Regular weeding was carried out as at when due depending on the rate of weed emergence with

hands. No herbicide was applied throughout the period of the experiment.

Extraction of Root-Knot Nematode.

100g soil sample was collected at each Experimental plot; the soil was collected at the middle of each plot at the depth of 20cm. Then each of the soil lumps was spread and wrapped with two lays of facial tissue and placed inside a 2mm sieve and was placed on top of a plastic basket. Then, water was poured through sieve to an extent the water level is touching the bottom of the sieve (USDA, 2007). This setup was left to stand for 3 days, a pipette, 5ml was pipette and poured into the nematode counter dish and was placed on a binocular microscope for viewing after which it was decanted to a certain level (100ml). Then, using a pipette, and poured 5ml was pipetted and poured into the nematode container dish and was placed on a binocular compound microscope for viewing.

Data Collection

The following parameters were collected.

- i. Plant height (cm): This was determined by measuring the height of soybean crop using meter rule from the base to the tip of the plants in each plot at 3,6,and 9 weeks after planting.
- ii. Number of leaves: The total numbers of leaves per plant were determined on each of the plants on the plots at 3, 6, and 9 weeks after planting.
- iii. Number of pods: The total number of soybean pot per plant was determined on the plants on the plots at harvest.
- iv. Weight (kg) of pods: This was determined by weighing the pods harvested per plot on the land area using a weighing balance.
- v. Number of galled roots per treatment at harvest: This was determined by counting the number of galled roots harvested per plot on the land area.
- vi. Number of galls per root (gall index) at harvest: This was counted on a scale as described by Ogwulumba and Okonta (2015) thus:

0	= No galls	= No infection
1	= 1- 10 galls	= Mild infection
2	= 11-20 galls	= Moderate infection
3	= 21-30 galls	= High infection
4	= 31-40 galls	= very high infection
5	= 41-50 galls	= severe infection
6	= >51 galls	= Very severe infection.
- vii. Nematode population density in 100g soil per treatment at harvest.

Statistical Analysis

The data collected were averaged over the two years and subjected to the analysis of Variance (ANOVA). Significant treatment means were separated using

LSD at 5% level of probability as stated in Obi, (2002).

RESULTS

Effect of commercial pesticides on plant height (cm) at 3, 6, and 9 weeks after planting

In table 1, the result obtained showed that both worm force and clofos had significant ($P < 0.05$) effect on

the plant height at 3, 6 and 9 weeks after planting (WAP). However the height plant of 34.6 cm was obtained from the plot treated with worm force, followed by the plot treated with clofos (31.9cm), while the least plant height of 15.5cm was obtained from the control plots.

Table 1: Effect of commercial pesticides on plant height (cm) at 3, 6 and 9 weeks after planting.

Treatment	3WAP	6WAP	9WAP
Worm force	15.9	25.8	34.6
Mite force	10.0	15.6	22.7
Clofos	15.5	24.4	31.9
Control	9.4	14.2	15.5
LSD (0.05)	1.98	6.81	7.91

LSD = Least Significant Different

WAP = Weeks After Planting

Effect of commercial pesticides on number of leaves at 3, 6, 9, weeks after planting

In table 2, the result obtained showed that worm force and clofos had significant ($P < 0.05$) effect on the plant number of leaves at 3 weeks after planting (WAP) but at 6,9 weeks after planting all the

treatment were statistically the same. However, worm force had the highest number of leaves (87.5) followed by the clofos (83.2) while the control plot had the least number of leaves (48.0), mite force had (59.5) number of leaves.

Table 2: Effect of commercial pesticides on number of leaves at 3, 6, and 9 weeks after planting.

Treatments	3WAP	6WAP	9WAP
Worm force	11.1	41.9	87.5
Mite force	8.6	24.9	59.5
Clofos	11.0	28.6	83.2
Control	6.1	17.8	48.8
LSD (0.05)	2.21	NS (figure)	NS figure

LDS = Least Significant Different

WAP = Weeks After Planting

Effect of commercial pesticides on the weight and number of pod of soybean.

The result obtained in table 3 showed significant effect ($P < 0.05$). The highest number of pod was obtained from the plot treated with worm force (799.2) followed by clofos (433.2), the least number of pod was obtained from the plot control plot (163.3).

In table 3, it was also observed that there was significant effect ($p < 0.05$) among the treatments on the weight of pod of soyabean. However, the highest weight of 4.08 kg was obtained from plot treated with worm force, followed by plot treated with clofos (2.26kg) and then mite force (1.57kg), while the least weight of pod was obtained in the control plot (0.87kg).

Table 3: Effect of different commercial pesticides on the weight and number of pod of soyabean.

Treatment	Number of pod	Weight (kg)
Worm force	799.2	4.08
Mite force	326.7	1.57
Clofos	433.2	2.26
Control	163.3	0.87
LSD (0.05)	168.73	1.30

LSD = Least Significant Difference

WAP = Weeks After Planting

Effect of different commercial pesticides on number of galled root and number of galls per root.

In table 4, the result obtained showed that the treatments had significant ($P < 0.05$) on the number of galled roots and galls per root at harvest. However

the control plot had the highest number of gall per root (2.833). This was followed by plot treated with mite force (1.625) and then plot treated with clofos (0.708), while the plot treated with worm force (0.075) had the least number of galls per root.

The result also showed significant ($p < 0.05$) different among the treatments applied. However, the control

plots had the highest number of galled root with a mean value of 4.211. This was followed by plot treated with mite force (2.233) and then followed by plots treated with clofos (1.502), while the least galled root was obtained from the plots treated with mite force (1.069).

Table 4: Effect of different commercial pesticides on number of galled root and number of galls per root

Treatment	Number of Galls Per Root	Galled Root
Worm force	0.075	1.069
Mite force	1.625	2.233
Clofos	0.708	1.502
Control	2.833	4.211
LSD (0.05)	0.81	1.10

LSD = Least Significant Difference

WAP = Weeks After Planting.

Effect of different commercial pesticides on soil nematode population

The result obtained from table 7 showed that treatments had significant ($P < 0.05$) effect on nematode populations. The highest nematode

population was obtained from the control plot with the mean value of 7.76, while the plots treated with worm force had the least the nematode population.

Table 7: Effect of different commercial pesticides on soil nematode populations/100g soil

Treatment	Nematode Population
Worm force	1.71
Mite force	3.12
Clofos	3.06
Control	7.76
LSD (0.05)	2.59

LSD = Least Significant Difference

WAP = Weeks After Planting.

DISCUSSION

The result of this work also shows that plots treated with worm force (carbofuran) significantly influenced the growth and yield performance of soybean. The commercial pesticides increased the plant height and number of leaves produced by the plants on the treated plots. They also significantly increased the number of pods and weight of pods of soybean at harvest. Therefore, this implies that the application of carbofuran suppressed the activities of root knot nematodes around the plants allowing the improvement of the growth and yield attributes of the plants in the treated plots. The results agreed with the findings of other researchers who recorded increased growth and yield parameters of crops with application of carbofuran (Adegbite and Agbaje, 2007; Akinlade and Adesiyani, 1992; Adegbite and Adesiyani, 2001; Adekunle, and Fawole, 2003).

The insecticides suppressed the rates of infection of the nematodes on the plants when compared with the plants from the control plots. The plants from the control showed the clear evidence of the susceptibility of the crop to root knot nematodes and their presence in the study areas. However, the

application of carbofuran was more effective in controlling root knot nematodes (*Meloidogyne incognita*) of soybean when compared with other insecticides and control. This was shown by the reduced number of galled roots and gall index observed on the plots treated with clofos (carbofuran). This lent more credence to the works of Adekunle and Fawole (2003) and Adegbite and Adesiyani (2001). The low number of galled root and number of galls per root observed in the treated plots compared to that of the control suggests the phytotoxicity effect of the chemical on *Meloidogyne* species in the soil. It was earlier on reported that carbofuran has some phytotoxicity effect on the roots of tomato (Crozzoli and Diego, 1991). However application at planting might reduce the population of nematodes early enough and ensure that nematodes present in the soil that may reduce growth and yield will be fewer in number. If the application is delayed, there may be more nematodes in the soil at an early stage, which will affect early growth and subsequent performance of the crop.

CONCLUSION

In conclusion, this work revealed that some of these commercial insecticides also contain nematicidal properties. They are not limited to insecticidal efficacies alone and could be employed in the control/management of *Meloidogyne* infections in most crops. Mite force could be employed in the control of root knot nematodes in soy bean farms.

REFERENCES

- Abad P., Gouzy J., Aury J.M, Castagnone-Sereno P., Danchin E.G.J, Deleury E. (2008) Genome sequence of the metazoan plant-parasitic nematode *Meloidogyne incognita*. *Nature Biotechnology* 26, 909–915
- Adegbite A. A. and Agbaje, G. O. (2007) “Efficacy of carbofuran in control of root-knot nematode (*Meloidogyne incognita* race 2) in hybrid yam varieties in southwestern Nigeria,” *Electronic Journal of Environmental, Agricultural and Food Chemistry*, vol. 6, no. 6, pp. 2083–2094, 2007.
- Adegbite A. A. and S. O. Adesiyon, (2001) “Effect of Carbofuran (Furadan) on the performance of four Nematode susceptible varieties of soybean (*Glycine max* (L.) Merr,” *Tropical Oilseeds Journal*, vol. 6, pp. 11–23.
- Adekunle O. K. and Fawole, B. (2003) “Chemical and non chemical control of *Meloidogyne incognita* infecting cowpea under field conditions,” *Moor Journal of Agricultural Research*, vol. 4, no. 1, pp. 94–99.
- Akinlade, E. A. and Adesiyon, S. O. (1992) “The efficacy of Carbofuran in controlling *Meloidogyne incognita* on Okra (*Abelmoschus esculentus*),” *Nigerian Journal of Pesticides and Agricultural Chemical*, vol. 1, pp. 22– 27.
- Caveness F.E, Olayode G, Couper D.C & Claassen S.L. (2000) Nematodes in soybean plot identified, yield losses assessed. IITA Research Briefs 8, 4.
- Crozzoli P. and Diego, R. G. (1991) “Control of the root-knot nematode, *Meloidogyne incognita* (Kofoid and White, 1919) Chitco 1994,” in *Tomatoes Treated with Cincocin and Carbofuran*, <http://www.agrisciences.com/pdf/DATA/R214.pdf>.
- FAO, (2009), UN Food and Agriculture Organization, in: *Wikipedia*. org/wiki/soybean; Accessed, 23/09/2011
- Gai, M.A. (2000) Legume Production in Semi-Arid Areas: Comparative Study of the Physiology of Drought Tolerance in Common Bean (*Phaseolus vulgaris* L.) and Mungbean (*Vigna radiate* (L.) Wilczek). A thesis submitted to McGill University in partial fulfilment of the requirements of the degree of doctor of philosophy.
- Gibson, L. and Benson, G. (2005), Origin, History and uses of soybean (*Glycine max*): Department of Agronomy, Iowa State University. *Wikipedia*.
- Khan, A.Z., P. Shah, S.K. Khalil and F.H. Taj, (2003). Influence of planting date and plant density on morphological traits of determinate and indeterminate soybean cultivars under temperate environment. *J. Agron.*, 2: 146-152.
- Khan, H. Khan, A.Z., Khan, R. Matsue N. and Henmi, T. (2008). Soybean Leaf Area, Plant Height and Reproductive Development as Influenced by Zeolite Application and Allophanic Soil. *Journal of Plant Sciences*, 3: 277-286.
- Mousai M.D. (2012). Evaluation of foliar fungicides and insecticides on soybean in 2011. ICM news Jan 8, 2012.
- Natarajan SS, Xu CP, Bae H, et al. (2006) Characterization of storage proteins in wild (*Glycine soja*) and cultivated (*Glycine max*) soybean seeds using proteomics analysis. *J. Agric Food Chem.* 54(8):3114–3120. doi: 10.1021/jf052954k.
- Nicol J.M, Turner S.J, Coyne D.L, Nijs L.D, Hockland S. & Maafi Z.T. (2011) Current Nematode Threats to World Agriculture. In: *Genomics and Molecular Genetics of Plant-Nematode Interactions* (Eds Jones J, Gheysen G & Fenoll C), pp. 21–43. Springer, Dordrecht (NL)
- Obi, I.U. (2002), Statistical methods of detecting differences between treatments means, SNAAP Press, Enugu, Nigeria, VI + 45 pp.
- Ogwulumba, S.I. and J.I. Okonta, (2015). Management of *Meloidogyne incognita* infections on soybean (*Glycin max*) with *Jatropha curcas* leaf powder as soil amendment in Ishiagu, Nigeria. *Int. J. Agric. Rural Dev.*, 18: 2327-2330.
- U.S. Department of Agriculture (USDA) (2007). National Agricultural Statistics Service. *Vegetables 2006 Summary*33