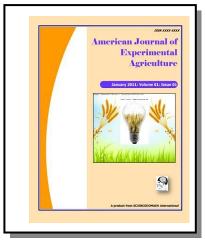

American Journal of Experimental Agriculture
1(3): 79-85, 2011

SCIENCEDOMAIN *international*
www.sciencedomain.org

Assessment of Yield Loss of Cowpea (*Vigna unguiculata* L.) due to Root Knot Nematode, *Meloidogyne incognita* under Field Conditions

Ayodele Adesina Adegbite[1]*

[1]*Institute of Agricultural Research and Training, Obafemi Awolowo University, P.M.B. 5029, Moor Plantation, Ibadan-Nigeria.*

Research Article

Received 2nd January 2011
Accepted 2nd February 2011
Online Ready 28th February 2011

ABSTRACT

The root knot nematodes are included within the genus *Meloidogyne* Goldi, 1892 and belong to a relatively small but important polyphagous group of highly adapted obligate plant pathogens. Typically, they are distributed worldwide and parasitize nearly every species of higher plant. Due to their endoparasitic way of living and feeding, root knot nematodes disrupt the physiology of the plant and may reduce crop yield and product quality and, therefore, are of great economic importance and make control necessary. Field studies were conducted in 2008 and 2009 to determine yield loss of cowpea (cv. ART98-12) due to natural infestation by *M. incognita* using Carbofuran 3G at 2kg a.i./ha and untreated as check. The yield of cowpea was found to be higher with the application of nematicide-Carbofuran 3G at 2kg a.i. /ha. The percentage increase over control was 39.0 and 33.0% in the years 2008 and 2009, respectively. A significant reduction in the yield of cowpea in untreated plots was mainly attributed to direct damage of the root system by the feeding of root-knot nematode, *M. incognita*. The root knot nematode population in carbofuran treated plots was significantly lower than in check in the two years, also at harvest. In the check the nematodes reproduced many folds during the cropping season. Higher nematode population in the untreated check decreased plant growth and consequently reduced the number of harvested seeds and other agronomic parameters.

Keywords: Carbofuran, Cowpea, field conditions, Meloidogyne incognita, root-knot nematode, yield loss;

**Corresponding author: Email: ayodeleadegbite@ymail.com*

1. INTRODUCTION

Root knot nematode, *Meloidogyne incognita* is a serious pest of cowpea, *Vigna unguiculata* (L.) Walp. in most growing areas of the world (Sikora et al., 2005). This nematode constitutes a major constraint to cowpea production (Sikora and Greco, 1990). Symptoms of damage induced by root-knot nematode include patches of stunted and yellowed plants, presence of root galls, excessive branching of roots, and reduced root systems. Poor germination and death of seedlings may be observed in cases of heavy infestations (Mishra, 1992). *M. incognita* in Georgia cowpea fields caused an estimated 5-10% yield loss; all other species detected were sporadic in occurrence, with losses estimated at below 1% (Toler et al., 1963). In India, the threshold level, determined in glasshouse studies in sterilized soil, was 100 juveniles of *M. incognita*/500g soil (Sharma and Sethi, 1975), with significant yield reduction occurring at 2 juveniles/cm^3 of soil (Sarmah and Sinha, 1995). Visual symptoms of damage first occurred at 1000 and 10,000 juveniles/500g of soil. In Venezuela, the tolerance limit of the susceptible cv. Manuare was 0.03 eggs and juveniles/cm^3 of soil for *M. incognita* race 2, while the resistant cv. Ojito Negro tolerated up to 0.74 eggs and juveniles/cm^3 of soil. Maximum yield reductions were 72% for the susceptible cultivar and only 20% for the resistant cultivar (Crozzoli et al., 1997; 1999).

The root knot nematode, *Meloidogyne incognita* was first reported in Nigeria on cowpea in 1958 and documented in 1960 (Anon, 1961). Bridge (1972) reported a yield loss of 40% and Olowe (1976) demonstrated a yield reduction of 25% at inoculums level of 133 eggs of *M. incognita* per kg of soil or a 91% reduction with 13,300 eggs per kg soil. Similarly, Caveness (1973) and Ogunfowora (1976) reported yield loss of 20% and 50% respectively, due to infestation by *M. incognita*. A cowpea grain yield loss of 69% caused by root knot nematode was also reported (Babatola and Omotade, 1981). Heavy infestation of cowpea by *M. incognita* led to early senescence of the crop (Olowe, 1978).

Cowpea (*Vigna unguiculata* (L.) Walp. is known in the dry grain form as black-eyed pea, southern bean, China pea and marble pea, and in the green pod form as yard-long bean, asparagus bean, Bodi bean and snake bean. It is an annual plant with a great deal of varietal variation, including climbing, bushy prostrate and erect forms that probably originated in Africa or South-east Asia. It is an important food legume and essential component of cropping systems in the drier regions of the tropics and subtropics (Singh *et al*., 2003) and is important to the livelihood of millions of people (Quin, 1997).

The importance of cowpea in the farming systems of south western Nigeria cannot be over emphasized. The plant is used mainly for dried seeds; the plant is also used as a vegetable, pot herb and green manure. It is usually grown under rainfed conditions on well drained soil. The plant is often intercropped with cereals, especially maize, sorghum and millet and can be planted without land preparation.

Recently, several breeding lines of cowpea have been developed in Nigeria, but little is known about their reaction to root knot nematodes. Therefore it was felt desirable to report the yield loss of this newly released cowpea (ART98-12) due to *M. incognita* for two consecutive years.

2. MATERIALS AND METHODS

Field experiments were conducted in 2008 and 2009 on the same plots at the Institute of Agricultural Research and Training, Obafemi Awolowo University, Moor Plantation, Ibadan, Nigeria, located at 3^{o}54'E 7^{O}30'N. Annual rainfall is 1220mm and the daily mean temperature is 28^{o}C±2^{o}C.

The soil is coarse loam, greyish brown in colour, friable and is classified as Rhodic Harplustalf, Iwo series (USDA, 1990). The experimental site had been previously cultivated for three years with kenaf (cv. Cuba 108), which is very susceptible to root knot nematode (Adegbite *et al.,* 2008a). The experimental plots were naturally infested with *M. incognita* (about 345 and 438 juveniles per 250 cm^3 soil sample at planting during 2008 & 2009, respectively. The identity of *M. incognita* was confirmed using perineal patterns, as race 2, as described by Eisenback *et al.* (1981). One newly released cowpea variety (ART98-12) was used, obtained from the Grain Legumes Improvement Programme of the Institute of Agricultural Research and Training, Obafemi Awolowo University, Moor Plantation, Ibadan, Nigeria. The experiment was laid out in a randomized complete block design with four replications and plots measuring 10m x 5m, each consisting of five rows. The field was ploughed and harrowed, and the seeds were planted on the prepared field. Plant spacing was 60 cm x 30 cm with two seeds per hole. The seeds were not treated with pesticides. Weeds were removed manually, 4 and 8 weeks after planting. Basal application of fertilizer was carried out on the plots two weeks after planting, using NPK (15:15:15) and single superphosphate at a rate of 120 kg N, 50 kg P_2O_5 and 50 kg K_2O/ha. Also Carbofuran 3G was applied at 2kg a.i./ha in planting hole as a single side dressing at two weeks after planting. The choice of carbofuran was due to its availability, rapid metabolization, non-persistence and does not contaminate food. Like other carbamates it is metabolized rapidly in animals into less toxic and finally non-toxic metabolites and non-toxic to vertebrates and higher animals.

Soil samples were taken from the treatment plots before and after harvest and analyzed for nematode population counts, in order to determine the initial and final population of the nematodes (P_i and P_f). Ten soil core samples were taken from the plot at the depth of 20 cm and combined to obtain composite samples. Composite samples were taken to the laboratory in sealed plastic bags where they were stored at 10^{o}C for 24 hours. The samples were then thoroughly mixed and 250 cm^3 soil sub-samples were prepared for nematode extraction using the tray extraction method of Whitehead and Hemming (1965).

Ten weeks after planting, ten randomly selected plants per plot were carefully uprooted and the adhering soil washed off for assessment of root-galls using a stereoscopic microscope. Galling was assessed using a visual rating based on rating scale of Taylor and Sasser (1978) (Table1). Eggs were extracted from roots and their number estimated using the sodium hypochlorite method of Hussey and Barker (1973). Host status rating was determined using a rating scheme developed by Sasser et al., (1984) based on root gall index and reproductive factor (R) (Table 2) as follows:

Gall index: 0= no gall formation; 5= heavy gall formation.

Reproductive factor (R) = P_f/P_i

Where P_i =initial population density and P_f= final population density

At harvest, ten randomly selected plant per plot were measured for the following parameters; plant height from the soil surface to the tip of top leaf, stem circuit measured using vernier callipers, days to 50% flowering, days to maturity, and seed yield (kg/ha).

Data were subjected to analysis of variance and means separated using Duncan's multiple range test (Gomez and Gomez, 1984).

Table 1. Scale for assessment of root knot nematode galls or egg masses on roots (Taylor and Sasser, 1978)

Number of galls or egg masses/plant	Gall index	Resistance ratings
0	0	Immune (I)
1-2	1	Resistant (R)
3-10	2	Moderately resistant (MR)
11-30	3	Moderately susceptible (MS)
31-100	4	Susceptible (S)
100+	5	Highly susceptible (HS)

Table 2. Resistance rating scale for root knot nematode (Sasser *et al.,* 1984)

Root gall index*	R-factor host efficiency**	Host status
≤2	≤1	Resistant
≤2	≥1	Tolerant
≥2	≤1	Hypersusceptible
≥2	≥1	Susceptible

**Gall index: 0= no gall formation; 5= heavy gall formation.*
***Reproduction factor: R= P_f/P_i, where P_i =initial population density and P_f= final population density*

3. RESULTS AND DISCUSSION

The statistical analysis of the data revealed that performance of Cowpea cv. ART98-12 treated with carbofuran 3G at 2kg active substance (a.i)/ha was significantly better over the years as compared to the control (Tables 3, 4 and 5).

Table 3. Avoidable yield loss of cowpea cv. ART98-12 due to root-knot nematode, *Meloidogyne incognita*

Treatment	Yield (kg/ha)	
	2008	**2009**
Carbofuran 3G@2kga.i/ha	1590a	1339.8a
Control	969.9b	897.7b
SEm±	2.38	2.58
% Avoidable yield loss	39.0	33.0
Treatment	**Nematode population**	
Initial	345	438
Control	635a	745a
Carbofuran 3G@2kga.i/ha	130b	118b
SEm±	20.6	25.8

Means followed by the same letters are not significantly different at (P<0.05) according to Duncan's Multiple Range Test; SEm±=Error mean square.

Table 4. Reaction of cowpea cv.ART98-12 to field infestation by *M. incognita* treated with Carbofuran 3G in 2008

Treatment	Plant height (cm)	Stem girth (cm)	Days to 50% flowering	Days to Maturity	Seed yield (kg/ha)	Gall index	Reproductive factor
Carbofuran 3G@2kga.i/ha	48a	3.5a	40b	80b	1590a	1.5b	0.55b
Control	42b	2.1a	45a	86a	969.9b	3.0a	1.50a
SEm±	0.38	0.5	2.5	10.5	2.38	0.8	0.95

Means followed by the same letters are not significantly different at (P<0.05) according to Duncan's Multiple Range Test; SEm±=Error Mean Square.

Table 5. Reaction of cowpea cv.ART98-12 to field infestation by *M. incognita* treated with Carbofuran 3G in 2009

Treatment	Plant height (cm)	Stem girth (cm)	Days to 50% flowering	Days to Maturity	Seed yield (kg/ha)	Gall index	Reproductive factor
Carbofuran 3G@2kga.i/ha	46a	3.0a	40b	80b	1339.8a	1.9b	0.65b
Control	41b	2.0a	45a	86a	897.7b	3.2a	1.55a
SEm±	0.35	0.5	2.5	10.5	2.58	0.9	0.99

Means followed by the same letters are not significantly different at (P<0.05) according to Duncan's Multiple Range Test; SEm±=Error Mean Square.

The prophylactic effects of Carbofuran in increasing agronomic parameters have been demonstrated by Adegbite et al., (2008b) and Adegbite and Adesiyan (2001). The decreasing agronomic parameters recorded for the untreated cowpea was probably a result of the stunting action of root-knot nematode (*M. incognita*). The treated plants started flowering earlier than the untreated. Early flowering is very important because it affects the time of maturity and harvesting of plants.

The yield of cowpea seeds was found to be higher with the application of nematicide-Carbofuran at 2 kg active ingredient (a.i)/ha (Table 3). The percentage increase over the untreated control was 39.0 and 33.0% in the years 2008 and 2009, respectively. A significant reduction in the yield of cowpea in untreated plots was mainly attributed to direct damage of the root system by the feeding activities of root knot nematode (*M. incognita*). Toler et al. (1963) reported 5-10% yield loss of cowpea due to *M. incognita* in Georgia, USA. Crozzoli et al. (1997; 1999) reported a yield reduction of 72% for susceptible cowpea cultivar and 20% yield reduction for resistant cowpea cultivar in Venezuela. Also, Bridge (1972) reported 40% yield loss of cowpea due to *M. incognita*. Caveness (1973), Ogunfowora (1976), Olowe (1976) reported yield loss of 20, 50 and 25% respectively due to infestation by *Meloidogyne incognita*. Also Babatola and Omotade (1991) reported a yield loss of 69% due to infestation by *M. incognita*. Adegbite et al., (2008b) reported a yield loss of 48.7 and 40.8% respectively in Roselle due to infestation by *M. incognita*. *Meloidogyne incognita* population (Table 3) in carbofuran treated plots was significantly lower than in the untreated plot in the two years because, the nematode multiplied many folds during the crop seasons. High *M. incognita* population in the untreated control plots decreased the plant growth and ultimately reduced the flower size, number of seeds and weight of the seeds. The ovicidal effect of carbofuran is more effective in preventing penetration of nematodes into the root. This may suggest that carbofuran acts directly on the nematodes in the soil thereby preventing or limiting hatching of eggs and the movement of larvae into the root. This is in agreement with the work of Kinloch (1974; 1982), Adegbite and Adesiyan (2001), Adegbite and Agbaje (2007) and Adegbite et al. (2008b).

4. CONCLUSION

In summary, the work confirms the suppressive effects of Carbofuran-A nematicide and insecticide on root knot nematodes *Meloidogyne* species on cowpea crop which is well adapted to the stressful growing conditions of the tropics and has excellent nutritional qualities. And that without controlling the activities of root knot nematode (*M. incognita*), appreciable yield and income on cowpea cultivation will not be possible.

ACKNOWLEDGMENTS

I thank the Director for funding and approving the project also I thank the Breeder, Dr. (Mrs) S. R. Akande for providing the Cowpea seeds (cv.ART98-12) and Mr. M. O. Oyedepo for the technical assistance.

REFERENCES

Adegbite, A.A., Adesiyan, S.O. (2001). Efficacy of carbofuran on the performance of four nematode susceptible varieties of soybean (*Glycine max* (L.) Merrill). Tropical Oilseeds Journal, 6, 11-23.

Adegbite, A.A., Agbaje, G.O. (2007). Efficacy of carbofuran in control of root knot nematode (*Meloidogyne incognita* race 2) in hybrid yam varieties in southwestern Nigeria. Electr. J. Env., Agric. Food Chem., 6, 2083-2094.

Adegbite, A.A., Agbaje, G.O., Akande, M.O., Adetumbi, J.A., Adeyeye, O.O. (2008a). Expression of resistance to *Meloidogyne incognita* in kenaf cultivars (*Hibiscus cannabinus*) under field conditions. J. Plant Dis. Prot., 115(5), 238-240.

Adegbite, A.A., Agbaje, G.O., Raji, J.A., Adeyeye, O.O., Lamidi, G.O. (2008b).Assessment of yield loss of Roselle (*Hibiscus sabdariffa* L.) due to root knot nematode, *Meloidogyne incognita* under field conditions. J. Plant Prot. Res., 48(3), 267-273.

Anon. (1961). Report of the Department of Agricultural Research for the year 1959/1960.Federal Printing Division, Lagos.

Babatola, J.O., Omolade, O. (1991). Chemical control of the nematode pests of cowpea, *Vigna unguiculata* (L.) Walp. Crop Prot., 10, 131-134.

Bridge, J. (1972). Plant parasitic nematodes of irrigated crops in the Northern States of Nigeria. Samaru Miscellaneous Papers No. 42.

Caveness, F.E. (1973). Nematode attack on cowpea in Nigeria. In: Proceedings of the First International Institute of Tropical Agriculture (IITA) Grain Legume Improvement Workshop, October 29 to November 2 1977, Ibadan Nigeria pp. 213-218.

Crozzoli, R., Greco, N., Suarez, A.C., Rivas, D. (1997). Patogenecidad del nematodo agallador, *Meloidogyne incognita*, en cultivares de *Phaseolus vulgaris* y *Vigna unguiculata*. Nematropica, 27, 61-67.

Crozzoli, R., Greco, N., Suarez, A.C., Rivas, D. (1999). Patogenecidad del nematodo agallador, *Meloidogyne incognita*, en *Vigna unguiculata*. Nematropica, 29, 99-103.

Eisenback, D., Hirschmann, H., Sasser, J.N., Triantaphyllou, A.C. (1981). A guide to the four most common species of root knot nematodes (*Meloidogyne* spp.) with a pictorial key. North Carolina State University and USAID, Raleigh, N.C., 48 pp.

Gomez, K.A., Gomez, A.A. (1984). Statistical Procedures for Agricultural Research, 2nd edition, John Willey and Sons, New York.

Hussey, R.S., Baker, K.R. (1973). A comparison of methods of collecting eggs of *Meloidogyne* species including a new technique. Plant Disease Reporter, 57, 1025-1028.

Kinloch, R.A. (1974). Response of soybean cultivars to nematicidal treatments of soil infested with *Meloidogyne incognita*. J. Nematol., 6, 7-11.

Kinloch, R.A. (1982). The relationship between soil populations of *Meloidogyne incognita* and yield reduction of soybean in the coastal plain. J. Nematol., 14, 162-167.

Mishra, S.D. (1992). Nematode pests of pulse crops In: Bhatti, D. S., Walia, R.K. (Eds.). Nematodes pests of Vegetable crops, CBS Publishers and Distributors, Delhi India. 140pp.

Ogunfowora, A.O. (1976). Research on *Meloidogyne* at the Institute of Agricultural Research and Training, University of Ife, Moor Plantation, Ibadan, in: Proceedings of the First IMP Research Planning Conference on Root knot Nematodes, *Meloidogyne* spp., Region IV, IITA, Ibadan Nigeria, June 7-11, 1976 pp.9-14.

Olowe, T. (1976). Research work on root knot nematodes at the National Cereals Research Institute, Ibadan, In: Proceedings of the First IMP Research Planning Conference on Root knot Nematodes, *Meloidogyne* spp., Region IV, IITA, Ibadan Nigeria, June 7-11, 1976 pp.15-19.

Olowe, T. (1978). International *Meloidogyne* Project progress report, 1978, In: Proceedings of the second IMP Research Planning Conference on root knot nematodes, *Meloidogyne* spp., February 20-24, 1978. Abidjan, Ivory Coast pp.58-69.

Quin, F.M. (1997). Importance of cowpea. In: Singh, B. B., Dashiell, K.E., Mohan Raj, D.R., Jackai, L.E.N. (Eds.), Advances in cowpea research, Colorcraft, Hong Kong, China pp. ix-xii.

Sarmah, B., Sinha, A.K. (1995). Pathogenecity of *Meloidogyne incognita* on cowpea. Plant Health, 1, 12-14.

Sasser, J.N., Carter, C.C., Hartman, K.M. (1984). Standardization of host suitability studies and reporting of resistance to root knot nematode. North Carolina State University, Department of Plant Pathology, Raleigh, NC, USA.

Sharma, N.K., Sethi, C.L. (1975). Effects of initial inoculums levels of *Meloidogyne incognita* and *Heterodera cajani* on cowpea and on their population development. Ind. J. Nematol., 5, 148-154.

Sikora, R.A., Greco, N. (1990). Nematode parasites of food legumes. In: Plant parasitic nematodes in Subtropical and Tropical Agriculture. Luc, M., Sikora, R.A., Bridge, J. (Eds.) 1st edition, Wallingford, UK, CABI Publishing pp. 197-198.

Sikora, R.A., Greco, N., Silva, J.F.V. (2005). Nematode parasites of food legumes. In: Plant parasitic nematodes in subtropical and tropical agriculture, Luc, M., Sikora, R.A., Bridge. (Eds.) 2nd edition, Wallingford, UK, CABI Publishing, pp. 259-318.

Singh, B.B., Ehlers, J.D., Sharma, B., Freirefilho, F.R. (2003). Recent progress in cowpea breeding. In: Challenges and opportunities for enhancing sustainable cowpea production. Proceedings of the World Cowpea Conference III held at IITA Ibadan, Nigeria. 4-8 September, 2002 pp.22-40.

Taylor, A.L., Sasser, J.N. (1978). Biology, identification and control of root knot nematodes (*Meloidogyne* spp.,). A cooperative publication of North Carolina State University, Department of Plant Pathology and USAID, Raleigh, NC, USA. 111pp.

Toler, R.W., Thompson, S.S., Barber, J.M. (1963). Cowpea (Southern pea) diseases in Georgia, 1961-1962. Plant Disease Reporter, 47, 746-747.

USDA (United States Department of Agriculture) (1990). Soil Survey Staff keys to Soil Taxonomy. SMSS Technical Monograph No. 6, 1990, Blackburg, Virginia.

Whitehead, A.G., Hemming, J.R. (1965). A comparison of some quantitative methods of extracting small vermiform nematodes from soil. Ann. Appl. Biol., 55, 25-38.