EFFECT OF DIFFERENT POPULATION DENSITIES OF ROOT-KNOT NEMATODE (*MELOIDOGYNE INCOGNITA)* ON THE GROWTH AND YIELD OF OKRA (*ABELMOSCHUS ESCULENTUS* L. MOENCH)

O. S OSUNLOLA, K. O. MUSTAPHA, B.R AMINU-TAIWO

Abstract: The pathogenic effect of root-knot nematode, *Meloidogyne incognita* was investigated on two cultivars of okra in a pot experiment carried out at the Horticultural Nursery of Kwara State University, Malete, Kwara State.

Two -week old seedlings of two okra varieties, NHAe47-4 and LD88, were each inoculated with 0, 6000, 12,000 and 24,000 eggs of *Meloidogyne incognita.* The experimental design was a 2 X 4 factorial arranged in a completely randomized design. Data were collected on number of leaves and plant height at inoculation and subsequently on a weekly basis. Data were also taken on the number and weight of okra fruits, fresh shoot weight, fresh root weight, galling indices and nematode populations in the soil and roots. All data were analysed using ANOVA (P≤0.05).

Root-knot nematode infection significantly (P≤0.05) reduced the plant height, number of leaves, fresh root weight, fresh shoot weight, and yield of okra at different inoculum densities. Okra yield was reduced by 26.6%, 48.1% and 60.5% at 6,000, 12,000 and 24,000 inoculum densities respectively compared with control. Galling index (root damage) increased with increase in inoculum density.

It is recommended that root-knot nematode infested soil should be treated prior to okra cultivation.

Keywords: galling index, *Meloidogyne incognita,* okra, pathogenicity, yield.

Introduction: Okra (*Abelmoschus esculentus* L.Moench) is a flowering plant belonging to the family Malvaceae. It is cultivated throughout the tropical, sub-tropical and warm temperate regions of the world particularly in West Africa, India, Thailand and Brazil for its immature pods which are used for soups, canning and stews or as a fried or boiled vegetable [13]. The leaves are also used in soup making in many parts of the world. Okra is widely grown in Nigeria and consumed in fresh or dry forms [3]. Okra ranks third in terms of consumption and production following tomato and pepper [10]. It is a popular health food because it is an important source of vitamins, calcium, potassium and other mineral matters which are often lacking in the diet of developing countries [11]. Its medicinal value has also been reported in curing ulcers and relief from hemorrhoids [1]. The crop is prone to damage by various insects, fungi, nematodes and viruses [11]. The common diseases afflicting the okra plant are *Verticillium* wilt, often causing yellowing and wilting of the leaves, powdery mildew, leaf spots, and root-knot. Root-knot nematodes, *Meloidogyne spp,* are perhaps the most destructive group of nematodes known at present in Nigeria [2]. Okra is particularly susceptible to *Meloidogyne* species. The disease caused by this group of nematodes is characterized by numerous irregular swellings or galls on the roots of host plants [14]. In addition to yield decline, infected plants exhibit symptoms of nutrient deficiency. Annual loss from *Meloidogyne* attack in Nigeria must be running to millions of Naira because of its wide distribution, extensive host range and interaction with fungi and bacteria in disease complexes [14]. The objectives of this study were to investigate the effect of different population densities of *Meloidogyne incognita* on the growth and yield of okra and to determine the damage thresholds of *Meloidogyne incognita* to okra.

Materials And Methods:

Planting of okra seeds and inoculation of seedlings: The experiment was carried out at the Horticultural Nursery of the Kwara State University, Malete. Seeds of two okra varieties namely NHAe47-4 and LD88 were obtained from National Horticultural Research Institute (NIHORT), Idi Ishin Jericho Ibadan. Six-litre polyethylene bags used as pots were obtained from a local market and were each filled with steam-sterilized sandy-loam soil. Three seeds of each of the varieties of okra were planted per pot. *Meloidogyne incognita* eggs that served as inoculum in this study were extracted from galled roots of *Celosia argentea* collected from NIHORT, Ibadan [9]

Two weeks after sowing, the okra seedlings were thinned down to one uniformly vigorous seedling per pot and were inoculated at 0, 6,000, 12,000 and 24,000 eggs per pot (or 0, 1, 2 and 4 eggs per ml of soil) by pipetting the desired number of eggs into four holes each about 4 cm deep made at the base of each seedling. Distilled water was introduced into the holes for control plants (0 eggs). The holes were covered with steam-sterilized soil after inoculation. The experiment was a 2x 4 factorial (two cultivars of okra and four levels of inoculum) arranged in a

completely randomized design on the concrete floor of the Horticultural Garden of Kwara State University, Malete, Kwara State, Nigeria. Each treatment was replicated five times. In all, forty pots were used. The plants were watered twice a day throughout the period of study.

Data Collection and Analysis: Data were collected on plant height and numbers of leaves immediately after inoculation and subsequently on a weekly basis till the end of the experiment. At maturity, fresh okra fruits were harvested, counted and weighed using a weighing balance for each plant. At the end of the study, each okra plant was cut with a sharp knife at soil level and the fresh shoot weight and the fresh root weight were taken. The roots were thereafter rinsed, weighed and rated for root-knot infection on a scale of 0-5 where: 0= No gall on root system; 1= 1-20% of root system galled; 2= 21-40% of root system galled; 3= 41-60% of root system galled, 4= 61-80% of root system galled and 5= 81-100% of root system galled[6].Nematode eggs were thereafter extracted from each of the roots [9]. The soil nematode population was also estimated from 200ml soil obtained from each pot using the method of [18].All data were processed using the Statistical Analysis Systems [16] and the means were partitioned using the least significant difference (LSD) at 5% probability.

Results: There was no significant difference in the mean number of leaves until the four weeks after inoculation when control plants produced the highest mean number of leaves which was significantly higher than other treatments and the same trend was observed at the eight week (Table 1). Similarly, the mean plant heights were significantly different at four and eight weeks after inoculation with the highest value from the control plants and the least value from the plants with the highest inoculum density (Table 2).The mean fresh shoot weight differed from each other significantly ($P<0.05$). Similar observation was made for the fresh root weight. The highest mean fresh shoot weight came from uninoculated plants (28.2 g) followed by plants that were inoculated with 6,000 eggs (22.9 g), while the least mean shoot weight (12.9 g) was recorded from plants that received the highest inoculum density which was significantly lower than the value obtained from the plants infected with 12,000 eggs (18.8 g) (Table 3). However, the mean shoot weight did not differ significantly between the two cultivars (Table 3). The highest significant fresh root weight came from control plants (3.0 g) and was followed by plant inoculated with 6,000 eggs (2.31 g). The least mean root weight was recorded for the plants that received the highest inoculum density (1.2 g) (Table 3). The mean root weight value for NH47 (2.7 g) was significantly higher than that of LD 88 (1.4 g) (Table 3).

The mean values recorded for number of okra fruits did not differ significantly among the treatments. However, the mean fruit weights were significantly different from each other. The lowest significant value came from plants inoculated with 24,000 eggs, (16.2 g) followed by the plants that received 12,000 eggs (11.9 g). The highest mean value was obtained from uninoculated plants (6.4 g) (Table 3).

The mean gall index differed significantly at different inoculum densities. The highest mean gall index came from the plants that were inoculated with 24,000 eggs (4.4) followed by the plants that received 12,000 eggs (4.3) and the least mean value was from uninoculated (control) plant (0.0) (Table 3).

The mean root and soil nematode populations also differed significantly from each other (Table 3). The least significant mean populations of the second stage juveniles of nematode and egg were recorded from control plants followed by values for plants that were inoculated with 6,000 eggs and the highest populations were from plants infected with 24,000 eggs. There were no significant differences between the mean second stage juveniles and egg populations for the two cultivars.

Table 1: Effect of different population densities of *M. incognita* on the number of leaves of okra at various weeks

Inoculum densities	2 WAI*	4WAI	8WAI
0 egg	5.7	6.1	13.7
6000 eggs	5.7	5.0	11.0
12000 eggs	5.8	5.1	10.1
24000 eggs	5.2	5.3	9.6
LSD	0.8	0.7	2.6
Cultivars			
NHAE47-4	5.6	5.6	13.4
LD88	5.5	5.1	8.8
LSD	0.6	0.5	1.8

* WAI =Weeks After Inoculation

Table 2: Effect of different population densities of *M. incognita* on the height of okra plant at various weeks

Inoculum densities	2 WAI*	4 WAI	8 WAI
0 egg	11.5	26.4	38.3
6000 eggs	12.5	25.6	35.2
12000 eggs	11.4	24.6	34.2
24000 eggs	9.2	19.2	28.1
LSD	1.3	3.8	3.4
Cultivars			
NHAE47-4	11.2	26.0	36.3
LD88	11.1	21.8	31.6
LSD	0.9	2.7	2.4

* WAI =Weeks After Inoculation

Table 3: Effect of different population densities of *M. incognita* okra growth and yield, root damage and nematode reproduction

Inoculum densities	Fresh shoot weight (g)	Fresh root weight(g)	No. of fruits	Weight of fruits(g)	Gall index	Nematode pop. in soil (X500)	Egg pop. in root (X500)
0 egg	28.2	3.0	2.3	16.1	0.0	0.0	0.0
6000 eggs	22.9	2.3	1.8	11.9	3.1	2.1	103.0
12000 eggs	18.8	1.7	1.6	8.4	4.3	2.9	180.0
24000 eggs	12.9	1.2	1.2	6.5	4.4	3.6	288.7
LSD	4.4	0.4	1.1	8.4	0.4	0.5	69.7
Cultivars							
NHAE 47-4	20.0	1.4	1.6	10.80	3.1	2.1	150.3
LD88	21.3	2.7	1.8	10.60	2.7	2.1	135.5
LSD	3.1	0.3	0.8	5.9	0.3	0.4	49.4

Discussion And Conclusion: The impairment of okra growth and yield by *M. incognita* confirms the damage potential of the nematode to okra. The effects of different inoculum densities of *Meloidogyne* species have been studied by different workers on different host crops [7; 15]. The mean fresh shoot and root weights were reduced progressively as the inoculum levels increased. The reduction of mean shoot and root weights by root-knot nematode observed in this study is similar to the findings of [7] who reported stunting growth and reduction of top weights of cassava as the *M. incognita* population levels increased. It was also found out that *M. incognita* led to low performance of two banana cultivars [7]. It was reported by [5] that the Venezuelan population of *M.exigua* affected the growth of coffee plants negatively. Hussain *et al.* [19] also found that all inoculum levels of *M. incognita* reduced the shoot and root lengths and fresh and dry weights of okra. There are factors in the infected plants that reduce or stop growth and these include: root destruction and utilization of nutrient and related resources by the galled root to the detriment of tops. This might result from inefficient absorption of water and mineral salt, leading to a decrease growth rate. Infection with *Meloidogyne* was found to cause an increase in protein synthesis in galls and the consequent destruction of transport of growth regulator and other compounds between root and stems and this result in profound disturbance of top growth (shoot) [17].

The number of leaves and plant height were reduced by nematode at some weeks after inoculation. Galling indices correspond to nematode inoculum levels as there were no galls in the control plants since there were no nematodes to induce gall formation and the extent of galling increased with increase in inoculum density. This agrees with the findings of [19] who reported that root-knot gall index increased exponentially with increase in initial population levels of *M. trifoliophilia* on white clover. The root galling severity of tomato and pepper also increased with increase in inoculum levels of *M. javanica* [12]. Nematode reproduction is also related to the nematode population density of the soil. Nematode were absent from the uninoculated soil. This means that if one plants on a totally nematode free soil, at the end of the planting season other things equal, the soil will still be nematode free. But if infested soil is used the nematode population will increase most especially if a favoured host is used. Nematode infection also had a pronounced effect on the yield of okra. The reaction of the two okra varieties to nematode was similar in that all their yields were reduced by *M. incognita*. The yield reduction also increased as the inoculum level increased. The yield reduction of 26.5-59.3% was observed in this study. Yield losses of 91% in okra, 46% in tomato and 27% in brinjal were reported when infected by *M. incognita* [4] .Okra plant infected with *M. incognita* appeared to suffer from nutrient deficiency and tend to wilt on hot days. The wilting is as a result of reduction and deformation of the root system. The deformed root system does not utilize water and nutrients from as large a volume of soil as an uninfected root system. There is a change in vascular pattern of lateral root of infected plant. The galled roots of infected plants are inefficient in the transport of nutrient from the soil to the leaves. All these will reduce photosynthesis on which crop yield depend.

It was observed from the study that root-knot nematodes are among the important pests of okra

and they should not be planted in any field where they occur without controlling them. There is therefore the need to control them. For effective nematode control to be achieved, farmers generally have to be aware of the disease and the appropriate and sustainable management tactics. Several methods can be used to reduce the menace of root- knot nematode which include; use of cultivars that are resistant to root-knot nematode, organic amendments, use of biological method which includes employing microorganisms such as fungi (*Trichoderma viride, Paecilomyces lilacinus etc)* and bacteria in the management of root-knot nematode. Another approach is the use of chemical nematicides such as mocap, carbofuran, methylbromide, and ethylene dibromide. Although chemicals are effective but they are costly, cause environmental pollution and requires specialized skills and equipment for application. The use of integrated pest management which incorporates various measures is hereby advocated for safe and effective management of root-knot nematode on okra.

References:

1. Adams, C.F. Nutritive value of American foods in common units, U.S. Department of Agriculture,Agric Handbook, 425, 1975, pp. 29.
2. Adesiyan S.O, F.E. Caveness,M.O Adeniji and B. Fawole. Nematode Pests of Tropical Crops. Heinemann Education Books (Nigeria). 1990, 114pp.
3. Akanbi,W. B., Togun, A. O., Akinsafasoye,J. A. and Baiyewa, R.A. Nutrient uptake and yield of okra(*Abemochus esculentus*) as affected by varieties and Nitrogen mineral fertilizer. Proceedings of Annual Conference of Horticultural Society of Nigeria, 14-17 May (2002).Edited by V.C.Umeh and J.A.Fagbayide, 2002, pp.145-148.
4. Bhath, D.S. and Jain, R.K .Estimation of loss in okra, tomato and brinjal yield due to *M.incognita*. Indian Journal of Nematology 7 (1):37-41.1979
5. Di vito, M.R Crozzoli and N. Vovolas . Pathogenicity of *Meloidogyne exigua* on Coffee (*Coffea Arabica* L.*)* in pots Nematropica 2000, 30(1), , pp. 55-61.
6. Fawole, B. and O.S.Osunlola. Comparative efficacy of thermotherapy and chemotherapy on control of root-knot nematodes, *Meloidogyne* spp in yam tubers. African Journal of root and tuber crops. 3(2): 38-4., 1999
7. Gapasin, R.M Reaction of Golden yellow cassava to *Meloidogyne* spp. inoculation Annals of Tropical Research 1980, 2:49-53. 1980
8. Hussain, M.A, T. Mukhtar and M.Z. Kayani .Assessment of damage caused by *Meloidogyne incognita* on okra (*Abelmoschus esculenthus*). The Journal of animal and plant sciences 21 (4):857-861, 2001
9. Hussey, R.S and K.R. Barker .A comparison of methods of collecting inocula for *Meloidogyne* spp; including a new technique. Plant Disease Reporter 57: 1025-1028, 1973
10. Ibeawuchi. I.K. "Intercropping a food production Strategy for resources poor Farmers" Nature and Science, 2007, Vol.5, No.1, pp, 46-49.
11. International Board for Plant Genetic Resources IBPGR. Report on International Workshop on Okra Genetic resources held at the National bureau for Plant Genetic Resources, New Delhi, India.1990
12. Mekete, T.W. Manderfo and N. Greco. Relationship between initial population densities of *Meloidogyne javanica* and damage to pepper and tomato in Ethiopia. *Nemat. Medit., 2003,* 31:169-171.
13. Plant Resources of Tropical Africa (PROTA) 2004 Vegetables. Edited by G.J.H.Grubben, O.A. Denton, C.M. Messiaen, R. R.Schippers and R. H. M. J. Lemmens, L.P.A. Oyen. Published by PROTA Foundation/Backhuys Publishers/CTA. Waageningen, Netherlands. 2004
14. Ogunfowora, A.O. Reactions of some tomato cultivars to root-knot nematodes (*Meloidogyne spp*). *Niger. J. Pl. Prot*. 3:37-40. 1977
15. Ononuju .C.C and B. Fawole (1999). Pathogenicity of *Meloidogyne* spp on Banana Cultivars, *Niger J.Pl. Prot* , 1999 , 18:21-28.
16. SAS Institute . SAS User's guide :Statistics, version 8.oe SAS Institute, Cary. NC.USA.1999.
17. Taylor, A.L and J.N Sasser. Biology, identification and control of root-knot nematode, *Meloidogyne spp*.Coop. Publication Department. Plant pathol. North Carolina State .University and US. Agency International development. Raleigh .N.C.1978, pp.111.
18. Whitehead, A.G and J.R. Hemming. A comparison of some quantitative methods of extracting small vermiform nenatodes from the soil. *Ann. Appl. Biol.* 55: 25-38. 1965
19. Zahid, Mohammed, Jackie Nobbs, Geoff M. Gurr, Michael Hodda, Alexander Nikandrow,William J. Fulkerson and Helen .I. Nicol . Effect of the clover root-knot nematodes (*Meloidogyne trifoliophila)* on growth of white clover. Nematology, 2001. Vol.3 (5) 437-446.

***

O. S Osunlola,/Department of Crop Production/
Kwara State University/ Malete/ Kwara State/ Nigeria/ Lecturer II/ Kwara State University/ Malete/ Nigeria/
remiosunlola@gmail.com
K. O. Mustapha/
Department of Crop Production/ Kwara State University/
Malete/ Kwara State/ Nigeria/ Student
B.R Aminu-Taiwo /
National Horticultural Research Institute (NIHORT)/ Idi Ishin Jericho Ibadan/ Principal Research Officer/
National Horticultural Research Institute (NIHORT)/ Ibadan/
bukkyaminutaiwo@yahoo.com