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Effects of different agricultural wastes and botanical on root knot nematode (*Meloidogyne* spp) on okra (*Abelmoschus esculentus* L. Moench)

ONONUJU, C. C.[1], IKWUNAGU, E. A.*[1], OKOROCHA, A. D.[2] AND OKORIE, C. C.[2]

[1]Department of Plant Health Management, Michael Okpara University of Agriculture, Umudike, P.M.B. 7267, Umuahia, Abia State, Nigeria.
[2]Department of Nematology, National Root Crop Research Institute, Umudike, P.M.B. 7006, Umuahia, Abia State, Nigeria.

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The effect of agricultural wastes and a botanical on root knot nematode (*Meloidogyne* spp) on okra (*Abelmoschus esculentus* L. Moench) was investigated in pot experiment. The experiment was laid out in a completely randomized design with five treatments each replicated five times. The treatments included: sawdust, oil palm sludge, cassava peels, bitter leaf powder, carbofuran plus untreated control. All the treatments except oil palm sludge and nematicide were applied at the rate of 20 g each. Oil palm sludge was applied at the rate of 20 ml while the nematicide at 3.0 g ai per plant. The plants were inoculated with 2000 nematode eggs (*Meloidogyne* spp.) three weeks after emergence. Treatments and fertilizer were applied one and three weeks after inoculation respectively. Eight weeks after treatment application, the experiment was terminated and the following collected; fresh and dry shoot weight, plant height, number of leaves, number of galls, population of nematode eggs in the roots and nematode population in the soil. Results obtained indicated non-significant difference between the treatments in the parameters recorded except plants treated with bitter leaf and nematicide in some cases. Generally, results from bitter leaf were better and compared favourably with the nematicide treated plants.

Key words: Agricultural wastes, Meloidogyne spp, *Abelmoschus esculentus*

INTRODUCTION

Okra (*Abelmoschus esculentus* L. Monech) is a flowering plant, belonging to the family *Malvaceae* (Mallow family) (NRC, 2006). It is a warm-season crop grown in home gardens. It is an upright plant with a hibiscus-like flower (Smith et al., 2002), grown in tropical and warm temperate climates (Ijewere, 2012) and as a widely cultivated vegetable (Schippers, 2002) grown as annual or biannual crop.

It was first domesticated in West and Central Africa and is now cultivated throughout the tropics primarily for local consumption (Schippers, 2000; Kamara et al., 2005).

Okra has been found to be an important

*Corresponding author. E-mail: emmanuelikwunagu@yahoo.com.

vegetable crop in the tropical and subtropical zones of the world in that it is a good source of vitamins A, B complex and C, proteins and minerals for human diets (Adebisi et al., 2007). It is also a source of iron, calcium, potassium and other minerals with high thiamine, riboflavin and niacin than other vegetables (Rice et al., 1991). The young immature pods are used as boiled vegetable in cooking soup, while in dried form they are used as soup thickener (Yadev and Dhanker, 2002; George, 2005).

The stem can be used in making rope and paper while the foliage can serve as a good source of fodder to livestock (Raemakers, 2001; Ahmed et al., 2006). A greenish-yellow edible oil, gotten from the okra seed is as high as about 40% in some varieties (Mays et al., 1990). The oil has been found to be suitable for use as a bio fuel (Farrooq et al., 2010).

Okra is notorious for its susceptibility to root-knot nematodes (Noling, 2012). They are found to be a serious pest of okra, damaging a stand and greatly decreasing and delaying the production of pods (Bolles and Johnson, 2012). The extent of damage by the nematode is influenced by the level of soil nematode infestation and environmental factors (Ononuju and Fawole, 2000). Some plant-parasitic nematodes have the greatest impact on crop productivity when they attack the roots of seedlings immediately after seedling germination (Ploeg, 2001). Inasmuch as they are generally regarded as silent enemies, they have caused losses of up to 80% in vegetable fields where their infestation is very high (Kaskavalci, 2007).

The populations of plant-parasitic nematodes in the field can be minimised through several approaches which include the use of natural enemies (Khan et al., 2007), use of resistant varieties (Williamson and Kumar, 2006), enhancing cultural practices (Okada and Harada, 2007) and use of synthetic nematicides (Browning et al., 2006). Farmers generally have relied on the use of synthetic nematicides over the years and this has resulted to its excessive and unsafe usage (Taniwiryono et al., 2007). Indiscriminate use of synthetic nematicides for the control of nematodes leads to phytotoxicity, environmental pollution and nematode resistance (Yudelman et al., 1998). On the other hand, its unsafe usage may result in poisoning of humans especially in developing countries like Nigeria (Conway, 1995). To this effect, it is of economic importance to find alternative control strategies which are as effective as synthetic nematicides, safer to farmers, consumers, and the environment and relatively easily available at low price (Fernandez et al., 2001).

Such alternatives are the use of botanical nematicides (nematicides of plant origin) and agro wastes (Javed et al., 2006). The use of organic amendments for the control of plant-parasitic nematode has been advocated for the resource poor farmers from many African countries (Olaniyi et al., 2005). Inasmuch as they are slow to act and large quantities are needed before reasonable control can be achieved, it is relatively cheap, readily available and its application, technologically simple (Barman and Das, 1996). Ononuju and Okoye (2003) emphasised the advantages and potential use of ingredients of higher plants in controlling plant diseases. Organic amendments have beneficial effects on the soil's nutrient, physical conditions and biological activity hence improve the health of plants and reduce the nematode's population (Oka and Yermiyahu, 2000). According to Kimenju et al. (2004), organic amendment application stimulates the activity of natural antagonist of plant-parasitic nematodes. Numerous plant species belonging to 57 families have been identified locally to contain nematicidal compounds (Sukul, 1992). They are applied either as soil drench, root dip or as foliar spray (Agbenin, 2004).

This study therefore aims at determining the effect of different agricultural wastes (sawdust, cassava peels, oil palm sludge) and a botanical (bitter leaf) on *Meloidogyne* spp on okra.

MATERIALS AND METHODS

Experimental location

The experiment was carried out in the Department of Plant Health Management, Michael Okpara University of Agriculture Umudike, Abia state, Nigeria. Umudike is located on latitude 5°22' N and longitude 7°33' E and an altitude of 122 m above sea level with an annual rainfall of 1916 mm, relative humidity of 76% and temperature range of 19-35°C (NRCRI, 2010).

Experimental design

The experiment was arranged in a completely randomized design in an open field platform using plastic pots with five treatments replicated five times including the control.

Source of seeds

Seeds of okra variety TAE 38 were obtained from the Teaching and Training Farm Centre of College of Crop and Soil Sciences, Michael Okpara University of Agriculture Umudike, Abia state.

Agricultural wastes and botanical used

The agricultural wastes and botanical used were cassava peels, sawdust, oil palm sludge and bitter leaf. The cassava peels and bitter leaf were air dried before they were blended to powder with an electric blender.

Preparation of nematode inoculum

Root-knot nematode eggs were extracted from the heavily galled roots of *Basella alba* (Cylon spinach) using sodium hypochlorite (NaOCl) technique (Hussey and Barker, 1973). The number of eggs in the suspension on a millilitre was estimated by counting four samples of a millilitre each using down caster counting dish under stereomicroscope and the average was taken. Each millilitre contains about 125 nematode eggs, hence 16 ml of the suspension containing about 2,000 nematode egg was used to inoculate the plant.

Planting of seeds

Okra seeds were sown three seeds per hole in plastic pots whose diameter are 22.5 cm and contain 4.5 kg mixture of sandy loam soil. The soil was steam sterilized at 70°C for 120 min. Two weeks after planting, the okra plants were thinned down to a healthy seedling per pot.

Inoculation of nematode eggs to the plant

Three weeks after germination, the plants were inoculated by pouring a calculated volume of the suspension containing 2,000 nematode eggs extracted by Hussey and Barker (1973) method near the plant by making a groove around it.

Treatment and fertilizer application

Seven days after the inoculation, 20 g each of the powder of the cassava peels, bitter leaf and sawdust were applied evenly on the soil surface around the plant roots and covered with top soil. Also, 20 ml of the oil palm sludge and a synthetic nematicide (Carbofuran) at 3.0 g ai were applied. The control consisted of pots without treatment application. NPK fertilizer was applied at the rate of 100 kg/ha (Ijoyah and Dzer, 2012), that is, 0.4 g per bucket two weeks after. The plants were watered as when due.

Data collection and statistical analysis

At the end of the experiment, 12 weeks after planting, the following parameters were collected: Fresh shoot weight; dry shoot weight; plant height; number of leaves; number of galls; population of nematode in the soil (Hussey and Barker, 1973); population of nematode eggs in the roots (Hussey and Barker, 1973).

The data collected were subjected to Analysis of Variance (ANOVA) and means were compared using Least Significant Difference (LSD) at 5% probability level ($P<0.05$) by using computer software "Genstat Discovery Edition 4".

RESULTS

Table 1 shows the effect of treatments on plant height and number of leaves. There was no significant difference recorded among the treatments including the control on plant height although the highest plant height (31.55 cm) was recorded for the plants with nematicide treated soils while the least (26.67 cm) was recorded for the plants whose soils were treated with sawdust. On the number of leaves, significant difference ($P<0.05$) was recorded between the plants whose soils were treated with the nematicide (7.34) and the control (5.83), but the other treatments did not significantly differ from the control. However, the other treatments did not differ significantly from each other and the control.

The effect of treatments on fresh and dry shoot weight are shown in Table 2. Significant differences were not observed among the treatments including the control in fresh shoot weight although plants treated with bitter leaf recorded the highest fresh shoot weight (15.26 g) with the least weight (10.28 g) recorded for sawdust treated. On dry shoot weight, all the treatments did not differ significantly from the control, excerpt plants treated with bitter leaf. Still, bitter leaf and oil palm sludge treated plants gave the highest dry shoot weight (6.04 and 5.36 g respectively), but did not differ significantly from each other.

Table 3 shows the effect of treatments on the number of galls, egg and nematode population in the soil. The treatments and the control did not differ significantly from each other on the number of galls and the number of nematode eggs on the roots of the plants respectively. However, the plants whose soils were treated with the nematicide had the least number of galls (26.4) while the highest (59.4) was observed for the sawdust treated plants.

Also, the nematicide treated soil had the least number of nematode eggs (3340) in the plant roots while oil palm sludge treated plants, had the highest (6480). On the other hand, on the nematode population in the soil, significant differences ($P<0.05$) were recorded between the treatments and the control, but the nematicide (580), bitter leaf (1020) and cassava peels (1200) treated soils, did not differ significantly from each other. The least number of nematode population in the soil was recorded by nematicide treated soil (580) followed by the bitter leaf treated (1020), whereas the control recorded the highest (4400) population of nematode in the soil.

DISCUSSION

The stunted growth and reduction in number of leaves (defoliation) recorded were due to the inability of the plants to take up water and nutrient from the soil through its root, which they need for photosynthesis. This is in agreement with the findings of Alabama and Alabama (2009) who reported that nematodes damage plants by feeding on the roots, weakening the plant's ability to take up water and nutrient. Also, the findings of William and Robert (2007) confirmed that the nematode infestation leads to wilting and stunted growth. Observation on the lack of effect on the number of leaves in this study is similar to that of Claudius-Cole et al. (2010) who observed that there was no significant difference in total number of leaves of plants treated with some plant extracts.

The soils treated with bitter leaf provided organic matter and the additional nitrogen to the okra plants. This led to the significant increase in dry shoot weight of okra. Oka and Yermiyahu (2000) confirms the beneficial effects of organic amendments on soil's nutrients. Imafidor and Angaye (2009) also confirms the supply of soil nutrients by bitter leaf. However, the non-significant effect of the treatments on fresh shoot weight could be due to its slow

Table 1. Effect of treatments on vegetative growth of okra inoculated with nematodes.

Treatment	Plant height (cm)	Number of leaves
Oil palm sludge	31.27	6.71
Bitter leaf	28.07	6.89
Cassava peels	27.88	6.89
Sawdust	26.67	6.23
Nematicide	31.55	7.34[a]
Control	29.92	5.83[b]
LSD $_{(0.05)}$	NS	1.286

Where NS means no significant difference or non significance. ab means significant difference

Table 2. Effect of treatments on yield components of okra inoculated with nematodes.

Treatment	Fresh shoot weight (g)	Dry shoot weight (g)
Oil palm sludge	14.48	5.36*
Bitter leaf	15.26	6.04[a]*
Cassava peels	11.56	4.30
Sawdust	10.28	4.08
Nematicide	12.70	5.00
Control	12.52	3.94[b]
LSD $_{(0.05)}$	NS	1.935

Where NS means no significant difference or non significance. ab means significant difference.* means No Significant Difference

Table 3. Effect of treatments on nematode gall, egg (in the roots) and population (in the soil) on okra inoculated with nematodes.

Treatment	Number of galls	Number of nematode eggs in roots	Number of nematodes in the soil
Oil palm sludge	35.6	6480	2260.0
Bitter Leaf	39.8	3620	1020.0[a]
Cassava Peels	31.2	3360	1200.0[a]
Sawdust	59.4	4260	2200.0
Nematicide	26.4	3340	580.0[a]
Control	55.4	5340	4400.0[b]
LSD $_{(0.05)}$	NS	NS	1243.9

Where NS means no significant difference or non significance. ab means significant difference. aa means No Significant Difference.

rate to action (Barman and Das, 1996) or due to the poor nutrient and water flow as a result of the formed galls on the plant roots (Ploeg, 2001).

The treatments recorded significant reduction of nematodes in the soil due to their biological activity against the nematode population in the soil. Oka and Yermiyahu (2000) reported the effect of organic amendments on soil nematode. This they did by releasing some toxic chemicals to the nematodes (Olabiyi, 2004; Tobih et al., 2011). Galls recorded across the treatments indicated proliferation of nematodes and their active penetration due to the level of soil infestation (Ononuju, 1999) and low quantity of treatments applied which could not inhibit parasitic attack. Other workers, Barman and Das (1996) and Imafidor and Angaye (2009) confirmed this. The effectiveness of the nematicide in reducing gall formation, number of eggs and nematode population in the soil, is due to the ability of the nematicide to kill, inhibit or repel the nematode attack on the plant. Oudejans(1991) supported this in his report that the use of synthetic compounds kills, inhibit or repel injurious organisms.

Conclusion

There were significant differences between the control and treatments in some of the parameters measured while there were no significant differences in others. Synthetic nematicide appeared to be more effective in the control of the nematode and consequently increasing the yield components of the plant. Also from this work, bitter leaf appeared not to differ significantly (P<0.05) from the nematicide in most parameters.

In all, bitter leaf compared favourably with the nematicide. Further rates of application of treatments are needed in both green house and field trials. It is recommended that there should be further confirmation of crop seeds that have been released to be susceptible to root-knot nematode. Again it is recommended to determine the effect of the treatments on crop yield.

Conflict of Interests

The author(s) have not declared any conflict of interests.

REFERENCES

Adebisi MA, Akintobi DCA, Oyekale KO (2007). Preservation of okra seed vigour by seed treatment and storage containers. Nig. J. Hort. Sci. 12:1-7.

Agbenin NO (2004). Potentials of organic amendments in the control of Plant-Parasitic nematodes. Plant Protect Sci. 40:21-25.

Ahmed BI, Abdulhameed A, Yusuf SR, Aliyu M (2006). Comparative study of the defoliatory activities of Podagrica *sjotedti* and *P*. *uniforma* (*Coleoptera*: *Chrysomelidae*) on Two intercropped Okra varieties in Bauchi state Nigeria. Savannah J. Agric. 1(1):12-13.

Alabama A, Alabama M (2009). Nematode Control in the Home Vegetable Garden. Alabama Cooperative Extension system.

Barman M, Das P (1996). Effect of chemical seed dressing and organic amendments alone and in combination for the management of root-knot nematode on green gram. Indian J. Nematol. 26:72-76.

Bolles B, Johnson L (2012). Nematode damage of Okra. University of Florida IFAS Extention.

Browning M, Wallace DB, Dawson C, Alm SR, Amador JA (2006). Potential of butyric acid for control of soil-borne fungal pathogens and nematodes affecting strawberries. Soil Biol. Biochem. 38(2):401-404.

Claudius-Cole AO, Aminu AE, Fawole B (2010). Evaluation of plant extracts in the management of root-knot nematode *Meloidogyne incognita* on cowpea. [*Vigna unguiculata* (L) Walp]. Mycopathol. 8(2):53-60.

Conway G (1995). The depletion of natural resources: The impact of food. A 2020 vision for food, agriculture and the environment. International Food Policy Research Institute, Washington, D.C., 125pp.

Farrooq A, Umer R, Muhammad A, Muhammad N (2010). Okra (*Hibiscus esculentus*) seed oil for biodiesel production. Applied Energy. 87(3):779-785.

Fernandez C, Rodriguez-Kabana R, Warrior P, Kloepper JW (2001). Induced soil suppressiveness to a root-knot nematode species by a nematicide. Biol. Control. *22*(2):103-114.

George RAT (2005). Horticulture: Principles and Practices. 3rd Edition: Pearson Edu. Publishers U. K. 208pp

Hussey RS, Barker KR (1973). A comparison of methods of collecting inocula of *Meloidogyne* spp. including a new technique. Plant Disease Reporter. 57:1025-1028.

Ijewere S (2012). Fruit of the week: Okra. Eden lifestyle.

Ijoyah MO, Dzer DM (2012). Yield Performance of Okra (*Abelmoschus esculentus* L. Moench) and Maize (*Zea mays* L.) as Affected by Time of Planting Maize in Makurdi, Nig. J. Agron. 1(8):184-190.

Imafidor HO, Angaye GP (2009). Investigation on the nematicidal effects of bitter leaf extract (*Vernonia amygdalina*) on pepper plants (*Capsicum annuum*). Afri. J. Applied Zool. Environ. Biol. 11:106 - 110.

Javed N, Gowen SR, Inam-ul-Haq M, Abdullah K, Shahina F (2006). Systemic and persistent effect of neem (*Azadirachta indica*) formulations against root-knot nematodes, *Meloidogyne javanica* and their storage life. Crop Protect. *26*(7):911-916.

Kamara AY, Ajala SO, Kureh I (2005). Performance of diverse maize genotypes under nitrogen deficiency in the northern Guinea Savanna of Nigeria. Exper. Agric. 41(2):199-212.

Kaskavalci G (2007). Effects of soil solarization and organic amendment treatments for controlling *Meloidogyne incognita* in tomato cultivars in Western Anatolia. Turkish J. Agric. 31:159-167.

Khan Z, Kim YH, Kim SG, Kim HW (2007). Observations on the suppression of Root-knot nematode (*Meloidogyne arenaria*) on tomato by incorporation of cyanobacterial powder (*Oscillatoria chlorina*) into potting field soil. *Bioresource Technol. 98*(1):69-73.

Kimenju JW, Muiru DM, Karanja NK, Nyongesa MW, Maino DW (2004). Assessing the role of organic amendments in management of root-knot nematodes on common bean, *Phaseolus vulgaris* L. *Trop*. Microbiol. Biotechnol. 3:14-23.

Mays DA, Buchanan W, Bradford BN, Giordano PM (1990). Fuel production potential of several agricultural crops. *Advances in new Crops.* pp.260-263.

National Research Council (NRC) (2006). *"Okra" Lost Crops of Africa: Volume II: Vegetables*. Lost Crops of Africa 2. National Academic Press. ISBN 978-0-309-10333-6. Retrieved 15-07-2008.

Noling JW (2012). *Nematode Management in Okra*. Entomology and Nematology Department, Citrus Research Center, Cooperative Extension Service, Institute of Food and Agricultural Sciences, University of Florida, Lake Alfred, FL.

NRCRI (2010). *National Root Crops Research Institute*. NRCRI, Umudike, Metorological Station Data, 2010.

Oka Y, Yermiyahu U (2000). Suppressive effects of composts against the root-knot nematode *Meloidogyne javanica* on tomato. Nematol. 4(8):891-898.

Okada H, Harada H (2007). Effects of tillage and fertilizer on nematode communities in a Japanese soybean field. Appl. Soil Ecol. 35(3):582-598.

Olabiyi TI (2004). *Assessment of the nematicidal properties of extracts from Tagetes erecta, Ocimum gratissimum, Hyptis suavelous and Crotalaria retusa*. PhD thesis, University of Ilorin, Ilorin, Nigeria, 177pp.

Olaniyi MO, Moens M, Moermans M (2005). Effects of soil amendments with herbs in the control of *Meliodogyne incognita* on tomato. Nig. J. Plant Protect. 22:140-148.

Ononuju CC (1999). *Management of Plant Parasitic Nematode problems in commercial plantain and banana productions*. A paper presented at the third Annual Conference of Agricultural Society Institute Baddaggi, Nigeria.

Ononuju CC, Fawole B (2000). Evaluation of Ethoprophos Isazophos, Carbofuran for the control of plant-parasitic nematodes and their effects on plantain growth and yield. Nig. J. Sci. 34: 81-89.

Ononuju CC, Okoye CD (2003). Nematotoxic activity of some common weed extracts against root -knot nematode in soyabean. Afri. J. Appl. Zool. Environ. Biol. 5:64-66.

Oudejans JH (1991). Components of integrated pest management. In: *Agro-pesticides: properties and functions in integrated crop protection.* United Nations, Bangkok, 15-25pp.

Ploeg A (2001). *When nematodes attack is important*. California grower. October. 12-13pp.

Raemakers R (2001). *Crop Production in Tropical Africa and Vegetable Production in warm climates*. Macmillian Publishers, Belgium 453pp.

Rice RP, Rice LW, Tindall HD (1991). Fruit and Vegetable Production in

Warm Climate. Macmillian publisher London. 196pp.
Schippers RR (2000). *African Indigenous Vegetables: An Overview of the cultivated species*, Natural Resource Institute. E.U. Technical Centre of Agriculture and Rural Cooperation, Chathan, 214pp.
Schippers RR (2002). *Africa Indigenous Vegetable Crop Production*. Hobbs publishers, U.K. 112pp.
Smith P, Polomski B, Shaughnessy D (2002). *Okra*. Clemson Cooperative Extension.
Sukul NC (1992). Plant antagonistic to plant-parasitic nematode. Indian Rev. Life Sci. 12:23-52*.*
Taniwiryono WD, Brink PVD, Rietjens IMCM, Murk AJ (2007). A case study in Bangka Island, Indonesia on the habits and consequences of pesticide use in black pepper plantations. J. Environ. Toxicol. 22(4):405-414.
Tobih FO, Adegbite AA, Ononuju CC (2011). Evaluation of some plant materials as organic mulch for the control of root-knot nematode (*Meloidogyne* spp.) and its impact on growth and yield of *Celosia argentea* L. Inter. J. Agri. Sci. 1(4): 591-202.
William TC, Robert AD (2007). *Managing Nematodes for a Non-Commercial Vegetable Garden*. US Department of Agriculture, Cooperative Extension service, University of Florida A and M University Cooperative Extension Programs and Boards of Country Commissioners Cooperating.
Williamson VM, Kumar A (2006). Nematode resistance in plants: The battle underground. Trends Genetics 22(7):396-403.
Yadev SK, Dhanker BS (2002). Performance of (*Varsha uphar*) cultivar of okra as affected by sowing dates and plant geometry. Veg. Sci. 27:70-74.
Yudelman M, Ratta A, Nygaard D (1998). Pest Management and Food Production: Looking to the future, Food, Agriculture and the Environment. Discussion Paper 25, International Food Policy Research Institute, USA, 50pp.