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

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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. Moench) 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

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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 (Farroq 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, except 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.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Plant height (cm)</th>
<th>Number of leaves</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oil palm sludge</td>
<td>31.27</td>
<td>6.71</td>
</tr>
<tr>
<td>Bitter leaf</td>
<td>28.07</td>
<td>6.89</td>
</tr>
<tr>
<td>Cassava peels</td>
<td>27.88</td>
<td>6.89</td>
</tr>
<tr>
<td>Sawdust</td>
<td>26.67</td>
<td>6.23</td>
</tr>
<tr>
<td>Nematicide</td>
<td>31.55</td>
<td>7.34&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>Control</td>
<td>29.92</td>
<td>5.83&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

LSD (0.05) 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.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Fresh shoot weight (g)</th>
<th>Dry shoot weight (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oil palm sludge</td>
<td>14.48</td>
<td>5.36&lt;sup&gt;*&lt;/sup&gt;</td>
</tr>
<tr>
<td>Bitter leaf</td>
<td>15.26</td>
<td>6.04&lt;sup&gt;**&lt;/sup&gt;</td>
</tr>
<tr>
<td>Cassava peels</td>
<td>11.56</td>
<td>4.30</td>
</tr>
<tr>
<td>Sawdust</td>
<td>10.28</td>
<td>4.08</td>
</tr>
<tr>
<td>Nematicide</td>
<td>12.70</td>
<td>5.00</td>
</tr>
<tr>
<td>Control</td>
<td>12.52</td>
<td>3.94&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

LSD (0.05) 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.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Number of galls</th>
<th>Number of nematode eggs in roots</th>
<th>Number of nematodes in the soil</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oil palm sludge</td>
<td>35.6</td>
<td>6480</td>
<td>2260.0</td>
</tr>
<tr>
<td>Bitter Leaf</td>
<td>39.8</td>
<td>3620</td>
<td>1020.0&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>Cassava Peels</td>
<td>31.2</td>
<td>3360</td>
<td>1200.0&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>Sawdust</td>
<td>59.4</td>
<td>4260</td>
<td>2200.0</td>
</tr>
<tr>
<td>Nematicide</td>
<td>26.4</td>
<td>3340</td>
<td>580.0&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>Control</td>
<td>55.4</td>
<td>5340</td>
<td>4400.0&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

LSD (0.05) 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 nematode 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


Kaskaivali 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.


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.


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