Prevention of Ecosystem Dysfunction in Okra (*Abelmoschus esculentus*) Using Neem Based Biopesticide

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Abstract
There is increasing awareness on the use of environmentally-friendly crop protection and production products universally, in agricultural production. Thus, in this study the use of neem based biocide was investigated in Okra production. Neem seeds extract was prepared from dried neem seeds by milling the neem seeds and pouring on it boiling water at 160g/10 litres, in a container. The neem seeds extract obtained was allowed to cool overnight and sprayed at the rate of 1.5 l/2.25m^2 microplots, with hectare equivalent of 6,666l/10,000m^2 in a randomized complete block design with four replications, with control microplots not sprayed. Spacing was 0.75m × 0.50m with nine plants within each microplot. Plant growth parameters including height, girth, number of leaves, leaf damage index, galling index and fresh fruit yield were also determined at twelve weeks after planting. Data collected were subjected to analysis of variance and means separated with least significant difference. Results showed that the neem based biocide reduced leaf damage index and galling index of okra by 42.0% and 56.0% respectively. Fruit yield loss of 45.0% was prevented. The neem based biocide effectively controlled foliar and roots pests of okra.

Keywords: *Biological farming; enhanced yield; ecosystem dysfunction; Azadirachta*

Introduction

The production of okra is faced with many constraints, among which foliar and root pests are paramount. Farmers mostly embark on the use of pesticides which are toxic to humans and the ecosystem, in Okra pest management (Holderness *et al.*, 2000; Oyekanmi *et al.*, 2008). Such pesticides cause ecosystem imbalance and adversely affect the soil. There are legislations against the massive use of pesticides. Many research studies have been carried out on okra to show the efficacy of neem based biocide in the control of pests in okra. Okra is a notable vegetable crop grown for its tender fresh fruits which are rich in vitamins, protein and minerals. Okra is a popular vegetable crop which was reported to have originated from Africa (NMSU, 1998). It is widely grown in many continents of the world as an annual vegetable. Okra is a notable vegetable crop grown for its tender fresh fruits, which are rich in vitamins, protein and minerals (NMSU, 1998; Njoku *et al.*, 2007). Okra is easily grown because it tolerates environmental stress well. For most cultivars, flowering begins 35 days after planting. Normally flowers are self pollinating or are pollinated by insects. The production of okra is faced with many constraints among which foliar and root pests areparamount. Insects, viruses, southern stem blight,

Verticillium and *Fusarium* wilts and root-knot nematodes, are some of the more serious pests that attack okra and consequently reduce fruits yield of okra in quantity and quality (NMSU, 1998; UAEX, 2008).

Among the many insect pests that attack okra, but the most troublesome are silverleaf whitefly, rough bollworm, looper caterpillars and green vegetable bugs. Aphids and mites may also infest okra plants. Indiscriminate use of insecticides to control the pests may result in the development of resistance by the pests to the pesticides (NMSU, 1998). Although there are chemicals which will assist with management of these pests, they should only be used under strictly supervised conditions or the insects will quickly develop resistance to them. Also, such pesticides kill non-target organisms some of which may be offering free ecosystem services, and terminating such beneficial organisms, may lead to ecosystem, imbalance and dysfunction. Insect management in okra is very difficult as only a small number of insecticides are registered. Some of these have only limited effectiveness against some pests for which they are registered. Monitoring the crop regularly for pests is essential (UAEX, 2008).

There are also cases, where pests have been managed through the use of pesticides, which are now being strongly regulated for agricultural use, due to various health and environmental hazards. Therefore, global call to reduce pesticides residue in food and priority for organically produced agricultural products has made, crop scientists' and farmers' interest in organic farming to increase (Holderness *et al.*, 2000; Oyekanmi *et al.*, 2008). It is therefore essential to look for environmentally-friendly alternatives to synthetic pesticides used in okra production, okra being an important vegetable universally.

Neem seed extract has been reported to be effective in the control of pests. Neem seed extracts cause various effects on insects. They act as antifeedants, growth regulators and sterilants. Good results have been obtained in the control of insects with azadirachtin containing seed extracts under field conditions (Schmutterer, 1990). Neem has systemic activity (Larewy 1988, Isman and Port 1990). ISt is active at low concentrations, has negligible mammalian toxicity, degrades rapidly in the environment and it proves in most cases not deliterious, or only slightly harmful, to important natural enemies of pests (Schmutterer, 1990).

The current study was carried out to assess the efficacy of neem based biocide for the control of the foliar and root pests of okra.

Materials and Methods

Experimental site and details

The experiments were conducted in the Research Farm of The organic agriculture centre, (OOCORD) moor plantation, Apata Ibadan, from April to October in 2008. Neem seeds were collected from neem trees growing around OOCORD and other parts of Ibadan city. The seeds were dried to constant weights. The efficacy of neem based biocide was investigated in this experiment, to investigate the effect of neem based biocide. The variety of okra used in this experiment was forty days dwarf, a promising early maturing (40 days) variety of okra. The seeds were collected from a horticultural research institute in Ibadan, NIHORT. The seeds were planted during the copping season of 2008. Three seeds were planted per hole, at a spacing of 0.75m × 0.5m the plants were thinned to one per hole at three weeks after planting. Nine plants were maintainedper microplot. Neem extract was prepared from the dried and milled neem

seeds with boiling water (160g/10 litres). The extract obtained was allowed to cool over night. The neem extract obtained was applied to the okra plants at the rate of 1.5L, with microplots size of 1.5m × 1.5m, in a randomized complete block design with four replications, the treatments were neem based biocide and no neem based biocide (Control).

Root galling and leaf damage indices and root-knot staining

Root galling index was assessed on a scale of 1-5, where 1= no galling,2 = 1 – 25% of roots with galls, 3 = 26 – 50% with galls, 4 = 51 -75% with galls and 5 ≥ 75% root galling (Benjamin and Grover, 1987). A scale of 1 to 5 was used to assess leaf damage index, where 1= no damage on leaf, 2 = ≤ 2mm diameter of damage on leaf, 3 = ≤ 3mm diameter of damage on leaf, 4 = ≤ 5mm diameter of damage on leaf and 5= ≥ 6mm diameter of damage on leaf.

Meloidogyne incognita densities (Juveniles, egg mass and females) were assessed from 2 g subsample of each root after staining in hot lactoglycerol with acid fuschin stain (Bridge *et al.*, 1982).

Data collection, analyses and management of Experiments

Height was measured with a meter rule, fruit and number of leaf were effected by visual count and girth was determined with a twine which was stretched on a ruler. Fresh (immature) fruit yield were weighed by metler balance at twelve weeks after planting. Data collected were subjected to analysis of variance, regression analysis was performed through excel 2000 and means were separated with least significant difference at 5% level of probability.

Results

The neem based biocide significantly ($P \leq 0.05$) enhanced okra height by 68.18% when compared with control plots to which biocide was not applied (Table 1).

Table 1: Neem based biocide effects on Okra mean height and girth at 12 weeks after planting (WAP) and number of leaves at 9WAP.

Treatments	Growth Parameters		
	Height (cm)	Girth (cm)	Number of leaves
Neem extract (Biocide)	121.60	5.88	18.13
No Neem extract (Control)	72.30	5.76	13.31
$P \leq 0.05$; LSD values	35.21	1.09	6.12

There was no significant difference in plant girth at 12 weeks after planting (WAP) and number of leaves at nine weeks after planting. However, microplots with biocide application still had 36.21% more leaves than control plots (Table 1). The neem based biocide reduced leaf damage index and galling index by 83.98% and 33.33% respectively. Fresh fruit (immature) yield loss of 44.57% was also prevented (Table 2).

Table 2: Neem based biocide effects on Okra mean fruit yield, leaf damage index and root galling index at 12 weeks after planting.

Treatments	Parameters		
	Fruit yield (g)	Leaf damage index	Root galling index
Neem extract (Biocide)	210.00	2.31	2.25
No Neem extract (Control)	145.25	4.25	3.00
$P \leq 0.05$; LSD values	46.82	1.80	0.20

The percentage leaf retention following application of neem based biocide at twelve weeks after planting was 40.39% when compared with control plots where biocide was not applied. Application of biocide significantly reduced number of root-knot nematode female and egg mass per 2g root (Table 3).

Table 3: Neem based biocide effects on Okra leaf retention, female and egg mass of root knot nematode at 12 weeks after planting.

Treatments	Parameters		
	Percentage leaf retention	Female	Egg mass per 2g root
Neem extract (Biocide)	57.58	2.15	2.00
No Neem extract (Control)	17.19	3.00	8.00
$P \leq 0.05$; LSD values	32.89	0.63	4.70

Female and egg mass number were reduced by 39.53% and 75.00% respectively. Regression analysis of fresh fruit yield of treatments on galling index at twelve weeks after planting was conducted the relationship showed that fresh fruit yield was inversely related to galling index. The relationship had R^2value 0.96, in figure 1.

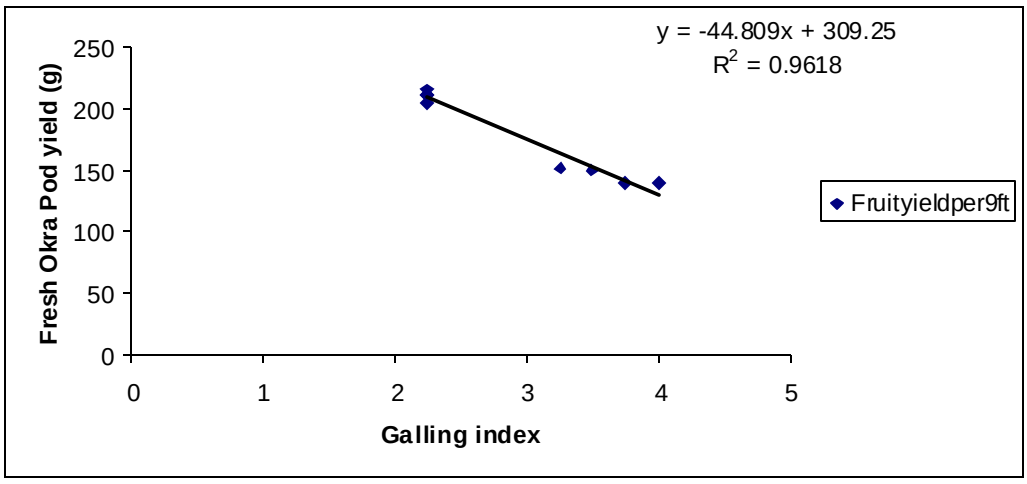

Figure 1: Regression analysis of fresh pod yield of treatments on galling index, at 12 weeks after planting n = 8.

Also, regression analysis of fresh fruits yield was inversely related on leaf damage index, at 12 weeks after planting was conducted, lower fruits yield were obtained at higher leaf damage index (figure 2), R^2 value was 0.89 and the graph was inverse linear relationship.

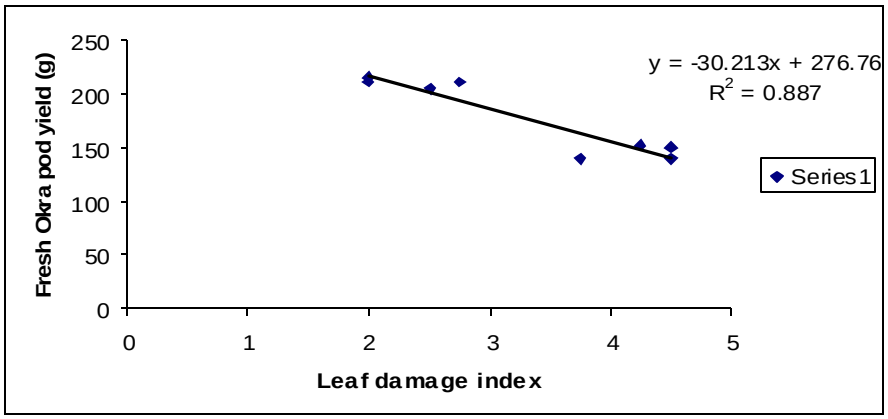

Figure 2: Regression analysis of fresh pod yield of treatments on leaf damage index, at 12 weeks after planting n = 8.

Discussion

The neem based biocide supported crop growth in terms of plant height and number of leaves when pests were put under control and this was reflected in improved height and number of leaves. This result was supported by the findings of Isman and Port (1990) and Mohamed (2000) in research work which were conducted on the control of *Pieris brassicae*; and research work on okra, tomatoes and onions.The authors established that reducing pests population improved yield quantity and quality. The neem based biocide did not only controlled insect it managed root-knot nematodes, this add to the credence of the neem based biocide acting as a wide spectrum organic pesticides (Mohamed, 2000). In order to support sustainable vegetable production, it is important to develop alternative methods of pests control. Neem products, in most cases being practically non-toxic to man and warm blooded animals and relatively harmless to beneficial insects, are very suitable for biological and integrated pest control programmes (Mohamed, 2000).

In addition, in many developing countries of the world, subsistence farmers who cannot afford to purchase synthetic pesticides and other chemical inputs to produce vegetables can rely on this approach. Many farmers practicing organic Agriculture who are familiar with this technology have found that the neem based biocide is working effectively in the management pests in their farms (Personal Communication).

Larewy (1988), and Isman and Port (1990), also found that the neem based biocide is systemic in it's activities. The results obtained in this study corroborated with the work carried out by these authors. In spite of the application of neem based biocide to the leaves of okra only it was still found to control root-knot nematodes in the roots of okra. This systemic ability of the neem based biocides makes it a wide spectrum crop protection preparation, which records no loss of beneficial biota present in the ecosystem, thus preventing ecosystem dysfunction and maintaining the biotic life of the soil which is a major component of the ecosystem and the good basis of crop production.

Conclusion and Recommendation

The study established that the reduction in pest population resulted in improved yield in quantity and quality. Thus, the neem based biocide showed tendency of replacing synthetic pesticides being used in controlling pests in okra field. Therefore, it is promising for okra production and protection and further research should be carried out on it to develop it for use in organic agriculture.

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