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Field Evaluation of Plant Extracts in the Management of *Megalurothrips sjostedti* and *Maruca vitrata* of Cowpea in Southeastern Nigeria

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ABSTRACT: The study evaluated the impact of plant extracts (*Azerachita indica, Allium sativum* and *Zingiber officinale*) in the management of post-flowering insect pests (*Maruca vitrata* and *Megalurothrips sjostedti*) of cowpea against synthetic insecticides, during 2011/12 farming seasons in Nigeria. The results indicated that the incidences of *Maruca vitrata* and *Megalurothrips sjostedti* were significantly influenced by the application of *Azerachita indica, Allium sativum* and *Zingiber officinale* aqueous extracts in a descending order respectively. At the application of *Azerachita indica* and *Allium sativum* extracts at 10% concentration, they significantly ($P<0.015$) reduced the abundance of *Megalurothrips sjostedti* and *Maruca vitrata,* decreased the cowpea pod damage comparatively to Uppercott at 1.5 kg a.i. ha^{-1} standard check. Results of the experiments showed that all the plant extract treatments were significantly better than control treatment. Similarly, yield results corresponded positively with the effectiveness of the treatments. Grain yields were significantly higher in plots treated with *Azerachita indica, Allium sativum* extracts compared to plots treated with *Zingiber officinale* and the control. Results of the present finding therefore suggest the use of all the tested plant extracts in the management of cowpea pests and could serve as an alternative to synthetic insecticides. It is cheap, safe, and environmentally friendly and if adopted could increase cowpea production in Nigeria especially for the resource poor farmers.
Keywords: *Maruca vitrata, Megalurothrips sjostedti*, plant extracts, pest management, cowpea grain yield.

INTRODUCTION

Cowpea, [*Vigna unguiculata,* (L.) Walp] is one of the annual leguminous food crops grown in many parts of the tropics. The genus *Vigna* is pan-tropical and highly variable with several species, whose exact number varies according to authors. Cowpea has a wide variety of uses. It is a primary source of plant proteins in human and animal feeds. The percentage nutritional value of cowpea indicated its protein content to be 23%, fats 1.3%, fibre 1.8%, carbohydrate, 67% and water 8 – 9% (Jefferson, 2005). Cowpea also serves as a cover crop important for nitrogen fixation (Asiwe *et al.,* 2009). Majority of people in the developing countries including Nigeria are engaged in cowpea production and it has the potential to produce reasonably well under conditions that may render other crops unproductive, but productivity has been very low, less than 200 kg ha^{-1} (Oparaeke *et al*., 2005).

This has been attributed to several biotic and abiotic factors (Singh 2005; Timko *et al*., 2007). The biotic factors that cause yield reduction include insect pests, parasitic plants as well as viral, fungi and bacterial diseases (Emechebe and Lagoke, 2002; and Amatobi *et al.,* 2005). While the abiotic factors include poor soil fertility, drought, heat, acidity and stress due to intercropping with cereals (Singh and Ajeigbe 2002). Furthermore, Cowpea production in the rain forest zone of eastern Nigeria is time bound. Most times, cultivation of this legume coincides with the season during which oviposition and breeding of most insect pests of cowpea is highest. Hence, Terao *et al.* (1997) reported that of all these factors, insect pests and plant diseases are the major constraints to increased cowpea productivity. The incidence of insect pest attacks has been a reoccurring phenomenon in cowpea production. It attacks the crop at different stages of growth and often leads to significant reduction in yield especially where little or no control measure is applied (Oparaeke 2006).

Cowpea is host to so many insect pests at all stages of its growth resulting in economic damage. Some of the insect pests of economic importance of cowpea in the tropics are aphids, *Aphis craccivora* Koch, foliage beetle, *Ootheca mutabilis*, the flower bud thrips, *Megaurothrips sjostedti* Trybom, the legume pod borer, *Maruca vitrata* Fab and sucking bug complex e.g. *Clavigralla spp, Nezeera viridula, Aspavia armigera* etc (Amatobi *et al.,* 2005). Tremendous yield losses associated with these pests have been reported in many parts of Africa where cowpea is grown in large scale. However, amongst the insect pest that causes economic damage on cowpea plants, flowering and post-flowering insect pests are the most recalcitrant ones. Of the entire reproductive insect pests, the most serious ones in Nigeria are; flower bud thrips, *M. sjostedti* and the pod borers, *M. vitrata*. *M. sjostedti* are small opportunistic and ubiquitous insects that are mainly phytophagous and inhabit a wide range of habitats generally in the tropical, sub-tropical and even in the temperate regions (Morse and Hoddle, 2006). Thrips frequently inhabit flowers or florescence of various kinds, shoots, tender leaves and fungus infested dead or decaying wood. At pre-flowering stage, the thrip may damage the terminal leaf bud causing it to be deformed with yellow mottled appearance. During flowering stage they feed on pollens resulting in the abortion of the flowers (Okparaeke 2006). On the other hand, *M. vitrata* belongs to the family Pyralidae of order Lepidoptera. The caterpillars damage flower buds, flowers and developing pods. They also web inflorescences and the pods are malformed because of webbing. The caterpillars remain in the webbed mass and also feed upon the flowers and developing pods. In developing countries where soil infertility is high, rainfall is limited and cowpea is grown without the use of fertilizer and adequate plant protection measures, its infestation has been tremendous. Under these conditions, *M. vitrata* alone can cause losses in cowpea field varying from 20–80% (Singh 2005). Similarly, losses from infestation by, flower pod thrips ranges from 70 - 100 % (Ta' Ama 1983).

In Nigeria cowpea production can be improved and raised to many fold when insect pests are controlled. In the recent years, several control measures have been advocated such as the use of synthetic insecticides, biological controls, physical control and host plant resistance by many researchers to control post-flowering insect pests in cowpea production (Sharah and Ali, 2008). Results show that insecticides are the most effective control measure against these pests and majority of the farmers rely heavily on the use of synthetic insecticides in the management of their cowpea pests. Unfortunately, most farmers in the tropics are resource-poor and cannot afford the use of synthetic pesticides. Synthetic insecticides are costly, toxic to humans and when used excessively may be harmful to the environment (Sharah and Ali 2008). Hence the need for alternative control measures that exclude or minimise the use of synthetic insecticides in the management of cowpea pests. There are considerable literatures that indicates that the use of some plant extracts are promising alternative control measures to synthetic chemicals (Schmutterer, 1990). These botanicals are economical, environmentally safe, and less hazardous to humans and often less toxic to ecologically beneficial insects as well as the development of resistance by insect pests. The efficacy of plant extracts in the control of insects pest is based either on the insecticidal, larvacidal, repellent, antifeedant and/or fumigant characteristics they possess. These properties predispose extracts from the plants as an important biochemical substance for control of insect pest (Isirima Chekwa *et al*., 2010). However, most findings on this aspect of crop protection were focused on stored pests control (Oparaeke 2006). There is paucity of information on field application of extracts from plant sources for pests control on cowpeas. This study therefore aims to investigate the effect of Neem (*Azerachita indica*), garlic (*Allium sativum*) and ginger (*Zingiber officinale*) aqueous extracts in the management of cowpea flowering and post flowering insect pests in eastern Nigeria.

MATERIALS AND METHODS

Field experiments were conducted at the teaching and research farm of the Faculty of Agriculture, Ebonyi State University Abakaliki during 2011 and 2012 farming seasons. The cowpea variety used for the experiment was Sampea 10 bought from Institute for Agricultural Research, Samaru Zaria. The fields were laid out in randomized complete block design consisting of five treatments- three plant extracts, a synthetic insecticide check (Uppercott) and untreated check, and each treatment was replicated thrice. Each plot was 5.0 x 4.0 m. The beds were made manually using a hoe. Seeds were sown at 3 seeds per stand at 2 – 3 cm depth within intra row spacing of 30 cm and inter row spacing of 75 cm apart. The cowpea seedlings were later thinned to two plants per stand at two weeks after germination. Gap filling was done at three weeks after germination to replace dead seedlings. Fertilizer NPK (15: 15: 15) was applied as top-dressing at 80 kg ha^{-1} 14 days after germination. Manual weeding was done at 3 - 4 weeks intervals after planting to ensure clean plots.

Fresh and clean leaves of neem were obtained from the University farm, while garlic bulbs and ginger rhizome were bought from Abakaliki main market. Each was pounded separately into paste. The pastes were each weighed 500 g and poured into 500 ml conical flask containing 100 ml hot clean water and soaked in it for 24hrs and thereafter sieved using a Muslin cloth, and liquid soap at 0.1% was added as emulsifier. The extracts were applied at 10% concentration at one week intervals using Knapsack sprayer at the rate of 200 l ha^{-1} beginning from flower bud initiation and stopped when most of the pods were matured and ready for harvesting. Uppercott (Cypermethrin 250 g a. i /l + Dimethoate 350g a.i /l) was applied twice, firstly at bud initiation (30 – 36 days after planting) and secondly at 50% flowering (42 – 46 days after planting at the rate of 1. 5 kg a. i/ha as standard check, while the control plots did not receive either of the pesticides.

Observations on the incidences of insect pests were recorded on tagged plants. Five plant stands per plot were randomly selected and tagged within the middle rows of each plot. The target insect pests were *M. sjostedti* and *M. vitrata*. The incidences of *M. sjostedti* and *M. vitrata* were assessed weekly from flower bud initiation to first pod maturity stage. At each sampling period, the population densities of *M. sjostedti/ M. vitrata* were estimated by randomly picking 20 flowers buds or flowers depending on the stage of growth. The buds or flowers were placed in glass vials containing 50% ethanol solution. Subsequently, nymphs and adults of *M. sjostedti/ M. vitrata* were counted under binocular microscope in the laboratory. Pod damage (shriveling, twisting, stunting, constriction) was assessed by examining 20 pods randomly selected from the tagged plants per plot. At harvest, data were collected on total grain yield from the tagged plants. Estimate of grain yield per unit area was done when the grains were dry using the tagged plants. The pods were threshed and winnowed. The results were extrapolated to kilogram per hectare. Damage percentages were subjected to Arcsine transformations before analyses of variance were carried on them through computer software (SAS, 2003). The mean separation was carried out by Student Newman's Keuls ($P < 0.05$) test.

RESULTS

The results of the investigation showed that the three plant extracts have high insecticidal potentials and significantly ($p < 0.01$) reduced the incidences of *M. sjostedti* and *M. vitrata* damage compared to untreated check. The application of neem extracts considerably reduced the incidences of Thrips and Maruca. This is evident on the population of these insects on cowpea flower buds and flowers (Tables 1 and 2). Similarly, the application of garlic extracts significantly reduced the incidences of these post-flowering pests of cowpea throughout the experimental period. However, it differed significantly lower from that of neem extract, indicating that neem extract showed superior efficiency in the management of these pests in the field. This downward efficiency of the extracts was equally observed on plots treated with ginger extract. Plots treated with ginger showed some level of efficiency in the management of these pests but differed significantly from both neem and garlic thus taking the third position in the ranking of their efficiency. Thus, although all the sprayed plots had significant control of thrips and maruca compared to the untreated control, ginger extracts was less effective than others. The untreated plots differed from the treated plots and had the highest level of infestations of the two insects.

On the other hand, the performance of aqueous extracts of neem was not inferior to the synthetic insecticide treatment on most of the parameters tested. Thus, there were no significant different between the plots treated with neem from those treated with the synthetic insecticide even though plots treated with the synthetic insecticide had less infestation than that of neem treated plots. Throughout the experimental periods, the incidences of these insects were more severe during the 2011 farming season than during the 2012 season.

The results on grain yield showed significant relationship between the incidences of the pests, plant extracts applications and grain yield. Plots treated with the pesticides had least number of pods damaged (Table 3) and were significantly ($p<0.05$) different from the control plots on number of damaged pods and total grain yield. However, plots treated with neem and garlic extracts were found to be superior over ginger extract by producing higher total grain yield (Table 4). Grain yields from plots treated with ginger were also statistically different from the control plots. Plots treated with synthetic insecticide however recorded the highest total grain yields throughout the experimental periods. The untreated control plots recorded the highest number of damaged pods and least total grain yields and were significantly inferior to the other pesticides applied.

DISCUSSION

The results showed that the application of plant extracts (Neem, garlic and ginger) on cowpea plants at flowering/podding stages of the plant significantly ($p<0.05$) reduced the population of both thrips and maruca insect pests when compared with the control suggesting the importance of this technology in the management of insect pests. The use of plants, plant material or crude plant extracts for the protection of crops and stored products from insect pests have been recorded as one of the oldest crop protection methods (Thacker, 2002). The high potentials observed under these plant extracts could be attributed to insecticidal properties they contain that are lethal to a wide range of insects including thrips and maruca (Oparaeke, 2007). Similarly, the highest significant reduction on the incidences of these pests observed under neem extract may be attributed to its genetic property that posses better insecticidal properties that enhanced its performance when compared to other plant extracts except the synthetic insecticide check. This is in line with the results reported by Ogah *et al*. (2011). In another research experiment, Oparaeke (2004) found that the stem bark extracts of *A. indica* and *E. citriodora we*re effective against some cowpea pests. Similarly, the considerable reduction on the incidences of pod borer insects that live and feed inside the flowers/pods conspicuously out of the reach of spray liquids may be attributed to the antifeedant property of neem. The findings of this study are supported by those of Dzemo *et al*. (2010), who reported that aqueous plant extracts significantly reduced the infestation of pod borers and pod sucking bugs (PSBs) on cowpea thereby reducing pod and seed damage and increasing grain yield.

The efficacy of these plant extracts were corroborated with the significant increase in grain yields recorded on plots where they were applied. The results indicated that the application of these extracts during the podding stage of cowpea considerably enhanced the grain yields obtained than those from the unsprayed control plots suggesting that damage inflicted on cowpea by post flowering insect pests were responsible for the significant reduction on grain yield observed under the control plots. The significant increase in grain yields recorded on plots treated with plant extracts than untreated control plots may therefore be attributed to the role of the extract in reducing the incidences of pests. This was in line with Panhwar (2002) who reported that plant extracts applied on cowpea plants protect them from insects. The higher grain yield recorded in plots treated with neem and garlic extract compare to ginger and the control correspond positively with the earlier work conducted by previous researchers which showed that neem and garlic plant extracts significantly increased grain yields in cowpea plants (Jackai *et al* ., 1992, Oparaeke 2005).

This implies that cowpea post flowering pests are serious threat to cowpea production and most be managed effectively for increased grain yield. This result confirms the findings of Sharah and Ali (2008) and Degri *et al*. (2012) who found that insect pest infestation at flowering and podding stages are a significant limiting factor to increased and sustainable cowpea grain production. Pod borers and Pod – sucking Insect pests like Maruca vitrata, Clavigralla spp, Anoplocnemics sp, Riptortus sp, Mirperus sp Neizara sp and other post flowering pests of the reproductive structures of cowpea with early feeding leading to flower abortion, pod shriveling and seed damage are important and hence poor grain yield observed when not managed (Dzemo *et al*., 2010). Panhwar (2002) also reported that good aqueous solution of neem, garlic and ginger will effectively control worms, beetles and thrips in cowpea. Plant extracts have been reported to possess toxic organic poison that is effective in reducing insect pest species population including pod borer (Gaby, 2000,). The ability of these plants extracts to protect cowpea from severe insect attack of the leaf defoliators, leaf hoppers and various pod sucking bugs is probably anchored on their antifeedant and repellent properties. It has been reported that the presence of olerisine substance, a volatile oil in ginger and presence of an essential oil (allyl proply disulphide and daily disulphide) an antifeedant in garlic and tetranortriterpenoid, azadirachtin, an antifeedant and hormone inhibition enzyme in neem extract are responsible for their insecticidal effect in the management of pests.

On the other hand, the increase in yield recorded across the plots treated with plant extracts may be attributed to their role in improving the crop growing conditions. This was in line with Panhwar (2002) who reported that plant extracts applied on cowpea plants increased flower production per plant with a resultant increase in grain yield. They also reported that plant extracts increase the yield of vegetables and pea plants. More so, field observations throughout the experimental periods indicated that none of the extracts used in the study produce any phototoxic effect on cowpea leaves. This observation is however in contrast with the observation made by Olaifa and Adenuga (1998). According to them neem products caused chlorosis with resultant shedding of cowpea leaves. So the decrease in flower bud abscissions and the linear increase in grain yield with the application of the plant extracts clearly show the potency of the extracts in the management of cowpea pests.

CONCLUSION

Result of the experiment showed that though the application of these bio-pesticides did not eradicate the target insect pests completely, all the tested plant extracts were effective against the major post flowering insect pests of cowpea with increased grain yield implication. The results also indicated that these plant extracts have the potential value to substitute synthetic insecticides in pest management. This has to be encouraged since they are available to poor resource farmers, friendly to environment, relatively cheap and easy to apply by none-professionals for enhanced cowpea production in Nigeria.

Table 1. Effect of the plant extracts on the mean population of *M. sjostedti*

Treatments	2011	2012
Neem	3.1a	3.0a
Garlic	4.3b	4.9b
Ginger	7.2c	6.1c
Uppercott	0.8a	0.9a
Control	19.3d	17.7d

Means in the same column followed by the same letter(s) do not significantly differ according to Student Newman Keuls ($P < 0.05$) test

Table 2. Effect of the plant extracts on the mean population of *M. vitrata* larvae

Treatments	2011	2012
Neem	9.3a	6.3a
Garlic	17.7b	11.1b
Ginger	27.9c	19.5c
Uppercott	7.8a	4.2a
Control	33.4d	30.1d

Means in the same column followed by the same letter(s) do not significantly differ according to Student Newman Keuls ($P < 0.05$) test

Table 3. Effect of the plant extracts on mean percentage number of pods damage

Treatments	2011	2012
Neem	11.5b	7.1b
Garlic	17.3c	8.7b
Ginger	21.7d	14.0c
Uppercott	4.2a	3.6a
Control	32.7e	14.3d

Means in the same column followed by the same letter(s) do not significantly differ according to Student Newman Keuls ($P < 0.05$) test

Table 4. Effect of the plant extracts on mean grain yield (kg ha^{-1})

Treatments	2011	2012
Neem	941.6b	985.3b
Garlic	883.3c	933.0b
Ginger	525.0d	547.1c
Uppercott	958.3a	997.1a
Control	47.5e	36.7d

Means in the same column followed by the same letter(s) do not significantly differ according to Student Newman Keuls ($P < 0.05$) test

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