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RESEARCH ARTICLE

Estimates of Flea beetles (Podagrica spp.) Population and their Defoliating Effects on Okra (Abelmoschus esculentus L. Moench) Treated with Plant Leaf Extracts and Synthetic Pyrethroid, Lambda-cyhalothrin

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Abstract

Evaluation of insecticidal activities of Annona squamosa and Tephrosia vogelii leaf extracts against Podagrica species compared to a synthetic pyrethroid, lambda-cyhalothrin, were investigated on okra in southern Guinea Savanna of Nigeria. This study was carried out in buckets arranged in a completely randomized design. A leaf beetle population was monitored and their defoliating effect on the crop was determined. The plant extracts were effective in reducing the population of Podagrica species compared with untreated plants. Mixed application of A. squamosa and T. vogelii at 25% (w/v) exhibited higher efficacy than single application of the plant extracts. Mixed application of the plant extracts was less effective than pirimiphos-methyl EC. Results showed that these botanicals can be exploited for effective use during pest management programme.

Introduction

Okra, Abelmoschus esculentus (L.) Moench, is a member of the family Malvaceae. The world production of okra as fresh fruit vegetable is estimated at 1.7 million t/year and the yield of okra in Nigeria has been very low, hardly up to 7 t/ha (Schippers, 2000). Cultivation of the crop, especially in the northern states of Nigeria, is done by the peasant farmers who usually intercrop it with other staple crops (Ahmed et al., 2006). Despite the nutritive values of okra, its production is very low in most developing countries (Akintoye et al., 2011).

Okra is rich in vitamins, calcium, potassium and other mineral matters. Its fruits can be fried in butter or oil and cooked with necessary ingredients (Yadav et al., 2001). It has been found that okra mucilage application serves as a plasma replacement or blood volume expander (Onunkun, 2012).

Nevertheless, despite the great demand for okra due to its uses and importance, its production is being hampered by some major pests and diseases such as flea beetles (Podagrica spp.); cotton stainer (Dysdercus superstitus); white fly (Bemisia tabaci); and green stink bug (Nezera viridula) among others (Senjobi et al., 2013). The damage caused by Podagrica species comprises characteristic perforation of leaves, the irregular holes reducing photosynthetic surface area of the leaf (Echezona and Offordile, 2011). Important yield losses are reported in Nigeria and Ghana (Obeng-Ofori and Sackey, 2003; Ahmed et al. 2007). These insects also transmit the okra mosaic virus which causes significant yield losses (Vanlommel et al., 1996).

In West Africa, the plant is attacked by two flea beetle species, P. uniformis (Jac.) and P. sjostedti (Jac.) (Coleoptera: Chrysomelidae) which are responsible for heavy defoliation (Odebiyi, 1980; Osisanya and Tayo, 1981). The former has shiny brown elytra while the latter has bluish-black elytra.

These two species of Podagrica have been observed to commence their infestation on okra plants from the stage of germination throughout all stages of its growth. They are mainly leaf eaters.

Although researchers in times past have done few works on discovery of botanicals but little is known about the most effective botanicals and their recommended rates (Omoloye et al., 2002).

Awareness regarding the food safety has increased the demand for organically produced food, which necessitates evaluating the performance of biopesticides as safer alternatives to conventional insecticides (Muhammad et al., 2010). The ban of toxic chemical pesticides in Nigeria will encourage the use of alternative plant protection products which currently are not known to have detrimental effects on non-target organisms and the environment. Botanical insecticide is a promising alternative in the protection of crops against insect pests (Olaniran et al., 2013). They are generally pest-specific and relatively harmless to non-target organisms (Kabaru and Gichia, 2001). This study was carried out to examine the effectiveness of Annona squamosa, Tephrosis vogel*i* in comparison to synthetic pyrethroid, lambda-cyhalothrin against Podagrica species.

MATERIALS AND METHODS

Experimental site

The study was conducted at the pavilion behind Faculty of Agriculture, University of Ilorin, Ilorin, located in southern Guinea Savanna region of Nigeria. Ilorin is the capital of Kwara State and lies on longitude 4^0 35`E and latitude 8^0 30^0N with an annual mean rainfall of about 1150 mm (Jatto and Ogunlela, 1999). Mean monthly temperature varies between 25^0C and 29^0C, and the relative humidity varies between 70% and 80% (Jimoh, 1992).

Sample collection and preparation

Okra seeds (variety NHAE 47- 4) were obtained from the National Institute for Horticultural Research, (NIHORT), Ibadan. The seeds were placed in water and allowed to soak overnight before sowing. Fresh leaves of A. squamosa and T. vogelii were plucked from botanical garden, Ladoke Akintola University of Technology, Ogbomoso, Nigeria. The plant materials were thoroughly washed and ground separately to obtain the paste using a mortar and pestle. Aqueous extraction involved 15 g and 25 g each of A. squamosa and T. vogelii into separate plastic buckets (25 cm in diameter) and appropriate volume of distilled water added (15 g w/v represents an extract made with 15 g plant part per 100 ml of water). The pastes were soaked overnight in separate covered buckets and then filtered using muslin cloth.

Soil sterilization

Two solid stones were allowed to stand on level ground while a drum was set on top. Water and soil were placed in the drum. The soil was sterilized by lighting a fire wood under the drum for about 1 h. The drum was covered with a sheet of plywood to prevent escape of heat and smoke.

Experimental arrangement

Direct sowing of the okra seeds was carried out in 2.5-liter plastic bucket at three seeds per bucket at a depth of 2 cm in each bucket. The buckets were arranged under ambient temperature and humidity in a completely randomized design (CRD) with five replications. Thinning was done one week after sowing to give one plant per bucket. Manual weeding was carried out as required. Spot application of N-P-K fertilizer (10-10-10) was done at the rate of match-box full.

Application of treatments

In this study, single and mixed applications of two botanicals, A. squamosa and T. vogelii sprayed at 15% and 25% w/v, one synthetic pyrethroid (lambda-cyhalothrin EC) sprayed at 0.01% and the control were the eight treatments examined against the population of Podagrica species and their defoliating effects on okra. Spraying was done on weekly basis after sowing with hand-held sprayer of 2-litre capacity. The spraying was done early in the morning and separate application of lambda-cyhalothrin served as standard check.

Data collection

Data were collected on population of P. uniformis and P. sjostedti on weekly basis for five weeks after spraying (WAS). Counts of insects were based mainly on the number of Podagrica species collected using visual observation, a pooter (an inspirator) and collecting tubes. Collection was done before 7.00 a.m. when the insects were less active. Estimates of the number of leaves that dropped from each replicate at weekly intervals were counted from 28 to 42 days after planting (DAP).

RESULTS

Table 1 shows the effects of single and mixed applications of plant extracts and lambda-cyhalothrin against P. uniformis on okra. The number of P. uniformis on okra sprayed with mixed A. squamosa and T. vogelii at 15% w/v was significantly reduced ($p<0.05$) when compared to single application of A. squamosa and T. vogelii (15% w/v) and the control at 1 WAS. The rate of application was however less effective than lambda-cyhalothrin. Single and mixed applications of A. squamosa and T. vogelii at 25% was not significantly different but more effective against P. uniformis than other rates of plant extracts at 1 WAS.

Mixed application of A. squamosa and T. vogelii applied at 25% had least population of P. uniformis compared with other leaf extracts and was significantly different compared with a single application of A. squamosa and T. vogelii at 15% (w/v) at 2 WAS . The population of P. uniformis in the mixed application of A. squamosa and T. vogelii at 25% was comparable with lamda-cyhalothrin at 2 WAS.

Mixed application of A. squamosa and T. vogelii at 25% (w/v) had least population of P. uniformis but the difference was not significantly different from other plant extracts at 3 WAS. Mixed application of A. squamosa and T. vogelii at 15% and 25% w/v showed higher insecticidal activity than single application. Combination of the two leaf extracts had comparable efficacy with lambda-cyhalothrin throughout the period of the study with P. uniformis. All applications were less effective than lambda-cyhalothrin. Highest mean number of P. uniformis was observed on untreated okra plants.

Table 2 shows the effects of plant extracts on population of P. sjostedti. Plants treated with the extracts significantly reduced the population of P. sjostedti when compared with control. Flea beetles were found on both treated and untreated plants during the investigation. Single application of T. vogelii at 25% (w/v) was as effective as lambda-cyhalothrin and mixed application of A. squamosa and T. vogelii at both 15% and 25%. All rates of plant extracts were significantly different when compared to the control.

However, mixed application of A. squamosa and T. vogelii at 25% had the least population of P. sjostedti at 2 and 3 WAS which was comparable to lambda-cyhalothrin. Significant difference in the number of P. sjstedti was observed between the extracts at a single application of A. squamosa at 15% and mixed application of A. squamosa and T. vogelii at 25% from 1 to 4 WAS. Single application of A. squamosa 15% showed significant increase in the number of P. sjostedti when compared with mixed application of A. squamosa and T. vogelii at 25% before 5 WAS. All rates of application were significantly different from the control.

Table 3 shows the effects of the plant extracts compared with lambda-cyhalothrin against defoliation of okra by Podagrica spp. All treatments were significantly different from the control at 28 and 35 DAP. However, single application of T. vogelii at 25% w/v had the same mean defoliation as mixed application of A. squamosa and T. vogelii at 15% and 25% and the synthetic chemical at 28 DAP. Mixed application had lower defoliation at 35 and 42 DAP although lambda-cyhalothrin was more effective in reducing defoliation.

Table 1: Effects of single and mixed applications of plant extracts and a synthetic pyrethroid on population of P. uniformis on okra

Treatment (%)	Population of Podagrica uniformis (1 WAS)	Population of Podagrica uniformis (2 WAS)	Population of Podagrica uniformis (3 WAS)	Population of Podagrica uniformis (4 WAS)	Population of Podagrica uniformis (5 WAS)
Annona squamosa (15%)	2.2c	1.8b	1.3ab	0.7a	0.7a
Tephrosia vogelii (15%)	2.2c	1.6bc	1.2ab	0.7a	0.7a
Annona squamosa (25%)	2.0bc	1.3ab	1.1ab	0.7a	0.7a
Tephrosia vogelii (25%)	1.6bc	1.3ab	1.1ab	0.7a	0.7a
A. Squamosa + T. vogelii (15%)	1.8b	1.2ab	1.0a	o.7a	0.7a
A. Squamosa + T. vogelii (25%)	1.6bc	1.0a	0.8a	0.7a	0.7a
Lambda-cyhalothrin	0.7a	0.7a	0.7a	0.7a	0.8a
Control	1.8b	1.8b	2.3c	2.3c	2.3c
SE	0.15	0.22	0.22	0.12	0.76

Values with the same superscript(s) in the same column are not significantly different at p=0.05 using Duncan`s multiple range test

Table 2: Effects of single and mixed applications of plant extracts and a synthetic pyrethroid on population of Podagrica sjostedti on okra

Rate (%)	Population of Podagrica sjostedti (1 WAS)	Population of Podagrica sjostedti (2 WAS)	Population of Podagrica sjostedti (3 WAS)	Population of Podagrica sjostedti (4 WAS)	Population of Podagrica sjostedti (5 WAS)
Annona squamosa (15%)	2.7d	2.3c	1.5b	1.2c	0.7b
Tephrosia vogelii (15%)	2.4c	1.6bc	1.1bc	0.9b	0.7b
Annona squamosa (25)	2.4c	1.7bc	1.1bc	0.9b	0.7b
Tephrosia vogelii (25%)	2.0b	1.5b	1.1bc	0.7b	0.7b
A. squamosa + T. vogel*ii* (15%)	2.0b	1.5b	1.0c	o.7b	0.7b
A. squamosa + T. vogelii (25%)	2.0b	1.4b	0.8c	0.7b	0.7b
Lambda-cyhalothrin	2.0b	1.2b	0.7c	0.7b	0.7b
Control	2.0a	2.5a	3.0a	3.0a	3.0a
SE±	0.15	0.22	0.22	0.12	0.08

Values with the same superscript(s) in the same column are not significantly different at p=0.05 using Duncan`s multiple range test

Table 3: Effects of single and mixed applications of plant extracts and a synthetic pyrethroid on defoliation of okra by Podagrica spp.

Rate (%)	Defoliation 28 DAP	Defoliation 35 DAP	Defoliation 42 DAP
Annona squamosa (15%)	2.7d	2.3c	1.5b
Tephrosia vogelii (15%)	2.4c	1.6bc	1.1ab
Annona squamosa (25)	2.4c	1.7bc	1.1ab
Tephrosia vogelii (25%)	2.0b	1.5b	1.1ab
A. squamosa + T. vogelii (15%)	2.0b	1.5b	1.0a
A. squamosa + T. vogelii (25%)	2.0b	1.4b	0.8a
L.C	2.0b	1.2b	0.7a
Control	3.0a	3.0a	3.0
SE±	0.15	0.22	0.22

Values with the same superscript(s) in the same column are not significantly different at p=0.05 using Duncan`s multiple range test

DISCUSSION

Spraying okra with single application of A. squamosa and T. vogelii leaf extracts at 15% and 25% w/v was less effective than mixed application in reducing the population of Podagrica species. Increasing the rate of application probably increases the active agents in the biopesticides, thereby causing the insect pest to be susceptible. A number of researchers had previously reported the presence of rotenoids in the T. vogelii (Adebayo, 2003; Kamanula et al., 2010; Nyirenda et al., 2011; Olaniran et al. 2013).

In this study, the plant extracts were found to be less effective than lambda-cyhalothrin. This may be due to the challenge of volatile components and photo-degradation associated with botanicals. The experiment showed that extract-treated plants had higher Podagrica spp. population than lambda-cyhalothrin. The synthetic insecticide despite its quick knockdown action against insects could not confer complete protection of the okra against re-infestation of Podagrica spp. The rates of plant extract application did not show any phytotoxic effect observed on okra leaves treated with chemical insecticide.

Results indicated that the plant extracts exhibited some degree of insecticidal activity in reducing flea beetle population and showed significant difference from the control. Olaniran et al. (2013) have shown that the plant extracts of T. vogelii had potent insecticidal properties against flea beetles.

Fasunwon and Banjo (2010) reported that pests have been a major setback for the success or growth of many crops all over the world. Onunkun (2012) had reported that the plant extracts of Jatropha curcas, Ageratum conyzoides, C. odorata, Vernonia amygdalina and Annona squamosa demonstrated potent insecticidal properties against flea beetles. Amuji et al. (2012) attributed the action of lambda-cyhalothrin to toxic effects of the synthetic chemical on the insect pest.

It has been reported that the beetles bored holes into the leaves and as a consequence, reduced the photosynthetic ability of the leaves (Dabire-Binso et al., 2009). There was no significant difference in the ability of the plant extracts and lambda-cyhalothrin in reducing infestation of flea beetles 4 WAS. Efficiency of lambda-cyhalothrin against flea beetles in the southern Guinea Savanna of Nigeria had earlier been reported (Dabire-Binso et al. 2009; Ahmed and Musa, 2010).

The flea beetles infested the okra at varying densities from 1 WAS. Slight reduction in the mean number of the insect per plant was ascribed to agronomic precautions and treatment after sowing. The insect infestation was lower in chemically treated plants with a maximum of 0.8 per plant. It could be observed that the flea beetle population increases on weekly basis probably caused by movement of the insect from treated plants to untreated plants. Continuous feeding of flea beetles on okra leaves resulted in significantly higher defoliation of untreated plants compared with treated plants.

CONCLUSION

The findings encourage environmental safety and discourage the use of synthetic insecticides. The study observed that single and mixed applications of A. squamosa and T. vogelii helped in reducing the population of beetle without any toxic effects on the plant. The toxic effect of lambda-cyhalothrin on plants still negates its beneficial role in reducing the damaging behaviour of insect pests on okra. The findings recommend further research work to be carried out on identifying major components of the plant extracts to be able to develop a botanical insecticide that would render the results required by farmers.

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