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Bioefficacy of Plant Extract Mixtures for the Protection of Cowpea Flowers Against *Megalurothrips sjostedti* Trybom (Thripidae)*

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Abstract: The present study was conducted to conrol *Megalrothrips sjostedti* thrips, infestation on cowpea flowers. Aqueous extract mixtures of different plant species were applied on cowpea plants at 10:10 % w/w on weekly basis in two years of field studies in Samaru, northern Guinea savanna of Nigeria. The result indicates that the extract mixtures of *Gmelina arborea* and *Eucalyptus* tree barks, African marigold (*Tagetes erecta* L.) and *G. arborea* leaves as well as mixtures of *G. arborea* and *Azadirachta indica* were effective in protecting cowpea flowers from damage and consequently increased pod density of plants under field conditions compared with the untreated control. The performance of aqueous bark extracts of *G. arborea* + *Eucalyptus citriodora* was not inferior to the synthetic insecticide treatment on the parameters tested. These findings would generate further interest in the application of plant extract mixtures as a pest management strategy on cowpeas grown by limited resource farmers in third world countries and possibly other crops with similar pests complex problems.

Key words: Bioefficacy, insecticidal plants, extract mixtures, thrips, management, cowpea

Introduction

The bean flower thrips, *Megalurothrips sjostedti* Trybom (Thysanoptera: Thripidae) is one of the most noxious post flowering pests of cowpea and the least affected by available control measures outside chemical control in the savannas of West Africa (Singh *et al.*, 1990, Tamo *et al.*, 1993). Damage by the pest is characterized by distortion, malformation, discolouration of floral parts and drying up of the flowers (Taylor, 1969). Severe attacks may lead to flower shedding (Okwakpam, 1967). Several control measures have been advocated such as cultural, biological, use of resistance varieties and insecticides. For instance, thrips infestation on cowpea has been reduced by intercropping cowpea with cereals and cassava (Matteson, 1982; Ezueh and Taylor, 1984), use of varieties that have low levels of resistance (Jackai and Oyediran, 1991), use of early maturing varieties to escape the period of high thrips population, chemical application and the use of plant based insecticides (PBIs). The first two intervention measures have not solved the problems of thrips on farmers' fields. Presently, insecticides application is the only method for effective control of thrips for reasonable pod yields (Jackai and Adalla, 1997). Chemical intervention however, is not a sustainable practice as it is inundated with a number of problems such as pest resistance and resurgence, escalating costs of spraying, non-availability of appropriate products at critical periods of need, environmental

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degradation and high mammalian toxicity among others. These problems have encouraged recent researches worldwide in to Alternative Pest Management System (APS) using Plant Based Insecticides (PBIs), mineral products and waste matter.

At the Institute for Agricultural Research, Ahmadu Bello University, Zaria, Nigeria work on the alternatives to the synthetic insecticides are aimed at developing a pest management strategy using locally available resources which are less harmful, but effective and affordable for pests control in the savanna ecological zone. A number of plants have been found effective in various trials worldwide for pests control on crops (Saxena, 1989; Schmutterer, 1990). However, most findings on this aspect of crop protection were focused on stored pests control (Ivbijaro, 1983; Su, 1977; Sowunmi and Akinnusi, 1983; Oparaeke *et al.,* 1998; Dike and Mbah, 1992; Kossou, 1989). There is a paucity of information on field application of extracts from plant sources for pests control on cowpeas and the few available were based on single plant species. For instance, neem extracts have been used against rice pests in Asia (Saxena, 1989), cassava in West Africa (Olaifa and Adenuga, 1988) and on cowpea (Cobbinah and Osei-Owusu, 1988; Tanzubil, 1991; Oparaeke, 2004). However, PBIs are slow acting mortality agents and the incidence and difficulty of controlling thrips inside cowpea flowers indicate that a single plant extract is unlikely to produce satisfactory results. As a result, the 'best mix' approach using insecticidal plants of different species is being advocated. This involves the most logical combination of different compatible plant species in formulations for pests control on cowpea. At present, there is a dearth of data on the use of botanical mixtures for pests control (especially thrips) on cowpea.

This study investigated the efficacy of mixtures of extracts from botanical landraces in Nigeria as protectants of cowpea flowers from thrips infestation under rain fed conditions.

Materials and Methods

Preparation of Aqueous Plant Extract Mixtures

Fresh leaves of African marigold (*Tagetes erecta* L.), *Eucalyptus citriodora* Denn, neem (*Azadirachta indica* A. Juss), African bush tea (*Hyptis suaveolens* Poit), bitter leaf (*Vernonia amygdelina* L.), lemon grass (*Cymbopogon citratus* Staph) and stem barks of *Gmelina arborea* L., *E. citriodora* and *A. indica* were collected from plants/trees around the Institute in Samaru (11° 11′ N; 08° 15′ E) which is located in the Northern Guinea savanna. Five hundred gram of each material were weighed out separately and pounded in wooden mortar with pestle. The appropriate combinations (Table 1) of plant materials on 1:1 basis were then soaked overnight in plastic buckets containing 3.5 L hot water (70°C). The extract mixtures were separately filtered with one liter of tap water using a double folded muslin cloth. Each of the solutions in plastic buckets received 250 mL of 20% w/v bar soap and starch solutions each to improve its rain fastness and even spread on plants surfaces. The plastic buckets were labeled and the extract mixtures taken to the field for spraying the same day.

Experimental Site

The trials were established in 2000 and 2001 cropping seasons in the Research Farm of the Institute in Samaru. The rainy season began on average in early June and lasted till the first or second week of October. Cowpea is usually sown from mid July to third week of August in this ecological zone. The soil is described as a leached Ferruginous, Tropical soil, which developed on very fine sandy Aeolian drift over gneiss with a well developed B-horizon (sandy clay loam) with iron concretions

(McDonald and Fowler, 1975). The field was sprayed with glyphosate at 5 l ha^{-1} and kept for three weeks to fallow before harrowing and ridging.

Field Layout

Nine treatments comprising seven different extract mixtures, a synthetic insecticide check and untreated control were laid out in three replicates using a randomized block design. Plot sizes were 6.0x5.0 m and contained five ridges (three inner rows and two discards) spaced at 0.75 m apart and each plot was separated by 1.5 m wide border margin along the ridge. Cowpea variety SAMPEA 7 dressed with Apron plus 50 DS at the rate of one satchet per two kilogrammes seeds was used and sown three seeds per hole at intra-row spacing of 0.25 m apart in the first week of August in both periods. The plots were sprayed with a pre-emergent herbicide, Galex (Metolachlor 250 g a.i. and Metabromuron 250 g a.i. L^{-1}) at 2.5 kg a.i. ha^{-1} immediately after sowing to suppress weeds regrowth. Compound fertilizer NPK (15:15:15) was applied at 37.5 kg a.i. ha^{-1} by side placement two Weeks After Sowing (WAS). Two to three WAS the seedlings were thinned to three plants per hill. At four WAS, the plants received a tank mixture of 0.33 kg a.i. ha^{-1} each of benomyl and mancozeb which were sprayed once every week for four weeks to control fungal diseases. Manual weeding was also carried out at five to six WAS to ensure a weed free condition. Field spraying of extract mixtures and synthetic insecticide against thrips commenced at flower bud initiation phase (7 WAS) and four weekly applications were made using CP 3 knapsack sprayers. All the sprayers were rinsed with copious amount of water after each treatment application to avoid contamination. A single row of cowpea plant was sprayed per pass.

The bean flower thrips were sampled by randomly removing 20 flowers from plants located within the three inner rows per plot. These were placed in vials containing 30% alcohol and taken to the laboratory where flowers were dissected next day and number of thrips found was recorded.

Pod yield (a measure of efficacy of an insecticide to control thrips incidences on cowpea flowers) was assessed at 10 WAS by finding the average number of pods produced from a random sample of 10 plants in each plot.

All data collected were subjected to Analysis of Variance (ANOVA) while treatment means were separated by SAS-SNK test ($p<0.05$) (SAS, 1989).

Results

After four weekly application of spray liquids the stem bark extracts of *G. arborea* + *E. citriodora* and leaf extracts of *T. erecta* + *G. arborea* (in that order) considerably reduced ($p<0.05$) the number of thrips on cowpea flowers compared with the mixtures of *T. erecta* + *E. citriodora*, *H. suaveolens* + *C. citratus*, *T. erecta* + *A. indica* and the untreated control. The two extract mixtures were not significantly different from mixtures of *G. arborea* + *A. indica* stem bark, *H. suaveolens* + *V. amygdelina* and the synthetic insecticide treatment in the two years of study (Table 1). Although, all the sprayed plots had significant control of thrips compared with the untreated control, some extracts mixture treatments were less effective and these included the leaf mixtures of *T. erecta* + *A. indica*, *H. suaveolens* + *C. citratus* and *T. erecta* + *E. citriodora*.

The number of pods produced per plant was significantly greater ($p<0.05$) in plots sprayed with stem bark mixtures of *G. arborea* + *E. citriodora* and leaf mixtures of *T. erecta* + *G. arborea* compared with other extracts mixture treatments and the untreated control. Pod density in stem bark extract mixtures of *G. arborea* + *E. citriodora* treated plots was not significantly different from

Table 1: Mean number of *M. sjostedti* per flower and pod load of cowpea treated with aqueous plant extract mixtures in 2000 and 2001 seasons in Northern Guinea savanna of Nigeria

	Thrips per flower		Pods produced plant^{-1} (%)	
Treatment	2000	2001	2000	2001
T. erecta + *E. citriodora* leaves	1.6c	1.7c	34.2c	33.5c
T. erecta + *A. indica* leaves	2.5b	2.7b	30.1b	29.5b
T. erecta + *G. arborea* leaves	0.7de	0.8de	43.5ef	42.7ef
G. arborea + *E. citriodora* barks	0.3de	0.4de	45.3fg	44.4fg
G. arborea + *A. indica* barks	0.9cd	1.1cd	41.2de	40.3de
H. suaveolens + *V. amygdelina*	1.0cd	1.2cd	39.6d	38.8d
H. suaveolens + *C. citratus* leaves	1.7c	1.8c	33.3bc	32.6bc
Uppercott	0.2e	0.3e	48.4g	47.3g
Control (0.0)	4.7a	4.6a	9.3a	8.3a
SE±	0.2	0.1	1.1	1.0

Means in a column followed by similar superscript (s) are not significantly different by SAS-SNK ($p<0.05$) test

T. erecta + *G. arborea* leaf treatment and the synthetic insecticide check which however, recorded the highest pod numbers during the periods (Table 1). The untreated control plots recorded the least pod numbers and were significantly inferior to the extract mixtures sprayed plots.

Discussion

Since thrips infestation on cowpea flowers is one of the first hurdles militating against yield improvement on the crop, its effective management is necessary. This experiment was conducted to ascertain the level of efficacy of three-plant species namely *G. arborea, T. erecta* and *H suaveolens* (stem bark or leaf) in mixtures with other plants (*E. citriodora, A. indica, C. citratus* and *V. amygdelina* leaf or stem bark) as protectants of field cowpea against thrips incidences on flowers. The stem bark mixtures of *G. arborea* + *E. citriodora* and leaf mixtures of *T. erecta* + *G. arborea* were more potent against thrips compared with the others. These findings however, indicate that the stem bark materials were more efficacious than the leaves possibly due to more concentration of the active principles in that part of plants (Jackai and Oyediran, 1991). The study also shows that *G. arborea* (stem bark or leaf) has better insecticidal properties as could be observed in its performance when in mixtures with other plants where thrips number per flower was lower (<1.0) compared with other treatments (except the synthetic insecticide check). This reduction in thrips number led to an equivalent increase on podding rates in *G. arborea* (stem bark or leaf) mixtures treated plots. The result was similar to the findings of Oparaeke (2005) in separate screening trials involving *G. arborea* products (fruits, stem bark and leaf extracts) for control of thrips on cowpea flowers.

G. arborea contains toxins and other secondary metabolites believed to be among the triterpenes, which exhibit antifeedant and /or lethal contact actions on insects (Musa Ayuba, pers. comm.). The tree grown for shade along the high ways in Nigeria remain evergreen all year round and no report has indicated any serious attack by insects in this country. The leaves are harvested during the peak period of dry season in the Northern Guinea and Sudan savannas for cattle feeding and some herdsmen claim that the fruits and leaves facilitate rumen movements and feed digestibility in cattle (privileged information). The effectiveness of stem barks of *G. arborea* + *E. citriodora* and leaf extracts of *G. arborea* + *T. erecta* shows the degree of compatibility or synergism of the plant materials. In separate studies, Oparaeke (2004a) found the stem bark extracts of *A. indica* and *E. citriodora*

effective against some cowpea pests while leaf extracts of *T. erecta*, *E. citriodora*, *A. indica*, *H. suaveolens*, *V. amygdelina* and *C. citratus* also used in this trial were less effective. The combination of extracts of the latter group with each other did not improve their potency, which might further confirm their suspicion of weakness as biopesticides for field pests control on cowpea. In this study, *T. erecta* + *G. arborea* leaves extracts caused considerable reduction in thrips population in treated plots probably due to the complimentary role played by the latter (*G. arborea*) in the mixture. This was not the case for *T. erecta* mixture with *A. indica* leaf extract, which recorded the highest thrips number among the extract mixtures and was the second highest following the untreated control plots. *A. indica* contains Azadirachtin, Nimbin, Salannin and Meliatrol (Reed *et al.*, 1982), which were possibly hampered by *T. erecta* constituents indicating antagonistic or incompatible activity. However, in a separate study, Oparaeke (unpublished) found extracts of neem leaf mixed with leaves of either *C. citriodora*, *C. citratus*, *V. amygdelina*, or *Lycopersicum esculentum* to be toxic to thrips and consequently resulted in considerable reduction in their numbers.

The mechanism of activity of *G. arborea* + *E. citriodora*, *G. arborea* + *A. indica* and *G. arborea* + *T. erecta* against *M. sjostedti* is unclear; but considering the fact that thrips live and feed inside the flowers conspicuously out of the reach of spray liquids, an antifeedant and /or systemic action could be implicated.

Conclusions

This study highlights the need to formulate and use mixtures of plant extracts as sprays against crop pests similar to what obtains with the synthetic insecticides. Since plant extracts are slow acting mortality agents mixing these with compatible and potentially potent materials could improve their effectiveness against noxious pests of crops. The plant materials involved in this experiment are readily available for local farmers use and they are cheap, safe, non-toxic to mammals and biodegradable as well as being environmentally friendly. More work is needed to ascertain the efficacy of these materials against other pests of cowpea. It is important to extract, isolate, identify and characterize the active principles in *G. arborea* and other plants used in the extract combinations so that their insecticidal attributes would be known and used in pesticides formulations. Future work should also be geared towards the formulation of oil-based sprays from these plants to reduce their bulkiness and water requirements for preparing the extracts.

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