Efficacy Of Some Lambda-Cyhalothrin-Based Insecticides In Control Of Major Field Pests Of Cowpea (*Vigna Unguiculata* L.)

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Abstract: - A major constraint to the increased and sustainable production of cowpea (*Vigna unguiculata* L. Walpers) in the savanna ecology of Ghana is damage caused by field insect pests. Field studies were conducted during the 2012 cropping season at the Experimental Farms of the University for Development Studies, Nyankpala, Ghana, to evaluate the efficacy of six Lambda-cyhalothrin formulations namely; Clear, Controller-super, CW-Lambda, Kombat, Lambda-super and Zap on flower thrips, pod-borers, and pod-sucking bugs, and their effects on the grain yield and grain quality of cowpea. The randomized complete block design with three replications was used to obtain data on the abundance and incidence of the pests. The results showed that infestations of of all the target pests were significantly lower in the insecticide-treated plots than the control. Although significant differences were not observed in all the parameters evaluated among the insecticide treatments, cowpea plants treated with Lambda-super or CW-Lambda recorded the lowest infestation of flower thrips, pod-borers and pod-sucking bugs. Cowpea grain yield and grain quality from the Lambda-super treatment were statistically similar to that of CW-Lambda treatment but different from that of the other insecticides. Farmers can use Lambda-super or CW-Lambda for effective control of the major pests of cowpea for maximum grain yield and quality in the savanna ecology of Ghana.

Index Terms: - Lambda-cyholothrin, Cowpea, Insect pests, Control.

INTRODUCTION

Cowpea, *Vigna unguiculata* (L. Walpers) is an important grain legume widely cultivated in tropical Africa. It is well known for its economic importance as food for humans, feed for livestock and for the enrichment of soil fertility (Singh and van Emden, 1997). Although cowpea is widely grown in Ghana, commercial production is restricted to the northern belt of the country (Tweneboah, 2000). Production level for seed grain has been estimated to range between 0.8 mt/ha and 2.0 mt/ha and this is still far below the national and world averages of 2.5 mt/ha and 3.2 mt/ha, respectively (FOA, 2007). One major constraint to the increased and sustainable production of cowpea in the savanna ecology of Ghana is damage caused by field insect pests, particularly during the flowering and post-flowering growth stages (Singh *et al.,* 1990; Obeng-Ofori, 2007). Among the most serious pest species include flower thrips, *Megalurothrips sjostedti* Tryb. (Thysanoptera: Thripidae); pod borers, *Maruca vitrata* Fab. (Lepidoptera: Pyralidae), and a complex of pod- and seed- sucking bugs such as *Riptortus dentipes* Fab (Heteroptera: Alydidae), *Clavigralla tomentosicollis* Stal. *Anoplocnemis curvipes* Fab. *Mirperus jaculus* Fab. (Heteroptera: Coreidae), and *Nezara viridula* L. (Heteroptera: Pentatomidae) (Jackai and Daoust, 1986; Badii *et al.,* 2008). Losses in grain yield and quality due to these pests have been estimated to be very high in unprotected fields (Jackai and Daoust, 1986).

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The insect pest situation of cowpea in sub-Saharan Africa dictates that it is impossible to produce cowpea for maximum grain yield without protection with chemical insecticides (Jackai and Adallah, 1997; Dzemo *et al*., 2010). Asante *et al*. (2001) reported that chemical control will still remains an indispensable component of integrated pest management of cowpea in Ghana if maximum economic yields are to be obtained. Most cowpea farmers in the savanna ecology of Ghana now rely on the use of synthetic chemical insecticides such as Kombat, Pawa, Lambda-super, Zap, Clear, Controller-super, CW-Lambda and others which are usually obtained from the agrochemical shops, for the management of these pests in their cowpea farms. These insecticides which have all been known to contain the same active ingredient, Lambda-cyhalothrin, are generally expected to provide comparable results when used at the recommended rates of 36g/ha for pest control on cowpea. However, reports from extension workshops and farmers' field schools have shown that these chemical formulations do not normally provide the same results when used in control of cowpea pests under field conditions. This could be attributed to variations in dosage, amount of active ingredient and pest susceptibility. Thus, the efficacy of the various formulations of Lambda-cyhalothrin as a chemical control intervention for the major field pests of cowpea in the area needs to be given a more comprehensive evaluation. In this study, we tested the efficacy of the six most commonly used Lambda-cyhalothrin-containing insecticides in control of the major field insect pests of cowpea, and their effects on the grain yield and quality of cowpea in the savanna ecology of Ghana.

MATERIALS AND METHODS

Experimental Procedure

The study was conducted at the Experimental Farms of the University for Development Studies, Nyankpala (9° 252 N and 0.58° 582 W; 183 m above sea level; 1000-12000mm rainfall) in the northern region of Ghana during the 2012 main cropping season (July-September) (SARI, 2008). The experimental field was laid out in a Randomized Complete Block Design (RCBD) with seven treatments, each replicated four times. Each experimental unit measured 7m x 5m, with 2 m alley between each plot to prevent insecticides drifts and inter-plot interference. A total of 1025m^2 area size (41m x 25m) was covered. The experimental field was ploughed and disc-harrowed to fine soil tilt with a tractor during the 2nd week of July. The field was then lined and pegged prior to sowing. Seeds of an improved, early maturity (60 days), high yielding and susceptible cowpea variety (Songotuya) obtained from Savanna Seed Service Company Ltd in Tamale, Ghana, were used for sowing. A planting distance of 60cm x 20cm between and within rows respectively was used. Sowing was done in the third week of July, a time of the season generally considered most appropriate for covering the peak incidence of cowpea insect pests in the ecology (Tanzubil, 1991; Badii *et al.*, 2008). Four seeds were sown per hill and later thinned to two plants per stand two weeks after planting. The insecticide treatments were the six commonly used Lambda-cyhalothrin-based formulations, laid out as follows;

CW-Lambda @ 2.5l/ha, 3 applications

Zap @ 2.5l/ha, 3 applications

Clear @ 2.5l/ha, 3 applications

Lambda-super @ 2.5l/ha, 3 applications

Controller-super @ 2.5l/ha, 3 applications

Kombat @ 2.5l/ha, 3 applications

Control (Check), sprayed with water.

Application of the insecticide treatments was done at the vegetative, flowering and podding stages. On each spraying occasion, all plants in each plot were sprayed until complete coverage or wetting was achieved. Weed control was done using the pre-emergence herbicide (Sarosate) two weeks before sowing, and by hoeing 5 and 7 weeks later. All other recommended cultural practices, except for pest control, were common in all plots and were strictly followed throughout the experiment.

Sampling for Insect Pest Infestations

Sampling for insect pests and their infestations was carried out two days after each insecticide treatment was applied. Ten inner rows, excluding 1m border from both ends of each row were selected from each plot for sampling. Sampling involved visual examination of each plant for target insect, namely, *M. sjostedti, M. vitrata, C. tomentosicollis, M. jaculus, N. viridula, A. curvipes,* and *R. dentipes.* Thrips infestation was assessed between flower bud initiation and 50% podding stage. Beginning from flower bud initiation (40 DAE) to 50 per cent (48 DAE), 20 racemes (flower buds) were sampled from each subplot and kept in vials containing 70% ethanol. Also, beginning from 50% flowering to first pod maturity (55 DAE), 20 flowers were sampled and kept in vials containing 70% ethanol. The number of thrips (nymphs and adults) in each sample was then counted under binocular microscope in the laboratory to determine the abundance of thrips on the plants. Pod borer infestation was also assessed between the stages of 50% flowering and first pod maturity. Twenty flowers from each plot were picked at random and kept in vials with 70% ethanol. These were also examined in the laboratory to record the number of pod borer larvae on the plants (i.e., abundance). Concurrently, the proportions of flowers infested by pod borers were estimated using the Rapid Visual Examination (RVE) method. Twenty flowers were collected at random from each plot, opened on the spot and examined for pod borer larvae or damage in the field (Jackai *et al.,* 1992). Visual examination was done on the mature pods to determine the extent of damage caused by pod borers. Assessment of pod-sucking bugs (PSBs) infestation was carried out between the podding and the harvesting stages. Visual counts of adults and nymphs of the different PSBs species were made on rows of cowpea plants within a marked area in each plot. These were then recorded for PSBs abundance. Counting was done between 1400 and 1700hrs (Hammond, 1983). Also, the mature pods were sampled and examined visually to determine the number of shriveled pods caused by PSBs infestations (i.e. incidence).

Estimation of Grain Yield and Grain Quality

Grain yield in kilogram per plot was estimated from each plot after harvesting the pods. The grains obtained after threshing of pods were sun dried to 12% moisture content. Cowpea grains from each plot were weighed and the results extrapolated to kilograms per hectare (Kg/ha) for each treatment. Grain quality estimation was done using a visual grain damage rating scale of 1-6, where 1= 1-5% damage grains (dg), 2 = 6-25% dg, 3 = 26-50% dg, 4 = 51-75% dg, and 5 = 76-95% dg and 6 = 95% dg (Passerine and Hill, 1993). Damaged grains counted include all cowpea grains whose quality has been reduced as a result of the infestation by pod borers and/or pod-sucking bugs.

Statistical Analysis

Differences in infestations and damage caused by the insects, grain yield and grain quality between treatments were analyzed by subjecting all the data to one way Analysis of Variance (ANOVA) using GENSTAT (3rd edition). The least significant difference (LSD) test was used to separate the treatment means at 5% significance level.

RESULTS

Pest Incidence and Abundance

The effect of the different Lambda-cyhalothrin formulations on the abundance of flower thrips, *Megalurothrips sjostedti Tryb*. in the flowers of the cowpea plants is presented in Figure 1. There were significant differences ($p < 0.001$) among the treatments means with respect to abundance of thrips on the cowpea plants. The mean number of flower thrips was significantly lower ($p < 0.05$) in the treated plots than in the control. Although significant differences were not observed among the insecticide treatments, plants treated with Lambda-super recorded the lowest population of flower thrips while those of Controller-super recorded the highest. Number of thrips in the Kombat-treated plot was the same as that of the Zap, which also recorded higher a number of thrips than Clear or CW-Lambda.

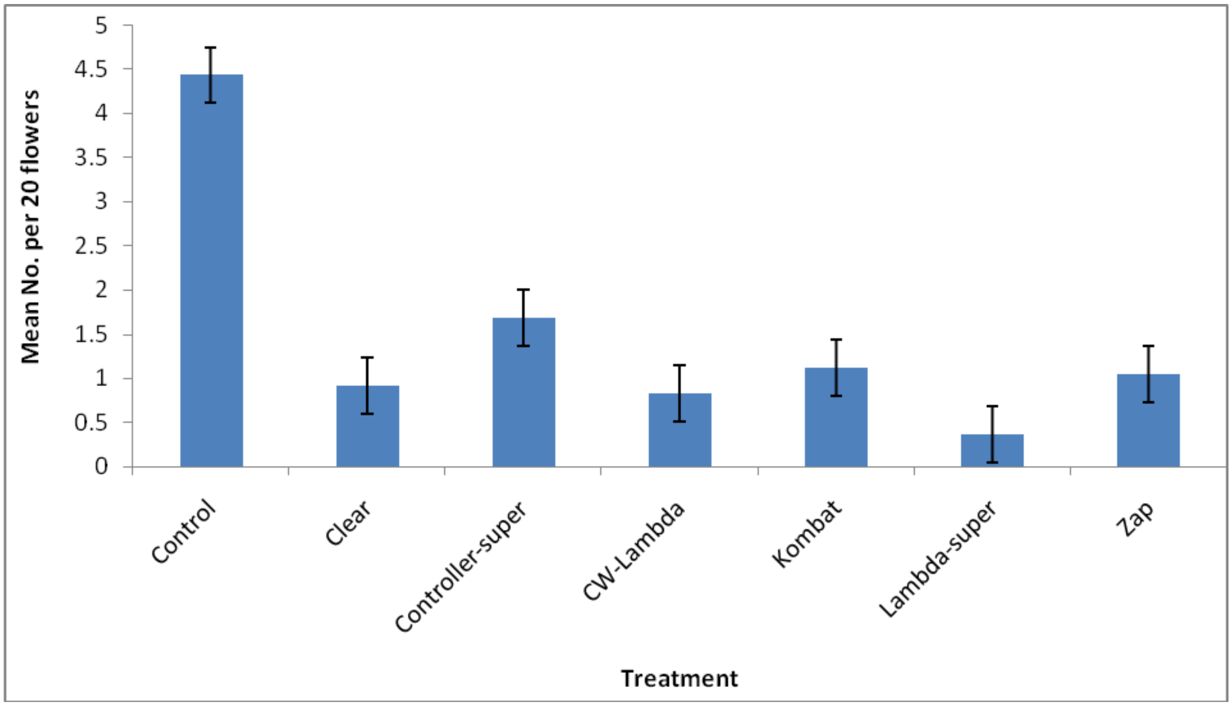

Figure 1: Abundance of *M. sjostedti* on cowpea plants sprayed with different Lambda-cyhalothrin formulations.

The abundance of pod borers, *Maruca vitrata*, Fab on cowpea plants sprayed with the insecticide formulations is shown in Table 1. The mean number *of M. vitrata* larvae recorded on flowers was significantly higher ($p < 0.001$) in control plot than those of the insecticide treated plots. Among the insecticide treatments, no significant difference in pod borer infestation was observed, even though cowpea plants treated with Zap recorded the highest number of *M. vitrata* larvae, followed by Clear, Controller-super, Kombat, CW-Lambda and Lambda-super. Also, there were significant differences ($P < 0.024$) among the treatments in the abundance of pod borers in pods examined in the field. Plants treated with Lambda-super, again recorded lowest infestation by pod borers while the control recorded highest.

Table 1: Levels of infestation of *M. vitrata* on cowpea plants sprayed with different Lambda-cyhalothrin formulations.

Treatment	*Mean No. of larvae in flowers (n=20)*	*Mean No. of larvae in pods (n=20)*
Control	9.67	0.73
Clear	1.13	0.33
Controller-super	0.87	0.33
CW-Lambda	0.60	0.23
Kombat	0.07	0.33
Lambda-super	0.07	0.16
Zap	1.57	0.40
P-value	***0.001***	***0.024***
LSD (5%)	***2.050***	***0.288***

n = number of plants sampled

The effect of the insecticide formulations on the abundance of pod sucking bugs (PSBs) complex and their damage incidence is presented in Table 2. The mean number of PSBs was significantly lower in the treated plots than in the untreated plots. Among the insecticide treatments, however, no significant difference in number of PSBs was observed among the treated plots ($p < 0.06$) even though cowpea plants treated with Lambda-super and Controller-super recorded the highest and lowest populations of PSBs, respectively. The treatments had significant effect ($p < 0.007$) on the incidence of PSBs on the cowpea plants. Among the insecticides, plants sprayed with Lambda-super or CW-Lambda recorded significantly lower number of shriveled pods than those of the other insecticide treatments. The highest number of shriveled pods was recorded from plants treated with Kombat. A similar trend was observed in the proportion of shriveled pods in which Lambda-super recorded the lowest percentage of shriveled pods while Kombat recorded the highest. (Table 2).

Table 2: Abundance and incidence of PSBs on cowpea plants sprayed with different Lambda-cyhalothrin formulations

Treatment	*Mean No. of PSBs Per 5m row*	*Mean No. of shriveled pods (N = 50)*	*Proportion of shriveled pods*
Control	11.7	19.7	39.4
CW-Lambda	1.7	3.3	6.6
Controller-super	3.0	4.4	8.8
Clear	2.3	5.0	10.0
Kombat	2.3	6.3	12.6
Lambda-super	1.9	3.0	6.0
Zap	2.3	6.2	12.4
P-value	***0.001***	***0.007***	***0.009***
LSD (5%)	***2.36***	***2.87***	***5.25***

n = number of plants sampled

Grain Yield and Grain Quality

Table 3 shows the effects of different insecticide formulations on the grain yield and quality of the cowpea crop. Cowpea grain yield and grain quality were significantly affected ($p < 0.001$) by the insecticide treatments. All the insecticide treatments recorded higher grain yield than the control. Among the insecticide treatments, grain yield was significantly higher in the Lambda-super or CW-Lambda treatment than that of the other insecticides. Grain yield recorded from Clear, Combat, Controller-super and Zap treatments were not statisitically different even though Controller-super treatment recorded the lowest yield. Cowpea grain quality was significantly lower in the control but did not differ significantly among the insecticide treatments. However, grains obtained from the Lambda-super treatment were of best quality, followed by those of CW-Lambda, Controller-super, Zap, Clear and Kombat.

Table 3: The grain yield and grain quality obtained from cowpea plants sprayed with different Lambda-cyhalothrin formulations.

Treatment	*Mean grain yield (Kg/ha)*	*Mean rating of damaged grain*
Control	324.0	5.00
Clear	645.4	2.10
Kombat	668.0	2.33
Controller-super	605.0	1.90
Lambda-super	1189.1	1.50
Zap	665.3	1.97
CW- Lambda	988.5	1.70
P- Value	***0.001***	***0.001***
LSD (5%)	***174.8***	***0.83***

Damaged grains include all cowpea seeds whose quality has been reduced as a result of infestation by the field insect pests. Grain damage rating was based on a visual scale of 1-6, where 1= 0-5%, 2= 6-25%, 3= 26-50%, 4= 51-75%, 5= 76-95%, and 6= >95%.

DISCUSSION

The results of this study revealed that the abundance and incidence of cowpea flower thrips, *M. sjostedti* on the cowpea plants were significantly higher in the control plots than that of the insecticide treated plots. This could be due to the chemical-independent nature of the control. Ascher (1993) and Dzemo *et al.,* (2010) observed that, chemicals provide a rapid, effective and dependable means of controlling whole complexes of insects. The nymphal thrips were found to be more sensitive to the test insecticides than the adult thrips as a result of their larger numbers, low mobility, confined habit and gregarious feeding on the plants. *Megalurothrips sjostedti* is an important pest of the reproductive structures of cowpea, with early feeding leading to flower bud and flower shedding, hence poor pod set (Tamo *et al.,* 1993; Dzemo *et al.*, 2010). Among the different Lambda-cyhalothrin formulations, Lambda-super treated plots recorded the lowest *M. sjostedti* infestation in the cowpea plants while Controller-super recorded the highest *M. sjostedti* infestation in the cowpea plants. This could be attributed to the fact that the levels of their active ingredient and adjuvant vary even though both insecticides appeared to contain the same amount of the active ingredient in emusifiable concentration and recommended rates. The results of this study have confirmed that the use of insecticides in thrips management is necessary in order to reduce flower losses and increases pod production in the cowpea crop. CW-Lambda, Clear, Kombat and Zap treated plots recorded relatively low infestations. In controlled experiments, thrips and pod borer infestations were effectively cotrolled by Karate (ai = lambda-cyholothrin) and Dursban (ai = dimethoate) (Omongo *et al.*, 1988). Salifu and Hodgson (1987) and Kyamanywa and Tukahirwa (1988) showed thrips populations to increase with growth of cowpea and to reach full infestation at flower ripening and fruit maturation. Spraying during the vegetative and flowering stages can thus, reduce thrips, pod borer and pod-sucking bug populations as indicated in this study. Eggs and third instar larvae are the most unprotected stages of these pests (Okeyo-Owuor and Oloo, 1991). The eggs are eposed on the leaf surfaces and third instar larvae usually move about the plant in search of fresh freeding sites.

Commencement of spraying at early stages probably destroyed eggs and early instars of the pests in this study, and connsequently, restricted further development of the pests. Pod-sucking arthropods were significantly affected by the insecticides applied. This, however, did not agree with the findings of Alghali (1992) who reported insignificant effect of Karate-based insecticides on the abundance of pod bugs of cowpea, and attributed this to persistent invasion of cowpea fields by adult arthropods from adjacent areas. It seems possible in our study that even the active flying pod bugs were unable to stand the insecticidal activity, systemic action and high knockdown effect of the Lambda-cyhaolothrin (Dina, 1977; Amatobi, 1994). The better control shown by Lambda-super and CW-Lambda over the other insecticides may be attributed to the presence of more of the active ingredient in these formulations. The high infestation of pod-sucking bugs in the control over the insecticide treatments corroborates the findings of Ayamga, (2008) and Dzemo *et al.,* (2010) who reported that *C. tomentosicolis* exhibited feeding behavioral patterns such as palpation and nibbling in response to the toxicity repellent effect of chemical insecticides on treated cowpea plants. Similar behavioral manifestations were reported by Jackai *et al.,* (1992) on male and female *N. viridula* of chemical treated cowpea pods. The high grain yield and quality obtained from the Lambda-super and CW-Lambda treatments could be due to their high residual effects on the insect pests. Tanzubil (1991) and Dzemo *et al.,* (2010) obtained a significantly higher grain yield in insecticide treated plots than control plots. According to Ndoye (1978), some fields may escape serious infestations and yield well but extensive and judicious use of agrochemicals will increase the reliability of yield with quality cowpea grain. Jackai and Dauost (1986) also, observed that losses caused by insect pests have been estimated to be very high in unprotected field. The higher grain yield in the insecticide treatments might be due to the reduction in the abundance of the major insect pests and their subsequent damage to the cowpea crop as a result of the insecticidal activity (Omongo *et al*., 1998). Saxena and Kidiavai (1997) and Ayamga (2008) also obtained more superior grain quality in insecticide treated plots than in the untreated plots.

Conclusions

The study has shown that the insecticide formulations applied have considerable potential for managing the major field insect pests of cowpea in the ecology. The incidence and abundance of all target pests were found to decrease with application of the insecticides. Lambda-super and CW-Lambda treatments offerred the best protection resulting in higher grain yield and better grain quality. Hence, farmers can use these formulations for effective pest control and maximim grain yield and quality in cowpea. The results further suggest that the farmers in this ecology would have a wide range of insecticides to choose from if all of them are eventually recommended for use. The use of any of the insecticides would therefore depend on the availability, cost, environmental sustainability and copatibility with the farming system and production practice of the zone. The application of the formulations must coincide with the most vulnerable growth stages of the crop and high risk period of insect pest infestations. Further work needs to verify the economic efficacy of these insecticides under multiple locations.

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