EVALUATION OF KARATE EC, CYPERDIM EC, AND CONFIDOR SL FOR THE CONTROL OF *HELOPELTIS SCHOUTEDENI* REUTER (HEMIPTERA: MIRIDAE) ON CASHEW IN GHANA

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ABSTRACT

Cashew (Anacardium occidentale L.) has become a very important non-traditional tree crop in Ghana, with increasing area of cultivation and nut yield. An important threat to the sustained production of the crop is the cashew mosquito, Helopeltis schoutedeni. Petri dishes laboratory bioassay was carried out with different rates of Karate, Cyperdim and Confidor on the 5th instar nymphs and adults of H. schoutedeni, to determine a suitable insecticide and its minimum effective dosage to control this insect. Field experiments were also conducted to determine the efficacy and persistence of Karate and Cyperdim on H. schoutedeni. In the laboratory bioassay, Karate and Cyperdim were found suitable with minimum effective dosages as 0.010% and 0.102% active ingredient (a.i.), respectively. The mean corrected mortality recorded for the minimum effective dosages of the two insecticides on the 5th instar nymphs and adults was more than 95% in the bioassay. The persistence tests indicated that, one day after insecticide application, both Karate and Cyperdim gave 100% kill. Seven days after treatment, only the Cyperdim killed more than 95% of the insect. From 14 days after treatment, there was a marked reduction in the percentages killed and the differences were no longer significant between the two insecticides, although the Cyperdim still gave higher per cent kill. From the results, either Karate or Cyperdim can be used in the case of a massive invasion of a cashew farm by the pest, to knock them off. But on prophylactic basis Cyperdim would be a better choice as it showed longer persistence than Karate.

Keywords: *Helopeltis schoutedeni*, Cashew, Chemical control, Karate, Cyperdim, Confidor, Ghana.

INTRODUCTION

Cashew (*Anacardium occidentale* L.) has become a very important non-traditional tree crop in Ghana (Anon, 2005). The crop was introduced into Ghana by the Government in the 1960s for afforestation in the Guinea savannah, coastal savanna and transitional zones in Greater Accra, Eastern, Volta and Brong-Ahafo regions (Anon, 2005). It was also to provide tree cover in eroded areas and where land reclamation pro-

grammes were under way to prevent further erosion.

Cashew has been identified as one of the non-traditional export crops and the Government is promoting its production through the provision of incentive packages for the establishment of new plantations and rehabilitation of existing ones. Between 2000 and 2004, the areas under cultivation as well as nut yields have markedly increased from 18,000 ha to 52,000 ha, with a corresponding rise in nut yield from 3,600 MT to 26,000 MT (Anon, 2005). Cashew is mainly produced in the Brong-Ahafo, Upper West, Northern, Ashanti and Eastern regions of Ghana (Anon, 2005).

A number of insect pests, including sap feeders cause severe damage to the flushing shoots, inflorescence, developing fruits and the trunks of cashew (Eguagie, 1972; Pillai, *et al.,* 1976; Devasahayam and Nair, 1986; Malipatil and Houston, 1990; Xianli and Van Der Geest, 1990). The most important sap feeders include several species of *Helopeltis* (Hemiptera: Miridae), *Pseudotheraptus devastans* (Dist.) and *Anoplocnemis curvipes* (F.) (Hemiptera: Coreidae), the cotton stainer, *Dysdercus superstitiosus* (F.) (Hemiptera: Pyrrhocoridae) and tree trunk pests such as *Apate telebrans* Pall. (Coleoptera: Bostrychidae) and *Analeptes triafasciata* F. (Coleoptera: Cerambycidae) (Stonedahl, 1991; Peng *et al.,* 1999; Topper, *et al.,* 2001). Of the *Helopeltis* species, *H. schoutedeni* is the most important in Ghana (Boakye, 1995; Topper, *et al.,* 2001). Both the nymphs and adults feed on the tender succulent shoots, inflorescences, immature nuts and apples, causing the same type of damage. Shoot damage is characterized by withering of such shoots, followed by progressive die back, generally beginning from the tips and later advancing downwards to the main floral shoots and leaves. The shoots turn brownish black followed by drying up and necrosis with subsequent arrest of fruit formation (Stonedahl, 1991). The few fruits formed also later drop. Dwomoh (unpublished) studied the life cycle and ecology of the pest and observed that the duration from egg to adult was 23.8 days. He also recorded a mono-modal population curve which peaked in January and declined from June to September. Surveys conducted between 2003 and 2005 by authors (unpublished) revealed that the pest occurred in large numbers in all cashew-growing districts of Ghana causing significant damage to flushing shoots, inflorescence and developing fruits. All farmers interviewed during the survey indicated that *H. schoutedeni* damage on cashew had reached alarming proportions and required urgent attention.

The present study aimed at assessing the efficacy and persistence of Karate, Cyperdim and Confidor for the control of *H. schoutedeni* on cashew in Ghana. In recent years, many different chemicals and formulations have been tested to find alternatives to gamma-HCH for the control of several *Helopeltis* species. The most successful of these has been endosulfan, which is now widely used to control *H. antonii* on cashew (Devasahayam and Nair, 1986; Rajapakse, 1997) and *H. theivora* on tea (Das, 1984; Smith *et al.,* 1985). However in Ghana, endosulfan is a restricted chemical and its use on vegetables is forbidden (Biney, 2005). Other tested chemicals with efficacies similar to that of endosulfan include monocrotophos, phosalone, phosphamidon and quinalophos (Nair and Abraham, 1984). These chemicals are, however, not easily available on the Ghanaian market. Karate, Cyperdim and Confidor were, therefore, tested because, they have been recommended by Environmental Protection Agency of Ghana (EPA) for use in both vegetable (Karate and Cyperdim) and tree crop production. Confidor in particular, has been recommended for the control of mirids in Ghana (Biney, 2005). The three insecticides are available on the Ghanaian market.

Karate is a synthetic pyrethroid that contains lambda-cyhalothrin [Cyano (3-phenoxyphenyl) methyl 3-(2-chloro-3, 3, 3,-trifluoro-1-propenyl-2,2-dimethyl-cyclopropanecarboxylate] as its active ingredient. It is characterised by rapid

knockdown and it is very effective against a number of insect pests of vegetables and tree crops (Anon, 2003). It has both contact and stomach poisoning effect, with some repellent properties. It is photo-stable and moderately hazardous. The LD_{50} (oral) for rat is 450 mg/kg (Anon, 2003).

Cyperdim is a broad spectrum, cocktail insecticide containing the pyrethroid, cypermethrin [(RS)-α-cyano-3-phenoxybenzyl (1RS, 3RS; 1RS, 3SR)-3-(2,2-dichlorovinyl)-2,2-dimethylcyclopropanecarboxylate] and the organophosphorus dimethoate [O,O-dimethyl S-methylcarbamoylmethylphosphoro-dithioate]. Dimethoate has contact, stomach and systemic action. It is used against a wide range of sucking and chewing insect pests of vegetables, fruits and field crops. It is photo-stable and moderately hazardous. The LD_{50} (oral) of dimethoate and cypermethrin for rat are 387 mg/kg and 250-4150 mg/kg, respectively (Anon, 2003).

Confidor contains imidacloprid 1-[(6-Chloro-3-pyridinyl)-4,5-dihydro-N-nitro-111-imidazol-2-amine], which acts on the central nervous system of insects. It has broad spectrum of activity and acts as an acute contact, stomach and systemic poison, and also persistent. It is immobile in the soil, thus does not leach into deeper soil layers and has no adverse effect on the nitrogen cycle . The LD_{50} (oral) for rat is 400 mg/kg (Anon, 2003).

MATERIALS AND METHODS

Laboratory bioassay for toxicity and minimum effective dosage of Karate, Cyperdim and Confidor.

Three insecticides, Karate 2.5EC (lambda-cyhalothrin 25 g a.i. litre^{-1}), Cyperdim 28.5EC (cypermethrin 35 g a.i. + dimethoate 250g a.i. litre^{-1}), and Confidor 200SL (imidacloprid 200g a.i litre^{-1}), were compared with untreated (water) control. The procedure for screening insecticides against cocoa mirids (Ackonor and Acheampong, in press) was adopted. Thus, the sides of five clean Petri dishes were smeared with silicon fluid and the base of each lined with a No. 1 Whatman filter paper. Five serial dilutions of the formulation of each insecticide (see Table 1) were prepared in 100 ml of distilled water in conical flasks, and 1 ml taken by means of a 2 ml pipette to moisten each filter paper. In the control treatment, 1 ml of distilled water was used to moisten the filter paper. Ten 1-day-old 5th instar nymphs of *H. schoutedeni* from a laboratory-bred stock, were transferred by means of a camel's hair brush onto each treated filter paper and covered. Each treatment was replicated three times and 24 hr bug mortalities were recorded. A nymph was considered dead when it did not move or shake the limbs after being pricked with a pin. The lowest concentration that causes at least 95% mortality was considered the minimum effective concentration (Collingwood and Marchart, 1971). Abbott's (1925) formula was used to correct for mortalities due to causes other than the chemical.

Field testing of Karate and Cyperdim for persistence

Having determined the minimum effective concentrations in the laboratory, the promising insecticides (Karate and Cyperdim) were tested in cage experiments to simulate field situations. Ten nylon cages (15 cm x 15 cm x 30 cm) each for Karate and Cyperdim, were hoisted over pulleys 3–4m in the canopy of 0.2 ha plots of mature cashew. Ten 1-day-old 5th instar nymphs of *H. schoutedeni* were introduced into each cage and three fresh flushing shoots were cut and placed inside the cages as food. The insecticides were applied into the entire canopy containing the cages, using a 'Solo' motorized mist blower. The delivery rate of the mist blower was 1.1 litres min^{-1}. Ten 5th instar nymphs each were also placed in 10 cages in an adjacent unsprayed plot to serve as the control, which was sprayed with water only. The experiment was replicated three times, and the number of dead insects counted 24 hr after spraying. This method is similar to one described by Marchart and Pickett

(1969) except that in this case the mirids were fed on flushing shoots.

Persistence of Karate and Cyperdim to *H. schoutedeni*

Cyperdim and Karate were sprayed on five mature trees each at 3.4 and 4.0 ml litre^{-1} tree^{-1} respectively, while using a litre of blank water per tree on five trees as control, with three replications. Ten flushing shoots from each treated tree, marked before treatment, including the control, were harvested at 1, 7, 14 and 21 days after the insecticide application (Corey, 1965; Wolfenbarger *et al.*, 1966; Dwomoh and Boakye, 2003). The shoots were used to feed 10, 6-hr starved, 5th instar nymphs in hurricane lamp glass chimneys lined with filter paper. The dead nymphs were counted after 24 hr. A nymph was considered dead when it did not move or twitch its legs when pricked with a pin. The same procedure was used to determine the persistence of the chemicals on the adults of *H. schoutedeni*.

Per cent mortality of *H. schoutedeni* in each treatment was calculated and transformed to arcsine values before analysis. A Completely Randomized Design was used for both the laboratory and field experiments. Only the data for insecticide persistence experiment was analysed statistically, using the GENSTAT package. The minimum effective concentration for the various insecticides was based on the 95% mortability (Collingwood and Marchart, 1971).

Table 1: Concentrations of Karate, Cyperdim and Confidor tested on 5th instar nymphs of *H. schoutedeni* in the laboratory

Concentration (% a i. litre^{-1})	Amount of formulation in ml/100 ml of water
Karate (Lambda-cyhalothrin)	
0.025	1.0
0.020	0.8
0.015	0.6
0.010	0.4
0.005	0.2
Cyperdim (Cypermethrin+dimethoate)	
0.112	0.38
0.107	0.36
0.102	0.34
0.097	0.32
0.092	0.30
Confidor (Imidaclopid)	
0.040	0.200
0.035	0.175
0.030	0.150
0.025	0.125
0.020	0.100
Distilled water (Control)	-

RESULTS

Minimum effective concentrations of the insecticides

In the laboratory bioassay, 0.010% a.i. and 0.102% a.i. Karate and Cyperdim, respectively, in 100 litres of water ha^{-1} were the minimum effective concentrations against the 5th instar *H. schoutedeni*, recording corrected percentage mortality of >95% after 24 hr (Table 2). Confidor at (0.04% a.i.) concentration, far higher than the manufacturer's recommended rate of 0.03% a.i. in 100 litres of water, was not effective against the 5th instar nymphs (Table 2).

Mortality of *H. schoutedeni* in field cages

The results of the field cage tests are presented in Table 3. Toxicity of the chemicals to both the 5th instar nymphs and adults were identical. Both the Karate and Cyperdim were highly toxic to the insect with a mean corrected mortality of 100%, after only 24 h exposure.

Persistence of Karate and Cyperdim to *H. schoutedeni*

The persistence of Karate and Cyperdim on the 5th instar nymphs and adults of *H. schoutedeni* are shown in Table 4. Twenty four hours after insecticide application, both insecticides caused

Table 2: Toxicity of Karate, Cyperdim and Confidor against 5th instar nymphs of *H. schoutedeni* in the laboratory

Concentration (% a i. l^{-1})	%Mortality after 24 h. (n = 30)	% Corrected mortality after 24 hours
Karate		
0.025	100	100
0.020	100	100
0.015	100	100
0.010	96.7	96.2
0.005	90.0	88.5
Cyperdim		
0.112	100	100
0.107	100	100
0.102	96.7	96.2
0.097	80.0	76.9
0.092	80.0	76.9
Confidor		
0.040	93.3	92.3
0.035	86.7	84.6
0.030	50.0	42.9
0.025	46.7	38.5
0.020	26.7	15.4
Distilled water (Control)	13.3	13.3

100% mortality of the nymphs and adults introduced onto the treated flushes. However, seven days after treatment, both the adults and nymphs succumbed differently to the chemicals. Cyperdim killed more than 95% of the nymphs while Karate killed only 63.3% but the differences were not significant ($P = 0.05$) (Table 4). Ninety per cent of adults died on the flushes treated with Cyperdim while significantly less (40%) died on the flushes treated with Karate seven days after treatment (Table 4). There was a marked reduction in the potency of the insecticides from 14 days of treatment, however, the Cyperdim was always more potent than the Karate.

DISCUSSION

In the present study Cyperdim, a combination of cypermethrin and dimethoate at 0.102% a.i., was highly toxic to *H. schoutedeni* in the laboratory, cage test and the in persistence studies in the field. Insecticide cocktails have been used in China to control *Helopeltis* spp. (Xianli and Van Der Geest, 1990). Damodaran and Nair (1969) and Abraham and Nair (1981) reported that systemic insecticides are much less effective against *Helopeltis* spp. than contact chemicals. The effectiveness of Cyperdim against *H. schoutedeni* could largely be due to both its contact (cypermethrin) and systemic (dimethoate) actions that ensured a two-way attack on the pest. The dimethoate, also being more persistent than the synthetic pyrethroids such as Karate, would confer longer residual effect on Cyperdim than the Karate. The results, however, indicate that Karate was also very effective in the laboratory, cage test and the residual studies, particularly a day after its application, in the field. All nymphs and adults of *H. schoutedeni* released on the Karate-treated plants after 24 h of insecticide

Table 3: Toxicity of Karate and Cyperdim to 5th instar nymphs of *H. schoutedeni* in field cage tests 24 h after treatment.

Chemical	% a i. ha^{-1}	Mortality after 24 h. (n = 100)	% Corrected mortality after 24 h.
Karate	0.010	100	100
Cyperdim	0.102	100	100
Control (Water)	0.0	10.0	10

Table 4: Residual effect of Karate and Cyperdim on 5th instar nymphs and adults of *H. schoutedeni*

Insecticide and rate (in 100 l of water)	Mean % mortality Days after insecticide application			
	1	7	14	21
(a) 5th instar nymphs				
Karate (0.010% a.i ha^{-1})	100 [a]	63.3 [a]	33.3 [a]	10 [a]
Cyperdim (0.102% a.i ha^{-1})	100 [a]	96.7 [a]	80.0 [a]	36.7 [a]
Water (Control)	13.3 [b]	10.0 [b]	13.3 [a]	10.0 [a]
LSD ($P = 0.05$)	**15.3**	**37.0**	**81.9** [ns]	**40.3** [ns]
(b) Adults				
Karate (0.010% a.i ha^{-1})	100 [a]	40.0 [b]	20.0	13.3
Cyperdim (0.102% a.i ha^{-1})	100 [a]	93.3 [a]	40.0	13.3
Water (Control)	13.3 [b]	10.0 [b]	10.0	10.0
LSD ($P = 0.05$)	**15.3**	**39.6**	**63.8** [ns]	**15.3** [ns]

application did not survive. This may be due to its quick knock-down effect (Anjaneyulu and Bhaktavatsalam, 1987). There is no information on the efficacy of Karate and Cyperdim against *H. schoutedeni*, but these insecticides have been reported to be effective against some hemipterans (Xianli and Van Der Geest, 1990; Tejeda, *et. al.*, 1990; Rajapakse, 1997). Confidor was still not effective against *H. schoutedeni* even at a far higher concentration than the manufacturer's recommended rate. Owusu-Manu and Siaw (1993) tested Confidor at 0.03% a.i. ha^{-1} against two species of mirids, *Sahlbergella singularis* Hagl. and *Distantiella theobroma* (Dist.) in the field. They reported that Confidor was more effective in the control of *S. singularis* than *D. theobroma*. It is, therefore, possible that Confidor exhibits differential toxicity to different mirids.

In this study, although, Cyperdim and Karate were both effective, the toxicity of these treatments declined after seven days. This observation conforms to the general trend of loss of potency with time as reported by Leuck *et al.* (1975) and All *et al.* (1986). At seven days after treatment, the differences between the persistence effect of Karate and Cyperdim were not significant. However, any chemical that kills less than 95% of any pest is not desirable for the control of that particular pest (Collingwood and Marchart, 1971). Even though, the Karate was equally as potent as the Cyperdim statistically, Karate could not kill at least 95% of the insects after seven days. Cyperdim is therefore a better choice over Karate as one would need to treat the crop much less frequently than with Karate. But should there be an outbreak of *H. schoutedeni*, either Karate or Cyperdim could be used to knock them off with near total control within 24 h.

CONCLUSION

The study has revealed the minimum effective concentrations of Karate, and Cyperdim for the control of *H. schoutedeni* at both laboratory and field cage tests. Confidor at 33% more than the manufacturer's recommended rate was less toxic to *H. schoutedeni* than Karate and Cyperdim. The persistence of Karate and Cyperdim indicated that one day after insecticide application, both insecticides gave excellent kill (>95%). In

the case of massive invasion of the pest, either Karate or Cyperdim could be used to knock them off with near total control. However on prophylactic basis, Cyperdim would be a better choice as it showed longer persistence than Karate.

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