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Efficacy of Stamina 50 (Thiocyclam hydrogenoxalate) on *Coelaenomenodera elaeidis* (Coleoptera – Chrysomelidae – Hispinae) in Okomu oil palm plantation, Nigeria

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Abstract: Efficacy of Stamina 50, Thiocyclam hydrogenoxalate was evaluated for its bio-insecticidal control on *Coelaenomenodera elaeidis* larvae, pupae and adult forms, at Okomu oil palm plantation, Nigeria. The experimental plot was 10.2Ha compared with similar untreated plot. Observations were made for 4 weeks after treatment, for dead leaf miner populations. Data were subjected to one way analysis of variance, independent sample T-test and testing for significant difference on the effect of insecticidal treatment on leaf miner populations. Results indicated that exposure to the insecticide at 500g per Kg induced high mortality against the leaf miner. The highest population of dead leaf miner external adult was observed one day after treatment. Total percentage mortality of leaf miner was 89.13% (treatment) and 28.40% (control) indicating effective control. Spot application of stamina 50 was selective on leaf miner and is therefore recommended as a control measure for the leaf miner in Nigeria.

Keywords: *Coelaenomenodera elaeidis*, Hydrogenoxalate, Oil palm, Stamina 50, Thiocyclam,

INTRODUCTION

Oil palm suffers from many pests that can have a serious impact on growth and yields. Hartley (1988) have accounts of the destructive insects of the oil palm and aspects of their control. The spectrum of activity of Thiocyclam hydrogenoxalate (N, N-dimethyl-1,2,3 – trithian – 5 ylamine hydrogenoxalate) is limited to certain species, most of which belong to the Lepidoptera and Coleoptera (Philippe, 1989). It has a moderate residual effect of two to three weeks. Its formula is: $C_5H_{11}NS_3.C_2HO_4$. It has been known that carnivorous insects die after eating the marine worm, *Lumbrinereis brevicirra or Lumbriconereis heteropoda*, used as bait. The neurotoxin responsible for the death of the insects has been isolated and called Nereistoxin (Nitta, 1934). Its structure was explained in detail by Okaichi and Hashimoto (1963) and it was first synthesized by Hagiwara *et al.* in 1965. It acts through contact and ingestion directly upon the nervous system by masking neuron receptors. *Coelaenomenodera elaeidis* is one of the most serious insect pests of the oil palm in Nigeria. Insecticides are some of the most potent, dependable substances that can be employed to manage insect pests. Side effects cannot be avoided totally, but they can be minimized by proper use, which includes applying insecticides as effectively as possible and having utmost regard for human and environmental safety (Pedigo, 2004). Morin and Mariau (1972) and Hartley (1988) gave accounts of the incidence, life cycle and damage of *C. elaeidis*. The adults in cases of severe attack can be observed flying within the crown, and show preference for migrating to the higher leaves. In visibly heavy outbreaks, control measures become necessary. Control of the oil palm leaf miner has mainly been by the use of insecticides (Morin and Mariau, 1971). Cultural control by pruning and heaping of all affected leaves during the rains has been reported to be very effective (Agwu *et al*, 1986). Ultracide 40 E.C. at 1.5 litres/hectare using the tecnoma for tall palms has also been reported (Agwu, 1979). The natural enemies of *C. elaeidis* and other control measures at present seem not to be effective enough to stem outbreaks, and preventing oil palm defoliation over thousands of hectare. Some of the insecticides used in Nigeria presently for the control of the leaf miner are highly persistent and could bioaccumulate in human tissues (Anikwe *et al.*, 2009). It is against this background that a safer product formulation of natural origin has been evaluated. The mode of action is by contact and ingestion on larvae, pupae and adults.

The objective of this study was to evaluate the efficacy of stamina 50 containing 500 gm/Kg of Thiocyclam hydrogenoxalate for the control of larvae, pupae and adult forms of the oil palm leaf miner, *C. elaeidis* in Nigeria.

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MATERIALS AND METHODS

Study site: The study was conducted in field I - 24 consisting of 52 lines (10.2 Ha) of oil palm made up of a total of 1407 palms at the Okomu oil palm estate, Udo, Edo State, Nigeria. The field was planted in 1989 at a planting density of 138 palms at 9m triangular spacing per hectare. Field J – 42 (10.2 Ha) was the control where no treatment application was made. It was planted in 1990. Distance between the two plots is 1.5km making it difficult for insect migration.

Insecticide evaluation: Stamina 50 containing 500 gm/ Kg of Thiocyclam hygrogenoxalate was obtained from INSIS Nig. Ltd. It was evaluated for the control of larvae, pupae and adult of the *C. elaeidis*, using a rate of 1.17 kg in 400 litres of water to treat 12 lines or 2.34 ha of oil palm.

Experimental design: The study area was selected based on phytosanitary observations of 5 palms in every 5 lines of the plot on a weekly basis that indicated a history of *C. elaeidis* infestation. A complete randomized design (CRD) was utilized. The total experimental plot was 10.2Ha. The chemical treatment was applied through out the trial plot. A Massey Ferguson 435 tractor mounted Jacto Cannon mist blower AJ 401 was used for spraying the insecticide following Philippe *et al.* (1989). The equipment passed twice down each clear interrow.

A treatment pre-application assessment of the study site was conducted for the identification and counting of observed insect stages. Samples were taken at every fifth line at 5 palms per line. Census of insects on the basis of damage was done by walking the full length of a planted line, assessing damage on randomly selected palms, and the damaged fronds opened up and immature stages of *C. elaiedis* counted.

This was followed by the application of the insecticide treatment. 40ml tenac sticker was added to retain the active ingredient of the insecticide on the palm surface. On application of insecticide treatment, an observation was made for dead insect pest populations after 24 hours. Thereafter, weekly observations were made for 4 weeks. Adulticide action was evaluated on external adults on the underside of each whole frond at three levels on the crown (9, 17, 25). In addition, physical phytosanitary checks and counting of dead or immobile *C. elaiedis* population was made to monitor mortality. Since, Thiocyclam hygrogenoxalate is systemic and acts via the leaves, a second treatment was made after 2 weeks of the first treatment to ensure effective action on any residual population. It is assumed that immigration and emigration were held to a minimum and there were no recruitments from births.

Pre-treatment application assessment on trial and control plots for larvae, pupae and adult were conducted. First treatment application was conducted and insect observations were made after 24hours and 2 weeks. After second treatment, insect observations were made after 1 week and 2 weeks respectively.

Statistical analysis: Data were analyzed as one way Analysis of variance to test for significant difference between control and experimental means and within various treatments. Independent sample T-test was used to evaluate significant differences among the two treatment means (Study area and control). P values of 0.05 or less were considered statistically significant (Fisher, 1950). Levels of infestation (Mariau and Bescombes, 1972), were calculated

Using: $I = \frac{L + P + A}{F / H}$

RESULTS AND DISCUSSION

Analysis of variance on population of leaf miner insect stages in the study area is presented in table 1. It shows differences between the effects of the insecticide at the various times the insecticide was applied. Larva significance ($P = 0.005$) indicates that there are differences in the effect of the insecticidal treatment on the larva at the various times of application. Significance of pupa, adult and the total insects combined ($P = 0.000$) also indicate differences in insecticidal treatment at various times of application. Comparing the means of the larva, pupa and adult populations, before treatment application and 4 weeks after, it was observed that there was a significant difference on insecticidal application.

Table 2 shows comparison of insecticide effectiveness on leaf miner stages in the treatment areas (study and control plot) to show differences between the insect stages and the various periods of observation. For the larva stage, all the values were greater than 0.05 (insignificant). This implies that the insecticide was not effective on the larvae before application, 1 day, 2 weeks and 4 weeks after treatment application was made. This could be attributed to the fact that the larvae are usually between the mines of the palm leaflets. The insecticide was effective on the pupae before treatment, 1 day and 2 weeks after treatment ($P < 0.05$) while it was not effective on pupae 4 weeks after ($P > 0.05$). The insecticide was effective on the adult 1 day, 2 weeks and 4 weeks after treatment ($P < 0.05$) while it was not effective on the adult before treatment was made ($P > 0.05$). The insecticide was effective on the total insect stages combined at before application, 1 day and 2 weeks after treatment ($P < 0.05$) while it was not effective 4 weeks after treatment was made ($P > 0.05$).

Table 3 shows percentage mortality for the various insect stages (larvae, pupae, and adult) and total combined insects for both study area and control. 2 weeks after treatment, adult leaf miner mortality was 84.91% (treatment area) and 20% (control) respectively. 2 weeks after second treatment, adult leaf miner mortality was 92.45%

Table 1. Analysis of variance on population of leaf miner stages in the treatment plot.

Time of insecticide application	Larva	Pupa	Adult	Total insects
Before application	2.64 ± 1.502	5.09 ± 2.809	4.82 ± 2.316	12.55± 3.959
1 day after	2.09 ± 1.578	6.27 ± 2.901	12.9 ± 4.346	21.27± 5.815
2 weeks after	2.36 ± 1.859	1.27 ± 1.104	0.73 ± 1.009	4.36 ± 2.157
3 weeks after	0.55 ± 0.688	0.82 ± 1.250	0.18 ± 0.405	1.55 ± 1.635
4 weeks after	1.00 ± 1.414	0.18 ± 0.405	0.36 ± 0.505	1.36 ± 1.433
Significance	0.005	0.000	0.000	0.000
Least significant difference	1.25	1.73	1.94	2.94

Table 2. Showing comparison of insecticide effectiveness on leaf miner stages in treatment and control plots.

Time of insecticide application	Larva	Pupa	Adult	Total insect
Before application	0.587	0.001	0.256	0.001
1 day after	0.115	0.000	0.000	0.000
2 weeks after	0.791	0.006	0.002	0.002
4 weeks after	0.131	0.152	0.000	0.392

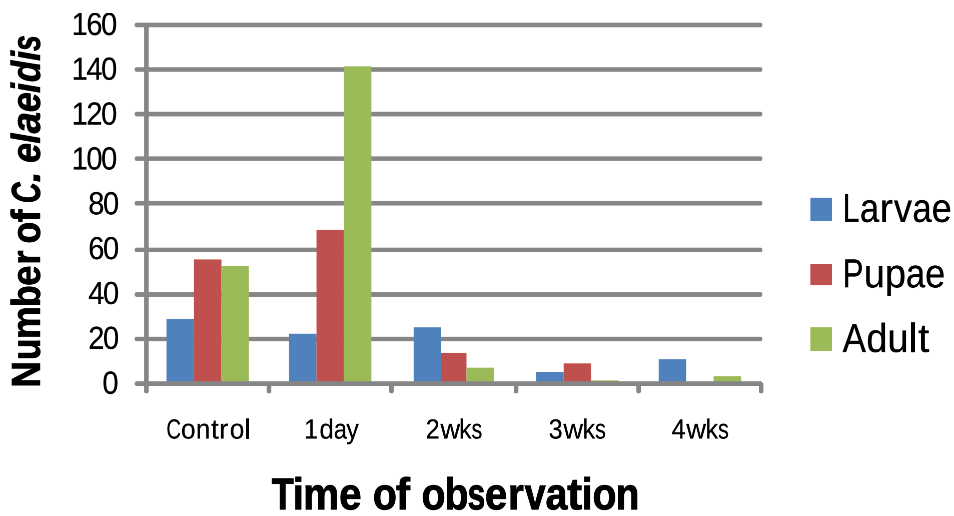

Fig. 1. *Variation in number of leaf miner larvae, pupae and adults in the treatment plot.*

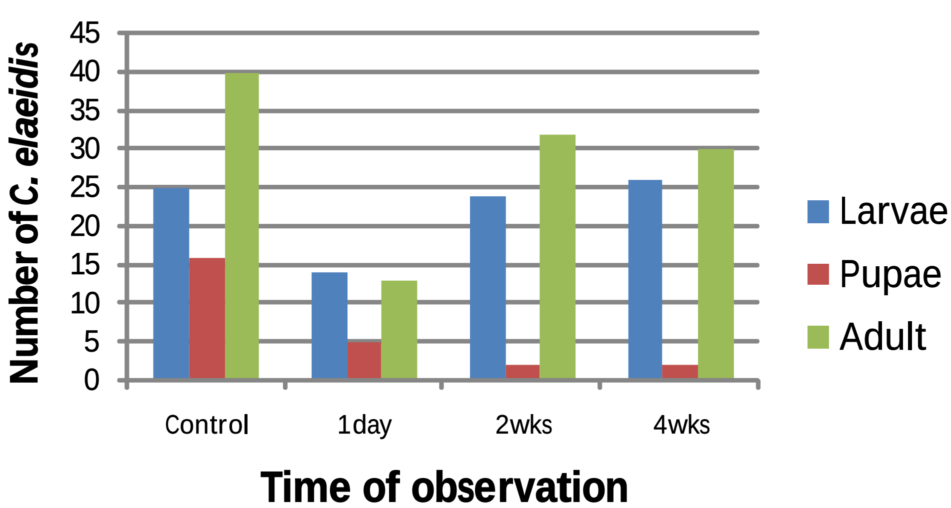

Fig. 2. *Variation in number of leaf miner larvae, pupae and adults in the control plot.*

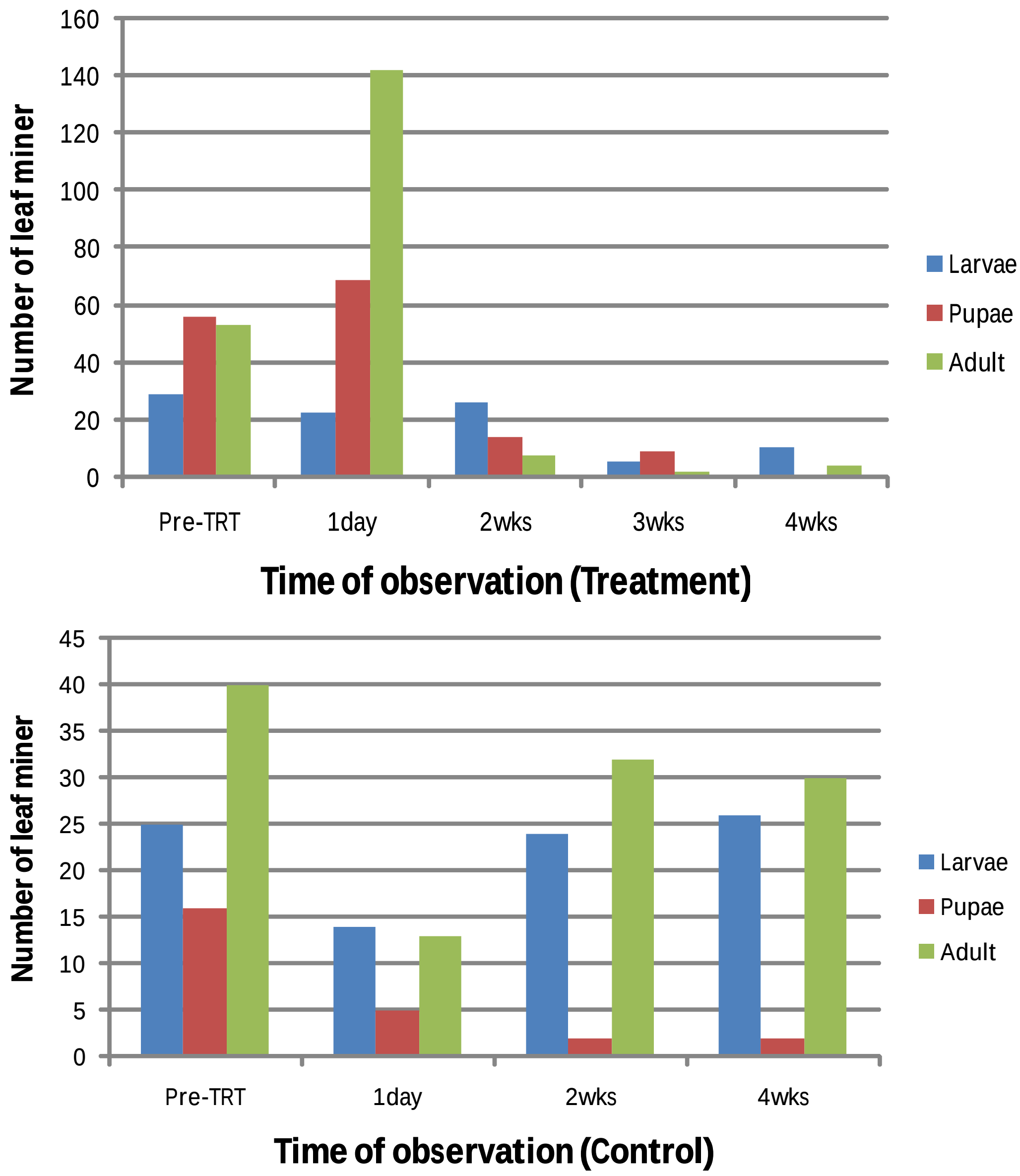

Fig. 3. *Total leaf miner distribution in treatment and control plot.*

Table 3. Percentage mortality for various insect stages and total insects for treatment and control plots.

	Study area				Control plot			
Treatment period	**Larvae (%)**	**Pupae (%)**	**Adult (%)**	**Total insects**	**Larvae (%)**	**Pupae (%)**	**Adult (%)**	**Total insects**
1 day after treatment	20.69	-23.21	-167.9	-69.57	44	68.75	67.5	60.49
2 weeks after treatment	10.35	75	84.91	65.22	4	87.5	20	28.40
2 weeks after treatment	62.07	100	92.45	89.13	-4	87.5	25	28.40

(treatment) and 25% (control) respectively. 2 weeks after second treatment, total insect mortality was 89.13% (treatment) and 28.40% (control) respectively. This indicates a high level of control achieved by the insecticide.

Summary of *C. elaeidis* population in the study plots is presented in table 4. The highest number (12.9) of dead leaf miner external adult was sighted one day after insecticidal treatment. This indicates that the insecticide knock-down action is most potent one day after application. The lowest number (0.4) of dead leaf miner was observed 2 weeks after the second treatment. This indicates that a second insecticide application is required to complement the first application. No pupa or internal

Table 4. Means of leaf miner in treatment and control plots.

Observation time	Mean *C. elaeidis* numbers					
	L		P+IA		EA	
	Treatment plot	Control	Treatment plot	Control	Treatment plot	Control
Pre-treatment	2.6	2.3	5.1	1.5	4.8	3.6
1 day after treatment	2.1	1.3	6.3	0.5	12.9	1.2
2 weeks after first treatment	2.4	2.2	1.3	0.2	0.7	2.9
2 weeks after second treatment	1.0	2.4	0.0	0.2	0.4	2.7

Key: L - Larva, P + IA - Pupa + Internal adult, EA - External adult

adult was recorded two weeks after second application. In contrast, the control plot and the pre-treatment observations had pupae or internal adults through out the duration of the study. The lowest number (1.0) of larvae was observed 2 weeks after the second treatment. This indicates an inhibitory effect on egg laying.

Table 5 shows the pre-treatment and post-treatment numbers of *C. elaeidis* with stamina 50. A total of 138 were observed before insecticide application, while 15 were observed after insecticide application. This study corroborates the findings of Turner and Gillbanks (2003) that the Thiocyclam hydrogenoxalate has been found to be very effective against the leaf miner, *Coelaenomenodera*, in West Africa. Survey of leaf miner population before insecticidal application to estimate levels of infestation 'I', where 'I' is the ratio of larvae + pupae + adult to the number of fronds sampled, by picking one frond per palm per hectare. This showed that indices of infestation before treatment 'I' was 13.8. This implies that there is need for control action to be taken. Similar estimates of *C. elaiedis* numbers after pesticide application showed the beetle to have indices of infestation of 1.5 (Yawson *et al.,* 2006). This implies a reduction of infestation levels after insecticide application.

Variation in number of leaf miner larvae, pupae and adult in the treatment and control plots is presented Figs. 1 and 2. Total leaf miner distribution in the treatment and control plots is presented in Fig. 3. In the treatment plot, number of larvae recorded was highest after 2 weeks, while number of pupae and adults were most abundant 1 day after treatment (Fig. 1). It can be deduced that most of the leaf miner were observed 1 day after treatment. In the control plot, number of larvae recorded was highest after 4 weeks, while number of pupae was most abundant after 1 day and number of adults after 2 weeks (Fig. 2). This indicates that there was no trend in the distribution of leaf miner as opposed to the treatment plot. Total leaf miner distribution in the treatment plot indicates that most of the leaf miner was recorded 1 day after treatment with no pupae recorded 2 weeks after second application, while the control plot recorded presence of pupae through out the study period (Fig. 3).

Conclusion

The mortality of adult leaf miner recorded in this work could be attributed to the contact toxicity of stamina 50 while the larvicidal effect on the development stages of the beetle may be as a result of the stomach poison characteristics of the insecticide.

The insecticide belongs to a new group of pesticides derived from a natural substance extracted from a marine worm (*Lubrineries* sp). It has a good knock-down effect. The effect was seen 24 hrs after treatment in this study. It was observed that no other dead insects were sighted one day after treatment observation. This indicated the insecticide's specificity on *C. elaiedis*. It is concluded that stamina 50 could effectively reduce *C. elaiedis* population with least pollutive effects, without reduction in the presence of other beneficial insects.

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