

## Evaluation of Carbofuran, Chlorpyrifos and Endosulfan for the Control of Yam Beetles, *Heteroligus* spp. (Coleoptera: Dynastidae), in Delta State, Nigeria.

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**ABSTRACT.** The efficacy of carbofuran (Furadan 5G), chlorpyrifos (Tricel 48EC) and endosulfan (Endocel 35EC) for the control of yam beetles (*Heteroligus* spp.) was evaluated in 2004 and 2005 at the Teaching and Research Farm, Faculty of Agriculture, Delta State University, Asaba Campus and at Ugbolu, a village in Oshimili North Local Government Area, Delta State, Nigeria. The experiments were laid out in randomized complete block design and the three insecticides as well as an untreated control were replicated three times. The insecticides were applied at the time of planting at the rate of 1.75kg a.i./ 2tonnes of yam setts for Furadan 5G; 1.92L a.i./ 2tonnes of yam setts for Tricel 48EC and 0.7L a.i./2tonnes of yam setts for Endocel 35EC. Data collected were the number of dead beetles per heap, the number, depth and diameter of feeding holes on yam (*Dioscorea rotundata* cv *Adaka*), tuber yield and percentage yield increase over control. There were significantly higher numbers of dead beetles in chlorpyrifos- and endosulfan-treated plots than in carbofuran and untreated-control plots. All insecticide-treated plots had significantly lower number of feeding holes, depth of feeding holes than control at the two locations. Chlorpyrifos and endosulfan were more effective than carbofuran in reducing yam beetle damage. There were no significant differences ( $P>0.05$ ) in yield of tubers in insecticide-treated plots compared with control plots in 2004 and 2005 at Asaba and in 2005 at Ugbolu. However, significantly lower tuber yields were obtained in untreated control plots at Ugbolu in 2004. Application of insecticides brought tuber yield increases which ranged between 23% and 68% across the locations and in the two years of evaluation.

### INTRODUCTION

Cultivated yams belong to the family *Dioscoreaceae* and genus *Dioscorea* (Coursey, 1967). For most people in West Africa, the Caribbean, South Pacific Island and parts of Asia, edible yam constitute an important part of their diet (Adelusi and Lawanson, 1987; Coursey, 1967; Hahn *et al.*, 1987). It was reported that West and

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Central Africa produce 95% of the annual global output of 30 million metric tonnes of yam and Nigeria accounted for 75% of this production (FAO, 1998; IITA, 1995).

The greatest constraint to increasing yam production in Nigeria apart from the scarcity and high cost of seed yams is the damage (estimated average yield loss of 25% annually) caused by pests and diseases (Arene, 1987; Ezeh, 1998; FAO, 1998; Nweke *et al.*, 1991). Among the major insect pests of yam are the dynastid beetles *Heteroligus meles* Billb., *H. appius* Burn., *Prionoryctes rufopiceus* Arrow and *P.*

*canaliculus* Arrow. The commonest and most widely distributed species is *H. meles* (Taylor, 1964). The adult *H. meles* is about 23 – 33mm in length while *H. appius* is about 21 – 23mm long. Both are brown to black, short distance fliers and usually oviposit in moist and damp sites. Adult beetles feed on tubers making large hemi- and semi-spherical holes 1 – 2cm, resulting in low yields and market value and predisposing tubers to microbial attack both in the field and storage (Onwueme, 1978; Taylor, 1964).

In Igala land, and in the Niger-Delta area, adult and larval *H. meles* have been reported to cause economic damage to yam tubers (Acholo *et al.*, 1997). The adult beetles are attracted to yam fields by the foliage. Stand loss results in cases of extreme damage to the planted yam setts. Feeding continues for the next 4 – 5 months and is followed by a relatively quiescent period around August and September. Voracious feeding and damage to the growing tubers occur prior to beetle breeding migration in late October – December (Taylor, 1964; Moro, 1990).

Attempts to control yam beetles using chemicals date back to 1953 when some insecticide dust rubbed on yam setts resulted in economic control of the beetle (Jerath, 1967). Many organochlorine insecticides were evaluated either as dressing or sprays on yam heaps and Aldrin 2.5% dust proved the most effective and economic resulting in about 70% reduction in damage and 20 – 77% increase in tuber yield (Taylor, 1964).

To date, the most effective control measure against yam beetles is the use of insecticides, particularly Aldrin dust, a chlorinated hydrocarbon. Due to its undesirable side effects such as tumor promotion, carcinogenicity, neurotoxicity in human and animals coupled with its persistence and residue problems in the soil, Aldrin has been banned both in USA and Nigeria. Carbofuran (2, 3, dihydro-2, 2-dimethyl-7-

benzafuranyl methylcarbamate) has been documented as an effective substitute to Aldrin dust for the control of yam beetle (Umeozor, 1998). Desirable properties of carbofuran include low contamination on application, rapid metabolism and excretion by vertebrates and invertebrate and thus negligible bio-accumulation in food chain as well as undesirable effect on reproduction. Carcinogenicity, mutagenicity and teratogenicity tests were all found to be negative. All these notwithstanding, the LD<sub>50</sub> oral of 8 – 14 mg/kg body weight puts carbofuran in the highly hazardous class (IB) of pesticides (Barnthose *et al.*, 1991; Van Schoubroeck *et al.*, 1992).

Chlorpyrifos is an organophosphate insecticide with contact, stomach poison and fumigant action. It is non-phytotoxic, easily degraded in soil between (60 – 120 days residual activity) and moderately hazardous (LD<sub>50</sub> oral 150 mg/kg; class II).

Endosulfan, is an organochlorine insecticide with contact and stomach poison action. It is non-selective, more easily degraded in humid than in dry soils, moderately toxic to mammals (LD<sub>50</sub> oral 80 mg/kg class II) and easily decomposed and excreted rapidly in the faeces and urine, with no records of accumulation in human body, mutagenicity or carcinogenicity (Van Schoubroeck *et al.*, 1992).

Endosulfan was recommended for yam beetle control (PAN, 1978), and some organophosphate and carbamates are being evaluated. Carbofuran was reported to be effective in controlling yam beetle at Choba, Port-Harcourt while pirimiphos-methyl, fenitrothion and chlorobenzilate were equally reported to reduce the beetle damage to yam tubers (Emehute *et al.*, 1991; Nwana, 1978; Umeozor, 1998).

The study was undertaken to assess the efficacy of chlorpyrifos, endosulfan and carbofuran against yam beetle with a view to reducing environmental pollution arising

**Table 1. Evaluation of three insecticides for the control of yam beetles (*Heteroligus spp.*) at Asaba.**

Treatment	Mean no. of dead beetles/mound	Mean no. of holes/tuber	Feeding holes(cm)		Tuber yield t/ha	% increase over control
			Depth	diameter		
2004						
Control	0.00	16.00	1.57	1.07	9.9	-
Carbofuran	0.75	4.08	1.02	1.06	14.1	42.0
Chlorpyrifos	1.16	0.08	0.00	0.00	13.2	33.0
Endosulfan	1.08	0.00	0.00	0.00	12.1	23.0
<b>LSD (P&lt;0.05)</b>	<b>0.15</b>	<b>2.17</b>	<b>0.34</b>	<b>0.26</b>	<b>NS</b>	
2005						
Control	0.00	12.63	12.63	1.39	10.1	-
Carbofuran	0.06	4.83	4.83	0.80	13.7	36.0
Chlorpyrifos	1.08	0.08	0.08	0.03	14.5	44.0
Endosulfan	0.91	0.25	0.25	0.04	16.2	60.0
<b>LSD (P&lt;0.05)</b>	<b>0.07</b>	<b>0.07</b>	<b>5.08</b>	<b>0.69</b>	<b>1.19</b>	

from extensive usage of highly persistent organochlorine insecticide such as Aldrin in yam producing areas.

#### MATERIALS AND METHODS

The experiment was carried out at the Faculty of Agriculture Teaching and Research Farm, Delta State University, Asaba Campus, as well as other at Ugbolu, a village in Oshimili North Local Government Area of Delta State in 2004 and 2005. The fields at both locations were cleared and yam mounds were made with Abakiliki traditional hoe (Ikeorgu and Igwilo, 2002). Twelve plots, each 4m long by 3m wide were demarcated and three insecticide treatments and an untreated control were assigned to them in randomized complete

block design replicated three times. The space between plots was 1.5m while it was 2.0m between blocks. The insecticides evaluated for the yam beetle control were 1.75kg carbofuran/2tonnes yam setts, 1.92L chlorpyrifos 2/tonnes yam setts and 0.7L endosulfan 2/tonnes of yam setts. For the liquid insecticides, setts of *D. rotundata* cv Adaka were dipped in the rate applied for about 2 – 5 min and allowed to dry before planting. Carbofuran was sprinkled on the proximal end of the yam setts in the mounds and then covered with soil (Umeozor, 1998). Yam setts weighing 200 – 250 g were planted in mounds spaced 1m x 1m apart at the rate of one sett per mound on May 20 – 21, 2004 and May 17 – 18, 2005. After sprouting and vine establishment, the

**Table 2. Evaluation of three insecticides for the control of yam beetles (*Heteroligus* spp.) at Ugbolu.**

Treatment	Mean no. of dead beetle/mound	Mean no. of feeding holes/tuber	Feeding holes(cm)		Tuber yield t/ha	% increase over control
			Depth	diameter		
2004						
Control	0.00	15.83	1.21	1.55	8.10	-
Carbofuran	1.00	3.92	0.61	0.78	12.10	49.0
Chlorpyriphos	1.58	0.16	0.08	0.12	11.50	42.0
Endosulfan	1.81	0.08	0.13	0.13	13.60	68.0
<b>LSD (P=0.05)</b>	<b>0.60</b>	<b>5.41</b>	<b>0.48</b>	<b>0.65</b>	<b>3.4</b>	
2005						
Control	0.00	15.91	1.40	1.16	9.90	-
Carbofuran	0.90	3.15	0.98	0.98	16.30	65.0
Chlorpyriphos	1.83	0.16	0.12	0.15	15.80	60.0
Endosulfan	1.87	0.00	0.00	0.00	13.30	34.0
<b>LSD (P=0.05)</b>	<b>0.92</b>	<b>4.26</b>	<b>0.33</b>	<b>0.40</b>	<b>0.74</b>	

yams were staked using 2.5m Indian bamboo stakes. The plots were kept weed-free manually by hoeing at 3, 8 and 12 weeks after planting. At the harvest (Nov. 28, 2004 and Nov. 26, 2005), the number of dead beetles in the mounds were counted. The harvested tubers were weighed and beetle damage quantified as the number, depth and diameter of feeding holes per tuber. Percentage yield increase over the control was computed. Data were subjected to analysis of variance and significantly different means were separated by Fisher's Latest Significant Difference (F-LSD) at 5% level of probability.

### RESULT AND DISCUSSION

The effects of application of insecticides on beetle damage and tuber yield are shown in Tables 1 and 2. No dead beetle was found in the control plots but the plots treated with insecticides had varied numbers which differed significantly in both years with carbofuran showing the least efficacy (Table 1). The numbers of feeding holes were

significantly ( $P < 0.05$ ) lower in treated plots compared to untreated plots at both locations in 2004 and 2005. Feeding holes were more in carbofuran-treated plots than in plots treated with other insecticides probably because it has short residual activity in the soil. Van Schoubroeck *et al.* (1992) reported 50% loss of active ingredient within 30 – 60 days in the soil. In contrast, chlorpyriphos and endosulfan acted both as non – systemic, contact, stomach poison and respiratory insecticides; they are degraded in soil within 60 – 120 days.

At Asaba, plots treated with chlorpyriphos and endosulfan either had no feeding hole damage or had feeding damage of negligible depth and diameter (2005) whereas control plots had significantly ( $P < 0.05$ ) more severe damage. The results obtained at Ugbolu (Table 2) showed negligible damage in all plots treated with insecticides; the damage in untreated control plots in both 2004 and 2005 was significantly ( $P < 0.05$ ) higher. At Asaba, tuber yields in all insecticide-treated plots were numerically higher than in untreated

control plots in both 2004 and 2005; however, the differences were not significant ( $P > 0.05$ ). A similar trend was noted at Ugbolu in 2005 (Table 2) but in 2004 tuber yield in the control was significantly lower than the yield in insecticide-treated plots. The higher tuber yield in insecticide-treated plots apparently is the consequence of reduction in beetle damage. Application of insecticides at Asaba gave tuber yield increase over control ranging between 36% and 60% in 2004 and between 23% and 42% in 2005 (Table 1). The effects of the insecticides on tuber yield was more pronounced at Ugbolu where yield increase between ranged 42% and 68% in 2004 between and 34% and 65% in 2005 (Table 2). Previous studies by Taylor (1964) similarly showed higher tuber yield increase (20-77%). Chlorpyrifos and endosulfan appear more effective than carbofuran in controlling yam beetles considering the beetle feeding holes on the tuber and dead beetles found per yam heap.

Endosulfan has been recommended for the control of yam beetle (PAN, 1978). The fear of persistence and bio-magnification expressed in the use organochlorine insecticides was allayed by Taylor (1969) when he reported that peeled aldrin-treated yam (pulp) were safe for human and animal consumption. Presently, Aldrin and other related organochlorine insecticides are no longer used or recommended in many countries due to their long-term residual effect and risk of environmental pollution. Some organophosphate and carbamates are being evaluated currently for the control of yam beetles. Carbofuran was recently shown to be effective in controlling yam beetle at Choba near Port-Harcourt (Umeozor, 1998). Similarly, Emehute, *et al.* (1991) showed unequivocally that damage by yam beetle (*Heteroligus* spp.) can be reduced appreciably by application of fenitrothion (Sumithion 2.5D) and chlorobenzilate

(Promet 40 S.D). The report, however, showed that these insecticides were not rapidly available in the market – a very serious and unfortunate set back.

### CONCLUSION

The result of this study indicated that application of insecticides to yam sets where yam beetle is a problem is required for optimum yield and improved market values of the yam tubers. The order of effectiveness of the three insecticides evaluated were chlorpyrifos  $\geq$  endosulfan  $>$  carbofuran. Thus, chlorpyrifos and endosulfan, which are less hazardous and easily bio-degradable in the soil, could therefore serve as a substitute to Adrin dust.

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