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Establishment, Yield and Control of *Heteroligus meles* (Bilb.) (Coleoptera: Dynastidae) in *Dioscorea rotundata* Poir on *Amitemes evancifer* (Silv.) Infested Site Using Wood Ash, Carbofuran and Aldrin

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Abstract: Trials were conducted in 2003 and 2004 to evaluate the effect of wood ash, carbofuran and aldrin dust on the control of yam tuber beetle (*Heteroligus meles*) and the performance of *Dioscorea rotundata*. Yam vines emerged earlier from the treated setts than the untreated setts and it was much higher in carbofuran (25.3%) than wood ash (22.3%) and aldrin dust (20.4%) in that order. However, there were no significant differences among the treatments. Dry matter was much higher in carbofuran followed by wood ash and then aldrin dust. Fresh yam tubers produced by carbofuran treated setts weighed significantly more (1.97 kg stand^{-1}) than those produced by wood ash treated setts (1.62 kg stand^{-1}), aldrin dust treated setts (1.45 kg stand^{-1}) and untreated setts (1.43 kg stand^{-1}). During both years, a highly significant difference ($p<0.05$) existed among treatments. In 2003, the mean of beetle feeding holes was 9, 4, 2 and 11 for aldrin dust, wood ash, carbofuran and control respectively. The pattern of distribution in 2004 was not quite different from that of 2003. There was no significant difference between damage in the aldrin treated setts than the control. From the trial, it appeared that *Heteroligus meles* have developed insensitivity to aldrin dust and that carbofuran should be used instead since insect pests was sensitive to it while wood ash can be used as substitute to carbofuran by resource-poor farmers and when carbofuran was not available.

Key words: *Dioscorea rotundata*, *Heteroligus meles, Amitermes evancifer*, carbofuran, wood ash, aldrin dust

INTRODUCTION

Yam (*Dioscorea* sp.) is a tuber crop widely cultivated in humid and sub-humid regions of West Africa, Caribbean and Southeast Asia (Onwueme and Sinhad, 1991). West Africa is the most important area of yam production in the world. About 96% of global yam production comes from this region. The main producer being Nigeria, which produces about 71% of world output, with Ghana, Côte d'Ivoire, Bénin and Togo following in that order (FAO, 2002). The yam producing areas in Nigeria are situated mostly in the middle belt, much of the South-East and a smaller portion of the South-South and South-West (TREP, 2003). The factor limitingyam production in the South-South is that of insect pests among other factors (Onwueme, 1978). The most devastating of these insect pests are the yam tuber beetles *(Heteroligus meles)* and termites *(Amitermes evancifer)* which causes considerable loss to farmers who grow yams (Taylor, 1963). The adults of yam tuber beetles feed on the tuber making hemispherical holes which reduces quantity and quality of the tubers and predisposed them to rot organisms (Onwueme and Sinhad, 1991). Eggs are laid by adult female in the damp soil in the river bank in November to December. The larvae hatch out and feed on roots of aquatic plant and pupate. Within 5 months, the life cycle is completed. The mature adult female and male fly to yam mound in upland area, penetrate and feed on yam tuber by this time, it is May-July. By November, they return to swamp to breed.

As for the *A. evancifer*, they live in colonies in ground or trees. They run a castle system comprising workers, soldiers and the queen. The termites damage the tuber by entering and tunneling the tubers in the field. The tunnels are lined with dark faecal deposits of the termites and can predisposed the tuber to rot organism.

To date, the most effective control method is to apply any of the following insecticides: aldrin, Lindane or Methyl-pirimiphos. The first two are organo-chloride while the third is organo-phosphate. These organic compounds are neutrotoxicant and in humans and

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animals, seizures are often induced in addition to nausea, vomiting and headaches. Chronic toxicity includes carcinogenicity and tumor promotion (Hodgon *et al*., 1991). Carbofuran, on the other hand, is not persistent and as a result, it is rapidly metabolized and does not pass along the food chain. They are not toxic to vertebrates and other higher animals. As for wood ash, it is a natural material that is non-toxic to human and its effect is not usually beyond the site of application. It has the added advantage of adding potassium to the soil and also reducing the soil acidity.

This trial was conducted to evaluate the effectiveness of aldrin, carbofuran and wood ash in *A. evancifer* infested site in the control of *H. meles* with a view to finding a good replacement for organochloride or organophosphate compounds which has been banned in virtually all parts of the world.

MATERIALS AND METHODS

Site and experimental design: These trials were conducted in 2003 and 2004 at Obayanto village near Ugo in Orhiomwon Local Government Area of Edo State. The design for the trial was Randomized Complete Block Design based on four treatments and four replicates. The plot gross size was 11x6 m and the net plot was 10x5 m. The site used for the trial was termites infested area. Soil surveys were made in each site by sampling the top soil (0–30 cm) and routine soil analysis was made (Table 1) using standard laboratory procedure described by Mylavapus and Kennelley (2002).

Land preparation: The land was cleared of the existing vegetation and ridges constructed. The ridge was 10 long and 1 m apart.

Planting and crop maintenance: *D. rotundata* cv. Obiaoturugo (average 0.25 kg sett^{-1}) was planted and spaced at 1x1m to achieve a planting population of 10,000 stands ha^{-1}. At planting, 3 g of each of the following; aldrin, carbofuran and woodash, were sprinkled on the yam sett on different plots constituting a treatment and then covered with soil. There was no addition of any of these materials in the control plots. After planting, each stand was mulched with dry grasses/leaves to conserve soil moisture. The planting was done in March in both years. Staking was done a stake per stand. The plots were weeded at 4, 6, 11 and 17 Weeks After Planting (WAP). NPK 15:15:15 fertilizer was applied at 6 WAP using basal method.

The field was artificially infested of one yam beetle/plant. The yam beetle for the trial was artificially collected at night during the migration of beetles from the breeding sites to the yam field in May of both years in Koko, Delta State, Nigeria. Artificial infestation was carried out on the 25th of May in both years. During infestation, a stick was used to make a small hole in each of the base of the yam plant. The beetle was then placed and covered with the soil.

Table 1: Soil properties for 0-30 cm layer in the experiment field. Samples were collected and analysed in 2003

Soil characters	
pH (H_2O)	5.7
Exchangeable Ca	4.2%
Exchangeable Mg	1.7%
Exchangeable K	0.3%
Cation Exchangeable Capacity (CEC)	8%
Available P	11 ME gkg^{-1}
Total nitrogen	0.73 g kg^{-1}
Total organic matter	11.5 g kg^{-1}

Crop performance was assessed through morphological characters assessed include vine length, stem girth, internode length, % field establishment, number of nodes, leaves and vine/plant. All parameters were determined in-situ from two randomly sampled plant/plot.

Total dry matter was determined at 16 WAP, 24 WAP and at harvest. The method of determination was by destructive sampling as described by ISTA (1993). The growth attributes were the growth rate and relative growth rate.

The yam tubers were harvested at 33 WAP after the large scale drying up of leaves. After harvesting, the tubers were sorted into their respective plots. Data were collected on tuber yield per stand, tuber yield per hectare and relative yield. Relative Yield (RY) was computer as:

$$RY = \frac{\text{Weight of tubers with insecticidal material}}{\text{Weight of tuber without insecticidal material}}$$

Number of feeding holes on the tuber was used as damage index. At harvest, the numbers of holes in each tuber were counted and average computed.

Data analysis: Data were analysed with the SAS programme version 8.02. The Analysis Of Variance (ANOVA) of fresh tuber at harvest was performed using the GLM procedure. The means procedure was used to calculate the means of the four blocks of each treatment.

RESULTS

Early vine development: There were significant differences among treatments in the pattern of early vine development (Table 2). Carbofuran treated setts generally had 2 vines

Table 2: Evaluation of Carbofuran, aldrin dust and wood ash on early vine development

			Morphological characters				
Treatment	No. of vine stand^{-1}	% Stand	Stem girth (cm)	Internodes length(cm)	Vine length (m)	No. of nodes plant^{-1}	No. of leaves plant^{-1}
4 WAP							
Carbofuran	2.00^{a}	25.30^{ns}	2.00^{a}	10.00^{a}	0.97^{a}	12.30^{a}	4.90^{a}
Aldrin dust	1.00^{b}	20.40^{ns}	1.30b	5.40^{b}	0.52^{b}	9.30^{b}	2.70^{b}
Wood ash	1.30^{b}	22.30^{ns}	1.50^{ab}	6.80^{b}	0.84	9.70^{b}	4.10^{a}
Control	1.00^{b}	18.20^{ns}	1.20^{b}	4.50^{b}	0.52	6.30^{b}	2.00^{b}
8 WAP							
Carbofuran	3.00^{a}	40.20^{a}	2.50^{a}	12.60^{a}	2.09^{a}	31.30^{a}	25.60^{a}
Aldrin dust	1.00	34.30^{a}	1.70^{b}	6.40^{b}	1.04^{b}	10.70^{b}	6.30^{c}
Wood ash	1.70^{b}	38.40^{a}	2.00^{ab}	5.80^{b}	1.47^{ab}	17.70^{ab}	16.30^{b}
Control	1.00^{b}	23.60^{b}	1.50^{b}	5.70^{b}	1.04^{a}	7.70^{a}	4.60^{c}

Means followed by the same letter are not significantly different at 5% probability level (Comparison made only vertically)

Table 3: Effect of Carbofuran, Aldrin dust and wood ash on growth

	Growth						
	Total Dry Matter (DM)			Growth Rate (C)		Relative growth rate (E)	
	DM_1	DM_2	DM_3	C_1	C_2	E_1	E_2
Treatments	(t ha^{-1})			(tm^{-2} wk^{-1})		(tt^{-1} wk^{-1})	
Carbofuran	2.70^{a}	4.97^{a}	6.58^{a}	0.28	0.18	0.08	0.03
Aldrin dust	1.61^{b}	4.52^{a}	5.62^{c}	0.36	0.12	0.13	0.02
Wood ash	1.85^{ab}	4.83^{a}	6.31^{b}	0.38	0.16	0.12	0.03
Control	1.42^{b}	3.35^{b}	3.82	0.24	0.05	0.11	0.02

Means followed by common letters are not significantly different at 5% probability level (Comparison made only vertically)

Table 4: Effect of Carbofuran, aldrin dust and wood ash on yield components

Treatments	Yield stand^{-1}	Yield ha^{-1}	Relative yield
Carbofuran	1.97^{a}	19.7^{a}	1.37^{a}
Aldrin dust	1.45^{ab}	14.47^{bc}	1.01^{b}
Wood ash	1.62^{a}	16.20^{b}	1.13^{ab}
Control	1.43^{ab}	14.31^{c}	1

Means followed by common letter(s) are not significantly differently at 5% probability level (Comparison made only vertically)

Table 5: Effect of Carbofuran, aldrin dust and wood ash on the index of damage

	Means of holes on the tuber	
Treatments	2003	2004
Carbofuran	2^{c}	3^{c}
Aldrin dust	9^{ab}	14^{b}
Wood ash	4^{b}	6^{c}
Control	11^{a}	18^{a}

Means followed by common letters are not siqnificantly differently at 5% probability level (Comparison made only vertically)

per stand which tended to be longest among treatments and also having more leaves and longest internodes. At the same period, aldrin dust treated setts were comparable with control (Table 2) as they generally had one vine per stand as control.

The highest field establishment at 8 WAP was observed from carbofuran treated setts (40.2%) and lowest (23.6%) from control. Percentage plant establishment was significantly different from control but not among themselves. The vine length was highest in carbofuran treated stand (2.09 m) and lowest (1.04 m) in control as at 8 WAP. The mean number of leaves varied from 4.6 in control to 25.6 in carbofuran at 8 WAP (Table 2).

Growth: Total dry matter for all treatment increased until harvest (33 WAP) (Table 3). Dry matter was higher for carbofuran treated sett (6.58 tons) and out yielded alrdin dust (5.62 tons) and wood ash (6.31 tons). These differences were noticeable at first sampling and remained so throughout crop growth (Table 3).

Tuber yield and relative yield: The tuber yield varied mostly among treatments (Table 4). Tuber yield was highest with Carbofuran treated sett (19.67 t ha^{-1}) and the differences were quite significant ($p<0.05$). The Carbofuran treated setts also gave a significant larger yield stand^{-1} and more than 25% greater than in aldrin dust treated setts and more than that on control (Table 4) Relative yield varied from 1.00 untreated setts to 1.37 for Carbofuran treated setts. There were significant differences among treatments, however, the untreated control setts and the aldrin dust treated setts were not significantly different (Table 4).

Index of damage: During both years, a high significant difference ($p<0.05$) existed among treatments. In 2003, the means of beetle inflicted holes were 2, 9, 4 and 11 for Carbofuran, aldrin dust, wood ash and control, respectively (Table 5). There were significant differences

among treatments. The infestation was higher in 2004 as reflected in higher amount of holes observed on the tubers than the subsequent years.

DISCUSSION

The study revealed that total dry matter and fresh tuber yield were much higher in carbofuran treated setts. This was due to a higher number of leaves than in the other treatments and highest field establishment. The field establishment is a function of the level of infestation by termites (Onwueme, 1978). Termites tunnelled the setts and hindered the ability of the setts to sprout and they also predisposed the sett to secondary rot organisms to disintegrate the setts. This is the main reason for low field establishment in the untreated setts as most of the setts did not sprout due to high rate of infestation and rotness.

The ability of the plant to grow extensively both primary growth in terms of lengthening its length and ability to give out more leaves and secondary growth in terms of stem girth depends on the food reserve in the sett planted. The untreated sett had the lowest vine length, number of leaves and stem girth because the termites and beetles consumed most of their food reserve and little is left for the plant growth. The wood ash treated sett was next to carbofuran treated sett and aldrin dust was the least among the treated setts. In fact, their performance was highly comparable with the untreated setts. The reason for this is probably that the termites and beetles are not sensitive to aldrin dust anymore due to widespread usage. The number of leaves is a function of the dry matter accumulation. The higher the number of leaves, the higher the rate of photosynthesis and the more accumulation of dry materials.

The fewer the number of holes for carbofuran treated plants than the other treatments indicate low infestation. The tremendous increase in the number of holes in the untreated as compared with the treated yam setts is an indication of high infestation level. High infestation causes extensive tuber damage often results in total economic loss as it predisposes the tubers to rot organisms (Onwueme and Sinhad, 1991). The infestation level associated with wood ash was low as revealed through the fewer numbers of infested holes in both years. Wood ash mode of action against insect pests was by impacting resistant to the plant and thereby avoiding penetrating by beetles; it blocked spiracle thereby imparting respiration and it also reduces soil acidity and thereby making nutrients available to the plant roots for growth and development.

Based on this trial, carbofuran could be used with caution to treat yam sett before planting instead of aldrin dust which has proved to be ineffective against termites and beetles. The wood ash should be used instead when carbofuran is not available as it has proved to be equally effective against termites and beetles.

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