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Determination of Repellency and Toxicity of Neem leaf, municipal waste extracts and Termidust (carbofuran) on termites.

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Abstract
The repellency and toxicity activities of neem (Azardiracta indica) leaf extracts, municipal waste extracts and termidust (carbofuran) on termites (Macrotermes bellicosus) was investigated in 2015 at the teaching and research laboratory of the Department of Crop Science and Technology, Federal University of Technology, Owerri. The filter paper impregnation method was used and the treatments consisted six different concentrations (%w/v) of each of the three materials including Control (0, 5, 10, 15,20, and 25%). The experiment was laid out in Complete Randomized Design (CRD) with three replications. Results showed that A. indica leaf extract significantly (P< 0.05) recorded the highest termite repellency (58.8%) than municipal waste (46.9%) and carbofuran (36.7%), while no repellency was noticed in control. On the other hand highest termite mortality was produced with carbofuran solution (82.2%) especially at 20% concentration, followed by A. indica leaf (51.8%) and municipal waste (47.5%), however no termite mortality was observed in control experiment. Generally, the laboratory bioassay carried out revealed that A. indica leaf extracts exhibited highest level of repellency, while carbofuran achieved highest level of toxicity (mortality) on termites (M. bellicosus).

Key words*: Termites, repellency, mortality, toxicity and extracts.*

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I. Introduction

Termites are social insects belonging to the Order Isoptera. They are small (4-15mm long) and variable in color from white to tan and even black (UNEP/FAO, 2000). They occur between Latitude 45^{o}N and 45^{o}S where they are restricted by a combination of extreme aridity and lack of vegetation (Badejo, 2000). They are rarely found at altitudes above 3000m (Wood, 1988). As social insects, termites live in organized colonies comprising hundreds to millions of individuals inside a nest system which could be arboreal, epigeal or subterranean. A colony consists of several castes which are morphologically and functionally distinct. About 2,500 species of termites have been identified worldwide. Out of these, only about 300 species have been recorded as pests (Logan and Bakri, 1990). Nearly all of them have been implicated in soil modification which can be brought about by construction of subterranean galleries, changes in distribution of plant nutrients, changes in nature and distribution of organic matter, changes in soil texture and physical disturbance of soil profiles (Wood, 1988).Termite attack on field and tree crops, and on forestry especially in the semi and sub-humid tropics causes significant yield losses (Harris, 1971, Johnson, *et al.*, 1981).

Municipal waste, also called urban solid waste includes predominantly household wastes (domestic waste) with sometimes the addition of commercial waste collected by a municipality within a given area (Assembly,2005). They are in either solid or semi solid form and generally exclude industrial hazardous wastes. Municipal waste is often incorporated into the soil in advance. Amending soil with mature and stable composted materials such as municipal waste and yard trimmings have been investigated extensively and have been reported to increase root and tuber crops yield (Bryan and Lance, 1991).

According to Belloti *et al.* (1999), improvement of soil particularly by greater use of municipal waste may not necessarily reduce termite numbers, but may well reduce crop damage by providing an alternative source of food.

Neem (*Azadirachta indica* A Juss.) has attracted global attention due to its strong and inherently safer insecticidal properties, less persistence in the environment and thus less prone to the problem of pest resistance than the synthetic insecticides. Intensive search during the past decade has led to identification of neem as one of the most potent alternative to chemical pesticides and fertilizers The neem products are biodegradable, relatively less toxic and easily available (Srivastav, 2007). Among the major inputs of organic agriculture, plants

or botanicals serve as a source of natural manure and pesticide which play a major role in pest control. to identification of neem as one of the most potent alternative to chemical pesticides and fertilizers.

With the continued robust growth of the global bio-pesticides market, Azadirachtin is uniquely positioned to become a key pesticide. Further, *A. indica* has shown a great promise as a potential organic manure and has been in use since ancient time in India. The neem leaves and neem cake can be an important organic manure source now and in future (Ramarethinam, 2007)..

Effective control measures applied against termites rely principally on the use of organochlorine insecticides (Cyclodienes), such as aldrin, dieldrin, lindane etc. However, environmental contamination and health hazards associated with these forms of termicides has led to their condemnation in many parts of the world (Umeh, 2002). The dilemma of synthetic insecticides has made it essential that alternative sources of termites control that are not only safer, effective, economic and locally available but also acceptable to the public be found (Kolade, 2002). Because of these, there is need therefore to search for new and better environmentally friendly alternatives that could utilize locally available resources and techniques. Although, extensive research has been done on neem leaf and municipal waste on their bio-pesticidal activities in the recent time, but there has not been an in-depth study on determination of the efficacy of their extracts on repellency and toxicity on termites which forms the objective of this research.

II. Materials and Method

Samples of the neem leaves collected from Neem trees growing around the study area were air-dried in the laboratory under room temperature (27-30^{0}C) for a period of two weeks. The dried samples were ground and extracted in distilled water according to the concentrations needed (i.e. % w/v = grams ground leaves/ 100ml water) (Leatemia and Isman, 2004). Also, Municipal waste collected from the dumping site was air-dried, sieved and extracted in distilled water (Leatemia and Isman, 2004). The same method was used for termidust except that the carbofuran was made into solution and decanted.

The experiment was laid out in a Complete Randomized Design (CRD) with Three (3) replications, Six different concentrations of each of the three material extracts including control (0, 5, 10, 15, 20 and 25%) were prepared by weighing out equivalent weights in grams of the individual samples and dissolved in 100ml distilled water. Zero concentration (i.e water without sample extracts/solution) was used as control. The filter paper impregnation method was used to determine both repellency and toxicity in each of the sample extracts/solutions. The individual suspensions was stirred for one hour and then filtered using a Muslin cloth (Leatemia and Isman, 2004).

Six pieces of filter paper (8.0cm diameter) per sample were each divided with a marker into two equal halves and placed inside six different Petri dishes. One half of the filter papers was then impregnated with 0.5ml aliquots of a particular concentration of sample extracts (repellency), while on others, the aliquots were allowed to cover the whole diameter of the filter paper (toxicity). The control received only distilled water impregnation.

Ten adult termites collected from the study site were released in the middle of each filter paper circle with a plastic cover with small holes placed in the Petri-dish for determination of repellency. Equally, the same number of termites were released to each of another set of petri-dishes containing filter papers of different concentrations to achieve direct contact with the sample extracts. Control received only distilled water impregnation and live termites. Three replicates were set up for each of the concentrations and control per experiment. The experiments were allowed to stand for a period of 24 hours. Data were collected on termite repellency and mortality,

For the repellency test, termites that settled on each half of the filter paper disc were counted. Repellency was determined using the following formulae according to Talukdar and Howse (1995);

Percentage repellency (PR) = 2 (C- 50)

Where c is the percentage of insect on the untreated half of the disc and it is calculated as thus;

$$\text{Percentage insects} = \frac{\text{Number of insects on the untreated half of the disc}}{\text{Total number of insects released}} \times \frac{100}{1}$$

A Positive value would indicate repellency while a negative value would express attractancy.

For the toxicity test, mortality was determined by dividing number of dead termites by the total number of termites and multiplied by 100. Mathematically expressed;

$$\text{Percentage mortality} = \frac{\text{Number of dead insects}}{\text{Total number of insects released}} \times \frac{100}{1}$$

Statistical Analysis

All data collected were subjected to analysis of variance (ANOVA) using Mix- Model Procedure of Statistical Analysis Software System (SAS) (Little *et al.*, 1996). Means were separated using Least Significant Difference (LSD) at 5% level of probability.

III. Results

Termites repellency differed significantly ($P<0.05$) due to manure sources and manure concentration. Results indicate that *A. indica* leaves achieved highest level of termite repellency (58.8%) when compared with municipal waste and carbofuran (Table1). Also, while higher concentration achieved higher repellency, no repellency was recorded for the control. There was no significant effect due to treatment interaction between manure sources and concentration.

Table 1: Effect of *A. indica* leaves, municipal waste extracts and carbofuran on termite repellency.

Concentration (W/V %)	Municipal waste	*A. indica* leaves	Carbofuran	Mean
0.0	0.0	0.0	0.0	0.0
5.0	51.7	72.1	46.7	56.8
10.0	53.3	72.4	43.3	56.3
15.0	56.7	70.0	33.3	53.3
20.0	58.3	68.3	46.7	57.8
25.0	61.7	70.0	50.0	60.6
Mean	46.9	58.8	36.7	
$LSD_{(0.05)}$ Manure Source (M)		11.46 (P<0.05)		
$LSD_{(0.05)}$ Concentration (C)		6.72 (P<0.05)		
$LSD_{(0.05)}$ (M × C)		17.52 (NS)		

Table 2 indicates that significant ($P<0.05$) differences existed in termites mortality due to manure sources, concentration and treatment interaction effects. Results indicate that carbofuran produced highest termite mortality (82.2%) in comparison with municipal waste (47.50%) and *A. indica* leaves (51.80%). However, the greatest mean termite mortality (75.90%) was achieved at 20% concentration across all the treatments. Equally, no termite mortality was observed with control.

Table 2: Effect of *A. indica* (neem) leaves, municipal waste extracts and carbofuran on termite mortality.

Concentration (W/V %)	Municipal waste	*A. indica* leaves	Carbofuran	Mean
0.0	0.0	0.0	0.0	0.0
5.0	53.3	60.0	93.3	68.9
10.0	56.7	64.6	100.0	73.8
15.0	53.3	56.7	100.0	70.0
20.0	60.0	67.8	100.0	75.9
25.0	61.7	61.7	100.0	74.4
Mean	47.5	51.8	82.2	
$LSD_{(0.05)}$ Manure Source (M)		11.07 (P<0.05)		
$LSD_{(0.05)}$ Concentration (C)		6.20 (P<0.05)		
$LSD_{(0.05)}$ (M × C)		7.05 (P<0.05)		

IV. Discussion

The higher repellency exhibited by *A. indica* leaves extracts compared to municipal waste extract and carbofuran confirms the earlier work on the antifeedant, repellant and insecticidal properties of neem (Ivbijaro 1983, Sowunmi and Akinnusi 1983, Olaifa *et al*., 1987). The different parts of the neem plant have been reported to have a number of metabolites that are invaluable in crop protection. The leaves, fruits and seeds of the neem tree contain two triterpenoids, Azadirachtin and solamin that are antifeedants and repellants and also have growth modifying properties (Reed *et al*., 1982).

This study has proven that the neem plant has a great potential as an insecticide. It could be a desirable and easily accepted component of an integrated pest management programme on termites control at relatively low cost to the poor resource farmer and with minimum environmental disruption. Tamil *et al.* (1998), Widhotz

et al. (1983) and Schmutterer (1990) reported that one of the alternatives to usage of synthetic organic pesticides is to tap plant resources which have evolved astonishingly diverse array of pesticides. Also, municipal waste extracts showed appreciable level of repellency from the test. This is in line with Khashyap *et al*. (1984) and UNEP/FAO (2000) that wood ash (an important component of municipal waste) heaped around the base of the trunk of coffee bushes helped in preventing termites infestation as well as repelling termites from date palms. It is also possible that the presence of some identified heavy metals (copper, cadmium, lead, manganese etc.) in the municipal waste could have contributed substantially to its repellent ability against termites.

On the other hand, mortality (toxicity) test which indicates that carbofuran recorded highest termite mortality than municipal waste and *A. indica* leaves extracts showed that carbofuran possessed high contact effect and minor repellant activities to termites. It also further showed the high vulnerability of termites to the toxic effect of carbofuran when in contact with them. This confirms earlier work by Umeh (2002) who stated that control of termites by pouring a solution of insecticides such as aldrin or carbofuran into holes made in mounds or applying insecticide solutions to the soil before planting, is a method found effective against mound builders and subterranean termites. The applied insecticides form protective barrier around the roots of crops or trees.

V. Conclusion

The laboratory bioassay carried out revealed that *A. indica* leaves exhibited highest level of repellency, while carbofuran achieved highest level of toxicity (mortality) on termites. Also, appreciable level of repellency was shown by municipal waste.

The study therefore suggests that effective termite management in area inundated with termites as it is with this zone investigated, the use of neem leaf extract should be complemented with carbofuran so as to achieve both repellency and mortality. This approach may serve as an integrated pest management tool which can be recommended to farmers operating both in this agro-ecological zone and similar areas.

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