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# Laboratory Evaluation of Chlorpyrifos-Ethyl and Fipronil against *Ancistrotermes cavithorax* (Isoptera: Termitidae) in South Côte d'Ivoire

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***Abstract* – *Ancistrotermes cavithorax*, is an economically important species causing damage to wooden structures and agricultural crops in Côte d'Ivoire. Toxicities of two new chemical insecticides (Chlorpyrifos-ethyl and fipronil) were evaluated against this termite. The results showed that, Chlorpyrifos-ethyl was the highest toxicity than fipronil. The LT50 value of chlorpyrifos-ethyl at highest concentration (2000 ppm) was shorter (4±1.73 Mins.) than that of fipronil (97.3±1.32 Mins.). Chlorpyrifos-ethyl killed the termite workers faster than fipronil witch concentrations were slower than to kill the termites. The LD50 value of chlorpyrifos-ethyl was shorter (27.119) than that of fipronil (31.035). The study provides an opportunity to compare the toxicities of two new chemical insecticides and to use them effectively in the termite management programs.**

***Keywords* – *Ancistrotermes cavithorax*, Chlorpyrifos-Ethyl, Fipronil, Termites, Toxicity.**

## I. Introduction

Termites are social insects which belong to the order Isoptera containing approximately 2,900 described species [1]. They are one of the most abundant animals of tropical ecosystems with their biomass in Neotropical forests reaching more than 10 g fresh weight/m² [2]. Termites possess a great ability to digest cellulose that allows them to redirect a considerable proportion of the energy flow [3]. By reason of their feeding habits and preferences for relatively undecayed living and dead plant material, about 10% of described species of termites have been reported as pests [4]. The damage caused can be to cultivated plants, buildings, pastures and forests, and in addition even to noncellulosic materials such as electric cables ([5], [6], [7], [8]). Around US$ 22 billion are spent annually for termite control and repairing the damages [9]. *Macrotermes bellicosus, Ancistrotermes cavithorax* and *Microtermes* sp. belonging to Termitidae, were recorded as pests of agricultural in Côte d'Ivoire ([10], [11]). Overs the past 50 years, synthetic insecticides from chemical groups have been used to control termites. Presently, new generation of termicides which contain imidacloprid, fipronil, chlorpyrifos, dursban are recommended as soil applied or by direct injection in the colony and posed lethal effect to subterranean termite ([12], [13], [14]).

The objective of this present study is to evaluate laboratory efficacy of two commonly termiticides, fipronil and chlorpyrifos 480 SC in controlling *Ancistrotermes cavithorax* in soils from Abidjan in Côte d'Ivoire.

## II. Materials and Methods

### A. Termites samples

Subterranean termites were collected from the agricultural fields near the University Félix Houphouët Boigny of Abidjan (5°25'0" N, 4°1'60" W), in Côte d'Ivoire. Workers and soldier of *Ancistrotermes cavithorax* have been chosen because damaging cultures and have always meet in the study area. They were collected from the selected area and separated according worker and soldier and placed in the plastic boxes. Termites were transferred to laboratory and maintained in growth chamber 28±2oC, 80±5% relative humidity in dark conditions to further use. Distilled water was sprayed on insides wall of the container to keep the relative humidity above 80%.

### B. Insecticides

The insecticides tested were fipronil and chlorpyrifos-ethyl. The formulations and active ingredient percentage of insecticides are given in Table 1.

Table 1: Different formulations of insecticides, chemical group and their concentrations used

| Trade name | Entry name | Formulation | Chimical group | Concentration (ppm) |
|---|---|---|---|---|
| Regent® | fipronil | EC 5% | phenylpyrazole | 31.5, 62.5, 125, 250, 500, 1000, 2000 |
| Pyriforce | Chlorpyrifos- etyl | EC 48% | Organophosphate | 31.5, 62.5, 125, 250, 500, 1000, 2000 |

### C. Soil sampling

Soil samples were collected from the botanical garden of university Félix Houphouët Boigny of Abidjan. The soil was sifted through a 30-mesh screen and moisture was

International Journal of Agriculture Innovations and Research
Volume 3, Issue 2, ISSN (Online) 2319-1473

determined with the help of Oven Wet and dry method. More amount of water was added up to 50% of water holding capacity of soil to avoid mortality of termites due to dehydration.

*D. Bioassay*

Two types of bioassay were carried out:

- *Mixing insecticide in soil*

Toxicity tests were done in Petri dishes (70 mm diameter, 20 mm height), containing 10g sifted soil, strips of wood having dimension 1.5 x 6 cm were placed in each Petri plate to keep the termites alive. Experimental units were oven dried for 24 h for solvent evaporation. Control units were treated with acetone only. 40 workers of termites were released in the Petri dishes having treated and untreated soils. These dishes were placed under controlled conditions 28±20C and 80±5% relative humidity in a growth chamber. Termites were examined after every 2 hours up to 12 hours, later, and then after each 24 hours until 100% mortality occurred.

- *Direct exposure test:*

Filter papers were deepened in the different concentrations of the insecticides and allowed to dry for three hours. After drying, they were placed in petri dishes (70 mm diameter, 20 mm height), and left in an incubator at 28±2$^{o}$C in the dark conditions. The mortality of termite's, exposed directly to fipronil and chlorpyrifos-etyl, were recorded after 24 hours of exposure. The experiments were carried out in ten replications per treatments using 100 workers and 10 soldiers per a dish. Termites were examined after every 4 hours up to 24 hours, later, and then during 4 days. Mortality data were submitted to Probit analyses.

*E. Statistical Analysis*

The mortality data were corrected using Abbott's formula [15], if the mortality in the control was more than 5% (P< 0,005) among means in percentage survival Data were analyzed by probit analysis using XLStats 2014 to determine the LD50 and LD95.

## III. Results

Fig.1 shows the LT50 values of differents concentration of chlorpyrifos-ethyl and fipronil on *Ancistrotermes cavithorax* in soil. For *Ancistrotermes cavithorax*, our findings demonstrated that LT50 value of chlorpyrifos-ethyl at highest concentration (2000 ppm) was shorter (4±1.73 Mins.) than that of fipronil (97.3±1.32 Mins.)(Fig. 1a). These values increased with decline in concentrations. Direct exposure of different concentrations of chlorpyrifos-ethyl and fipronil to the termite (Fig. 1b) did not show difference in LT50 values recorded in case of when these were applied in the soils. The value of LD50 (27.119 ppm) and LD95 (34.173ppm) of chlorpyrifos-ethyl were lower than those of fipronil with respectively 31.035 ppm (LD50) and 665.448 ppm (LD95). Termite mortality occurred among the termites which were directly exposed to the termiticides as compared to unexposed termites (control) (Table 2). The results showed that chlorpyrifos-ethyl killed the termite faster than fipronil. At 250 to 500 ppm, chlorpyrifos-ethyl caused high mortality on termite at 24 hours for both concentrations where the mortality was 100%. In comparison to chlorpyrifos-ethyl at 250 and 500 ppm, the mean mortality at 24 hours was 84.33±1.373 and 92.33±1.37 respectively for fipronil. It was observed that chlorpyrifos-ethyl concentration of 125 ppm, achieved 100% mortality at 24 hours, while for fipronil, the 100% mortality was observed on 96 hours. Thus, fipronil concentrations were slower than to kill the termites.

The values of LD50 (27.119 ppm) and LD95 (34.173ppm) of chlorpyrifos-ethyl were lower than those of fipronil with respectively 31.035 ppm (LD50) and 665.448 ppm (LD95) (Table 3). Note that LD50 is the lethal dose required to kill 50% of termites in 24 hour

## IV. Discussion

The subterranean termite, *Ancistrotermes cavithorax* is an important insect pest causing a tremendous amount of damage to different natural resources and structures in Côte d'Ivoire ([10], [11]). The complex behavioral patterns of social insects such as termites in conjunction with the cryptic nature of their foraging make them challenging to manage with conventional insecticides [23]. In the current research, we investigated the mortality of workers *Ancistrotermes cavithorax* after exposure to too insecticides in order to compare the toxicity effect of the tested insecticides.

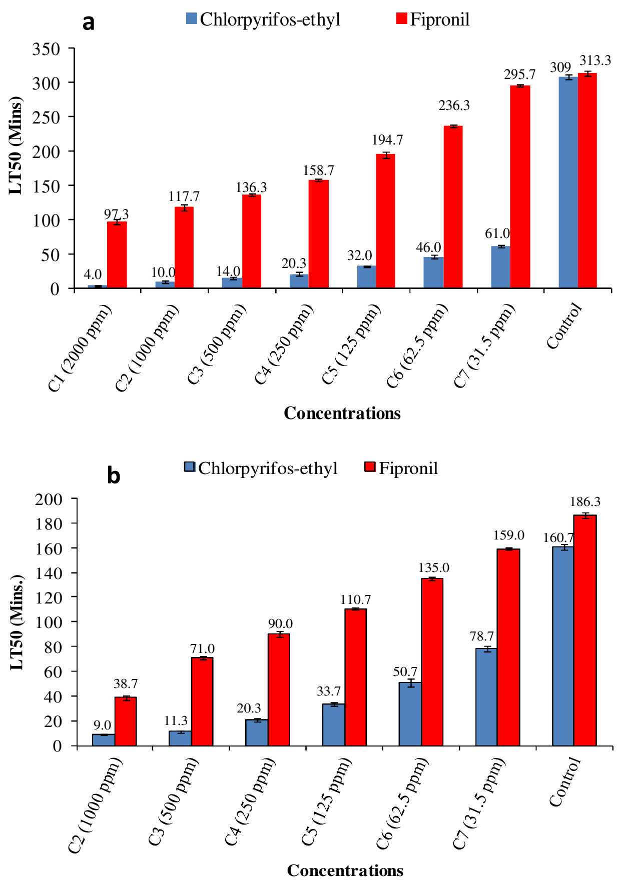


Fig.1. $LT_{50}$ values of differents concentration of chlorpyrifos-ethyl and fipronil on *Ancistrotermes cavithorax* in soil (a) and by direct exposure (b)

International Journal of Agriculture Innovations and Research
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Comparing the LT50 value of different insecticides used in this research indicated that LT50 value of chlorpyrifos-ethyl was shorter than that of the fipronil, suggesting that the termiticidal efficacy of chlorpyrifos-ethyl against *Ancistrotermes cavithorax* was the highest. This result is in agreement with the findings of other studies, who reported that the chlorpyrifos 40 EC gave the best results in controlling the population of subterranean termites in sugarcane.

Table 2: Mortality (%) of *Ancistrotermes cavithorax* workers against insecticide within 96 hours

| Insecticide | Concentrations | 0h | 4h | 8h | 12h | 16h | 20h | 24h | 48h | 72h | 96h |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Chlorpyrifos-ethyl | **2000 ppm** | 0 | 69.33±4.73 | 78.00±2.37 | 90.33±2.25 | 100.00±00 | - | - | - | - | - |
| | **1000 ppm** | 0 | 58.67±2.25 | 69.33±3.39 | 88.33±1.86 | 95.00±1.79 | 97.67±1.37 | 100.00±0 | - | - | - |
| | **500 ppm** | 0 | 35.67±2.25 | 56.33±1.37 | 84.33±3.61 | 90.33±0.52 | 96.33±0.52 | 100.00±0 | - | - | - |
| | **250 ppm** | 0 | 25.00±1.79 | 38.33±4.50 | 81.00±0.89 | 89.00±0.89 | 94.67±1.86 | 100.00±0 | - | - | - |
| | **125 ppm** | 0 | 20.33±2.25 | 41.00±2.68 | 67.33±1.37 | 82.67±4.03 | 95.33±1.86 | 100.00±0 | - | - | - |
| | **62,5 ppm** | 0 | 17.67±2.25 | 28.33±1.86 | 59.00±3.22 | 71.00±4.47 | 88.33±2.73 | 100.00±0 | - | - | - |
| | **31,25 ppm** | 0 | 10.00±0.89 | 35.00±1.79 | 48.67±1.37 | 60.33±2.25 | 74.33±1.86 | 85.67±1.86 | 95.00±0.89 | 98.67±1.37 | 100±0 |
| | **Contol** | 0 | 0 | 0 | 3.00±0.89 | 10.00±0.89 | 14.67±1.86 | 18.33±1.37 | 20.33±2.25 | 27.62±1.86 | 38±2.47 |
| Fipronil | **2000 ppm** | 0 | 81.67±3.61 | 83.33±3.61 | 94.33±1.86 | 99.00±0.89 | 100±00 | - | - | - | - |
| | **1000 ppm** | 0 | 66.67±1.37 | 76.00±1.79 | 85.00±2.37 | 91.33±1.37 | 94.33±1.37 | 98.33±0.52 | 100±0 | - | - |
| | **500 ppm** | 0 | 59.33±3.14 | 67.67±2.25 | 73.33±1.86 | 78.00±1.79 | 85.00±0.89 | 92.33±1.37 | 99.00±0.89 | 100±0 | - |
| | **250 ppm** | 0 | 42.00±6.68 | 52.33±1.86 | 64.67±1.86 | 69.67±2.25 | 79.00±0.89 | 84.33±1.37 | 92.67±0.52 | 100±0 | - |
| | **125 ppm** | 0 | 31.67±1.86 | 44.67±1.03 | 54.33±1.03 | 65.33±1.37 | 71.67±1.86 | 74.67±2.73 | 79.67±1.37 | 89.67±1.37 | 100±00 |
| | **62.5 ppm** | 0 | 28.00±0.89 | 37.33±1.37 | 44.33±1.37 | 52.00±1.55 | 60.00±2.37 | 64.67±0.52 | 67.67±1.86 | 74.67±1.86 | 87±2.33 |
| | **31.25 ppm** | 0 | 20.33±2.25 | 29.00±0.89 | 35.33±2.25 | 46.67±0.52 | 50.33±2.25 | 53.67±1.86 | 59.33±2.25 | 65.00±0.89 | 72±1.89 |
| | **Control** | 0 | 0 | 1.33±0.53 | 7.67±1.37 | 14.67±1.86 | 16.33±1.37 | 18.67±1.03 | 24.67±1.37 | 32.00±1.79 | 36±1.61 |

Table 3: LD50 and LD95 (ppm) values of chlorpyrifos-ethyl and fipronil estimated by Probit analisis

| Insecticide | LD50 (ppm) | LD95 (ppm) |
|---|---|---|
| chlorpyrifos-ethyl | 27.119 (20.361-29.402) | 34.173 (26.85-42.20) |
| fipronil | 31.035 (24.844-37.373) | 665.448 (534.426-869.293) |

The action of chlorpyrifos-ethyl on insects in general has been described. This insecticide is a neurotoxin that acts on the nervous system of the insect by inhibiting acethylcholinesterases action ([17]-[18]). Broad-spectrum insecticide, chlorpyrifos-ethyl acts by contact, ingestion and inhalation of soil insects. Chlorpyrifos-ethyl is an organophosphate that has a shorter residual life in soils than other insecticide, lasting for approximately five years in the soil at levels which can kill or repel termites [19]. The action of this insecticide is rapid against termite. This rapid action is correlated with a low LD50 (27.119 ppm). Our results were similar to the result of other studies which described that Chlorpyrifos killed termites quickly [20]. Fipronil was also toxic for the termites in this research and the efficacy of this insecticide increased with decline in concentrations. Many studies showed that fipronil is toxic to insects because they kill insects through hyper-excitation of the central nervous system ([21], [22]). Fipronil treatment was not affecting termites as quickly as chlorpyrifos ethyl. Several authors also proved the relatively slow speed of fipronil against soldiers [23]. However these authors show that, even though fipronil is slow acting termiticide but it acts faster on workers as compared to soldiers. Concerning the persistence of this insecticide, it has been shown showed that the half-life of fipronil in treated soils exceeds 18 months [24].

## V. Conclusion

According to the results from this study carried out to find the most effective insecticides against *Ancistrotermes cavithorax*, it would be concluded that chlorpyrifos-ethyl killed the termite faster than fipronil. Chlorpyrifos-ethyl was effective insecticide for a temporary period of treatment. However, fipronil can be more effective on termites for a long time of treatment. Further studies are required to investigate the termiticidal potential of the other insecticides registered in Côte d'Ivoire against dominant species of termites in the field and laboratory conditions.

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