Repellency and Toxicity of Calneem$_{TM}$ Oil to *Tribolium castaneum* (Herbst) (Coleoptera: Tenebrionidae) in Stored Products

Adarkwah Charles, [1,3] Obeng-Ofori, D.,[2] Büttner, C.,[1] Reichmuth, Ch[3]., Shopna Morden[4]

[1]Humboldt University Berlin, Faculty of Agriculture and Horticulture, Institute of Horticultural Sciences, Department of Phytomedicine,
[2]Department of Crop Science, School of Agriculture, College of Agriculture and Consumer Sciences, University of Ghana, Legon, Accra,
[3]Federal Research Centre for Cultivated Plants, Institute for Ecological Chemistry, Plant Analysis and Stored Product Protection, Berlin
[4]Caldor Trading Ltd, Shenley Hill, Rad

Contact Address: Adarkwah Charles: adarkwac@cms.hu-berlin.de/lesadark@yahoo.com

INTRODUCTION

The use of pesticides to control stored-product pests is posing serious environmental and health problems if not carried out properly. Native to India and Burma, the neem tree *Azadirachata indica* A. Juss is a member of the mahogany family Meliaceae. It was introduced to Africa in the previous century and is now well established in at least 30 countries, including Ghana where it has become an important source of fuel, lumber and bioinsecticide. Calneem is a biopesticide produced and marketed in Ghana by AQUA AGRIC Community Projects (AACP). It is an in-house prepared, cold pressed, double filtered, pure and natural oil derived from high quality neem seeds. Calneem contains about 0.3% azadirachtin as its major active ingredient. It is a broad-spectrum insecticide which is effective against several pests of vegetables, food crops, fruit and other tree crops, fruit and other tree crops, and durable stored products.

GOAL

Determination of toxicity and protectant potential of Calneem oil against *Tribolium castaneum* in the laboratory using contact toxicity, grain treatment and repellency assays

MATERIAL AND METHODS

Calneem$_{TM}$ oil — ***Tribolium castaneum* - Red Flour Beetle**

Calneem oil was applied as contents in which the oil was dissolved in water using soap as emulsifier. It was applied at six contents (0.1%, 0.2% 0.5%, 1.0%, 2.0% and 3.0%). Pirimiphos-methyl (0.16%) concentrate, a commonly used synthetic insecticide against stored product insect pests, was used as reference insecticide. Calneem oil was applied to *T. castaneum* adults by exposing them on impregnated Whatman filter paper (0.58 g and 90 mm diameter) or on treated whole grains. The treatments were replicated five times. Insect mortality was recorded after 24 h, 48 h and 72 h, respectively. The insects were presumed dead if they failed to respond to three probings with a blunt dissecting probe after five minutes recovery period. Mixtures with different contents of the neem product were applied individually topically to the dorsal abdomen using a micro-pipette applicator. Treated insects were transferred to Petri dishes containing maize as food. Mortality of the insects was recorded after 24h, 48h and 72 h, respectively. The area preference test described by McDonald et al. (1970) was used in evaluating the repellent action of Calneem oil against *T. castaneum.* In this experiment, the filter papers were cut into two equal half discs. Half of the discs were treated with the different dosages of the Calneem solutions. The entire surfaces of the half discs were covered entirely with Calneem oil solutions by the aid of a pipette. Water was used to cover the other half as control. Both halves were air dried for about 5 minutes after which the treated and untreated halves were remade together by attaching them with sellotape. The joined filter papers were placed in separate Petri dishes and 20 adult beetles were released separately at the centre of each filter paper disc. The Petri dishes were covered again. Each treatment was replicated five times. The numbers of insects present on the control (N_c) and the number on the treated area (N_t) were recorded and computed as follows to get Percent Repellence (PR). **Percent Repellency (PR) = $\{(N_c - N_t)/(N_c + N_t)\} \times 100$, where : N_c = number of insects on the control disc, N_t = number of insects on the treated disc.** In the toxicity and persistence experiment, 100 g of wheat grains were mixed with different doses of Calneem oil in sterilized glass jars and subjected to a mechanical roller to ensure uniform distribution of the oil on the grain surface. Beetles were released into separate jars and mortality was recorded after 24h. Calneem oil was also tested against the immature stages of *T. castaneum* (eggs, larvae and pupae). In another experiment, 100g of cracked wheat was mixed with solutions with different contents of Calneem oil as described above and stored for 1, 10, 20 and 30 and 60 days, respectively. Twenty adult beetles were introduced into the wheat samples at the appropriate days. Mortality counts were carried out after 24h exposure to assess the persistence and longevity of the oil.

Results: Efficacy of Calneem$_{TM}$ Oil

Calneem oil was more effective on grain and on filter paper discs: the lowest dosage of 0.1% killed more than 50% of the beetles within 24h [Figure 3]. The effectiveness of Calneem oil was significantly reduced by the length of storage after application. Calneem oil was also highly repellent to *T. castaneum* tested with overall repellency in the range of 80-100% [Figure 1]. The development of eggs and immature stages inside cracked wheat was completely inhibited by Calneem oil treatment [Figure 4]. High contents of Calneem oil on filter paper were required to achieve 100% kill; Calneem oil concentrates completely inhibited the development of eggs, larvae and pupae hidden inside the wheat kernels.

RESULTS AND DISCUSSION

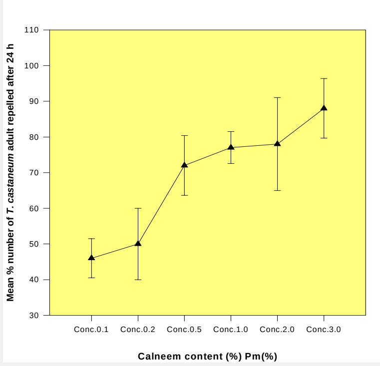

Figure 1:. Mean percentage repellency (PR) for different contents of Calneem oil on filter paper against *T. castaneum* adults aged 7-14 days in the choice arena. Mean of replicates of 20 insects each was significantly different, column means (P = <0.001, Student-Newman-Keuls Test).

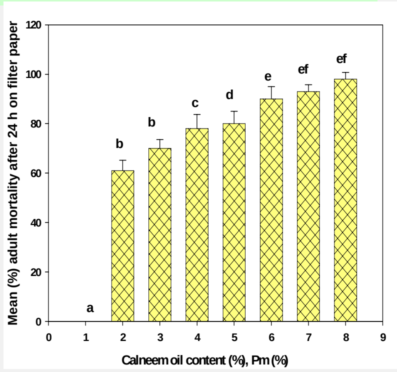

Figure 3: Toxicity of *T. castaneum* after exposure to different contents of Calneem oil on impregnated filter paper discs, means of five replicates of 20 insects each, column means followed by different letter(s) are statistically significantly different at 0.05 level SNK.

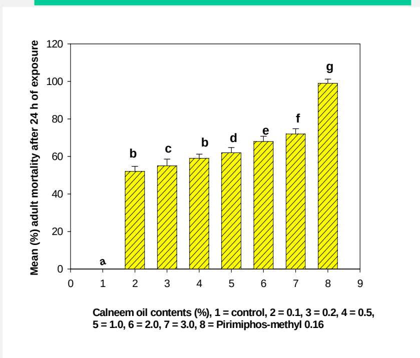

Figure 2: Mortality of *T. castaneum* in Calneem treated grain after 24h, mean of 5 replicates of 20 insects each. Column means followed by different letter(s) are statistically significantly different at 0.05 level following the SNK test. All treatments caused significantly (P=<0.001) higher mortality than found in the untreated samples.

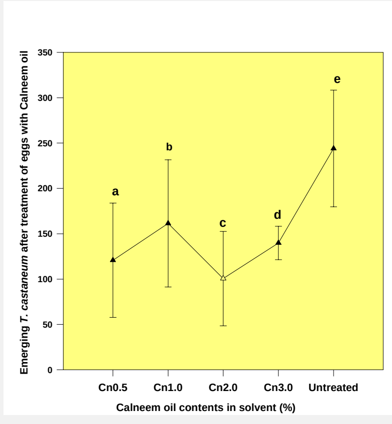

Figure 4: Emerging *T. castaneum* adults after treatment of early eggs in crushed grain with different mixtures of Calneem oil in solvent, means of five replicates of 20 insects each, emergence recorded after 6 weeks, column means followed by different letter(s) are statistically significantly different at 0.05 level following a SNK test.

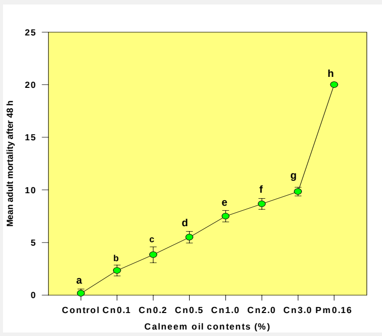

Figure 5: Toxicity of Calneem oil applied topically to the beetles, means of five replicates of 20 insects each, column means followed by different letter (s) are statistically significantly different at 0.05 level (Ducan's multiple range test).

CONCLUSION

All tested contents reppelled *T. castaneum* in a dose-dependent manner. This repellent action increases the potential practical value of Calneem oil for grain protection against insect pest attack.
The use of plant materials in pest control could become an important supplement or alternative to the use of imported synthetic pesticides. Therefore, it is important that appropriate technology is developed to promote a direct preparation of neem extracts at the farm level for those resource-poor farmers who have no access to commercial pesticides or cannot afford them.

Acknowledgement: The Schweisfurth Foundation supported this research.

Federal Research Centre for Cultivated Plants

Institute for Ecological Chemistry, Plant Analysis and Stored Product Protection

Formerly: