

Response of Potential Stored Grain Insect Pests to BFL 225 Multi-Attractant Lure in Commercial Warehouses.

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Abstract
Farmers generally store their harvested products to ensure a continuous food supply for their household, provide seed for subsequent crops and farm, and as a source of income because it allows farmers to sell the products for cash or to exchange it for other products. But the introduction of new crop varieties, satisfying primarily an increased yield, has led to a contemporary selection of plants susceptible to infestation by insects, due to a loss of resistance to insect attack. Studies were conducted to determine the efficacy of traps baited with the kairomone BFL 225 multi-attractant lure for the detection and monitoring of storage insect pests into commercial warehouses in southern Nigeria for ten months. This trapping experiment demonstrated that floor traps baited with BFL 225 lure significantly (P< 0.001) captured insects compared to the unbaited (control). The predominant insects captured include *Sitophilus spp.*, *Plodia interpunctella*, *Tribolium castaneum*, *Callosobruchus maculatus*, *Alphitobius laevigatus* and *Rhyzopertha dominica.* The implication of his study is that BFL 225 could be utilized as a part of integrated pest management strategies for early detection of potential insect pests migrating into stored grain warehouses in tropical Africa.
Keywords: Baited traps, storage pests, kairomone, monitoring, warehouses.

1. Introduction

The economic damage of stored products pest infestation relates to the physical loss of commodity by direct consumption by insects, spoilage and loss of quality of the product, and the encouragement of mould growth (Ukeh and Mordue 2009). Contamination of commodities with insect bodies and waste products some of which are toxic, repulsive or allergenic are also other major effects of stored product pests (Okiwelu *et al.* 1987; Arlian 2002), as well as the cost of labour in growing, handling, manufacturing and storing commodities which are destroyed by insect infestation, rejection by consumers of infested commodities and the resultant social and legal costs (Rees 2004).

The foundation of most successful agricultural production systems is an effective pest monitoring programme that provides information on the type of pests infesting an agricultural enterprise detects changes in pest population over time, locates foci of infestation and emigration routes (Chambers 1990). Searching for a host plant for feeding or oviposition is a key process in the life of an herbivorous insect. To find a host an insect must move, encounter cues from the host, and then respond to the cues appropriately (Campbell and Burden 2006; Malo *et al.* 2011; Ukeh *et al.* 2012). Monitoring stored product insect pests is a part of integrated pest management that suppresses pest population at a minimal cost and reduced risk to non-target species. Pest monitoring is therefore one of the cornerstones of an effective Integrated Pest Management (IPM). Pest monitoring can be carried out as part of the routine sanitation in a food from pest control, receiving production, packaging and shipping. Monitoring can involve active inspection or sampling for pest or utilize monitoring tools such as traps to detect and assess insect pest population (Arthur and Philips 2002; Semeao *et al*. 2012).

The use of pheromones is one of the most promising techniques aimed at the control of stored product insects. Tolerance levels as set out in Food and Drug Administration (FDA) of the US regulations for these cryptic species are usually zero for processed food products. Stored products therefore present a unique pheromone trapping situation in contrast to the higher insect tolerances that are allowed in the forest and field crops. Pheromone traps in storage insect management can be used to detect both the presence and density of pests. They are useful in defining areas of pest infestation, particularly where the overall distribution and life cycle are poorly understood. Their purpose is to achieve a more accurate control to limit insecticide use (Trematerra 2007; Ukeh *et al*. 2008). Pheromone traps are generally effective when pest numbers are very low and they can be used qualitatively to provide an early warning of pest incidence.

The objectives of the study were to determine the period of emigration of insect species associated with stored grains and their relative abundance in Calabar, Southern Nigeria, as well as the effectiveness of BFL 225 multi-attractant lure in baited traps in the monitoring of stored product insects.

2. Materials and Method

2.1 Experimental Procedure

An experiment was conducted to trap and monitor the emigration of stored grain insect pests into commercial warehouses in Calabar Municipality of Cross River State, in Southern Nigeria. Four stores were selected in 'Watt market' Calabar for the study. In each of the four grain storage houses 4 floor traps made of cardboard paper with sticky bases were placed in the 4 cardinal locations in the stores at room temperature. Floor traps with sticky bases and the synthetic multi-attractant pheromone (BFL 225) were obtained from AgriScence BCS Ltd, UK. The pheromone dispensers consists of non-hazardous plant extract component impregnated into a flat profile cellulose matrix controlled medium. The traps included two baited traps with BFL 225 lure, and two unbaited (control) but lined with sticky base. All traps were inspected weekly for catches of insects, and the sticky bases replaced weekly. The BFL 225 lure was replaced after every 4 weeks, while the experiment was terminated after 10 months. Insects caught were identified following the procedures described in Rees (2004), counted and recorded.

Data on the number of insects caught in baited and unbaited traps were analysed using paired t-test using Minitab 16 statistical software package.

3. Results and Discussion

The results of the mean number of insects captured in BFL 225 multi-attractant lure in baited and unbaited traps over the 10 months study period are presented in Fig. 1. The result showed significant differences ($P< 0.001$) in the mean number of insects caught in baited traps, compared with the control (unbaited). The population of the emigrating insects to commercial warehouses increased gradually from June peaked in February of the next year and declined. The major insects caught were the weevils *Sitophilus spp.* (Coleoptera: Curculionidae), Indian meal moth, *Plodia interpunctella* (Lepidoptera: Pyralidae), red flour beetle, *Tribolium castaneum* (Coleoptera: Tenebrionidae), cowpea beetle, *Callosobruchus maculatus* (Coleoptera: Bruchidae), black fungus beetle, *Alphitobius laevigatus* (Coleoptera: Tenebrionidae) and the lesser grain borer, *Rhyzopertha dominica* (Coleoptera: Bostrichidae) (Table 1). Generally, there were significant differences ($P<0.001$) in the number of insects caught in baited and unbaited traps (Table 1).The insects *Sitophilus* species and *C. maculatus* were not caught in any trap in June 2012, but their population rose drastically and progressively from July, and peaked in February 2013, then declined. Bruchid beetles such as *C. maculatus* are one of the most important storage pests of legumes and associated commodities and whose damage results to weight loss and reduction in market value of the affected product (Ofuya *et al*. 2010). *P. interpunctella* was captured in June 2012 but the insect's monthly population declined gradually till December, none was captured in January and February of the following year, but re-appeared in March. *T. castaneum* and *R. dominica* were trapped by BFL 225 baited floor traps throughout the duration of the experiment indication that they are regular pests associated with stored products in the tropics (Ukeh and Umoetok, 2011). However, *A. laevigatus* was not captured in December, January and February which are the hottest and driest months in southern Nigeria, indicating that this insect may not tolerate very dry conditions. *Alphitobius* species have been described as scavengers, part-time predators and fungus feeders and in nature are associated with decaying organic material (Rees 2004).

Data from this study also showed that the number of catches toward the dry season was higher than that of the rainy season except for *A. laevigatus*. The number of insects caught decreased as the rain increased both in the baited and unbaited (control) traps. Similar findings have been reported elsewhere, for instance, Arthur and Philips (2002) reported that regular monitoring using several insect traps of different types at multiple locations throughout a facility can yield information regarding the presence of specific insect species. Relative changes in numbers and specie consumptions over time and the location of insects and their relative abundance at different locations. Light traps have also been deployed to monitor insects in storage facilities. Many insects including stored product insects will fly towards the light visible-to-ultraviolet range of the electromagnetic spectrum, thus most light traps are relatively non-specific and are useful for any flying insects that may be sensitive to the wave lengths emitted from a particular trap design (Arthur and Philips 2002).

Pheromone trap captured data in individual traps can be variable for many reasons beyond differences in temperature and insect population density. Warehouses and food stores are often temporally and spatially fragmented landscapes therefore; some traps could be positioned closer to food than others. Campbell and Hagstrum (2002) studied *T. castaneum* adult movement in small arenas and showed that individuals outside of flour patches were much more likely obscure near the edges of the area than out in the open.

It should be noted that these pheromones (BFL 225) and sticky base traps are available when needed. They require simple techniques to prepare and apply. Nevertheless, they are very safe to handle and leaves no residue on the crops (Ukeh *et al*. 2008). So far their main use has been restricted to monitoring pest populations, and there are a number of traps on sale which can hold lures for moths and beetles in grain stores and mills. On a large scale there have been some attempts at direct control of insect pests on growing crops, in forestry and animal husbandry using semiochemicals but as yet work with grain pests has been restricted to experimental studies (Cox 2004) . In field studies, Ryall *et al*. (2013) reported the efficacy of traps baited with kairomone (3Z)-hexenol and pheromone(3Z)-lactone lures for early detection of emerald ash borer *Agrilus planipennis*, an invasive wood-boring beetle species that is causing significant mortality to ash trees (*Fraxinus* spp.) in North America. In Kenya, traps baited with 4S, 5R-sitophilure and cracked wheat gave higher catches of *S. zeamais* and *S. oryzea* than those baited with pheromones or cracked wheat alone (Likhayo and Hodges 2000).

4. Conclusion

The use of pheromones is one of the most promising techniques aimed at the control of insect pests. Pheromone traps in stored insect management can be used to detect both the presence and density of pests. The use of pheromone-baited traps to monitor insect populations offers several advantages over inspections and fumigation with synthetic insecticides. The most promising technique that has been developed and continues to be refined is monitoring populations with insect pheromones and/or food attractants. Many of the known insect pheromones operate as long-term attractants by luring one or more adult individuals to the pheromone-producing individuals. The main practical applications of insect pheromones in pest management include; survey and monitoring with pheromones as attractants for early-warning, quarantine work, timing of control measures, population trends, dispersion risk of assessment of the effects of control measures; mass trapping; mating disruption; and crop trapping. The use of pheromone traps to monitor pests is increasing in the food industry, but adoption has been hampered by lack of information on how to effectively implement and interpret pheromone-monitoring programs. The concept of IPM is based on the recognition that no single approach to pest control offers a universal solution and that the best crop protection can be provided by a fusion of various tactics and practices based on sound ecological principles.

In conclusion, this study has shown that traps baited with BFL 225 lure showed significant differences in catches of stored products insects namely; *Sitophilus* species, *A. laevigatus, C. maculatus, P. interpunctella, T. castaneum* and *R. dominica* than the control (unbaited) during the study period.

5. Acknowledgements

The authors wish to thank Professor A. Jennifer Mordue (Emeritus Professor of Zoology, University of Aberdeen, UK) for her support which enabled us to carry out this field trial. We are also very grateful to Owen Jones and Charles Phillips of AgriSense , UK for the supply of BFL 225 multi-attractant lure used in this field trial.

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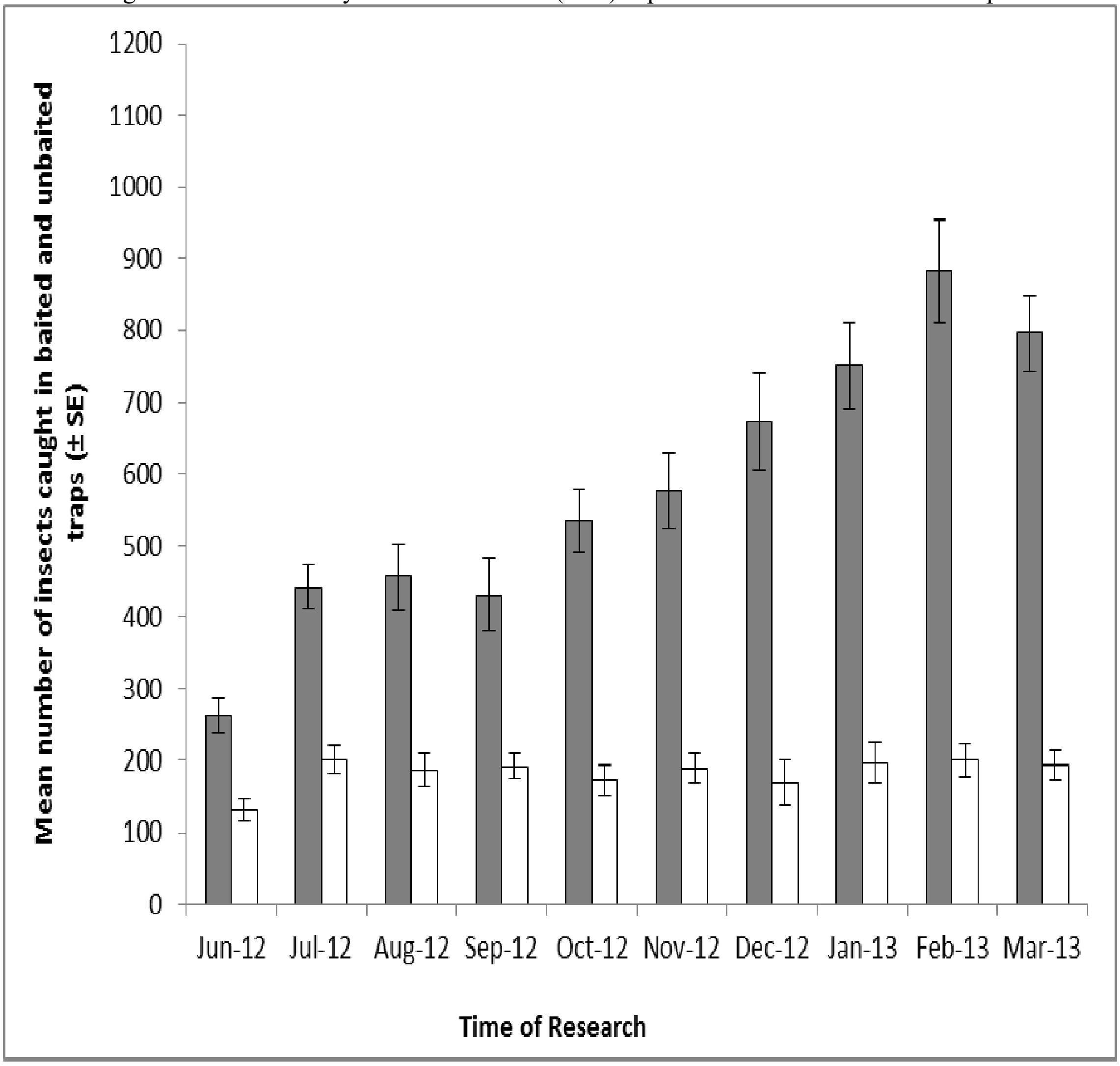
Figure 1. Mean monthly number of insects (±SE) captured in baited and unbaited traps.



= Baited Traps = Unbaited Traps

Table 1. Mean Monthly numbers (± SE) of the Major insect species trapped using BFL 225 Multi-attractant Lure Baited in Floor Traps in Calabar, Southern Nigeria.

Month	Trap Type	Insect species					
		Sitophilus spp.	*P. interpunctella*	*T. castaneum*	*A. laevigatus*	*C. maculatus*	*R. dominica*
Jun-12	Baited	0.0 ± 0.0a	180.0 ±12.0a	56.5 ±5.5a	37.0 ± 2.0a	0.0 ± 0.0a	9.0 ± 0.5a
	Unbaited	0.0 ± 0.0a	99.0 ± 14.0b	25.5 ± 2.5b	19.0 ± 3.0b	0.0 ± 0.0a	0.0 ± 0.0b
Jul-12	Baited	56.5 ± 1.5a	181.4 ±8.5a	80.5 ± 5.0a	43.5 ± 1.5a	60.6 ± 5.5a	18.0 ± 1.0a
	Unbaited	25.5 ± 2.5b	90.5 ± 3.5b	36.0 ± 2.5b	20.5 ± 2.0b	35.5 ± 2.5b	6.0 ± 0.5b
Aug-12	Baited	88.0 ± 2.0a	148.0 ± 4.0a	92.5 ± 2.5a	14.5 ± 2.5a	90.0 ± 7.0a	34.5 ± 2.0a
	Unbaited	33.5 ± 2.5b	67.5 ± 4.5b	41.0 ± 3.0b	14.0 ± 2.5a	4.5 ± 2.5b	11.0 ± 2.5b
Sep-12	Baited	90.0 ± 2.0a	85.0 ±13.0a	134.0 ± 6.0a	21.5 ± 1.5a	97.0 ± 2.5a	44. 5 ± 2.5a
	Unbaited	53.5 ± 2.5b	38.5 ± 4.5b	53.5 ± 1.5b	12.0 ± 1.5b	59.0 ± 3.0b	17.0 ± 3.0b
Oct-12	Baited	87.5 ± 2.5a	66.5 ± 4.0a	129.5 ± 4.5a	16.5 ± 2.5a	102.5 ± 7.5a	75.5 ± 4.0a
	Unbaited	41.0 ± 2.0b	27.0 ± 3.5b	46.0 ± 3.0b	6.0 ± 1.5b	55.5 ± 4.5b	13.0 ± 1.5b
Nov-12	Baited	105.0 ± 3.5a	38.0 ± 3.5a	158.0 ± 6.0a	5.5 ± 0.5a	117.0 ± 8.5a	61.5 ± 3.0a
	Unbaited	38.5 ± 4.0b	12.5 ± 3.0b	54.0 ± 3.5b	5.0 ± 0.5a	39.0 ± 5.5b	22.0 ± 2.5b
Dec-12	Baited	122.5 ± 4.5a	25.0 ± 3.0a	98.5 ± 6.5a	0.0 ± 0.0a	86. 5 ± 7.5a	71.5 ± 5.5a
	Unbaited	44.0 ± 3.0b	8.5 ± 2.0b	26.0 ± 5.5b	0.0 ± 0.0a	32.0 ± 4.0b	19.0 ± 3.0b
Jan-13	Baited	156.5 ± 6.5a	0.0 ± 0.0a	48.5 ± 3.5a	0.0 ± 0.0a	183.5 ± 7.5a	116.0 ± 9.5a
	Unbaited	57.5 ± 5.0b	0.0 ± 0.0a	8.0 ± 1.5b	0.0 ± 0.0a	57.0 ±6.5b	25.0 ± 4.5b
Feb-13	Baited	188.0 ± 12.0a	0.0 ± 0.0a	24.5 ± 4.5a	0.0 ± 0.0a	201.0 ± 13.5a	91.5 ± 6.5a
	Unbaited	63.0 ± 5.5b	0.0 ± 0.0a	5.5 ± 1.5b	0.0 ± 0.0a	76.5 ± 8.0b	23.0 ± 3.5b
Mar-13	Baited	112.0 ± 4.5a	24.5 ± 3.0a	63.5 ± 5.0a	10.5 ± 2.0a	122. 0 ± 10.5a	59.5 ± 6.0a
	Unbaited	31.5 ± 2.5b	5.5 ± 0.5b	11.0 ± 2.5b	4.0 ± 0.5b	71.0 ± 9.5b	26.0 ± 5.5b

Means followed by the same letter in the same column are not significantly different at P = 0.05 level.