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Evaluation of feeding deterrents of *Tephrosia Vogelii* Hook and *Calodendrum capense* Thunb dusts against *Prostephanus truncatus* Horn in grain storage

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Biossay experiments were conducted both in the laboratory and in storage to evaluate efficacy and repellent properties of two botanicals; *Tephrosia vogelii* Hook and *Calodendrum capense* Thunb dust at the rate of 0.11%, w/w and 0.22% w/w as feeding deterrents against shelled hybrid 5HB maize weevil, *Prostephanus truncatus* Horn. Their efficacies were compared with standard actellic super (2% dust 0.056% w/w). *T. vogelii, C. capense* and actellic super dust attained mean mortalities of 60%, 70% and 100% respectively on adults of *P. truncatus* over exposure period of 28 days .The lethal mean mortality exposure time (LT_{50}) varied from 8-14 days for the two botanicals. The two botanicals and actellic super effectively reduced the F1 progeny by more than 60%. The former products exhibited a higher repellency against *P. truncatus* at lower dosages (0.11%w/w) compared to actellic super dust. The three treatments offered effective protection of shelled maize grain for the first 90 days. However, significant (P=0.05) percent weight loss was observed there after, hence requiring a repeat application after the initial 3 months.

Key words. Mortality, *Calodendrum capense, Tephrosia vogelii* Hook, , *Prostephanus truncatus* efficacy, repellency and hybrid 5HB maize.

Introduction

Maize is the number one staple food grain for the entire sub- Saharan Africa. Over 100 million inhabitants of East Africa in the region depend on maize. This includes the livelihood of Kenya's entire population of 33 million. To sustain its population Africa holds her annual grain harvests in storage to ensure food security among others. Often stored grains are actually leftovers of already insect inflicted field losses, which in Kenya are as high as 20% (Wanjekeche, 1997).

Storage is an integral phase of post harvest farming systems. When there is lack of improved storage and absence of appropriate storage management technologies, grain growers sell their produce immediately after harvest because of fear of insect damage (Golob, 1998). Consequently, costly insecticides are used widely to control insects in storage. The most widely used insecticide is pirimiphos methyl. It is commonly called Actellic dust. This product singly forms a substantial part of the entire US $ 12 million pesticide import bill that Kenya spends on insecticides annually. All convectional insecticides have a myriad of undesirable side effects and need replacement with biodegradable products.

Grain storage in Kenya became aggravated in 1983 with the arrival of *Prostephanus truncatus* Horn (Ramos *et al.,* 1984).The pest is commonly called the Larger grain borer or appropriately described as a scania beetle due to the voracity with which it ravages infested grain. Since assuming epidemic levels, *P. truncatus* aroused the need to be controlled effectively throughout Kenya and Tanzania except for Uganda where the pest does not occur (Hodges *et al.,* 1985). In order to manage the larger grain borer botanical biocides have been proposed as the most eco-friendly products that can complement other acceptable methods of control (Hodges, 2002). Two plants, *Tephrosia vogelii* Hook and *Calodendrum capense* Thunb have been identified as the most readily available sources of providing appropriate replacements to the long residual synthetic insecticides. Dusts and other derivatives from the two plants appear most amenable since they can be integrated with pheromones Trunc 1 and 2 (Williams *et al.,* 1981).

The aim of study was to determine efficacy *T. vogelii* and *C. capense* against *P. truncatus* infestation of grains in storage.

Materials and Methods

Evaluation of pesticides in the laboratory and grain store

Experiments were conducted simultaneously in two separate sets: One set was conducted in the laboratory and another in the grain storehouse of the KARI- Kiboko subcentre Makueni District, Kenya where the *P truncatus* is endemic. The centre lies between latitude 1^0 35' south and longitude 37 ^{0} 30' East, about 200 km South East of Nairobi.

The stock *P. truncatus* adults were obtained from stock culture at Kiboko – Subcentre, reared on clean maize 5HB (*Zea mays*) under controlled conditions (constant temperature and humidity (CTH) room temperature at 27+-5^{o}C, 60+-5% r.h, 12:12 light:dark). Unsexed 7-21 days old insects were used in all trials.

The test plant materials used for insect mortality, repellency and weight loss bioassay were obtained from fresh leaves of *T. vogelii* Hook and seeds of *C. capense* Thunb collected from KARI - Kitale and Eldoret Municipality, Kenya, respectively. All fresh samples were selected and dried under ambient temperatures of 23- 27^{o}C for a week before grinding using a blender to obtain the powder.

Experimental maize grains (100 Kg) of newly harvested 5HB maize was acquired from KARI - Kiboko Sub centre . The maize was sieved and fumigated in air tight plastic drums for 4 days using phosphine fumigant and used in artificial infestation.

Laboratory Bioassay

Based on farmers' experience, quick bioassay series were conducted. Two rates 0.11%w/w and 0.22%w/w were selected as test rates. Disinfected maize grains were weighed into six 100 g lots in one (1) litre jars and treated with the two rates of botanicals (*T. vogelii* and *C. capense*). Experiments involving actellic super 2% dust at the rate of 0.056%w/w and control were also set up. The experiments replicated four times to give a total of 24 jars per batch. Five batches of 24 jars each were made to allow for five adult mortality reading periods of 1,7, 14, 21 and 28 days.

Jars were covered with filter paper, sealed, shaken to achieve uniform coating and arranged in completely randomized design (CRD). Thirty (30) reared adults of *P.*

trancatus of mixed sex ratio 1:1 were randomly picked and introduced into each jar. The experiment was conducted in a controlled temperature room (CTR).
Adult mortality and knockdown assessment were made as above. The term knockdown was used to include those insects killed by the treatment or immobilized to a state where only the antennae or legs could twitch. On the 28th day, all live and dead insects were discarded. Subsequently, all emerging F1 progeny were retrieved from the jars by sieving method and counted on a weekly basis for the next four weeks i.e. 35th, 42nd, 49th and 56th day.

Storehouse bioassay

Quantities of 5kg of experimental maize were used for each of the six treatments as in the laboratory bioassay experiments above. Grains were treated, put in lidded bucket and swirled to ensure a thorough admixing before putting in mini jute bags. These were replicated four times and arranged in completely randomized design (CDR) giving a total of 24 samples, which were then placed on wooden shelves in a brick store.

For proper establishment of the *P. truncatus* in the store, artificial seeding was done using petri dishes placed in different corners in the store. After every four weeks, 300 gm of grains were sampled from each mini jute bags using a grain spear (probe) and transferred to the laboratory for analysis. The samples were sieved to remove foreign matter, frass and insects. A riffle divider was used to reduce the sample into four sub samples of about an eighth of the original samples. Grain damage analysis was assessed following the internationally recognized count and weight method using only three of the four sub samples. Weight of the holed grains expressed as percentage of the total weight of sub sample was used in the determination of grain damage. Sub samples were obtained from each mini bag after 4, 8, 12,16 and 20 weeks.

Repellency testing involved treated and untreated grain lots evaluated in a choice bioassay system similar to Talukder and Howse (1993) with modification using circular plastic basin measuring 50 cm (diameter) by 30 cm (height).The base of each basin was clearly marked into four quadrants and alternately treated with treatments and a control. Grain samples weighing 100 gm were placed equidistant from the centre of the circular base in each quadrant. Thirty unsexed insects were introduced at the centre of each circular basin which were then covered with tightly fitting meshed nylon for free air flow and replicated four times. The number of insects that settled in treated (Nt) and control (Nc) grain were recorded after 6, 12 and 24 hours of exposure. The experiment was then reset and records taken daily for four days. Percent repellency was calculated as per Talukder and Howse (1993).

Results and Discussion

Data on adult mortalities of *P. truncatus* caused by *T. vogelii* and *C. capense* and actellic super 2% dust were 60%, 70% and 100% respectively after an exposure period of 28 days as shown in Table 1. Treatments significantly ($P<0.05$) interacted with the *P. truncatus* within the exposure time and cumulatively produced a higher effect on adult insect mortality. Actellic super dust was first acting within the first 7 days of exposure, compared to the two botanicals, which acted slowly in inducing mortality of the weevil and causing 60 - 70% mortality within 21 days of exposure.

The lethal mean mortality exposure time (LT_{50}) varied between 8-14 days for the two botanicals (Fig. 1). Doubling dosage rates of the pesticides had no effect on toxicity to insects indicating that mortality was more dependent upon the exposure period than increased dosage. Two distinct types of effects were revealed when botanicals are applied on weevils. The two are contact toxicity and direct insecticidal effect as manifested in the cumulative adult insect mortality over the test period.

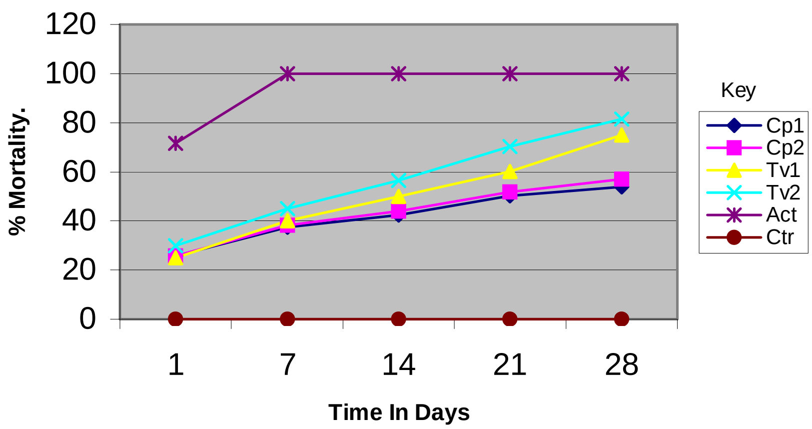
The slow responses observed was consistent with Regmoult- Rodger and Hamraoui (1998) in which plant materials invariably produced low insecticidal effect on the bean beetle, *Acanthoscelides obtecus* during a 12 day exposure period. A similar activity was exhibited by Neem powders on *P. truncatus* (Niber, 1994 and Cobbinah and Appica-Kwarteng, 1989).

Table 1: Mortality of *P. truncatus* adults after exposure to maize treated with *T. vogelii* and *C. capense* (botanicals) powders after 28 days exposure.(Each datum represents the mean of four replicates)

Treatment Code	**Dose (%w/w)**	**Number of dead Insects after X days**					**%mortality after 28 days n = 4**
		D01	**D07**	**D14**	**D21**	**D28**	
CP1	0.11	7.75^{b}	11.0^{b}	16.0^{bc}	20.0^{c}	17.75^{b}	59
CP2	0.22	7.75^{b}	10.75b	13.5^{b}	18.25^{c}	18.0^{b}	60
Tv1	0.11	7.50^{b}	9.0^{b}	17.75b^{c}	13.50^{b}	21.0^{b}	70
Tv2	0.22	9.0^{b}	9.25^{b}	18.75^{c}	18.5^{c}	21.0^{b}	70
Actellic super	0.056	21.50^{c}	30.0^{c}	29.75^{d}	30.00^{d}	30.0^{c}	100
Control	-	0.0^{a}	0.0^{a}	0.0^{a}	0.75^{a}	0.75^{a}	32.5

Means followed by the same letter in a column are not significantly different from each other at P = 0.05 by Duncan's Multiple Range Test (DMRT) mean percent mortality after 28 days presented here are means of the original data.

Fig 1 Cummulative mean (n=4) % Mortality over a 28 Day period(Effect of the Two Botanicals)



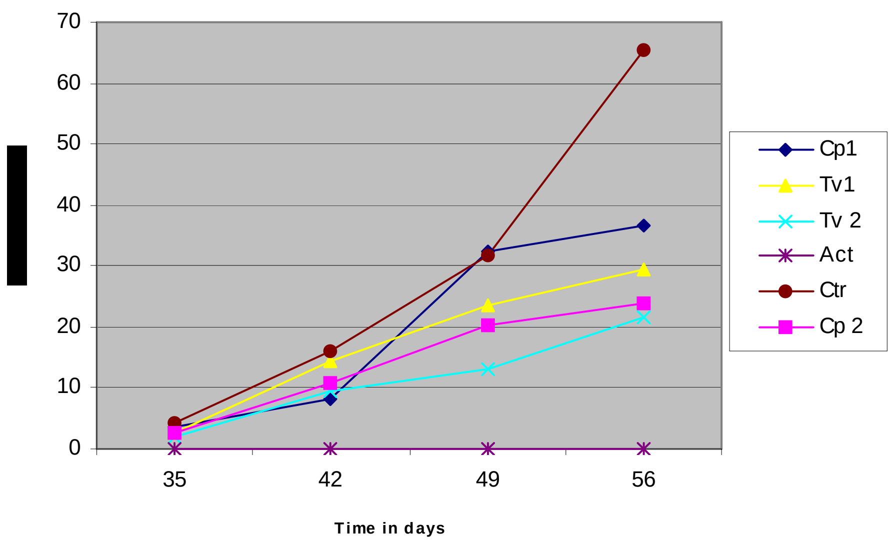
Progeny emergence ($p<0.05$) was significant across treatments. F1 progeny adult insects also increased with an exposure period of 35 days for the two botanicals while double dosages lowered F1 adult emergency. Actellic super completely suppressed F1 emergence as summarized in Table 2. The reduction in the size of the F1 generation may be attributed to the repellent effect of the substances in the botanicals disturbing oviposition behaviour of the parent insects (Fig. 1). This is a common mode of action as per preceded studies (Pereira, 1983).

Table 2. Mean Adult F1 counts *Prostephanus truncatus* in grains treated with powders of *T. vogelii* and *C capense* (botanicals) after 56 days

Treatment code	**Dose (% w/w)**	**Do 7**	**D14**	**D21**	**D28**
CP1	0.11	3.5b	8.25ab	32.5c	38.2bc
CP2	0.22	2.75ab	10.75b	20.25bc	25.0b
Tv1	0.11	2.5ab	14.5b	23.5bc	30.0bc
Tv2	0.22	2.0ab	9.5b	13.0ab	21.0ab
Actellic super 2% dust	0.056	0.00a	0.0a	0.0a	0.00a
Control	0.00	4.25b	31.75bc	65.5c	

Means of four replicates of F1 progeny produced by 30 unsexed adult *Prostephanus truncatus* means in column followed by the different letters are significantly different at α = 0.05 by Turkey's studenized range (HSD) test.

Fig. 2. Growth of filial Generation I over 28 Days



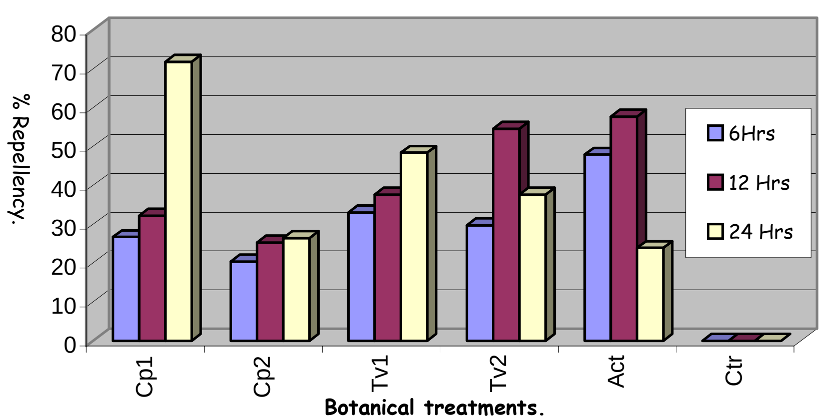
Significant difference ($p<0.05$) in repellency was noted in treated grains compared to untreated grains. *C. capense* treated grains treated at lower dosage had a highest percent repellency (PR) of upto 71% while at higher dosage, (PR) was 26%. *T. vogelii* was second in order of repellency with 48% and 37% for lower and higher dosage respectively. Actellic super offered least repellency of 23% (Table 3, Fig. 3). The significant PR, values observed against *P. truncatus* indicated presence of natural insect repellent compounds in the tissues of plants such as dequelin and tephrosin, which are responsible for their pungent odour (Oliver – Bever, 1986).

Table 3. Mean percent repellency of untreated grains and treated with botanical treatment against *Prostephanus truncatus*

Treatment Code	**Dose** (% W/W)	**NT 6**	**NT12**	**NT24**	**PR24**	**Repellency** CLASS n= 4
CP1	1.0	4.00^{b}	4.75^{bc}	3.00^{b}	71.85	IV
CP2	2.0	7.50^{bc}	8.00^{bc}	7.50b^{cd}	26.425	II
TV1	1.0	6.00^{bc}	4.50^{bc}	5.00b^{c}	48.4	III
TV2	2.0	4.25^{bc}	3.25^{b}	5.75^{bc}	37.65	II
Actellic super	0.056	5.75^{bc}	7.75^{bc}	10.00^{cd}	23.85	II
Control	0	0.00a	0.00a	0.00a	0.00	0

Means of four replicates of 30 unsexed adult *Prostephanus truncatus* test in a choice bioassay of alternate untreated- treated grains recorded after 24 hours exposure. Means in column followed by different letters are significantly different at P = 0.05 by Turkey's studenized range (HSD) test.

Fig.3. Repellency of Botanicals Against *P.truncatus* As offected by Exposure Time.



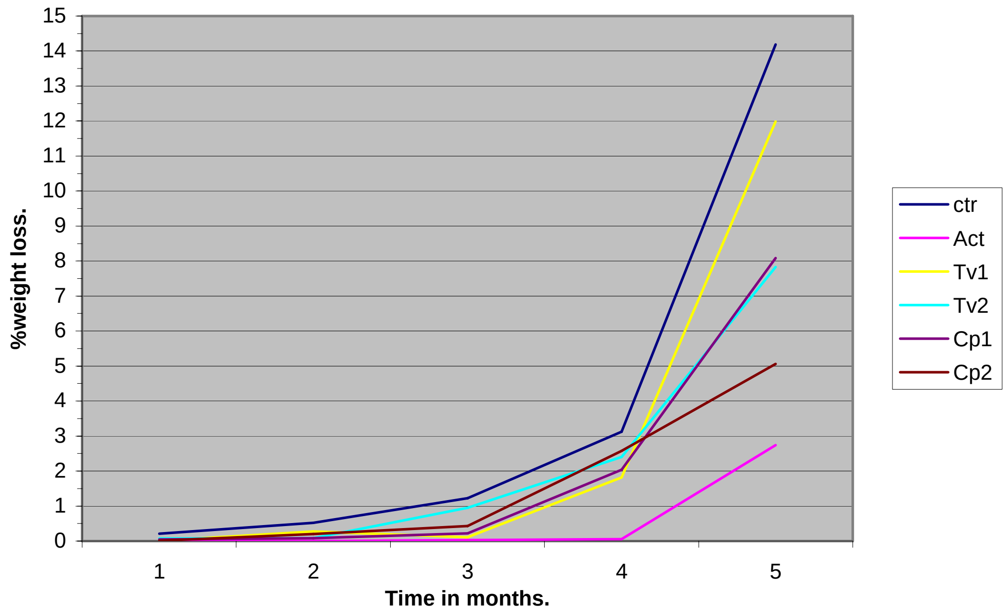
Analysis on grain damage was not significantly different (P>0.05) within the first 3 months of storage period across the treatments. The two tested botanicals compared well with the convectional actellic super dust. Increasing the rates/dosage of botanicals had no effect on damage by insects. Percent weight loss in grains treated with *T. vogelii* and *C. capense* increased to 12% and 8% in the fifth month respectively (Fig. 4). The botanicals and actellic super offered better protection to shelled maize grains in store for upto 3 months. Significant weight losses were noted from the 4th month onwards. Results are summarized in Table 4.

Table 4. Percent weight loss of maize treated with botanicals (*T. vogelii and C. capense)* after exposure of 5 months (150 days)

Treatment Code	**Dose (% W/W)**	**Post treatment period (weeks)** 4	8	12	16	20
CP1	0.11	0.0458[a]	0.085[a]	0.2208[a]	2.04[a]	8.0892[a]
CP2	0.22	0.0333[a]	0.2008[a]	0.4275[a]	2.58[a]	12.135[a]
Tv1	0.11	0.133[a]	0.2525[a]	0.1067[a]	1.8192[a]	12.042[a]
TV2	0.22	0.0725[a]	0.0808[a]	0.9533[a]	2.4042[a]	7.8258[a]
Actellic	0.056	0.00[a]	0.00[a]	0.0242[a]	0.0542[a]	2.7408[a]
Control	__	0.10[a]	0.1567[a]	0.5117[a]	1.9858[a]	14.3408[b]

Means of four replicates of percent weight loss of grains treated with botanicals over (150 day) weeks storage period. Turkey's (HSD) test with significant level 0.05

Fig. 4. Trend in % weght loss with time (Months)



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