Advances in Science and Technology, Vol. 11, No. 2, September / October 2017, pp 62 - 67

The Use of Woodash, Onion Scale Leaves and Chilli Pepper Powders for Reducing *Callosobruchus Maculatus* Damage in Cowpea Seeds During Storage

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(Submitted: September 2, 2017; Accepted: October 15, 2017)

Abstract

Most cowpea farmers in sub-Saharan Africa are confronted with low yields, caused by insect pests and diseases. Cowpeas are susceptible to a wide range of pests and pathogens that attack the crop at all stages of growth. The main storage pests are the Bruchids. The primary insect pest causing losses to stored cowpeas in West Africa is the cowpea weevil, *Callosobruchus maculatus*.A laboratory study was conducted to investigate the effects of natural products on the reproduction and damage of *Callosobruchus maculatus*, the cowpea weevil, on cowpea seeds at Federal University of Agriculture, Abeokuta, Nigeria. The cowpea variety 'Ife-brown' was used in the study. Five grams of each plant product (onion, and chilli pepper) and woodash was added to 50g of the cowpea seeds. Findings of this experiment on survival and development of *C. maculates* revealed that the fecundity and adult emergence significantly reduced in treatment with onions. Chilli pepper had similar effect. Woodash showed negative result on the cowpea weevils .The extent of seed damage was minimal in chili pepper treated seeds (48.96g) and onion-treated seeds (48.50g). Seed damage was high in cowpea seeds treated with woodash (41.23). The results indicated that these plant products have the potential to protect cowpea seeds from cowpea weevils' damage compared to when the seeds are left or stored unprotected. They should, therefore, be included in pest management strategies for cowpea weevil in grains stored on-farm in rural tropical and subtropical regions.

Keywords: Woodash, onion scale leaves, chilli pepper, *callosobruchus maculatus*, cowpea seeds.

1.0 Introduction

1.1 Background

Cowpea, (*Vigna unguiculata* (L) Walpers, Fabaceae), is an important edible legume crop in many parts of the world especially in tropical and subtropical regions. It is used as human food due to its high protein content (Diouf, 2011). The pulse seed suffer a great damage during storage due to insect attack (Sharma, 1989). Bean weevil is a pest of stored beans and peas belonging to the beetle family Bruchidae (commonly known as the seed weevils because the larvae develop inside the seeds of various plants).Pulse beetle *Callosobruchus* species is serious one and this insect has been reported from the Philippines, Japan, Indonesia, Sri lanka, Burma and India. Among these, pulse beetle, *C. maculatus* is a major pest that causes serious damage and is a cosmopolitan (Dinesh and Deepshikha, 2012). It is a notorious pest of chickpea, mung, peas, cowpeas, lentil and arhar (Aslam, 2002). Cowpea seeds damaged by *C. maculatus* are riddled with exit holes of adult beetles and have reduced weight, low market value and poor viability (Dinesh and Deepshikha, 2012).

Insect infestation is a major contributor to quality deterioration of durables (cereals, pulses, roots and tubers) stored in warm and humid climates. Apart from the detrimental economic impact, these losses pose a major threat to food security (Narong, 2003).Pulse beetle being internal feeder cannot be controlled with insecticides. It is also not advisable to mix insecticides with food grains (Dinesh and Deepshikha, 2012). Applicability of these disinfestation techniques in a majority of developing countries is however, limited by cost and socio-economic factors. Thus, the traditional methods of applying spices, medicinal plants and their extractives, and inert materials (sand, charcoal and ash) with pest control potential as storage protectants, have increasingly been explored and exploited in the developing world as alternatives for the control of pests of stored products. Effectiveness of insecticidal property of any plant material depends on the active constituents of the plant material (Idoko and Adebayo, 2011). The active constituent in these plant materials appears to be responsible for their insecticidal properties against the maize weevil. Many of the active constituents have been reported to possess contact, stomach and respiratory poisoning properties attributed to them (Stoll, 1988).

1.2 How Insects Get Into Grains

Some insects infest the grain while still in the field because they can fly from field to stored grains and from stored grains to the field. Secondly, farmers store grains year after year in the same sacks, containers and buildings, without disinfecting. Bins made of wood or woven grasses have cracks and spaces, which fill up with dirt and broken grains. Further still, new grain is put into a storage building containing grain left from the last harvest, (grain already heavily infested) and grain goes from the field to the storage place in carts and wagons, which were not cleaned after the last use (Lindblad *et al*, 1976).

1.3 Objective

We wish to establish the protective ability of products derived from the plant materials and ashes against Callosobruchus maculatus as among the major stored product insect pest.

i. Effect of ground plant powders of chili pepper, onion scale leaves on fecundity and fertility of *C. maculatus*.

ii. The protective ability of ashes on cowpea seeds in long-term storage.

We shall justify the practice by some farmers in West African, who uses ash from wood and botanicals in the storage of cowpea seeds against depredation by storage insects as practiced by some farmers in West Africa.

2.0 Materials and Methods

2.1 Research Location

The experimental work was performed in the Pure and Applied Zoology Laboratory, College of Biosciences (COLBIOS), Federal University of Agriculture, Abeokuta, Ogun State, Nigeria.

2.2 Collection of Samples

2.2.1 Cowpea Weevil Collection

The cowpea weevils (*Callosobruchus maculatus*) used for the study were obtained from pre-infested beans bought from local market. The culture was made by isolating beans with larval or pupal stages of the weevil. Newly emerged adult were used for the experiment.

2.2.2 Cowpea Collection

The cowpea variety –Ife-brown (locally known as *Ewa Oloyin*) used for the study were obtained from a grain store in Bodija market, Ibadan, Oyo state, Nigeria.

2.3 Initiation of Experiment

2.3.1 Sterilization of Glass Wares

The Kilner glass jars were the glass wares used. They were washed thoroughly with detergent, rinsed with clean tap water, drained and dried under sunlight.

2.3.2 Treatment Preparation

The plant products were chopped into pieces, oven-dried for 3 hours and ground to powder in an electric mill which was then kept in an air tight container. The woodash used was obtained from FUNAAB bakery.

2.3.3 Initiation of the Laboratory Experimental Work

The cowpeas were sorted individually and manually to avoid any pre-storage infestation seeds or egg laying of the seeds by visual observation for presence of eggs or any suspicious material. Cowpea seeds were sterilized in the oven at 70ºC for 3 hours and allowed to cool to room temperature (Allotey and Azalekor, 2000). 50g of the cowpea seed was weighed and transfered into the glass jars and 5g of each treatment was applied. The jars were shaken thoroughly to ensure uniform treatment plant material coverage of seeds. 5 pairs of matured adults were released into each jar obtained from the motherstock. The treatments were replicated thrice as well as a control. All glass jars were kept under the room temperature of 27 ± 2Ú˜ and 75 ±5 percent relative humidity. The mouth of each glass jar was covered with net and tied with perforated plastic lid. The insects in the jars were left for 14 days to allow for oviposition, after which they died and were removed.

2.3.4 Data Collection

Data on the number of seeds with eggs, as well as the number of eggs on each seeds were counted and recorded. From the 21st day of infestation, adult emergence were observed, counted and recorded for 14 days. Progeny adults were recorded daily when their emergence started. Damaged seeds were obtained after 49 days, the extent of weevil damage was determined.

2.3.5 Data Analysis Statistical Method

Data obtained was subjected to statistical analyses using the Statistical Package for Social Sciences (SPSS) version 20.0 (IBM Corp, 2011). Mean values of each of the treatments were compared with the control using the Independent Sample T – test while the number of eggs emerging to adult was compared with the control using the Paired Sample T – test. Mean values of fecundity and parameters of bean weevils were compared between onion, chilli pepper and wood ash treatments using Analysis of Variance (ANOVA). Means was separated using Student-Newman-Keuls (SNK) and Domnica respectively. Means was presented as Mean ± Standarderror of mean. P value was set at 0.05.

3.0 Results and Discussion

3.1 Results

3.1.1 Effect on the growth and development of *Callosobruchus maculatus*:

The plant products namely: chili pepper, onion scale leaves and an inert material –woodash were tested on the growth and development of *C. maculatus* and data presented in Table 1. The mean number of eggs of the controls were compared and it was discovered that the control of beans treated with woodash showed a lower significant mean difference (-3.87) while those treated with chilli pepper was not significant and onion scale leaf powders had a higher significant mean difference (4.80) with significance at $P < 0.05$.

3.1.2 Effect on Fecundity

The eggs laid by female on the bean grains treated with chilli pepper powder were less in comparison to untreated check (control). The minimum number of eggs were laid on the seeds treated with onion (10.63) powder which was significantly different from the control while the highest number of eggs on beans were recorded in beans treated with chilli pepper (35.00) and woodash (44.67) respectively. The number of eggs laid (oviposition) was also significantly different from the control in the onion treatment and it had the minimum number (11.33) of eggs laid among the treatments. Oviposition in chilli pepper control treatment was slightly higher than in the treatment test. Woodash control treatment was lower than the test treatment both in the number of beans with egg and in oviposition (Table 2).

3.1.3 Effect on the emergence

The emergence of adult beetles of *C. maculatus*, recorded from the cowpea seeds showed a significant difference with different treatment materials (onion, chilli and woodash) used. The emergence of adult beetles was less in case of seed treated with chilli pepper powder (1.20), which was slightly at par with onion powder (2.94) (Table 3). The seed treated with onion scale leaf powder gave significantly better results in comparison with control to reduce the beetle emergence from the seed treated (Figure 1). The maximum number of adult emergence (3.54 %) was observed on woodash treated cowpea seeds (3.39) (Table 3). It was observed that adult emergence showed higher number of *C. maculatus* adults emerging from

Table 1: Mean comparison (T – test) the treatment groups and their respective control

		Mean difference	Std. Error	t	Df	Sig.
Pair 1	Control – Onion	4.80	3.23	1.49	14.00	0.16
Pair 2	Control – Chilli Pepper	0.00	0.31	0.00	14.00	1.00
Pair 3	Control – Wood Ash	-3.87	0.82	-4.74	14	0.01*

*Significant at $P < 0.05$; Sig. = Significant value (P – value)

Table 2: Egg laying properties of the bean weevils on cowpeas treated with onion, chilli pepper and wood ash

		Weight of beans (g)	No. of beans with eggs	No. of eggs
Onion	Control	50	120.00±0.58	191.00±0.58
	Test	50	10.00±3.61*	11.33±3.53*
Chilli Pepper	Control	50	71.00±0.58	91.00±0.58
	Test	50	35.00±16.74	40.67±19.36
Wood ash	Control	50	23.00±0.58	32.00±0.58
	Test	50	44.67±19.40	62.67±29.67

*Mean value (±Standard error of mean) for the test group is significantly different from the control; No. = Number

Table 3: Mean comparison of the fecundity rate and seed damage of bean weevils on cowpeas treated with onion, chilli pepper and wood ash

	Onion	Chilli Pepper	Wood Ash
Initial weight of beans (g)	50	50	50
No of beans with eggs	$10.00±3.61^{a}$	$35.00±16.74^{a}$	$44.67±19.40^{a}$
No of eggs	$11.33±3.53^{a}$	$40.67±19.36^{a}$	$62.67±29.67^{a}$
Emergence	$2.94±0.64^{a}$	$1.20±0.28^{b}$	$3.39±0.60^{a}$
Final weight of beans (g)	$48.50±0.55^{a}$	$48.96±0.83^{a}$	41.23±4.40
Final weight of control (g)	39.00	42.00	48.00

^{ab}Mean values (±Standard error of mean) having similar superscript in the same row are not significantly different at $P < 0.05$). Emergence = Number of weevil eggs emerging to adult.

woodash treated seeds, but was significantly higher than the number of *C. maculatus* adults that emerged from control (Figure 1).

3.1.4 Effect on damage

The effect of different treatment materials on damage was recorded by assessing the loss in weight of *C. maculatus* seeds (Table 3). It is evident from Table 3 that least damage (48.96) occurred in grains treated with chilli powder as initial weight was 50.00. The grains treated with onions also do not differ with the chili pepper powder providing the mean weight of 48.50 after weight loss. Woodash treated seeds showed the maximum damage mean of 41.25. Weight loss in the controls of onions and chilli treatment were higher than the test treatments (39.90 and 42.00 respectively). Seed damage of woodash control treatment was recorded to be lower than the test (48.00) (Table 3).

3.2 Discussion

It is evident from the result of this study that treatments differed in number of eggs laid, number of adult emergence and weight loss. It has been shown in this experiment that onions had the most detrimental effect on cowpea weevils for the parameters measured. Chilli pepper also had similar effect with onions on the performance of stored cowpea weevils. This, therefore, implied that these plant products negatively impacted the weevils more

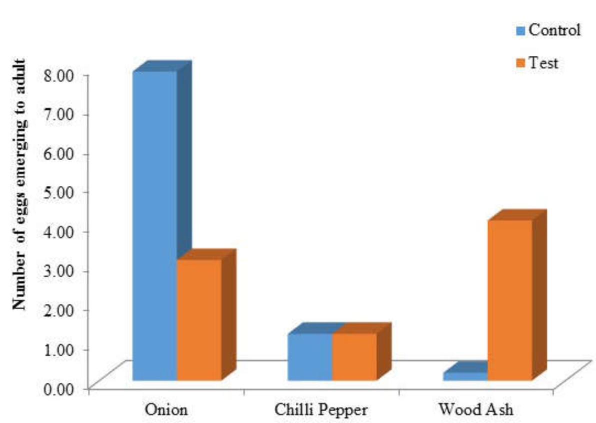

Figure 1: The number of weevil eggs emerging to adult on cowpeas treated with onion, chilli pepper and wood ash.

than woodash and control. The control of woodash showed a negative significant value. This is in contrast with the findings from literatures where ashes obtained from various plant parts have also been tested and proven to be effective as protectant against cowpea storage pests infestation (Ofuya and Salami 2002; Boeke *et al*., 2003; Ngamo *et al*., 2007). This could be as a result of the woodash obtained from unknown plant source. It can, therefore, be mentioned that chilies and onion can better protect cowpea seeds from cowpea weevil damage than if seeds are left or stored unprotected. The reduction in the egg laying by the plant products (onion and chilies) relative to the control might be due to toxicity of the plant materials to the weevils. This is because, as it can be seen from Table 2, these plant materials resulted in less progeny produced which can be linked to toxicity of the plant materials as pepper seeds possess phytochemicals such as chavicine, yellow alkaloid (piperine), guineensine and pipericide, that confer on them significant insect repellent and insecticidal value (Ofuya, 1986; Parmar *et al.*, 1997). This finding is seemingly consistent with results of several other researchers (Ivbijaro, 1990, Ntonifor and Monah, 2001; Okonkwo and Ewete, 1999; Abdullahi and Muhammad, 2004; Udo, 2005; Rajapakse, 2006; Asawalam and Emosairue, 2006), who reported that plant powders of pepper and so many others can be used in suppressing the population of *Callosbruchus maculatus*. The implication of these effects is that onion and chilies used as treatment in this experiment lowered the weevil progeny numbers and effects on the cowpea seeds while woodash treatment had positive effect on *Callosobruchus maculatus* on stored cowpea seeds

4.0 Conclusion

Based on our results, it can be concluded that onion scale leaves, chillies might serve as alternatives to insecticides on rural farms in tropical and subtropical regions. The use of these plant products would be cost effective and sustainable, especially considering that these plants are grown locally in Nigeria. In addition, these products are safe to users as evidenced by the fact that they are used as culinary spices and herbs.

The tested products served as good botanicals for the management of storage insect pests. It is therefore, recommended that farmers use botanicals from onion scale leaves and chilli pepper as alternative to synthetic chemicals which have detrimental effect on human health and th environment due to their relative abundance and accessibility throughout the year

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