African Journal of General Agriculture
Vol. 6, No. 1, March 31, 2010
Printed in Nigeria

1595-6984/2010 $12.00 + 0.00

http://www.asopah.org

AJGA 2009158/6105

The effect of insecticides and airtight storage on the storability of cowpea in Maiduguri, Nigeria

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(Received December 31, 2009)

ABSTRACT: This experiment was carried out in Maiduguri (2005) to determine the period of airtight storage and pesticide/insecticide treatment that would best protect cowpea against the infestation of *Callosobruchus maculatus*. These periods of airtight storage condition 4, 6, and 8 weeks and 2 types of storage pesticides (Pepper powder, Phostoxin and a control) were factorially combined. Data were collected on weight loss, egg count, number of drilled seed (bored) germination percentage and number of dead insects. The number of bored seed was significantly ($P \leq 0.05$). Phostoxin gave the best result followed by grounded pepper. Egg laid (oviposition) was not significantly ($P \leq 0.05$) between ground pepper and control. While oviposition was lowest with Phostoxin, while egg laid was highest at 8 weeks but not significantly difference between 4 and 6 weeks. The highest insect count was recorded from no pesticide application, while Phostoxin gave the lowest insect count at 8 weeks followed by pepper at 8 weeks. The highest germination percentage was recorded from Phostoxin and not significantly difference between 6 and 8 weeks. The interaction of airtight condition and pesticide gave similar result. This means that the airtight storage and chemical treatment is very effective. The combination of airtight storage condition with or without suitable pesticide will effectively control *Callosobruchus maculatus*, in cowpea.

Keywords: Cowpea; *Vigna unguiculata*; Preservation; Storage; Insecticides; Airtight storage.

Introduction

Grain storage plays an important role in ability of any nation to feed its citizens, in predominately agricultural countries, this is usually an abundance of food immediately following harvest where appropriate storage technology is available, the surplus is usually stored against the period of scarcity in countries where food storage has been perfected, such as in the United States of America and parts of Europe, period of scarcity have practically ceased to exist, as food is made regularly available irrespective of harvest time.

In many developing countries. The period of food shortage can mean extreme starvation when food intake may drop below level required for normal daily consumption. In many countries, the extent and level of these losses have not been fully assessed, and figures quoted often have more political than scientific validity. However, where some assessments have been made of the quantities of stored food damaged or lost through various agents, the indications are that serious wastage occurs and a substantial addition to available food supplies would be achieved through improved storage. FAO (1998) has published figures of losses caused by insects associated with various food grains in a number of African countries. Other figures from such countries as India are closely similar and confirm the magnitude of losses in edible materials caused by various insect species. Stored products entomology is of added importance in many developing and tropical countries of the world because most of their agricultural food products are stored and marketed in the dry condition. This is partly due to established traditional eating preferences, often necessitating the consumption of relatively dehydrated foods, other related infrastructure for the long term preservation of perishable foods.

The success and abundance of insects are largely due to their high degree of adaptability, which ensures their survival in practically all situations where other animals would perish. Most insects are terrestrial but some have also made a success of the aquatic environment. They are the only invertebrates equipped with the ability to fly, a feature that has contributed in no small measure to their dispersed and dominance.

Hermetic storage can be defined as the process of storing grains in an airtight storage system e.g. drum, bottles etc. to exclude air in order to kill the insects present for safer and longer storage include:

1. It is economical
2. The material used for the hermetic storage is readily available
3. It does not involve the use of chemicals
4. It prevents moisture migration.
5. It does not require sophisticated technical know-how.

Successful hermetic storage depends on the fulfillment of a number of requirements, which include storing only dry grains making sure that the containers or structures are really airtight, filling the containers as completely as possible and keeping the container at low temperature.

The principles involved in hermetic storage are that insects respire and use up oxygen that may be contained in the storage device. Carbon dioxide build up, insect will die from reduced oxygen (hypoxia) and there after from the lack of oxygen (anoxia) but with increase in concentration of carbon dioxide poisoning a condition known as hyperbia.

In Nigeria, cowpea is not only a source of food but also a source of revenue to the farmers, it is used in preparation of many kinds of dishes which, includes:

(i) Fried bean cake
(ii) Beans soup
(iii) Boiled fresh green beans for salad
(iv) Boiled bean balls (Danwake)
(v) Boiled cans paste (moin-moin)

Several methods are adapted in efforts to contain stored products insects numbers, or as is usually said "to keep them below economic injury levels". The measure to be applied in a particular situation are dictated by a combination of factors, including the nature of the community under consideration, and having regard to the biology and behaviour of the insect spares present.

These broad criteria may be applied to any agent to be chosen for the control of stored products insects.

1. It must be sufficiently selected as it eliminates only the target pest species
2. It should not damage or contaminate the environment
3. It should be sufficiently cheap to make its application economically worthwhile.

It is doubtful if any single measure in current use combines all these attributes. Stored products pest management requires an integrated approach, incorporating the best of various materials in a complementary manner from the forgoing the objective of the present study is to develop a cowpea storage technology that would be ideal for the prevailing situation in Maiduguri. To achieve this, it was intended to:

Determine the effectiveness of integrated control method on the storability of cowpea.

Aims and Objectives

(i) Determine the effect of longevity of airtight storage condition on the storage conditions on the storability of cowpea.
(ii) Determine the effect of type of pesticide used on the storability of cowpea.
(iii) Determine the effect of the interactions of type of pesticide and period of airtight storage on the storability of cowpea.

Methodology

This study was conducted in the laboratory of Agric Science and Technology, Ramat Polytechnic Maiduguri (11°51N, 13° 15E), situated within Northern guinea savannah Vegetational zone of Nigeria.

Experimental Material.

A local variety of cowpea was obtained from Maiduguri open market and used for the experiment. Jam bottles were used as the storage structure. This had a suitable cover that afforded an efficient airtight condition.
Two storage insecticides namely phostoxin and a natural plant pesticide dust was used as the storage chemicals.

Experimental Procedure.

About 7441 g was needed for this study. After procurement, the batch was kept in a waterproof container and stored in a deep freezer (at O°c) for at least 3 days. This was intended to destroy any developmental stage of insects pre-existing in the batch. Another batch of about 1kg that was already infected was purchased and the young immerging insects were used later to inoculate the experimental batch.

Preparation of Treatment Samples.

The refrigerated cowpea bulk was used to fill up all the bottles. Four pairs of (male and female) Callosobruchus were

Results and Discussion

Effect of insecticide, period of airtight storage and their interaction on number of eggs laid on cowpea by *Callosobruchus maculatus.*

Table 1: shows that egg laying (oviposition) was significantly affected by the interaction of pesticides and longevity of period of airtight storage. The highest numbers of egg were attached to the grain at 4 weeks when no pesticide were used and the lowest at 8 weeks with phostoxin.

The control and use of ground pepper did not record any difference in egg number but phostoxin recorded the least egg count.

Egg laying was highest at 4 weeks and lower at 6 weeks where similar counts were recorded.
Phostoxin killed the adult insects that lays eggs (ground pepper did not kill adult insect they don't feed they kill larvae). The depletion of O_2 at 6 and 8 weeks probably reduced insects count drastically to the extent that the number of insect available to lay egg were reduced. It is also possible that metabolic activities of the insects that were alive also reduced the egg laying greatly impaired.

Table 1: Effect of insecticide, period of airtight storage and their interaction on number of eggs laid on cowpea by *Callosobruchus macuJatus.*

Insecticide	Period of Airtight storage (wks)			
	4	6	8	Insecticide mean
Phostoxin	12.0cd	4.3c	4.0c	6.8b
Ground pepper	19.3b	13.7c	11.0cd	14.7a
Control	26.3a	7.7de	11.3cd	15.1a
Storage period mean	19.2a	8.8b	8.6b	

SE + = 0.7, LSD 0.05 ≤ 3.2 (Insecticide); SE± = 0.77, LSD 0.05 = 3.2, (period of storage); SE + = 1.33, LSD 0,05 = 5.5 (interaction).

Effect of Insecticides, period of airtight storage and their interaction of number of seeds of cowpea bored by *Callosobruchus maculatus*.

Table 2 shows that effect of insecticide, period of airtight storage and their interaction of number of seeds of cowpea bored by *Callosobruchus maculatus*. Interaction shows that pesticide X period of airtight storage significantly affected the number of seed drilled by grain weevil.

At week 4 phostoxin and pepper recorded similar result while the control recorded the highest number of damaged seed. At 8 weeks seed damaged was significantly reduced with no different for the various treatment. Insecticide mean, insecticide significantly reduced damage due to seed by *Callosobruchus maculatus*. Phostoxin recorded the lowest damage, while non-pesticide recorded the highest. For period of storage, the longevity of storage significantly (p=0.05) affected the number of seed drilled by insect number of drilled seed reduces with increasing storage time. Meaning that the least damage was recorded at 8 weeks.

Table 2: Effect of Insecticides, period of airtight storage and their interaction of number of seeds of cowpea bored by *Callosobruchus maculatus*.

Insecticide	Period of airtight storage (wks)			
	4	6	8	insecticide Mean
Phostoxin	7.0[b]	3.0[d]	2.0[d]	4.0[b]
Ground pepper	8.0[b]	6.0[c]	2.7[d]	5.6[b]
Control	15.7[a]	3.0[d]	2.3[d]	7.6[a]
Storage period mean	10.2[a]	4.0[b]	2.3[c]	

SE + = 0.31, LSD 0.05 = 0.93 (Insecticide); SE + = 0.31, LSD 0.05 = 0.93, (period of storage); SE + = 0.54, LSD 0.05 = 1.61 (interaction).

Phostoxin is a fumigant and the smell kills adult and larvae of insects, while ground pepper killed only larvae gradually reduces with time of respiration. It was abundant at 4 weeks but get towards exhausting (finishing) at 8 weeks, death of insect and larvae.

Effect of insecticide, period of airtight storage their interaction on insect counts.

Table 3 shows that the effect of insecticide, period of airtight storage and their interaction on the number of insects on cowpea by *Callosobruchus maculatus,* interaction of insect and longevity of storage period shows that the highest insect population was recorded with the control at 4 weeks. While the least was recorded from phostoxin at 4 weeks 6 week and 8 weeks.

The application of insecticide significantly affected insect count. The least was recorded from phostoxin and the highest from the control.

Insect population was significantly (p=0.05) reduced by storage period. The trend was a decreasing insect count with increasing storage period, that at 8 weeks of airtight storage condition the population of surviving insect has drastically reduced.

Fumigating action of phostoxin could have affected parent insect (that laid the eggs) thus a reduction in egg and even the ones that succeeded in hatching to larvae and adults were also further reduced. While ground pepper reduced population probably only at larvae stage being a powder there may be no uniform coverage of the seeds.

Table 3: Effect of insecticide, period of airtight storage their interaction on insect counts.

Insecticide	Period of airtight storage (wks)			
	4	6	8	insecticide Mean
Phostoxin	3.0[b]	2.0[d]	2.0[d]	2.3[c]
Ground pepper	11.0[b]	4.0[d]	2.0[d]	5.6[b]
Control	35.5[a]	22.3	7.0[cd]	21.7[a]
Storage period mean	16.6[a]	9.4[b]	3.7[c]	

SE + = 0.98, LSD 0.05 = 2.94 (Insecticide); SE + - 0.98, LSD 0.05 = 2.94, (period of storage); SE + = 1.70, LSD 0.05 = 5.1 (interaction).

Effect of insecticide, period of airtight storage and their interactions on the germination percentage of cowpea.

Table 4 shows the effect of insecticide, period of airtight storage and their interactions, on the germination percentage of cowpea. The highest germination was recorded from seeds stored at up to 4 weeks while at 6 and 8 weeks there was not significance different (p=0.05) in germination percentage.
The germination percentage is an expression of how much seed embryo had been destroyed by the insect, insecticide or lack of oxygen. The result may be an effect of the pesticide and reduction in oxygen on insect population leading to a lower damage at 8 weeks of airtight storage.

Table 4: Effect of insecticide, period of airtight storage and their interactions on the germination percentage of cowpea.

Insecticide	Period of airtight storage (wks)			
	4	6	8	insecticide Mean
Phostoxin	96.0	81.3	88.7	88.7^{a}
Ground pepper	94.0	76.3	76.7	82.3^{b}
Control	89.7^{a}	73.3	81.3	81.4^{b}
Storage period mean	93.2^{a}	82.2^{b}	77.0^{b}	

SE + = 1.96, LSD 0.05 = 5.88 (Insecticide); SE + - 1.96, LSD 0.05 = 5.88, (period of storage); SE + = 3.40, LSD 0.05 = NS (interaction).

Effect of insecticide, period of airtight storage and their interaction on weight difference of cowpea.

Table 5 shows the effect of insecticide, period of airtight storage and their interaction on weight difference of cowpea. The effect of insecticide X longevity of period of storage did not significantly (p=0.05) affect weight loss in cowpea.
The combination of the treatment probably kept the insect population below damage to the stored cowpea at level that could do appreciable

Table 5: Effect of insecticide, period of airtight storage and their interaction on weight difference of cowpea.

Insecticide	Period of airtight storage (wks)			
	4	6	8	insecticide Mean
Phostoxin	41.0^{a}	39.6^{a}	2.0^{a}	40.3^{a}
Ground pepper	43.3^{a}	40.8^{a}	40.2^{a}	41.44^{a}
Control	40.2^{a}	43.0^{a}	38.0^{a}	40.4^{a}
Storage period mean	41.5^{a}	41.1^{a}	39.5^{a}	

SE+=1.19, SE±= 1.19, SE+=2.1

Conclusions

The result of the experiment shows that phostoxin through its fumigating effect kills both adult insects and larvae thus period most effective in the experiment ground pepper, pesmoved better next to phostoxin in the trial. It was effective in reducing larvae and thus the number of damage seeds but powder, it was not lowering a total adhesively or attachment to the seed neither was there a uniform coverage or distribution amongst the seeds. So

the insects could survive when the effect of the pepper did not reach.
The utilization of O_2 lead reduction in O_2 with time and there was a built up of CO_2, which probably lead to suffocation of insect. However little moisture could have been introduced into the grain to affect the quality of nutrient in it. Thus, however did not affect the germination percentage of the grains. Thus the longer the period (up to 8 weeks) the length of storage, the more protected the grains at least against storage weevil.

Recommendations

1. Integrated storage method of phostoxin or ground pepper for a period up to 8 weeks is recorded for cowpea.
2. More storage pesticide is recommended for trail over different or longer period of storage condition.
3. The effect of microbial growth on the quality resulting from moisture build up due to respiratory on the stored cowpea should also be investigated.

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