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Efficacy Evaluation of Eight Bio-Pesticides and two Synthetic Pesticides in the Control of Cowpea Weevils (*Callosobruchus maculatus)* and Mold in Sokoto State, Northwest Nigeria

S.U. Awere and D.U. Ubah

Department of Agronomy and Ecological Management, Enugu State University of Science and Technology, P.M.B. 01660, Enugu Nigeria.

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***Abstract*— *Two laboratory experiments to evaluate the efficacy of eight bio-pesticides (Plant derivatives) and two synthetic pesticides in mitigating post-harvest losses caused by cowpea bruchids (Callosobruchus maculatus) and storage mold were carried out in Illela, Sokoto state, Northwest Nigeria. The research used a completely Randomized Design (CRD) experiments with ten (10) treatments replicated four (4) times. The efficacy of each treatment was evaluated against egg oviposition, seed perforation, weight loss and mold infestation levels across both restricted and unrestricted weevil attack. The result of the experiment showed significant treatments effect across all parameters taken ($P \leq 0.05$). Phostoxin significantly demonstrated absolute potency under restricted condition, achieving complete inhibition of egg oviposition (0.00 egg). However, under unrestricted infestation condition, the absolute potency of phostoxin in inhibiting egg oviposition observed under restricted infestation was broken as up to 483.00 eggs were laid, but still maintain absolute potency in inhibiting seed perforation (0.00 holes) as the eggs failed to hatch. A combination of mancozeb 80%WP and Acetamprid 40% proved dual significant control against bruchid and fungal infestation throughout the storage period. Regarding bio-pesticides, turmeric proved significantly superior in reducing egg oviposition by 84.53% (152.45 as against 986.01 in the control and also reducing seed perforation by 76.90% (14.81 as against 64.00 exit holes). Again, grape peel powder also exhibited significant deterrent effect by reducing egg oviposition by 83.77% (160.03 as against 986.01 eggs in the control) and in seed perforation by 73.05%. Regarding storage mold infestation, Alligator pepper recorded significantly higher antifungal potency than other bio-pesticides achieving near total mold suppression (1.00 infested seed).**

Keywords*— Cowpea (Vigna unguiculata), Bruchids (Callosobruchus maculatus), Bio-pesticides, synthetic pesticides, mold.

I. INTRODUCTION

Cowpea (*Vigna unguiculata)* is one of the most versatile and important legume crops cultivated widely across various regions of the world, particularly in tropical and subtropical climates. It is a major vegetable source of protein for human consumption especially in Africa (Ileke *et al. 2013*). Cowpea is a staple component of the diet in several developing countries and a major source of protein to combat malnutrition in young children in view of expensive animal protein. Cowpea seeds contain about 25% protein, making it extremely valuable in area where many people cannot afford proteinous food such as meat and fish (Lephale *et al.* 2001*)*.

It has been regarded as poor man's meat (Ileke *et al.* 2012. It is an extremely important protein source to vegetarians and people who cannot afford animal protein (Adeyemi *et al*. 2012). Cowpea seeds are also a rich source of minerals and vitamins (Hall *et al.* 2003). The green and dry haulum are feed to livestock particularly in dry season when animal feed is scarce (Ababe et al. 2005) and also as source of income when sold to farmers who use them as livestock feed (Dugje et al. 2009).

Cowpea is a warm weather crop that is well adapted to dryer regions of the tropics like Nigeria where other food legumes do not thrive well. Cowpea, a herbaceous annual plant exhibits a variable growth habit, which can be categorized into erect, semi-erect, prostrate and climbing forms (Ehler and Hall, 1997).

This variability allows it to be cultivated under divert farming systems, from traditional small-scale farms to more intensive large scale agricultural practices. In terms of its morphology, cowpea typically exhibit trifoliate leaves, which are broad and green, enhancing its photosynthetic efficiency. This efficiency helps the plant endure and thrive in harsh environmental conditions, such as extreme heat and limited moisture availability.

Nigeria is the largest producer and consumer, accounting for about 45% of the world's production (Lowenberg – Deboer and Ibro 2008, Ndong *et al. 2012)* while Africa accounts for 75%. Despite the numerous benefits of cowpea, its production and storage face significant challenges.

The production of this crop in Nigeria is low and has not matched the demand of the consumers (Okelede and Ariyo 2000). Among the pulses, cowpea, Banbara groundnut and pigeon pea are the most common and important legume crops in the world (Mahdi and Rahman 2008. Pulses suffer a great damage during storage due to insect attack. The extent of damage by *Callosobruchus maculatus* to pulse seeds is very high both qualitatively and quantitatively (Atwal 2006). *Callosobruchus maculatus* alone accounts for over 90% of damage done to stored cowpea seeds by insect (Caswell 2001). Therefore, an option that can produce satisfactory result in an acceptable and feasible manner to farmers is necessary to achieve the desired goal. The use of plants and minerals as traditional protectants of stored products is an old practice used all over the world. Some of these knowledge have been neglected over past decades. However, there is an increasing interest and necessity to revisit such knowledge. In Nigerian traditional grain storage, *Afrimonium melegueta* seed, *capsicum nigrum* seed, *Allium Sativum, Zingiber Officinale* rhizome, *Azadirachta indica* leaves and *ocimum gratissimum (*scent leaf, are often employed singly or in combination as seed/grain protectant with different but encouraging results, which lead to the objective of this research to evaluate the efficacy of eight bio-pesticides and two synthetic pesticides in the control of cowpea burchid (*Callosobruchus maculatus)* (L) Walp) and mold in Illela, Sokoto state, Northwest Nigerian.

II. MATERIALS AND METHOD

EXPERIMENTAL SITE

The two (2) experiments were conducted at Illela, located in Sokoto state, Northwest Nigeria. The area lies within the semi-arid region of the country and experiences long dry season with high temperature ranging between 35^{oc} and 45^{oc}and short eratic rain periods. These climatic conditions make cowpea storage highly susceptible to insect and Fungal infestations, particularly the cowpea weevil (*Callosobruchus maculatus* and mold growth.

EXPERIMENTAL DESIGN

The research comprised two experiments, each conducted under a controlled laboratory condition, using a complete randomized Design (CRD), with ten (10) treatments replicated four (4) times.

EXPERIMENTAL MATERIALS

Experimental materials used were

- Cowpea (*Vigna unguiculata)* seeds obtained from an accredited agro-input store in Illela Sokoto state metropolis to ensure purity and uniformity
- Young adults of cowpea bruclids (*Callosobruchus maculatus*) obtained from two (2) months multiplication culture in 10Kg cowpea seeds in non-air tight container.
- Eight plant-based bio-pesticides such as; Wood ash, Grape peel (*vitis vinifera)* powder, Ginger (*zingiber officinale)* rhizome powder, moringa (*moringa oleifera)* leaf powder, scent leaf (*ocinum gratissimum*) powder Alligator pepper (*Aframomum meleguata)* powder, Jatropha curcas (Physic nut) leaf powder and Turmeric (*curcuma longa)* rhizome powder.
- Two (2) synthetic pesticides such as phostoxin (fumigant) and mancozeb 80% WP+ Acetamprid 40% (fungicide plus insecticide) obtained from an accredited agro-input store in Illela, Sokoto state metropolis.
- A wooden storage cage with four (4) partitions. The cage measured 120cm (height) x60cm (width)x 40cm (depth), netted with a wooden door in each partition making a total of four (4) doors for adequate ventilation and easy observation.
- **Production of bio-pesticides**
  The plant materials (Grape peel, Ginger, moringa, scent leaf, Alligator pepper, Turmeric and *Jatropha curcas* were sundried until crisp, and

ground separately into fine powders with a clean mechanical grinder. These were used immediately to avoid caking.

- Wood ash was collected from burnt woods from a charcoal kitchen.

DATA COLLECTION (Experiment 1)

Data were collected on:

- Number of eggs laid by weevils during restricted infestation/attack
- Number of eggs laid by weevils during unrestricted infestation/attack.
- Number of holes created by weevils during restricted infestation/attack
- Number of exit holes created by weevils during unrestricted infestation/attack
- Loss in grain weight due to attack by weevils obtained by subtracting the weight after the attack from the initial weight before the attack.

Experiment 2

- Number of eggs laid by weevils 14 DAI and 28 DAI
- Number of exit holes created by weevils 14DAI and 28DAI.
- Mold incidence 28DAI.

Statistical analysis:

The data collected were analyzed using the genstate release (2012) and analysis of variance outlined by Obi (2001). Separation of treatment means for significant effect was done using fisher's least significance deference (F-LSD) Method.

III. RESULTS

Effect of the pesticides on the mean number of eggs laid during restricted and unrestricted attacks.

The result of the experiment showed significant pesticides treatment effect ($P \leq 0.05$) on the mean number of eggs laid by the cowpea weevil during restricted attack. The control recorded the highest mean number of 986.01 eggs followed by moringa, alligator pepper and ginger with mean number of 503.00, 492.50 and 455.50 eggs respectively whereas phostoxin recorded the lowest mean of 0.00 egg followed by turmeric with a mean of 152.45 eggs. However, during unrestricted attack, a mean number of 483.00 eggs were laid on samples treated with phostoxin which was also the lowest among all the treatment means. This indicated that phostoxin being a fumigant performs better in an enclosure than in open situation.

Table 1. Effect of the pesticides on the mean number of eggs laid on the grains by the cowpea weevils during restricted and unrestricted attacks.

Treatments	Restricted	Unrestricted
Control	986.01	1910.00
Wood ash	312.02	1529.00
Grape peel powder	160.03	875.00
Ginger rhizome power	455.50	623.00
Moringa leaf powder	503.00	1035.00
Scent leaf powder	372.50	880.00
Alligator pepper fruit powder	492.50	615.00
Phostoxin (synthetic fumigant)	0.00	483.00
Jatropha curcas leaf powder	353.50	644.00
Turmeric rhizome powder	152.45	741.00
F – LSD $_{(0.05)}$	259.80	335.80

Effect of the pesticides on the mean number of exit holes created on the grains by cowpea weevils during restricted and unrestricted attacks.

Statistical analysis of the experiment showed significant treatments effect ($P \leq 0.05$) on the mean number of exit holes created on the grains by the cowpea weevils during restricted and unrestricted attacks. During restricted attacks, the control recorded the highest mean exit holes of 64.00, while phostoxin recorded the least mean value of 0.00 exit hole followed by turmeric, grape peels and jatropha with mean values of 14.81, 17.25 and 22.85 exit holes respectively. On the other hand, during unrestricted attacks, control also recorded the highest mean number of

130.89 holes and phostoxin also recorded the least means number of 0.00 exit hole followed by jatropha, turmeric alligator pepper with mean number of 46.53, 50.51, and 77.95 exit holes respectively (Tables 2).

Table 2. Effect of the pesticides on the mean number of exit holes created on the grains by cowpea weevils during restricted and unrestricted attack.

Treatments	Restricted	Unrestricted
Control	64.00	130.89
Wood ash	29.30	88.90
Grape peel powder	17.25	92.96
Ginger rhizome power	27.05	98.86
Moringa leaf powder	24.95	82.79
Scent leaf powder	35.85	102.86
Alligator pepper fruit powder	29.95	77.95
Phostoxin (synthetic fumigant)	0.00	0.00
Jatropha curcas leaf powder	22.85	46.53
Turmeric rhizome powder	14.81	50.51
F – LSD $_{(0.05)}$	14.85	45.64

Effect of pesticides on the mean weight loss of seeds (g) due to weevils attack.

There was significant treatment effect ($P \leq 0.05$) on mean weight loss of seeds (g) due to weevils attack. The control had the highest seed weight loss of 7.48g as a result of weevils attack, followed by wood ash that recorded 6.30g and moringa with 6.26g, while phostoxin recorded the least weight loss of 1.01g, followed by turmeric, ginger, scent leaf, jatropha, alligator pepper with 3.02g, 6.23g and 6.24g respectively (Table 3).

Table 3. Effect of the pesticides on the mean weight loss of seeds (g) due to weevils attack.

Treatments	Seed Weight Loss (g)
Control	7.48
Wood ash	6.30
Grape peel powder	6.24
Ginger rhizome power	6.20
Moringa leaf powder	6.26
Scent leaf powder	6.23
Alligator pepper fruit powder	6.24
Phostoxin (synthetic fumigant)	1.01
Jatropha curcas leaf powder	6.24
Turmeric rhizome powder	3.02
F – LSD $_{(0.05)}$	2.04

Effect of the pesticides on the mean number of eggs laid, mean number of exit holes by weevils and mean number of seeds infested by mold, twenty eight days after infestation (28 DAI).

The result of the experiment showed significant treatment effect ($P \leq 0.05$) on all the parmeters taken. Treatment eight (8) (Mancozeb + Acetamprid) being a combination of fungicide and insecticide, completely suppressed egg oviposition and fungal growth on cowpea seeds. The control recording a lower number of 96 eggs laid and higher exit holes of 95 than all the bio-pesticides used actually showed that bio-pesticides acted as luring agents (atractant) for eggs oviposition and at the same time poses detaring activities against egg hatching. Again, since there was no significant difference between treatment means of mancozeb + acetamprid (synthetic pesticide) and the bio-pesticides used, bio-pesticides could be used as better sustainable alternatives to synthetic pesticides against grain storage insect pests. On mold infestation of seeds, mancozeb + acetamprid recorded the least mean number of 0.00 infested seed, followed by alligator pepper, ginger, control and moringa with mean number of 1.00, 2025, 2.25 and 3.25 seeds respectively. The result of the experiment therefore suggests that those bio-pesticides that recorded higher means of mold infestation than the control should not be used to preserve grains in storage (Table 4)

Table 4. Effect of the pesticides on the mean number of eggs laid, mean number of exit holes by weevils and mean number of seeds infested by mold, twenty-eight days after infestation (28DAI)

Treatments	Number of Eggs.	Number of Exit Holes	Number of seeds Infested by mold
Control	96.00	85.00	2.25
Wood ash	207.00	28.20	4.00
Grape peel powder	211.00	16.80	10.25
Ginger rhizome power	206.00	31.20	2.25
Moringa leaf powder	199.00	9.80	3.25
Scent leaf powder	162.00	21.80	4.50
Alligator pepper fruit powder	174.00	10.20	1.00
Phostoxin (synthetic fumigant)	0.00	0.00	0.00
Jatropha curcas leaf powder	172.00	22.00	4.25
Turmeric rhizome powder	205.00	15.20	5.75
F – LSD $_{(0.05)}$	209.40	78.15	3.49

IV. DISCUSSION AND RECOMMENDATION

In the two experiments carried out, phostoxin being a synthetic fumigant insecticide exhibited a complete control of *Callosobruchus maculatus* (Cowpea weevils) in stored cowpea grains, and was closely followed by turmeric rhizome powder and grape peel powder which control effects were not significantly different from that of the phostoxin. Although, phostoxin is a well-known synthetic chemical used to protect grains against storage insect pests, it causes health hazards, poses residual effects and also not eco-friendly unlike bio-pesticides.

Traditionally, synthetic pesticides have been widely used to control pests like the cowpea weevils. These chemicals are often fast-acting and highly effective, making them an attractive option for farmers seeking to protect their stored produce (Pimentel, 2005). However, in response to the health risk chemical pesticide residues on food pose to consumers, particularly when used indiscriminately or inappropriately, bio-pesticides have emerged as promising alternatives. In view of this, I therefore recommend Turmeric rhizome powder and grape peel powder to be used in grain storage as sustainable approach to pest management.

This finding is in agreement with Isman, 2006 who stated that Bio-pesticides, derived from natural sources such as plants, bacteria and fungi, offer a more sustainable approach to pest management and are generally considered to be safer for human health and the environment compared to synthetic pesticides. He further gave *Azadirachta indica* an extract from plant like Neem as an effective pesticide in controlling a wide range of insect pests including the cowpea weevils. Also, Awere and Nkollo (2024) found Bio-pesticides as sustainable alternatives to synthetic pesticides in crop production.

The result of experiment one (1) showed that phostoxin, turmeric rhizome powder and grape peel powder exhibited significantly higher control of cowpea weevil, in restricted infestation than in unrestricted infestation. This research also revealed that turmeric powder and grape peel powder could be considered as potential bio-pesticide fumigants, since their pest control potency is higher in a closed environment than in an open one, just like phostoxin which is a well-known standard conventional synthetic fumigant pesticide in use today.

In the second experiment, fungal colonization of stored cowpea seeds differed significantly ($P \leq 0.05$) among treatment means. Mancozeb + acetamprid completely suppressed fungal infestation (0.00 infested seed, followed by Alligator pepper powder (1.00 infested seed) and Ginger (2.25 infested seeds). The result of this experiment therefore suggests that alligator pepper and ginger could be used to control fungal incidence in stored agricultural produce since their effect did not significantly differ from that of Mancozeb + acetamprid. It is also important to note in this experiment that some bio-materials such as grape peel powder, Turmeric, scent leaf, wood ash and moringa encourage mold infestation instead of suppressing it in stored produce, and therefore should not be used if the intention of the famer is to control storage mold.

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