Efficacy of *Azadirachtine and Allium Sativa* Powder as Biopesticides of Beans Weevil (*Callosobrunchus Maculatus)* In Store Cowpea *(Vigna unguiculata*)

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Abstract

In Nigeria, the loss that occur after harvest of food crop/produce can be considered as a major parameter of food insecurity. *Azadirachtine* (from *Azadirachta indica* tree) and *Allium sativa* (Garlic bulbs) are tested as biopesticides to explore the effectiveness of dry residues in control of beans weevil and extended life span of the produce during storing. A 3x3 factorial experiment was design in a Complete Randomized Design (CRD) with two replicated. The result of the study indicated that all the treatment has shown high repellence against beans weevils at different treatment rate (5,10,15gm) throughout the period of the research. However, there was no significance difference between 5, 10, and 15 grains for all the treatments including *Azadirachtine*, *Allium sativa* and combination of *Azadirachtine* and *Allium sativa* powders. The beans weevil mortality rate during 48 days of treatment with different amounts of *Azadirachtine* and *Allium sativa* powders shows high mortality rate of *Callasobrunchus maculatus* compared to the control. However, there was significant mortality rate recorded for each treatment during 48 days of storage. The highest mean mortality rate was recorded for *Azadirachtine* powder than the *Allium sativa* powder, and combination of *Azadirachtine* and *Allium sativa powders*. Therefore, this research concluded that *Azadirachtine* and *Allium sativa* powders can be used as effective insect repellents.

Key words: - Plant extracts, Treatment, Weevils, Beans seeds, Mortality rate

INTRODUCTION

A storage pest can be described as any living organism (smaller animals and insects) that is capable of, and causing destruction to stored food items or other organic substances. It has the potential to cause serious cost-effective and dietary damage to agricultural produce and products. The presence of these insects in store food products can also be a source of very harmful odour which subsequently lead to complete pollution of the produce. In most cases the waste product and remains of the insect may be deposited of the food items (Mondal, 2016).

The most important pest of Cowpea (*Vigna unguiculata*) in store is the beans weevil (*Callosobrunchus masculatus*) (Asawalam et al., 2015). This insect is known to be problematic in terms of control and when not treated carefully, it may lead to complete contamination of the store beans with objectionable pesticides during application, especially when chemical pesticide is to be used (Sighamony et al, 2014).

The use of chemicals in the treatment of food items is highly discouraged due to public health concerns especially as it lacks safety guarantee and the attending environmental negative consequences, thus the shift to natural/biological control method which are now gaining more popularity and increasing public acceptability worldwide especially those of plants derivation (Radha, 2014). Chemical insecticides are also not readily available to the rural populace coupled with lack of funds for purchase by the rural farmer as it is costly. It is also often seen as been adulterated by the traders and mostly obsolete. Rural farmers not properly trained on the proper handling and safety of the chemicals leads to noxiousness (khalaquzzaman, 2016). Exporting the potential to utilize the pesticidal properties of plants has become a key focus of research in pest control, some plants are known to contain bioactive metabolites, which show antifeedant repellent and toxic effect on a whole range of insect pests (Oparaeke *et al.*, 2017). *Allium sativum* is commonly known for its antimicrobial activities. The extract of oil and powder are known to comprise of dynamic ingredients mechanisms like Amino acid, typically known as Alicin and an enzyme refers to as Alinase. These ingredients constitute an antibiotic that can be used as antibacterial and antifungal agents useful in food produce management and sustainable storage. The extract from *Allium sativa* exhibits insecticidal potential and show substantial noxiousness to a significant population of insects' varieties (Mousa *et al.*, 2013). The need for use of plant-based pesticides such as plant essential oils and powders which are environmentally friendly is very necessary (Zira *et al*, 2012).

Consequently, this work is design to explore the potentials for grounded *Azadirachta indica seed* and *Allium sativa* bulb powders in control of beans weevil and improve storability cowpea using bioinsecticide.

METHODOLOGY

The research was carried out in the Biology Laboratory of the Federal Polytechnic, Damaturu Yobe State, Nigeria in which Open Pollinated Variety (OPV) of Cowpea (*Vigna unguiculata*) commonly grown by the local farmers were used. A 5kg bean seeds was obtained from Yobe State Agricultural Development Programme (ADP). The beans were sieve to remove, dirty and broke seeds and other debris. The clean beans were randomly sampled and packed into 2kg containers and stored in a refrigerator for 2 weeks to kill any prior sources of the *Callosobrunchus maculatus* and eggs which might already be pre-existing. The beans were transferred into 375ml bottles with minimally perforated lids to prevent weevil from escaping and for aeration. The seeds were

collected from *Azadirachta indica* tree within Damaturu metropolis, while *Allium sativa* was purchase from local market at Damaturu town. The *Azadirachta indica* seed samples were air dried at ambient temperature to avoid photo degradation of its active ingredient by ultra-violet rays in line with the recommendation of (Salako, 2012). For *Allium sativa*, the samples were chopped and dried then grounded to fine powder using grinding machine and sieve with a 10mm pore size. Then fine powder was then kept in air-tight containers until required.

Preparation of Insect Culture

The parent stock of bean weevil *Callosobrunchus maculatus* were gotten from infested beans. The insect was cultured under room temperature. The food media for the insect culture was 1kg beans seed for *Callosobrunchus. maculatus.* The 1kg beans seed was measured and transferred into different glass jars and 100 adult insect pests were introduced into each culturing medium which spanned for 45 days period.

DATA COLLECTION

Test for Repellence

In carrying out the insects' repellant test, the standard Garcia, (2010) method was adopted in which Crystal-clear plastic tubing's 13cm long x 1.3cm diameter test cylinder was used. Each test cylinder was plugged at one end with fine mesh tulle containing 5, 10 and 15gms of *Azadirachtine* seeds and *Allium sativa* bulb powders, while the other end was plugged with cotton ball which serve as control. About 30 weevils were introduced at the middle of each test cylinder through a hole at the middle portion of the cylinder. The cylinder were left undisturbed and the number of weevils that move towards the untreated halves of the cylinders were counted and rated every hour, for the first five (5) hours and at 24, 48 and 96 hours thereafter and the Repellency rating was determined.

Mortality Test

The rate at which the bean weevils die off during the experiment as a result of application of the different treatments (*Azadirachta indica* seed powder and *Allium sativa* bulb powder) for the first and second treatments respectively were determined while a combination of the two initial treatments (*Azadirachta indica* seed powder + *Allium sativa* bulb powder) make up the third treatment. The treated bean seeds were allowed to stand without interruption for one hour, subsequently, adults beans weevils (30 number) were introduced per treatment. The containers with the insects were covered with filter paper and sealed with molten wax so as to prevent the insects inside from escaping. The untreated beans seeds were used as the control and fourth treatment in the experiment. All the treatments were designed in two replications. The rate of death of the bean weevil was measured by physically counting dead weevils at an interval of 24 and 48 hours after exposure to the treatment. The mortality count was carried out during the day when the bean weevils were very active due to high temperature and relative humidity. The rate at which the adult mortality was determined is by counting the number of dead insects and applying the formular presented below.

Beans seed assessment was determined by using hundred beans seed

$$HBS = \frac{\text{Initial HBS} - \text{Final HBS}}{\text{Initial HBS}} \text{ X 100}$$

Key: HBS = Hundred Beans Seed

Progeny Emergence

The treated beans seed and the control were kept in containers in conducive culture conditions for 48 days. At the end of the culture period, the number of emergence insect pest for each treated beans seed and the control was recorded.

Statistical Analysis

The rate of mortality/migration of the insect pest was determined by calculating the number of progeny emergence from the treated bean seeds after six (6) weeks. Means were separated based on M-Turkey HSD (Honesty Significantly Different) test and ANOVA was carried out using the SPSS software version 25.0.

Results and Discussion

The test result for repellence of bean weevil (*Callosobrunchus maculatus*) against *Azadirachta indica* seed powder (*Azadirachtine)* and *Allium sativa* powders are presented below.

Table 1: Mean values for repellence test of bean weevil (*Callosobrunchus maculatus*) under different treatment conditions/measures of *Azadirachtine* and *Allium sativa* powders over time

Treatment		24hrs			48HRS	
Grams	AZ	AS	AZ+AS	AZ	AS	AZ+AS
0	3.15±0.21	3.15±0.21	3.15±0.21	3.15±0.22	3.15±0.22	3.15±0.22
5	4.68±0.13	4.08±0.35	4.25±0.27	4.08±1.01	2.84±0.58	3.32±0.06
10	5.57±52	5.85±0.41	3.46±0.14	4.57±1.50	3.46±0.53	3.87±0.38
15	6.68	5.53±0.57	6.81±0.66	6.03±0.14	4.01±0.56	4.53±0.15

Key: AZ - *Azadirachtine,* AS - *Allium sativa*, AZ+AS - *Azadirachtine* and *Allium sativa*

Significant repellence of the bean weevils was observed in all the different treatments meted i.e. (5, 10, and 15 grams) during the period of the experiment. Nevertheless, there was no significance difference among the treatments. Similar result was obtained in a study by Vityanna (2016) using *Azadirachta indica* leaves powder in which it was found to show significant effect in terms of repellence of the insect pest. The common bean weevil (*Callosobrunchus maculatus)* is widely known to be a major source of economic loss in cowpea. The principal control measure of this insect pest is the use of chemical pesticides, and this has been observed (Anonymous) to have serious environmental negative consequences and also to the consumers of the products due to residual effect, thus the need for natural sources such as plant materials which are biodegradable.

The death rate or mortality rate of the Bean weevils in the experiment over the duration of 24 and 48 days of treatment of the bean seeds using varied quantities of *Azadirachta indica* seed powder (*Azadirachtine)* and *Allium sativa* powders are as presented in table below.

Table 2: Mortality rate of bean Weevils after 24 days of treatment with different quantities of *Azadirachta indica* (*Azadirachtine)* and *Allium sativa* powders.

Treatment		**24days**	
Grams	**AZ**	**AS**	**AZ+AS**
0	0.00	0.00	0.00
5	18.25±3.26	8.81±0.01	6.02±3.26
10	27.82±3.26	16.36±0.01	8.81±0.01
15	65.38±4.84	16.37±0.01	16.69±4.80

Key: AZ - *Azadirachtine,* AS - *Allium sativa*, AZ+AS - *Azadirachtine* and *Allium sativa*

Table 3: Mortality rate of bean Weevils after 48 days of treatment with different quantities of *Azadirachta indica* (*Azadirachtine)* and *Allium sativa* powders.

Treatment		**48days**	
Grams	**AZ**	**AS**	**AZ+AS**
0	0.00	0.00	0.00
5	18.25±3.26	8.81±0.01	6.02±3.26
10	29.82±3.26	16.38±4.80	8.81±0.01
15	42.57±2.38	21.35±2.38	29.36±2.38

Key: AZ - *Azadirachtine,* AS - *Allium sativa*, AZ+AS - *Azadirachtine* and *Allium sativa*

The result of the study also indicated that the mortality rate increases with increase in the concentration of the treatment applied in both cases. That is to say, the mortality rate is highest in 15grams of both powders as compared to the 10 and 5 grams concentration as presented in Table 2. However, no mortality was recorded in the control (0grams) application as expected.

Table 4: Bean weevil progeny emergency rate during 48 days storage period

Treatment			
Grams	**AZ**	**AS**	**AZ+AS**
0	0.95±0.21	0.95±0.21	0.95±0.21
5	-0.19±0.07	0.32±0.07	-0.17±0.04
10	-0.32±0.07	0.25±0.09	-0.30±0.04
15	-0.40±0.04	0.04±0.04	-0.34±0.04

Key: AZ - *Azadirachtine,* AS - *Allium sativa*, AZ+AS - *Azadirachtine* and *Allium sativa*

The rate at which Beans weevil progeny appear during extended period of beans seed storage after treatment with *Azadirachtine* and *Allium sativa* powders is as presented Table 4 above. Consequently, the maximum progeny appearance observed in only the control group in all the treatments. The initial appearance of new progeny was noticed only after 48 days for experimental groups. The least progeny appearance was observed for 15gm *Azadirachtine* powder followed by combination of *Azadirachtine* and *Allium sativa* powders while the highest progeny appearance was observed in *Allium sativa* powders.

It was generally observed from the result of the study that, in all the experimental groups, highest progeny appearance was observed in 5gm powder treatment while the least was seen in the 15gm powder treatment, thus indicating that increase in quantity of treatment powders have inhibitory effect on weevil population. Similar studies were carried out by Zahradeen (2015), in which significantly higher mortality rate of bean weevils was observed after direct exposure of bean weevil for 3 days 5 and 10% doses.

The rate of bean Seed weight loss and percentage germination due to damage by beans weevil (*Callosobrunchus maculatus*) on the seeds after 48 days of treatment with *Azadirachtine* and *Allium sativa* powders are presented in table 5 below.

Table 5: Assessment of Seed weight loss due to damage by beans weevil (*Callosobrunchus maculatus*) and germination percentage on beans seed after 45 days of treatment with *Azadirachtine* and *Allium sativa* powders.

Treatment		**BWL (%)**			**G (%)**	
Grams	AZ		AZ+AS	AZ	AS	AZ+AS
0	36.57±0.51	36.57±0.51	36.57±0.51	62.46±4.85	62.46±4.85	68.50±3.45
5	16.00±3.85	23.18±1.42	20.04±2.22	70.40±2.10	59.01±5.56	3.32±0.06
10	87.50±2.10	68.01±2.63	68.02±1.40	4.57±1.50	3.46±0.53	3.87±0.38
15	8.25±0.94	10.41±2.73	8.94±2.51	89.00±1.40	76.40±2.10	75.41±0.61

Key: BWL= Bean weight loss, G= Germination, AZ=*Azadirachtine,* AS= *Allium sativa*, AZ+AS= *Azadirachtine* and *Allium sativa*

From the result of the experiment, a significance differences between control and treatment groups in both seed weight loss and germination test was recorded. The maximum loss and the least percent germination was recorded for control group (ie with no treatment) indicating that *Azadirachtine* and *Allium sativa* powders can be used to reduced beans seed weight loss during post-harvest storage. Moreso, the treatment with minimal percentage beans seeds weight loss and the highest percentage germination was the *Azadirachtine* powders treatment demonstrating strong efficacy of *Azadirachtine* powder over the *Allium* sativa powder and combination of the two treatments.

CONCLUSION

It can therefore be concluded based on the findings of the work that, *Azadirachtine* and *Allium sativa* powders may well be applied as effective repellant of beans weevil during post-harvest storage with close monitoring and application. Also, *Azadirachtine* and *Allium sativa* powders can readily be used as a

biopesticide and control choice in integrated storage pest management by especially the peasant farmers. Further studies need to be carried out to ascertain and select the most effective botanical pesticides.

REFERENCES

Asawalam, E.F., Emosairue, S.O. and Hassanali, A. (2015). Contribution of different constitutents to the toxicity of essential oil of vermonia amygadlina (compositae) and *Xylopia aetiopica* (Annonaceae) on Maize weevil, *Sitophilus Zeamais* Motshulsky (*Coleopatra curculioniade*). *Africa Journal of biotechnology;* **7**: 3771-3776.

Garcia, J.R. (2010). Bioassay of five botanical material against the bean weevil (*Callosobrunchus maculatus*) on mung bean (*Vigna radiata*) *Journal of stored product and post harves Research 9* **(2)**: 8-15.

Khalaquzzaman, T.H. (2016). Insecticidal product from local *Azadirachta indica* A. Juss and *Plectranthus glandulosus* Hook for the protection of stored grains against the infestation of *Callosobrunchus maculatus* and *Sitophilus Zeamais.* Dissertationen aus dem Julius Kuhn-institute, p 190.

Mondal, M. (2016) Toxicity of natural occurring compounds of plant essential oil against *Tribolium castaneum. Journal of Biological sciences* **10:** 10-17.

Mousa, B., Lowenberg, B.J. Fulton, J, and Boys, K. (2013). The economic impact of cowpea research in West and Central Africa: A regional impact assessment of improved cowpea storage technologist *Journal of stored product Research.* **47**: 147-156.

Oparaeke, K.M., Khodeir, A.I., El-Dakhakhni, T.K. and Youssef, A.E. (2017). Effect of Garlic and Eucalyptus oils in comparison to organophosphate insectidies against some piercing – sucking faba beans insect pest and natural enemies population. *Egyptian Academica Journal of Biological Science* **5 (2):** 21-27.

Radha, R. (2014). Toxicity of three plant extract against bean weevil, *Callasobrunchus maculatus* (F) and maize weevil, *Sitophilus Zeamais* Motsch. *Int. J. Curr, Res,* **6:** 6105-6109.

Salako, E.A. (2012). A Review of Neem bio-pesticide shadia utilization and challenges in central Nigeria.

Sighamony, G., Tefera, T. and Tadesse, A. (2014). Efficacy of intergraion of three management tactics relative to unitary tactics against maize, weevil, *Sitophilus zeamais* (*Mostchulksy colepotera curculionidae*) of stored maize in Ethiopia. *Journal of Stored product and postharvest Research* **9(2):** 10-25.

Vijyanna, P. (2016): Effect of fumigation on seed quality during storage of beans. M.Sc. thesis Univ. Agric. Sci. Dharwad, Karnataka India.

Zahradeen, Y. (2015). The beans seed weevil, *Bulletin of Entomological Research,* **49(2):** pp 385-404.

Zira, P., Kaigama, I., Joseph, U and Isah, H. (2012). Studies on Relative Resistancce and Susceptibility of bean seed to beans weevil *Bulletin of Entomolgical Research* **49(2):** 225-2