



## EFFICACY OF OLIVE SEED POWDER AND DIATOMACEOUS EARTH AGAINST COWPEA WEEVIL (*CALLOSBRUCHUS MACULATUS* FAB. ON STORED COWPEA

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### ABSTRACT

The study evaluated the efficacy of olive (*Olea europaea*) seed powder and diatomaceous earth (DE) as eco-friendly alternatives to chemical insecticides for controlling cowpea weevil (*Callosobruchus maculatus*) on stored cowpea seeds. The experiment was conducted in the Entomology Laboratory of the Department of Agricultural Technology, Mohamet Lawan College of Agriculture, Maiduguri. The treatments consisted of four rates (0.0, 250, 500, and 750 g kg<sup>-1</sup>) of both olive seed powder and diatomaceous earth. These were laid out in a Completely Randomized Design (CRD) replicated three times. Data were collected on adult mortality at 24, 48, and 72 hours after exposure. Results showed that both treatments significantly ( $P < 0.05$ ) increased mortality of *C. maculatus* compared to the control. Olive seed powder caused progressive mortality with increasing dosage and exposure time, reaching 100% mortality at 750 g kg<sup>-1</sup> after 72 hours. Diatomaceous earth, however, performed more effectively, achieving 100% mortality at 500 g kg<sup>-1</sup> within 72 hours and at 750 g kg<sup>-1</sup> within 48 hours. The superior performance of DE is attributed to its desiccating action on the insect's cuticle, leading to dehydration, while olive seed powder likely acted through bioactive secondary metabolites. This study confirms that both olive seed powder and diatomaceous earth are effective, low-cost, and environmentally safe materials for the management of *C. maculatus* in stored cowpea. The use of DE at 500 g kg<sup>-1</sup> is recommended for small-scale farmers due to its rapid action and affordability. Further studies on synergistic combinations of both materials are suggested to enhance sustainable storage pest management in tropical environments.

**Keywords:** Cowpea, Weevil, Olive, Diatomaceous earth, Storage, Pest.

### INTRODUCTION

Cowpea [*Vigna unguiculata* L. (Walp.)] is one of the most important food legumes in the tropics and sub-tropics valued for its high protein content and role in food security (Togola *et al.*, 2023). In West and Central Africa, cowpea constitutes the cheapest source of dietary protein for low-income earner of the population thus helping to alleviate protein, malnutrition in human (Kim *et al.*, 2025). It is also an important cash crop that makes up part export commodities for the countries cultivating it. Nigeria produces about 48% of the production in Africa and 46% worldwide (IITA, 2020). Other countries with significant area and seed production in West Africa include Niger, Benin, Togo, Ghana, Mali, Burkina Faso and Senegal (Singh *et al.*, 2006). After harvest, the crop is normally stored by farmers in the pod, and much of it is stored in mud granaries while the rest is stored in sacks. A granary may hold from 100 to 500 kg of seed (Caswell, 2001). Eggs of some insect species are usually laid on the Tipening pods and larvae or adults may be found at harvest. Such insect pest species include the Agromyzid, *Melanagromyza vignalis* Spencer, the apionid, *Varius* and the bruchids, *Bruchidius atrolineatus* Pic., *Piezotrachelus Callosobruchus rhodesianus* Pic., *C. maculatus* (Fab.), *C. chinensis*, *C. analis* rab.), *C. phaseoli* and *Acanthocelides obtectus* (Hajam and Kumar, 2022). The bruchids *B. atrolineatus* and *C. maculatus* have been reported as the main bruchid species attacking stored cowpea in the sahelian zone of West Africa (Stoll, 2000), Caswell, (2001) reported that *C. maculatus* alone accounts for over 90% of the damage done to cowpea seeds. According to Hajam and Kumar (2022) elevated temperature and relative humidity significantly enhance insect metabolism, reproduction, and



survival, thereby leading to a rapid increase in the number of insect population density during storage. Complete loss of grain (upto 100%) can occur within 3-5 months of storage due to infestation by *C. maculatus* (Hajam and Kumar, 2022). Caswell, (2001) reported that damage of the seeds in the Nigerian markets varied from 14 to 37% and losses amount to 24,000 tonnes yearly (4% of national production). It has been estimated that a 5% loss of cowpea due to bruchid infestation cost Nigeria US \$30 million per year (Caswell, 2003). This kind of situation also prevails in other tropical countries and these high losses might have contributed immensely to cowpea's subsidiary position in the farming systems of several countries in the tropics.

Farmers have been reported using even banned and highly toxic chemical insecticides in their quest to protect their agricultural products against insect pests. These poisonous pesticides have been reported to affect the nervous system, producing a range of symptoms from nausea, vomiting, headache, dizziness to seizures, convulsions and sometimes death in addition to development of tolerance by treated insects (Brinks *et al.*, 2000). Therefore, in small-scale farming, control of storage insect pests should not become dependent on the use of fumigants or residual insecticides. There is a tremendous wealth of traditional local knowledge on the use of plant materials in storage protection (Govindan *et al.*, 2010). Some of this knowledge has been neglected over past decades. However, there is an increasing interest and necessity to reactivate the knowledge (Stoll, 2000).

Therefore, it has become necessary to search for an option that can produce satisfactory result in a way that such option is not only acceptable to the farmers, but must also be feasible from a socio-economic stand point. In the present circumstance, an approach that would rely on the use of plant products (without involving synthetic pesticides) appears to hold the greatest hope for increased cowpea production in the traditional cereal-dominated cropping system throughout the tropics and sub-tropics, including Nigeria. The main objective of the study were to;

- i. determine the mortality rate of *C. maculatus* caused by Diatomaceous earth (Diafil) and olive seed powder on stored cowpea;
- ii. determine minimum effective dosage for controlling the stored Coleopteran beetles.

## **MATERIALS AND METHODS**

### **Experimental site**

The study was carried out in the Entomology laboratory of the Department of Agricultural Technology, Mohamet Lawan College of Agriculture, Maiduguri. The experiment was carried out under ambient conditions of temperature 27-32 OC, a relative humidity of 65-75%, and a photoperiod of 12-hour light: 12-hour darkness. The study was carried out over a period of 72 hours, which lies between latitude 11050' and 120 05' North and longitude 130 09' and 120 20' East in the North eastern agro-ecological zone of Nigeria.

### **Sources of Experimental Materials**

The cowpea seed variety locally called "*Banjara*" were obtained from Borno State Agricultural Development Program (BOSADP) Maiduguri, Borno State. To eradicate any potential insect eggs and larvae, the seeds were handpicked to remove damaged ones and contaminants, the clean seeds were put in a polyethylene bag, firmly tied with a rubber band and inserted into a transparent airtight plastic bucket, and underwent a 72-hour sterilization process at -5°C in a deep freezer, exploiting the susceptibility of all insect life stages to low temperatures (Sinclair *et al.*, 2003). The seeds were disinfected by means of sun drying for 72 hours, and then put into plastic bucket covered with lid before commencement of the experiments. Following deinfestation, the seeds were left to air dry naturally for 72 hours in the laboratory, a precautionary measure to prevent mould growth on the seeds before use for the experiment (Adedire *et al.*, 2011).

### **Insect Culturing Procedure**

The stocks of adult *C. maculatus* was obtained from the Entomology laboratory of Mohamet Lawan College of Agriculture, Maiduguri and were used in raising new progenies of the same cohort. The adults of *Callosobruchus maculatus* 50 pairs of newly emerged (1-2days old) adults were placed in jars containing the cowpea seeds, the jars were covered with perforated lids to allow for aeration, for a maximum of 2 weeks. They were then allowed for mating and oviposition. The parent insects were



removed afterwards and the seeds containing the eggs was transferred to fresh seeds in rearing jars measuring 500ml which were covered with pieces of muslin cloth, fastened with rubber bands to prevent the contamination of the seeds and escape of the beetles. The subsequent progenies emerging from the stock were then used as parental generation for the experiments.

### Experimental Procedure

The experiment was laid out in a completely randomize design (CRD) with four (4) treatments replicated three times making 12, the treatment are: T<sub>1</sub> (0.0g/kg) which serve as control (untreated) others include T<sub>2</sub> Olive seed powder (250g/kg), T<sub>3</sub> (500g/kg) and T<sub>4</sub> (750g/kg) respectively. The same procedure was used for the diatomaceous earth (DE).

150g sample were divided into 3 jars measuring 50g each where appropriate treatment and insect species were added to each 250ml capacity jar and then shaken vigorously for 3 mins in order to achieve active distribution and attachment of the ingredients to the seed. And then arranged them in the laboratory shelf in random manner. Insect mortality were observed after 24hrs, 48hrs, and 72hrs of exposures by counting dead insect in each jar.

### Data Analysis

All data collected were subjected to one way analysis of variance and the different between the mean was separated using Tukey-Kramer HSD test at 5% level of probability.

## RESULTS

### Effect of Olive Seed Powder on Mortality of *C. Maculatus*

The result in Table 1 showed the effect of olive seed powder on mortality of *C. maculatus* on stored cowpea. The results indicated that olive seed powder exhibited a significant insecticidal effect on *C. maculatus*, and that mortality increased proportionally with both dosage and exposure duration. At 250 g/kg, mortality was  $28.1 \pm 3.1\%$  after 24 hours, increasing to  $70.0 \pm 4.0\%$  after 72 hours. The highest dose (750 g/kg) achieved complete (100%) mortality after 72 hours of exposure, indicating a strong dose-dependent effect. At all the application rates, there were significant difference with the untreated control.

**Table 1:** Effect of Olive Seed Powder on Mortality of *C. maculatus* on Stored Cowpea

Application Rate (g/kg)	Mortality (Exposure Period)		
	24hrs	48hrs	72hrs
0.0	0.0+0.0 <sup>d</sup>	1.0+0.1 <sup>d</sup>	1.0+0.1 <sup>d</sup>
250	28.1+3.1 <sup>c</sup>	64.3+4.3 <sup>c</sup>	70.0+4.0 <sup>c</sup>
500	49.6+3.6 <sup>b</sup>	76.3+2.0 <sup>b</sup>	91.3+0.9 <sup>b</sup>
750	62.0+2.5 <sup>a</sup>	86.0+1.5 <sup>a</sup>	100+0.0 <sup>a</sup>
F	26.2	25.8	35.2
P	<0.0001	<0.0001	<0.0001

\*Means within a column followed by same letters are not significantly different from one another (Turkey Kramer's HSD Test, P< 0.005).

### Effect of Diatomaceous Earth (DE) on Mortality of *C. maculatus*

The result in Table 2 showed the mortality of *C. maculatus* on cowpea seeds treated with D.E. The result revealed that mortality increase with increase in application rate. Diatomaceous earth (DE) performed exceptionally well against *C. maculatus*, producing 100% mortality at 750 g/kg after 48 hours, and at 500 g/kg after 72 hours of exposure. Even at the lowest concentration (250 g/kg), mortality reached 76.3% after 72 hours, significantly higher than the untreated control.

**Table 2: Effect of Diatomaceous Earth (DE) on Mortality of *C. maculatus***

Application Rate (g/kg)	Mortality (Exposure Period)		
	24hrs	48hrs	72hrs
0.0	1.0+1.0 <sup>d</sup>	2.0+1.0 <sup>d</sup>	3.0+0.2 <sup>c</sup>
250	49.6+3.6 <sup>c</sup>	64.3+4.3 <sup>c</sup>	76.3+2.0 <sup>b</sup>
500	62.0+2.5 <sup>b</sup>	91.3+0.9 <sup>b</sup>	100.0 <sup>a</sup>
750	86.0+1.5 <sup>a</sup>	100.0 <sup>a</sup>	—
F	21.2	33.8	25.3
P	< 0.0001	<0.0001	<0.0001

\*Means within a column followed by same letters are not significantly different from one another (Turkey Kramer's HSD Test,  $P < 0.005$ ).

## DISCUSSION

The findings of this study clearly demonstrated that both olive seed powder and diatomaceous earth significantly reduced the survival of *Callosobruchus maculatus*, with DE showing superior efficacy. These results align with earlier studies emphasizing the effectiveness of natural and inert materials for bruchid control.

Adedire *et al.* (2011) reported that several plant-derived materials such as cashew kernel extracts, neem seed powder, and groundnut oil caused over 90% mortality of *C. maculatus* within 72 hours, which is consistent with the 100% mortality recorded for olive seed powder at 750 g/kg in this study. Similarly, Govindan *et al.* (2010) documented that powders from seeds and leaves containing phenolics, saponins, and flavonoids act as repellents, anti-feedants, or toxins against storage beetles. The current results therefore validate the traditional use of plant materials in protecting stored grains.

The outstanding performance of DE corroborates the findings of Stoll (2000) and Caswell (2003), who reported that diatomaceous earth provided complete protection of cowpea and maize grains under tropical storage conditions. Its mechanical action makes it highly reliable, even against pesticide-resistant populations, because it does not rely on chemical toxicity. Sinclair *et al.* (2003) also observed that DE's efficacy increases under warm and dry environments—similar to the ambient conditions of the present study (27–32 °C and 65–75% RH).

Moreover, this study supports the call by Togola *et al.* (2023) and Kim *et al.* (2025) for integrating non-synthetic pest management strategies into sustainable cowpea production systems in West Africa. With Nigeria being the largest cowpea producer globally (IITA, 2020; Singh *et al.*, 2006), adopting eco-friendly approaches like DE and olive seed powder could reduce post-harvest losses while minimizing human and environmental health risks associated with synthetic insecticides.

## CONCLUSION AND RECOMMENDATION

The present findings confirmed that both olive seed powder and diatomaceous earth are effective bio-rational options for the control of *C. maculatus* in stored cowpea. However, DE at 500 g/kg is more effective, faster-acting, and economically viable. Future research should be conducted to examine the synergistic effects of combining olive seed powder with DE to further enhance storage pest management under diverse environmental conditions.

## REFERENCES

- Adedire, C. O., Obembe, O. M., Akinkurolere, R. O., & Oduleye, O. (2011). Response of *Callosobruchus maculatus* (Coleoptera: Chrysomelidae: Bruchinae) to extracts of cashew kernels. *Journal of Plant Diseases and Protection*, **118**(2): 75–79. <https://doi.org/10.1007/BF03356489>
- Brinks, M. E., Harvey, J. C., & Taylor, R. L. (2000). Human health impacts of pesticide exposure in developing countries: A review. *Environmental Health Perspectives*, **108**(4): 240–248. <https://doi.org/10.1289/ehp.00108240>
- Caswell, G. H. S. (2001). Damage to stored cowpea in the northern part of Nigeria. *Samaru Journal of Agricultural Research*, **17**(1), 11–19.



- Caswell, G. H. S. (2003). *Insect pests of stored grain and pulses in Northern Nigeria: Biology, ecology, and control*. Samaru Agricultural Research Bulletin 1: 1–20.
- Govindan, R., Ramaswamy, S., & Kumar, M. S. (2010). Traditional plant-based pest management practices: An overview. *Indian Journal of Traditional Knowledge*, **9**(3): 497–502.
- Hajam, Y. A., & Kumar, R. (2022).** *Management of stored grain pest with special reference to Callosobruchus maculatus, a major pest of cowpea: A review*. *Heliyon*, **8**(1): 87-93. <https://doi.org/10.1016/j.heliyon.2021.e08703>
- International Institute of Tropical Agriculture (IITA). (2020, October 16). *Cowpea: Improving livelihoods in sub-Saharan Africa*. Retrieved from <https://www.iita.org/crops/cowpea/>
- Kim, D. K., Park, S., Agbicodo, E. M., & Muchero, W. (2025). Cowpea (*Vigna unguiculata*): Production, genetic improvement, and adaptation in Africa. *Frontiers in Plant Science*, **16**: 137-142. <https://doi.org/10.3389/fpls.2025.1378214>
- Sinclair, B. J., Vernon, P., Jaco-Klok, C., & Chown, S. L. (2003). Insects at low temperatures: Ecological perspectives. *Journal of Thermal Biology*, **28**(5): 257–262. [https://doi.org/10.1016/S0306-4565\(02\)00101-3](https://doi.org/10.1016/S0306-4565(02)00101-3)
- Singh, B. B., Ajeigbe, H. A., Tarawali, S. A., Fernandez-Rivera, S., & Abubakar, M. (2006). *Improving the production and utilization of cowpea as food and fodder*. *Field Crops Research*, **98**(2–3), 209–218. <https://doi.org/10.1016/j.fcr.2006.03.003>
- Stoll, G. (2000). *Natural crop protection in the tropics: Letting information come to life* (2nd ed.). Margraf Verlag, Weikersheim, Germany.
- Togola, A., Datinon, B., Laouali, A., Traoré, F., Agboton, C., Ongom, P. O., Ojo, J. A., & Ba, N. M. (2023). Recent advances in integrated pest management of cowpea in West Africa. *Frontiers in Agronomy*, **5**: 1220387. <https://doi.org/10.3389/fagro.2023.1220387>