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RESEARCH ARTICLE

RESPONSE OF FIVE SELECTED STORED LEGUME SEEDS SPECIES TO OVIPOSITION DETERRENT, OVICIDAL AND GRAIN PROTECTANT ACTIVITIES OF SOME BOTANICALS AGAINST *Callosobruchus Maculatus* (FAB.) (*Coleoptera: Chrysomelidae*)

Augustine Matthew Adinoyi[a], Ofuya Thomas Inomisan[b], Idoko, Joy Ejemen[b], Adesina Jacobs Mobolade[c*]

[a] Department of Crop, Soil and Pest Management, University of Africa Toro-Orua, Bayelsa State, Nigeria
[b] Department of Crop, Soil and Pest Management, Federal University of Technology, P. M. B. 704, Akure, Ondo State, Nigeria
[c] Department of Crop Production Technology, Rufus Giwa Polytechnic, P. M. B. 1019, Owo, Ondo State, Nigeria.
**Corresponding Author Email: mobolades ina@rugipo.edu.ng*

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ABSTRACT

Ten plant powders were tested at 2% on five legume seeds for their entomocidal effects against *Callosobruchus maculatus*. A completely randomized design (CRD) with five pairs of freshly emerged adult bruchids was used to treat 40g of disinfected legume seed types with 2g of the selected plant powders. An analysis of variance was performed on the data on the percentage of oviposition deterrence, hatchability, pest tolerance, and weight loss. *Zanthoxylum zanthoxyloides* (87.02%) *P. guineense* (77.36%) and *E. aromatica* (73%) significantly deterred oviposition. The maximum percentage egg hatched was recorded in *G. max* (94.71%) and significantly lower on *C. cajan* with *P. guineense* (2.33). Ife Brown (20.83%) recorded significantly lowest tolerance compared to *M. pruriens* (99.17%). Percentage weight loss was significantly reduced in *G. max* irrespective of treatment and *M. pruriens* suffer no weight loss. Incorporation of *Z. zanthoxyloides*, *P. guineense* and *E. aromatica* powder proved to be promising biopesticide.

KEYWORDS

egg hatchability: egg laid; legume seed types; percentage pest tolerance; resistance and susceptibility; *Vigna subterranean.*

1. INTRODUCTION

Grain legumes serve as the most important sources of dietary protein, oil, and micronutrients like iron and zinc, that are lacking in the diets of the vulnerable groups (Adesina et al., 2019a; Ofuya, 1986). Grain legumes also fulfils the protein demand of vegetarian and low-income groups of the population (Viashali et al., 2018). However, they become infested with Bruchid Beetles *Callosobruchus maculatus* (Fab.) (Coleoptera: Chrysomelidae), a cosmopolitan polyphagous stored legumes insect pest during postharvest storage (Bushara, 1988, Kashiwaba, et al., 2003; Ofuya, 2001; Adebayo et al., 2013). Within three to four months of storage, the infestation rate on grains may reach 50%. (Oparaeke and Dike, 2005). Damage caused by the insect leads to quality and quantity deterioration of the grains thus resulted in loss of weight, seed viability, nutritional and economic value and makes the grains unfit for human consumption (Adesina and Idoko, 2013; Adesina et al., 2019b; Rawat and Srivastava, 2011).

Chemical control using fumigants and synthetic insecticides has dominated efforts to stop insects and other storage pests from wreaking havoc (Akinkurolere et al., 2006). Although it has been claimed that these pesticides work well against pests on stored goods but with various attendant problems such as residual toxicity, widespread environmental and health hazards, genetic resistance by insect species which have directed the need for the development of alternative strategies that are effective, ecofriendly and biodegradable pesticides (Isman, 2006; Dayan et al., 2009). Empirical evidence have shown that plant derivatives mixed with stored food grains, reduced oviposition rate, suppressed adult bruchids emergence and also reduced seed damage rate (Golob and Webley, 1980; Prakash and Rao, 1997; Joey et al., 2001; Pugazhvendan et al., 2009; Khater, 2011).

In order to prevent infestation among susceptible legume seed species when stored together, it is essential to be aware of host preference, the biology of the insect pest, and how the environment interacts with it. This will help prevent a large buildup of the *C. maculatus* population and their preference for less preferred host grains of the polyphagous insect pest. (Kosini and Nukenine, 2017). The physical appearances of legume seed types can also limit their tolerability by *C. maculatus* females for oviposition. Oviposition suppression agents are crucial to the storage beetle's life cycle because they establish the circumstances for progeny development from the egg to the adult stage in ensuring generational development (Mitchell, 1990). Hence, the need to investigate *C. maculatus* infestation suppression through use of insecticidal active botanicals thus mitigate the undiscriminating usage of synthetic chemicals and their attendant shortcomings.

2. MATERIALS AND METHODS

2.1 Experimental Conditions

The study was conducted in the Entomology Laboratory of the Department of Crop, Soil, and Pest Management at the Federal University of Technology in Akure, Ondo State, Nigeria (7° 16' N, 5° 12' E), under ambient conditions of 28 ± 2°C temperature, 70 ± 5% relative humidity, and a 12L: 12D photo regime.

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2.2 Collection and Preparation of Legume Seed Types

Five legume seed types were collected from the International Institute of Tropical Agriculture (IITA), Ibadan, Nigeria. The seeds were hand-selected to guarantee that only entire, uninfected seeds were used, however, they were nonetheless sterilized in a freezer at -5° C for seven days to eradicate any undetected infestations (Adesina et al., 2012; Augustine et al., 2016). The seeds were then removed and allowed to adjust and acclimate for 24 hours at room temperature in the open laboratory before being used to prevent mould growth. (Olotuah, et al., 2007; Idoko and Adesina, 2012). The morphological characteristics of the legume's seeds examined were texture and colour. The colour was visually observed, while texture was observed by rolling the seeds between the thumb and index fingers.

Table 1: Morphological Characteristics of The Six Legumes Seeds.

Legumes	Common name	Texture	Colour
Cajanus cajan (L.) Mill-	Pigeon pea	Rough	Brown
Glycine max (L.) Merrill	Soya bean	Smooth	Milky
Vigna subterranean L. Verdcourt	Bambara Groundnut	Smooth	Brown
Sphenostylis stenocarpa Hochst. Ex A. R.	African yam Bean	Smooth	Glossy milk
Mucuna pruriens (L.)	Velvet Bean	Smooth	Black

2.3 Preparation of Botanical Powders Used as Treatment:

Oryza sativa bran was obtained from a rice mill in Iju-Itaogbolu, Ondo State, Nigeria, the well-researched insecticidal plants indicated in Table 2 were purchased from a local herb shop in Oja-Oba, Akure, Ondo State, Nigeria. In the lab, the various plant materials were air dried before being individually processed into fine powders. The powders were sieved through a $1mm^2$ screen and kept cool and dry until usage in an airtight nylon bag. Cypermethrin dust a synthetic insecticide used as standard check (control) was purchased from agro chemical store.

Table 2: Different Botanicals with The Part Used for The Study

Scientific Name	Family	Common name	Part used
Eugenia aromatica (O. Berg)	*Myrtaceae*	Clove plant	Pod
Zanthoxylum zanthoxyloides (Lam)	Rubiaceae	Candlewood	Root bark
Piper guineense (Schum and Thonn)	Piperaceae	West African black pepper	Seed
Oryza sativa L.	Poaceae	Rice	Bran
Allium sativum L.	Alliaceae	Garlic	Bulbs
Momordica charantia Linn.	Cucurbitaceae	Bitter melon	Leaf
Ocimum gratissimum L.	Lamiaceae	Clove Basil	Leaf
Xylopia aethoipica (Dunal A. Rich)	Annonceae	Negro pepper	Pod
Nicotiana tabacum (L.)	Solanaceae	Tobacco	Leaf
Zingiber officinale (Rosc.)	Zingiberaceae	Ginger	Rihzomes

2.4 Insect Culture

A well-known susceptible cowpea variety, Ife Brown, was obtained from the International Institute of Tropical Agriculture (IITA) and was subcultured on it in a 2-liter Kilner jar, covered with muslin cloth to allow for adequate aeration. The original culture of *C. maculatus* used for the study was obtained from already infested cowpea grains purchased from Oja-Oba market in Akure, Ondo State, Nigeria. About 400 g of thoroughly cleaned and sterilized cowpea seeds were placed in a subculture along with 10 pairs (10 males and females each) of adult *C. maculatus* in order to facilitate oviposition and provide a consistent flow of emerging adults for the study.

2.5 Entomotoxic Test

About 40g of the disinfected legumes seeds were weighed separately into a Petri-dish (9.0cm) and 2g of the chosen plant powders were added to a petri dish. The Petri dish was thoroughly shaken to guarantee equal mixing and coating of the powders with grains (Adesina and Ofuya, 2011). Each ten newly developed adult bruchids of both sexes were then introduced into the petri dishes of each group. Based on the outline used and the color of the plate covering the end of the abdomen, the sex was identified (Iloba et al., 2007). In contrast to the male, who has a smaller plate with no stripes, the female has a larger plate that is darkly colored on both sides (Christopher and Lawrence, 2014). Five replicates of each treatment and control were used, and they were set up in the lab in an undisturbed completely random design (CRD). At 5 and 7 days after infestation, respectively, observations were taken on the number of eggs laid and hatching eggs, and the percentage weight loss following the emergence of adults was noted at the conclusion of the study. These data were used to determined; percentage reduction of egg laid or oviposition deterrent, hatchability, pest tolerance and weight loss respectively (Arivoli and Tennyson, 2013; Olakojo et al., 2007; Abdullahi et al., 2011; Ileke and Oni, 2011).

2.6 Data Analysis

Using SPSS version 16.0, an analysis of variance (ANOVA) was performed on the data obtained on the number of eggs laid and the number of eggs that hatched. To guarantee data normalization and homogeneity prior to ANOVA, data based on counts (numbers of egg laid and hatched eggs) were square root transformed and data based on percentages were arc-sine transformed. The Abbott formula was also used to assess the extent to which the botanicals proved effective (Abbot, 1925). The formula for Abbot: (1-Ta/Ca) x 100 where Ca represents the number of eggs in the control petri dish and Ta represents the number of eggs in the petri dish that was treated. The Tukey test was used to differentiate the significant treatment means of the investigated parameters at the 5% level of significance.

3. Results

3.1 Oviposition Response of *C. Maculatus* to Active Botanicals on Some Legume's Seeds

Figure 1 to 3 reveals an overview of *C. maculatus* oviposition response and percentage pest tolerance to the six varieties of legume seed. The result shows that legume types significantly ($F = 1.36$; $df = 4$; $P < 0.05$) influence *C. maculatus* oviposition preference in terms of percentage egg laid reduction and egg hatched and percentage pest tolerance. *M. pruriens* (85.33) had the highest mean number of eggs laid compared to the other types of legume seed, while *S. stenocarpa* came in second. (72.00) whereas the lowest number of eggs were laid on *C. cajan* (46.67) and statistically lower than number of eggs laid on Ife brown (Figure 1). Meanwhile, number of hatched eggs was highest in *G. max* (59.67), trailed by *V. subterranean* (44.00) and *C. cajan* (18.67) had the least (Figure 2). Percentage pest tolerance was significantly lowest ($F = 3.47$; $df = 4$; $P<0.05$) in Ife Brown (20.83) compared to *M. pruriens* (99.17%) that had the significantly highest ($F = 1.34$; $df = 4$; $P<0.05$) percentage of pest tolerance, followed by *S. stenocarpa* (83.33) and *C. cajan* (Figure 3).

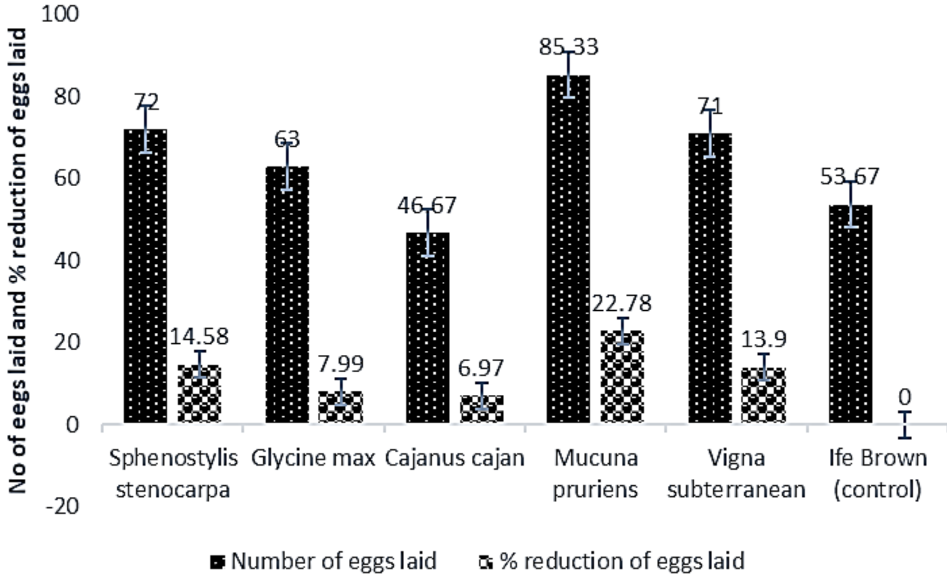

Figure 1: Number of eggs laid and percentage reduction of eggs laid

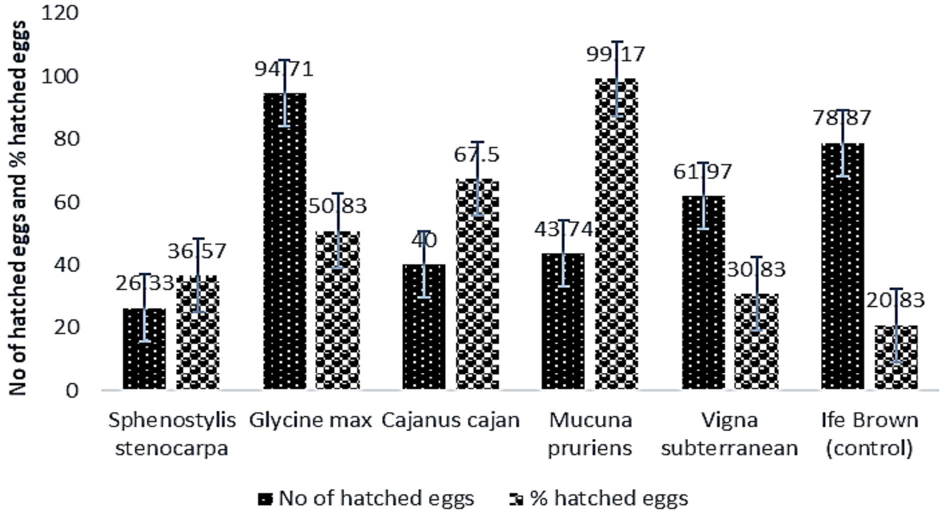

Figure 2: Number of hatched eggs and percentage hatched eggs

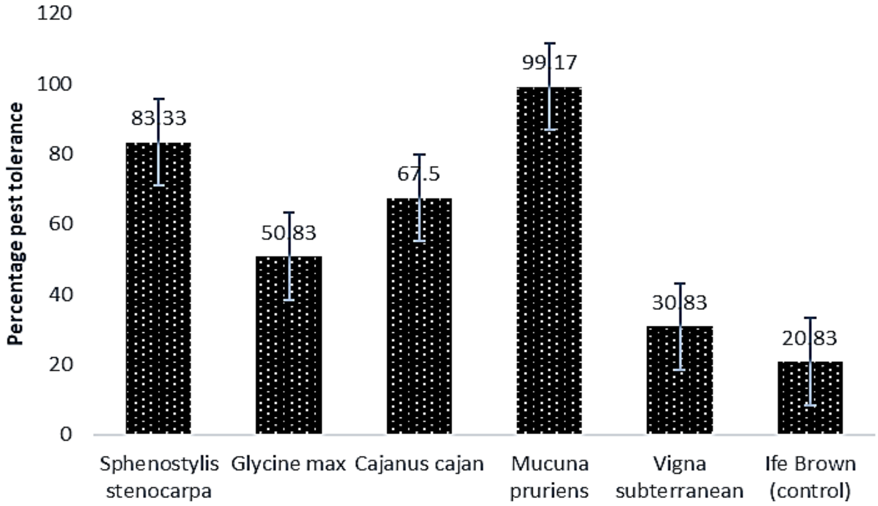

Figure 3: Percentage pest tolerance of some legumes seeds preserved with some botanicals

3.2 Oviposition Deterrent Potentials of Some Botanicals on Legumes Seeds

Results in Table 4 showed that *C. maculatus* egg laying capabilities was significantly influenced (F = 2.52; df = 4; P > 0.05) in relation to the various botanicals and legumes seeds types. *C. cajan* preserved with *P. guineense* (4.33), *E. aromatica* (7.67) and *Z. zanthoxyloides* (17.00) recorded significantly lowest number of eggs laid compared to other plant powders and control but was not significantly different from those laid on Cypermethrin (12.67). The number of eggs laid ranged from 8.67 to 151.00 in seeds treated with *G. max*; substantially more eggs were laid in seeds treated with *O. gratissimum* (151.00), *M. charantia* (145.00), *A. sativum* (144.00), *Z. officinale* (141.33), and *X. aethiopica* (141.33). (130.67) compared with *P. guineense* (8.67), *E. aromatica* (11.00) and other botanicals treated seeds (Table 4). Additionally, it was uncovered that the number of eggs was significantly higher on seeds treated with *X. aethiopica* (114.67), *O. gratissimum* (106.33), and *M. charantia* (96.33) compared to seeds treated with *Piper guineense* (24.00), *Z. zanthoxyloides* (24.00), and *E. aromatica* (28.67) (F = 3.13; df = 4; p0.05).

S. stenocarpa seeds treated with *O. sativa* (17.33) and *Z. zanthoxyloides* (31.33) had expressively lesser amount of eggs laid compared to those preserved with *Z. officinale* (175.33), *X. aethiopica* (152.67), *M. charantia* (135.33) and *A. sativum* (105.67) that recorded significantly increased number of eggs laid (Table 4). Meanwhile, *Z. zanthoxyloides* (3.67) followed by *O. sativa* (17.00) recorded significantly lower (F = 2.39; df = 4; P<0.05) quantity of eggs set on *M. pruriens* seeds. All the plant materials used, did not significantly suppressed oviposition by *C. maculatus* irrespective of the types of legume seeds in comparison with control and Cypermethrin treated seeds (Table 4).

Table 4: Number of Eggs Laid by *C. Maculatus* on Different Types of Legume Seeds Treated with Botanical Powders

Plant species	*Cajanus cajan*	*Glycine max*	*Vigna subterranea*	*Sphenostylis stenocarpa*	*Mucuna pueriens*
E. aromatic	7.67±1.16d	11.00±1.16c	28.67±2.93cde	84.67±3.41abcd	44.33±2.85abc
P. guineense	4.33±0.46d	8.67±2.22c	24.00±1.78cde	82.00±4.62abcd	26.00±1.84abc
X. aethiopica	141.00±2.46ab	130.67±5.54a	114.67±6.99ab	152.67±3.37ab	90.00±3.01abc
Z. officinale	139.00±3.62ab	141.335.06a	83.33±3.25abcd	175.333.46a	142.33±5.45a
M. charantia	93.00±4.12abc	145.003.18a	96.33±2.68abc	135.33±6.56abc	129.67±7.08a
O. gratissimum	157.33±3.72ab	151.006.52a	106.33±5.32abc	98.00±3.46abcd	139.33±3.02a
O. sativa	26.33±2.55cd	15.67±1.75c	53.00b±3.01cde	17.33±0.62cd	17.00±1.89bc
Z. zanthoxyloides	17.00±2.27d	23.00±0.85bc	24.00±2.12de	31.33±1.46bcd	3.67±0.61c
A. sativum	124.00±3.52ab	144.00±7.02a	64.00±2.73bcde	105.67±4.62abcd	57.33±3.36abc
N. tabacum	55.00±4.26cd	45.67±abc	53.33±6.34bcde	71.33±4.92abcd	104.33±6.12ab
Cypermethrin	12.67±1.22d	15.67±0.73c	9.00±2.07e	14.67±2.21d	16.33±1.94bc
Control	177.67±5.53a	96.33±5.68ab	201.33±5.65a	160.33±7.91a	62.67±4.04abc

The Tukey test indicates that there is no statistically significant difference between the means in each column with the same letter at the 5% level of probability.

3.3 Ovicidal Activities of Some Botanicals Against *Callosobruchus Maculatus* of Different Legume Seeds

Table 5 shows number of hatched eggs on different types of legume seeds treated with botanical powders. In *C. cajan* seeds treated with *P. guineense* (2.33), *E. aromatica* (5.00) and *Z. zanthoxyloides* (14.33) there were considerably fewer eggs that hatched compared to a substantially larger (F = 2.15; df = 4; P 0.05) number of hatching eggs in seeds treated with *O. gratissimum* (140.67), *Z. officinale* (124.33) and *X. aethiopica* (115.67).

Egg hatchability was considerably decreased (F = 2.03; df = 4; P<0.05) on G. max seeds treated with *P. guineense* (5.00) and *E. aromatica* (8.33) among other treatments. *Oryza sativa* (11.67) and Z. zanthoxyloides (14.33) came after it. Meanwhile, seeds treated with *A. sativum* (130.67), *M. charantia* (98.67) and *Z officinale* (89.67) were substantially more prevalent in hatching eggs.

Vigna subterranean seeds treated with *Z. zanthoxyloides* (17.00) recorded significantly (F = 2.17; df = 4; P<0.05) lowest hatched among the various botanicals used. On the other hand, the number of hatched eggs was considerably more (F = 4.95; df = 4; P<0.05) in seeds treated with *X. aethiopica* (96.67), *M. charantia* (89.33) and *Z. officinale* (70.67) ineffectual in lowering the hatchability of eggs deposited by *C. maculatus* (Table 3).

Results obtained from *S. stenocarpa* treated seeds showed that hatched eggs was significantly (F = 3.05; df = 4; P<0.05) affected by the various plant powders (Table 4). Seeds treated with *O. sativa* and *N. tabacum* (12.67) recorded significantly lower hatched eggs compared to those treated with *X. aethiopica* (119.67), *Z. officinale* (108.33) and *M. charantia* (104.00) that recorded significantly higher (F = 3.85; df = 4; P<0.05) hatched eggs. Meanwhile, hatched eggs from *E. aromatica* (2.33) and *Z. zanthoxyloides* (2.67) powders treated *M. pruriens* seeds were significantly lower compared to those preserved with *Z. officinale* (109.67) and *M. charantia* (95.67) ensured considerably higher (F = 1.93; df = 4; P<0.05) mean hatched eggs.

Table 5: Percentage of Eggs Hatched from Eggs Oviposited by *C. Maculatus* on Legume Seeds Treated with Different Botanical Powders and Cypermethrin.

Plant species	*Cajanus cajan*	*Glycine max*	*Vigna subterranea*	*Sphenostylis stenocarpa*	*Mucuna pueriens*
E. aromatic	5.00±1.28d	8.33±2.73d	23.33±bcd	57.67±4.16ab	2.33±0.38c
P. guineense	2.33±0.83d	5.00±1.83d	22.67±bcd	27.00±3.32ab	5.00±1.15bc
X. aethiopica	115.67±5.57a	98.67±4.21ab	96.67±ab	119.67±6.13a	52.00±5.03abc
Z. officinale	124.33±4.91a	89.67±4.67ab	70.67±abc	108.33±8.41ab	109.67±8.45a
M. charantia	84.33±4.58abc	103.33±6.52ab	89.33±ab	104.00±6.65ab	95.67±7.32a
O. gratissimum	140.676.18a	82.67±5.47ab	93.67±6.53ab	78.33±5.57ab	94.67±5.64ab
O. sativa	24.00±3.05cd	11.67±0.56cd	49.33±5.12bcd	12.67±3.82b	13.67±3.13abc
Z. zanthoxyloides	14.33±0.66d	14.3319±1cd	17.00±1.46cd	18.33±2.43ab	2.67±1.22c
A. sativum	103.00±4.72ab	130.67±7.02a	55.33±3.85bcd	80.67±4.01ab	54.00±6.14abc
N. tabacum	35.00±2.12bcd	38.33±3,52bcd	45.67±2.25bcd	12.67±1.59ab	70.00±4.07abc
Cypermethrin	11.67±2.04d	13.33±2.25cd	6.00±1.04d	11.67±0.83b	11.33±1.84abc
Control	153.67±4.54a	66.33±3.94abc	171.33±5.72a	119.00±5.03a	39.67±4.92abc

The Tukey test indicates that there is no statistically significant difference between the means in each column with the same letter at the 5% level of probability.

3.4 Legume Seeds Treated with Various Botanical Powders and Their Percentage Weight Reduction

Percentage of weight loss in various *C. maculatus* infested legume seeds was documented in Table 5. The result bared that *M. pruriens* seeds preserved with botanical powders do not suffered any weight loss. Similarly, *G. max* seeds admixed with *E. aromatica*, *P. guineense* and *X. aethiopica* did not suffered weight loss, also no weight loss was noted in *V. subterranean* seeds preserved with *E. aromatica*. *C. cajan* seeds treated with *A. sativum* (6.43%) and *Z. officinale* (5.30%) ensured maximum ratio of weight loss whereas seeds preserved with *P. guineense* (0.40%) and *Z. zanthoxyloides* (0.83%) offered the minimum percentage weight loss.

Percentage weight loss was significantly higher (F = 4.59; df = 4; P<0.05) on *V. subterranean* seeds treated with *X. aethiopica* (21.50%) and *O. gratissimum* (20.53%) respectively. Meanwhile, *G. max, C. cajan* and *S. stenocarpa* treated seeds recorded non-significant weight loss among all the botanical treatments used except the control.

Table 5: Different Plant Powders' Effects on The % Weight Loss of Various Types of Legume Seeds

Plant species	*Cajanus cajan*	*Glycine max*	*Vigna subterranea*	*Sphenostylis stenocarpa*	*Mucuna pueriens*
E. aromatica	1.3±0.50a	0.00b±0.0	0.00±0.0b	1.67±0.32a	0.00±0.0
P. guineense	0.4±2.70a	0.00b±0.0	13.77±2.34ab	1.87±0,85a	0.00±0.0
X. aethiopica	3.4±1.50a	0.00b±0.0	21.50±2.68a	2.23±1.70a	0.00±0.0
Z. officinale	5.3±2.48a	0.17±1.67b	6.53±2.07ab	2.60±1.51a	0.00±0.0
M. charantia	2.43±1.18a	1.53±0.96b	14.37±1.94ab	1.87±1.14a	0.00±0.0
O. gratissimum	4.6±0.93a	1.20±2,54b	20.53±3.32a	3.37±0.63a	0.00±0.0
O. sativa	1.03±1.56a	0.00b±0.0	6.67±2.74ab	2.57±1.35a	0.00±0.0
Z. zanthoxyloides	0.83±1.43a	1.23±1.35b	6.77±2.73ab	1.67±0.96a	0.00±0.0
A. sativum	6.43±2.52a	2.17±1.12b	5.30±1.46ab	3.30±2.07a	0.00±0.0
N. tabacum	4.27±2.92a	0.43±1.26b	10.03±0.62ab	1.63±1.02a	0.00±0.0
Cypermethrin	1.27±0.68a	0.50±1.13b	3.17±1.89ab	3.13±0.11a	0.00±0.0
Control	5.07±1.19a	12.33±3.25a	14.00±2.77ab	2.83±2.55a	0.00±0.0

The Tukey test indicates that there is no statistically significant difference between the means in each column with the same letter at the 5% level of probability.

5. Discussion

According to numerous authors, the comparison of *E. aromatica, P. guineense, Z. zanthoxyliodes*, and *O. sativa* in the control of *C. maculatus* had been justified (Ivbijaro and Agbaje, 1986; Olaifa and Erhun, 1988; Lale, 1994; Ogunwolu and Odunlami, 1996; Adedire and Lajide, 2001). The present investigation has indicated that some of the bean varieties tested exhibited varied degrees of resistance and vulnerability to adult *C. maculatus* infestation. The result obtained clearly reveals, there was a substantial difference in the levels of resistance and susceptibility among the legume seed types to *C. maculatus*. It was discovered that Ife Brown and *M. pruriens* are very resistant and vulnerable to *C. maculatus* infestation, respectively. This confirms the findings of Oke and Olajire 2012, who found that different cowpea types varied in their susceptibility and resistance to *C. maculatus*. Seed characteristics such as seed coat texture (smooth or rough), hardness could and nutritional variables might have contributed to the ovipositional preference reported and minimize the destruction caused by *C. maculatus* to infested cowpea seeds.

According to the bruchid beetle favoured cowpea with a smooth seed cover less for oviposition (Messina and Renwick, 1985). While Ndakidemi and Dakora, 2003 noted that phenolics, alkaloids, and terpenes are abundant in *V. unguiculata* cultivars that are resistant to bruchids. It is clear that *C. maculatus* was susceptible to the insecticidal effects of the powders prepared from these plants. It was evident that *Z. zanthoxyliodes, E. aromatica* and *P. guineense* applied at 0.2g/10g of legume seed types performed as the best botanicals to exhibit insecticidal and ovicidal action in suppressing egg hatching and ultimately preserved stored legumes seeds from weight loss and consequently damage caused by *C. maculatus* infestation.

These findings corroborated Mbata's, 1993 findings that susceptibility index and weight reduction are typically substantially associated. The toxic effect exhibited by these botanicals may possibly be associated to the occurrence of secondary metabolites in the plants. The observed bioactivities of the plants against *C. maculatus* may be influenced by the relative concentrations of these compounds, their interactions, and the volatility of their products. *Zanthoxylum zanthoxyloides* contain compound known as zanthoxylol; *P. guineense* contains piperidine, piperine and chavicine, while *E. aromatica* contains bioactive compounds such as limonene, eugenol and cineole as the major active components which are ovicidal and have a lethal effect on insect pests in stored product (Udo, 2011; Akinneye and Ogungbite, 2013; Lale, 1995; Okonkwo and Okoye,1996). This could account for their identical response to the insects in the current investigation.

In the present study, oviposition was found not to only vary significantly with different plant materials but also with the legume types. *C. maculatus* laid suggestively less eggs on seeds preserved with diverse types of materials than control sets. *Mucuna pruriens* seeds do not suffered weight loss, while *G. max* treated with *E. aromatica, P. guineense* and *X. aethiopica* also do not recorded any weight loss indicating that *M. pruriens* and G. max may be resistant to *C. maculatus* because, despite the insect laying numerous eggs on the seed, it was unable to penetrate the seed in any way. Alternatively, it may be because the chemical components of the botanical powders have ovicidal properties that prevent *C. maculatus* females from ovipositing. Inhibition in oviposition, ovicidal effects, a larvicidal effect on neonate larvae before the penetration of the seeds or a larvicidal effect on larvae settled within the seed have all been reported to inhibit the reproduction of stored insects at various stages of the cycle (Ofuya, 1990; Regnault-Roger and Hamraoui, 1995; Kim et al., 2003). As a result, insects were unable to infest grain and and cause seed destruction/weight loss (Tapondjou et al., 2002; Pandey et al., 2011).

Another result was that hormoligosis may be the cause of the major ineffectiveness of botanical powders of *O. gratissimum, X. eithopica, Z. officinale, M. charantia, A. sativum*, and *N. tabacum* in safeguarding legumes. According to some studied sub-lethal dosages of botanical pesticides promote female oviposition as well as behavioral hormoligosis in oviposition preference (Lale, 1991; Abdullah et al., 2006). The reduction in weight loss of stored food grains is directly proportional to larvae feeding activities and insect population (Adesina and Mobolade-Adesina, 2020). Neonatal larvae must break through the outer skin of the legume seeds because *C. maculatus* females lay their eggs on the seed surface in order to reach the endosperm, where they feed. The lower weight loss noted in the study could be due to less oviposition, increased egg or larval mortality, or possibly decreased egg hatching. (Adesina and Mobolade-Adesina, 2020). The percentage of seed weight loss increased dramatically as larval density increased.

6. Conclusion

The study shows that *C. maculatus* oviposition deterrent and pest tolerance capabilities were significantly influenced in relation to the various botanicals and legumes seeds types. *Zanthoxylum zanthoxyloides, P. guineense* and *E. aromatica* powders possessed insecticidal, ovicidal and grains protectant properties. While *G. max*, *C. cajan* and *M. pruriens* exhibited low susceptibility to *C. maculatus* infestation. Therefore, incorporation of *Z. zanthoxyloides*, *P. guineense* and *E. aromatica* powder for controlling *C. maculatus* proved to be an encouraging biopesticide grain protectant for the safeguard of stored pulses seeds as replacements to synthetic insecticides. Conversely, mixture of pulse seed types in storage should be avoided or minimized since all the seeds with the exception of *M. pruriens* exhibited susceptibility to *C. maculatus* infestation. The tolerant seeds should be incorporated into grain legumes breeding programmes against *C. maculatus* infestation to suppress grain losses during storage.

Conflict of Interests Statement

The writers say they have no conflicting interests.

Authors Contribution

The experiment was developed, planned, and carried out by AMA; it was supervised by OTI; and its findings were analyzed and explained by IJE.

JMA gathered relevant literature and developed the manuscript draft. The paper has been read and approved by all authors.

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