

ISSN (Print): 2651-6144; ISSN (Online): 2651-6365 Website: http://www.jasd.daee.atbu.edu.ng INVESTIGATION OF COMBINED EFFECT OF THREE PLANT POWDERS WITH DIATOMACEOUS EARTH AGAINST CALLOSOBRUCHUS MACULATUS ¹Fayemiro, S. S. and ²Abdul, K. O.

¹Department of Crop Science and Horticulture, Federal University Oye-Ekiti, Ekiti. ² Department of Agricultural Science Education Lagos State University of Education, Lagos ***Corresponding Authors' Email:** <u>abdulko@lasued.edu.ng;</u> <u>oluwasegun.fayemiro@fuoye.edu.ng</u>.

GSM: +2347016981618

ABSTRACT

The study was conducted to investigate the combined effects of various plant powders and Silicosec, a diatomaceous earth, on Callosobruchus maculatus at the research laboratory of the Department of Crop Pest and Soil Management, the Federal University of Technology, Akure. The study included three replications. The treatments consisted of three (3) plant materials derived from the dry flower buds of Eugenia aromatica, seeds of Piper guineense, and leaves of Nicotiana tabacum and their combination with Silico-sec. In one experiment, 0.4g of each plant material was added to 20 C. maculatus adults (10 couples, aged 1-2 days) in 20g of Ife Brown cowpea seeds, all contained within an air-tight plastic container. Another experiment involved the addition of 0.4g mixtures of Silico-sec and each plant powder (E. aromatica, P. guineense, and N. tabacum) in various ratios (1:5, 5:1, 1:10, 10:1, and 1:1) to the same number of C. maculatus adults in 20g of cowpea seeds, also in separate air-tight plastic containers. All the treatments and their combination were laid out in a completely randomized design (CRD) repeated three times. Data were collected at 12, 24, and 48 at p,0hours post-treatment. Oviposition, adult emergence, and seed weight loss were evaluated. The results demonstrated that both the plant powders and Silicosec were effective in controlling C. maculatus infestation on cowpea by causing significant adult mortality at p< 0.05, reducing oviposition, suppressing F1 adult emergence, and minimizing seed damage. Among single applications, Silico-sec and E. aromatica powder provided the best protection for stored cowpea, yielding the highest adult mortality, lowest oviposition, most suppressed F1 adult emergence, and minimal seed damage. However, the mixture of Silico-sec and P. guineense at ratios of 5:1 and 10:1 offered the best protection, exhibiting significantly higher mortality, lower oviposition rates, suppressed F1 adult emergence, and reduced seed damage compared to other treatments. This study suggests that combination of P. guineense and Silico-sec is particularly effective in controlling cowpea storage pests and could serve as a viable alternative to synthetic insecticides for protecting stored cowpea against C. maculatus. Keywords: Combined, Effect, Investigation, Plant and Powders

INTRODUCTION

Legumes are high in protein, lipids, and carbohydrates, and hence play an important role in human nutrition. As a fast-growing crop, it reduces erosion by covering the ground, fixing atmospheric nitrogen, and contributing to soil fertility (Oyeyinka *et al.*, 2013). *Callosobruchus maculatus* is a major pest of leguminous crops because it thrives in tropical and subtropical temperatures all over the world. This pest targets legumes in the field and during storage, producing physical damage and quality loss as a result of post-harvest feeding and reproductive activity caused by larvae development along with devouring within seeds.



ISSN (Print): 2651-6144; ISSN (Online): 2651-6365 Website: http://www.jasd.daee.atbu.edu.ng

Furthermore, it results in significant economic losses for stored legume seeds due to reduced weight and germination (Musa and Adeboye 2017). High infestations of these insects are known to reduce seed quality and germination (Edde and Amatobi, 2003; Ali *et al.*, 2005). Damaged seeds are defaced with beetle egg covers, riddled with adult exit holes leading to reduced weight and poor seed germinating capacity. Severely damaged seeds are unfit for human consumption being reduced to powdery mass which often becomes mouldy.

The control of C. maculatus has been based primarily on the use of synthetic insecticides with either contact or fumigant action, and is quite effective. Over the years, however, use of synthetic insecticides for pest control has been accompanied by adverse effects such as toxicity to non-target organisms including man and development of pest tolerance or resistance (Nwosu LC 2008). The increasing concern over the negative effects of synthetic chemicals on the environment and human health has forced researchers to look for alternatives to them. Plants are endowed with myriad of chemical compounds which can be usefully exploited for plant protection purposes. Therefore, in the past few decades, scientists have focused on botanicals as likely source of materials that could replace the hazardous synthetic chemicals. Plant derived insecticidal materials are thought to be safer and more environment friendly than synthetic chemicals (Goudoungou *et al.*, 2018).

Traditionally, grain producers also use plant materials to mitigate insect damage to stored grain. Efficacy of the use of plant materials in the mitigation of insect damage to stored grain has been subjected to empirical verification by many workers, but with varying degrees of success (Ashamo 2019]. Products from single plant species have been involved in the efficacy studies against storage insect pests, a mixture of herbs is deployed against pest organisms [Suleiman 2021] For these reasons, the application of sustainable alternative management tools such as eco-friendly botanical insecticides, physical treatments, inert dusts, and microbial/bio control agents has been assessed (Abdelgaleil *et al.* 2021). To address this issue, numerous researchers have identified plant-based pest management products (Isman, 2013). Use of mixtures of herbal preparations against storage insects has not been adequately investigated. Therefore, in this current investigation, s The objective is to investigate the joint action between three insecticidal plant powders and a diatomaceous earth against *C. maculatus* for mortality, emerging adults, and seed weight loss caused by *C. maculatus* damaging stored gram seeds.

MATERIALS AND METHODS

The Study Area

Laboratory experiments were carried out in the research laboratory of the Department of Crop Pest and Soil Management, the Federal University of Technology, Akure, at room temperature of 28+ 20C and 75+ 5% relative humidity. The cowpea seed used was first disinfested by deep-freezing for 1 month and acclimatized to the open laboratory condition for 24 hours. The design of the experiment was completely randomized design (CRD) with four treatments replicated three times. Three plant powders and Diatomaceous earth powder were used against one cowpea cultivar. Mortality readings for were taken at 12, 24 and 48 hours after setting the experiment. Numbers of dead and live insects were recorded then the dead insects were discarded. The data obtained from progeny emergence were analyzed statistically and compared with the control and with one another.





(JASD)

Volume 7, Number 3, September, 2024 ISSN (Print): 2651-6144; ISSN (Online): 2651-6365 Website: http://www.jasd.daee.atbu.edu.ng

Initial Weight - Infested Weight ×100

20

...(1)

Rearing of test insect

Adults of *Callosobruchus maculatus* were initially obtained from an open market in Akure from a colony originating from infested cowpea seeds. Ife-brown, a susceptible variety of cowpea was used for culturing *C. maculatus* was purchased from Agricultural Development Programme (ADP) office in Akure, Ondo State, Nigeria. This same variety was used for the experiment in the laboratory at temperature 28+ 20C and 75+ 5% relative humidity

Preparation of Plant Powders

Three insecticidal plants, West African brown pepper, *Piper guineense, Eugenia aromatica* and *Nicotiana tabacum* were used for the investigation. Dry seeds of *P.guineense*, dry flower buds of *E. aromatica* and dry leaves of *N. tabacum* were sourced from a local market in Akure, Ondo State. The plants parts were air dried for two weeks. Thereafter, the plants materials were pulverized in a laboratory mill and sieved, through $300\mu m$ diameter mesh sieve. Each plant powder was immediately put in a separate plastic container with tightly fitting lids and kept under ambient laboratory condition. Control was set up without plant powder on seeds

Diatomaceous Earth

The diatomaceous earth was obtained from Federal Research Centre for Cultivated Plants, Julius Kunhn-Institute (JKI), Institute for Ecological Chemistry and Plant Analysis and Stored Product Protection Berlin Germany, supplied by AGRINOVA/BIOFA, Germany with the trade name SILICO-SEC.

Data Collection and Analysis

Data were collected on adult mortality, adult emergence, oviposition and % seed damage. All data collected were subjected to analysis of variance (ANOVA SPSS IBM 24) using Turkey test at 5% significance. while significantly different treatment means were compared using Tukey test at 5% level of significance (ANOVA) while significant means were compared using Tukey test at 5% level of significance.

RESULTS AND DISCUSSION

Comparison Effect of Single Application and Mixture of Plant Powders and Silico-sec on Adult Mortality and Oviposition of *Callosobruchus maculatus* on Treated Cowpea Seeds

The results in table 1 below presents the main effects of three plant powders and Silico-sec on adult mortality and oviposition of *Callosobruchus maculatus (C. maculatus)* on 20g treated cowpea seeds. At 12 hours post-treatment, *E. aromatica* powder caused the highest mortality, followed by *P. guineense*, Silico, and *N. tabacum*, with the control exhibiting the lowest adult mortality. By 24 hours, Silico-sec had the highest mortality, followed by E. *aromatica, P. guineense*, and *N. tabacum*, while the control still had the lowest mortality. At 48 hours, Silico-sec, *P. guineense*, and *E. aromatica* had the highest percentage mortality, with significantly lower mortality observed in the other treatments. Oviposition rates on control seeds were significantly higher than those on seeds treated with *N. tabacum, E. aromatica*, and *P. guineense* powder, while Silico-sec exhibited significantly lower oviposition compared to other treatments.



ISSN (Print): 2651-6144; ISSN (Online): 2651-6365 Website: http://www.jasd.daee.atbu.edu.ng

Regarding the mixture of plant powders and Silico-sec at a 1:1 ratio on 20g of treated cowpea seed, at 12 hours post-treatment, the combination of Silico and *E. aromatica* caused the highest mortality, followed by Silico and *N. tabacum*, then Silico mixed with *P. guineense*, with the control exhibiting the lowest adult mortality. By 24 hours, Si/lico mixed with *E. aromatica* and Silico mixed with *P. guineense* showed significantly higher adult mortality, followed by the mixture of Silico with *N. tabacum*, while the control had significantly lower adult mortality. At 48 hours, all treatment combinations showed significantly higher adult mortality compared to the control. Oviposition after the death of all insects was significantly higher in the control, while there were also significant differences in the combined effects of Silico with *P. guineense*, Silico with *E. aromatica*, and Silico with *N. tabacum*. The findings underscore the efficacy of both single applications and mixtures of plant powders and Silico-sec in controlling *C. maculatus* infestation on stored cowpea seeds, highlighting the potential of these treatments as bio pesticides for postharvest pest management. Further research is needed to optimize treatment formulations and application methods for practical implementation in storage facilities.

Table 1:	Comparison Effect of Single Application and Mixture of Plant Powders and Silico-
	sec on Adult Mortality and Oviposition of <i>Callosobruchus maculatus</i> on Treated
	Cowpea Seeds

Treatments	Percentage Adult Mortality at 12hrs	Percentage Adult Mortality at 24hrs	Percentage Adult Mortality at 48hrs	Oviposition After Death of All Insects
Control	4.61 ^b	12.92 ^b	19.88 ^b	22.22ª
P. guineense	14.76 ^a	18.04 ^b	33.00 ^a	10.32 ^c
Silico	14.76 ^a	36.27 ^a	46.92 ^a	7.28 ^d
N. tabacum	6.30 ^b	16.59 ^b	16.59 ^b	15.85 ^b
E. aromatic	18.04 ^a	18.61 ^b	31.93 ^a	11.12 ^c
Control (Mixture)	4.31 ^b	12.92 ^{bc}	16.59 ^b	19.86 ^a
Silico + P. guineense (1:1)	6.14 ^b	36.90 ^a	47.09 ^a	11.65 ^{bc}
Silico + E. aromatica (1:1)	16.21ª	39.15 ^a	45.00 ^a	6.53 ^c
Silico + N. tabacum (1:1)	10.45 ^a	34.14 ^{ab}	51.38 ^a	8.85 ^{bc}

Means in each column followed by the same alphabet(s) are not significantly different from each other by tukey test at 5% level of significance

Effect of Combinations of Silico-sec and Plant Powders on *Callosobruchus maculatus* Infestation at ratio 1:5 and 5:1 respectively

The results from Tables 2 below shed light on the efficacy of combinations of Silico-sec and plant powders in controlling *Callosobruchus maculatus* infestation on treated cowpea seeds. At ratio 5:1 it was observed that at 12, 24, and 48 hours post-treatment, the control group exhibited significantly lower adult mortality compared to all treatment groups. Conversely, there were no significant differences in adult mortality among the combinations of Silico-sec with *P. guineense*, Silico-sec with *E. aromatica*, and Silico-sec with *N. tabacum* at all-time points. Additionally, oviposition after the death of all insects was significantly higher in the control group compared to the combination of Silico-sec with *N. tabacum*, while no significant differences were observed in oviposition among the other treatment combinations. Similarly, at a ratio of 1:5, significant





Volume 7, Number 3, September, 2024

ISSN (Print): 2651-6144; ISSN (Online): 2651-6365 Website: http://www.jasd.daee.atbu.edu.ng

differences were observed in all treatment groups at 12 hours post-treatment, with Silico mixed with P. *guineense* resulting in the highest adult mortality followed by Silico mixed with E. *aromatica* and Silico mixed with N. *tabacum*, while the control group exhibited the lowest adult mortality. At 24 and 48 hours post-treatment, the combination of Silico with P. *guineense* and Silico with E. *aromatica* showed significantly higher adult mortality compared to the combination with N. *tabacum*, with the control group consistently exhibiting the lowest adult mortality. Oviposition after the death of all insects was significantly higher in the control group and the combination of Silico with N. *tabacum*, while no significant differences were observed in oviposition among the other treatment combinations.

Overall, these findings suggest that combinations of Silico-sec with plant powders can effectively control C. *maculatus* infestation on stored cowpea seeds. While the control group consistently exhibited lower mortality, the treatment combinations showed comparable efficacy in reducing adult mortality and oviposition rates. Further research is needed to optimize the formulations and concentrations of these treatments for practical application in storage facilities, aiming to minimize post-harvest losses and ensure food security.

Treatments	Percentage Adult Mortality at 12hrs	Percentage Adult Mortality at 24hrs	Percentage Adult Mortality at 48hrs	Oviposition After Death of All Insects
Mixture (1:5)				
Control	0.00c	8.61b	18.05b	20.29a
Silico + P. guineense (1:5)	14.76ab	19.50a	27.59a	13.14c
Silico + E. aromatica (1:5)	18.05a	18.05a	24.05a	13.59c
Silico + N. tabacum (1:5)	8.61b	14.76ab	21.34ab	19.36a
Mixture (5:1)				
Control	4.31b	12.92b	16.59b	17.91a
Silico + P. guineense (5:1)	16.76a	41.16a	45.00a	4.59b
Silico + E. aromatica (5:1)	16.45a	42.12a	45.00a	5.26b
Silico + N. tabacum (5:1)	16.76a	38.24a	47.88a	4.29b

Table 2: Combined Effect of Silico-sec and Plant Powders at Ratios 1:5 and 5:1 Effect on	1
Adult Mortality and Oviposition of Callosobruchus maculatus on Treated Cowpea Se	eds

Means in each column followed by the same alphabet(s) are not significantly different from each other by tukey test at 5% level

Combined Effect of Different Ratios of Silico-sec and Plant Powders at 1:10 and 10:1 on *Callosobruchus maculatus* on treated cowpea seeds

At ratio 1:10, the 12 hours post-treatment, have few significant differences among all treatments. However, at 24 hours, Silico-sec mixed with *P. guineense* exhibited a significantly higher percentage mortality compared to other treatments. By 48 hours, the combination of Silico-sec and *P. guineense* maintained a significantly higher percentage mortality compared to other treatments. In terms of oviposition rates, the control group had a significantly higher oviposition compared to the other treatments, indicating that the mixtures effectively reduced the reproductive success of *C. maculatus*. At 10:1, the 12 hours post-treatment and the control group had a significantly lower adult mortality. Among the treatments, Silico-sec mixed with *P. guineense* resulted in the highest adult mortality, followed by the mixture with *N. tabacum* and then *E.*





Volume 7, Number 3, September, 2024

ISSN (Print): 2651-6144; ISSN (Online): 2651-6365 Website: http://www.jasd.daee.atbu.edu.ng aromatica. At 24 hours, the combination of Silico-sec with P. guineense again showed significantly higher adult mortality, followed by the combinations with E. aromatica and N. tabacum, with the control group having the lowest mortality. By 48 hours, the control group still had a significantly lower adult mortality compared to the treatment groups, though there were no significant differences among the combinations of Silico-sec with P. guineense, E. aromatica, and *N. tabacum.* Oviposition rates were significantly higher in the control group, with no significant differences among the different combinations of Silico-sec and plant powders. This data collectively suggest that mixtures of Silico-sec with plant powders, particularly P. guineense, can significantly increase adult mortality and reduce oviposition of C. maculatus on treated cowpea seeds. While the control consistently showed lower adult mortality and higher oviposition, the treated groups demonstrated effective pest control, especially with Silico-sec mixed with P. guineense. These findings support the potential use of these mixtures in integrated pest management strategies to protect stored cowpea seeds from C. maculatus infestation, thereby reducing post-harvest losses and enhancing food security. Further research is warranted to optimize the formulations and application methods of these treatments, as well as to explore their long-term efficacy and potential effects on seed quality and safety.

Treatments	Percentage Adult Mortality at 12hrs	: Percentage Adult Mortality at 24hrs	Percentage Adult Mortality at 48hrs	Coviposition After Death of All Insects
Mixture (1:10)				
Control	4.30b	12.92a	16.59bc	20.26a
Silico + P. guineense (1:10)	6.14b	16.21a	24.05a	13.93bc
Silico + <i>E. aromatica</i> (1:10)	4.75b	8.61b	12.92c	11.34c
Silico + N. tabacum (1:10)	14.75a	15.65a	19.50b	15.00b
Mixture (10:1)				
Control	4.31c	8.61b	18.05b	16.57a
Silico + P. guineense (10:1)	18.05a	38.24a	45.00a	4.34bc
Silico + <i>E. aromatica</i> (10:1)	8.61bc	26.45ab	61.22a	6.77b
Silico + N. tabacum (10:1)	14.76b	28.66ab	54.83a	9.57b

 Table 3: Combined Effect of Mixture Silico-sec and Plant Powders at Ratios 1:10 and 10:1

 on Adult Mortality and Oviposition of Callosobruchus maculatus on Treated Cowpea Seeds

Means in each column followed by the same alphabet(s) are not significantly different from each other by tukey test at 5% level

Combined Effect of Single Application and Mixture of Plant Powders and Silico-sec on Progeny Development and Seed Weight Loss Caused by *Callosobruchus maculatus* on Treated Cowpea Seeds

The data indicate that adult emergence from eggs laid by the introduced beetles was significantly higher (P < 0.05) in the control group compared to the other treatments. Among the treatments, cowpea seeds treated with *Piper guineense* exhibited the lowest F1 adult emergence, indicating its effectiveness in reducing progeny development. Furthermore, the percentage of seed weight loss did not show significant differences (P < 0.05) among the treatments, except for the control, which experienced significantly higher (P < 0.05) seed weight loss compared to the other





Volume 7, Number 3, September, 2024

ISSN (Print): 2651-6144; ISSN (Online): 2651-6365 Website: http://www.jasd.daee.atbu.edu.ng treatments. This suggests that the plant powders, including Piper guineense, effectively protected the seeds from damage. Similar patterns were observed at ratio 1:1 mixture, where adult emergence from eggs laid by the introduced beetles was significantly higher (P < 0.05) in the control group. There was no significant difference in adult emergence between the combinations of Silico-sec with E. aromatica and Silico-sec with N. tabacum. However, the combination of Silico-sec with Piper guineense showed the lowest adult emergence, further underscoring its effectiveness. Regarding seed weight loss, the control group again exhibited significantly higher (P < 0.05) weight loss, while there were no significant differences among the combinations of Silico-sec with the different plant powders. These findings consistently demonstrate that the use of Silico-sec and plant powders, especially Piper guineense, effectively reduces the progeny development and seed weight loss caused by Callosobruchus maculatus on treated cowpea seeds. The significantly higher adult emergence and seed weight loss observed in the control group indicate the vulnerability of untreated seeds to C. maculatus infestation. In contrast, treatments with Silico-sec and plant powders, particularly Piper guineense, provide substantial protection, highlighting their potential as effective bio pesticides for stored cowpea seeds. Future research should focus on optimizing the formulations and application rates of these treatments to maximize their efficacy while ensuring safety and cost-effectiveness. Additionally, long-term studies are necessary to evaluate the sustained impact of these treatments on seed quality and pest resistance.

maculatus on freated Cowpea Secus					
Treatments	Fi Adult Emergence	% Seed Weight Loss			
Single Application					
Control	16.00a	5.70a			
P. guineense	4.28c	1.58b			
Silico	3.67d	0.60b			
N. tabacum	8.91b	2.38ab			
E. aromatic	1.46d	0.12b			
Mixture (1:1)					
Control	13.91a	5.58a			
Silico + P. guineense (1:1)	0.62c	0.02b			
Silico + E. aromatica (1:1)	1.15b	0.03b			
Silico + N. tabacum (1:1)	1.05b	0.03b			

Table 4: Combined Effect of Single Application and Mixture of Plant Powders and Silico-sec on Progeny Development and Seed Weight Loss Caused by Callosobruchus

maculatus on Treated Cownea Seeds

Means in each column followed by the same alphabet(s) are not significantly different from each other by tukey test at 5% level.

Combined Effect of Silico-sec and Plant Powders at Ratios 1:5 and 5:1 on Progeny Development and Seed Weight Loss Caused by Callosobruchus maculatus on Treated **Cowpea Seed**

The result in Table 5 indicate that adult emergence from eggs laid by the introduced beetles was significantly higher (P < 0.05) in the control group compared to all other treatments. Among the treatments, the combination of Silico-sec with N. tabacum at a 1:5 ratio exhibited the next highest adult emergence; though it was still significantly lower than the control. In terms of





Volume 7, Number 3, September, 2024

<u>ISSN (Print): 2651-6144; ISSN (Online): 2651-6365</u> Website: http://www.jasd.daee.atbu.edu.ng</u> percentage seed weight loss, the control group and the combination of Silico-sec with *N. tabacum* at a 1:5 ratio showed significantly higher (P < 0.05) seed damage compared to the other treatments, which did not differ significantly from each other. This suggests that the combination of Silicosec with *N. tabacum* at this ratio was less effective in reducing seed damage and progeny development compared to other mixtures. Similar patterns were observed at ratio 5:1 where adult emergence from eggs laid by the introduced beetles was significantly higher (P < 0.05) in the control group. Among the treatments, the combination of Silico-sec with *E. aromatica* at a 5:1 ratio resulted in the lowest number of adult emergence, indicating its effectiveness in reducing progeny development. Regarding seed weight loss, significantly greater (P < 0.05) damage was recorded in the control group and the combination of Silico-sec with *N. tabacum* compared to other treatments. The other treatments did not show significant differences in seed damage among themselves, suggesting that these combinations were more effective in protecting the seeds.

The findings from tables 5 are consistently demonstrate that Silico-sec mixed with plant powders can effectively reduce progeny development and seed weight loss caused by *Callosobruchus maculatus* on treated cowpea seeds. The control group consistently showed the highest adult emergence and seed damage, highlighting the vulnerability of untreated seeds. The combination of Silico-sec with *E. aromatica* at a 5:1 ratio was particularly effective, resulting in the lowest adult emergence and seed weight loss. Conversely, the combination of Silico-sec with *N. tabacum* at a 1:5 ratio was less effective, showing higher adult emergence and seed damage compared to other treatments. These results underscore the potential of using Silico-sec and plant powders as part of an integrated pest management strategy to protect stored cowpea seeds from *C. maculatus* infestation. Further research should aim to optimize these mixtures and explore their long-term efficacy and impact on seed quality.

Treatments	Fi Adult Emergence (1:5)	% Seed Weight Loss (1:5)	Fi Adult Emergence (5:1)	% Seed Weight Loss (5:1)
Control	17.41 ^a	7.19 ^a	15.99ª	5.94 ^a
Silico + P. guineense	7.48 ^c	1.44 ^b	4.25 ^b	0.83 ^b
Silico + E. aromatic	8.04 ^c	1.54 ^b	0.93 ^c	0.13 ^b
Silico + N. tabacum	14.43 ^b	6.57 ^a	3.96 ^b	6.53 ^a

Table 5: Combined Effect of Silico-sec and Plant Powders at Ratios 1:5 and 5:1 on Progeny Development and Seed Weight Loss Caused by *Callosobruchus maculatus* on Treated Cowpea Seed

Means in each column followed by the same alphabet(s) are not significantly different from each other by tukey test at 5% level

Combined Effect of Silico-sec and Plant Powders at Ratios 1:10 and 10:1 on Progeny Development and Seed Weight Loss Caused by *Callosobruchus maculatus* on Treated Cowpea Seeds

The result in Table 6 revealed a few significant differences (P < 0.05) at ratio 1:10 in all treatments at 12 hours. However, at 24 hours, the mixture of Silico-sec with Piper had a significantly higher (P < 0.05) percentage mortality compared to other treatments. At 48 hours, the Silico-sec mixed with Piper continued to exhibit significantly higher (P < 0.05) percentage



ISSN (Print): 2651-6144; ISSN (Online): 2651-6365 Website: http://www.jasd.daee.atbu.edu.ng mortality compared to others. Regarding oviposition rate, the control group had a significantly higher (P < 0.05) oviposition compared to the other treatments.

The findings at 10:1 further corroborate these observations. At 12 hours post-treatment, the control group had significantly lower (P < 0.05) adult mortality. Among the treatments, Silico-sec mixed with P. guineense resulted in significantly higher (P < 0.05) adult mortality, followed by Silico-sec mixed with N. tabacum, and then Silico-sec mixed with E. aromatica. At 24 hours posttreatment, the combination of Silico-sec with P. guineense again showed significantly higher (P < 0.05) adult mortality, followed by the combinations of Silico-sec with E. aromatica and Silico-sec with N. tabacum, while the control had the lowest adult mortality. By 48 hours post-treatment, the control continued to have significantly lower (P < 0.05) adult mortality compared to the other treatments, with no significant differences among the combination effects of Silico-sec with P. guineense, E. aromatica, and N. tabacum. For oviposition after the death of all insects, the control exhibited significantly higher (P < 0.05) rates, whereas there were no significant differences among the combinations of Silico-sec mixed with P. guineense, E. aromatica, and N. tabacum.

Table 6: Combined Effect of Silico-sec and Plant Powders at Ratios 1:10 and 10:1 on Progeny Development and Seed Weight Loss Caused by Callosobruchus maculatus on Treated **Cowpea Seeds**

Treatments	Fi Adult Emergence	% Seed Weight Loss	Fi Adult Emergence	% Seed Weight Loss
	(1:10 Ratio)	(1:10 Ratio)	(10:1 Ratio)	(10:1 Ratio)
Control	13.42 ^a	6.20 ^a	10.52 ^a	5.17 ^a
Silico + <i>P. guineense</i>	6.93 ^b	1.15 ^b	2.66 ^{cd}	0.33 ^b
Silico + <i>E. aromatic</i>	1.76 ^c	0.07^{b}	5.15b ^c	0.72 ^b
Silico + N. tabacum	11.05 ^{ab}	1.40 ^b	7.61 ^{ab}	1.62 ^b

Means in each column followed by the same alphabet(s) are not significantly different from each other by tukey test at 5% level

CONCLUSION AND RECOMMENDATIONS

The potential of plant botanicals and Diatomaceous earth in imparting acute toxicity, discouraging damage to cowpea seed by Callosobruchus maculatus has been demonstrated in this study, its adoption for use as grain protectant is easy and should be encouraged because it will provide suitable alternative to the synthetic insecticides. It is pertinent to point out that the admixture of plant botanical and diatomaceous earth investigate in this study should be encouraged as it manifest its effectiveness within the few hours of application thereby discouraging oviposition of insect pest and should be used for control in stored product against insect pest in Nigeria.

It is therefore recommended that:

- The most effective economic rate of applying plant botanicals powder and Diatomaceous earth i. for the control of Callosobruchus maculatus should be investigated.
- Further experiment should be carried out to know whether the combination of plant powder ii. and Diatomaceous earth shows synergistic or additive effect on the control of Callosobruchus maculatus.
- Plant powder and Diatomaceous earth should be tested for efficacy in the control of other iii. stored product insects.
- Further studies are needed to determine the efficacy of plant botanical oil, which will reduce iv.



ISSN (Print): 2651-6144; ISSN (Online): 2651-6365 Website: http://www.jasd.daee.atbu.edu.ng

the bulkiness of the powder when used for storage control of crop pests in bags or in storage bins. It is also important to ascertain the shelf life of different formulation of plant powder to ensure effective protection of produce thereby reducing losses to the farmer.

REFERENCES

- Abdelgaleil, S. A., Gad, H. A., Hamza, A.F. and Al-Anany, M. S. (2021). Insecticidal efficacy of two inert dusts and *Trichoderma harzianum*, applied alone or in combination, against *Callosobruchus* maculatusand *Callosobruchus chinensis* on stored cowpea seeds. *Journal of Crop Protection146:105656*.
- Ali, W., Afsheen, Zehra, Z. A. and Beena, N. (2005). Effect of salinization and alkalization on seed germination and early seedling growth of leguminous species *Vigna mungo L. Journal by Innovative Scientific Information &Services Network*
- Ashamo, M. O. (2019). Man's weapons of warfare against the hexapods. Akure, Nigeria: The Federal University of Technology Inaugural Lecture Series. 2019; 104: 70.
- Boeke, S. J., van Loon, J. J. A., van Huis, A., Kossou, D. K. and Dickle, M. (2015). The use of plant material to protect stored leguminous seeds against seed beetles: A review. The Netherland: Backhuys Publishers; Pp108.
- Dales, M. J. A. (2013). Review of plant materials used for controlling insect pests of stored products. Bulletin Natural Resources Institute. 1996; 65: 1-84.
- Edde, A. and Amatobi, C. I. (2003). Seed coat has no value in protecting cowpea seed against attack by *Callosobruchus maculatus* (F.) Nigeria Plant Quarantine Service, Plantation, Ibadan, Nigeria Institute for Agricultural Research, Ahmadu Bello UniversityP.M.B. 1044, Zaria,
- Ewete, F. K., Ashimilowo, O. R. and Adohi, A. (2019). EA Survey of plants used in maize storage in Abeokuta North Local Government Area and the efficacy of a selected species against *Sitophilus zeamais Motschulsky* (*Coleoptera: Curculionidae*). *Nigerian Journal of Entomology*, 2(4):19-126.
- Goudoungou, J. W., Nukenine, E. N., Suh, C., Gangué, T. and Ndjonka, D. (2018). Effectiveness of binary combinations of *Plectranthus glandulosus* leaf powder and *Hymenocardi aacida* wood ash against *Sitophilus zeamais* (*Coleoptera: Curculionidae*). Agriculture & Food Security. 2018; 7: 26.
- Isman, M. B. and Yasmin, A .(2013). Horizontal Transfer of Diatomaceous Earth and Botanical Insecticides in theCommon Bed Bug, *Cimex lectularius* L.; Hemiptera: *Cimicidae* Published: September 25,2013. <u>https://doi.org/10.1371/journal.pone.0075626</u>
- Isman, M. G. (2014). Botanical insecticide research: many publications, limited useful data. *Environmental Science, Biology* Published in Trends in Plant Science 1 March 2014
- Musa, A. K. and Adeboye, A. A. (2017). Susceptibility of some cowpea varieties to the seed beetle *Callosobruchusmaculatus* (F.)(*Coleoptera: Chrysomelidae*) Journal of Agricultural Science, **2**(1):45-55
- Nwosu, L. C. (2018). Maize and the maize weevil: advances and innovations in postharvest control of the pest. *Food Quality and Safety*. **2**(3):145-152.
- Oyeyinka, S. A., Oyeyinka, A. T., Karim, O. R., Kayode, R. M. O., Balogun, M. A. and Balogun, O. A (2013). Quality attributes of weevils (*callosobruchus maculatus*) Infested cowpea (*vigna unguiculata*) products. *Nigerian Journal of Agriculture, Food and Environment.* 9(3):16-22
- Suleiman, M. (2021). Application of botanical powders for the management of stored sorghum insect pests insmallscale farmers' storage structures in Northern Nigeria. *IOSR Journal of Agriculture andVeterinary Science*, 1(4):12-24.