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INSECTICIDAL ACTIVITY OF BLACK PEPPER (*PIPER NIGRUM*) AND PAWPAW (*CARICA PAPAYA*) SEEDS POWDER AGAINST MAIZE WEEVILS (*SITOPHILUS ZEAMAIS*)

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ABSTRACT: Laboratory experiment was carried out to investigate the insecticidal activity of Black piper *Pepper nigrum* and Pawpaw seed *Carica papaya* seeds powder against Maize weevils *Sitophilus zeamais*. The experiment was laid in Completely Randomized Design (CRD) comprising of black pepper seeds (1 g, 3 g and 5 g), pawpaw seed powder (1 g 3 g and 5 g), Spintor Dust and control. Spintor Dust was used a positive control and untreated Maize seeds serving as negative control. These were applied to 100 g healthy maize seeds contained in plastic jars (measuring 4.5 x 6.5 x 8.5 cm). Five pairs of laboratory reared F_2 generation of the maize seed weevils (*S. zeamais*) were introduced into the treated and untreated Cowpea seeds. The open end of the plastic containers was covered with a fine muslin cloth and tied firmly with rubber band and kept at room temperature (29 – 32°C) in the laboratory and were repeated three times. All data collected were subjected to analysis of variance (ANOVA) and means were separated using NDMRT at 1% and 5% probability level. The results showed that seed treated with (5 g/100g) of *P. nigrum* recorded the highest (3.66), (4.00) and (2.33) adult mortality of adult S. zeamais after 24, 48 and 72 hours post exposure to the treatments. Similarly, the application of 5 g/100 g and 3 g/100g of *P. nigrum* significantly reduce oviposition, adult emergence, percentage seed damage, number of exit holes and grain weight lost. Germination of the treated seeds was not affected negatively. The 3 g/100 g of *P. nigrum* could be recommended as suitable alternatives to chemical pesticides to be used as contact protectants against *S. zeamais* on stored maize seeds.

Key words: *Carica papaya,* Control *Piper nigrum, Spintor dust, Sitophilus zeamais*,

INTRODUCTION

Black pepper (*Piper nigrum* L.) is a member of family Piperaceae [1]. The genus piper has more than 1000 species but the most well-known species are *P.nigrum*, *P.longum* and *P.betle*. 51 cultivars of *p. nigrum* have been reported from the tropical and subtropical regions of India [16]; [3]. Black pepper can be used for different purposes such as human dietaries, as medicine, as preservatives, as biocontrol agents [8]; [11]. This plant and its active component piperine can stimulate the digestive enzymes of pancreas and intestines and also increases biliary bile acid secretion when orally administrated [29]. Ukpai [31] recently reported the insecticidal potential of *Piper guineense* seed powder against *Sitophilus zeamais* in stored corn grain. Pawpaw (*Carica papaya)* Native to Mexico and northern South America, papaya has become naturalized throughout the Caribbean Islands, Florida, Texas, California, Hawaii, and other tropical and subtropical regions of the world [13]. The ripe fruit of the papaya is usually eaten raw, without skin or seeds. The unripe green fruit can be eaten cooked, and is used as an ingredient in salads and stews [19]. Moreover, powdered seed has been shown to have molluscicidal activity and to combat the protozoan fish parasite *Ichthyophthirius multifiliis* [11]

Numerous cases of poisoning and environmental hazards and insufficient financial resources of African farmers have drawn attention to safe means of pest control. The control of insect pest of stored products (such as *Callobruchus maculatus*, *Sitophilus zeamais, Tribolium castaneum and Rhyzopertha dominica)* was based on the use of fumigants like (methyl bromide and phosphine). However, their increasing use in recent years has created a range of ecological problems such as bio-magnification, resurgence and the development of insecticide tolerant strains of pest species [12]; [18]; [28]. These debilitating effects have directed the need for effective but

relatively safe, eco-friendlier, readily available and biodegradable botanical pesticides [10].

MATERIALS AND METHODS

Study Area

The research was conducted at the agronomy laboratory, faculty of Agriculture, Abubakar Tafawa Balewa University Bauchi. The experiments was carried out under an ambient temperature of 28°C to 32°C and relative humidity of 55% to 75% for period of three months. Bauchi is located at 10° 74'E latitude and 9°47'E and situated at 690.3m above the sea level in savannah zone of Nigeria.

Collection and Preparation of Black Seed Pepper and Pawpaw Seed

The pawpaw seed (*Carica papaya* L.) were collected from the pawpaw from Muda market in Bauchi metropolis. The pawpaw was cut off and the seeds were collected dried under the shade dried for two weeks and it was grounded with pestle and mortal separately. Black pipper (*Piper nigrum* L.) seeds was obtained from the same market and it was shade dried and grounded with morta and pestle to obtain a fine powder of the product as describe by [6]. The fine powder of each plant materials were separately kept on the leather until when needed.

Disinfestation of Maize Seeds

The maize Seeds were manually sorted to remove broken seeds with holes and other contaminants was sieved using a mesh sieve to remove insects and remaining contaminants. The sorted seeds were fumigated with aluminium phosphide (Phostoxin tablets) at the rate of 0.2 g/kg for 72 hours under airtight conditions to exclude any possible infestation that may affect the seeds. After 72 hours, the fumigated maize seed was spread on a clean polythene mat covered with baft

cloth to remove any residual effect of the fumigant and to exclude infestation. This was done for 48 hours.

Source and Rearing of Experimental Insects

Samples of maize weevil were collected from previously infested stored maize seeds obtained from Muda Lawal market in Bauchi Local Government Area of Bauchi State, Nigeria. The insects were brought to the laboratory and kept at room temperature 28 $\pm$ 2 ^0C and relative humidity 70 $\pm$ 5%. 10 kg of sound uninfested maize seeds was weight and transferred into an earthen clay pot. Thereafter, maize weevils were transferred into the earthen clay pot. The top of the earthen clay pot was covered with white muslin cloth, tightened firmly with a rubber band and *S. zeamais* were allow to oviposit under crowded conditions in a light:dark regime of 12L:12D at room temperature and relative humidity for one week. After one week, dead and live parent stocks were completely sieved out to await the emergence of F_1. The same procedure was used with F_1 generation to obtain F_2 generation used for the experiment.

Treatment and Experimental Design

The treatment consisted of pawpaw seeds powder (1 g, 3 g and 5g), pepper seeds powder (1 g, 3 g and 5g), Spintor 125% Dust (0.125 g) (positive control) and untreated maize seeds (negative control). These were applied to 100 g healthy cowpea seeds and repeated three times. The experiment was laid out in completely Randomized Design (CRD) and means were separated using New Duncan Multiple Range Test (NDMRT).

Determination of the Bioactivity of Test Materials on Maize Weevil by Mode of Action

Contact toxicity

Five pairs of laboratory reared F_2 generation of the maize seed weevils (*Sitophilus zeamais*) were introduced into the treated and untreated Cowpea seeds already contained in plastic jars (measuring 4.5 x 6.5 x 8.5 cm). The open end of the plastic containers was covered with a fine muslin cloth and tied firmly with rubber band and kept at room temperature (29 – 32°C) in the laboratory. Observation on insect mortality was recorded at 24 hours, 48 hours and 72 hours after exposure to the treatment for three days according to [17].

Evaluation of Oviposition

Ten infested maize seeds were randomly selected from treated and untreated seed. Numbers of eggs were counted with the aid of magnifying hand lens and percentage oviposition deterrence was calculated using the formula (%Deterrence = $\frac{Cs-Ct}{Cs}$x100) as described by [32]. Where *Cs* = number of eggs laid on control seed, *Ct* = Number of eggs laid on treated seed

Evaluation of Adult Emergence

All the treated and untreated seed were subjected to incubation at room temperature in the dark for eight weeks to monitor the emergence of adult weevil from the seeds. The number of adult weevils emerged by the weevil were recorded. The percentage adult emergence deterrence was calculated using the formula (%Deterrence = $\frac{Ac-At}{Ac}$ x 100) as described by [16]. Where *Ac* = Number of adult emerged on control, *At* = Number of adult emerged on treated seed

Evaluation of Percentage Seed Damage

Ten seeds were randomly selected from each treatment and examined the number of exit holes. Seeds containing three or more holes were considered as damaged seeds. Number of damaged and undamaged seeds were counted and recorded for each repetition using the formula (% Seed Damage = $\frac{G1}{G2}$x100) as described by [31].

Were G_1 is Number of seed with holes

G_2 is number of seed without holes

Evaluation of Weight Loss

At the end of the experiment, the cowpea seeds were sieve to remove the dead insect and powder, and reweight to obtain the weight loss using the formula (%Loss = $\frac{initial\ weight - final\ weight}{initial\ weight} x100$) as described by [31].

Evaluation of Viability Test

Ten uninfested seeds were randomly selected from each treatment to evaluate germination test. The seeds were arranged on a moisten Petri dishes, the germination process lasted for a period of seven days after which the number of germinated seeds in each Petri-dishes was counted and recorded. The germination percentage was calculated using the formula (GP = $\frac{number\ of\ seed\ germinated}{\text{Total number of seed planted}}$× 100) as described by [7].

Data Collection and Analysis

Data were collected on Adult Mortality, Number of seed with holes, Number of eggs laid, Number of weevils that emerge, Number of germinated seed, Weight loss and Percentage grain damage. All data collected were subjected to statistical analysis of variance (ANOVA)

using SPSS software (version) and New Duncan's Multiple Range Test (NDMRT) was used to separate the difference between treatment means.

Result and Discussion

Table 1 showed the effect of pawpaw seeds and Black pepper seeds on adult mortality of adult *Sitophilus zeamais*. The result showed that All treated seeds significantly ($P \leq 0.05$) caused mortality of adult *Sitophilus zeamaise*. Maize seed treated with 5 g/100g Black pepper seeds powder significantly caused highest (3.66) mortality of adult *S. zeamais* than other treated seeds. The result further showed that the application of 3 g/100g Black pepper was statistically the same at 48, 72 and 96 hours post exposure compared to 5 g/100 g and Spintor 0.125% Dust. The highest mortality recorded in this study could be as a result of highest phytocompounds present in the black pepper. This is in conformity to that of [7] who reported that maize seed treated with Black pepper seed powder significantly ($P<0.05$) causing complete mortality at highest concentration level tested (0.5%). He further stated that the toxicity was highest *S. granarius* because it caused complete mortality in the first five days but *R. dominica* showed complete mortality after 14 days so that *S. granarius* adults were more susceptible than *R. dominica* adults. This result is also similar to that of [6] who reported that, 2% concentration the powders of *P. guineense* and *C. frutescens* had the highest percentage mortality against *S. zeamais* (Mots) 79.8 and 75.1 respectively, and significantly reduced adult emergence when compared to control.

Table 1: Mean mortality of adults *Sitophilus zeamais* exposed to Maize seeds treated with different concentration of Pawpaw seeds and Black Pepper Seeds seeds powder

	Mean adult mortality (Hours)

Insecticidal Activity Of Black Pepper (*piper nigrum*) and Pawpaw (*carica papaya*) Seeds Powder Against Maize Weevils (*sitophilus zeamais*)

Treatments	Conc./100g seed	24	48	72	96	168	336
Carica papaya	1	0.66^{d}	1.33^{c}	1.33^{b}	0.33^{b}	0.66^{b}	0.66
	3	1.33^{c}	1.33^{c}	1.33^{b}	0.66^{b}	0.66^{b}	0.33
	5	1.66^{c}	2.00^{b}	1.33^{b}	1.33^{a}	1.00^{a}	0.33
Piper nigrum	1	1.33^{c}	2.33^{b}	1.33^{b}	0.33^{b}	0.66^{b}	0.66
	3	2.66^{b}	3.33^{a}	2.33^{a}	1.00^{a}	0.00^{c}	0.66
	5	3.66^{a}	4.00^{a}	2.33^{a}	1.00^{a}	0.00^{c}	0.00
Spintor 0.125% Dust	0.125	3.33^{a}	3.66^{a}	2.33^{a}	0.33^{b}	0.33^{cd}	0.00
Control (untreated)	0	0.00^{e}	0.00^{d}	0.00^{c}	0.00^{c}	0.00^{d}	0.66
LS		**	**	**	*	*	NS
S. E(±)		0.46	0.48	0.45	0.38	0.35	0.38

**Significant at 1%, and * at 5%

Means followed by the same letter are not significantly different ($P \leq 0.01$) from each other, using New Duncan's Multiple Range Test (NDMRT).

LS = level of Significance

SE = Standard Error

Table 2 showed the effect Pawpaw seeds and Black pepper seeds Powders on oviposition and percentage oviposition deterrence of on *Sitophilus zeamais*. The result revealed that the highest (39.33) oviposition was recorded in the untreated cowpea seeds (control) and the number is more doubled compared to those recorded in other treated maize seed. Maize seeds treated with 5 g and 3 g per 100 g showed similar efficacy. This can be compare to seeds treated with chemical pesticide (Spintor 0.125% Dust). The lowest number of egg recorded in seeds treated with 3 g and 5 g of Pepper seeds powder could be as result of high mortality of adult *S. zeamais.* This in consistent to the result obtained by [21] who earlier recorded the lower number of egg in treated seeds. He further stated that the leaf powder of the plant he study has the tendency of blocking the spiracles of the insects thereby impede respiration leading to the death of the weevils. This also corroborate with the work of [5] who

reported that the insecticidal activities of the plant powders are variable and broad and dependent on different factors like the presence of bioactive chemicals which need to be identified, isolated and manufactured in the factory for pest management. In this study, the number of eggs decreased with the increase in concentration and the number of egg lay. Earlier, [20] found that higher concentration of the powder of plant he used in his research significantly reduced the oviposition suggesting that even at low concentration *Piper guinensis* is effective in reducing the numbers of eggs by the *S. zeamais.*

Table 2: Effect of Pawpaw seeds and Black Pepper Seeds Powder on Number of Eggs and percentage Oviposition Deterrence of *Sitophilus zeamais* on treated and untreated Maize seeds

Treatment	Conc. (g)/100g seed	Oviposition	Oviposition (%) deterrence
Carica papaya	1	5.33^{b}	86.44
	3	2.00^{de}	94.91
	5	1.66^{e}	95.77
Piper nigrum	1	3.00^{c}	92.37
	3	0.67^{f}	98.32
	5	0.00^{f}	100.00
Spintor 0.125% Dust	0.125	0.00^{f}	100.00
Control (untreated)	0	39.33^{a}	0.00
LS		**	
S. E(±)		0.92	

**Significant at 1%

Means followed by the same letter are not significantly different ($P \leq 0.01$) from each other, using New Duncan's Multiple Range Test (NDMRT).

LS = level of Significance

SE = Standard Error

The effect Pawpaw seeds and Black pepper seeds Powders on adult emergence and percentage adult emergence deterrence of *sitophilus*

zeamais is presented in Table 3. The result showed that untreated cowpea seed recorded the highest (39.00) adult emergence of *sitophilus zeamais* compare to other treated maize seeds. The application of 5 g (0.00), 3 g (0.33) black pepper powder and Spintor Dust (0.00) significantly ($P \leq 0.05$) reduced adult emergence of adult *Sitophilus zeamais* compare to other treated seed. The inability of the insects to emerge may be due to the death of the insect larval which might have been caused by inability of the larval to fully cast off their exoskelecton which typically remained linked to the posterior part of their abdomen [22]. This agreed with the work of [30] in which the extract of *Z. zanthoxyloides* was found to reduce adult emergence of *C. maculatus*. The application of 5 g pawpaw seeds powder have higher efficacy compared to 1 g and 3 g. this indicated that the higher the concentration the higher the effect on insect. The finding of this is also study is in line with the finding of [21] who found that 20 g of Pawpaw seeds have higher (47.02) mortality than 10 g (32.40) and 5 g (15.44). Moreover, [26] reported that *T. minuta* leaf powder may have antifeedant activity on the weevils. In addition to causing adult mortality, the botanical leaf powders either completely hindered or significantly reduced progeny emergence indicating their potential for use in the management of the maize weevil.

Table 3: Effect of Pawpaw seeds and Black Pepper Seeds Powder on Adult Emergence and percentage Adult Deterrence of *Sitophilus zeamais* on treated and untreated Maize seeds

Treatment	Conc. (g)/100g seed	Adult Emergence	Adult Emergence deterrence (%)
Carica papaya	1	4.66[b]	86.44
	3	2.00[c]	94.91
	5	1.33[c]	95.77
Piper nigrum	1	1.66[c]	92.37
	3	0.33[d]	98.32
	5	0.00[d]	100.00

Spintor Dust	0.125%	0.125	0.00[d]	100.00
Control (untreated)		0	39.00[a]	0.00
LS			**	
S. E(±)			0.86	

**Significant at 1%

Means followed by the same letter are not significantly different ($P \leq 0.01$) from each other, using New Duncan's Multiple Range Test (NDMRT).

LS = level of Significance

SE = Standard Error

Table 4 showed the effect of Black pepper and Pawpaw seed powder on percentage seed damage and number of exit holes. The result showed that, there is significant ($P \leq 0.05$) difference between treated and untreated cowpea seeds with respect to percentage seed damage and number of exit holes. The percentage seed damage (21.00%) and number of exit hole (40.66) was high in the untreated control compared to other treated Maize seeds. The application of 5 g Black pepper powder recorded no (0.00%) seed damage and number of exit holes (0.00) which is comparable to Spintor Dust that recorded no (0.00%) seeds damage and (0.00) exit holes. The lowest number of exit hole and percentage grain damage could be attributed to higher concentration of phytocompounds present in Black pepper seeds. Earlier [4] has observed that in cowpea seeds treated with *Lippia adoensis* essential oil, most of the eggs laid could not complete their life cycle, thereby leading to a reduced adult population capable of producing subsequent generations and thus limiting seed damage. [15] reported that sweet *O. basilicum* oil extract can caused 96 to 100% mortality of maize weevil, 5 days after application. He concluded that plant extracts have a potential to control maize weevil without causing lethal effects on stored commodity and environment and safer for health.

Table 4: Effect of Pawpaw Seeds and Black Pepper Powder on Percentage Grain Damage and Number of Exit Holes of on treated and untreated Maize Seed after Exposure to the treatments

Treatment	Conc. (g)/100g seed	Number of Exit Hole	Percentage Seed Damage
Carica papaya	1	5.00^{b}	3.66^{b}
	3	3.00^{b}	2.33^{c}
	5	1.66^{bc}	1.33^{d}
Piper nigrum	1	2.66^{b}	1.33^{d}
	3	0.66^{cd}	0.66^{de}
	5	0.00^{d}	0.00^{e}
Spintor 0.125% Dust	0.125	00.0^{d}	0.00^{e}
Control (untreated)	0	40.66^{a}	21.00^{a}
LS		**	**
S. E(±)		2.93	0.73

****Significant at 1%**

Means followed by the same letter are not significantly different ($P \leq 0.01$) from each other, using New Duncan's Multiple Range Test (NDMRT).

Table 5 showed the effect of Black pepper and Pawpaw seed powder on weight loss. Weight loss was significantly ($P \leq 0.01$) higher in the untreated control (16.00%). Weight loss decline with increasing concentration of both Black Pepper and Pawpaw seeds Powder.

Table 5 also showed the effect of plant powder on viability test after exposure to the treatments. The result revealed that, there is no significant difference in relation to germination percentage on all treated and untreated seed.

This study agrees with the work of [23] who reported that *Piper guineense* seed powder at higher concentrations offered comparatively good protection of the stored seeds. The toxicity effects of *P. nigrum* essential oils against *S. oryzae* adults and 3rd instar larvae of *C. cephalonica* was earlier studied by [27] he attributed the lower weight

loss recorded to the presence of high concentrations of well-known toxic components such as caryophyllene and piperine. This result is in consistent with earlier works of [25] who reported the effect of *Mondora myristica* (Gaertn.) Dunal on seed germination after storage for some period.

The powder and Spintor 125% Dust did not adversely affect seed viability, proximate composition or the organoleptic characteristics of the stored seeds. *P. nigrum*, is highly nutritional and medicinal plant that is locally available, could therefore be an acceptable, cheap, safe and environmentally friendly alternative to synthetic chemicals for protecting seeds in storage. [23] observed that Actellic dust had no negative effect on seed viability. This also corroborated by earlier works of [2] and [24] who reported that actellic did not affect the viability of stored cowpea or maize, respectively.

Table 5: Effect of Pawpaw seeds and Black Pepper Seeds Powder on Percentage Weight Loss and Percentage Germination after Exposure to the Treatments

Treatment	Conc. (g)/100g seed	Weight Loss	Germination Percentage
Carica papaya	1	4.46^{b}	97.33
	3	2.20^{c}	95.00
	5	1.96^{c}	98.33
Piper nigrum	1	1.86^{c}	97.78
	3	0.76^{d}	98.33
	5	0.00^{d}	98.66
Spintor 0.125% Dust	0.125	00.0^{d}	95.00
Control (untreated)	0	16.00^{a}	97.33
LS		**	NS
S. E(±)		0.79	2.78

**Significant at 1%

Means followed by the same letter are not significantly different ($P \leq 0.01$) from each other, using New Duncan's Multiple Range Test (NDMRT).

LS = level of Significance

SE = Standard Error

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SE = Standard Error

CONCLUSION and RECOMMENDATION

The plant powders evaluated in the study clearly demonstrated contact toxicity against *S. zeamais* on treated seeds. All treated maize seeds significantly ($P \leq 0.005$) caused adult mortality of *S. zeamais*. It could be concluded that *Piper nigrum* could be used as contact protectants against the bruchid *S. zeamais* (3 g/100 g). The result further showed that both the pawpaw and black pepper seeds powder have decreased oviposition, emergence, number exit holes, grain damage and weight loss of adult weevil of stored maize seed.

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