RESEARCH ARTICLE Legume Research- An International Journal, Volume 46 Issue 10: 1385-1391 (October 2023)

Effect of Various Plant Powders on Pulse Beetle, *Callosobruchus maculatus* (F.) (Coleoptera: Bruchidae) and Seed Weight Loss in Stored Black Gram

K. Govindan[1], S. Geethanjali[1], S. Douressamy[1], G. Brundha[1]

10.18805/LR-4435

ABSTRACT

Background: Pulse beetle, *Callosobruchus maculatus* is the most serious pests in stored legumes in majority of tropical countries. Attention has been given to the possible use of plant products or plant dry powders as promising alternatives to synthetic insecticides in controlling insect pests of stored products. Present study seven plant species evaluated for their bio activity to pulse beetle.

Methods: Laboratory studies were conducted at Department of Crop Protection, Agricultural College and Research Institute, Valavachanur, Thiruvannamalai district to study the effect of various plant powders tested against, *Callosobruchus maculatus* (F.) infesting stored black gram. The experiments were conducted two sets, first experiment (insecticidal action) and second on ovipoistion, egg hatchability, adult emergence and seed weight loss.

Result: The *Piper nigrum* 2 per cent seed powder was found to be significantly the best compared to other treatments and caused 100 per cent mortality at one day after treatment. At seven days after treatment, *Azadirachta indica* (87.77%), *Coccinia indica* (80.50%), *Abutilon indicum* (73.50%), *Acalypa indica* (73.33%) and whereas untreated control recorded only 36.66 per cent mortality was recorded. *Piper nigrum* was significantly superior than all other treatments in complete inhibiting the oviposition, adult emergence and seed weight loss showed in *P. nigrum* 2 per cent seed powder treated black gram seeds as compared to untreated control higher numbers eggs laid (107 eggs), adult beetle emergence (90 adults) and seeds weight loss (34.26%) at 30 DAT, (39.22%) at 45 DAT and (45.28%) at 60 DAT. Different concentration of *P. nigrum* seed powder experiment results concluded that all the four doses (0.50, 1.00, 1.50 and 2.00%) highly effective against *C. macultus viz.*, mortality, oviposition adult emergence and seed weight losses.

Key words: *Callosobruchus maculatus*, Plant powders, Stored black gram.

INTRODUCTION

Pulses are an important part of the vegetarian diet of Indian subcontinent, being a rich source of protein (20-30%) and high nutritional value, offer the most practical means of solving malnutrition in our country (Vasanthakumar, 2016). India stands first in terms of area and production of pulses. Black gram is (4.05 lakh ha), Production (3.10 lakh tonnes) and Productivity (851 kg/ha) and among the pulses black gram and green gram account for about 71 per cent of the area in Tamil Nadu (Vasanthakumar, 2016). Black gram *Vigna munga* (L.), an important legume crop suffers losses both qualitatively and quantitatively due to the attack by bruchids in the post harvest stages (Raghu *et al.,* 2016). Infestation begins in the field but causes serious damage to the seeds during storage and cause quantitative and qualitative losses to stored pulses (Dongre *et al.,* 1996). *Callosobruchus spp.* can cause damage of legume seeds up to 100 per cent during storage (Gbaye *et al.,* 2011).

Many synthetic insecticides have been found effective against stored product pests but proved to be hazardous to men and domestic animals. The over reliance on and non judicious use of synthetic pesticides especially insecticides since last four decades led to wide spectrum of pests problem like pests resistance to chemicals, resurgence of pests, residues in food and soil and risks to human and animal health, besides environmental pollution (Mohapatra and Gupta, 1998). Musa and Uddin (2016) reported that many plants possess activities against stored grain pests. To solve this problem, many researchers have discovered alterna-tive pest management products derived from plants (Isman, 2013). Plant products are cheap and are easily accessed by farmers and small-scale industries in the form of crude or partially purified extracts. It was indicat-ed that mixing storage pulses and plant products such as leaf, bark, powder or extracted oils reduced the oviposition rate, inhibited the adult emergence of bruchids and decreased the seed damage rate (Soe *et al.,* 2020). Therefore, in

[1]Department of Crop Protection, Agricultural College and Research Institute, Tamil Nadu Agricultural University, Valavachanur-606 753, Thiruvannamalai, Tamil Nadu, India.

Corresponding Author: K. Govindan, Department of Crop Protection, Agricultural College and Research Institute, Tamil Nadu Agricultural University, Valavachanur-606 753, Thiruvannamalai, Tamil Nadu, India. Email: govindan_nivesh@yahoo.co.in

How to cite this article: Govindan, K., Geethanjali, S., Douressamy, S. and Brundha, G. (2023). Effect of Various Plant Powders on Pulse Beetle, *Callosobruchus maculatus* (F.) (Coleoptera: Bruchidae) and Seed Weight Loss in Stored Black Gram. Legume Research. 46(10): 1385-1391. doi: 10.18805/LR-4435.

Submitted: 02-06-2020 **Accepted:** 25-01-2022 **Online:** 30-03-2022

present study seven plant powders were tested for the mortality, adult emergence and seed weight loss against caused by *C. maculatus* infesting stored black gram seeds.

MATERIALS AND METHODS

Laboratory experiments were carried out at of Crop Protection, Agricultural College and Research Institute, Vazahavacnur during 2018-2019 study the effect of seven plant powders on *C. maculatus.*

Rearing of test insect

Adults of *Callosobruchus maculatus* were initially collected from three villages of Vanapuram, Perunduraipattu and Vazhavachanur infested stored black gram seeds from the farmers granaries and brought to the laboratory. The pulse beetle, *Callosobruchus maculatus* was reared on black gram seeds in glass jars covered with muslin cloth by following the method developed by Credland and Wright (1989). *C. maculatus* were maintained at ambient laboratory temperature (28±2°C) and relative humidity (70±5%) conditions.

Preparation of plant powders

Seven insecticidal plants are indicated below in (Table 1) collected, washed with distilled water and shade dried at room temperature for seven days and crushed a pulverizer model of fritsch rotor speed mill pulverisette 14 with motor load is normal and rotational speed 14, 000 rpm using in to fine powder using a pulveriser (0.05 mm mesh sieve) (Govindan and Nelson, 2007). All the powders were kept in plastic containers at room temperature and properly sealed to prevent quality loss and used for conducting experiments.

Effect of insecticidal plant powders on the adult mortality of pulse beetle, *Callosobruchus maculatus* (F.)

Twenty grams of black gram seeds were taken in petridishes. The powder of various plant parts at the rate of 2: 100 (w/w) were added to black gram seeds and shaken thoroughly. Thirty newly emerged adults were released in to each petridish and kept in laboratory. Mortality (lack of locomotion and or response to repeated probing) was recorded at one day intervals up to seven days (Govindan and Nelson, 2007). Per cent mortality was calculated by the following formula:

$$\text{Per cent mortality} = \frac{\text{Number of insect died}}{\text{Total number of insect released}} \times 100$$

Effect of insecticidal plant powders on oviposition, egg hatching and adult emergence of *C. maculatus*

Oviposition

Twenty grams of black gram seeds were taken in glass bottles. The powder of various plant parts at the rate of 2:100 (w/w) were added to black gram seeds and shaken thoroughly. Then the glass bottles were covered firmly using muslin cloth. Five pairs of newly emerged adults of male and females *C. maculatus* were released to each glass bottle, covered firmly and kept in laboratory at ambient conditions. Three replications were maintained for each treatment. Numbers of eggs laid on the seeds were counted on third day after the release of beetles (Govindan and Nelson 2007).

Egg hatching

On 5th day after the release of beetles counts on translucent unhatched eggs and opaque hatched eggs were taken and hatchability percentage was worked out (Govindan and Nelson 2007).

Adult emergence

On 15th day after the release of beetles all the dead insects were removed from the bottles to prevent them from the mixing with first generation (F1) offspring. The number of newly emerged adults were counted and removed from the bottle once in three days till the complete emergence of F1 offspring (up to 30 days after treatment) (Govindan and Nelson 2007).

Seed weight loss

The weight of the seed was taken on 30, 45 and 60 days after the treatment and seed weight loss percentage was worked out (Govindan and Nelson, 2007).

$$\text{Per cent weight loss} = \frac{\text{Initial weight of grain - Final weight loss of grain}}{\text{Initial weight of grain}} \times 100$$

The experiment was laid out in completely randomized design (CRD) with three replication were maintained for each treatments.

Statistical analysis

The methods of Gomez and Gomez (1984) were followed in scrutinizing the data from various experiments. Square root and angular transformations were adopted for the data

Table 1: The plant species evaluated against *Callosobruchus maculatus* (F.).

Common name	Botanical name	Family	Parts used
Black pepper	*Piper nigrum* L.	Piperaceae	Seeds
Akathi	*Sesbania grandiflora* (L.)	Fabaceae	Leaves
Tutti	*Abutilon indicum* L. sweet	Malvaceae	Leaves
Kolincai	*Tephrosia purpurea* (L.) Pers	Fabaceae	Leaves
Neem	*Azadirachta indica* A. Juss.	Meliaceae	Leaves
Kovai	*Coccinia indica* L.	Cucurbitaceae	Leaves
Tutti	*Acalypha indica* L.	Euphorbiaceae	Leaves

in numbers and percentage respectively (Abbott, 1925). Means in simple CRD analysis were separated by Duncan's multiple range test (Duncan, 1955).

RESULTS AND DISCUSSION

Effect of plant powders on the adult mortality of *Callosobruchus maculatus*

The results of experiments conducted to study the effect of seven insecticidal plants parts against *Callosobruchus maculatus* and presented. The results clearly indicated that all the treatments revealed a wide variation in mortality compared to untreated control (Table 2). The insecticidal action of first experiment powders of ten plants 2.00 per cent (w/w) were tested for their insecticidal action in comparison with untreated control. Among them results showed that *Piper nigrum* 2 per cent seed powder was found to be significantly the best compared to other treatments and caused 100 per cent mortality with in 24 hrs after treatment, other plant powders showed least morality range of 3.33 to 10.22 per cent mortality registered one days after treatment (DAT) as compared to untreated control no mortality was observed. This similar study confirmed and documented by Abdullah *et al.* (2017) observed black pepper caused highest mortalities (98.3% at 24 hr and 100.0% at 48 hr) to *C. maculatus*. The present finding could be substantiated with the findings of Manju *et al.* (2019) who stated that *P. nigrum* one per cent treated green gram seeds resulted in 100 mortality to *C. maculatus* within 12 hrs. The highest per cent mortality can be arranged in the order of *A. indica* (64.66%) > C. *indica* (62.22%) > *S. grandiflora* (49.50 %) > *Acalypa indica* (48.88%) > *Abutilon indicum* (45.99 %) as untreated control (31.11%) for *C. maculatus* at 5 DAT. Same trend of mortality at 6 DAT. The present findings corroborate the findings of Kaur *et al.,* (2019) who stated that Neem leaf powder 5 g/100 g of pea seed was highly effective and causing 80.00 per cent mortality to pulse beetle at five days after treatment. At 7 DAT, 87.77 per cent mortality was seen in *Coccinia indica* 2 per cent followed by *A. indica* 2 per cent (80.50%) and in untreated control 36.66 per cent mortality was recorded. Similar results reported by Ahmad *et al.,* (2015) through neem leaf powder protection from pulse beetle infestation in mung bean. Among the botanicals, *Piper nigrum* 2 per cent seed powder was significantly different from all other treatments. *Piper nigrum* have active compound called Piperine is a major active principle compound found in seeds and it is the responsible for the killing the *C. maculatus* (Swamy and Raja, 2018).

Effect of plant powder on oviposition, egg hatchability adult emergence of *Callosobruchus maculatus* and seed weight losses

The number of eggs laid by *Callosobruchus maculatus* females, egg hatchability, adult emergence and seed weight loss in the black gram seeds treated with seven plant dry powders (Table 1) @ 2 per cent compared with untreated control in results were furnished in (Table 3). *P. nigrum* seed powder 2 per cent acted as best oviposition deterrent wherein no egg was laid compared to 107 eggs in control. The present findings also collaborate with the findings of Manju *et al.* (2019) also stated that *P. nigrum* 1 per cent seed powder treated green gram seeds sowed highest

Table 2: Effect of insecticidal plant powders on the adult mortality of pulse beetle, *Callosobruchus maculatus* (F.).

Treatments*	% Adult mortality**							Mean
	1 DAT	2 DAT	3 DAT	4 DAT	5 DAT	6 DAT	7 DAT	
Piper nigrum 2%	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
	(89.47)a	(89.47)a	(89.47)a	(89.47)a	(89.47)a	(89.47)a	(89.47)a	(89.47)
Sesbania grandiflora 2%	10.22	26.80	40.50	45.10	49.50	62.50	70.50	43.58
	(18.32)b	(30.45)b	(34.45)b	(36.30)c	(38.99)c	(50.75)c	(59.40)c	(38.38)
Abutilon indicum 2%	4.00	17.00	24.66	35.88	45.99	64.66	73.50	37.95
	(11.00)bc	(24.51)bc	(28.06)c	(38.57)d	(42.99)d	(52.75)c	(60.44)c	(36.90)
Tephrosia purpurea 2%	3.33	23.50	25.50	34.40	45.10	49.50	55.55	33.84
	(8.66)c	(28.70)b	(30.30)c	(35.90)d	(36.30)d	(38.99)d	(48.21)d	(32.43)
Azadirachta indica 2%	4.44	24.66	42.22	49.99	64.66	75.55	87.77	48.86
	(11.49)bc	(28.06)b	(40.52)b	(45.00)b	(52.75)b	(64.24)b	(69.57)b	(44.91)
Coccinia indica 2%	6.66	15.55	33.33	51.11	62.22	78.88	80.50	47.93
	(14.63)b	(23.13)d	(35.24)bc	(45.64)b	(52.09)b	(62.86)b	(72.31)bc	(43.31)
Acalypa indica 2%	4.44	10.00	18.88	43.33	48.88	63.33	73.33	37.45
	(11.99)bc	(18.43)e	(25.74)d	(41.16)c	(44.36)c	(52.74)c	(58.93)c	(36.19)
Control	0.00	8.88	14.44	17.77	31.11	33.33	36.66	20.31
	(0.52)d	(17.27)f	(22.30)e	(24.91)e	(33.89)e	(35.24)e	(37.25)e	(24.48)

DAT- Days after treatments.

*Mean of three replications.

**Figures in parentheses are transformed arcsine values.

In a column means followed by same letter(s) are not significantly different (p=0.05) by DMRT.

percentage of oviposition deterrence (71.6%) in *C. macultus*. Next effective treatment was neem, *Azadirachta indica* treated seeds distinct in reducing the oviposition with only 42.22 eggs on treated black gram seeds followed by *Coccinia indica* (47.66 Nos) eggs then the next most effective in deterring the bruchids from ovipositing (55.00 Nos) in *Abutilon indicum* and *Acalypa indica* (64.44 Nos). Among the different insecticidal plant powders, *Sesbania grandiflora* least found least effective (72.33 Nos) while 107 eggs laid in untreated control. Regarding the hatchability, insecticidal plant powder reduced the egg hatching significantly. Hatchability in *P. nigrum, Acalypa indica, A. indica, Tephrosia purpurea* and *Abutilon indicum* were significantly different from untreated check (90.73%) (Table 3). Regarding the adult emergences, no adult beetle emergence was recorded in *P. nigrum* and it was significantly different from other treatments. The present findings are in agreement with the reports of Emeasor and Chukwu, (2019) who found that 2 g of *P. nigrum* powder admixed with 20 g of mung bean seeds resulted complete inhibit the adult beetle emergences of *C. macultus* and the result was in line with Manju *et al.,* 2019; Rathod *et al.,* 2019. Next effective treatment is

Table 3: Effect of insecticidal plant powders on oviposition, hatchability and adult emergence of *Callosobruchus maculatus* (F.).

Treatments***	No. of eggs*	Hatchability**	No. of adults	% Seed weight loss**		
	laid/5 females	%	emerged*	30 DAT	45 DAT	60 DAT
Piper nigrum 2%	0.00	0.00	0.00	0.00	0.00	0.00
	(0.00)a	(0.52)a	(0.00)a	(0.52)a	(0.52)a	(0.52)a
Sesbania grandiflora 2%	72.33	82.59	49.00	26.25	28.26	33.22
	(1.24)e	(65.65)d	(1.70)d	(30.71)e	(31.79)d	(37.77)d
Abutilon indicum 2%	55.00	74.64	29.66	12.45	14.84	22.84
	(1.73)c	(59.87)c	(1.46)bc	(20.64)c	(22.39)b	(23.41)c
Tephrosia purpurea 2%	68.33	66.91	23.66	12.88	15.48	19.50
	(1.83)d	(54.91)b	(1.51)b	(21.02)c	(22.95)b	(25.55)c
Azadirachta indica 2%	42.33	77.81	32.00	10.15	13.88	15.51
	(1.62)b	(62.00)c	(1.50)c	(18.57)b	(22.02)b	(22.98)b
Coccinia indica 2%	47.66	75.28	26.66	17.20	20.97	22.50
	(1.67)bc	(60.25)c	(1.42)b	(24.49)d	(26.93)c	(32.40)c
Acalypa indica 2%	64.44	69.29	31.00	16.46	24.64	28.55
	(1.80)d	(56.41)b	(1.49)c	(23.93)d	(27.87)cd	(32.66)d
Control	107.00	90.73	90.00	34.26	39.22	45.26
	(2.07)f	(72.27)e	(1.96)e	(35.82)f	(37.82)e	(46.37)e

DAT- Days after treatments.

*Figures in parentheses are transformed square root values.

**Figures in parentheses are transformed arcsine values.

***Mean of three replications.

In a column means followed by same letter(s) are not significantly different (p=0.05) by DMRT.

Table 4: Insecticidal action of different concentration *Piper nigrum* seed powder on *Callosobruchus maculatus* (F.).

Treatments*	% Adult mortality**			
	5 HAT	10 HAT	15 HAT	Mean
P. nigrum 0.50%	36.44	76.66	100.00	71.00
	(37.31)c	(61.15)c	(89.47)a	(59.50)
P. nigrum 1.00%	63.33	92.22	100.00	85.00
	(52.78)b	(73.87)b	(89.47)a	(63.87)
P. nigrum 1.50%	65.55	94.44	100.00	86.60
	(54.08)b	(76.51)b	(89.47)a	(64.87)
P. nigrum 2.00%	71.10	100.00	100.00	100.00
	(56.99)a	(89.47)a	(89.47)a	(89.47)
Control	0.00	0.00	0.00	0.00
	(0.52)d	(0.52)d	(0.52)b	(0.52)

HAT- Hours after treatment.

*Mean of three replication.

**Figures in parentheses are transformed arcsine values.

In a column means followed by same letter(s) are not significantly different (p=0.05) by DMRT.

Coccinia indica (26.66 Nos) and *A. indica* (32 .00 Nos) among the different insecticidal plant powders highest adult beetles was emerged from *S. grandiflora* (49.00 Nos), as untreated 90 adult beetles emerged (Table 3). Similarly the results agree with the report of Kaur *et al.* (2019) who stated that neem leaf powder at 5 g / 100 g of pea seed was highly effective and inhibit the adult beetle emergence.

No seed weight loss (0.00%) was recorded *P. nigrum* and it was statistically significant with other treatments. This observation supported by the reports of Islam *et al.,* (2013) who reported that the black pepper seed powder has the high insecticidal property and no seed weight loss was recorded at 1.0 per cent powder. Next effective treatment was *A. indica* 2 per cent leaves powder (10.15%), *Abutilon indicum* 2 per cent leaf powder (12.45%), *Tephrosia purpurea* (12.45%) and *Acalypa indica* (16. 46%) among the insecticidal plants maximum seed weight was noticed in loss *Sesbania grandiflora* 2 leaves powder (26.25%) while 34.26 per cent loss was registered in control at 30 days after treatments. Minimum seed weight loss was (13.88%) observed in seed treated with *A. indica* followed by *A. indicum* (14.84%) which was on par effect with *T. purpurea* (15.48%) followed by *Coccinia indica* (20.97%) > *Acalypa indica* (26.64%) and *S. grandiflora* (28.26%), respectively compared to untreated (39.22%) at 45 DAT. These results are in conformity with the findings of earlier researchers with black pepper powder Rathod *et al.,* (2019) who stated that black pepper powder causes less infestation and least weight loss noticed. At 60 DAT, 15.51, 19.50, 22.84 and 22.50 per cent weight loss in *A. indica, T. purpurea, A. indicum* and *Coccinia indica* respectively, as compared with untreated (45.26%) (Table 3). *P. nigrum* was significantly superior to all other treatments in inhibiting the oviposition, hatchability, adult emergence and seed weight loss.

Effect different concentration of *Piper nigrum* seed powder on *Callosobruchus maculatus*

Insecticidal action on *C. maculatus*

The screening on insecticidal plant powders tested against *C. maculatus* (Table 2) based on screening results showed the *Piper nigrum* seed powder have 100 per cent mortality with in 24 hrs. This plant has highly effective in controlling the pulse beetle. *Piper nigrum* selected for further experiment on different concentrations tested for insecticidal action against *C. maculatus* and observation taken on 5 hourly interval. *Piper nigrum* seed powder at 0.50, 1.00, 1.50 and 2.00 per cent concentrations. Data on mortality of *C. maculatus* after 5,10 and 15 hourly interval were recorded. Results (Table 4) revealed that *P. nigrum* at 2.00 per cent was significantly different from all other treatments with 71.11 per cent mortality after 5 hours after treatment (HAT) next best dose 1.50 per cent (65.55%) and 1.00 per cent (63.33%) among the four concentrations minimum mortality (36.44%) was observed in lowest dose at 0.50 per cent. All the beetles were dead in *P. nigrum* at 2.00 per cent at 10 HAT, which was followed by 1.50 per cent (94.44%), 1.00 per cent (92.22%) and 0.50 per cent (76.66%) as compared to untreated control no mortality was recorded. All the four doses recorded cent per cent mortality recorded with in 15 hours after treatment. The present finding could be substantiated with the findings of Kaur *et al.,* (2019).

Effect different concentration of *Piper nigrum* seed powder on oviposition, egg hatchability and adult emergence of *Callosobruchus maculatus* and seed weight loss

C. maculatus laid significantly variable number of eggs on black gram seeds treated with different concentrations of *P. nigrum viz*., 0.50, 1.00, 1.50 and 2.00 per cent (Table 5). There was no eggs laying observed in *P. nigrum* at 1.50

Table 5: Effect of different concentration of *Piper nigrum* seed powder on oviposition, egg hatchability and adult emergence of *Callosobruchus maculatus* (F.) and seed weight loss.

Treatments***	No. of eggs laid*	Hatchability %**	No. of adults emerged*	% Seed weight loss**		
				30 DAT	45 DAT	60 DAT
P. nigrum 0.50%	7.00	66.33	3.32	0.43	1.33	2.55
	(0.89)b	(56.14)c	(0.41)c	(2.12)b	(4.43)b	(4.99)b
P. nigrum 1.00%	7.66	75.33	1.00	0.88	1.03	1.23
	(0.81)b	(57.89)b	(0.20)b	(3.66)b	(4.03)b	(4.33)b
P. nigrum 1.50%	0.00	0.00	0.00	0.00	0.00	0.00
	(0.00)a	(0.52)a	(0.00)a	(0.52)a	(0.52)a	(0.52)a
P. nigrum 2.00%	0.00	0.00	0.00	0.00	0.00	0.00
	(0.00)a	(0.52)a	(0.00)a	(0.52)a	(0.52)a	(0.52)a
Control	246.00	72.55	124.00	29.76	34.27	38.22
	(1.89)c	(58.42)d	(2.09)d	(33.05)c	(32.85)c	(36.82)c

DAT- Days after treatment.

*Figures in parentheses are transformed logarithmic values.

**Figures in parentheses are transformed arcsine values.

***Mean of three replications.

In a column means followed by same letter(s) are not significantly different (p=0.05) by DMRT.

and 2.00 per cent. Few eggs were laid by female in *P. nigrum* 1.00 per cent (7.66 Nos) which dose statistically on par with 0.50 per cent (7.00 Nos) as compared to untreated (246 Nos) eggs were laid similar results were reported by Swamy and Raja (2018) green gram mixing of black pepper powder even at lower doses of 0.2, 0.3 and 0.4% could control pulse bruchids very effectively.

Regarding the egg hatchability was significantly less in *P. nigrum* 1.50 and 2.00 per cent. No adult beetle emergence was observed in all the treatments *P. nigrum* 1.50 and 2.00 per cent except in *P. nigrum* 1.00 per cent (1.00 Nos) and 0.50 per cent (3.32 Nos) as compare with untreated 124 adult beetles were emerged. The present findings also collaborate with the findings of Swamy and Raja (2018) stated that green gram seeds on mixing of black pepper powder @ 0.1, 0.2 and 0.3 per cent treated seeds of green gram were also found significantly effective as very negligible numbers (0.33, 1.0 and 8.33 adults respectively) emerged. Regarding the seed weight loss, *P. nigrum* 1.50 and 2.00 per cent showed no weight loss was observed. Lower dose of *P. nigrum* 0.50 per cent at 30 DAT (0.43%), 45 DAT (1.33%) and 60 DAT (2.55%) as compare with untreated 30 DAT (29.76%), 45 DAT (34.27%) and 60 DAT (38.22%). The results were in agreement the findings of Swamy and Raja, (2018 stated that green gram seeds on mixing of pepper powder even at lower doses of 0.2, 0.3 and 0.4% could control pulse bruchids effectively and no seed weight losses and protection up to six month of storage period. At 60 DAT, *P. nigrum* 1.00 per cent caused 0.83, 1.03 and 1.23 per cent mortality at 30, 45 and 60 DAT, respectively. Poornasundari and Daniel (2015) found black pepper powder at doses of 0.5, 1.0, 1.5 and 2.0 g mixed with 40 g of green gram as effective against *C. chinensis* and protection up to six months of storage period.

CONCLUSION

Study the effect of seven insecticidal plant dry powders against *Callosobruchus maculatus* infesting the stored black gram the results revealed that the efficacy of various powders among them, *Piper nigrum* 2 per cent seed powder caused 100.00 per cent mortality to pulse beetle on two days after treatment. *P. nigrum* caused complete inhibited egg laying and progeny development and also no weight losses recorded up to 60 days after treatment. Different concentration of *P. nigrum* experiment results concluded that all the four dose of *P. nigrum* (0.50, 1.00, 1.50 and 2.00%) highly effective against *C. macultus viz.,* mortality, oviposition, adult emergence and seed weight loss. Therefore, the resource poor farmers can use botanicals namely, black pepper, *P. nigrum* seed powder in controlling pulse beetle, *C. macultus* is stored black gram as they may not afford to buy chemical pesticides due to high cost. Furthermore, the use of botanical pesticides to control pulse beetle is an appropriate strategy to avoid environmental pollution and other hazards, since the chemical pesticides are used by farmers and in agro industries currently.

Conflict of interest: None.

REFERENCES

Abbott, W.W. (1925). A method of computing the effectiveness of insecticide. Journal of Economic Entomology. 18: 265-267.

Abdullah, A., Magdi, A.A.M., Ahmed, A.Z. (2017). Efficacy of some botanical oils against stored-product pest cowpea beetle, *Callosobruchus maculatus* (F.) (Coleoptera: Bruchidae). International Journal of Zoology Studies. 2(1): 05-09.

Ahmad, K., Adnan, M., Anwar, M. Hussain, Z., Junaid, K., Saleem, N. (2015). Bioactive neem leaf powder enhances the shelf life of stored mung bean grains and extends protection from pulse beetle. Pakistan Journal of Weed Science and Research. 21: 71-81.

Credland, P.F. and Wright, A.W. (1989). Factors affecting female fecundity in the cowpea seed beetle, *Callosobruchus maculatus* (Coleoptera: Bruchidae). Journal of Stored Product Research. 25(3): 125-139.

Dongre, T.K., Pawar, S.E., Thakare, R.G., Harwalkar, M.R. (1996). Identification of resistant sources to cowpea weevil (*Callosobruchus maculates* (F.) in *Vigna* sp. and inheritance of their resistance in black gram (*Vigna mungo* var. *mungo*). Journal of Stored Product Research. 32(3): 201-204.

Duncan, D.B. (1995). Multiple range and multiple tests. Biometrics. 11: 1-42.

Emeasor, K.C. and Chukwu, L.A. (2019). Evaluation of toxicity of some plant materials against the bruchid (*Callosobruchus maculatus* (F.) (Coleoptera: Chrysomelidae) on mung bean [*Vigna radiata* (L.) Wilczek] seeds in storage. Acta Scientific Agriculture. 3(9): 1-5.

Gbaye, O.A., Millard, J.C., Holloway, G.J. (2011). Legume type and temperature effects on the toxicity of insecticide to the genus *Callosobruchus* (Coleoptera: Bruchidae). Journal of Stored Product Research. 47:8-12.

Gomez, K.A. and Gomez, A.A. (1984). Statistical Procedures for Agricultural Research, Wiley Inter Science Publication, John Wiley and Sons, New York, 680.

Govindan, K and Nelson, S.J. (2007). Effect of *Piper nigrum* seed powder and dust formulation on *Callosobruchus maculatus* (F.). Annals of Plant Protection Science. 15(1): 39-42.

Islam,S., Haque, A., Ahmed, S., Mondal, Dash, C.K. (2013). Evaluation of some spices powder as grain protectant against pulse beetle, *Callosobruchus chinensis* (L.). Universal Journal Plant Science. 1(4): 132-136.

Kaur, K.D., Verma, S.C., Sharma, P.L. (2019). Efficacy of plant powders against pulse beetle, *Callosobruchus chinensis*, L. infesting pea seed. Journal Entomology and Zoology Studie. 7(1): 737-741.

Manju, K., Jayaraj, J., Shanthi, M. (2019). Efficacy of botanicals against pulse beetle *Callosobruchus maculatus* (F.) in green gram. Indian Journal Entomology. 81(1): 144-147.

Mohapatra, G.K., Gupta, G.P. (1998). Pesticide induced resurgence. Pestology. 22 (12): 14-20.

Musa, A.K. and Uddin, R.O. (2016). Insecticidal Potential of indigenous plant powders against beetle, *Callosobruchus maculatus* (F.)(Coleoptera: Chrysomelidae) in stored cowpea. International Journal Phytofuels and Allied Science. 5(1): 1-14.

Poornasundari, B. and Daniel, T. (2015). Pest control in greengram seeds (*Vigna radiata*) by using plant extracts. International Letters of Natural Science. 40: 38-40.

Raghu, B., Kumar, R.P., Gowda, B., Manjunatha, N., Alur, R.S. (2016). Post harvest seed quality of greengram as influenced by pre-harvest spray of insecticides. Indian Journal of Agricultural Research. 50(2): 113-116.

Rathod, L., Sasane, A.R., Kawre, P.R., Chaware G.G., Rathod. P.K (2019). Effect of botanicals on pulse beetle and per cent seed germination of stored green gram, Journal of Pharmacognosy and Phytochemistry. 8(3): 2428-2430.

Soe, T.N., Aran, N., Wisut, S. (2020). Bioactivity of some plant essential oils for seed treatment against pulse beetle, *Callosobruchus maculatus* (F.) (Coleoptera: Bruchidae) on mung bean. Bulgarian Journal Agricultural Science. 26(1): 141-147.

Swamy, S.G., Raja, S.V.S.D. (2018). Use of black pepper and clove against pulse beetle *Callosobruchus maculatus* (F.) in green gram. Indian Journal of Entomology. 80(4): 1291-1295.

Vasanthakumar, J. (2016). Constraints to productivity of black gram (*Vigna mungo* L.) and green gram (*Vigna radiata* L.) in Tamil Nadu, Indian Journal Natural Science. 7(38): 16-21.