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Study the evaluate the efficacy of botanicals and inert dusts for pulse beetle management

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Abstract
Custard apple leaf powder (10g/kg) showed the maximum (18.33%) mortality of pulse beetle after 7 days. The minimum mortality (5.00%) was observed in grains treated with cow dung ash. All the plant powders and inert dusts at their application rates of 5g/kg and 10g/kg reduced the number of eggs laid by pulse beetle when compared with the control, which had the maximum (60.33, 64.33 and 66.33) eggs after 3, 7 and 10 days. The lowest (19.67, 21.33 and 23.00) number of eggs was recorded on grain treated with custard apple leaf powder (10 g/kg). The cow dung dust was least effective at the dose level of 10 g/kg. The plant powders and inert dusts even at their lowest application rate reduced the emergence of adults when compared with control, where the maximum (44.00, 51.33 and 58.67%) adults emerged after 30, 60 and 90 days of intervals. The minimum (20.67, 23.33 and 27.33 %) adults emerged in seeds treated with custard apple leaf powder (10g/kg). The minimum seed damage of 26.67 per cent was recorded in custard apple leaf powder treated seeds, while maximum seed damage (63.33 %) was recorded in the control. The minimum weight loss of 7.17 per cent was recorded in custard apple leaf powder treated seeds, while maximum weight loss (23.40%) was recorded in the control. The maximum germination (52.67 %) was recorded in custard apple leaf powder treated seeds of green gram, while and minimum germination (31.33%) was recorded in control.

Keywords: mortality, cow dung, custard apple leaf powder, inert dusts and pulse beetle

1. Introduction
Pulses being is a vital source of protein form a major constituent of the vegetarian diet for a majority of the rural and urban population in India, where the consumption of animal protein except milk is still considered a religious and social taboo. Among the pulse crops, green gram, *Vigna radiata* (L) is important pulse crop as it is widely used as a whole grain or as a split pulse on account of its easy digestibility. It contains 24 percent protein, 56.7 per cent carbohydrates, 3.5 per cent fibre and 1.3 per cent fat. The area under green gram in India is 43.05 lakh hectares with a production of 20.70 lakh tonnes and productivity 481 kg/ha. In Madhya Pradesh green gram is cultivated in 2.51 lakh hectare with an annual production of 1.16 lakh tonnes and productivity of 464 kg/ha (Anonymous, 2016-17) [2]. The pulse beetle (*Callosobruchus chinensis* L.) is a key pest of stored pulses and mainly responsible for causing significant damage. In severe cases, the entire quantity of stored grain gets reduced to a mass of empty shells and dust. It has been reported that *C. chinensis* also harbours certain pathogenic micro-organisms that cause food poisoning and spoilage besides quantitative damage (Neelgund and Kumari, 1983) [16].The plant materials as powder form and their extracts have also been reported effective against pulse beetle in storage by Pandey *et al.*, (1976)[17], Juneja and Patel (2002) [10], Kotkar *et al.*, (2002) [13], Bajya *et al.*, (2007) [4], Chander *et al.*, (2007) [5], Shaheen and Khaliq (2005) [18], Suthar and Bharpoda, (2016) [19], Khinchi *et al.*, (2017) [11], Kosar and Srivastava, (2016) [12].
Hence, looking to seriousness of the pest and to develop economical, eco-friendly approach for the management of the beetle in storage, water and ethanol extracts of some easily available plants material were tested against pulse beetle.

2. Material and Methods
The plant materials were collected; shade dried and were powdered in a grinder mixer and

sieved through a mesh of size 50 to remove the waste and coarse matter. The botanicals were mixed with pre-sterilized grains (50g) at application rates of 5 and 10 gram per kilo seeds and each treatment was replicated thrice. The treated samples were kept in plastic containers, shaken vigorously in order to have an even coating of the test material on the grain surface. Five pairs of freshly emerged (0-24 hr) adults of *Callosobruchus chinensis* were released into each container including that of control. Observations from each replicate were taken for the average number of eggs laid on 100 randomly selected grains/seeds from each treatment after 3, 7 and 10 days of adult release; the numbers of adults that emerged from each treatment were counted and removed after 1, 2 and 3 months of storage; while, seed damage (%), weight loss (%) and seed germination (%) was recorded after 3 months of storage. The data thus obtained were analyzed statistically following completely randomized design. Number of treatments 9, Experimental design Completely Randomized Design (CRD), No of replications 3.

Table 1: Treatment details of plant products, inert dusts and their doses.

Treatment symbol	Common name	Doses (g/kg seed)
T_1	Custard apple leaf powder	5g
T_2	Custard apple leaf powder	10g
T_3	Dhatura leaf powder	5g
T_4	Dhatura leaf powder	10g
T_5	Neem leaf powder	5g
T_6	Neem leaf powder	10g
T_7	Cow dung ash	5g
T_8	Cow dung ash	10g
T_9	Untreated control	--------

2.1. Mortality counts of pulse beetle

Twenty insects were released in each jar to assess the efficacy of the plant products/ inert dusts on bruchid mortality; the number of dead beetles in each replicate jar was counted after 7 days of treatment. Analyses and computation of data after 3 months of storage:

2.1.1. Grain/ seed damage was computed as suggested by Adams and Schulten method (1978) [1]

$$\text{Grain/ seed damage (\%)} = \frac{\text{No. of holed seeds}}{\text{Total seeds}} \text{X } 100$$

2.1.2. Weight loss was calculated using the following equation

$$\text{Weight loss (\%)} = \frac{\text{Initial weight of seeds} - \text{Final weight of seeds}}{\text{Initial weight of seeds}} \text{ X } 100$$

3. Results and Discussion

3.1. Mortality per cent of pulse beetle after 7 days of release

It is evident from (table – 2) that the botanicals and inert dusts at all the application rates and time intervals caused significant pulse beetle mortality as compared to control. Custard apple leaf powder (10 g/kg) showed the mean maximum of 18.33 per cent mortality. The mean minimum of 5.00 per cent mortality was observed in seeds treated with cow dung ash (5 g/kg). The application of powders at different rates exerted marked effect on the mortality, but at higher dose caused rapid mortality. However, more effective powders like custard apple leaf powder and Neem leaf Powder at their higher application rates (10 g/kg) provided higher mortalities as compared to the other treatments.

3.2. Fecundity of pulse beetle

All the plant powders and inert dusts after 3, 7 and 10 days at their application rates of 5 and 10 g/kg reduced the number of eggs laid by pulse beetle when compared with that in control. The lowest average number of eggs laid after 3,7 and 10 days were 19.67, 21.33 and 23.00 respectively where the grain was treated with custard apple leaf powder (10 g/kg) (Table- 2). The cow dung ash treatment was least effective at the dose level of 10 g/kg. The table also indicated that powders of leaf parts (neem and custard apple) were more effective in reducing fecundity of pulse beetle as compared to those prepared from Cow dung ash.

3.3. Effect of botanicals and inert dusts on adult emergence

3.3.1. At 30 days after release

All the treatments at the lowest doses reduced the total per cent adult emergence when compared with control, where 44.00 percent adults emerged. The average minimum adult emergence 20.67 was recorded in seeds treated with custard apple leaf powder (10g/kg). leaves parts (custard apple and Neem leaf) again showed better insecticidal potency than the Cow dung ash (Table-3).

3.3.2. At 60 days after release

All the botanicals and inert dusts even at their lowest doses reduced the total population build-up when compared with control, where the average maximum (51.33%) adults emerged in untreated control. The minimum adults (23.33%) emerged from seeds treated with custard apple leaf powder (10g/kg). The leaf powders of Neem (10g/kg) exhibited an average 24.00 per cent adult emergence (Table-3).

3.3.3. At 90 days after release

The result as indicated in (Table-3) showed that all the botanicals and inert dusts even at their lowest doses reduced the per cent adult emergence when compared with control, where the average maximum adults emerged was 58.67 per cent. The average minimum adult emergence (27.33%) was recorded in seeds treated with custard apple leaf powder. Leaves parts (custard apple and neem) again showed better insecticidal potency than the cow dung ash. The cow dung ash treated seeds showed 47.33 and 43.33 per cent adult emergence after 90 days of storage at the treatment dose of 5g and 10g per kilogram of seeds, respectively.

3.4. Bio-efficacy of botanicals and inert dusts on per cent seed damage, weight loss and germination on pulse beetle up to 90 days after storage of pulse beetle.

3.4.1. Seed damage (%)

As per (Table-4) all the plant powders and inert dusts even at their lowest application rate reduced the seed damage per cent when compared with control, where the average maximum seed damage (63.33%) was observed. The minimum seed damage of 23.33 per cent was observed in seeds treated with custard apple leaf powder (10g/kg). The Cow dung Ash (5g/kg) exhibited maximum (38.33%) seed damage.

3.4.2. Weight loss (%)

The average maximum weight loss (23.40%) was observed in

untreated control; whereas, the minimum weight loss of 7.17 and 5.07 per cent was observed in seeds treated with custard apple leaf powder (5g/kg), (10g/kg) respectively. The leaf powders of neem (10g/kg) exhibited 6.03 per cent weight loss (Table-4).

3.4.3. Green gram germination (%)

A Perusal of (table – 4) shows that the average maximum germination (57.33%) was recorded in green gram treated with custard apple leaf powder (10g/kg); whereas, in the control 31.33 per cent germination was recorded.

Table 1: Bio-efficacy of plant powders and inert dusts on mortality of pulse beetle

Treatment	Doses (g/kg)	Seed Cumulative mortality (%) 7 days after release
Custard apple leaf powder	5	16.67(24.05)
Custard apple leaf powder	10	18.33(25.31)
Dhatura leaf Powder	5	8.33(16.60)
Dhatura leaf powder	10	10.00(18.05)
Neem leaf Powder	5	11.67(19.50)
Neem leaf powder	10	15.00(22.60)
Cow dung Ash	5	5.00(12.92)
Cow dung ash	10	6.67(14.76)
Control	--------	5.00(12.92)
S.Em±	--------	1.96
C.D. at 5%	--------	5.81

= Figures in parentheses are angular transformed values.

Table 2: Comparative preference for egg laying on green gram variety.

Treatments	Doses (g/kg) seed	Number of eggs laid/100 grains		
		3 DAR	7 DAR	10 DAR
Custard apple leaf powder	5.00	19.67(4.49)	21.33(4.66)	23.00(4.84)
Custard apple leaf powder	10.00	17.33(4.22)	19.33(4.45)	20.67(4.58)
Dhatura leaf Powder	5.00	29.33(5.46)	32.33(5.72)	33.33(5.81)
Dhatura leaf powder	10.00	27.33(5.27)	29.00(5.43)	30.00(5.51)
Neem leaf Powder	5.00	23.33(4.88)	25.67(5.11)	26.67(5.21)
Neem leaf powder	10.00	21.33(4.66)	23.67(4.90)	25.00(5.04)
Cow dung Ash	5.00	39.33(6.30)	42.33(6.54)	43.67(6.64)
Cow dung ash	10.00	34.67(5.93)	36.33(6.07)	38.00(6.20)
Untreated Control	----------	60.33(7.80)	64.33(8.05)	66.33(8.17)
S.Em±	----------	0.16	0.19	0.20
C.D. at 5%	----------	0.46	0.56	0.59

= Figures in parentheses are square root transformed values.

Table 3: Comparative adult emergence of *Callosobruchus chinensis* (L.) on different green gram varieties

Treatments	Doses (g/kg) seed	Adult emergence (%) days after release		
		30 DAR	60 DAR	90 DAR
Custard apple leaf powder	5.00	20.67(27.00)	23.33(28.85)	27.33(31.48)
Custard apple leaf powder	10.00	18.67(25.55)	21.33(27.47)	24.67(29.70)
Dhatura leaf Powder	5.00	27.33(31.50)	30.00(33.18)	38.67(38.43)
Dhatura leaf powder	10.00	25.33(30.19)	28.67(32.32)	41.33(39.99)
Neem leaf Powder	5.00	24.00(29.32)	26.67(31.07)	37.33(37.62)
Neem leaf powder	10.00	22.67(28.40)	24.00(29.28)	34.00(35.65)
Cow dung Ash	5.00	28.67(32.35)	32.67(34.82)	47.33(43.47)
Cow dung ash	10.00	26.67(31.07)	30.00(33.18)	43.33(41.15)
Untreated Control	----------	44.00(41.55)	51.33(45.77)	58.67(50.01)
S.Em±	----------	1.10	1.50	1.76
C.D. at 5%	----------	3.27	4.45	5.24

= Figures in parentheses are angular transformed values.

Table 4: Damage caused by *C. chinensis* to seed quality parameter on different varieties of green gram

Treatment	Doses(g/kg) Seed	Seed Damage %	Weight loss %	Germination %
Custard apple leaf powder	5.00	26.67(31.07)	7.17(15.51)	52.67(46.53)
Custard apple leaf powder	10.00	23.33(28.67)	5.07(12.87)	57.33(49.23)
Dhatura leaf Powder	5.00	35.00(36.24)	13.83(21.80)	43.33(41.16)
Dhatura leaf powder	10.00	31.67(34.15)	11.97(20.20)	46.67(43.09)
Neem leaf Powder	5.00	33.33(35.22)	9.13(17.55)	47.33(43.47)
Neem leaf powder	10.00	30.00(33.16)	6.03(14.10)	49.33(44.62)
Cow dung Ash	5.00	38.33(38.19)	18.77(25.65)	37.33(37.65)
Cow dung ash	10.00	35.00(36.24)	16.13(23.64)	40.67(39.60)
Untreated Control	----------	63.33(52.80)	23.40(28.91)	31.33(33.99)
S.Em±	----------	2.24	1.02	1.41
C.D. at 5%	----------	6.65	3.04	4.19

= Figures in parentheses are angular transformed values.

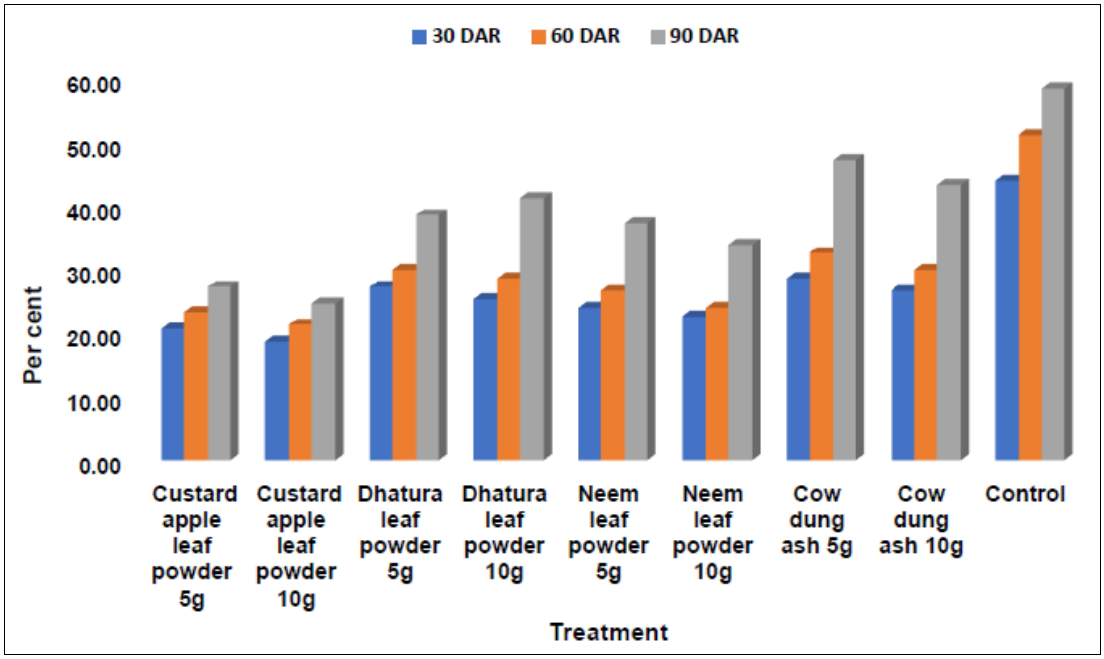

Fig 1: Influence of botanicals and inert dusts on bruchid adult emergence.

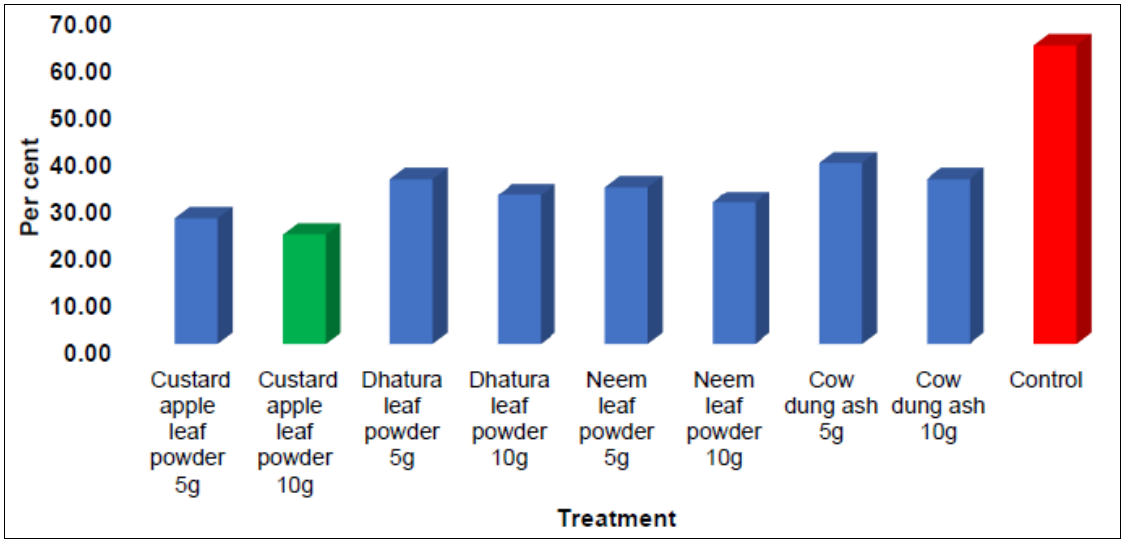

Fig 2: Influence of botanicals and inert dusts on bruchid Grain damage percent after 90 days in forced condition.

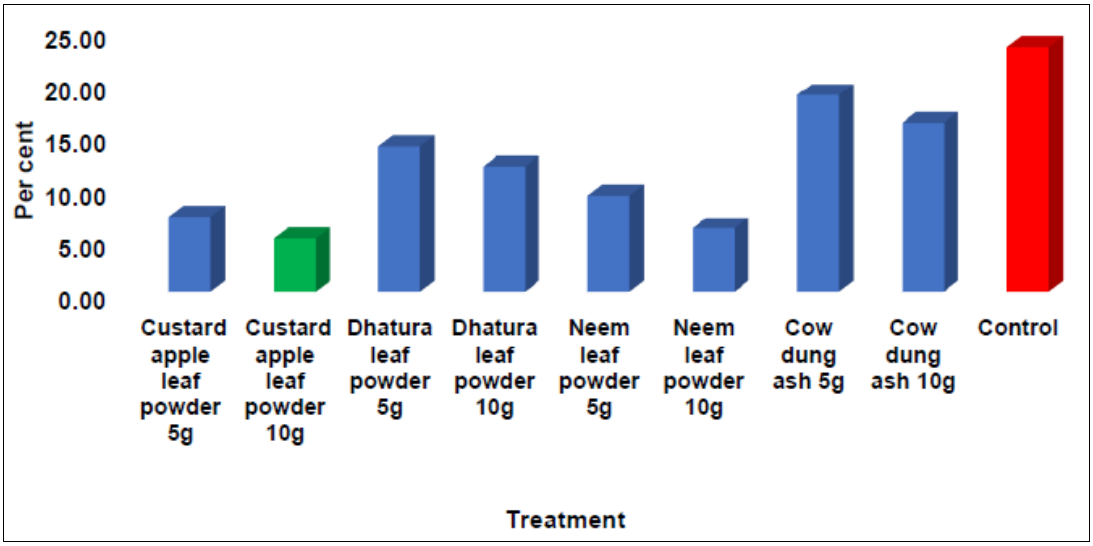

Fig 3: Influence of botanicals and inert dusts on bruchid Weight loss percent after 90 days in forced condition.

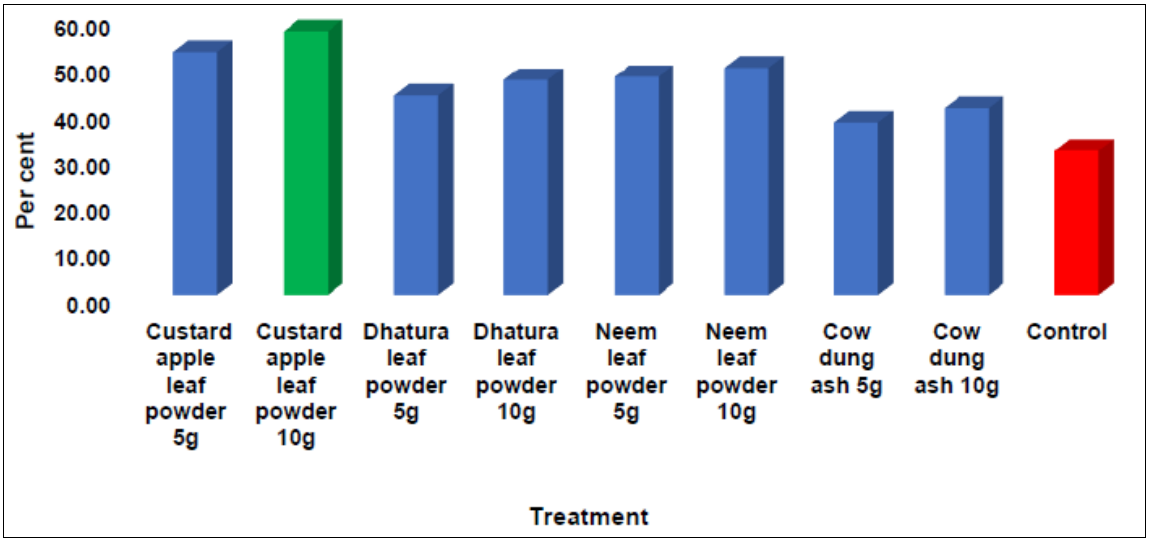

Fig 4: Influence of botanicals and inert dusts on bruchid germination percent after 90 days.

1. Custard apple leaf powder 2. Neem leaf powder

3. Dhatura leaf powder 4. Cow dung ash

Plate 1: Botanicals and inert dust protecting against infesting *C. chinensis* (L.)

3.4.4. Efficacy of botanicals and inert dusts

The present study's findings indicate the effects of some of the plant powders and inert dusts on mortality, egg-laying, adult emergence, seed damage percent, weight loss, and germination of *C. chinensis.* Varying activity by different powders and inert dusts indicate that the pest controlling factors are not uniformly present in every aromatic plant and inert dusts.

3.4.5. Mortality of pulse beetle

The present Custard apple leaf powder (10 g/kg) showed the mean maximum of 16.67 percent mortality. The mean minimum of 5.00 percent mortality was observed in seeds treated with cow dung ash (5 g/kg). After 7 days of exposure. Juneja and Patel, (1994) [9] reported that the seed powders of custard apple at 5 parts per 100 parts of green gram (w/w) resulted in 100 percent adult mortality.

3.4.6. Egg laying of pulse beetle

The average lowest number of eggs was recorded in grains treated with custard apple leaf powder (10g/kg). The neem leaf powder and Dhatura leaf powder showed the least effect

but these were better as compared to the control. Govindan and Nelson, (2008) [7] reported that pulse beetle laid no eggs on green gram treated with custard apple seed powder up to 168 hr, which justifies our results.

3.4.7. Adult emergence (%)
In the present investigationitt was observed that the minimum average adults emerged from the seeds treated with custard apple leaf powder (10g/kg) of after 30, 60 and 90 days. Leaves portion of neem and Dhatura showed better insecticidal potency than their Cow dung ash.

3.4.8. Seed damage (%)
In the present investigation custard apple leaf powder (10g/kg) treated seeds recorded average lowest (23.33%) seed damage and neem leaf powder, Dhatura leaf powder also showed the good result as compared to control. The reduction in seed damage as observed by mixing various plant powders with black gram @ 5 g per 100 g seed has been reported earlier by Gautam *et al*., (2000) [6]. The present findings also draw considerable support from the work of Mishra (2000) [15] who found neem leaf powder treatment ideal at a percentnt dose in black gram seeds resulting in less seed damage by *C. chinensis.* Aslam *et al.,* (2002) [3], however reported the complete effectiveness of black pepper in preventing *C. chinensis* infestation of stored pulses when applied @ 25 g per kg of seed.

3.4.9. Weight loss (%)
The average minimum (5.07%) weight loss was recorded in custard apple leaf powder (10g/kg) treated seeds at 90 days of storage. The maximum weight loss (23.40%) was recorded in the untreated control. However, powders of neem leaf powder, Dhatura leaf powder and cow dung were least effective in protecting grains from the damage of pulse beetle when applied at 10 g/kg of seeds. The present findings are in conformity with that of Mishra, (2000) [15] and Juneja and Patel (2002), who reported negligible weight losses in seed weight treated with 1 percent of either powdered custard apple or black pepper seed. Similarly, Laxmi and Venugopal, (2007) [14] also reported minimum weight loss in green gram treated with custard apple seed powder.

3.4.10. Germination (%)
The effect of four growth disrupting compounds viz., custard apple leaf powder, neem leaf powder, Dhatura leaf powder and cow dung powder at 5 and 10 g/kg on germination of green gram seeds was studied. The average maximum germination (57.33%) was recorded in seeds treated with custard apple leaf powder and the lowest 31.33%) in the untreated control. No adverse effect on seed viability of green gram by seed and leaf powders of custard apple at 3.0 percent was reported by Gundannavar and Deshpande, (2006) [8] and Lakshmi and Venugopal, (2007) [14]. No harmful effect of neem leaf powder at a dose level of 5.0 percent on soybean (Gundannavar and Deshpande, 2006) [8] and on mothbean (Yadav and Bhargava, 2005) [20] was reported up to 90 days of treatment, support the present investigations.

4. Conclusion
Green gram variety MH 421, JAKI-9218 and Subhra were found least preferred against *C. chinensis*, in which the lowest numbers of eggs were laid, seed damage percent, weight loss percent and has least emergence of adults. The maximum germination percentage showed in MH 421 while the minimum percentage showed in pusa vishal. Variety Pusa vishal was most susceptible on the basis of above parameter.

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