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Eco friendly treatments for the management of pulse beetle *C. chinensis* L. on chickpea

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Abstract
Among the different eco-friendly evaluated treatments for their efficacy, karanj oil @ 5ml/kg seeds, castor oil @ 5ml/kg seeds and tobacco leaf powder @ 10 gm/ kg seeds were found to be more effective by recording minimum oviposition adult emergence, seed infestation and less weight loss. Eco-friendly protectants can be used as a sustainable, safer to humans and environment, alternative to chemical protectants for long term storage of pulses.

Keywords: Eco-friendly, oviposition, protectant

Introduction
Chickpea (*Cicer arietinum* L.) is considered as "King of Pulses" and is commonly known as "Bengal Gram or Chana", belongs to family Fabaceae. It is an important winter season soil fertility restorative legume crop and is grown globally as food source. The origin of chickpea is still controversial as postulated by several botanists in different geographical origins. De Candolle (1883) [5] vaguely identified that the region between the South of the Caucasus and in the North of Persia are the place of possible origin of chickpea as this was also supported by (van der Maesen, 1972) [12], (Vavilov 1926) [14] supported the ideas that the South west Asia and the Mediterranean region as the primary centers of origin with Ethiopia as the secondary centers.

It was reported that when mixed with stored-grains, leaf, bark, seed powder or oil extracts of reduce oviposition rate and suppress adult emergence of bruchids, and also reduced seed damage rate (Onu and Aliyu 1995; Shaaya *et.al* 1997; Keita *et.al* 2001; Bhuiyh 2001) [9, 11, 7] reported that the oils of neem, royna and castor at 6 and 8 ml/kg and leaf powder of bishkatali, marigold and castor at 5% w/w were most effective in preventing the egg laying in lentil and chickpea and leaf powder of bishkatali, marigold, castor and mango at 5% were most effective in reducing the adult emergence in lentil and chickpea, whereas the adult emergence were nil in pre and post storage release methods. In considering hazards free management of *C. chinensis* using botanicals in storage aiming to assess the extent of damage of stored chickpea grains infested by *C. chinensis* as well as determining the efficacy of some botanicals against this insect pest

One of the eco-friendly and economic approaches to keep the stored food grains free from insect attack, is the use of plant products as grain protectants. The growing awareness of environmental hazards due to synthetic insecticides has attracted attention towards products of plant origin. Plant products are known to have many advantages, as they are safe to environment and consumer. Inability of the insect pest to develop resistance against them is an added advantage. There are encouraging reports on the use of certain indigenous plant products as grain protectants and impregnation of packaging materials with plant products. These conventional practices needed scientific evaluation. This situation dictates the need for safe, locally available and less expensive materials for pest control in storage. There are encouraging reports on the use of certain indigenous plant products as grain protectants (Sundria *et al.*, 2001, Bhargava and Meena, 2002, Bajiya, 2010) [12, 2, 1] but definite information on mortality doses, efficacy of oils and extracts by treatment of packaging materials and direct feeding with the seed and their residual life is meager, hence needs detailed investigations.

Material and Methods

Per cent mortality

Number of surving and dead insects were collected, counted after 48 hrs interval upto 15 DAT after release of insects. Moribund insects were recorded as dead. Per cent mortality of *C. chinensis* was calculated with the help of following formula**.**

$$\text{Mortality (\%)} = \frac{\text{Number of dead beetles}}{\text{Total number of released beetles}} \text{ X } 100$$

Number of eggs

Average number of eggs per grain laid by pulse beetle was calculated to check the effect of treatment on its oviposition\ fecundity. Ten grain were randomly selected from each replication calculated to determine eggs per grain in each jar.

3.6.4.3 No. of adult emerged

45 DAT and 75 DAT plastic containers were observed for the no. of adults emerged (both live and dead) counted the F1 generation and F2 generation respectively and recorded. Counted adults were thrown out at each time.

$$\text{Per cent adult emergence} = \frac{\text{Number of adult emerged}}{\text{Number of egg laid}} \text{ X } 100$$

Number of holes

Average number of holes per grain was calculated by counting the number of holes made by pulse beetle. For this, ten grain were randomly selected from each jar and holes on those grains were counted. Then average was taken to determine number of holes per grain in each replication.

Per cent seed infestation

Total number of seed were counted also the number of seeds damaged by pulse beetle were recorded and infestations was calculated with the following formula.

$$\text{Per cent seed infestation} = \frac{\text{Number of damaged grains}}{\text{Total number of grains}} \text{ X } 100$$

Per cent seed weight loss (g):

This activity was done simply using the count and weight method. For this, the number and weight of damaged and undamaged grains of composite sample of 100 grains was taken from each experimental unit at final observation. The per cent weight loss by using following equation:

$$\text{Percent weight loss} = \frac{I - F}{I} X100$$

Where, I = initial weight of grains,
S = final weight of grains after removal of beetles frass and excreta

Result and Discussion

Effect of ecofriendly treatments on per cent mortality of *Callosobruchus chinensis*

Number of live and dead insects were collected, counted and recorded at 48 hrs interval upto 15 DAT after release of insects i.e. 48 hrs, 96 hrs, 144 hrs, 192 hrs,240 hrs and 288 hrs after release of insect in each replication of treatment. Moribund insects were taken as dead. The data on per cent mortality discussed under different subheadings..

48 hrs after treatment

significantly maximum mortality of pulse beetle was observed in karanj oil @ 5ml/kg seed (13.89 per cent) which was found to be statistically at par with tobacco leaf powder @ 10 g/kg seed (12.96 per cent) followed by castor oil @ 5ml/kg seed (12.95 per cent), respectively. However, these three treatments were found to be significantly superior over rest of the treatments. The next best treatment in respect of recording mortality was sesamum oil @ 5ml/kg seed (12.18 per cent) followed by neem seed powder @ 10 g/kg seed (8.50 per cent), custard apple leaf powder @ 10 g/kg seed (8.36 per cent) and cow dung cake ash @ 10 g/kg seed (8.06 per cent), respectively. Lowest mortality of pulse beetle was recorded in untreated control.

96 hrs after treatment

significantly maximum mortality of pulse beetle in karanj oil @ 5ml/kg seed (14.50 per cent) which was found to be statistically at par with castor oil @ 5ml/kg seed (13.55 per cent) followed by tobacco leaf powder @ 10 g/kg seed (13.44 per cent), respectively. However, these three treatments were found to be significantly superior over rest of the treatments. The next better treatment in respect of recording mortality was sesamum oil @ 5ml/kg seed (12.95 per cent) and was followed by neem seed powder @ 10 g/kg seed (9.40 per cent), custard apple leaf powder @ 10 g/kg seed (9.14 per cent) and cow dung cake ash @ 10 g/kg seed (9.06 per cent), respectively. Significantly Lowest mortality of (8.55 per cent) pulse beetle was recorded in untreated control.

144 hrs after treatment

significantly maximum mortality of pulse beetle in karanj oil @ 5ml/kg seed (15.87 per cent) which was found to be statistically superior over the rest of the treatments. The next superior treatment in respect of recording mortality was castor oil @ 5ml/kg seed (13.66 per cent) which was found at par with tobacco leaf powder @ 10 g/kg seed (12.98 per cent), respectively. Significantly minimum mortality of (8.77 per cent) pulse beetle was recorded in untreated control.

192 hrs after treatment

significantly maximum mortality of pulse observed in karanj oil @ 5ml/kg seed (18.96 per cent) which was found to be statistically at par with castor oil @ 5ml/kg seed (18.65 per cent) followed by sesamum oil @ 5ml/kg seed (17.47 per cent) and tobacco leaf powder @ 10 g/kg seed (17.07 per cent), respectively. The next best treatment in respect of recording mortality was custard apple leaf powder @ 10 g/kg seed (12.28 per cent) followed by neem seed powder @ 10 g/kg seed (9.95 per cent), and cow dung cake ash @ 10 g/kg seed (9.92 per cent), respectively. Significantly lowest mortality of (9.00 per cent) pulse beetle was recorded in untreated control.

240 hrs after treatment

significantly maximum mortality of pulse beetle in karanj oil @ 5ml/kg seed (19.96 per cent) which was found to be statistically at par with castor oil @ 5ml/kg seed (19.29 per cent). The next better treatment in respect of recording mortality was sesamum oil @ 5ml/kg seed (17.51 per cent) and was followed by tobacco leaf powder @ 10 g/kg seed

(17.05 per cent). The minimum mortality of (9.00 per cent) pulse beetle was recorded in untreated control.

288 hrs after treatment

revealed that significantly maximum mortality of pulse beetle was in karanj oil @ 5ml/kg seed (14.94 per cent) which was found to be statistically at par with tobacco leaf powder @ 10 g/kg seed (14.73 per cent) followed by castor oil @ 5ml/kg seed (14.59 per cent) and sesamum oil @ 5ml/kg seed (14.40 per cent), respectively. The next best treatment in respect of recording mortality was custard apple leaf powder @ 10 g/kg seed (12.51 per cent) followed by neem seed powder @ 10 g/kg seed (9.11 per cent) and cow dung cake ash @ 10 g/kg seed (9.07 per cent), respectively. Significantly minimum mortality (8.44 per cent) of pulse beetle was recorded in untreated control.

Table 1: Effect of different treatment on per cent mortality of pulse beetle (*Callosobruchus chinensis).*

Tr. No	Treatment	Per cent mortality / adult of pulse beetle *					
		48 hr	96 hr	144 hr	192 hr	240 hr	288 hr
T1	Castor oil @ 5ml/kg seed	12.95 (3.61)	13.55 (3.69)	13.66 (3.70)	18.65 (4.32)	19.29 (4.40)	14.59 (3.83)
T2	Karanj oil @ 5 ml/kg seed	13.89 (3.73)	14.50 (3.81)	15.87 (3.99)	18.96 (4.36)	19.96 (4.47)	14.94 (3.87)
T3	Sesamum oil @ 5 ml/kg seed	12.18 (3.50)	12.95 (3.61)	13.61 (3.70)	17.47 (4.19)	17.51 (4.19)	14.40 (3.80)
T4	Caw dung cake ash @ 10g /kgseed	8.06 (2.85)	9.06 (3.02)	9.13 (3.03)	9.92 (3.16)	11.48 (3.40)	9.07 (3.02)
T5	Neem seed kernel powder @ 10g /kgseed	8.50 (2.92)	9.40 (3.07)	9.44 (3.08)	9.95 (3.16)	11.63 (3.42)	9.11 (3.03)
T6	Tobacco leaf powder @ 10g /kgseed	12.96 (3.61)	13.44 (3.67)	12.89 (3.60)	17.07 (4.14)	17.05 (4.14)	14.73 (3.84)
T7	Custured Apple leaf powder @ 10g /kgseed	8.36 (2.90)	9.14 (3.03)	9.29 (3.06)	12.28 (3.51)	14.63 (3.83)	12.51 (3.54)
T8	Untreated control	0.52 (0.22)	8.55 (2.93)	8.77 (2.97)	9.00 (3.01)	10.89 (3.31)	8.44 (2.91)
	"F" test	Sig	Sig	Sig	Sig	Sig	Sig
	SE (m)±	0.06	0.04	0.04	0.08	0.03	0.05
	CD at 5%	0.18	0.12	0.13	0.25	0.09	0.14
	CV (%)	3.54	2.13	2.28	3.98	1.55	2.53

*Figures in parentheses are square root transformation values.

Number of Eggs laid

The mean number of eggs laid on the chickpea seeds ranged from 46.67 eggs to 68.33 eggs/ 100 seeds. Among the treatments the karanj oil @ 5 ml/kg seeds recorded significantly the lowest (46.67 eggs/100 seeds)which was on par with castor oil@ 5ml/kg seeds (47.33 eggs/100 seeds) followed by tobacco leaf powder @ 10 g/kg seeds (47.67 eggs/ 100 seeds) and sesamum oil @5ml/ kg seeds (50.67 eggs/100 seeds), respectively. The significantly maximum eggs were recorded on (68.33 eggs/100 seeds) untreated control.

The present findings are true with report of Khaire *et al*. (1989) [8] The average number of eggs laid on per 50 seeds ranged from 24.33 to 118.66 in different treatments. Neem oil at 1.0 per cent level was found to be significantly superior over the rest of the treatments except karanj oil at 1.00 per cent which was at par with it than castor oil at 1.00 per cent level was significantly superior over the rest of the treatment. Other findings are similar with Hossain *et al*. (2014) [6] they reported that among all the tested plant materials, tobacco leaf powder (TLP) had promising effects on inhibiting oviposition and reducing adult emergence, seed infestation, and weight loss by *C. chinensis*. Tobacco leaf powder offered complete protection of chickpea seeds applied at 20.0 g/kg seeds. The lowest number of eggs (24.60), egg bearing seeds (23.40), adult emergence (23.20), seed infestation (8.28%), and weight loss (0.50%) were obtained from the TLP treated at 10.0 g/kg seeds, while the highest of these parameters were in untreated control. In the ovicidal test, TLP showed 100% inhibition at 20.0 g/kg seeds over control. The lowest numbers of adults (37.20) were emerged when larvae bearing seeds were treated with TLP at 20.0 g/kg seeds along with 59.39% retardation over the control and had no adverse effect on seed germination up to 3 months.

Table 2: Effect of different treatment on total number of eggs laid and per cent adult emergence of Pulse beetle

Tr. No	Treatment	Total number of egg laid by female per 100 seeds	Per cent adult emergence **	
			45 DAT	75 DAT
T1	Castor oil @ 5ml/kg seed	47.33 (43.47)	44.33 (41.75)	41.00 (40.20)
T2	Karanj oil @ 5 ml/kg seed	46.67 (43.09)	43.33 (41.17)	40.67 (39.62)
T3	Sesamum oil @ 5 ml/kg seed	50.67 (45.38)	56.67 (48.83)	56.00 (48.45)
T4	Caw dung cake ash @ 10g /kgseed	55.00 (47.87)	60.67 (51.16)	59.00 (50.18)
T5	Neem seed kernel powder @ 10g /kgseed	54.33 (47.49)	59.67 (50.57)	58.33 (49.80)
T6	Tobacco leaf powder @ 10g /kgseed	47.67 (43.66)	44.00 (41.55)	43.00 (40.80)
T7	Custured Apple leaf powder @ 10g /kgseed	54.67 (47.68)	58.33 (49.80)	58.33 (49.80)
T8	Untreated control	68.33 (50.80)	61.67 (51.75)	59.67 (50.57)
	"F" test	Sig	Sig	Sig
	SE (m)±	1.08	1.22	0.80
	CD at 5%	3.16	3.58	2.34
	CV (%)	4.06	4.50	3.00

*Figure in parentheses square root

******Figures in parentheses are angular transformation values.

Per cent adult emergence of pulse beetle

Number of adult emergence (F1) 45 days after emergence

As per Table 8, the minimum F1 adults emergence on (43.33 per cent) was recorded in grains treated with karanj oil @5ml/kg seed which was statistically at per with tobacco leaf powder (44.00 per cent) @ 10g/kg seed followed by castor oil (44.33 per cent) @ 5ml/kg seed. The maximum adults F1 (60.67 per cent) were observed in the untreated control followed by cow dung cake ash @ 10g/kg seed (60.67per

cent), (59.67 per cent) in neem seed powder@ 10g/kg seed and sesamum oil @ 5ml/kg seeds (56.67percent).

Number of Adult emergence (F2) 75 days after emergence

The minimum F2 adults emergence on (40.67per cent) was recorded in grains treated with karanj oil @ 5ml/kg seeds which was statistically at per with castore oil (41.67 per cent) @ 5 ml/kg seeds and was followed by Tobacco leaf powder (43.00 per cent) @ 10 g/kg seeds. The maximum adults F2 (59.67 per cent) were observed in the untreated control followed by cow dung ash at 10 g/kg seeds (59.00 per cent) and custurd apple leaf powder @ 10 g/kg seed and neem seed powder @ 10g/kg seeds (58.33 per cent), respectively.

Similar result were reported by Choudhary (1992) who tested different vegetable oil viz., sesame, castor and safflower @0.25, 0.50 and 1.0 ml/100 g seed against *C. chinensis* on chickpea. He found that all oil treatments showed significant reduction the number of eggs laid, adult emergence and seed damage due to *C. chinensis*. Oil effect increased with an increase in doses of all oils. Neem, groundnut, castor and sesame oil were most effective whereas linseed oil was least effective. The present findings are confirmed with other crop also and findings of Bhargava and Meena (2002) [2] reported that *C. chinensis* in cowpea and found that castor oil @ 1.0 ml/100 g seed was the most effective in inhibiting the oviposition (26.6 eggs/ female) as against 79.4 eggs/ female in untreated seeds. At 1.0 ml/100 g seeds, castor oil caused maximum reduction in egg viability (61.7%) followed by mustard oil (56.7%). The longevity of male and female adult decreased with the increase in doses of oil. The treatment of castor oil @ 1.0 ml/100 g seeds caused maximum reduction in adult emergence in F1 generation (85.0%) followed by mustard oil (83.7%), groundnut oil (73.3%).

The present findings are in accordance with Hossin *et.al* (2013) who reported lowest number of adults (37.20 per cent) emergence when larvae bearing seeds were treated with tobacco leaf powder at 20.0 g/kg seeds along with 59.39% retardation over the control and had no adverse effect on seed germination up to 3 months.

Number of holes on chickpea seed

Table 3: Effect of different treatments on Number of holes on chickpea seeds by pulse beetle

Tr. No	Treatment	No of holes on 10 grain (%)*
T1	Castor oil @ 5ml/kg seed	42.33 (40.59)
T2	Karanj oil @ 5 ml/kg seed	41.67 (40.20)
T3	Sesamum oil @ 5 ml/kg seed	44.33 (41.75)
T4	Caw dung cake ash @ 10g /kgseed	47.00 (43.28)
T5	Neem seed kernel powder @ 10g /kgseed	47.33 (43.47)
T6	Tobacco leaf powder @ 10g /kgseed	42.33 (40.59)
T7	Custured Apple leaf powder @ 10g /kgseed	47.33 (43.47)
T8	Untreated control	48.33 (44.04)
	"F" test	Sig
	SE (m)±	0.95
	CD at 5%	2.78
	CV (%)	3.91

*Figures in parentheses are sqare root transformation values.

Karanj oil @ 5 ml/kg seed, castor oil @ 5ml/kg seeds and tobacco leaf powder @ 10 g/ kg seed showed the minimum holes 41.67 holes/ 10 seeds, 42.33 holes/ 10seeds and 42.33 holes/10 seeds which was found statistically significant and at par with each other to all other treatments including the control (Table 9). The maximum holes (48.33 holes/ 10 seeds) were seen in un-treated grains, which were statistically different from all the materials. Karanj oil @ 5 ml/kg seed, castor oil @ 5ml/kg seeds and tobacco leaf powder @ 10 g/ kg seeds were the most effective at all their application rates compared to other materials including the un-treated grains.

Per cent seed infestation

Per cent seed infestation after 45 DAT

It was noticed that significantly minimum seed infestation (48.67 per cent) was in treatment karanj oil @ 5 ml/kg seed on chickpea followed by tobacco leaf powder @ 10 gm/ kg seed (47.67 per cent) treated and castor oil @ 5ml/ kg seeds (48.33 per cent) which were at par with each other .

Table 4: Effect of different treatment on per cent seed infestation by pulse beetle**.**

Tr. No.	Treatments	Per cent seed Infestation **	
		45 DAT	75DAT
T1	Castor oil @ 5ml/kg seed	48.33 (44.04)	47.67 (43.66)
T2	Karanj oil @ 5 ml/kg seed	46.67 (43.09)	46.67 (43.09)
T3	Sesamum oil @ 5 ml/kg seed	56.67 (48.83)	57.33 (49.22)
T4	Caw dung cake ash @ 10g /kgseed	61.67 (51.75)	63.33 (52.73)
T5	Neem seed kernel powder @ 10g /kgseed	60.00 (50.77)	62.33 (52.14)
T6	Tobacco leaf powder @ 10g /kgseed	48.67 (43.66)	47.00 (43.28)
T7	Custured Apple leaf powder @ 10g /kgseed	58.33 (49.80)	60.00 (50.77)
T8	Untreated control	65.00 (53.73)	64.00 (53.13)
	"F" test	Sig	Sig
	SE (m)±	1.02	0.75
	CD at 5%	3.00	2.98
	CV (%)	3.68	2.08

**Figures in parentheses are angular transformation values.

The maximum seed damage recorded (65.00 per cent) in untreated control followed by treatment with cow dung cake ash @ 10 gm/kg seeds (60.00per cent), neem seed kernel powder @ 10 gm/ kg seeds (60.00 per cent) and custard apple leaf powder (58.33 per cent) treated with @ 10 gm/kg seeds which was found at par with each other's.

Per cent seed infestation after 75 DAT

It was noticed that lowest seed infestation (46.67 per cent) was in karanj oil @ 5 ml/kg seed on chickpea followed by tobacco leaf powder @ 10 gm/ kg seed (47.00 per cent) treated and castor oil @ 5ml/ kg seeds (47.67 per cent) which were at per with each other.

The maximum seed damage was recorded (64.00 per cent) in untreated control followed by treatment with cow dung cake ash @ 10 gm/kg seeds (63.33 per cent), neem seed kernel powder @ 10 gm/ kg seeds (62.33 per cent) and custard apple leaf powder (60.00 per cent) treated with @ 10 gm/kg seeds which was found at par with each other.

The present findings are in accordance with Sahoo and Chandrakar (2013) [10] who reported the seed damage in coconut oil treated seeds at 0.25 ml/ 100g seed was found highest (20.50 and 43.79 per cent) while lowest (9.25 and 30.39%) in karanj oil treated seeds 0.25ml/100g seeds after 45 days and 90 days, respectively. Lowest (8.06 and 23.73) weight loss was recorded on karanj oils treated with 0.25ml/ 100g seed and highest (16.34 and 35.14%) was recorded on coconut oil treated with 0.25 ml/ 100g seed after 45 days and 90 days. Similarly, Choudhary (1990) [3] investigated in laboratory the effect of neem (*Azardirachta indica)*, groundnut, Castor *(Ricinus communis)*, soyabean and sesamum oil 0.5 and 1 ml/100g against *Callosobruchus chinensis* L. He reported that neem and groundnut oil were also effective at 0.25 ml/100g seed.

The present findings are similar with that of Hossin *et.al* (2014) [6] who reported the tobacco leaf powder offered complete protection to chickpea seeds applied at 20.0 g/kg seeds. The lowest number of eggs (24.60), egg bearing seeds (23.40), adult emergence (23.20), seed infestation (8.28%), and weight loss (0.50%) were obtained from the TLP treated at 10.0 g/kg seeds, while the highest of these parameters were in untreated control.

Per cent seed weight loss

Per cent weight loss after 45 DAT

It was noticed that minimum weight loss (12.28%) was observed in karanj oil @ 5 ml/kg seeds on chickpea seeds, followed by tobacco leaf powder (12.50%) and Castor oil (12.67%) which were at per with each other. Per cent weight loss varied from 12.28 to 30.04 par cent on all the treated 0.5g chickpea seeds. All the treatments were significantly superior over untreated control (30.04%). The maximum weight loss (29.11%) was in Caw dung cake ash followed by Neem seed powder (27.28%) and Custurd Apple leaf powder (27.88%) which were at par with each other.

Table 5: Effect of different treatments on per cent seed weight loss by pulse beetle

Tr. No	Treatment	Per cent weight loss **	
		45 DAT	75 DAT
T1	Castor oil @ 5ml/kg seed	12.67 (20.85)	10.94 (19.32)
T2	Karanj oil @ 5 ml/kg seed	12.28 (20.51)	10.28 (18.70)
T3	Sesamum oil @ 5 ml/kg seed	17.94 (25.06)	18.27 (25.30)
T4	Caw dung cake ash @ 10g /kgseed	29.11 (32.65)	29.83 (33.11)
T5	Neem seed kernel powder @ 10g /kgseed	27.28 (31.48)	28.44 (31.23)
T6	Tobacco leaf powder @ 10g /kgseed	12.50 (20.70)	10.94 (19.32)
T7	Custured Apple leaf powder @ 10g /kgseed	27.88 (31.87)	29.50 (32.90)
T8	Untreated control	30.04 (33.24)	30.44 (33.49)
	"F" test	Sig	Sig
	SE (m)±	0.22	0.27
	CD at 5%	0.64	1.06
	CV (%)	1.40	1.72

**Figures in parentheses are angular transformation values.

Per cent weight loss after 75 DAT

It was noticed that minimum weight loss (10.28%) was recorded in karanj oil on chickpea, followed by Tobacco leaf powder (10.94%) and Castor oil (10.94%) which were at par with each other. Per cent weight loss varied from 10.28 to 30.44 per cent on all the treated 0.5g on chickpea seeds. All the treatments were significantly superior over untreated control (30.44%).The maximum weight loss (29.83%) was in Cow dung cake ash followed by Neem seed kernel powder (28.44%) and Custurd Apple leaf powder (29.50%) which were at per with each other.

Sahoo and Chandrakar (2013) [10] reported Lowest (8.06 and 23.73) weight loss was recorded on karanj oils treated with 0.25ml/ 100g seed and highest (16.34 and 35.14%) was recorded on coconut oil treated with 0.25 ml/ 100g seed after 45 days and 90 days

Fig 1: Different treatments with plant materials and oils

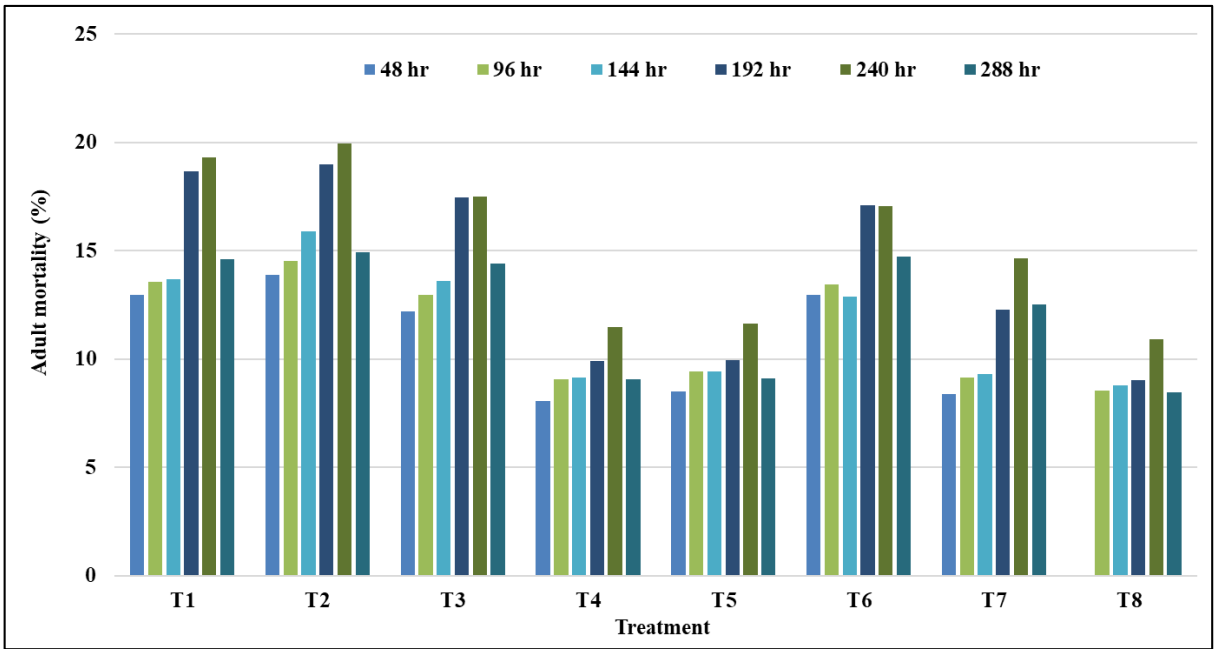

Fig 2: Effect of different treatments on per cent adult mortality of pulse beetle

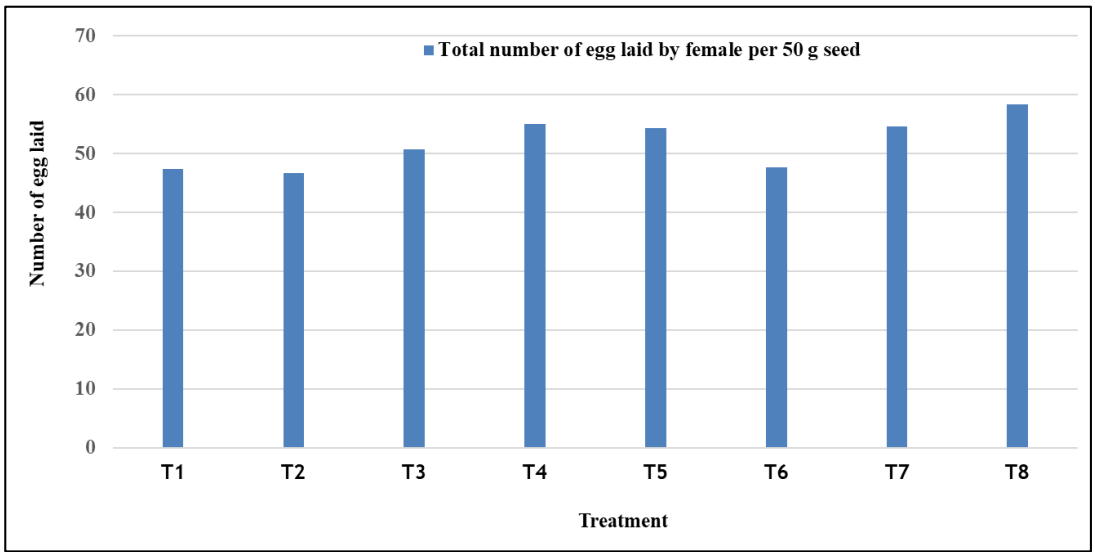

Fig 3: Effect of different treatment on total number of eggs laid by pulse beetle

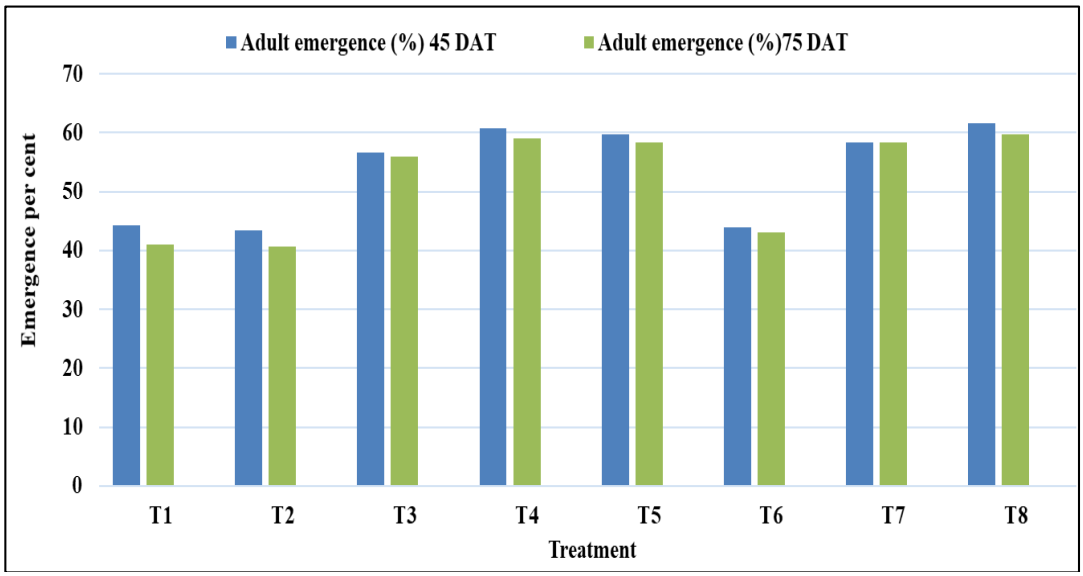

Fig 4: Effect of different treatment on per cent adult emergence of pulse beetle

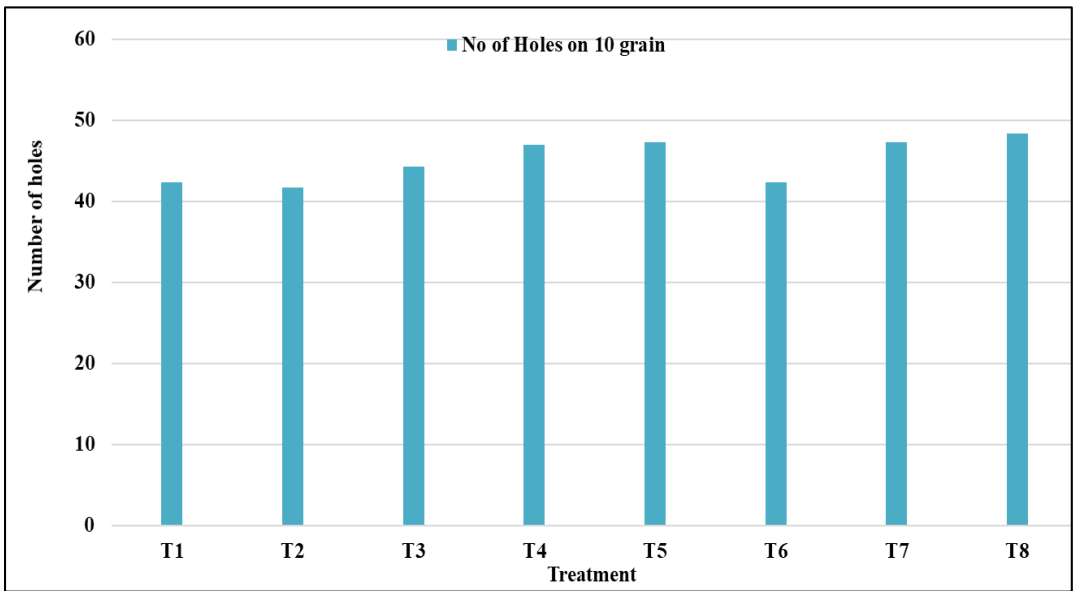

Fig 5: Effect of different treatments on number of holes on chickpea seeds by pulse beetle

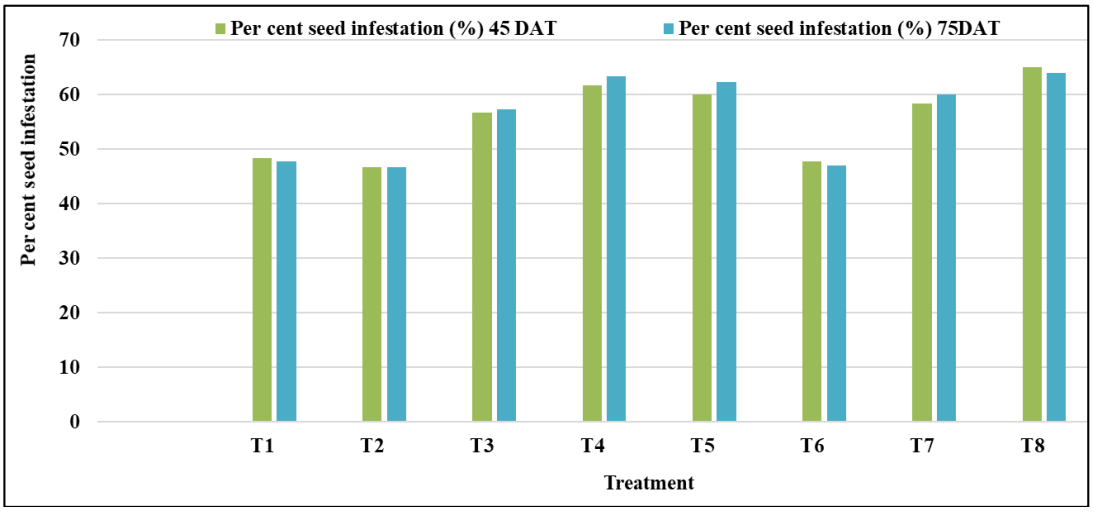

Fig 6: Effect of different treatment on per cent seed infestation

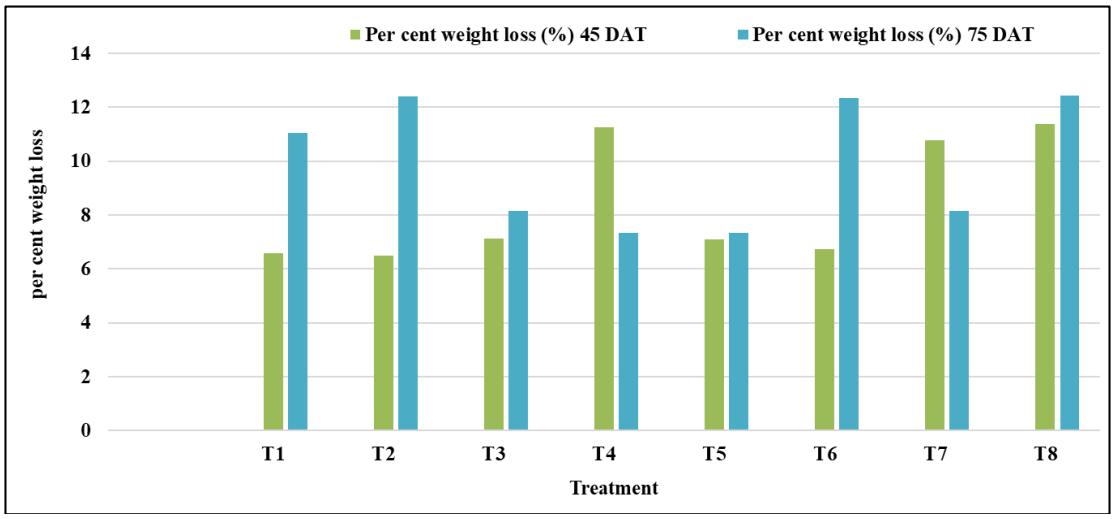

Fig 7: Effect of different treatment per cent seed weight loss by pulse beetle

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