

Study of Impact of Edible and Non-Edible Oils on Grain Damage and Weight Loss of Green Gram in Storage Condition Infested with Pulse Beetle *Callosobruchus chinensis*

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Abstract: Pulse beetle, *Callosobruchus chinensis* (Coleoptera: Bruchidae) is a major stored grain pest of pulses in Odisha. Percent of grain damage and weight loss were studied with edible and non-edible oils treated green gram in storage condition at 45 days and 90 days after treatment during 2010-11 in the Post graduate Department of Zoology, Utkal University laboratory. The grain damage and weight loss were studied in different concentrations of oils i.e. 1.00 ml, 1.25 ml and 1.50 ml per 100 g. of green gram seed of neem, karanja, sesamum, castor, palm, mustard, ground nut and sunflower. It was found that Neem and Karanja oil @ 1.5 ml/ 100 gram seed were effectively manage the grain damage and weight loss after 90 days of treatment of green gram in storage condition.

Keywords: *Callosobruchus chinensis*, Pulse beetle, Green gram, Coastal Odisha, Edible & non-edible oils

1. Introduction

During the last decade, agriculture production in India has reached a significant level mainly due to systemic planning which include both increase in cultivated area and scientific crop management. In our country, there is little scope of horizontal expansion of crop farming and therefore, all attempts are to be made towards vertical growth of agriculture and safe preservation of the much needed food grains in order to meet the demand of the growing population. Maintenance of good food grain quality during long term storage has become one of the major considerations in food security and safety planning. Failure to comply with good storage management practice can jeopardize food supply chain. Pulses are important not because they form a daily diet as far as an ordinary India is concerned, but because they are nearly thrice as high in total protein as the cereals and they supplement the cereal dominated diet in protein quality. In addition to this, the consumers demand for pulses is mainly due to their cheap source of vegetable proteins, essential amino acids, vitamins and particularly when animal proteins are inadequate and expensive, besides being unacceptable to many persons because of religious sentiments. Protein malnutrition is the most serious aspect of Indian food shortage. The estimated availability of pulses has gone down from 70.1 gm/day/person in 1951 to 31 gm/day/person in 2008 whereas Indian Council of Medical Research recommends 65 gm/day/person (Ready, et.al. 2012.). The pulse crops are associated with a large no of insect pests. Among the insects those infest various pulses; *C. chinensis* is the most important and common of all the bruchid pests in India.

Green gram or Mung, *Vignaradiata* L. Wilcek is an important pulse crop in almost all states of the country. Pulse beetle *Callosobruchus chinensis* Linn., Coleoptera :Bruchidae causing loss to stored legume seeds is considered as a destructive pest in India. The biology of pulse beetle, *C. chinensis* on various stored pulses was earlier investigated by Mandal and Konar (2006). The initial infestation starts in the field itself, where female insect lays eggs on the green pods, grubs feed on the pod cover and remain concealed inside the developing seeds. When such seeds are harvested and stored, the pest population increases rapidly and results in total destruction within a short duration of 3-4 months. Rahman and Talukder, 2006 reported that 8.5 % loss in pulses during post-harvest handling and storage in India. Groundnut oils and palm oil were evaluated in the laboratory against pulse beetle *Callosobruchus maculatus* in stored cowpea and found that ground nut oil significantly reducing the damage caused and inhibiting progeny emergence (I.O. Udo, 2011). Jatwani and Sircar, 1967, reported that seeds of green gram, bengal gram, cowpea and peas can be effectively protected from the damage by the bruchids for about 8 to 11 months respectively by mixing the seed with crushed neem seed @ 1 to 2 parts per 100 parts of seed (w/w).

2. Methods

1) Study Site

The studies on biology of *Callosobruchus chinensis* in green gram were carried out during the year 2010-11 in the Post graduate Department of Zoology, Utkal University laboratory. The edible and non- edible oils were collected from the Baliapal, Basta, Jaleswar and Remunablock of Balasore district. The main culture medium viz. the seeds of

green gram (*Vignaradiata*) var. PDM-139 was also collected from the farmers' field of Baliapal block of Balasore district.

2) Preparation of Main Culture Medium and Plant Extract

The seeds of green gram (*Vignaradiata*) var. PDM-139 was cleaned and sieved to remove the undesired other seeds and the other foreign materials. The seeds were taken in airtight galvanized seed bin and fumigated by ethylene-di-bromide (EDB) in order to eliminate the traces of insects and mite infestation. Half kilogram of disinfested seeds was taken in glass jar (15 x 10 cm). The moisture content of grain was measured before experimentation by using OSAW digital moisture meter. For preparation of stock culture, adult beetles of *Callosobruchus chinensis* were collected from infested grains of godowns using an aspirator. A pair of adults was then released in jar containing conditioned green gram grains. The jars were kept in incubator at $27 \pm 5^{\circ}\text{C}$ temperature and 70 ± 5 per cent relative humidity. After emergence, pairs of freshly emerged adult beetles from this uniparental culture were taken for experiment. In the glass flask 100 g. of undamaged different concentrations oils treated green gram seeds were taken and five pair of adults released in the jar and covered the flask with muslin cloth. The observations on grain damage and weight loss were recorded at 45 days and 90 days after treatment. The edible and non-edible oils viz., neem, karanja, sesamum, castor, palm, mustard, ground nut and sunflower were collected from Baliapal, Basta, Jaleswar and Remona blocks of Balasore district of Odisha. Then the oils were mixed with conditioned green gram seeds @ 1.00 ml, 1.25 ml and 1.5 ml /100 g of grains separately. Untreated check was also kept simultaneously. The treatments were replicated three times. Five pairs of freshly newly emerged bruchids were released in each flask. Then the flask was covered with muslin cloth and tied with rubber band and then kept in room for three months.

3) Data Analysis

Each treatment was replicated three times and data on adult emergence were subjected to statistical analysis as per Completely Randomised Block Design (CRBD). Data on the emergence of adult beetles were transformed using angular and square root values and analysed as per Gomez and Gomez (1984).

3. Results and Discussion

Eight nos edible, non-edible oils and one untreated check were tested against the stored grain pest, *Callosobruchus chinensis* and studied the grain damage and weight loss at 45 days and 90 days after treatment.

Damage of green gram seed infested by *Callosobruchus chinensis* treated with 1.00 ml/100 g seed 45 days after treatment

It was recorded that minimum grain damage (13.32 per cent) was in karanj oil on green gram, followed by neem oil (14.98 per cent). Per cent grain damage varied from 13.32 to 21.76 per cent on all the treated green gram seeds. All the treatments were significantly superior to untreated check (45.42 per cent). Mustard (17.48 per cent), sesamum (17.72 per cent), castor (18.32 per cent), sunflower (18.58 per

cent), groundnut (18.81 per cent) and palm (21.76 per cent) oils showed significantly lower per cent grain damage in comparison to untreated check (Table 1).

Damage of green gram seed infested by *Callosobruchus chinensis* treated with 1.25 ml/100 g seed 45 days after treatment

It was observed that neem and karanj oils completely prevented the per cent grain damage by pulse beetle. Minimum 13.59 per cent grain damage was in mustard oil on green gram. Per cent grain damage varied from 13.59 to 19.81 per cent among the entire treated green gram. All the treatments were significantly superior to untreated check (45.42 per cent). Castor (17.12 per cent), sesamum (16.34 per cent), sunflower (17.22 per cent), groundnut (16.82 per cent) and palm (19.81 per cent) oils showed significantly lower per cent grain damage as compared to untreated control (Table 1).

Damage of green gram seed infested by *Callosobruchus chinensis* treated with 1.5 ml/100 g seed 45 days after treatment

It was noticed from the investigation that neem and karanj oils were quite effective to prevent 100 the per cent grain damage caused by pulse beetle. Minimum 11.61 per cent grain damage was in mustard oil on green gram. Per cent grain damage varied from 11.61 to 15.67 per cent on all the treated green gram seeds. All the treatments were significantly superior to untreated check (45.42 per cent). Castor (13.54 per cent), sesamum (14.11 per cent), groundnut (14.32 per cent), sunflower (14.76 per cent) and palm (15.67 per cent) oils showed significantly lower per cent grain damage as compared to untreated check (Table 1). Kumari et al. (1990) reported the efficacy of oils of mustard, linseed, Sesamum, groundnut and sunflower as grain protectant against *C. chinensis* (linn.). The results indicated that all the oils each at 1.5 % level proved equally effective for reduction in the percentage of damaged grains by number as well as by grain damage.

Damage of green gram seed infested by *Callosobruchus chinensis* treated with 1.00 ml oil/ 100g seed 90 days after treatment

It was recorded that minimum seed damage (24.88 per cent) was in karanj oil on green gram, followed by neem oil (28.12 per cent). Per cent seed damage varied from 24.88 to 36.12 per cent on all the treated green gram seeds. All the treatments were significantly superior to untreated check (66.12 per cent). Mustard (29.38 per cent), castor (29.58 per cent), sesamum (33.24 per cent), sunflower (31.22 per cent), groundnut (30.08 per cent) and palm (36.12 per cent) oils showed significantly lower per cent seed damage as compared to untreated check (Table 2). Khairet et al. (1992) reported the minimum grain damage was noted in castor, mustard and groundnut oils at 1.0 per cent up to 100 days after treatment. Srinivasan (2008) reported his findings that, after 9 months of treatment also revealed that neem oil at 10 and 5 ml/kg of seeds was highly effective against *C. chinensis* registering the minimum seed damage of 9.2 and 15.0% as against 96.0% in untreated check.

Damage of green gram seed infested by *Callosobruchus*

chinensis treated with 1.25 ml oil/ 100g seed 90 days after treatment

It was observed that neem and karanj oils were quite effective to prevented the 100 per cent seed damage by pulse beetle. Minimum 18.92 per cent seed damage was in mustard oil on green gram. Per cent seed damage varied from 18.92 to 24.42 per cent on all the treated green gram seeds. All the treatments were significantly superior to untreated check (66.12 per cent). Groundnut (21.28 per cent), sunflower (21.38 per cent), sesamum (21.88 per cent), castor (23.01 per cent) and palm (24.42 per cent) oils showed significantly lower per cent seed damage as compared to untreated check (Table 2).

Damage of green gram seed infested by Callosobruchuschinensis treated with 1.5 ml oil/ 100g seed 90 days after treatment

It was noticed that neem and karanja oils were fully effective to prevent the 100 per cent seed damage by pulse beetle. Minimum 18.32 per cent seed damage was in mustard oil on green gram. Per cent seed damage varied from 18.32 to 24.38 per cent on all the treated green gram. All the treatments were significantly superior to untreated check 1 (66.12 per cent). Sesamum (19.87 per cent), sunflower (20.96 per cent), groundnut (21.28 per cent), castor (23.01 per cent) and palm (24.38 per cent) oils showed significantly lower per cent seed damage as compared to untreated control (Table 2).

Weight loss of green gram seed infested by Callosobruchus chinensis treated with different doses of oils 45 days after treatment

The observations were recorded on 100g seeds on different edible and non-edible oil treated green gram seeds and are presented in Table 3.

Weight loss of green gram seed infested by Callosobruchus chinensis treated with 1.00 ml/100 g seeds 45 days after treatment

It was observed from the experiment that minimum weight loss (2.94 per cent) was in karanj oil on green gram, followed by neem oil (3.62 per cent). Per cent weight loss varied from 2.94 to 6.84 per cent on all the treated green gram seeds. All the treatments were significantly superior to untreated check (24.01 per cent). Castor (4.88 per cent), mustard (4.58 per cent), sesamum (4.92 per cent), sunflower (5.67 per cent), groundnut (5.04 per cent) and palm (6.84 per cent) oils showed significantly lower per cent weight loss of green gram seeds as compared to untreated check (Table 3). Parasalet al. (1990) observed the effect of groundnut and mustard oil @ 0.3 per cent concentration on the fecundity, longevity of *C. chinensis* and grain weight loss. They observed the number of eggs, adult emergence and grain weight loss decreased with increase in oil concentration. Biswas and Biswas (2005) reported that citronella and neem oil at 0.25 and 5.0 ml/kg of seed recorded the least per cent weight loss in pulse beetle infested grains. Khalequzzaman et al. (2007) studied the efficacy of seven vegetable oils viz., sunflower, mustard, groundnut, sesame, groundnut, olive and palm oils applied at the rates of 5, 7.5, and 10 ml/kg grain protectants against the pulse beetles (*Callosobruchuschinensis* L.). Effects on progeny emergence, loss in grain weight, and germination

up to 66 days after treatment were observed. Adult emergence was completely prevented and the minimum grain loss was achieved by groundnut oil at 1% up to 66 days after treatment. Kumari et al. (1990) reported the efficacy of vegetable oils viz. mustard oil, linseed oil, til oil, groundnut oil and sunflower oil as grain protectant against *C. chinensis* (Linn.). The results recorded that all the vegetable oils each at 1% level proved equally effective for reduction in the percentage of damaged grains by number as well as by weight loss.

Weight loss of green gram seed infested by Callosobruchus chinensis treated with 1.25 ml/100 g seed 45 days after treatment

It was observed that neem and karanj oils completely prevented the per cent weight loss by pulse beetle. Per cent weight loss varied from 2.47 to 4.12 per cent among all the treated green gram seeds. All the treatments were significantly superior to untreated check (24.01 per cent). Castor (2.47 per cent), mustard (2.39 per cent), sesamum (3.16 per cent), palm (3.31 per cent), sunflower (3.74 per cent) and groundnut (4.12 per cent) oils showed significantly lower per cent weight loss of green gram seeds as compared to untreated check (Table 3).

Weight loss of green gram seed infested by Callosobruchus chinensis treated with 1.5 ml/100 g seed 45 days after treatment

It was observed that neem and karanj oils completely prevented the per cent weight loss by pulse beetle. Minimum 1.22 per cent weight loss was in mustard oil on green gram. Per cent weight loss varied from 1.22 to 3.93 per cent among all the treated green gram seeds. All the treatments were significantly superior to untreated check (24.01 per cent). Castor (1.89 per cent), sesamum (1.96 per cent), groundnut (1.98 per cent), sunflower (2.99 per cent) and palm (3.93 per cent) oils showed significantly lower per cent weight loss of green gram seeds as compared to untreated check (Table 3). Srinivasan (2008) reported the loss in seed weight loss was less in neem oil (10.6 and 14.5% in 10 and 5 ml, respectively) followed by 10 ml castor oil (22.8%) when compared to 49.9% in the control.

Weight loss of green gram seed infested by Callosobruchuschinensis treated with 1.00 ml oil/ 100g m seeds 90 days after treatment

It was noticed that minimum weight loss 3.84 per cent was in karanja oil on green gram, followed by neem oil (5.38 per cent). Per cent weight loss varied from 3.84 to 15.46 per cent among all the treated seeds. All the treatments were significantly superior to untreated check (28.42 per cent). Castor (7.81 %), mustard (8.11 %), sesamum (9.32 %), groundnut (11.62 %) and sunflower (12.72 %) oils showed lower per cent weight loss as compared to untreated check (Table 1). Singal and Singh (1990) reported that the oils of groundnut, palm, mustard, sesamum, groundnut and rapeseed used as surface grain protectants at 3, 6 and 10 ml/kg of seed to test their efficacy against *Callosobruchuschinensis* on a variety of green gram seeds showed only 0.5% weight loss when treated with mustard oil @ 6 and 10 ml/kg, and rapeseed at 6 ml/kg of seed. Biswas and Biswas (2005) reported citronella and neem oil at 0.25 and 5.0 ml/kg of seed recorded the least seed damage and

weight loss. Kumari *et al.* (1990) studied the efficacy of oils of mustard, linseed, sesamum, groundnut and sunflower as grain protectant against *C.chinensis* (linn.). The results recorded that all the oils each at 1% level proved equally effective for reduction in the percentage of damaged grains by number as well as by weight loss.

Weight loss of green gram seed infested by *Callosobruchus chinensis* treated with 1.25 ml oil/ 100g seeds 90 days after treatment

From the experiment it was noticed that neem oil and karanj oil completely prevented the weight loss by pulse beetle. Per cent weight loss varied from 5.32 to 13.92 per cent among all the treated seeds. All the treatments were significantly superior to untreated check (28.42 per cent). Castor (5.92 per cent), sesamum (6.48 per cent), groundnut (9.52 per cent), sunflower (12.04 per cent) and palm (13.92 per cent) oils showed significantly lower per cent weight loss as compared to untreated check (Table 1).

Weight loss of green gram seed infested by *Callosobruchus chinensis* treated with 1.5 ml oil/ 100g seeds 90 days after treatment

It was observed that neem and karanj oils completely prevented the seed damage by pulse beetle. Minimum seed damage (4.81 per cent) was in mustard oil on green gram. Per cent seed damage varied from 4.81 to 13.21 per cent on all the treated green gram seeds. All the treatments were significantly superior to untreated check (28.42 per cent). Castor (5.74 per cent), sesamum (6.02 per cent), groundnut (8.83 per cent), sunflower (9.96 per cent) and palm (13.21 per cent) oils showed significantly lower per cent seed damage as compared to untreated check (Table 4).

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Table 1 : Effect of different doses of edible and non-edible oils on grain damage due to pulse beetle *Callosobruchus chinensis* in green gram after 45 days of treatment

Treatments	Percent grain damage on different doses of oils on 100g seeds		
	(Dose : ml / 100 g. seed)		
	1.00	1.25	1.50
Neem oil	14.98 (23.02) ^b	* -	* -
Karanj oil	13.32 (21.48) ^a	* -	* -
Sesamum oil	17.72 (24.92) ^{cd}	16.34 (23.84) ^b	14.11 (21.84) ^{bc}
Castor oil	18.32 (25.31) ^{cde}	17.12 (24.44) ^{bcd}	13.54 (21.58) ^b
Palm oil	21.76 (27.85) ^h	19.81 (26.51) ^f	15.67 (23.34) ^f
Mustard oil	17.48 (24.69) ^c	13.59 (21.46) ^a	11.61 (19.92) ^a
Groundnut oil	18.81 (26.78) ^g	16.82 (24.26) ^{bc}	14.32 (22.21) ^{bcd}
Sunflower oil	18.58 (25.53) ^{def}	17.22 (24.47) ^{bcd}	14.76 (22.62) ^{de}
Untreated check	45.42	45.42	45.42
SEM (±)	0.22	0.34	0.26
C.D. (P = 0.05)	0.68	0.94	0.71

Figures in parentheses are square root transformed value
 * No weight loss
 Similar superscripts in a column indicate that their differences are not statistically significant at P = 0.05

Table 2: Impact of different doses of edible and non-edible oils on grain damage due to pulse beetle, *Callisobruchus chinensis* in green gram after 90 days of treatment

Treatments	Percent grain damage on different doses of oils on 100g seeds		
	(Dose: ml / 100 g. seed)		
	1.00	1.25	1.50
Neem oil	28.12 (31.92) ^b	*	*
Karanj oil	24.88 (30.36) ^a	*	*
Sesamum oil	33.24 (35.12) ^g	21.88 (27.71) ^{bcd}	19.87 (26.54) ^b
Castor oil	29.58 (32.92) ^{cd}	23.01 (28.44) ^{cde}	23.01 (28.44) ^{de}
Palm oil	36.12 (37.01) ^h	24.42 (29.62) ^f	24.38 (29.62) ^f
Mustard oil	29.38 (32.84) ^c	18.92 (25.91) ^a	18.32 (25.32) ^a
Groundnut oil	30.08 (33.24) ^{cde}	21.28 (27.52) ^b	21.28 (27.52) ^{cd}
Sunflower oil	31.22 (33.96) ^f	21.38 (27.62) ^{bc}	20.96 (27.22) ^{bc}
Untreated check	66.12	66.12	66.12
SEM (±)	0.26	0.32	0.32
C.D. (P = 0.05)	0.71	0.85	0.92

Figures in parentheses are square root transformed value
 * No seed damage
 Similar superscripts in a column indicate that their differences are not statistically significant at P = 0.05

Table 3: Effect of different doses of edible and non-edible oils on grain weight loss due to pulse beetle, *Callisobruchus chinensis* in green gram after 45 days of treatment

Treatments	Percent grain weight loss on different doses of oils on 100g seeds		
	(Dose: ml / 100 g. seed)		
	1.00	1.25	1.50
Neem oil	3.62 (2.10) ^b	*	*
Karanj oil	2.94 (1.82) ^a	*	*
Sesamum oil	4.92 (2.32) ^{bcd}	3.16 (1.91) ^{ab}	1.96 (1.54) ^{ab}
Castor oil	4.88 (2.29) ^{bc}	2.47 (1.72) ^a	1.89 (1.58) ^{bc}
Palm oil	6.84 (2.71) ^f	3.31 (1.96) ^{bc}	3.93 (2.12) ^f
Mustard oil	4.58 (2.32) ^{bcd}	2.39 (1.72) ^a	1.22 (1.33) ^a
Groundnut oil	5.04 (2.36) ^{cde}	4.12 (2.21) ^d	1.98 (1.62) ^{bcd}
Sunflower oil	5.67 (2.49) ^{cdef}	3.74 (2.12) ^{bcd}	2.99 (1.86) ^e
Untreated check	24.01	24.01	24.01
SEM (±)	0.06	0.06	0.06
C.D. (P = 0.05)	0.23	0.22	0.23

Figures in parentheses are square root transformed value
 * No weight loss
 Similar superscripts in a column indicate that their differences are not statistically significant at P = 0.05

Table 4: Impact of different doses of edible and non-edible oils on grain weight loss due to pulse beetle *Callisobruchus chinensis* in green gram after 90 days of treatment

Treatments	Percent grain weight loss on different doses of oils on 100g seeds		
	(Dose : ml / 100 g. seed)		
	1.00	1.25	1.50
Neem oil	5.38 (2.42) ^b	*	*
Karanj oil	3.84 (2.09) ^a	*	*
Sesamum oil	9.32 (3.11) ^e	6.48 (2.68) ^{bc}	6.02 (2.61) ^{bc}
Castor oil	7.81 (2.91) ^c	5.92 (2.62) ^b	5.74 (2.51) ^b
Palm oil	15.46 (3.96) ^h	13.92 (3.84) ^f	13.21 (3.71) ^f
Mustard oil	8.11 (2.96) ^{cd}	5.32 (2.42) ^a	4.81 (2.28) ^a
Groundnut oil	11.62 (3.52) ^f	9.52 (3.18) ^d	8.83 (3.06) ^d
Sunflower oil	12.72 (3.66) ^{fg}	12.04 (3.52) ^e	9.96 (3.28) ^e
Untreated check	28.42	28.42	28.42
SEM (±)	0.07	0.05	0.07
C.D. (P = 0.05)	0.14	0.10	0.15

Figures in parentheses are square root transformed value
 * No seed damage
 Similar superscripts in a column indicate that their differences are not statistically significant at P = 0.05