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# Efficacy of some seed plant protectants against *Caryedon serratus* (Olivier) infesting Groundnut

**Anita Sharma, Purushotam Sharma, Suman Choudhary and Manisha Sharma, KC Kumawat and SK Khinchi**

**Abstract**
The present research was aimed to study the efficacy of different plant powders and oils against *Caryeon serratus* (Olivier) on groundnut. The *neem* oil was the most effective treatment in reducing the adult emergence of *Caryeon serratus* (Olivier) on groundnut. The mean per cent adult emergence in different treatments ranged from 14.85 to 31.16, being minimum in *neem* oil, while maximum in annona leaf powder treatment. Pod damage and loss in weight were minimum in the pods treated with *neem* oil followed by castor oil, *neem* kernel powder, *neem* leaf powder, bakan leaf powder and annona leaf powder. The effect of some plant materials as powders and oils was found to be significantly more superior in reducing the pod damage and loss in weight in comparison to control.

**Keywords:** Efficacy, seed protectants, *Caryedon serratus*, Groundnut

## Introduction
Groundnut, *Arachis hypogaea* (L.) is one of the major oilseed crop of India. It is popularly known as peanut or monkey nut. Groundnut kernel is rich in easily digestible protein (26%) and edible oil (48%) as compared to other oilseed crops and known to be poor man's almond. It contains different types of vitamins *viz*; thiamine, riboflavin, vitamin E and minerals like phosphorus, calcium and iron. Globally 50 per cent of groundnut produce is used for oil extraction, 38 per cent for confectionary use and 12 per cent for seed purpose. In our country, about 80 per cent is used for oil extraction, 11 per cent as seeds, 8 per cent as direct food and one per cent for export to other countries. India contributes about 20 per cent area and less than 10% production of oil seeds of world. Whereas groundnut crop accounts for 40% of the area (4.19 million ha) and 30% of the production (5.62 million tonnes) of total oilseeds grown in India. In Rajasthan, groundnut crop is cultivated in an area of 3.97 lakh hectares with 4.18 lakh tonnes of production having an average productivity of 1051 $kg^{-1}$ (Anonymous,2012) [1].
About 100 insect species have been reported to infest stored groundnut. Out of these, *Caryedon serratus* (Olivier), *Tribolium castaneum* (Herbst), *Oryzaephilus mercator* (Fawel), *Ephestia cautella* (Walker) and *Elasmolomus sordidus* (Fab.) are very important and cause considereble losses. However, *C. serratus* (Coleoptera: Bruchidae) is of economic importance and posed to be a potential threat to stored groundnut (Wightman *et al*., 1987) [28]. The bruchid is native of the tropics and subtropics of the globe (davey, 1958) [6] and has been introduced into different parts of the World (Prevett, 1967) [21]. In India, it has been reported from South India (fletcher, 1914) [9], Rajasthan, Gujarat, Madhya Pradesh, Maharashtra and Uttar Pradesh (Mittal and Khanna, 1974) [18], Punjab, Haryana, Jammu and Kashmir, Himachal Pradesh, Tamil Nadu, Kerala and some of the Islands in the Indian ocean (Arora and Singal, 1978) [2]. In recent years in India, it has become a serious pest of stored groundnut wherever, groundnut is grown and stored. Beside groundnut, the infestation of *C. serratus* was noticed for the first time infesting *Oryza sativa* L. (Arora and Singal, 1978) [2], *Acacia nilotica (*L.), *A. tortilis* (Forssk.) and *Prosopis cineraria* (L.) (Singal and Toky, 1988) [24], *Pongamia pinnata* (L.) Pierre (Singal and Toky, 1989) [25], *Bouhinia variegata* L. (Nilsson and Johnson, 1992) [20] and *Cassia moschata* HBR (Romero and Johnson, 2002) [22]. In 1957, this bruchid was reported on stored groundnut at Gambia and resulted in poor germination which ultimately led to poor yield (Green, 1959) [10]. The larvae of *C. serratus* bored into the seeds via small holes and fed on the embryo and the endosperm (Conway, 1983) [5]. Insect infestation caused considerable quantitative and qualitative losses to the groundnut either stored in shell for seed purpose or unshelled for milling purpose.

As a result of feeding by this beetle, acidity of oil in nuts increased, ultimately deteriorated the quality of oil. Groundnuts are often stored for 6 to 9 months from harvest to next sowing season. The use of the selected protectants may be one of the eco-friendly and economic approach to keep the stored groundnut free from insect infestation. The growing awareness of environmental hazards due to synthetic insecticides has attracted attention towards the products of plant origin, because they have been proved safe to environment and consumers. There are encouraging results on the use of certain indigenous plant products as protectants reported. (Delobel and Malonga, 1987; Jacob and Sheila, 1990; Joseph *et al*., 1994; Lale and Abdulrahman, 1999; Bhargava and Meena, 2002; Sahayaraj and Ravi, 2003; Naga *et al*., 2007 and Mishra and Dash, 2009) [7, 11, 12, 15, 3, 23, 19, 17].

## Materials and Methods

### Location and climatic conditions

The experiment on efficacy of some seed plant protectants against *C. serratus* infesting Groundnut, *A. hypogaea* were conducted under laboratory conditions in the Department of Entomology, S.K.N. College of Agriculture, Jobner during, August to December, 2014, which is situated at $75^0$ 28' East longitude, $26^0$ 05' North latitude and at an altitude of 427 meters above mean sea level. It falls under agro-climatic zone III$^{rd}$ A, the "Semi-Arid Eastern Plain Zone" of Rajasthan. The climate of this area is typically semi-arid, characterized by extremes of temperature both in summer and winter with low rainfall and moderate humidity. Maximum temperature in summer reaches as high as 45 $^0$C and minimum temperature in winter falls down below 0 $^0$C. The average annual rainfall of locality varies from 400-500 mm occurring mostly from the last week of June to September.

### Maintenance of insect culture

The culture of bruchid, *Caryedon serratus* was maintained in B.O.D. incubator on groundnut kernels at 29+1.5$^0$c temperature and 70+5 per cent relative humidity. Every care was taken not to handle the kernels and insects with naked hands to avoid any contamination. During experimentation, forcep, camel hair brush and aspirator were used for transferring kernels and insects.

### Efficacy of seed protectants against *C. serratus*

The fine powders of different plant products presented in Table 1 were prepared by drying them in shade and then grinded in electric grinder. The powders were sieved through 60 mesh sieve and mixed with pods (Lomentum) @ 10, 15 and 20 g/ kg pods. For mixing the powder, 100 g pods were placed in plastic jar (11x7 cm dia.) and desired doses of powder were added to each jar. The powders were mixed thoroughly with pods (Lomentum) by shaking the jars. For mixing the plant oils, the solution was prepared in acetone,an organic solvent for better effectiveness. 100g pods (Lomentum) were placed in plastic jar (11×7 cm dia.) and desired doses of plant oils were added to each jar and mixed well. Simultaneously, a control (untreated) was also kept. The treatments were replicated thrice. Ten pairs of newly emerged adults were released in treated pods for taking the observations on adult emergence, pod damage and weight loss. The per cent adult emergence was worked out on the basis of number of eggs laid and number of adult emerged after completion of life cycle. The weight loss and pod damage were also determined. The loss in weight was recorded after the end of experiment. Before weighing, all insect stages and frass were removed. The weight loss was worked out by subtracting the final weight from the initial weight and converted into percentage. The per cent pod damage was calculated by counting the damaged and undamaged pods.

**Table 1:** Details of different plant products used

| Common name | Scientific name | Doses |
|---|---|---|
| *Neem* kernel powder | *Azadirachta indica A. Juss.* | 10,15 and 20g/ kg pods |
| *Neem* leaf powder | *Azadirachta indica A. Juss.* | 10,15 and 20g/ kg pods |
| Annona leaf powder | *Annona reticulata L.* | 10,15 and 20g/ kg pods |
| Bakan leaf powder | *Melia azadirach L.* | 10,15 and 20g/ kg pods |
| Castor oil | *Ricinus communis L.* | 0.1,0.5 and 1.0 ml/kg pods |
| *Neem* oil | *Azadirachta indica A. Juss.* | 0.1,0.5 and 1.0 ml/kg pods |
| Control (untreated) | - | - |

## Results and Discussion

### Effect on adult emergence

The data presented in Table 2 indicated that the emergence of *C. serratus* bruchids from pods treated with different plant powders @ 10, 15 and 20 g/kg pods and oils @ 0.1, 0.5 and 1.0 ml/kg pods showed significant difference as compared to control. The per cent adult emergence decreased with the increase in dose levels of the test compounds. The adult emergence at different dose levels varied from 22.83 to 28.70 per cent as against 43.00 per cent in control. In *neem* oil, the adult emergence was 18.10 per cent at lowest dose level (0.1 ml / kg pods) which decreased to 12.12 per cent at highest dose level (1.0 ml / kg pods), whereas, in control, it was 43.00 per cent. Similar trend of adult emergence was recorded in other treatments. Comparing the results obtained from various plant powders and oils, it was found that *neem* oil proved most effective in which minimum adult emergence (14.85%) occurred and remained significantly superior to rest of the treatments. The next effective treatment was castor oil (15.70%), followed by *neem* kernel powder (16.55%), *neem* leaf powder (28.20%), bakan leaf powder (29.19%) and annona leaf powder (31.16%). The maximum adult emergence was recorded in the treatment of annona leaf powder (31.93%).

**Table 2: E**ffect of plant powders on adult emergence of *Caryedon serratus*

| Dose | Per cent adult emergence * | | | | | | |
|---|---|---|---|---|---|---|---|
| | Plant product | | | | | | |
| | Neem kernel powder | Neem leaf powder | Annona leaf powder | Bakan leaf powder | Castor oil | Neem oil | Mean |
| $C_1$ | 20.10 | 33.00 | 35.10 | 33.10 | 18.53 | 18.10 | 28.70 |
| | (26.64) | (35.06) | (36.33) | (35.12) | (25.50) | (25.18) | (32.40) |
| $C_2$ | 16.23 | 27.22 | 30.00 | 29.00 | 15.43 | 14.33 | 25.03 |
| | (23.76) | (31.45) | (33.21) | (32.58) | (23.13) | (22.24) | (30.02) |
| $C_3$ | 13.33 | 24.37 | 28.37 | 25.47 | 13.13 | 12.12 | 22.83 |
| | (21.41) | (29.58) | (32.18) | (30.31) | (21.24) | (20.37) | (28.54) |
| Mean | 16.55 | 28.20 | 31.16 | 29.19 | 15.70 | 14.85 | |
| | (24.01) | (32.07) | (33.93) | (32.70) | (23.34) | (22.67) | |
| Control | 43.00 (40.98) | | | | | | |
| | | S.Em+ | CD at 5% | C.V. % | | | |
| | Treatment | 0.34 | 1.00 | 3.46 | | | |
| | Dose | 0.23 | 0.65 | | | | |
| | TxD | 0.60 | 1.72 | | | | |

* Data based on 30 pairs of adult (Three replications of 10 each)
Figures in parentheses are angular transformed values

| | $C_1$ | $C_2$ | $C_3$ |
|---|---|---|---|
| For plant powder (g) | 10 | 15 | 20 |
| For oils (ml) | 0.1 | 0.5 | 1.0 |

**Effect on pod damage**

The data presented in Table 3 showed that the per cent pod damage in all the doses of different treatments showed significant difference in comparison to control. In *neem* oil, the pod damage was 42.80 per cent at the initial dose level (0.1 ml / kg pods), which reduced to 15.00 per cent at highest dose (1.0 ml / kg pods). Similar trend was recorded in other treatments. The mean pod damage at different dose levels ranged from 27.79 to 48.09 per cent. While, assessing the results obtained in different plant powders and oils, the average pod damage ranged from 28.79 to 42.60 per cent, being minimum in *neem* oil (28.79%) and maximum in annona leaf powder (42.60%). However, the treatments of *neem* oil and castor oil and annona leaf powder and bakan leaf powder did not differ significantly.

**Table 3:** Effect of plant powders on weight loss caused by *Caryedon serratus*

| Dose | Per cent weight loss * | | | | | | |
|---|---|---|---|---|---|---|---|
| | Plant products | | | | | | |
| | Neem kernel powder | Neem leaf powder | Annona leaf powder | Bakan leaf powder | Castor oil | Neem oil | Mean |
| $C_1$ | 4.00 | 5.00 | 6.30 | 5.70 | 3.80 | 3.55 | 5.49 |
| | (11.54) | (12.92) | (14.54) | (13.81) | (11.24) | (10.86) | (13.55) |
| $C_2$ | 3.40 | 4.80 | 6.01 | 5.40 | 3.10 | 3.00 | 5.12 |
| | (10.63) | (12.66) | (14.19) | (13.44) | (10.14) | (9.97) | (13.07) |
| $C_3$ | 2.70 | 3.90 | 5.55 | 4.50 | 2.15 | 1.80 | 4.39 |
| | (9.46) | (11.39) | (13.63) | (12.25) | (8.43) | (7.71) | (12.09) |
| Mean | 3.37 | 4.57 | 5.95 | 5.20 | 3.02 | 2.78 | |
| | (10.57) | (12.34) | (14.12) | (13.18) | (10.00) | (9.60) | |
| Control | 10.10 | | | | | | |
| | (18.53) | | | | | | |
| | | S.Em+ | CD at 5% | C.V. % | | | |
| | Treatment | 0.17 | 0.49 | 4.04 | | | |
| | Dose | 0.11 | 0.32 | | | | |
| | TxD | 0.29 | 0.85 | | | | |

* Data based on 30 pairs of adult (Three replications of 10 each)
Figures in parentheses are angular transformed values

| | $C_1$ | $C_2$ | $C_3$ |
|---|---|---|---|
| For plant powder (g) | 10 | 15 | 20 |
| For oils (ml) | 0.1 | 0.5 | 1.0 |

**Effect on weight loss**

The data presented in Table 4 indicated that the relative efficacy of different treatments in per cent reduction in net weight of groundnut pods was found significant as compared to control. The mean per cent weight loss at different dose levels ranged from 4.39 to 5.49, as against 10.10 in control. A significant difference was observed among all the dose levels. Considering the results observed in different treatments, the minimum weight loss (2.78%) was recorded in *neem* oil, which remained significantly superior over rest of the treatments. Maximum weight loss (5.95%) was observed in annona leaf powder, however, stood at par with bakan leaf powder (5.20%).

The plant kingdom affords a rich store house of chemicals of diverse biological effects on insect. Different plants are also known to possess some insecticidal, antifeedent, repellent and juvelizing properties and as such they have been used in protecting the grains against the damage of number of stored

grain pests in different parts of the country according to local availability of such materials. In recent year several plants have been identified which can be used as safe and renewable source of insecticides for management of *C. serratus* (Delobel and Malonga 1987; Kumari *et al*., 1998, Joshi and Ghorpade 2001b; El-Atta and Ahmed 2002; Manjula 2003; Sundria 2003; Tripathy *et al*., 2004; and Mishra and Dash 2009) [7, 14, 13, 8, 16, 26, 27, 17]. The per cent adult emergence decreased with increase in dose levels of the test compounds. *Neem* oil was most effective treatment in which minimum percentage (14.85%) of adult emergence occurred, while maximum adult emergence (31.16%) was recorded in the treatment of annona leaf powder. The findings are in accordance with the observations of Sundria (2003) [26], Tripathy *et al*. (2004) [27], and Char (2008) [4], who found significant reduction in adult emergence of *C. serratus* from pods treated with different plant powders and oils. During present investigations, effect of some plant materials as powder and oils has been tested against *C. serratus* and results found to be significantly more superior in reducing the pod damage and loss in weight in comparison to control. The pod damage and loss in weight was minimum in the pods treated with *neem* oil followed by castor oil, *neem* kernel powder, *neem* leaf powder, bakan leaf powder and annona leaf powder. Joshi and Ghorpade (2001b) [13], Manjula (2003) [16], Sundria (2003) [26] and Char (2008) [4] also found significant reduction in pod damage as well as loss in weight by *C. serratus* with *neem* leaf powder, *neem* seed kernel powder and karanj seed powder treatments. However, Chander (2003) found significant reduction in grain damage and weight loss by *R. dominica* with karanj kernel, *aak* leaf and *tulsi* leaf powder treatments, which support the present findings.

**Table 4:** Effect of plant powders on pod damage infesting by *Caryedon serratus*

| Dose | Per cent pod damage * | | | | | | |
|---|---|---|---|---|---|---|---|
| | Plant products | | | | | | |
| | **Neem kernel powder** | **Neem leaf powder** | **Annona leaf powder** | **Bakan leaf powder** | **Castor oil** | **Neem oil** | **Mean** |
| $C_1$ | 45.70 | 46.10 | 50.70 | 50.50 | 43.50 | 42.80 | 48.09 |
| | (42.53) | (42.76) | (45.40) | (45.29) | (41.27) | (40.86) | (43.91) |
| $C_2$ | 32.10 | 31.80 | 42.11 | 41.31 | 29.46 | 28.56 | 37.52 |
| | (34.51) | (34.33) | (40.46) | (40.00) | (32.87) | (32.30) | (37.78) |
| $C_3$ | 17.51 | 19.20 | 35.00 | 34.28 | 16.20 | 15.00 | 27.79 |
| | (24.74) | (25.99) | (36.27) | (35.84) | (23.73) | (22.79) | (31.81) |
| Mean | 31.77 | 32.37 | 42.60 | 42.03 | 29.72 | 28.79 | |
| | (34.31) | (34.67) | (40.75) | (40.41) | (33.04) | (32.45) | |
| Control | 57.33 | | | | | | |
| | 49.21 | | | | | | |
| | | S.Em+ | CD at 5% | C.V. % | | | |
| | Treatment | 0.54 | 1.57 | 4.34 | | | |
| | Dose | 0.36 | 1.03 | | | | |
| | TxD | 0.94 | 2.72 | | | | |

* Data based on 30 pairs of adult (Three replications of 10 each)
Figures in parentheses are angular transformed values

| | $C_1$ | $C_2$ | $C_3$ |
|---|---|---|---|
| For plant powder (g) | 10 | 15 | 20 |
| For oils (ml) | 0.1 | 0.5 | 1.0 |

## Conclusion

The management of *C. serratus*, the *neem* oil was the most effective treatment in reducing the adult emergence. Pod damage and loss in weight were minimum in the pods treated with *neem* oil followed by castor oil, *neem* kernel powder, *neem* leaf powder, bakan leaf powder and annona leaf powder.

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## References

1. Anonymous. Eco/68, Economic Survey. Government of India, Ministry of Agriculture (Division Finance), New Delhi, 2012.
2. Arora GL, Singal SK. *Oryza sativa* Linn. (Paddy) as a new host-plants record of *Caryedon serratus* (Olivier) (Coleoptera: Bruchidae) from India. Indian Journal of Entomology. 1978; 40:86.
3. Bhargava MC, Meena BL. Efficacy of some vegetable oils against the pulse beetle, *Callosobruchus chinensis* L. on cowpea, *Vigna unguiculata* (L.). Indian Journal of Plant Protection. 2002; 30:46-50.
4. Char H. Biology and management of groundnut bruchid, *Caryedon serratus* (Olivier) on groundnut, *Arachis hypogae* (L.). *M. Sc.* Thesis Submitted to Rajasthan Agricultural University Bikaner, 2008.
5. Conway JA. Notes on the biology and ecology of groundnut seed beetle, *Caryedon serratus* (Ol.) (Coleptera: Bruchidae) under field conditions in Senegambia. Tropical Stored Products Information. 1983; 45:11-13.
6. Davey Pauline M. The groundnut bruchid, *Caryedon gonagra* (F.). Bulletin of Entomological Research. 1958; 49:385-404.
7. Delobel A, Malonga P. insecticidal properties of six plant materials against *Caryedon serratus* (Ol.) (Coleptera: Bruchidae). Journal of Stored Products Research. 1987; 23:173-176.
8. El-Atta HA, Ahmed A. Comparative effects of some botanicals for the control of the seed weevil, *Caryedon serratus* Olivier (Coleoptera: Bruchidae). Journal of Applied Entomology. 2002; 126:577-583.
9. Fletcher TB. Some South Indian Insects and other

Animals (of Importance Considered Especially from an Economic Point of View). Govt., Press, Madras. 1914, 565.
10. Green AA. The control of insect infesting groundnuts after harvest in the Gambia: A study of the groundnut borer, *Caryedon gonagra* (F.) under field conditions. *Tropical Science*. 1959; 1:200-205.
11. Jacob S,n Sheila MK. Treatment of green gram seeds with oils against the infestation of the pulse beetle, *Callosobruchus chinensis* L. Plant Protection Bulletin. 1990; 42:9-10.
12. Joseph M, Mukherjee SN, Sharma RN. Growth inhibition and impairment of reproductive potential in *Tribolium castaneum* (Herbst) (Coleoptera: Tenebrionidae) by commercially available plant extracts. Insect Science and its Application. 1994; 15:197-202.
13. Joshi VB, Ghorpade SA. Evaluation of some plant products and chemicals against, *Caryedon serratus* (Olivier) infesting stored groundnut. Journal of Insect Science. 2001b; 14:88-89.
14. Kumari DA, Kumar ST, Reddy VS. Management of the groundnut bruchid, *Caryedon serraus* (Olvier) with some plant products. Pest Management and Economic Zoology. 1998; 6:127-131.
15. Lale NES, Abdulrahman HT. Evaluation of *neem* (*Azadirachta indica* A. Juss) seed oil obtained by different methods and *neem* powder for the management of *Callosobruchus maculatus* (F.) (Coleoptera: Bruchidae) in stored cowpea. Journal of Stored Products Research. 1999; 35:135-143.
16. Manjula K. Management of groundnut bruchid, *Caryedon serratus* (Olivier) with botanicals in stored groundnut. Pest Management and Economic Zoology. 2003; 11:115-118.
17. Mishra PR, Dash D. Management of the groundnut bruchid, *Caryedon serratus* (Olivier) with some botanicals. Journal of Entomological Research. 2009; 33:139-141.
18. Mittal VP, Khanna SS. A note on tamarind bruchid *Caryedon gonagra* (Fabricius) (Bruchidae: Coleoptera) a serious pest of stored tamarind (*Tamarindus induca* L.) and other leguminous seeds of economic importance. Agra University Research Journal. 1974; 16:99-101.
19. Naga RP, Bhargava MC, Choudhary RK. Impregnation of cloth bags with botanical weapons as against the incidence of *Tribolium castaneum.* Indian Journal of Applied Entomology. 2007; 21:121-122.
20. Nilsson JA, Johnson CD. New host, *Bauhina variegata* L. and new locality records for *Caryedon serratus* (Ol.) in the new record (Coleoptera: Bruchidae: Pachymerinae). *Pan-pacifi, Entomologist.* 1992; 68:62-63.
21. Prevett PF. the field occurrence of *Caryedon serratus* (Ol.), the groudnut seed beetle (Coleoptera: Bruchidae) in Uganda. Journal of Stored Products Research. 1967; 3:267-268.
22. Romero J, Johnson CD. *Cassia moschata*, H.B.K. new host for *Caryedon serratus* Ol. In the new world (Coleoptera: Bruchidae: Pachymerinae). *Coleopterists Bulletin.* 2002; 56:95-96.
23. Sahayaraj K, Ravi C. Repellent property of the plants extracts on *Tribolium castaneum* Herbst. Journal of Applied Zoological Researches. 2003; 14:118-119.
24. Singal SK, Toky OP. New host plants of *Caryedon serratus* Ol. (Coleoptera: Brudhidae) from India. *Research and Development Reporter*. 1988; 5:91-92.
25. Singal SK, Toky OP. *Pongamia pinnata* (L.) Pierre: a new record of *Caryedon serratus* Ol. (Coleoptera: Bruchidae) from India. *Research and Development Reporter*. 1989; 6:91-92.
26. Sundria MM. Bio-ecology and management of groundnut bruchid, *Caryedon serratus* (Ol.) in groundnut. *Ph.D. Thesis submitted to RCA, MPUAT Udaipur*, 2003.
27. Tripathy MK, Das BC, Mohanty S. Efficacy of few botanicals against seed beetle, *Caryedon serratus* Olivier (Coleoptera: Bruchidae) infesting stored groundnut under Bhubaneshwar condition. Indian Journal of Agricultural Research. 2004; 38:15-21.
28. Wightman JA, Admin PW, Rao GVP, Dick TM. Research on groundnut pests at ICRISAT. Proceedings of the Second Regional Groundnut workshop for Southern Africa. 1987, 103-114.