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Impregnation of packaging material with protectants for management of *Caryedon serratus* (Olivier) on groundnut

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Abstract
The insecticides *viz.*, malathion and fenvalerate (0.05, 0.075 and 0.1%) and plant oils *viz.*, neem, castor and mustard oil each at three concentrations (5.0, 7.5 and 10%) were evaluated by impregnating the gunny bags against *Caryedon serratus* (Olivier) (Coleoptera: Bruchidae). The pod damage and weight loss were recorded after six months of storage groundnut, *Arachis hypogaea* (L.). The per cent pod damage decreased with the increase in the concentration of test compounds. Among the plant oils, the mean pod damage (21.65%) was observed in neem oil followed by castor oil (27.36%) and mustard oil (33.79%). In neem oil, the pod damage was 28.50 per cent at the initial dose level (5.0%) which reduced to 13.59 per cent at highest dose level (10%). While assessing the effect of chemicals, the mean pod damage 0.85 per cent and 2.90 per cent was observed in fenvalerate and malathion, respectively. The fenvalerate was found to be most effective treatment in which pod damage was 2.11 per cent at the initial concentration (0.05%) while no infestation was recorded at the highest concentration of 0.1 per cent. The mean per cent weight loss decreased with the increase in concentration of test compounds. Among the plant oils, the mean weight loss (1.35%) was observed in neem oil followed by castor oil (2.21%) and mustard oil (2.76%). In neem oil, the weight loss was 1.37 per cent at the initial dose level (5.0%) which reduced to 1.13 per cent at highest dose level (10%). However, similar trend was observed in other treatments. With regards to chemicals, no weight loss was observed in all concentrations of fenvalerate. In malathion, 0.56 per cent weight loss was observed at initial concentration (0.05%) whereas no weight loss was revealed at 0.075 and 0.1 per cent concentrations. The fenvalerate and malathion were the best treatment for impregnation of gunny bags resulting in which no infestation caused by *C. serratus*. Among the plant oils the neem oil was the best treatment for impregnation of gunny bags having minimum pod damage and weight loss while mustard oil was the least effective.

Keywords: insecticides, plant oils, *Caryedon serratus*, impregnating gunny bags, 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 1051 kg-1 productivity [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 [14, 25]. The bruchid is native of the tropics and subtropics of the globe6 and has been introduced into different parts of the World [20]. In India, it has been reported from South India [8], Rajasthan, Gujarat, Madhya Pradesh, Maharashtra and Uttar Pradesh [15], Punjab, Haryana, Jammu and Kashmir, Himachal Pradesh,

Tamil Nadu, Kerala and some of the Islands in the Indian Ocean [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. [2], *Acacia nilotica* (L.), *A. tortilis* (Forssk.) and *Prosopis cineraria* (L.) [24], *Bouhinia variegata* L. [19] and *Cassia moschata* HBR [22]. In 1957, this bruchid was reported on stored groundnut at Gambia and resulted in poor germination which ultimately led to poor yield [9]. The larvae of *C. serratus* bored into the seeds via small holes and fed on the embryo and the endosperm [3, 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. The use of the impregnation of packing material with selected protectants may be one of the eco-friendly and economic approach to keep the stored groundnut pods 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 and impregnation of packaging materials as reported by earlier workers [7, 10, 11, 12, 18, 23].

Materials and Methods

The experiments 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 IIIrd 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.

The culture of bruchid, *C. 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. Malathion 5^0 EC, Fenvalerate 2^0 EC, Neem oil, Castor oil, Mustered oil were used. The test materials were purchased from the local market. The packaging material (Gunny bags) were sprayed with different concentrations (5.0, 7.5 and 10 per cent) of plant oils *viz.*, neem oil (*Azadirachta indica*), castor oil (*Ricinus communis*) and mustard oil (*Brassica juncea*) and insecticides (0.05, 0.075 and 0.1 per cent) *viz.*, malathion and fenvalerate. The solution of insecticides was prepared in water while the solution of plant oils was prepared in acetone, an organic solvent for better effectiveness. The gunny bags of 12x15 cm2 were impregnated with three concentrations of plant oils and insecticides and finally kept for drying under shade. The treated bags were packed with 100 g of groundnut pods and kept in laboratory for six months for natural infestation. Two controls, each of acetone and untreated were maintained for comparison. The weight loss and pod damage were recorded. 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.

Statistical analysis

The data obtained on various characters/ parameters were subjected to analysis of variance applicable for completely randomized design. The level of significance used in 'F' test was p= 0.05 wherever, F calculated was significant, critical difference values were calculated for treatment comparisons. The values obtained in percentage were transformed into angular values and were subjected to analysis.

Table 1: Details of different plant oils and insecticides used

S. No.	Common name	Scientific name	Doses
1.	Neem oil	*Azadirachta indica*	5.0, 7.5 and 10%
2.	Castor oil	*Ricinus communis*	5.0, 7.5 and 10%
3.	Mustered oil	*Brassica juncea*	5.0, 7.5 and 10%
4.	Malathion	-	0.05, 0.075 and 0.1%
5.	Fenvalerate	-	0.05, 0.075 and 0.1%
6.	Control (untreated)	-	-

Results and Discussion

The data presented in Table 2 showed a significant decrease of pod damage in all the treatments as compared to both the control. The mean per cent pod damage decreased with the increase in the concentration of test compounds. Among the plant oils, the mean pod damage (21.65%) was observed in neem oil followed by castor oil (27.36%) and mustard oil (33.79%). In neem oil, the pod damage was 28.50 per cent at the initial dose level (5.0%) which reduced to 13.59 per cent at highest dose level (10%). Similar trend was observed in other treatments. While assessing the effect of chemicals, the mean pod damage 0.85 per cent and 2.90 per cent was observed in fenvalerate and malathion, respectively. The fenvalerate was found to be most effective treatment in which pod damage was 2.11 per cent at the initial concentration (0.05%) while no infestation was recorded at the highest concentration of 0.1 per cent.

The data presented in Table 3 indicated the mean per cent weight loss decreased with the increase in concentration of test compounds. Among the plant oils, the mean weight loss (1.35%) was observed in neem oil followed by castor oil (2.21%) and mustard oil (2.76%). In neem oil, the weight loss was 1.37 per cent at the initial dose level (5.0%) which reduced to 1.13 per cent at highest dose level (10%). However, similar trend was observed in other treatments. With regards to chemicals, no weight loss was observed in all concentrations of fenvalerate. In malathion, 0.56 per cent weight loss was observed at initial concentration (0.05%), whereas no weight loss was revealed at 0.075 and 0.1 per cent concentrations.

Table 2: Effect of impregnation of packing material with protectants against *Caryedon serratus.*

Concentration	Percent pod damage*					
	Protecants					
	Neem oil	Castor oil	Mustard oil	Malathion	Fenvalerate	Mean
C1	28.50	33.97	39.59	5.56	2.11	31.40
	(32.27)	(35.65)	(38.99)	(13.64)	(8.35)	(34.08)
C2	22.86	26.67	34.35	2.67	0.44	28.16
	(28.56)	(31.09)	(35.88)	(9.40)	(3.80)	(32.05)
C3	13.59	21.45	27.44	0.47	0.00	24.72
	(21.63)	(27.59)	(31.59)	(3.93)	(0.00)	(29.82)
Mean	21.65	27.36	33.79	2.90	0.85	
	(27.73)	(31.54)	(35.54)	(9.80)	(5.29)	
Control (Acetone)	54.15					
	(47.38)					
Control	55.95					
	(48.42)					
		S.Em+	CD at 5%	C.V. %		
	Treatment	0.53	1.53	5.49		
	Dose	0.35	1.00			
	TxD	0.92	2.66			

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

	C1	C2	C3
For plant product (%)	5.0	7.5	10.0
For chemical (%)	0.05	0.075	0.10

Table 3: Effect of impregnation of packing material with protectants against *Caryedon serratus.*

Concentration	Per cent weight loss*					
	Protecants					
	Neem oil	Castor oil	Mustard oil	Malathion	Fenvalerate	Mean
C1	1.37	2.58	3.07	0.56	0.00	2.69
	(6.72)	(9.24)	(10.09)	(4.29)	(0.00)	(9.43)
C2	1.54	2.21	2.97	0.00	0.00	2.56
	(7.13)	(8.55)	(9.92)	(0.00)	(0.00)	(9.21)
C3	1.54	2.21	2.97	0.00	0.00	2.56
	(7.13)	(8.55)	(9.92)	(0.00)	(0.00)	(9.21)
Mean	1.35	2.21	2.76	0.19	0.00	1.35
	(6.66)	(8.55)	(9.57)	(2.48)	(0.00)	(6.66)
Control (Acetone)	5.33					
	(13.35)					
Control	5.89					
	(14.05)					
		S.Em+	CD at 5%	C.V. %		
	Treatment	0.09	0.27	3.72		
	Dose	0.06	0.18			
	TxD	0.16	0.47			

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

	C1	C2	C3
For plant product (%)	5.0	7.5	10.0
For chemical (%)	0.05	0.075	0.10

The data recorded during the present investigations revealed that no infestation was recorded when gunny bags were impregnated with fenvalerate at highest dose level (0.1%) followed by malathion in which 0.47 per cent pod damage was observed at highest dose level (0.1%). Among the plant oils the most effective treatment was neem oil followed by castor oil and mustard oil for reduction in weight loss and pod damage. The work on the impregnation of packing material with insecticides/ plant oils for management, especially of *C. serratus* is not available, however, the same type of work on other insect pests have been discussed which support the present findings. The gunny bags impregnated with neem oil at 3.0 per cent were effective in avoiding The *S. cerealella* damage [21]. Muhammad *et al.* [16]. Also observed that 10.0 per cent neem oil treatment reduced the insect penetration. Meena [13] and Chander [4] reported that impregnation of gunny and cloth bags with different plant products proved effective and reduced reducing the grain damage and weight loss while working on *C. cephalonica* and *R. dominica*, respectively. Similarly, Naga [17]. Reported that impregnation of gunny and cloth bags with plant oils were found effective in reducing the infestation of *T. castaneum.*

Conclusion

On the basis of this study, it is concluded that the mean pod damage was 21.65 per cent observed in neem oil followed by castor and mustard oils 27.36 per cent and 33.79 per cent, respectively. In neem oil, the pod damage was 28.50 per cent at the initial dose level (5.0%) which reduced to 13.59 per cent at highest dose level (10%). The fenvalerate was found to

be most effective treatment in which pod damage was 2.11 per cent at the initial concentration (0.05%) while no infestation was recorded at the highest concentration of 0.1 per cent. The fenvalerate and malathion were the best treatment for impregnation of gunny bags resulting in which no infestation caused by *C. serratus*. Among the plant oils the neem oil was the best treatment for impregnation of gunny bags having minimum pod damage and weight loss while mustard oil was the least effective.

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