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RESEARCH ARTICLE

Evaluation of newer insecticides as fabric treatment against *Caryedon serratus* (Oliver) (Coleoptera: Bruchidae) on stored groundnut

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ABSTRACT

Different insecticides like flubendiamide 480 SC, emamectin benzoate 5 SG, spinosad 45 SC and deltamethrin 2.8 EC were evaluated during 2010-11 at National Seed Project, University of Agricultural Sciences, Bangalore against *Caryedon serratus*, which is a pest on stored groundnut by applying insecticides on three different types of packaging materials like gunny bag, porous HDPE bag and cloth bag. Also, the influence of these insecticides on seed quality attributes particularly germination, moisture content and vigour were studied during 2010-11. However, all the insecticides were proved effective in controlling *C. serratus* without affecting the seed quality attributes, deltamethrin 2.8 EC was found to be superior over all other insecticides. Spinosad 45 SC @100 ppm a.i., emamectin benzoate 5 SG at 100 ppm a.i. and flubendiamide 480 SC at 100 ppm a.i. were next in the order of efficacy. Among the fabric treatments, porous HDPE bag, gunny bag and cloth bag were in the order of effectiveness.

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INTRODUCTION

Groundnut (*Arachis hypogaea* L.) is an important legume plant with yellow sessile flowers and subterranean pods. It was originated in the Southern Bolivia/North-west Argentina region in South America and is presently cultivated in 108 countries of the world. Asia with 63.1 per cent area produces 71.1 per cent of world production followed by Africa and North Central America with a per cent area and production of 31.3 and 3.7 and 18.6 and 7.5, respectively. In India, groundnut is the principal oilseed crop and is grown in eleven states on an area of 4.93 million hectares with a production of 5.64 million tonnes of pod per annum and an average productivity of 1144 kg per hectare (Anonymous, 2010). Production is constrained due to insect pests both in field and storage. More than 350 species of insects infest the crop in different parts of the world (Stalker and Campbell, 1983). Among the pests, post harvest insect pests like *Caryedon serratus* (Oliver) is a primary feeder while, *Elasmolomus sordidus* (F.), *Ephestia cautella* (W.), *Corcyra cephalonica* (Staint) and *Tribolium castaneum* (Herbst) are secondary feeders. *C. serratus* belongs to the family Bruchidae which includes genera like *Callosobruchus, Caryedon, Bruchus, Acanthoscelides* and *Zabrotes* causing serious damage not only to the seeds of many forestry plants but also to numerous pulse grains during storage (Lefroy, 1909; Fletcher, 1914; Pruthi and Singh, 1943

and Mathur *et al*., 1958). *Caryedon serratus* (Oliver) is one of the major and important storage insect species causing 20 per cent damage (Dick, 1987) to groundnut and prevalent in Asia, Greece, France, Italy and the north and west coasts of Africa. *Caryedon serratus* has wide host range which includes *Bauhinia monandra* (Kurz.), *Prosophis juliflora* (SW.) (Beeson, 1918), *Acaia tomentosa* (Benth) (Van Hall, 1919), *Tamarindus indica* L. (Strong, 1922), *A. nilotica* (L.), *Cassia fistula* (L.) (Pruthi and Singh, 1950), *Pongamia pinnata* (L.) (Singal and Toky, 1990), *Hardwickia binata* (Roxb.) (Pruthi and Singh, 1950). In field condition, 6.8 per cent pod damage is noticed due to *C. serratus* in *A. nilotica* (Singal and Toky, 1990). Groundnut stored in godowns was attacked by the bruchid, *Caryedon serratus* causing approximately 17-47 per cent of the pods damage (Shukla and Rathore, 2007). The beetle damage not only reduces the weight and nutrient value but also adversely affects the quality of seed and oil. Infestation causes loss in dry mass of the kernels, increased levels of free fatty acids in the oil (thereby lowering the quality) and reduction in germination potential (Howe,1952). The heat and moisture generated by large insect population within heaps or stacks of groundnut may also increase the risk of mould growth.

C. serratus is a major insect pest of stored groundnut causing severe damage, preventing long term storage, meagre information is available on management of this pest using insecticides and fabric materials under storage. The present investigation was undertaken to study the efficacy of different insecticides as fabric treatment against *C.serratus* and its influence on seed quality attributes.

MATERIAL AND METHODS

To evaluate different insecticides as fabric treatments against *Caryedon serratus* on stored groundnut, freshly harvested and dried groundnut pods were collected from certified lot of National Seed Project (NSP) having 95 per cent germination, 8 per cent moisture content and free from insect infestation. For each treatment, one kg pod was used. Prepared insecticidal solution of given concentration and treated on three different types of packaging materials like gunny bag of 2kg capacity, porous HDPE bag and cloth bag with 7.5 ml spray fluid for a bag of 30 × 40 cm dimension. After shade drying, pods were filled in the above said fabric bags and kept in laboratory under ambient condition. The insecticide treatments imposed on the fabric bags are mentioned in Table A. The experiment was initiated during July 2010 with five treatments by adopting Factorial completely randomized design (FCRD) with three replications.

Observations :

Following observations were recorded at trimonthly interval up to 9 months or loss of germination below Minimum Seed Certification Standard (MSCS).

Table A : Details of insecticides used for fabric treatment

Sr. No.	Insecticide treatments	Concentration of a.i. (ppm)	Qty of formulation/mg or ml/ lit
T_1	Flubendiamide 480SC	100	2
T_2	Emamectin benzoate 5SG	100	2
T_3	Spinosad 45SC	100	2
T_4	Deltamethrin 2.8EC	100	3.5
T_5	Untreated control		

Per cent pod damage :

In each treatment, the number of pods damaged among the total number of pods were counted and expressed as per cent pod damage.

Number of live adults :

Number of live adults were counted in all the treatments by taking out one kg pods.

Germination of undamaged seeds :

The germination test was conducted by between paper (BP) method as prescribed by the International Seed Testing Association (ISTA). A total of 100 undamaged kernels of each replication in each of the treatments were selected and uniformly placed on a germination paper and the rolled towels were placed vertically in the germination cabinet maintained at 25° C, with 85 per cent relative humidity. Germination counts were taken on 5th day after incubation and worked out per cent germination.

Seed moisture content :

Moisture content of seed was done by oven dry method. 5g of seeds were taken from each replication and in each treatment and by taking the initial weight, the seeds were kept in oven for 17 hours and final weight was recorded. The moisture content of the seed was calculated by using the following formula :

$$\text{Moisture content (\%)} = \frac{W_2 - W_3}{W_2 - W_1} \times 100$$

W_1= Weight of empty cup with lid (g)

W_2= Weight of cup with seed samples before drying

W_3= Weight of cup with seed sample after drying.

Vigour index :

Measurements of root and shoot length was taken for ten randomly selected seedlings from germination test, from each treatment and replication. The mean seedling length was calculated. The vigour index-I was calculated by using formula:

Vigour Index-I = Germination (%) × Mean seedling length (cm)

Ten seedlings selected for seedling measurement were dried in hot air oven maintained at 80 ± 2° C for 24 hours, then dry weight was computed and calculated the vigour index - II, using the following formula :

Vigour index-II = Germination (%) × Mean dry weight of seedlings (g)

The data after suitable transformations (wherever required) were subjected to statistical analysis following Analysis of Variance technique for completely randomized design (CRD) to draw inference at 5 per cent level of significance.

RESULTS AND DISCUSSION

The findings of the present study as well as relevant discussion have been presented under following heads :

Table 1 : Effect of treating packing materials with different insecticides on the groundnut pod damage caused by *Caryedon serratus*

Treatments	Pod damage (%)											
	3 MAT				6 MAT				9 MAT			
	P_1	P_2	P_3	Mean	P_1	P_2	P_3	Mean	P_1	P_2	P_3	Mean
Flubendiamide 480 SC	0.0	0.0	0.0	0.0	2.2	2.18	2.0	2.12	3.0	2.53	2.07	2.53
	(0.0)	(0.0)	(0.0)	(0.0)	(8.45)	(8.46)	(8.13)	(8.35)[a]	(9.72)	(9.12)	(9.26)	(9.37)[a]
Emamectin benzoate 5 SG	0.0	0.0	0.0	0.0	2.07	2.37	2.37	2.27	2.83	2.78	3.0	2.87
	(0.0)	(0.0)	(0.0)	(0.0)	(8.22)	(8.81)	(8.72)	(8.58)[a]	(9.68)	(9.38)	(9.88)	(9.65)[a]
Spinosad 45 SC	0.0	0.0	0.0	0.0	1.87	2.13	2.23	2.07	3.0	2.67	3.33	3.0
	(0.0)	(0.0)	(0.0)	(0.0)	(7.66)	(8.16)	(8.57)	(8.13)[a]	(10.01)	(9.08)	(10.46)	(9.86)[a]
Deltamethrin 2.8 EC	0.0	0.0	0.0	0.0	1.93	1.90	1.57	1.8	2.17	2.6	2.67	2.48
	(0.0)	(0.0)	(0.0)	(0.0)	(7.87)	(7.92)	(7.12)	(7.64)[a]	(8.10)	(9.36)	(9.08)	(8.85)[a]
Untreated control	0.7	0.7	0.7	0.7	6.83	5.67	7.10	6.53	12.13	9.33	15.33	12.26
	(3.82)	(3.82)	(3.82)	(3.18)	(15.15)	(13.71)	(15.43)	(14.76)[b]	(20.38)	(17.78)	(23.04)	(20.40)[b]
Mean	0.14	0.14	0.14	–	2.98	2.85	3.04	–	4.63	3.98	5.28	–
					(9.47)	(9.41)	(9.59)		(11.58)	(10.94)	(12.35)	
					SEm ±		C.D. (P=0.05)		SEm ±		C.D. (P=0.05)	
Treatments (T)					0.45		1.29		2.30		6.67	
Packing material (P)					0.35		NS		1.78		NS	
TXP					0.77		NS		1.33		NS	

Figures in the parentheses are Arc sign transformed values; Means followed by same letter in a column do not differ significantly; MAT: Months after treatment; P_1, P_2 and P_3: Gunny bag, Porous HDPE bag and Cloth bag, respectively; NS: Non-significant.

Table 2 : Effect of treating packing materials with different insecticides on adult survival of *Caryedon serrates* in stored groundnut

Treatments	Number of live adult insects											
	3 MAT				6 MAT				9 MAT			
	P_1	P_2	P_3	Mean	P_1	P_2	P_3	Mean	P_1	P_2	P_3	Mean
Flubendiamide 480 SC	0	0	0	0	1.33	1.0	1.67	1.33	2.0	2.33	2.67	2.33
	(0.71)	(0.71)	(0.71)	(0.71)	(1.34)	(1.22)	(1.22)	(1.26)[a]	(1.58)	(1.64)	(1.77)	(1.66)[a]
Emamectin benzoate 5 SG	0	0	0	0	1.33	1.33	1.0	1.22	2.33	2.33	2.0	2.22
	(0.71)	(0.71)	(0.71)	(0.71)	(1.17)	(1.34)	(1.22)	(1.24)[a]	(1.68)	(1.68)	(1.56)	(1.64)[a]
Spinosad 45 SC	0	0	0	0	1.0	0.67	1.33	1.0	2.33	2.0	2.33	2.22
	(0.71)	(0.71)	(0.71)	(0.71)	(1.17)	(1.05)	(1.34)	(1.19)[a]	(1.68)	(1.56)	(1.68)	(1.64)[a]
Deltamethrin 2.8 EC	0	0	0	0	1.0	0.67	0.67	0.78	1.67	0.67	1.0	1.11
	(0.71)	(0.71)	(0.71)	(0.71)	(1.22)	(1.05)	(1.05)	(1.11)[a]	(1.46)	(1.05)	(1.17)	(1.23)[a]
Untreated control	1.0	0.67	1.33	1.0	3.0	2.67	3.33	3.0	6.33	5.0	7.0	6.11
	(1.12)	(1.05)	(1.34)	(1.17)	(1.86)	(1.77)	(2.04)	(1.89)[b]	(2.6)	(2.34)	(2.73)	(2.56)[b]
Mean	0.14	0.14	0.14		1.53	1.26	1.60		2.93	2.46	3.0	
	(0.79)	(0.77)	(0.83)		(1.35)	(1.28)	(1.37)		(1.80)	(1.64)	(1.78)	
					SEm ±		C.D. (P=0.05)		SEm ±		C.D. (P=0.05)	
Treatments (T)					0.08		0.24		0.09		0.25	
Packing material (P)					0.06		NS		0.07		NS	
TXP					0.14		NS		0.15		NS	

Figures in the parentheses are √X+0.5 transformed values; Means followed by same letter in a column do not differ significantly; MAT: Months after treatment; P_1, P_2 and P_3: Gunny bag, Porous HDPE bag and Cloth bag, respectively; NS: Non-significant.

Per cent pod damage:

Least pod damage was observed in deltamethrin 100 ppm a.i (1.8 and 2.48 %) and highest in untreated control (6.53 and 12.26 %) at six and nine months after treatment imposition (Table 1). All the insecticide treatments were statistically at par, but superior over untreated control in reducing the per cent pod damage. With respect to packaging material, all the three (gunny bag, porous HDPE bag and cloth bag) recorded least damage and there were no significant difference between them, however the porous HDPE bag recorded least infestation (3.98 %) and gunny bag recorded highest (4.63 %). The present results are in confirmation with Halle (1999), who recorded the least pod damage (4 %) on groundnut pods, in the gunny bag treated with deltamethrin at 5 g/bag. Mishra *et al.* (2008) revealed gunny bag impregnated with deltamethrin (0.0125 %) afforded complete protection up to 6 months. Yadav (1997), Yadav and Singh (1994), Bareth and Guptha (1989) and Sinha (1993) used insecticides for storage bag treatment and found that deltamethrin treatment was very effective against various storage pests.

Number of live adults :

Least number of adults were recorded in deltamethrin treatment (0.78 and 1.11 adults/ kg pods) at six and nine months after treatment imposition, respectively (Table 2). All the insecticide treatments were statistically at par, but superior over untreated control in reducing the adult insects. Present study revealed that all the treated insecticides proved better in controlling the attack of *C. serratus*. Among the packing material, porous HDPE bag recorded least number of insects (2.46 number/ kg pods) and cloth bag recorded highest (3.0 number/ kg pods). The present result is supported by Ramzan *et al.* (1987), in which gunny bags impregnation at 0.05 per cent deltamethrin solution proved significantly superior and was considered to be the best insecticide to control stored grain insect pests. Deltamethrin suppressed adult emergence of both insects and oviposition of *C. maculatus* (Santhi *et al*., 1993). Mishra *et al.* (2008) revealed gunny bag impregnated with deltamethrin (0.0125 %) afforded complete protection up to 6 months.

Table 3 : Effect of treating packing materials with different insecticides on germination of stored groundnut

Treatments	Germination (%)											
	3 MAT				6 MAT				9 MAT			
	P_1	P_2	P_3	Mean	P_1	P_2	P_3	Mean	P_1	P_2	P_3	Mean
Flubendiamide 480 SC	90.00	90.00	91.33	90.44	88.33	88.67	87.33	88.11[a]	87.00	87.00	86.00	86.67[a]
Emamectin benzoate 5 SG	96.67	90.00	90.67	90.44	88.00	87.67	88.67	88.11[a]	86.33	85.33	84.00	85.22[a]
Spinosad 45 SC	90.00	93.33	94.67	92.67	88.00	87.67	88.00	87.89[a]	86.67	86.33	86.67	86.56[a]
Deltamethrin 2.8 EC	90.00	91.33	90.67	90.67	87.67	88.33	90.00	88.67[a]	86.00	86.33	87.33	86.56[a]
Untreated control	91.33	92.00	92.00	91.78	82.33	83.33	82.67	82.78[b]	79.67	81.00	79.67	80.11[b]
Mean	90.40	91.33	91.87		86.87	87.13	87.33		85.13	85.20	84.73	
	SEm ±		C.D. (P=0.05)		SEm ±		C.D. (P=0.05)		SEm ±		C.D. (P=0.05)	
Treatments (T)	1.19		NS		0.54		1.55		0.43		1.24	
Packing material (P)	0.92		NS		0.41		NS		0.33		NS	
T X P	2.06		NS		0.93		NS		0.75		NS	

Means followed by same letter in a column do not differ significantly; MAT: Months after treatment; P_1, P_2 and P_3: Gunny bag, Porous HDPE bag and Cloth bag, respectively; NS: Non-significant.

Table 4 : Effect of treating packing materials with different insecticides on moisture content of stored groundnut

Treatments	Moisture content (%)											
	3 MAT				6 MAT				9 MAT			
	P_1	P_2	P_3	Mean	P_1	P_2	P_3	Mean	P_1	P_2	P_3	Mean
Flubendiamide 480 SC	8.50	8.19	8.17	8.29	7.54	7.73	8.14	7.80	7.33	6.87	6.87	7.02
Emamectin benzoate 5 SG	8.64	7.94	7.84	8.14	7.4	7.45	7.97	7.61	7.13	7.23	7.67	7.34
Spinosad 45 SC	7.89	7.67	8.78	8.11	7.7	7.61	7.88	7.75	7.50	7.43	7.10	7.34
Deltamethrin 2.8 EC	7.91	7.86	7.53	7.77	7.42	7.63	7.75	7.53	7.50	7.47	7.28	7.41
Untreated control	7.60	8.14	7.89	7.88	7.82	7.51	7.37	7.57	7.36	7.20	7.13	7.23
Mean	8.11	7.96	8.04		7.62	7.54	7.8		7.37	7.24	7.21	
	SEm ±		C.D. (P=0.05)		SEm ±		C.D. (P=0.05)		SEm ±		C.D. (P=0.05)	
Treatments (T)	0.25		NS		0.14		NS		0.10		NS	
Packing material (P)	0.20		NS		0.11		NS		0.08		NS	

MAT: Months after treatment; P_1, P_2 and P_3: Gunny bag, Porous HDPE bag and Cloth bag, respectively; NS: Non-significant

Germination:

The germination per cent of pods remained statistically same up to 3 months after treatment, and it remained high in all insecticide treatments compared to untreated control (Table 3). These insecticides did not have any effect directly on the seed germination but helped in control of the insects which indirectly prevented loss of germination. Present results are in aggrement with results obtained by Bareth and Guptha (1989); Sinha (1993), they revealed the germination of seed was not affected up to 15 months of storage. Patil *et al.* (2004) recorded the effectiveness of deltamethrin 1 ppm in providing complete protection from *R. dominica* on wheat for 6 months of storage without loss of viability.

Seed moisture content :

No significant differences were observed between the treatments with respect to moisture content even up to 9 months after treatment imposition (Table 4). So, the study concludes that fabric treatment with insecticides did not have any effect on moisture content of treated pods.

Vigour index :

Effectiveness of fabric treatment with insecticides was evaluated based on the vigour index. Both vigour indexes I and II not affected up to 3 months after treatment imposition in any of the treatments and packing materials. At 6 and 9 months after treatment imposition, the treatments deltamethrin 100 ppm a.i and spinosad 100 ppm a.i recorded highest mean vigour index-I (2099 and 2020, respectively) and vigour index II (126 each at 6 and 9 months) (Table 5 and 6). No significant differences were observed among the packing materials at 6 and 9 months after treatment imposition and all the three packing materials (gunny bag, porous HDPE bag and cloth bag) were found to be better with respect to vigour index. No

Table 5 : Effect of treating packing materials with different insecticides on vigour index-I of stored groundnut

Treatments	Vigour index-I											
	3 MAT				6 MAT				9 MAT			
	P_1	P_2	P_3	Mean	P_1	P_2	P_3	Mean	P_1	P_2	P_3	Mean
Flubendiamide 480 SC	1983	2071	1910	1988^{ab}	1943	2039	1833	1939^{ab}	1856	1943	1777	1859^{ab}
Emamectin benzoate 5 SG	1781	1680	1692	1718^{c}	1730	1636	1653	1673^{b}	1669	1592	1571	1611^{b}
Spinosad 45 SC	1740	1833	2021	1865^{b}	1699	1724	1878	1767^{b}	1675	1699	1761	1712^{b}
Deltamethrin 2.8 EC	2073	2130	2237	2147^{a}	2016	2061	2219	2099^{a}	1948	1985	2125	2020^{a}
Untreated control	2038	2116	1870	2008^{ab}	1838	1916	1680	1812^{b}	1779	1809	1620	1736^{b}
Mean	1923	1966	1946	–	1845	1875	1852	–	1785	1805	1771	–
	SEm ±		C.D. (P=0.05)		SEm ±		C.D. (P=0.05)		SEm ±		C.D. (P=0.05)	
Treatments (T)	59.10		170.68		51.87		149.82		47.71		137.81	
Packing material (P)	45.78		NS		40.18		NS		36.96		NS	
TXP	102.36		NS		89.85		NS		82.64		NS	

Means followed by same letter in a column do not differ significantly; MAT: Months after treatment; P_1, P_2 and P_3: Gunny bag, Porous HDPE bag and Cloth bag, respectively; NS: Non-significant.

Table 6 : Effect of treating packing materials with different insecticides on vigour index-II of stored groundnut

Treatments	Vigour index-II											
	3 MAT				6 MAT				9 MAT			
	P_1	P_2	P_3	Mean	P_1	P_2	P_3	Mean	P_1	P_2	P_3	Mean
Flubendiamide 480 SCz	116	131	135	128	122	123	121	122^{a}	119	120	116	119^{a}
Emamectin benzoate 5 SG	139	142	119	134	119	118	130	123^{a}	117	115	123	119^{a}
Spinosad 45 SC	139	136	122	133	129	125	122	126^{a}	127	129	120	126^{a}
Deltamethrin 2.8 EC	141	122	133	132	119	120	126	122^{a}	117	111	120	117^{a}
Untreated control	141	123	134	133	110	110	109	110^{b}	91	93	92	93^{b}
Mean	135	131	129		120	119	121		114.7	114	114.8	
	SEm ±		C.D. (P=0.05)		SEm ±		C.D. (P=0.05)		SEm ±		C.D. (P=0.05)	
Treatments (T)	6.96		NS		2.12		6.12		2.09		6.02	
Packing material (P)	5.39		NS		1.64		NS		1.62		NS	
TXP	12.05		NS		3.67		NS		3.61		NS	

Means followed by same letter in a column do not differ significantly; MAT: Months after treatment; P_1, P_2 and P_3: Gunny bag, Porous HDPE bag and Cloth bag, respectively; NS: Non-significant

information is available in literature on these aspects.

The evaluation of insecticide molecules as fabric treatment against *C. serratus* infesting groundnut pods showed that all the tested insecticides and fabric treatments were found to be effective in controlling *C. serratus* without affecting the seed quality attributes like germination, moisture content and vigour index. Therefore, application of these promising insecticides on fabric before storing the groundnut pods would help in reducing the damage caused by *C. serratus* without affecting the seed quality.

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