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National Academy of Agricultural Science (NAAS) Rating : 3. 03

Eco-friendly Management of *Callosobruchus Chinensis* L. in Pigeonpea

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ABSTRACT: *Laboratory studies on "Eco-friendly management of Callosobruchus chinensis L. in pigeonpea" were conducted in the Department of Entomology, College of Agriculture, Rajendranagar, Hyderabad during 2010-11. The grain protectants used in the study indicated that all the 4 oils viz., soyabean, sesamum, eucalyptus and karanj oil used @ 3ml/kg seed significantly reduced the fecundity, adult emergence and seed infestation were on par with the chemical protectants deltamethrin 2.8 EC (0.04ml/kg seed) and spinosad 45 SC (4 ppm). These grain protectants took upper hand with respect to adult mortality. These chemicals caused 100% mortality at 24 hours after treatment while among the oils, except karanj oil which recorded 82.67% mortality at 24 hours after treatment, the other 3 oils were slow in their action and caused 66.76% mortality of test insect after 7 days of treatment.*

Keywords: *Callosobruchus chinensis, pigeonpea, eco-friendly management*

INTRODUCTION

Pulses constitute the major source of protein in the diet of developing countries. They contain 20-30% of the protein which is almost 3 times higher than that found in cereals. Among the pulses, pigeonpea is an important pulse crop of rainfed agriculture in the semi arid tropics. It is cultivated either as a sole crop or intercropped with cereals or other legumes. The crop, also called as redgram/tur/arhar, is widely cultivated in India in an area of 33.8 million hectares with an annual production of 22.7 million tons. In Andhra Pradesh it is cultivated in 4.4 million hectares with the production of 2 million tons (CMIE Report., 2009). Qualitative and quantitative losses occur in pigeonpea seeds during storage, due to various pests. Among the stored pests, pulse beetle (cowpea weevil) *Callosobruchus chinensis* L. (Bruchidae: Coleoptera) is the most destructive species of stored legume seeds in India as well as in other countries. It causes 33% infestation to legume seeds as compared to 3% damage in cucurbits, solanaceous vegetables and oil seeds (Mukherjee *et al*., 1970). Larval feeding on the cotyledons causes significant losses in seed weight and viability. Gujar and Yadav (1978) reported 55-60% losses in seed weight and 45.5 to 66.3% losses in protein content due to bruchid infestation in storage and the infested seeds become unfit for human consumption.

In recent years, the use of various bio-pesticides, edible and non-edible oils and plant extracts have gained much importance due to their high bio-efficacy against a wide range of stored pests with no residual toxicity to the environment as compared to chemical pesticides (Kumari and Singh 1998). They also possess insecticidal as well as repellent properties with little or no mammalian toxicity and no effect on germinability and cooking quality of the treated seeds (Uma Reddy and Shoba Reddy 1987).

Apart from oils there are other several alternative insecticides which posses low mammalian toxicity and are eco-friendly. Spinosad, the only pesticide approved by United States Environmental Protection Agency for use as grain protectant against pests in January 2005 apart from pyrethrum, has great promise. It has low mammalian toxicity compared to other traditional insecticides (Thompson *et al.,* 2000) and a single application at 1mg (a.i.)/kg persisted on stored grain for 6-12 months with minimum loss in insecticidal activity (Fang *et al*., 2002, Flinn *et al*., 2004). Present investigation was conducted to investigate the insecticidal activity of vegetable oils and the efficacy of spinosad on *C. chinensis* L. which are alternative to chemical control methods.

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MATERIAL AND METHODS

For the management of *C. chinensis* in the stored pulses some of the eco-friendly management strategies comprising 7 treatments of which four are vegetable oils, the one safer insecticide, spinosad recommended by US-EPA for treatment of stored grains along with the check deltamethrin were tested as explained below.

Treatment	*Dosage*
T_1 (Soyabean oil)	3 ml/kg seed
T_2 (Sesamum oil)	3 ml/kg seed
T_3 (Eucalyptus oil)	3 ml/kg seed
T_4 (Karanj oil)	3 ml/kg seed
T_5 (Spinosad 45 SC)	4 ppm/kg seed
T_6 (Deltamethrin 2.8 EC)	0.04 ml/kg seed
T_7 (Untreated Control)	

For testing the efficacy of vegetable oils and insecticides, the pigeonpea seeds of local variety was thoroughly mixed with the oils/chemicals and 30 g of each treatment were placed in a glass vial (19 X 12.5 cm) and 5 pairs of freshly emerged bruchid adults were released in to each glass vial, closed with muslin cloth and tied with rubber bands.

The pigeonpea seeds without treatment served as the control. After 10 days, the adults were removed and the vials containing the treated grains were kept undisturbed in the incubator adjusted to a temperature of 28°C and 75% RH for the adult emergence. Three replications were maintained for each treatment. The performance of the treatments was assessed based on the fecundity, adult emergence, damaged per cent, weight loss of the seed, mortality per cent of the adults and germination test.

RESULTS AND DISCUSSION

The data recorded on the adult mortality of the pulse beetle by different grain protectants were presented in Table 1. The total mortality of adults recorded with different treatments showed the superior performance of spinosad and deltamethrin with 100% mortality followed by karanj oil (91.33). Eucalyptus oil which recorded 76.67% mortality was the next best treatment while soyabean oil (68.67%) and sesame oil (66.00) were found to be least effective. The adult mortality of *C. chinensis* in seeds treated with grain protectants clearly showed the superior performance of chemical treatments over vegetable oils. Among the oils karanj oil caused maximum mortality (82.67%) at 24 hours after treatment by recording a total mortality of 91.33% after 7 days of treatment indicating that chemical protectants were more toxic to the adults than the oils. These findings derive support from Patil *et al*., (1994) who found that deltamethrin (12.5 ppm) was the most effective treatment by recording high mortality. Sadat and Asghar (2006) also reported 75 to 100% mortality of adult pulse beetles in spinosad treated seeds. Huang *et al*., (2007) and Adel khashaveh *et al*., (2011) also observed the similar results.

The mean number of eggs laid by the bruchid ranged from 7.33 to 178.33 as against 353.33 recorded in untreated control. Lowest number of eggs were recorded in the seeds treated with deltamethrin 2.8 EC @ 0.04ml/kg seed (7.33), karanj oil @ 3ml/kg seed (14.33) and spinosad 45 SC @ 0.2ml/kg seed (28.67) and were on par and found to be superior over other treatments. Next best treatments were sesame oil and soybean oil @ 3ml/kg seed which recorded 69.33 and 118.33 eggs, respectively and were on par with each other. Eucalyptus oil treated seeds recorded 178.33 eggs which was highest among all other treatments followed by control (353.33). All the grain protectants used in present study significantly reduced the fecundity of *C. chinensis* than the control. The findings clearly showed that non-volatile oils and chemicals performed better than the volatile oil (Table 2).

No adult emergence was observed in deltamethrin, karanj oil and soybean oil treated seeds, while, the highest number of adults (38.40) were emerged from eucalyptus oil treated seeds. Sesame oil treatment which recorded only 0.30 per cent adult emergence was the next best treatment followed by spinosad in which 8.55 per cent adult emergence was recorded.

The seeds treated with deltamethrin, karanj oil and soyabean oil did not record any damaged seeds and were significantly superior over all the other treatments. Sesame oil (0.1) and spinosad (0.7) were also least damaged by the pest and were on par with each other. In case of eucalyptus oil treated seeds, 18.47% damaged seeds were recorded, however, it was less than the untreated control (74.67). The grain protectants used in the present study successfully reduced the fecundity, adult emergence of the test insect and subsequently reduced the weight of the treated seed. The chemical protectant deltamethrin was found highly effective in controlling the infestation by adversely affecting the fecundity and adult emergence. Among the oils, karanj oil was proved to be the most effective treatment by recording low fecundity and completely prevented adult

Table 1
Efficacy of grain protectants in pigeonpea against *C. chinensis* under laboratory conditions

Sl. No.	*Treatments*	*Concentration*	*Fecundity*	*Adult emergence (%)*	*Damaged grains (%)*	*Weight loss (%)*
01	Soyabean oil	3ml/kg seed	118.33	0	0	0.44
02	Sesamum oil	3ml/kg seed	69.33	0.30	0.10	0.5
03	Eucalyptus oil	3ml/kg seed	178.33	38.40	18.47	10.1
04	Karanj oil	3ml/kg seed	14.33	0	0	0.94
05	Spinosad 45 SC	4ppm/kg seed	28.67	8.55	0.7	1.24
06	Deltamethrin 2.8 EC	0.04ml/kg seed	7.33	0	0	0.49
07	Control		353.33	71.82	74.67	33.38
	SEm ±		16.393	2.332	2.205	0.641
	C.D (0.05)		49.73	7.07	6.69	1.94

Table 2
Effect of grain protectants on mortality of *C. chinensis* under laboratory conditions

Sl. No.	*Treatments*	*Concentration*	*Number of insects released*	*Mortality per cent (%)**			*Total % mortality after 7 days***
				After 24h	*After 48h*	*After 7 days*	
01	Soyabean oil	3ml/kg seed	50	44 (41.53)	9.33 (17.70)	15.33 (21.29)	68.67 (56.07)
02	Sesamum oil	3ml/kg seed	50	42.67 (40.76)	10.00 (18.19)	13.33 (19.50)	66.00 (54.50)
03	Eucalyptus oil	3ml/kg seed	50	34.67 (36.04)	20.67 (26.92)	21.33 (27.17)	76.67 (61.36)
04	Karanj oil	3ml/kg seed	50	82.67 (65.47)	1.33 (3.84)	7.33 (15.59)	91.33 (73.22)
05	Spinosad 45 SC	4ppm/kg seed	50	100 (90.00)	0 (0.0)	0 (0.0)	100 (90.00)
06	Deltamethrin 2.8 EC	0.04ml/kg seed	50	100 (90.00)	0 (0.0)	0 (0.0)	100 (90.00)
07	Control		50	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)
	S.Em ±			1.07	1.92	3.93	2.50
	C.D (0.05)			3.29	5.87	12.03	7.65

*Values in the parentheses are square root transformed values
** Values in the parentheses are angular transformed values

Table 3
Effect of grain protectants on germination of pigeonpea seeds

Treatment	*Shoot length (cm)*	*Root length (cm)*	*Germination(%)*	*Vigour index*
Soyabean oil	21.74	11.98	99.2	2155
Sesamum oil	24.82	16.84	97.6	2421.2
Eucalyptus oil	22.40	09.80	81.60	1829.2
Karanj oil	23.10	18.40	100	2320
Spinosad 45 SC	26.40	17.30	100	2640
Deltamethrin 2.8 EC	26.30	14.60	97.6	2577
control	27.30	19.42	100	2730
SEm±	1.94	1.47	0.98	186.9
CD	N.S	4.29	2.85	544.2

emergence and recorded no damaged grains. While the sesamum oil and soyabean oil treatments inspite of recorded more eggs compared to karanj oil were highly successful in preventing the adult emergence and resulted in less damage to the grains on par with karanj oil and sesamum oil and adversely affected the development of the insect inside the grain resulting in significantly lowest damage to the treated grains.

Spinosad treated seed inspite of recording eggs and adult emergence was successful in controlling the emerged adults and recorded less damaged grains (0.71). Patil *et al.,* (2001) and Huang *et al.,* (2007) reported that seeds treated with chemicals like spinosad and deltamethrin were least infested by *C. chinenis.* Biswas and Biswas (2005) reported least seed damage to pulses treated with different oils. Chowdhery (1992) also stated that pulses treated with vegetable oils recorded less seed damage by *C. chinensis*.

The lowest per cent weight loss was recorded in seeds treated with soybean oil (0.44) which was on par with deltamethrin (0.49), sesame oil (0.50), karanj oil (0.94) and spinosad (1.24) and they were found significantly superior. In eucalyptus oil treated seeds, 10.1 per cent weight loss was recorded. However, highest per cent weight loss was recorded in untreated control (33.38). The pigeonpea seeds treated with all grain protectants except eucalyptus oil were highly effective in adversely affecting development of the test insect in the treated seeds and reduced the infestation of the grain and recorded less weight loss. Eucalyptus oil which could not prevent the egg laying of the beetle recorded more adult emergence and subsequent high infestation and weight loss. The reports are in agreement with the findings of Patel *et al.*, (1994) and Biswas and Biswas (2005) who proved the effectiveness of deltamethrin against pulse beetle and subsequent infestation to the pulses.

The observations recorded on the germination of pigeonpea seed treated with different grain protectants were presented in Table 3. The lowest per cent germination was observed in eucalyptus oil treatment (81.60) as against 100 per cent in control. Karanj oil treatment and spinosad treatments recorded cent per cent germination and followed by soyabean oil (99.2), deltamethrin (97.6) and sesamum oil (97.6) treatments and were found to be on par with each other. The perusal of the data obtained on the effect of grain protectants on germination of pigeonpea seeds suggested that absolutely there was no negative effect of these grain protectants on the germination of the seeds. These findings are in accordance with the findings of earlier workers. Biswas and Biswas (2005) reported various plant based oils including karanj oil as very effective in reducing the adult emergence of *C. chinensis* without impairing the seed germination in gram. Sharanabasappa and Kulkarni (2008) also found no adverse effect of oils on germination of seeds at 60 and 120 days after treatment. Dikshit (2002) who worked on the stability and persistence of deltamethrin on various pulses also concluded that the insecticides did not affect the germination of treated pulse seed. Similar results were obtained by Patil *et al.*, (2006) where deltamethrin shown significantly higher germination than untreated control. From the above results it can be concluded that the vegetable oils *viz.*, soyabean, sesamum, eucalyptus and karanj oil and chemicals spinosad and deltamethrin were equally effective in preventing the egg laying, adult emergence of bruchid and subsequent seed infestation without affecting seed viability.

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