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Combined Effect of Neem and Inert Material with Grain Protectant Against Pulse Beetle, *Callosobruchus chinensis* L. in Stored Green Gram

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Abstract: Investigations were conducted on quantitative and qualitative losses caused by pulse beetle in stored green gram and also explore the possibility of using neem, inert materials and grain protectants in combination to protect the green gram grains. The seed damage, weight loss and germination loss in green gram caused by *Callosobruchus chinensis* after four months of storage were 100, 48.57 and 100%, respectively. The combination of deltamethrin (2.8 EC) at 20 mg m^{-2} + neem seed kernel powder (NSKP) at 15 g kg^{-1} seed treatment and malathion (50 EC) at 250 mg m^{-2} + NSKP at 15 g kg^{-1} seed gave 100% protection up to 12 months of storage. Whereas, deltamethrin at 20 mg m^{-2} + NSKP at 10 g kg^{-1} and malathion at 250 mg m^{-2} + NSKP at 10 g kg^{-1} seed provided full protection only up to six months. Green gram seeds treated with all doses of NSKP gave better protection over control and semi-control against the beetle. The weight loss after 12 months of storage was maximum in seeds treated with ash and minimum in seeds treated with NSKP 15 g kg^{-1} seed.

Key words: *Callosobruchus chinensis*, green gram, grain protectant, NSKP.

Pulses, being a vital source of protein, form the major constituent of diet for the masses in India, where the consumption of animal protein, except milk, is still considered a religious and social taboo. To meet protein requirement, it is not enough to boost the pulse production, but restrict losses due to pulse beetles during storage condition is also required. In India, about 8.5% losses have been reported in post-harvest handling of pulses (FAO, 1977; Agarwal *et al.*, 1988). Effort should be made to reduce the storage losses through safe and eco-friendly techniques such as cultural, physical, varietal, bio-rational, biological, etc. Various plant powders *viz.*, black pepper, neem seed kernel powder, turmeric, adhatoda, etc. and their suspensions possess insecticidal activity against bruchids (Mathur *et al.*, 1985; Sowunmi and Akinnusi, 1983; George, 1990) and persistent toxicity of malathion (25 WP), chlorpyriphos methyl (50 EC) and deltamethrin (25 flow) were evaluated on different storage surfaces by Yadav and Singh (1994). Considering the storage problem of pulses, the present studies were carried out to determine the qualitative and quantitative losses caused by *C. chinensis* and also explore the possibility of using neem, inert materials and grain protectants in combination to protect the green gram seeds against pulse beetle.

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Materials and Methods

Maintenance of insect culture

The culture of pulse beetle, *C. chinensis*, was reared on green gram [*Phaseolus radiata* (L.)] in glass jars at 28±2°C and 65±10% relative humidity for continuous supply of fresh adults of uniform age for experimentation at Department of Entomology, Rajasthan College of Agriculture, Udaipur. The distinguished features of male and female *C. chinensis* were identified according to Pandey and Singh (1997).

Quantitative and qualitative losses

To study the quantitative (seed damage and weight loss) and qualitative (germination loss) losses, four sets of jars in four replications having 500 g disinfected seed in each. were prepared and covered with lid having 0.75 mm perforations. Five pairs of 0 to 24 hr-old-adults of *C. chinensis* were released in each plastic jar. A set of four jars was taken out after 30, 60, 90 and 120 days to record weight loss, seed damage and germination losses caused by bruchid in stored green gram. Weight loss was determined gravimetrically, while seeds having hole were counted to record seed damage. To record germination loss seeds were kept in petri plates and number of ungerminated seeds was counted after six days

Management strategies for C. chinensis in stored green gram

Jute bags (6" x 12") sprayed with deltamethrin 2.8 EC at 20 mg m^{-2} and malathion 50 EC at 250 mg m^{-2}, were filled with two kg green gram seed treated with three doses of neem seed kernel powder (NSKP) at 5 g, 10 g and 15 g kg^{-1} seed, clay dust 10 g kg^{-1} seed and ash 10 g kg^{-1} seed in three replications. A control where both bags and grains were not treated and 2 semi-control where untreated grains were kept in bags treated with each insecticide were maintained. Five pairs of newly emerged adults (male and female) were released inside each jute bag and kept for twelve months in natural conditions i.e. there was no bar on pulse beetle to move out and inside the jute bags. The observations on weight loss and seed damage were recorded after 3, 6, 9 and 12 months of storage. The data were subjected to analysis of variance in a completely randomized design using Windostat 7.1.

Results and Discussion

The stored pests cause losses through feeding and destroying the stored grains. The loss in weight is caused by the grubs of the beetle feeding inside the pulse grains. Initially 4.4% weight loss was recorded after 30 days of storage. However, due to rapid multiplication of the pulse beetle population in next 120 days, the loss reached 48.6%. Earlier Doharey *et al.* (1987) also reported 0.6, 16.7, 25.6 and 43.3% weight losses after 30, 60, 90 and 120 days of storage, respectively, due to *C. chinensis*. Braich and Simwat (1984) also reported weight losses due to *C. chinensis* from 1.7 to 21.5% after one to six months of storage. Satyavir (1989) also reported weight loss of 24.2 to 58.2% in moth bean and 18.0 to 38.5% in cowpea seeds due to pulse beetle after six months of storage.

The initial damage after one month was low i.e., 7.6%, whereas after second month the seed damage increased abruptly to 56.3% due to fast population build up of pulse beetle (Table 1). The increase in damage thereafter was relatively slow, reaching 100% loss after 4 months. The extent of damage to the seed was dependent on the population of the pulse beetle in green gram. Doharey *et al.* (1987) also observed a similar trend in seed loss by *C. chinensis* with an initial loss of 1.4%, gradually increasing to 99.9% after 120 days of storage. Seed damage of 31.7 to 81.7% in moth bean and 35.0 to 68.9% in cowpea caused by pulse beetle after six months of storage was observed by Satyavir (1989).

The increase in insect population had an adverse effect on germination and was reciprocal to the population build up of the pulse beetle. The initial germination loss was 27.3% in green gram after one month of storage and increased to 79.2% after 60 days. After 120 days of storage germination loss was 100%. Similarly, Doharey *et al.* (1987) observed 5.0, 26.0, 98.0 and 100% loss in germination due to *C. chinensis* in green gram after 30, 60, 90 and 120 days of storage, respectively. From these findings we can conclude that a period of four months is sufficient for *C. chinensis* to cause 100% damage in infested green gram seeds stored under natural conditions.

Management strategy for safe storage of green gram

Persistent toxicity of insecticides varies against different stored pests (Srivastava *et al.*, 2003) and storage surfaces (Yadav and Singh, 1994). The results

Table 1. Effect of the pulse beetle infestation under different storage periods on seed damage, weight loss and germination loss in stored green gram

Storage period (days)	% seed damage*	% weight loss*	% germination loss*
30	7.61	4.37	27.29
	(16.01)	(12.07)	(31.49)
60	56.26	15.11	79.16
	(48.59)	(22.88)	(62.84)
90	92.60	43.50	94.40
	(74.29)	(41.26)	(76.32)
120	100.00	48.57	100.0
	(90.0)	(44.18)	(90.0)
SEm ±	0.49	0.43	0.50
CD at 5%	1.52	1.32	1.55

*Mean of four replications; Figures in parentheses are arc sine value.

indicated that the treatments deltamethrin 2.8 EC at 20 mg m^{-2} + neem seed kernel powder (NSKP) at 5, 10 and 15 g kg^{-1} seed and malathion 50 EC at 250 mg m^{-2} + NSKP at 10 and 15 g kg^{-1} seed were found highly effective and protected seeds against *C. chinensis* up to six months of storage, where mean seed damage was 0.66% as against 44.33% in control and after nine months of storage, it was 5.66% against 61.0% in control. Deltamethrin 2.8 EC at 20 mg m^{-2} + NSKP at 15 g kg^{-1} seed and malathion 50 EC at 250 mg m^{-2} + NSKP at 15 g kg^{-1} seed gave complete protection up to twelve months of storage as compared to 70.66% seed damage in control. In semi-control, deltamethrin 2.8 EC at 20 mg m^{-2} and malathion 50 EC at 250 mg m^{-2} treated jute bags, seed damage was 57.66 and 62.33%, respectively (Table 2).

With regard to seed weight loss deltamethrin 2.8 EC at 20 mg m^{-2} + NSKP at 5, 10 and 15 g kg^{-1} seed and malathion 50 EC at 250 mg m^{-2} + NSKP at 10 and 15 g kg^{-1} seed recorded minimum loss that ranged from 0.50 to 4.51%, as compared to control (16.64%) after six months of storage. Among the treatments, deltamethrin 2.8 EC at 20 mg m^{-2} + NSKP at 15 g kg^{-1} seed and malathion 50 EC at 250 mg m^{-2} + NSKP at 15 g kg^{-1} seed registered 2.56 and 3.62% and 4.28 and 4.51% weight loss after nine and twelve months of storage, respectively, as against 23.60 and 34.55% in control.

Malathion at 100 mg m^{-2} persisted up to 110 days on jute surface against *Callosobruchus maculatus* (Yadav and Singh, 1994). Persistent toxicity is dependent upon factors viz., temperature, humidity, pH, surface activity, area of treated surface, volatility of insecticide dosages, formulation and biological behavior of insect. Reddy and Srivastava (2003) also found EC formulation of deltamethrin to persist longer at 30, 50, 70 and 100 mg m^{-2} against MR strain of *Tribolium castaneum* on jute surface. NSKP was found effective against *C. chinensis* in stored black gram (Mathur *et al.*, 1985) and *Callosobruchus*

Table 2. Cumulative effect of neem, inert materials and grain protectant against pulse beetle in stored green gram during the year

Treatments	Per cent seed damage				Per cent weight loss			
	3 m	6 m	9 m	12 m	3 m	6 m	9 m	12 m
Malathion 50 EC at 250 mg m^{-2} + NSKP at 5 g kg^{-1}	1.66 (7.38)	4.66 (12.45)	9.33 (17.75)	14.33 (22.23)	0.56 (4.29)	5.49 (13.53)	9.58 (18.02)	12.80 (20.94)
Malathion 50 EC at 250 mg m^{-2} + NSKP at 10 g kg^{-1}	0.0 (4.05)	0.0 (4.05)	3.33 (10.47)	11.00 (19.34)	0.0 (4.05)	2.39 (8.87)	8.83 (17.26)	10.63 (19.01)
Malathion 50 EC at 250 mg m^{-2} + NSKP at 15 g kg^{-1}	0.0 (4.05)	0.0 (4.05)	0.0 (4.05)	0.66 (4.65)	0.0 (4.05)	2.05 (8.22)	3.62 (10.93)	4.51 (12.24)
Malathion 50 EC at 250 mg m^{-2} + Clay dust 10 g kg^{-1}	12.33 (20.51)	32.33 (34.65)	38.33 (38.24)	47.00 (43.27)	2.01 (8.14)	10.52 (18.91)	12.08 (20.30)	17.35 (24.61)
Malathion 50 EC at 250 mg m^{-2} + Cow dung ash 10 g kg^{-1}	13.33 (21.40)	33.33 (35.26)	38.66 (38.44)	49.00 (44.43)	3.43 (10.64)	11.33 (19.64)	14.59 (22.44)	18.50 (25.47)
Deltamethrin 2.8 EC at 20 mg m^{-2} + NSKP at 15 g kg^{-1}	0.0 (4.05)	0.0 (4.05)	0.33 (4.05)	0.33 (4.05)	0.0 (4.05)	0.50 (4.19)	2.56 (9.17)	4.28 (11.91)
Deltamethrin 2.8 EC at 20 mg m^{-2} + Clay dust at 10 g kg^{-1}	11.33 (19.65)	32.00 (34.44)	35.33 (36.46)	39.00 (38.64)	3.62 (10.95)	7.53 (15.91)	11.55 (19.85)	13.67 (21.69)
Deltamethrin 2.8 EC at 20 mg m^{-2} + Cow dung ash at 10 g kg^{-1}	14.66 (22.51)	33.33 (35.06)	40.00 (39.23)	50.66 (45.37)	4.80 (12.64)	8.56 (17.00)	13.60 (21.63)	18.30 (25.32)
Semi-control= deltamethrin 2.8 EC at 20 mg m^{-2}	19.66 (26.31)	34.66 (36.06)	41.00 (39.80)	57.66 (49.40)	4.71 (12.53)	11.07 (19.42)	18.85 (25.72)	20.80 (27.13)
Semi-control= malathion 50 EC at 250 mg m^{-2}	21.33 (27.48)	37.00 (37.45)	52.33 (46.33)	62.33 (52.14)	5.64 (13.72)	12.10 (20.35)	19.50 (26.20)	24.50 (29.66)
Control	22.33 (28.19)	44.33 (41.74)	61.00 (51.36)	70.66 (57.20)	7.84 (16.25)	16.64 (24.07)	23.60 (29.06)	34.55 (35.99)
SEm ±	0.48	0.41	0.75	0.60	0.27	0.49	0.57	0.51
CD at 5%	1.40	1.19	2.18	1.74	0.79	1.41	1.65	1.49
CV%	5.63	3.22	4.84	3.28	5.58	5.80	5.03	3.98

Figures in parentheses are arc sine value; m: months after release.

maculatus in stored cowpea (Sowunmi and Akinnusi, 1983). George (1990) found 10% NSKP to be more effective against *Callosobruchus analis* as compared to neem leaf powder in stored pulses, where as Sundria *et al.* (2002) found that green gram seed treated with NSKP at 20 g kg^{-1} had only 9.86% seed damage after three months of storage. These findings suggested that green gram seed may be stored up to twelve months in jute bags treated with deltamethrin 2.8 EC at 20 mg m^{-2} and seed treated with NSKP at 15 g kg^{-1} seed.

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