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INTEGRATED APPROACH FOR MANAGEMENT OF PULSE BEETLE (*CALLOSOBRUCHUS* SP.) IN GREEN GRAM

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ABSTRACT

In the present study, it was observed that pulse beetle damage after 9 months of storage exceeded 1.0%, the threshold set by the Indian Minimum Seed Certification Standards (IMSCS), in both T_6-pre-harvest spray of emamectin benzoate 5SG at 0.3 g/L applied at 50% maturity and full maturity of green gram, followed by seed treatment with diatomaceous earth at 5 g/kg seed and desiccant ($MgSO_4$ at 5 g/kg seed) and T_3-pre-harvest spray of azadirachtin 10,000 ppm at 6 ml/L at 50% maturity and full maturity of green gram, also followed by seed treatment with diatomaceous earth and $MgSO_4$ desiccant at the same rates. Moreover, germination rates were above the IMSCS threshold of 75.00% in both these treatments.

However, after 6 months of storage, pulse beetle damage remained below the IMSCS threshold of 1.0% in T_3 (1.00%) and T_6 (0.75%), with germination rates continuing above 75.00%. Given the significance of managing pulse beetle damage, a 6-month storage period under ambient conditions appears feasible for green gram when pre-harvest spraying and seed treatments are applied.

Key words : Green gram, Pulse beetle, Pre-harvest spray, Seed treatment, Storage period, Germination, Net realization.

Introduction

Green gram is one of the important pulse crops in India. It is quite versatile crop grown for seeds, green manure and forage and it is also considered as “Golden Bean” because of its nutritive values and suitability for increasing the soil fertility by the way of addition of nitrogen to the soil. Among several insect pests, pulse beetle or bruchids (*Callosobruchus chinensis*) is a serious storage pest, which causes major losses in green gram seed as it lays eggs on seeds in field itself even before harvest and becomes a serious pest during storage. Levels of infestation may be high (Raghu *et al*., 2016). Azadirachtin is both an anti-ovipositant and insecticide (larvicide and adulticide). Neem oil and other extracts or neem derivatives may be applied directly to seeds, where volatiles also have a fumigant effect (Chiranjeevi and Sudhakar, 1996). Solar heating of seeds in transparent polyethylene bags was found to effectively control bruchid damage in pigeon pea seeds (Chauhan and Ghaffar, 2002). Pulse beetle infestation can be prevented in stored green gram seeds by giving pre harvest sprays in the field (Patoliya *et al*., 2020). Hence, the present study was proposed to evaluate various combination treatments against major storage insect-pests damaging green gram seeds.

Materials and Methods

For pre harvest spraying, green gram crop was grown with standard package of practices in the field. All the agronomical package of practices was followed. For the treatment number one to six, two sprays of indicated insecticides at respective dose were done at 50% maturity and maturity of green gram. Whereas, for the treatment number seven to nine, there was no spray. Harvesting of the experimental seeds was done by leaving border rows. After threshing, 1.0 kg seeds of respective treatment were kept in cloth bags of 2.0 kg capacity fastening with the tight labels for ensuring protection from cross infestation during storage. For solarization treatments (T_1, T_4, T_7 &

Table 1 : Effect of insecticidal seed treatment on seed damage in green gram during storage at 3 months storage period.

No.	Treatments	Green gram seed damage % at 3 months		
		2021-22	2022-23	Pooled
1	T_1	5.48^{b} (0.92)	6.19^{bc} (1.17)	**5.84^{b} (1.05)**
2	T_2	5.23^{bc} (0.83)	5.97^{bc} (1.08)	**5.60^{b} (0.96)**
3	T_3	4.36^{cd} (0.58)	4.62^{cd} (0.67)	**4.49^{cd} (0.63)**
4	T_4	5.48^{b} (0.92)	6.19^{bc} (1.17)	**5.84^{b} (1.05)**
5	T_5	5.48^{b} (0.92)	6.42^{b} (1.25)	**5.95^{b} (1.09)**
6	T_6	3.66^{d} (0.42)	3.96^{d} (0.50)	**3.81^{d} (0.46)**
7	T_7	5.74^{b} (1.00)	5.94^{bc} (1.08)	**5.84^{b} (1.04)**
8	T_8	5.48^{b} (0.92)	5.18^{bcd} (0.83)	**5.33^{bc} (0.88)**
9	T_9	12.11^{a} (4.42)	12.98^{a} (5.08)	**12.54^{a} (4.75)**
T	**S.Em ±**	0.31	0.48	**0.29**
	C.D. at 5%	0.91	1.44	**0.82**
Y	**S.Em ±**	-	-	**0.13**
	C.D. at 5%	-	-	**0.39**
YXT	**S.Em ±**	-	-	**0.40**
	C.D. at 5%	-	-	**NS**
	C.V.%	-	-	**11.43**

N.B.: Figures in parenthesis are original values, while outsides are arcsine transformed values. Treatment means with the letter (s) in common are at par as per DNMRT at 5% level of significance.

T_8), clear polyethylene (700 gauge, 30X20 cm) packets of 2 kg capacity were taken. Solarization was done around noon (11.00 to 15.00 hrs) for 4 hrs for 6 days. During solarization, thickness of seed layer inside seed packet was kept at 5 cm. After giving the seed treatments (azadirachtin 10000 ppm 7.5 ml/kg, diatomaceous earth & $MgSO_4$ each at 5g/ kg seed), the seed was kept under ambient conditions in poly lined gunny bag of 2.0 kg capacity for 12 months.

Results and Discussion

Seed damage : The data presented in Table 1 indicate that, at the 3-month storage period, results were statistically significant during 2021-22, 2022-23 and in the pooled analysis. In the pooled data, T_6 recorded the least green gram seed damage (0.42%), which was on par with T_3 (0.58%). In contrast, the untreated control (T_9) recorded 4.42% damage. Similarly, at the 6-month storage period (Table 2), results were significant for both years and in the pooled data. The pooled data over two years revealed that T_6 showed the least green gram seed damage (0.75%), comparable to T_3 (1.0%), while T_9 (untreated control) showed 27.92% damage. At the 9-month storage period, pooled data (Table-3) show that T_6 had the lowest seed damage (5.67%), comparable to T_3 (6.00%), whereas the untreated control (T_9) recorded 63.33% damage. At the 12-month storage period (Table 4), T_3 recorded the lowest pulse beetle damage at 9.84%,

Table 2 : Effect of insecticidal seed treatment on seed damage in green gram during storage at 6 months storage period.

No.	Treatments	Green gram seed damage % at 6 months		
		2021-22	2022-23	Pooled
1	T_1	15.66^{b} (7.33)	14.87^{b} (6.67)	**15.26^{b} (7.00)**
2	T_2	14.95^{b} (6.67)	13.22^{b} (5.25)	**14.08^{b} (5.96)**
3	T_3	5.74^{d} (1.00)	5.71^{d} (1.00)	**5.72^{fg} (1.00)**
4	T_4	11.02^{c} (3.67)	10.64^{c} (3.42)	**10.83^{c} (3.55)**
5	T_5	10.50^{c} (3.33)	8.77^{c} (2.33)	**9.64^{cd} (2.83)**
6	T_6	4.29^{d} (0.67)	5.23^{d} (0.83)	**4.76^{g} (0.75)**
7	T_7	9.36^{c} (2.67)	8.41^{c} (2.17)	**8.88^{de} (2.42)**
8	T_8	8.74^{c} (2.33)	5.71^{d} (1.00)	**7.23^{ef} (1.67)**
9	T_9	33.17^{a} (30.00)	30.52^{a} (25.83)	**31.84^{a} (27.92)**
T	**S.Em ±**	0.90	0.71	**0.57**
	C.D. at 5%	2.67	2.11	**1.64**
Y	**S.Em ±**	-	-	**0.27**
	C.D. at 5%	-	-	**0.77**
YXT	**S.Em ±**	-	-	**0.81**
	C.D. at 5%	-	-	**NS**
	C.V.%	-	-	**11.66**

N.B.: Figures in parenthesis are original values, while outsides are arcsine transformed values. Treatment means with the letter (s) in common are at par as per DNMRT at 5% level of significance.

Table 3 : Effect of insecticidal seed treatment on seed damage in green gram during storage at 9 months storage period.

No.	Treatments	Green gram seed damage % at 9 months		
		2021-22	2022-23	Pooled
1	T_1	24.57 [b] (17.33)	25.83 [b] (19.00)	**25.20 [b] (18.17)**
2	T_2	22.47 [bc] (14.67)	21.68 [c] (13.67)	**22.07 [c] (14.17)**
3	T_3	14.15 [e] (6.00)	13.96 [e] (5.83)	**14.05 [e] (5.92)**
4	T_4	19.33 [d] (11.00)	20.69 [cd] (12.50)	**20.01 [d] (11.75)**
5	T_5	18.68 [d] (10.33)	18.41 [d] (10.00)	**18.55 [d] (910.17)**
6	T_6	13.73 [e] (5.67)	12.85 [e] (5.00)	**13.29 [e] (5.34)**
7	T_7	19.97 [cd] (911.67)	18.96 [d] (10.67)	**19.46 [d] (911.17)**
8	T_8	19.65 [cd] (11.33)	18.41 [d] (10.00)	**19.03 [d] (10.67)**
9	T_9	52.74 [a] (63.33)	54.49 [a] (66.25)	**53.62 [a] (64.79)**
T	**S.Em ±**	0.93	0.84	**0.63**
	C.D. at 5%	2.77	2.51	**1.81**
Y	**S.Em ±**	-	-	**0.30**
	C.D. at 5%	-	-	**NS**
YXT	**S.Em ±**	-	-	**0.89**
	C.D. at 5%	-	-	**NS**
	C.V.%	-	-	**6.75**

N.B.: Figures in parenthesis are original values, while outsides are arcsine transformed values. Treatment means with the letter (s) in common are at par as per DNMRT at 5% level of significance.

Table 4 : Effect of insecticidal seed treatment on seed damage in green gram during storage at 12 months storage period.

No.	Treatments	Green gram seed damage % at 9 months		
		2021-22	2022-23	Pooled
1	T_1	31.64 [b] (27.67)	31.62 [b] (27.50)	**31.63 [b] (27.59)**
2	T_2	29.93 [bc] (25.00)	30.54 [b] (25.83)	**30.23 [b] (25.42)**
3	T_3	18.38 [e] (10.00)	19.21 [d] (10.83)	**18.79 [d] (10.42)**
4	T_4	25.31 [d] (18.33)	25.63 [c] (18.75)	**25.47 [c] (18.54)**
5	T_5	24.55 [d] (917.33)	24.40 [c] (17.08)	**24.47 [c] (17.21)**
6	T_6	18.05 [e] (9.67)	18.41 [d] (10.00)	**18.23 [d] (9.84)**
7	T_7	26.56 [cd] (20.00)	26.74 [c] (20.25)	**26.65 [c] (20.13)**
8	T_8	25.77 [cd] (19.00)	27.12 [c] (20.83)	**26.44 [c] (19.92)**
9	T_9	82.67 [a] (98.33)	81.11 [a] (97.50)	**81.89 [a] (97.92)**
T	**S.Em ±**	1.43	0.86	**0.83**
	C.D. at 5%	4.25	2.54	**2.39**
Y	**S.Em ±**	-	-	**0.39**
	C.D. at 5%	-	-	**NS**
YXT	**S.Em ±**	-	-	**1.18**
	C.D. at 5%	-	-	**NS**
	C.V.%	-	-	**6.48**

N.B.: Figures in parenthesis are original values, while outsides are arcsine transformed values. Treatment means with the letter (s) in common are at par as per DNMRT at 5% level of significance.

closely followed by T_6 at 10.42%, while the untreated control (T_9) showed 97.92% damage.

Pulse beetle (*Callosobruchus* sp) adult population

At 3 months storage period (Table 5) the results were found significant during 2021-22 and 2022-23 and pooled. In case of pooled data T_6 recorded lowest pulse beetle population (8.50 pulse beetle adults/100g green gram seeds) and it was at par with T_3 (10.17 pulse beetle adults/

Table 5 : Effect of insecticidal seed treatment on adult population of Pulse beetle, *Callosobruchus* in gram seeds during storage at 3 months storage period.

No.	Treatments	Pulse beetle, *Callosobruchus* population/100g green gram seeds at 3 months		
		2021-22	2022-23	Pooled
1	T_1	4.81 [b] (22.67)	4.26 [b] (17.67)	**4.53 [b] (20.17)**
2	T_2	4.52 [bc] (20.00)	3.93 [b] (15.00)	**4.23 [bc] (17.50)**
3	T_3	3.62 [de] (12.67)	2.83 [d] (7.67)	**3.23 ef (10.17)**
4	T_4	4.22 [bcd] (17.33)	3.57 [bc] (12.33)	**3.89 [cd] (14.83)**
5	T_5	4.60 [b] (20.67)	4.02 [b] (15.67)	**4.31 [bc] (18.17)**
6	T_6	3.39 [e] (11.00)	2.54 [d] (6.00)	**2.97 [f] (8.50)**
7	T_7	4.24 [bcd] (17.67)	3.60 [bc] (12.67)	**3.92 [cd] (15.17)**
8	T_8	3.89 [cde] (14.67)	3.18 [cd] (9.67)	**3.54 [de] (12.17)**
9	T_9	8.08 [a] (65.00)	7.76 [a] (60.00)	**7.92 [a] (62.50)**
T	**S.Em ±**	0.20	0.22	**0.15**
	C.D. at 5%	0.58	0.67	**0.43**
Y	**S.Em ±**	-	-	**0.07**
	C.D. at 5%	-	-	**0.20**
YXT	**S.Em ±**	-	-	**0.21**
	C.D. at 5%	-	-	**NS**
	C.V.%	-	-	**8.52**

Figures in parenthesis are original values, while outsides are square root √X+0.5 transformed values. Treatment means with the letter (s) in common are at par as per DNMRT at 5% level of significance.

Table 6 : Effect of insecticidal seed treatment on adult population of Pulse beetle, *Callosobruchus* in gram seeds during storage at 6 months storage period.

No.	Treatments	Pulse beetle, *Callosobruchus* population/100g green gram seeds at 6 months		
		2021-22	2022-23	Pooled
1	T_1	9.51 [b] (90.00)	9.68 [b] (93.33)	**9.60 [b] (91.67)**
2	T_2	9.76 [b] (95.00)	10.02 [b] (100.00)	**9.89 [b] (97.50)**
3	T_3	3.89 [e] (14.67)	4.36 [e] (18.67)	**4.13 [e] (16.67)**
4	T_4	7.17 [c] (51.00)	7.44 [c] (55.00)	**7.31 [c] (53.00)**
5	T_5	6.94 [c] (47.67)	6.85 [c] (46.67)	**6.89 [c] (47.17)**
6	T_6	3.66 [e] (13.00)	3.84 [e] (14.33)	**3.75 [e] (13.67)**
7	T_7	7.11 [c] (50.33)	7.44 [c] (55.00)	**7.28 [c] (52.67)**
8	T_8	5.80 [d] (33.33)	5.95 [d] (35.00)	**5.87 [d] (34.17)**
9	T_9	13.28 [a] (176.67)	13.18 [a] (173.33)	**13.23 [a] (175.00)**
T	**S.Em ±**	0.31	0.22	**0.19**
	C.D. at 5%	0.93	0.66	**0.55**
Y	**S.Em ±**	-	-	**0.09**
	C.D. at 5%	-	-	**NS**
YXT	**S.Em ±**	-	-	**0.27**
	C.D. at 5%	-	-	**NS**
	C.V.%	-	-	**6.22**

Figures in parenthesis are original values, while outsides are square root √X+0.5 transformed values. Treatment means with the letter (s) in common are at par as per DNMRT at 5% level of significance.

100g green gram seeds). Whereas, in case of T_9-untreated control 62.50 pulse beetle adults/100g green gram seeds were recorded. At 6 months storage period in case of pooled data (Table 6) again the results were found significant and the lowest adult population was recorded in T_6 (13.67 pulse beetle adults/100g green gram seeds)

Table 7 : Effect of insecticidal seed treatment on adult population of Pulse beetle, *Callosobruchus* in gram seeds during storage at 9 months storage period.

No.	Treatments	Pulse beetle, *Callosobruchus* population/100g green gram seeds at 9 months		
		2021-22	2022-23	Pooled
1	T_1	12.67 [b] (160.00)	12.80 [b] (163.33)	**12.73 [b] (161.67)**
2	T_2	11.99 [b] (143.33)	12.13 [b] (146.67)	**12.06 [b] (145.00)**
3	T_3	8.19 [de] (66.67)	7.66 [d] (58.33)	**7.92 [d] (62.50)**
4	T_4	9.77 [cd] (95.00)	9.67 [c] (93.33)	**9.72 [c] (94.17)**
5	T_5	10.10 [c] (101.67)	10.34 [c] (106.67)	**10.22 [c] (104.17)**
6	T_6	7.43 [e] (55.00)	7.10 [d] (50.00)	**7.26 [d] (52.50)**
7	T_7	11.39 [bc] (130.00)	11.85 [b] (140.00)	**11.62 [b] (135.00)**
8	T_8	10.17 [c] (103.33)	10.42 [c] (108.33)	**10.30 [c] (105.83)**
9	T_9	22.88 [a] (526.67)	23.45 [a] (550.00)	**23.16 [a] (538.34)**
T	**S.Em ±**	0.57	0.32	**0.33**
	C.D. at 5%	1.70	0.95	**0.94**
Y	**S.Em ±**	-	-	**0.15**
	C.D. at 5%	-	-	**NS**
YXT	**S.Em ±**	-	-	**0.46**
	C.D. at 5%	-	-	**NS**
	C.V.%	-	-	**6.87**

Figures in parenthesis are original values, while outsides are square root √X+0.5 transformed values. Treatment means with the letter (s) in common are at par as per DNMRT at 5% level of significance.

Table 8 : Effect of insecticidal seed treatment on adult population of Pulse beetle, *Callosobruchus* in gram seeds during storage at 12 months storage period.

No.	Treatments	Pulse beetle, *Callosobruchus* population/100g green gram seeds at 9 months		
		2021-22	2022-23	Pooled
1	T_1	16.69 [b] (278.33)	17.48 [b] (305.00)	**17.08 [b] (291.67)**
2	T_2	15.61 [bc] (243.33)	15.98 [c] (255.00)	**15.80 [c] (249.17)**
3	T_3	9.65 [e] (93.33)	9.94 [g] (98.33)	**9.79 [f] (95.83)**
4	T_4	13.36 [d] (178.33)	13.62 [e] (185.00)	**13.49 [de] (181.67)**
5	T_5	13.12 [d] (171.67)	12.86 [f] (165.00)	**12.99 [e] (168.34)**
6	T_6	9.06 [e] (81.67)	9.34 [g] (86.67)	**9.20 [f] (84.17)**
7	T_7	14.27 [cd] (203.33)	14.44 [d] (208.33)	**14.36 [d] (205.83)**
8	T_8	13.92 [d] (193.33)	13.74 [e] (188.33)	**13.83 [de] (190.83)**
9	T_9	29.21 [a] (855.00)	29.78 [a] (886.67)	**29.50 [a] (870.84)**
T	**S.Em ±**	0.48	0.19	**0.26**
	C.D. at 5%	1.42	0.56	**0.74**
Y	**S.Em ±**	-	-	**0.12**
	C.D. at 5%	-	-	**NS**
YXT	**S.Em ±**	-	-	**0.36**
	C.D. at 5%	-	-	**NS**
	C.V.%	-	-	**4.16**

Figures in parenthesis are original values, while outsides are square root √X+0.5 transformed values. Treatment means with the letter (s) in common are at par as per DNMRT at 5% level of significance.

and it was at par with T_3 (16.67 pulse beetle adults/100g green gram seeds). Whereas, in case of T_9-untreated control 175.00 pulse beetle adults/100g green gram seeds were recorded. At 9 months storage period (Table 7), during 2021-22, 2022-23 and pooled the results were found significant and T_6 recorded the lowest adult population

Table 9 : Effect of insecticidal seed treatment on germination in green gram during storage at 3 months storage period.

No.	Treatments	Germination % at 3 months		
		2021-22	2022-23	Pooled
1	T_1	79.50 [b] (96.67)	80.64 [c] (97.33)	**80.07 [c] (97.00)**
2	T_2	79.50 [b] (96.67)	81.87 [abc] (98.00)	**80.69 [bc] (97.34)**
3	T_3	80.64 [ab] (97.33)	82.67 [ab] (98.33)	**81.65 [ab] (97.83)**
4	T_4	79.50 [b] (96.67)	81.87 [abc] (98.00)	**80.69 [bc] (97.34)**
5	T_5	79.50 [b] (96.67)	81.26 [bc] (97.67)	**80.38 [bc] (97.17)**
6	T_6	81.87 [a] (98.00)	83.46 [a] (98.67)	**82.67 [a] (98.34)**
7	T_7	79.50 [b] (96.67)	81.87 [abc] (98.00)	**80.69 [bc] (97.34)**
8	T_8	80.64 [ab] (97.33)	82.67 [ab] (98.33)	**81.65 [ab] (97.83)**
9	T_9	72.56 [c] (91.00)	76.24 [d] (94.33)	**74.40 [d] (92.67)**
T	**S.Em ±**	0.52	0.56	**0.38**
	C.D. at 5%	1.55	1.67	**1.10**
Y	**S.Em ±**	-	-	**0.18**
	C.D. at 5%	-	-	**0.52**
YXT	**S.Em ±**	-	-	**0.54**
	C.D. at 5%	-	-	**NS**
	C.V.%	-	-	**1.17**

N.B.: Figures in parenthesis are original values, while outsides are arcsine transformed values. Treatment means with the letter (s) in common are at par as per DNMRT at 5% level of significance.

Table 10 : Effect of insecticidal seed treatment on germination in green gram during storage at 6 months storage period.

No.	Treatments	Germination % at 6 months storage period		
		2021-22	2022-23	Pooled
1	T_1	72.22 [d] (90.67)	73.93 [b] (92.33)	**73.07 [b] (91.50)**
2	T_2	72.88 [d] (91.33)	74.66 [b] (93.00)	**73.77 [b] (92.17)**
3	T_3	77.08 [ab] (95.00)	78.98 [a] (96.33)	**78.03 [a] (95.67)**
4	T_4	73.98 [cd] (92.33)	74.66 [b] (93.00)	**74.32 [b] (92.67)**
5	T_5	74.76 [bcd] (93.00)	74.30 [b] (92.67)	**74.53 [b] (92.84)**
6	T_6	78.52 [a] (96.00)	79.50 [a] (96.67)	**79.01 [a] (96.34)**
7	T_7	74.32 [bcd] (92.67)	74.66 [b] (93.00)	**74.49 [b] (92.84)**
8	T_8	76.31 [abc] (94.33)	78.98 [a] (96.33)	**77.65 [a] (95.33)**
9	T_9	60.26 [e] (75.33)	64.16 [c] (81.00)	**62.21 [c] (78.17)**
T	**S.Em ±**	0.90	0.37	**0.49**
	C.D. at 5%	2.67	1.11	**1.40**
Y	**S.Em ±**	-	-	**0.23**
	C.D. at 5%	-	-	**0.66**
YXT	**S.Em ±**	-	-	**0.69**
	C.D. at 5%	-	-	**NS**
	C.V.%	-	-	**1.61**

N.B.: Figures in parenthesis are original values, while outsides are arcsine transformed values. Treatment means with the letter (s) in common are at par as per DNMRT at 5% level of significance.

(52.50 pulse beetle adults/100g green gram seeds) and it was at par with T_3 (62.50 pulse beetle adults/100g green gram seeds) in pooled data. Whereas, it was 538.34 pulse beetle adults/100g green gram seeds were recorded in T_9-untreated control. At 12 months storage period (Table-8) the trend was observed same in pooled data and T_6 recorded the lowest adult population (84.17 pulse beetle adults/100g green gram seeds) and it was at par with T_3

Table 11 : Effect of insecticidal seed treatment on germination in green gram during storage at 9 months storage period.

No.	Treatments	Germination % at 6 months storage period		
		2021-22	2022-23	Pooled
1	T_1	64.16 ^{c} (81.00)	65.15 ^{c} (82.33)	**64.66 ^{c} (81.67)**
2	T_2	65.66 ^{c} (83.00)	65.40 ^{c} (82.67)	**65.53 ^{c} (82.84)**
3	T_3	70.94 ^{ab} (89.33)	73.23 ^{a} (91.67)	**72.08 ^{a} (90.50)**
4	T_4	69.77 b (88.00)	70.64 ^{b} (89.00)	**70.21 ^{b} (88.50)**
5	T_5	70.03 ^{b} (88.33)	69.74 ^{b} (88.00)	**69.89 ^{b} (88.17)**
6	T_6	72.88 ^{a} (91.33)	73.93 ^{a} (92.33)	**73.41 ^{a} (91.83)**
7	T_7	69.74 ^{b} (88.00)	69.17 ^{b} (87.33)	**69.46 ^{b} (87.67)**
8	T_8	70.03 ^{b} (88.33)	68.88 ^{b} (87.00)	**69.45 ^{b} (87.67)**
9	T_9	47.88 ^{d} (55.00)	50.79 ^{d} (60.00)	**49.33 ^{d} (57.50)**
T	**S.Em ±**	0.73	0.72	**0.51**
	C.D. at 5%	2.18	2.13	**1.47**
Y	**S.Em ±**	-	-	**0.24**
	C.D. at 5%	-	-	**NS**
YXT	**S.Em ±**	-	-	**0.72**
	C.D. at 5%	-	-	**NS**
	C.V.%	-	-	**1.87**

N.B.: Figures in parenthesis are original values, while outsides are arcsine transformed values. Treatment means with the letter (s) in common are at par as per DNMRT at 5% level of significance.

Table 12 : Effect of insecticidal seed treatment on germination in green gram during storage at 12 months storage period.

No.	Treatments	Germination % at 12 months storage period		
		2021-22	2022-23	Pooled
1	T_1	57.46 ^{d} (71.00)	56.17 ^{d} (69.00)	**56.81 ^{c} (70.00)**
2	T_2	59.40 ^{cd} (74.00)	59.78 ^{c} (74.67)	**59.59 ^{c} (74.34)**
3	T_3	67.73 ^{ab} (85.33)	69.77 ^{a} (88.00)	**68.75 ^{a} (86.67)**
4	T_4	63.49 ^{bc} (80.00)	64.16 ^{b} (81.00)	**63.83 ^{b} (80.50)**
5	T_5	62.97 ^{bc} (79.33)	62.73 ^{b} (79.00)	**62.85 ^{b} (79.17)**
6	T_6	69.31 ^{a} (87.33)	70.64 ^{a} (89.00)	**69.98 ^{a} (88.17)**
7	T_7	62.79 ^{bc} (79.00)	62.73 ^{b} (79.00)	**62.76 ^{b} (79.00)**
8	T_8	63.02 ^{bc} (79.33)	62.73 ^{b} (79.00)	**62.87 ^{b} (79.17)**
9	T_9	5.74 ^{c} (1.00)	8.13 ^{e} (2.00)	**6.93 ^{d} (1.50)**
T	**S.Em ±**	1.64	0.49	**0.86**
	C.D. at 5%	4.87	1.46	**2.45**
Y	**S.Em ±**	-	-	**0.40**
	C.D. at 5%	-	-	**NS**
YXT	**S.Em ±**	-	-	**1.21**
	C.D. at 5%	-	-	**NS**
	C.V.%	-	-	**3.67**

N.B.: Figures in parenthesis are original values, while outsides are arcsine transformed values. Treatment means with the letter (s) in common are at par as per DNMRT at 5% level of significance.

(95.83 pulse beetle adults/100g green gram seeds) in pooled data. Whereas, it was 870.84 pulse beetle adults/ 100g green gram seeds were recorded in T_9-untreated control.

Germination : At 3 months storage period (Table 9), the results were found significant during both the years and in pooled data. The highest germination was recorded in T_6 (98.34%) and it was at par with T_3 (97.83%) and

T_8 (97.83%). Whereas, it was 92.67% in T_9-untreated-control (Table 5). At 6 months storage period (Table 10) the results were found significant during 2021-22, 2022-23 and pooled data. Incise of pooled the highest germination percentage *i.e.* 96.34% was recorded in T_6 and it was at par with T_3 (95.67%) and T_8 (95.33%). Whereas, in case of T_9-untreated-control it was 78.17%. At 9 months storage period in pooled data (Table 11), the highest germination was recorded in T_6 (91.83%). However, it was at par with T_3 (90.50%). Whereas, it was 57.50% in T_9-untreated-control. At 12 months storage period in case of pooled data (Table 12), the highest germination was again recorded in T_6 (88.17%). However, it was at par with T_3 (86.67%). Whereas, it was 1.50% in T_9-untreated-control.

Conclusion

This study confirms that pulse beetle damage in stored green gram can be effectively managed through specific pre-harvest sprays and seed treatments. The T_3 (azadirachtin) and T_6 (emamectin benzoate) treatments kept pulse beetle damage within acceptable limits (below the 1.0% IMSCS threshold) for 6 months of storage, with germination rates consistently above the IMSCS standard of 75.00%. These findings suggest that a 6-month storage period under ambient conditions is practical for green gram, maintaining seed quality and reducing pest impact through these targeted interventions.

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