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Biological Suppression of Lepidopteran Pests of Groundnut

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Field release/spray of various bio-control agents individually and in different combinations at ten days interval starting from 20 DAS for the management of major insect pests of groundnut at Thumpaipatti, Madurai district during August 2011 to November 2011 (31.8 ± 2.2$_0$C and 79.8 ± 3.6 RH) indicated that single release of *Chrysoperla zastrowi* and *Trichogramma chilonis* + *Trichogramma japonicum* on 20 and 30 DAS, single spray of *Beauveria bassiana* on 40 DAS and two sprays of *Bacillus thuringiensis* on 50 and 60 DAS was effective against leaf miner. Single release of *C. zastrowi* and *T. chilonis* + *T. japonicum* on 20 and 30 DAS, single spray of *B. thuringiensis* on 40 DAS and two sprays of NPV on 50 and 60 DAS was effective against *Spodoptera litura* and *Helicoverpa armigera*. Single release of *C. zastrowi* and *T. chilonis* + *T. japonicum* on 20 and 30 days after sowing, single spray of *B. bassiana* on 40 days after sowing and two rounds of spray of NPV on 50 and 60 days after sowing recorded the highest yield of 1632 kg wet pods/ha.

Key words: *Archis hypogaea*, *Aproaerema modicella*, Bio-control agents, *Spodoptera litura*, *Helicoverpa armigera*

Groundnut (*Arachis hypogaea* L.) is one of the main oilseed crops of India and it ranks second in the world in production. The groundnut yield in Tamil Nadu (1784 kg of pods/ha) is higher than that of the world average (1336 kg/ha) and it ranks first in India. Groundnut ranks first among oilseeds with high oil recovery (40%). Around 40 to 50 per cent of the output is used in oil production the rest being used as seed and feed.

Groundnut is a good source of niacin, and thus contribute to brain health and blood flow. More than 100 species of insects and mites are known to attack groundnut (Nandagobal, 1992). Total annual loss from these pests is estimated at about Rs.1600 million (Amin, 1983). Groundnut leaf miner, *Aproaerema modicella* Dev., tobacco caterpillar, *Spodoptera litura* F., and gram pod borer, *Helicoverpa armigera* L. are considered as major lepidopteran pests of groundnut (Paras Nath, 1993). Over dependence and indiscriminate use of mixtures of potent and wide spectrum pesticides induced pesticide resistance in insects, pest resurgence, higher mammalian toxicity, toxic effect on non-target organisms including natural enemies and pesticide poisoning resulting in ecological, economical, social and political problems around the globe.

The present study was carried out to generate information on the field efficacy of various bio-control agents individually and in combination for the management of lepidopteran insect pests of groundnut.

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Materials and Methods

A field experiment was conducted at Thumpaipatti, Madurai district during August 2011 to November 2011 at 31.8 ± 2.2$_0$C and 79.8 ± 3.6 % RH to evaluate the efficacy of various bio-control agents individually and with different combinations against lepidopteran pests of groundnut.

T_1 *Chrysoperla zastrowi* 50,000 eggs/ha (5 releases on 20, 30, 40, 50 and 60 DAS)

T_2 *Trichogramma chilonis* and *Trichogramma japonicum* 6.25 cc/ha (5 releases on 30, 40, 50, 60 and 70 DAS)

T_3 *Bacillus thuringiensis* 750 g/ha (5 sprays on 30, 40, 50, 60 and 70 DAS)

T_4 *Spodoptera* and *Helicoverpa* NPV 500 ml/ha (5 sprays on 40, 50, 60, 70 and 80 DAS)

I $_5$ *Beauveria bassiana* 2g/lit. (5 sprays on 30, 40, 50, 60 and 70 DAS)

T_6 *Chrysoperla zastrowi* (20 DAS) + *Trichogramma chilonis* and *Trichogramma japonicum* (40 DAS) + *Bacillus thuringiensis* (50 DAS) + NPV (60 and 70 DAS)

T_7 *Chrysoperla zastrowi* (20 DAS) + *Trichogramma chilonis* and *Trichogramma japonicum* (30 DAS) + *Beauveria bassiana* (40 DAS) + NPV (60 and 70 DAS)

T_8 *Chrysoperla zastrowi* (20 DAS) + *Trichogramma chilonis* and *Trichogramma*

japonicum (30 DAS) + *Beauveria bassiana* (40 DAS) + *Bacillus thuringiensis* (60 and 70 DAS)

T_9 Untreated control

Field experiment with various bio-control agents was conducted in a randomized block design with plot size of 5 x 4 m and spacing of 30 x 10 cm.

Each treatment was replicated thrice and compared with untreated check. Treatments involving combinations of bio-control agents were released or sprayed serially with ten days interval between them. The control plots were maintained 25 m away from other treatment plots to avoid the movement of bio-control agents to control and vice-versa. Per cent leaf damage by lepidopteran pests of groundnut was recorded at 10 days interval on 30, 40, 50, 60 and 70 DAS. Yield of wet pods was recorded during harvest.

Results and Discussion

a. Leaf damage by A. modicella

The reduction in leaf damage by *A. modicella* was highest in treatment, single release release/spray of *C. zastrowi* @ 50,000 eggs/ha and *T. chilonis* + *T. japonicum* @ 6.25 cc/ha, *B. bassiana* @ 2 g/lit and two rounds of spray of *B. thuringiensis* @ 750 g/ha, resulting 11.9 per cent with a reduction of leaf damage by 58.7 per cent over untreated check (Table 1).

Table 1. Per cent leaf damage by *Aproaerema modicella* on groundnut, as influenced by bio-control agents

Treatment*	Pre-count % leaf damage	% leaf damage by leafminer					Mean	% reduction
	(30 DAS)	30 DAS	40 DAS	50 DAS	60 DAS	70 DAS		over control
C. z. @ 50,000 eggs/ha (5 releases	20.6	22.8	19.4	16.6	13.2	10.0	16.4	43.1
on 20, 30, 40, 50 and 60 DAS)		(28.52)$_f$	(26.13)$_f$	(24.04)$_f$	(21.30)$_f$	(18.43)$_f$		
T. chilonis + *T. japonicum*@ 6.25 cc/ha (5 releases)	21.2	22.3	18.9	16.1	12.7	9.5	15.9	44.8
		(28.17)$_e$	(25.76)$_e$	(23.65)$_e$	(20.87)$_e$	(17.95)$_e$		
Bacillus thuringiensis 750 g/ha (5 sprays)	20.8	21.2	17.8	15.0	11.6	8.4	14.8	48.6
		(27.41)$_d$	(24.95)$_d$	(22.78)$_d$	(19.91)$_d$	(16.84)$_d$		
Spodoptera and Helicoverpa NPV 500 ml/ha (5 sprays)	21.4	24.8	28.4	26.6	20.2	18.0	23.6	18.0
		(29.86)$_h$	(32.20)$_h$	(31.04)$_h$	(26.70)$_h$	(25.10)$_h$		
Beauveria bassiana 2 g/lit (5 sprays)	19.8	23.6	20.2	17.4	14.0	10.8	17.2	40.3
		(29.06)$_g$	(26.70)$_g$	(24.65)$_g$	(21.97)$_g$	(19.18)$_g$		
C. z. (one release) + *T. c.* (one elease) + *B. t.* (1 sprays)	20.8	19.2	15.8	13.0	9.6	6.4	12.8	55.6
r + NPV (2 sprays)	(25.98)$_b$	(23.42)$_b$	(21.13)$_b$	(18.05)$_b$	(14.65)$_b$			
C. z. (one release) + *T. c.* (one	21.6	20.0	16.6	13.8	10.4	7.2	13.6	52.8
spray) + *B. b.* (1 sprays)+ NPV (2 sprays)		(26.56)$_c$	(24.04)$_c$	(21.80)$_c$	. (18.81)$_c$	(15.56)$_c$		
C. z. (one release) + *T. c.* (one	20.9	18.3	14.9	12.1	8.7	5.5	11.9	58.7
release) + *B. b.* (one spray) + *B. t* (2 sprays)		(25.32)$_a$	(22.70)$_a$	(20.35)$_a$	(17.15)$_a$	(13.56)$_a$		
Untreated check	21.2	26.8	30.2	31.8	29.8	25.6	28.8	—
		(31.17)$_i$	(33.61)$_i$	(34.32)$_i$	(33.08)$_i$	(30.39)$_i$		
SEd		0.0563	0.0592	0.0675	0.0613	0.0840	—	—
CD 5%		0.1203	0.1256	0.1430	0.1299	0.1780		

*Mean of three replications; Figures in parentheses are arcsine transformed values; In a column, means followed by same letter(s) are not significantly different by DMRT (P=0.05)

Single release of *C. zastrowi, T. chilonis* + *T. japonicum,* single spray of *B. bassiana* and two rounds of spray of *B. thuringiensis* recorded the lowest leaf damage by *A. modicella* (18.3, 14.9, 12.1, 8.7 and 5.5%) during 30, 40, 50, 60 and 70 DAS, respectively. followed by single release of *C. zastrowi* and *T. chilonis* + *T. japonicum* followed by single spray of *B. thuringiensis* and two rounds of spray of NPV (19.2, 15.8, 13.0, 9.6 and 6.4 %) and single release of *C. zastrowi* and *T. chilonis* + *T. japonicum* followed by single spray of *B. bassiana* and two rounds of spray of NPV (20.0, 16.6, 13.8, 10.4 and 7.2%) in contrast to 26.8, 30.2, 31.8, 29.8 and 25.6 per cent in untreated check. The next best treatment was five rounds of spray of *B. thuringiensis* (21.2, 17.8, 15.011.6 and 8.4%). Release/spray of bio-control agents individually at ten days interval were less effective, recording 22.8, 19.4, 16.6, 13.2 and 10.0 % plants for *C. zastrowi*, 23.6, 20.2, 17.4, 14.0 and 10.8 % for *B. bassiana* during and 24.8, 28.4, 26.6, 20.2 and 18.0 for NPV 30, 40, 50, 60 and 70 DAS, respectively (Table 1).

b. Leaf damage by S. litura

Single release/spray of *C. zastrowi* @ 50,000 eggs/ha and *T. chilonis* + *T. japonicum* @ 6.25 cc/ha, single spray of *B. thuringiensis* @ 750 g/ha and two rounds of spray of NPV @ 500 ml/ha recorded the lowest mean leaf damage by *S. litura* (11.0%) with a reduction of leaf damage by 62.1 per cent over untreated check followed single release of *C. zastrowi* @ 50,000 eggs/ha and *T. chilonis* + *T. japonicum* @ 6.25 cc/ha, single spray of *B. bassiana* @ 2 g/lit. and two rounds of spray of NPV @500ml/ ha (12.3% leaf damage; 57.5%) and single release/ spray of *C. zastrowi, Trichogramma chilonis* + *T. japonicum, B. bassiana,* and two rounds of spray of *B. thuringiensis* (1.31% leaf damage; 54.7%) (Table 2).

Single release of *C. zastrowi, T. chilonis* + *T. japonicum,* single spray of *B. thuringiensis* and two rounds of spray of NPV recorded the lowest leaf damage by *S. litura* (19.2, 15.2, 10.8, 5.9 and 4.0%) during 30, 40, 50, 60 and 70 DAS, respectively followed by single release of *C. zastrowi* and *T. chilonis* + *T. japonicum* followed by single spray of *B. bassiana* and two rounds of spray of NPV (20.4, 16.6, 12.2, 7.2 and 5.4 %) and single release/spray of *C. zastrowi, T. chilonis* + *T. japonicum, B. bassiana,* and two rounds of spray of *B. thuringiensis* (20.9, 17.4, 13.3, 8.1 and 6.2%) in contrast to 28.4, 29.6,

Table 2. Per cent leaf damage by *Spodoptera litura* on groundnut, as influenced by bio-control agents

Treatment*	Pre-count % leaf damage	% leaf damage by *S. litura*					Mean	% reduction
	(30 DAS)	30 DAS	40 DAS	50 DAS	60 DAS	70 DAS		over control
C. z. @ 50,000 eggs/ha (5 releases	20.4	22.9	20.8	16.7	11.5	9.6	16.3	44.0
on 20, 30, 40, 50 and 60 DAS)		$(28.59)_g$	$(27.13)_g$	$(24.12)_g$	$(19.82)_g$	$(18.05)_g$		
T. chilonis + *T. japonicum* @ 6.25 cc/ha (5 releases)	20.8	22.2	20.1	16.0	10.8	8.9	15.6	46.4
	$(28.11)_e$	$(26.63)_f$	$(23.57)_f$	$(19.18)_f$	$(17.35)_f$			
Bacillus thuringiensis 750 g/ha (5 sprays)	20.0	22.4	19.3	15.2	10.0	8.1	15.0	48.4
		$(28.24)_f$	$(26.06)_e$	$(22.94)_e$	$(18.43)_e$	$(16.53)_e$		
Spodoptera and Helicoverpa NPV 500 ml/ha (5 sprays)	19.3	21.5	17.8	13.7	8.5	6.6	13.6	53.2
		$(27.62)_d$	$(24.95)_d$	$(21.72)_d$	$(16.95)_d$	$(14.88)_d$		
Beauveria bassiana 2 g/lit (5 sprays)	19.9	23.5	22.3	18.2	13.0	11.1	17.6	39.4
		$(28.99)_h$	$(28.17)_h$	$(25.25)_h$	$(21.13)_h$	$(19.46)_h$		
C. z. (one release) + *T. c.* (one release) +	20.1	19.2	15.2	10.8	5.9	4.0	11.0	62.1
B. t. (1 sprays) + NPV (2 sprays)		$(25.98)_a$	$(22.94)_a$	$(19.18)_a$	$(14.05)_a$	$(11.53)_a$		
C. z. (one release) + *T. c.* (one spray) +	20.5	20.4	16.6	12.2	7.2	5.4	12.3	57.5
B. b. (1 sprays)+ NPV (2 sprays)		$(26.85)_b$	$(24.04)_b$	$(20.44)_b$	$(15.56)_b$	$(13.43)_b$		
C. z. (one release) + *T. c.* (one release) +	19.6	20.9	17.4	13.3	8.1	6.2	13.1	54.7
B. b. (one spray) + *B. t* (2 sprays)		$(27.20)_c$	$(24.65)_c$	$(21.38)_c$	$(16.53)_c$	$(14.41)_c$		
Untreated check	20.7	28.4	29.6	33.4	29.7	24.5	29.1	—
		$(32.20)_i$	$(32.96)_i$	$(35.30)_i$	$(33.02)_i$	$(29.66)_i$		
SEd		0.0536	0.0596	0.0637	0.0786	0.0940	—	—
CD 5%		0.1136	0.1262	0.1350	0.1666	0.1994		

*Mean of three replications; Figures in parentheses are arcsine transformed values; In a column, means followed by same letter(s) are not significantly different by DMRT (P=0.05)

33.4, 29.7 and 24.5 per cent in untreated check. Release/spray of bio- control agents individually at ten days interval were less effective, recording 22.2, 20.1, 16.0, 10.8 and 8.9% for *T. chilonis* + *T. japonicum,* 22.9, 20.8, 16.7, 11.5 and 9.6 % for *C. zastrowi* and 23.5, 22.3, 18.2, 13.0 and 11.1% for *B. bassiana* during 30, 40, 50, 60 and 70 DAS, respectively (Table 2).

c. Leaf damage by H. armigera

Single release of *C. zastrowi* @ 50,000 eggs/ ha, *T. chilonis* + *T. japonicum* @ 6.25 cc/ha, single spray of *B. thuringiensis* @ 750 g/ha and two rounds of spray of NPV 500 ml/ha recorded the lowest mean leaf damage by *H. armigera* (10.0%) with a reduction of leaf damage by 56.2 per cent over untreated check followed single release of *C. zastrowi* @ 50,000

Table 3. Per cent leaf damage by *Helicoverpa armigera* on groundnut, as influenced by bio-control agents

Treatment*	Pre-count % leaf damage	% leaf damage by *H.armigera*					Mean	% reduction
	(30 DAS)	30 DAS	40 DAS	50 DAS	60 DAS	70 DAS		over control
C. z. @ 50,000 eggs/ha (5 releases	15.4	22.4	17.3	13.2	8.3	4.3	13.1	42.5
on 20, 30, 40, 50 and 60 DAS)		$(28.24)_g$	$(24.57)_e$	$(21.13)_f$	$(16.74)_f$	$(12.52)_e$		
T. chilonis + *T. japonicum* @ 6.25 cc/ha (5 releases)	16.0	22.2	16.7	12.6	7.6	3.7	12.1	46.9
		$(26.70)_e$	$(24.12)_c$	$(20.44)_d$	$(16.03)_e$	$(11.53)_d$		
Bacillus thuringiensis 750 g/ha (5 sprays)	15.2	21.5	17.0	12.9	7.7	4.0	12.5	45.0
		$(27.62)_f$	$(24.35)_d$	$(20.79)_e$	$(16.11)_e$	$(11.68)_d$		
Spodoptera and Helicoverpa NPV 500 ml/ha (5 sprays)	14.7	20.7	16.7	12.3	7.4	3.7	11.9	47.6
		$(26.35)_d$	$(24.12)_c$	$(20.53)_d$	$(15.78)_d$	$(11.24)_c$		
Beauveria bassiana 2 g/lit (5 sprays)	15.1	22.9	17.5	12.9	8.1	4.0	13.5	40.9
		$(28.59)_h$	$(24.72)_f$	$(21.30)_g$	$(17.25)_g$	$(11.68)_f$		
C. z. (one release) + *T. c.* (one	15.3	19.6	15.9	11.8	6.6	2.9	10.0	56.2
release) + *B. t.* (1 sprays) + NPV (2 sprays)		$(24.65)_a$	$(22.70)_a$	$(18.62)_a$	$(13.68)_a$	$(8.13)_a$		
C. z. (one release) + *T. c.* (one spray) + *B. b.*	15.8	20.9	16.1	12.0	6.8	3.1	11.1	51.3
(1 sprays)+ NPV (2 sprays)		$(25.54)_b$	$(23.65)_b$	$(19.37)_b$	$(15.11)_b$	$(10.30)_b$		
C. z. (one release) + *T. c.* (one	15.4	21.5	16.3	12.2	7.0	3.3	11.5	49.5
release) + *B. b.* (one spray) + *B. t* (2 sprays)		$(25.98)_c$	$(23.81)_b$	$(20.09)_c$	$(15.34)_c$	$(10.62)_b$		
Untreated check	14.9	20.8	23.9	26.9	22.4	21.2	22.8	—
		$(29.06)_i$	$(31.24)_g$	$(32.52)_h$	$(25.69)_h$	$(23.73)_g$		
SEd		0.0566	0.0665	0.0664	0.0870	0.1166	—	—
CD 5%		0.1200	0.1410	0.1408	0.1844	0.2472		

*Mean of three replications; Figures in parentheses are arcsine transformed values; In a column, means followed by same letter(s) are not significantly different by DMRT (P=0.05)

eggs/ha and *T. chilonis* + *T. japonicum* @ 6.25 cc/ ha, single spray of *B. bassiana* @ 2 g/lit. and two rounds of spray of NPV 500 ml/ha (11.1% leaf damage; 51.3) and single release/spray of *C. zastrowi, T. chilonis* + *T. japonicum, B. bassiana* and two rounds of spray of *B. thuringiensis* (11.5% leaf damage; 49.5%) (Table 3).

Single release of *C. zastrowi, T. chilonis* + *T. japonicum,* single spray of *B. thuringiensis* and two rounds of spray of NPV recorded the lowest leaf damage by *H. armigera* (19.6, 15.9, 11.8, 6.6 and 2.9%) during 30, 40, 50, 60 and 70 DAS, respectively followed by single release of *C. zastrowi* and *T. chilonis* + *T. japonicum* followed by single spray of *B. bassiana* and two rounds of spray of NPV (20.9, 16.1, 12.0, 6.8 and 3.1 nos./five plants %) and single release/spray of *C. zastrowi, T. chilonis* + *T. japonicum, B. bassiana* and two rounds of spray of *B. thuringiensis* (21.5, 16.3, 12.2, 7.0 and 3.3%) in contrast to 20.8, 23.9, 26.9, 22.4 and 21.2 per cent in untreated check. The next best treatment was five round spray of NPV (20.7, 16.7, 12.3, 7.4 and 3.7%).

Release/spray of bio-control agents individually at ten days interval were less effective, recording 22.4, 17.3, 13.2, 8.3 and 4.3% for *C. zastrowi*, 22.9, 17.5, 12.9, 8.1 and 4.0% for *B. bassiana* during 20, 30, 40, 50 and 60 DAS, respectively (Table 3)

Sequential release/spray of bio-control agents is useful to manage various insect pests which occur in various growth stages of single crop, as well demonstrated by Dhandapani *et al* .(1991), Murali Baskaran *et al*. (2000) and Balakrishnan *et al.* (2005) on cotton and Kalyanasundaram *et al*. (1991) on groundnut in which release of either *C. zastrowi* or *T. chilonis* , followed by spraying of NPV was reported to be effective against various pests of cotton and groundnut rather using them individually.

Similarly, single release of *C. zastrowi* and *T. chilonis* + *T. japonicum* on 20 and 30 DAS, single spray of *B. bassiana* on 40 DAS and two sprays of *B. thuringiensis* on 50 and 60 DAS was found to be effective against leafminer on groundnut, recording the lowest mean leaf damage of 11.9 per cent with a reduction of 58.73 per cent over untreated check. Treatment involving single release of *C. zastrowi* and *T. chilonis* + *T. japonicum* on 20 and 30 DAS.

Single spray of *B. thuringiensis* on 40 DAS and two sprays of NPV on 50 and 60 DAS was found to be effective against *S. litura* (lowest leaf damage 11.0% with a reduction of 62.15 per cent over untreated check) and *H. armigera* (lowest leaf damage 10.0% with a reduction of 56.20 per cent over untreated check), as suggested in groundnut (Murali Baskaran *et al*., 2000) wherein the sequential release/spray of *T. chilonis* and NPV was reported to be effective against *S. litura,* resulting the highest cost benefit ratio of 1:2.53. Sequential release/spray of *B. thuringiensis, C. zastrowi* and *T. chilonis* was effective against lepidopteran pests of senna like *Catopsilia pyranthe*, *Eurema hecabe* and *Etiella zinckenella,* resulting highest cost benefit ratio of 1:1.39 (Senthil kumaran, 2008). There is a possibility to reduce the cost of organic inputs like bio-control agents by making them available to farmers through local production or subsidized rate from Government or Co-operative sector. Single release of *C. zastrowi* @ 50,000 eggs/ha and *Trichogramma chilonis* + *T. japonicum* @ 6.25 cc/ha on 20 and 30 DAS, single spray of *B. bassiana* @ 2 g/lit. on 40 DAS and two rounds of spray of NPV @ 500 ml/ha on 50 and 60 DAS recorded the highest yield of 1632 kg wet pods/ ha.

References

Amin, P.W. 1983. Major field insect pests of groundnut in India and associated crop losses. *Indian J. Entomol*., **2**: 337-334

Balakrishnan, N., Murali Baskaran, R.K., Mahadevan, N.R. and Jayaraj, S. 2005. TNAU IPM module for the Management of Major Insect Pests of Rainfed Cotton. pp. 80-88. **In**: Sustainable Insect Pest Management. (eds.,) S. Ignacimuthu, A. Sen and S. Janarthanan), Narosa Publishing House., New Delhi. 298 p.

Dhandapani, N., Kalyanasundaram, M., Swamiappan, M., Sundara Babu, P.C. and Jayaraj, S. 1991. Management of major pests of cotton with biocontrol agents. pp. 49-59. **In**: Mid Term Report: Biological Control of Insect Pests through Biotechnology. Tamil Nadu Agric. Univ., Coimbatore. 48 p.

Duncan, D.B. 1995. Multiple range and multiple F tests. *Biometrics,* **11**: 1- 42

Kalyanasundaram, M., Dhandapani, N., Swamiappan, M., Sundara Babu, P.C. and Selvaraj, P. 1991. Efficacy of *Trichograrmma chilonis* (Ishii), *Brinkochrysa scelestis* (Banks) and Nuclear Polyhedrosis virus of *Spodoptera litura* (Fb.) against major pests of groundnut in India. pp. 60-66. **In**: Mid Term Report: Biological Control of Insect Pests through Biotechnology. Tamil Nadu Agric. Univ., Coimbatore. 110 p.

Murali Baskaran, R.K. and Janarthanan, R. 2000. Effect of dust formulations of certain plant oils against important pests of paddy and cowpea in storage. *J. Ent. Res.,* **24**: 271-278

Nandagobal, V. 1992. Studies on integrated pest management in Groundnut in Saurashtra, Ph.D. Thesis, Saurashtra University, Rajkot. 246p.

Paras Nath 1993. Studies on the groundnut insect pest and their management in east Utter Pradesh. Final technical report of ICAR AD-HOC Project, Dept. of Entomology and Agrl.Zoology, Institute of Agrl. Sciences, Banaras Hindu University, Varanasi

Senthil Kumaran, S. 2008. Studies on development of organic package for the management of major insect pests of senna (*Cassia angustifolia* Vahl.) M.Sc. (Ag) Thesis, Tamil Nadu Agric. Univ., Coimbatore. 144 p.

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