



RELATIVE EFFICACY OF ENTOMO-PATHOGENS AND BOTANICALS AGAINST MAJOR INSECT PESTS OF SOYBEAN

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ABSTRACT

The relative efficacy of entomopathogens and botanicals against major insect pests of soybean [*Glycine max* (L.) Merrill] was evaluated in field trials laid out at Instructional Farm, Rajasthan College of Agriculture, Udaipur during *kharif* 2011. Among different treatments tested, quinalphos at 1250 ml/ha (standard check) caused maximum reduction in population of aphids, jassids, whiteflies and was significantly superior over other treatments followed by *Chrysoperla zastrowi* at 5000/ha and *Metarhizium anisopliae* at 1×10^{13} cfu/gm /ha. Quinalphos at 1250 ml/ha also gave significant reduction of tobacco caterpillar, followed by SNPV at 1.5×10^{12} POB/ha and *Bacillus thuringiensis* var. *kurstaki* at 1 kg/ha. The maximum net profit (Rs. 31980), and the highest cost benefit ratio, (1:2.00), was recorded for quinalphos at 1250 ml/ha.

Key words: Entomopathogens, botanicals, major insect pests, soybean

INTRODUCTION

Soybean is a major oil seed crop of the world cultivated in an area of 91m ha with production of 204 mt and productivity of 2,223 kg/ha (Anonymous, 2006). The crop is mainly cultivated in USA, China, Brazil, Argentina and India. India contributes more than 90 per cent of world acreage. In India it is grown over an area of 8.17 m ha with production of 9.46 mt and productivity of 1,069 kg/ha (Anonymous, 2007). Soybean is reported to be infested by about 350 species of insect pests in many parts of the world (Luckmann, 1971). Likewise, *Spodoptera litura* (Fab.), *Thysanoplusia orichalcea* (Fab.), *Cydia ptychora* (Meyric), *Helicoverpa armigera* (Hub.), *Maruca testulalis* (Geyer), *Eitella zinkenella* and sucking pests cause economic losses. The increasing population of these insect pest complexes may cause yield losses up to 50 per cent. In view of the harmful effects of synthetic pesticides there is an urgent need for the development of environment friendly methods such as utilization of insect pathogens, antagonist or competitor populations of a third organism and botanicals to suppress the pest populations.

MATERIALS AND METHODS

The present evaluation of the relative efficacy of entomopathogens and botanicals against major insect pests of soybean [*Glycine max* (L.) Merrill] was conducted through field trials at the Instructional Farm, Rajasthan

College of Agriculture, MPUAT, Udaipur during *kharif* 2011. The crop was sown on 7th July, 2011 and soybean cultivar JS-335 was sown with a row to row and plant to plant spacing of 40 cm and 15 cm, respectively. The experiment was laid out in Randomized Block Design with three replications. Observations on population of insect pests [whitefly *Bemisia tabaci* Genn., aphid *Aphis craccivora*, jassid *Amrsca kerri* Pruthi and tobacco caterpillar *Spodoptera litura* (Fab.)] were recorded 1 day before and 3, 5 and 7 days after each spray.

The relative efficacy of different biopesticides (Table 1) against the insect pests was analyzed by analysis of variance. The population data was corrected using the correction factor given by Henderson and Tilton (1952) as under:

$$\text{Per cent reduction in population} = 100 \left[1 - \frac{T_a \times C_b}{T_b \times C_a} \right]$$

Where,

T_a = Number of insects after treatment

T_b = Number of insects before treatment

C_a = Number of insects in untreated check after treatment

C_b = Number of insects in untreated check before treatment.

The reduction percentage figures were transformed to arc sine values and subjected to analysis of variance.

Table 1. Treatment details

Treatment	Dose/ha
Two releases of <i>Chrysoperla zastrowi</i>	5000/ha
Two spray of SI NPV	1.5 x 10 ¹² POB/ha
Two sprays of <i>Metarhizium anisopliae</i>	1 x 10 ¹³ cfu/g
Two spray of <i>Bacillus thuringiensis</i> var. <i>kurstaki</i>	1 kg/ha
Two spray of neem seed kernel extract	5 per cent
Two spray of <i>Nomurea rilyei</i>	1.5 x 10 ¹³ cfu/g
Insecticidal check (Quinalphos)	1250 ml/ha
Control (Water spray)	-----

RESULTS AND DISCUSSION

The relative efficacy of biopesticides and entomopathogens has been detailed out in Tables 2 to 6. A perusal of the tables show that two applications of quinalphos at 1250 ml/ha (Insecticidal check) caused maximum reduction in population of aphids (84.85%), jassids (83.40%), whitefly (80.84%) and was significantly superior over other treatments. The release of *Chrysoperla zastrowi* at 5000/ha caused 67.54 per cent reduction of white fly. *M. anisopliae* at 1 x 10¹³ cfu/gm/ha was next in order of effectiveness with 65.41 per cent reduction of white fly population. Quinalphos at 1250 ml/ha caused

Table 2. Relative efficacy of entomopathogens and botanicals against *Aphis craccivora*

S. No.	Treatments	Dose ml/ha, kg/ha	Mean reduction in population (%)					
			1 st Spray			2 nd Spray		
			3 DAS	5 DAS	7 DAS	3 DAS	5 DAS	7 DAS
1.	<i>Chrysoperla zastrowi</i>	5000/ha	55.10 (47.93)*	64.42 (53.40)	65.83 (54.25)	55.45 (48.13)	63.26 (52.70)	68.25 (55.73)
2.	SL NPV	1.5 x 10 ¹² POB/ha	0.00	0.00	0.00	0.00	0.00	0.00
3.	<i>Metarhizium anisopliae</i>	1 x 10 ¹³ cfu/g	54.09 (47.35)	57.42 (49.27)	58.15 (49.70)	54.08 (47.34)	60.44 (51.44)	67.50 (55.27)
4.	<i>Bacillus thuringiensis</i> var. <i>Kurstaki</i>	1 kg/ha	0.00	0.00	0.00	0.00	0.00	0.00
5.	Neem Seed Karnal extract	5 per cent	41.40 (40.04)	40.60 (39.58)	40.10 (39.29)	45.15 (42.21)	44.26 (41.70)	42.45 (40.65)
6.	<i>Nomurea rilyei</i>	1.5 x 10 ¹³ conidia/ha	51.82 (46.04)	56.42 (48.70)	57.30 (49.20)	52.12 (46.22)	59.75 (50.63)	66.89 (54.89)
7.	Quinalphos	1250ml/ha	77.38 (61.67)	83.61 (66.26)	79.54 (63.19)	80.08 (63.58)	84.85 (67.26)	82.25 (65.23)
8.	Control (Water spay)	-----	0.00	0.00	0.00	0.00	0.00	0.00
	S.Em±		(0.83)	(1.16)	(0.96)	(0.90)	(1.06)	(1.21)
	CD 5%		(2.56)	(3.59)	(2.98)	(2.79)	(3.27)	(3.74)

* Figure in parentheses are transformed values, DAS = Days after spray

Table 3. Relative efficacy of entomopathogens and botanicals against jassid, *Amrasca kerri* Pruthi

S. No.	Treatments	Dose ml/ha, kg/ha	Mean reduction in population (%)					
			1 st Spray			2 nd Spray		
			3 DAS	5 DAS	7 DAS	3 DAS	5 DAS	7 DAS
1.	<i>Chrysoperla zastrowi</i>	5000/ha	58.26 (49.76)*	65.30 (53.93)	67.40 (55.20)	62.24 (52.10)	66.61 (54.72)	71.05 (57.48)
2.	SL NPV	1.5 x 10 ¹² POB/ha	0.00	0.00	0.00	0.00	0.00	0.00
3.	<i>Metarhizium anisopliae</i>	1 x 10 ¹³ cfu/g	57.19 (49.14)	64.84 (53.65)	66.83 (54.86)	61.08 (51.41)	65.42 (54.00)	69.45 (56.53)
4.	<i>Bacillus thuringiensis</i> var. <i>Kurstaki</i>	1 kg/ha	0.00	0.00	0.00	0.00	0.00	0.00
5.	Neem Seed Karnal extract	5 per cent	40.33 (39.42)	33.59 (35.42)	32.19 (34.56)	41.41 (40.05)	35.40 (36.51)	33.26 (35.22)
6.	<i>Nomurea rilyei</i>	1.5 x 10 ¹³ conidia/ha	55.26 (48.02)	59.00 (50.19)	64.46 (53.42)	58.15 (49.70)	62.35 (52.17)	68.09 (55.63)
7.	Quinalphos	1250 ml/ha	76.61 (61.14)	82.38 (65.30)	78.54 (62.56)	79.25 (62.98)	83.40 (66.09)	81.85 (64.89)
8.	Control (Water spay)	-----	0.00	0.00	0.00	0.00	0.00	0.00
	S.Em±		(0.93)	(0.97)	(1.27)	(1.04)	(1.41)	(1.29)
	CD 5%		(2.87)	(3.00)	(3.93)	(3.21)	(4.35)	(3.98)

* Figure in parentheses are transformed values, DAS = Days after spray

Table 4. Relative efficacy of entomopathogens and botanicals against whitefly, *Bemisia tabaci* Genn.

S. No.	Treatments	Dose ml/ha, kg/ha	Mean reduction in population (%)					
			1 st Spray			2 nd Spray		
			3 DAS**	5 DAS	7 DAS	3 DAS	5 DAS	7 DAS
1.	<i>Chrysoperla zastrowi</i>	5000/ha	54.15 (47.38)*	58.40 (49.84)	60.87 (51.29)	60.25 (50.94)	62.25 (52.10)	67.54 (55.29)
2.	SL NPV	1.5 x 10 ¹² POB/ha	0.00	0.00	0.00	0.00	0.00	0.00
3.	<i>Metarhizium anisopliae</i>	1 x 10 ¹³ cfu/g	53.45 (46.98)	57.42 (49.27)	60.30 (50.95)	55.15 (47.96)	62.09 (52.01)	65.41 (53.99)
4.	<i>Bacillus thuringiensis</i> var. <i>Kurstaki</i>	1 kg/ha	0.00	0.00	0.00	0.00	0.00	0.00
5.	Neem Seed Karnel extract	5 per cent	39.19 (38.75)	33.87 (35.59)	32.10 (34.51)	40.42 (39.47)	37.84 (37.96)	32.87 (34.96)
6.	<i>Nomurea rilyei</i>	1.5 x 10 ¹³ conidia/ha	52.19 (46.26)	56.39 (48.8)	58.65 (49.99)	53.74 (47.15)	61.20 (51.48)	64.11 (53.21)
7.	Quinalphos	1250 ml/ha	76.40 (60.99)	79.08 (62.86)	78.60 (62.60)	78.50 (62.45)	80.84 (64.14)	79.25 (62.98)
8.	Control (Water spay)	—————	0.00	0.00	0.00	0.00	0.00	0.00
	S.Em±		(0.84)	(0.92)	(1.23)	(1.07)	(1.00)	(1.16)
	CD 5%		(2.61)	(2.83)	(3.81)	(3.29)	(3.08)	(3.50)

* Figure in parentheses are angular transformed values, DAS = Days after spray

Table 5. Relative efficacy of entomopathogens and botanicals against tobacco caterpillar, *Spodoptera litura* (Fab.)

S. No.	Treatments	Dose ml/ha, kg/ha	Mean reduction in population (%)					
			1 st Spray			2 nd Spray		
			3 DAS**	5 DAS	7 DAS	3 DAS	5 DAS	7 DAS
1.	<i>Chrysoperla zastrowi</i>	5000/ha	28.12 (32.02)*	30.76 (33.68)	31.83 (34.34)	32.19 (34.56)	35.00 (36.27)	38.03 (38.07)
2.	SL NPV	1.5 x 10 ¹² POB/ha	35.04 (36.29)	65.20 (53.87)	74.55 (59.75)	36.00 (36.92)	65.11 (53.81)	77.09 (61.47)
3.	<i>Metarhizium anisopliae</i>	1 x 10 ¹³ cfu/g	52.07 (46.19)	60.77 (51.23)	61.89 (51.89)	56.11 (48.50)	61.00 (51.36)	64.08 (53.19)
4.	<i>Bacillus thuringiensis</i> var. <i>Kurstaki</i>	1 kg/ha	62.12 (52.03)	70.30 (57.01)	65.00 (53.75)	66.35 (54.54)	76.12 (60.80)	69.09 (56.22)
5.	Neem Seed Karnel extract	5 per cent	43.11 (41.42)	37.77 (37.92)	35.43 (36.52)	46.00 (39.99)	43.20 (41.09)	41.88 (40.32)
6.	<i>Nomurea rilyei</i>	1.5 x 10 ¹³ conidia/ha	51.71 (45.98)	58.12 (49.68)	59.80 (50.66)	55.11 (47.94)	59.80 (50.67)	62.60 (52.31)
7.	Quinalphos	1250 ml/ha	66.30 (54.53)	75.40 (60.41)	70.89 (57.38)	72.23 (58.24)	83.23 (65.96)	80.23 (63.69)
8.	Control (Water spay)	—————	0.00	0.00	0.00	0.00	0.00	0.00
	S.Em±		(0.83)	(1.12)	(0.90)	(0.67)	(1.10)	(1.02)
	CD 5%		(2.52)	(3.40)	(2.75)	(2.05)	(3.34)	(3.10)

* Figure in parentheses are angular transformed values, DAS = Days after spray

maximum reduction (83.23%) of caterpillars and was significantly superior over other treatments followed by SINPV at 1.5 x 10¹² POB/ha (77.09) which was at par with *B. t. var. kurstaki* at 1 kg/ha (76.12 %). The cumulative effect of the treatments indicated that quinalphos (1250 ml/ha)

resulted into the maximum population reduction (Table 6).

The maximum net profit of Rs. 31980 and the highest cost benefit ratio of 1:2.00 were recorded for quinalphos at 1250 ml/ha. It was followed by *B. t. var. kurstaki* at 1 kg/ha, SINPV at 1.5 x 10¹² POB/ha, *M. anisopliae* at 1 x 10¹³

Table 6. Cumulative reduction in larval population of major insect pests of soybean crop after two applications of entomopathogens and botanicals during *kharif* 2011-12

Treatments	Population reduction (%)											
	Aphid			Jassid			Whitefly			Tobacco caterpillar		
	3 DAS*	5DAS	7DAS	3 DAS	5DAS	7DAS	3 DAS	5DAS	7DAS	3 DAS	5DAS	7DAS
T ₁ <i>C.zastrowi</i> @ 5000/ha	55.27	63.84	67.04	60.25	65.95	69.22	57.20	60.32	64.20	30.15	32.88	34.93
T ₂ SL NPV @ 1.5 x 10 ¹² POB/ha	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	35.52	65.15	75.56
T ₃ <i>M. anisopliae</i> @ 1 x 10 ¹³ cfu/gm	54.08	58.93	62.82	59.13	65.13	68.14	54.30	59.75	62.85	54.09	60.77	62.98
T ₄ <i>B.t. var. kurstaki</i> @ 1 kg/ha	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	64.23	60.88	67.04
T ₅ Neem Seed Karnal extract @ 5%	43.27	42.43	41.27	40.87	34.49	32.72	39.80	35.85	32.48	44.55	40.48	38.65
T ₆ <i>Nomurea rilyei</i> @ 1.5 x 10 ¹³ conidia/ha	51.97	58.08	62.09	56.70	60.67	66.27	52.96	58.79	61.38	53.41	58.96	61.20
T ₇ Quinalphos @ 1250 ml/ha	78.73	84.23	80.89	77.93	82.89	80.19	77.45	79.96	78.92	69.26	73.83	75.82

Table 7. Economics and cost benefit ratio of different treatments against major insect pests of soybean during *kharif* 2011-12

Treatments	No. of sprays	Average yield (q/ha)	Gross return (Rs.)	Increased yield over control (q/ha)	Value of increased yield over control (Rs./ha)	Management cost (labour + insecticide) (Rs./ha)	Net profit (Rs./ha)	C:B ratio
T ₁ <i>C. zastrowi</i>	2	15.65	41472.5	4.45	11792.5	3080	8712.5	1 : 1.265
T ₂ SI NPV	2	20.50	54325	9.30	24645	2180	22365	1 : 1.705
T ₃ <i>M. anisopliae</i>	2	18.60	49290	7.40	19610	2580	17030	1 : 1.527
T ₄ <i>B. t. var. Kurstaki</i>	2	22.90	60685	11.70	31005	2480	28525	1 : 1.886
T ₅ Neem seed karnal extract	2	13.34	35351	2.14	5671	1880	3791	1 : 1.120
T ₆ <i>Nomurea rilyei</i>	2	16.70	44255	5.50	14575	2680	11895	1 : 1.367
T ₇ Insecticidal check (Quinalphos)	2	24.10	63865	12.90	34185	2205	31980	1 : 2.00
T ₈ Control (Water spray)	0	11.20	29680	—	—	—	—	—

cfu/g/ha and *N. rilyei* at 1.5 x 10¹³ conidia/ha of *C. zastrowi* at 5000/ha with the net profit and C: B ratio of Rs.28525, 22365, 17030, 11895, 8712.5 and 1:1.886, 1:1.710, 1:1.527, 1:1.367, 1:1.265, respectively. The minimum net profit and cost benefit ratio of Rs. 3791 and 1:1.120 were recorded for NSKE (5%) (Table 7).

The present findings are in conformity with Joshi and Patel (2010), who reported that two applications of quinalphos 0.05 per cent were most effective for the control of jassid *Empoasca kerri* (Pruthi). *C. zastrowi* at 5000/ha was next in order of effectiveness. Similarly, Tauber *et al.* (2000) reported that *C. carnea* is one of the most common predators of soft bodied insects. Gupta (2008) reported that quinalphos 0.05% + neem oil 1% was most effective treatment against whitefly. *C. carnea*, being a generalist predator, consumes sucking pests (Chang, 1998) including 216-950 nymphs and adults of aphids and 510

nymphs of whitefly (Gautam and Tasfaye, 2002). Kulkarni (1999) reported that *N. rilyei* (1.2 x 10¹² conidia/l) significantly reduced *S. litura* larvae in soybean at 7 and 14 days after spray.

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