



## EVALUATION OF CERTAIN INSECTICIDES FOR THE MANAGEMENT OF SAFFLOWER INSECT PESTS UNDER FIELD CONDITIONS

POORNIMA MEGHANAVAR AND D.N. KAMBREKAR\*

Department of Agricultural Entomology, University of Agricultural Sciences, Dharwad - 580 005, Karnataka, India

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ABSTRACT

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A field experiment on bioefficacy of newer insecticides against the important insect pests was conducted using three systemic and three contact insecticides along with untreated check (UTC). The results revealed that the treatment with thiamethoxam 25 WG @ 0.2 g/l recorded 10.48 aphids/5 cm top shoot length (83.85% reduction over UTC). Management with respect to capsule borer and the safflower caterpillar chlorantraniliprole 20 SC @ 0.15 ml/l was superior with mean larval population of 0.84 larvae/plant and 0.77 larvae/plant (82.90 and 82.53% reduction over UTC, respectively). Highest benefit cost ratio was obtained in chlorantraniliprole 20 SC @ 0.15 ml/lit (2.85) followed by thiamethoxam 25 WG @ 0.2 g/l (2.81), buprofezin 50 SC @ 0.2 ml/l (2.51) and emamectin benzoate 5 SG @ 0.2 g/l (2.47).

**KEYWORDS:** Bioefficacy, safflower, pest

Safflower (*Carthamus tinctorius* Linn.) is a multipurpose oil seed crop with unexploited potential and world adaptability. Traditionally, the crop was grown for its seeds and flower petals used for colouring and flavouring foods. For the last fifty years, the safflower crop has been cultivated mainly for the vegetable oil extracted from its seeds. All the parts of the plant find useful applications in herbal medicine specifically in preparations to treat physical disorders. Safflower produces oil rich in polyunsaturated fatty acids which play an important role in reducing blood cholesterol level and is considered as a healthy cooking medium.

Although the crop is known for its tolerance to moisture stress conditions, the area is being drastically reduced over the years. Among the several factors that are responsible for reduction in area and production insect pests contribute a major share. A total of 101 insects have been recorded on safflower throughout the world. However, in India as many as 75 insect species have been reported by Basavangoud (1979) while Parlekar (1987) has enlisted 36 insect species in Maharashtra state. In Karnataka, 20 insect pests have been recorded on safflower along with nine species of natural enemies. Narayanan (1961) has recorded few caterpillar pests and aphids as serious pests among many insects that infest safflower crop. Twenty three insect pests in safflower ecosystem have been recorded in Vijayapur and Dharwad

district among which aphid, capsule borer and the safflower caterpillar were the major insect pests.

### MATERIAL AND METHODS

To know the bio efficacy of new insecticide molecules to aphids, capsule borer and the safflower caterpillar a field experiment was conducted at Regional Agricultural Research Station (RARS), Vijayapur during rabi 2015-2016. The experiment was laid out in Randomized Complete Block Design (RCBD) in three replications with six treatments and a control. The size of each plot was 17.64 m<sup>2</sup> (4.2 m x 4.2 m). The crop was raised using A-1 variety of safflower with a spacing of 60cm x 30cm by adopting recommended agronomical practices except for insect pest control. Three systemic and three safer contact insecticides were selected along with one untreated check. After spraying the systemic insecticides, the crop was sprayed with recommended contact insecticides for lepidopteran insect as blanket spray, similarly after spraying three contact insecticides; recommended systemic insecticide was sprayed for aphid control (Table 1).

The aphid count was recorded by counting the number of aphids per five cm top shoot length. The capsule borer and leaf eating caterpillar count was recorded by counting the number of larvae per plant and later the data was subjected to  $\sqrt{X + 0.5}$  transformation

\*Corresponding author, E-mail: kambrekardn@gmail.com

before statistical analysis. Per cent larval reduction was subjected to arc sine transformation before statistical analysis. Further, yield data was computed to quintals per hectare.

## RESULTS AND DISCUSSION

The efficacy of the insecticides to important insect pests *i.e.* aphids, leaf eating caterpillars and capsule borer was studied and the results are elucidated here under.

### Safflower aphid *Uroleucon compositae* (Theobald)

No statistically significant difference between the treatments with respect to mean number of aphids per five cm shoot length were observed in pre counts that were taken a day before spraying (Table 1).

At three Days After Spray (3DAS), there was a significant difference among the treatments where the population ranged between 5.43 to 72.83 aphids per five cm shoot length. The plots sprayed with thiamethoxam 25 WG @ 0.2 g/l recorded least number of aphids (5.43 aphid/five cm shoot length) which was on par with buprofezin 50 SC @ 0.25 ml/l (10.43 aphids/five cm shoot length) and spinetoram 12 SC @ 0.2 ml/l (11.50 aphids/five cm shoot length). The plots sprayed with emamectin benzoate 5 SG @ 0.2 g/l recorded highest number of aphids per plant (39.67 aphids/five cm shoot length). While, plots sprayed with spinosad 45 SC @ 0.15 ml/l recorded (33.17 aphids/ five cm shoot length) which was statistically on par with chlorantraniliprole 20 SC @ 0.15 ml/l (29.83 aphids/five cm shoot length). With respect to per cent aphid population reduction, at three days after spraying (3DAS) the highest reduction of aphid population (92.56 %) was recorded in plots treated with thiamethoxam 25 WG @ 0.2 ml/l followed by buprofezin 50 SC @ 0.2 ml/l (85.71%) and spinetoram 12 SC @ 0.2 ml/l (84.18%). Similar trend was also observed for the remaining observations

At seven DAS, a similar trend in the efficacy of insecticides was observed where the aphid population ranged from 7.83 to 75.83 per five cm top shoot length. Least number of aphids was recorded in plots treated with thiamethoxam 25 WG @ 0.2 g/l (7.83 aphids / five cm shoot length) and buprofezin 50 SC @ 0.25 ml/l (15.70 aphids / five cm shoot length) which were on par with each other. Next best treatment was spinetoram 12 SC @ 0.2 ml/l (14.93 aphids / five cm shoot length). Similarly, highest aphid population was recorded in plots treated

with emamectin benzoate 5 SG @ 0.2 g/l (48.73 aphids/ five cm top shoot length) followed by spinosad 45 SC @ 0.15 ml/l (36.17 aphids/ five cm top shoot length) and chlorantraniliprole 20 SC @ 0.15 ml/l (34.23 aphids/ five cm top shoot length). The highest per cent reduction in aphid population (89.69%) was recorded in the plots sprayed with thiamethoxam 25 WG @ 0.2 ml/l followed by spinetoram 12 SC @ 0.2 ml/l (80.26%) and buprofezin 50 SC @ 0.25 ml/l (79.48%). Least per cent reduction (35.59%) in aphid population were recorded in plots sprayed with emamectin benzoate 5 SG @ 0.2 g/l.

At 10 and 15 DAS, a similar trend in efficacy of insecticides was observed where, thiamethoxam 25 WG @ 0.2 ml/l, buprofezin 50 SC @ 0.25 ml/l and spinetoram 12 SC @ 0.2 ml/l sprayed plots recorded least population of aphids. Whereas, highest aphid population was recorded in plots sprayed with emamectin benzoate 5 SG @ 0.2 g/l, spinosad 45 SC @ 0.15 ml/l and chlorantraniliprole 20 SC @ 0.15 ml/l.

Similar results were also observed by Hanumantharaya *et al.* (2007), who reported that thiamethoxam was the most effective (97% kill) and economic insecticide against safflower aphids.

### Safflower capsule borer, *Helicoverpa armigera* (Hub)

No statistically significant difference between the treatments with respect to mean number of larvae per plant were observed in pre counts that were taken a day before spraying (Table 2). The larval population in different treatments were uniform and ranged from 3.43 to 3.91 per plant (Table 2).

At three DAS, there was a significant difference among the treatments where the population of larvae ranged from 1.53 to 5.30 larvae per plant. The plots sprayed with chlorantraniliprole 20 SC @ 0.15 ml/l recorded least larval population (1.53 larvae/ plant) which was on par with emamectin benzoate 5 SG 0.2 g/l (1.92 larvae/plant) and spinosad 45 SC @ 0.15 ml/l (3.01 larvae/ plant) sprayed plots. With respect to per cent larval reduction, highest reduction of larval population (71.41%) was also recorded in plots sprayed with chlorantraniliprole 20 SC @ 0.15 ml/l followed by emamectin benzoate 5 SG @ 0.2 g/l (61.99%) and spinosad 45 SC @ 0.15 ml/l (43.20%) which were on par with each other.

At seven DAS, the larval population ranged from 0.85 to 4.97 per plant. Least number of larvae were

Table 1. Bio-efficacy of certain new insecticides against safflower aphid, *Uroleuon compositae* (Theobald) under field condition

T. No.	Treatments	Dose ml/gm/l	Number aphids/5 cm top shoot length*					Per cent reduction over UTC**					
			1 DBS	3 DAS	7 DAS	10 DAS	15 DAS	Mean	3 DAS	7 DAS	10 DAS	15 DAS	Mean
1	Buprofezin 50SC	0.25	49.33 (7.06)	10.43 (3.27) <sup>a</sup>	15.70 (3.25) <sup>a</sup>	17.83 (4.23) <sup>a</sup>	28.33 (5.32) <sup>a</sup>	18.08 (4.02) <sup>a</sup>	85.71 (67.78)	79.48 (63.01)	74.36 (59.54)	45.04 (42.10)	71.15 (57.56)
2	Thiamethoxam 25WG	0.2	47.67 (6.93)	5.43 (2.43) <sup>a</sup>	7.83 (3.57) <sup>a</sup>	9.00 (3.06) <sup>a</sup>	19.67 (4.47) <sup>a</sup>	10.48 (3.38) <sup>a</sup>	92.56 (74.15)	89.69 (71.19)	87.16 (68.95)	65.99 (54.27)	83.85 (66.28)
3	Spinetoram 12 SC	0.2	52.33 (7.27)	11.50 (3.46) <sup>a</sup>	14.93 (3.93) <sup>b</sup>	20.03 (4.51) <sup>a</sup>	29.67 (5.38) <sup>a</sup>	19.03 (4.32) <sup>a</sup>	84.18 (9.20)	80.26 (63.58)	71.63 (57.80)	47.26 (43.39)	70.83 (57.29)
4	Enamectin benzoate 5SG	0.2	53.00 (7.31)	39.67 (6.34) <sup>c</sup>	48.73 (7.02) <sup>c</sup>	37.33 (6.11) <sup>b</sup>	45.33 (6.77) <sup>c</sup>	42.77 (6.56) <sup>b</sup>	45.53 (42.42)	35.59 (36.57)	47.58 (6.91)	27.72 (31.76)	39.10 (38.69)
5	Spinosad 45 SC	0.15	47.67 (6.94)	33.17 (5.79) <sup>b</sup>	36.17 (4.89) <sup>c</sup>	27.33 (5.21) <sup>b</sup>	34.33 (5.89) <sup>b</sup>	32.75 (5.45) <sup>c</sup>	54.25 (47.41)	52.24 (46.26)	61.13 (51.41)	43.68 (41.32)	52.83 (46.61)
6	Chlorantraniliprole 20 SC	0.15	44.33 (6.66)	29.83 (5.51) <sup>c</sup>	34.23 (4.92) <sup>c</sup>	25.27 (5.07) <sup>b</sup>	31.56 (5.66) <sup>b</sup>	30.00 (5.29) <sup>c</sup>	59.07 (50.18)	55.02 (47.87)	64.04 (53.13)	54.82 (47.75)	58.24 (43.72)
7	Un treated check	-	48.33 (6.97)	72.83 (8.57) <sup>d</sup>	75.83 (6.40) <sup>d</sup>	70.67 (8.43) <sup>c</sup>	63.33 (7.99) <sup>d</sup>	70.67 (7.85) <sup>d</sup>	-	-	-	-	-
	S.Em ±	-	-	0.46	0.45	0.42	0.39	0.51	4.78	4.79	4.78	4.17	4.21
	CD @ 5 %	NS	1.36	1.30	1.23	1.13	1.48	1.48	13.95	13.98	13.95	12.16	12.28
	CV (%)	-	15.92	16.65	13.47	11.38	16.03	16.61	17.66	16.61	17.66	19.38	16.45

Note:

NS – Non Significant. DBS – Day Before Spray, DAS – Days After Spray. UTC : Un treated Check

In a column, means followed by a same letter are not significantly different at p = 0.05 by Duncan's Multiple Range Test (DMRT)

\* Figures in the parentheses are subjected to  $\sqrt{X + 0.5}$  transformed values. \*\* Figures in parentheses are arc sin transformed values.

**Table 2. Bio-efficacy of certain new insecticides against safflower capsule borer, *Helicoverpa armigera* (Hub) under field condition**

T. No.	Treatments	Dose (ml or g/l)	Number of larvae/plant*							Per cent reduction over UTC**			
			1 DBS	3 DAS	7 DAS	10 DAS	15 DAS	Mean	3 DAS	7 DAS	10 DAS	15 DAS	Mean
1	Buprofezin 50SC	0.25	3.91 (2.10)	3.67 (2.04) <sup>b</sup>	2.20 (1.64) <sup>b</sup>	3.40 (1.97) <sup>b</sup>	3.80 (2.07) <sup>b</sup>	3.26 (1.94) <sup>b</sup>	35.81 (36.74)	55.73 (48.27)	20.40 (25.02)	24.00 (29.33)	33.98 (35.64)
2	Thiamethoxam 25WG	0.2	3.60 (2.02)	3.53 (2.00) <sup>b</sup>	3.47 (1.99) <sup>b</sup>	3.27 (1.94) <sup>b</sup>	3.20 (1.92) <sup>b</sup>	3.37 (1.96) <sup>b</sup>	33.62 (35.37)	30.24 (33.34)	23.95 (28.78)	36.00 (36.87)	30.95 (33.78)
3	Spinetoram 12 SC	0.2	3.89 (2.10)	3.83 (2.08) <sup>b</sup>	3.73 (2.06) <sup>b</sup>	3.57 (2.02) <sup>b</sup>	3.67 (2.04) <sup>b</sup>	3.70 (2.05) <sup>b</sup>	26.90 (30.31)	24.72 (29.76)	19.27 (25.05)	26.67 (31.05)	24.39 (29.31)
4	Emamectin benzoate 5SG	0.2	3.43 (1.95)	1.92 (1.56) <sup>a</sup>	0.85 (1.16) <sup>a</sup>	0.13 (0.79) <sup>a</sup>	1.05 (1.24) <sup>a</sup>	0.98 (1.22) <sup>a</sup>	61.99 (51.92)	80.54 (63.80)	97.07 (80.11)	79.00 (62.72)	79.65 (63.16)
5	Spinosad 45 SC	0.1	3.77 (2.07)	3.01 (1.87) <sup>a</sup>	1.92 (1.56) <sup>a</sup>	0.94 (1.20) <sup>a</sup>	1.23 (1.32) <sup>a</sup>	1.77 (1.51) <sup>a</sup>	43.20 (41.08)	61.36 (51.55)	78.48 (62.34)	72.23 (58.18)	63.81 (53.00)
6	Chlorantraniliprole 20 SC	0.15	3.50 (2.00)	1.53 (1.41) <sup>a</sup>	0.93 (1.20) <sup>a</sup>	0.70 (1.09) <sup>a</sup>	0.20 (0.84) <sup>a</sup>	0.84 (1.16) <sup>a</sup>	71.41 (58.10)	81.11 (64.28)	83.10 (66.06)	96.00 (78.46)	82.90 (65.56)
7	Untreated check	-	3.87 (2.09)	5.30 (2.41) <sup>c</sup>	4.97 (2.34) <sup>c</sup>	4.37 (2.20) <sup>c</sup>	4.43 (2.22) <sup>c</sup>	5.05 (2.36) <sup>c</sup>	-	-	-	-	-
	S.Em ±		-	0.14	0.15	0.19	0.17	0.19	3.76	3.28	3.23	2.65	3.82
	CD @ 5 %		NS	0.41	0.43	0.55	0.49	0.54	10.99	9.59	9.44	7.73	11.16
	CV (%)		-	14.11	14.33	17.40	15.14	17.49	17.94	15.60	16.45	10.89	17.81

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In a column, means followed by a same letter are not significantly different at p = 0.05 by Duncan's Multiple Range Test (DMRT)

\* Figures in the parentheses are subjected to  $\sqrt{(X + 0.5)}$  transformed values. \*\* Figures in parentheses are sin transformed values.

Table 3. Bio-efficacy of newer insecticides against safflower leaf eating caterpillar, *Perigia capensis* (Guen) under field condition

T. No.	Treatments	Dose (ml or gm/l)	Number of larvae/plant*					Per cent reduction over UTC**					
			1 DBS	3 DAS	7 DAS	10 DAS	15 DAS	Mean	3 DAS	7 DAS	10 DAS	15 DAS	Mean
1	Buprofezin 50 SC	0.25	3.00 (1.87)	1.93 (1.56) <sup>b</sup>	2.37 (1.69) <sup>b</sup>	2.57 (1.75) <sup>b</sup>	2.99 (1.87) <sup>b</sup>	2.46 (1.72) <sup>b</sup>	50.22 (45.10)	61.02 (51.35)	59.47 (50.42)	24.11 (29.40)	48.70 (44.24)
2	Thiamethoxam 25 WG	0.20	3.20 (1.92)	2.47 (1.72) <sup>b</sup>	2.80 (1.81) <sup>b</sup>	3.13 (1.91) <sup>b</sup>	3.36 (1.96) <sup>b</sup>	2.94 (1.85) <sup>b</sup>	36.47 (37.11)	53.91 (47.24)	50.63 (45.34)	14.72 (22.55)	38.93 (38.59)
3	Spinetoram 12 SC	0.20	3.23 (1.93)	2.33 (1.68) <sup>b</sup>	2.53 (1.74) <sup>b</sup>	2.73 (1.80) <sup>b</sup>	3.04 (1.88) <sup>b</sup>	2.65 (1.77) <sup>b</sup>	39.75 (39.06)	58.14 (49.66)	57.01 (49.02)	22.84 (28.54)	44.43 (41.79)
4	Emamectin benzoate 5 SG	0.20	3.27 (1.94)	0.77 (1.12) <sup>a</sup>	0.91 (1.19) <sup>a</sup>	1.60 (1.45) <sup>a</sup>	1.91 (1.55) <sup>a</sup>	1.29 (1.34) <sup>a</sup>	80.63 (63.87)	85.00 (67.21)	74.84 (59.87)	51.52 (45.85)	72.99 (58.66)
5	Spinosad 45 SC	0.15	3.00 (1.87)	1.03 (1.24) <sup>a</sup>	1.31 (1.35) <sup>a</sup>	1.53 (1.42) <sup>a</sup>	1.80 (1.52) <sup>a</sup>	1.41 (1.38) <sup>a</sup>	81.27 (64.33)	78.41 (62.29)	75.98 (60.63)	54.31 (47.45)	72.49 (58.34)
6	Chlorantraniliprole 20 SC	0.15	3.23 (1.93)	0.07 (0.75) <sup>a</sup>	0.90 (1.24) <sup>a</sup>	1.03 (1.24) <sup>a</sup>	1.10 (1.26) <sup>a</sup>	0.77 (1.13) <sup>a</sup>	98.72 (83.47)	85.17 (66.31)	74.28 (59.50)	72.81 (58.55)	82.53 (65.27)
7	Untreated check	-	3.30 (1.95)	5.50 (2.45) <sup>c</sup>	6.07 (2.56) <sup>c</sup>	6.37 (2.62) <sup>c</sup>	3.94 (2.11) <sup>c</sup>	5.47 (2.44) <sup>c</sup>	-	-	-	-	-
	S.Em ±		-	0.13	0.15	0.15	0.12	0.15	4.19	4.01	3.49	3.22	3.43
	CD at 5 %		NS	0.38	0.38	0.44	0.35	0.44	12.23	11.71	10.20	9.39	10.01
	CV (%)		-	14.54	15.20	15.20	12.23	15.37	16.92	16.20	13.01	17.44	13.84

Note:

NS – Non Significant. DBS – Day Before Spray, DAS – Days After Spray. UTC : Un treated Check

In a column, means followed by a same letter are not significantly different at p = 0.05 by Duncan's Multiple Range Test (DMRT)

\* Figures in the parentheses are subjected to  $\sqrt{X + 0.5}$  transformed values. \*\* Figures in parentheses are arc sin transformed values.

recorded in emamectin benzoate 5 SG @ 0.2 g/l (0.85 larvae/plant) sprayed plot which was on par with chlorantraniliprole 20 SC @ 0.15 ml/l (0.93 larvae /plant) and spinosad 45 SC @ 0.15 ml/l (1.92 larvae/plant) sprayed plots. Similarly, in these treatments highest per cent larval reduction was also recorded (Table 2).

At 10 and 15 DAS, similar trend in efficacy of insecticides was observed, where least larval population was recorded in plots sprayed with chlorantraniliprole 20 SC @ 0.15 ml/l followed by spinosad 45 SC @ 0.15 ml/l and emamectin benzoate 5 SG @ 0.2 g/l sprayed plots. Similarly, in these treatments highest per cent larval reduction was also recorded.

The efficacy of new insecticides molecules against lepidopteran insect pests has been well documented in various crops. Spinosad 45 SC and was found more effective against greengram leaf eating caterpillar, *Agrius convolvuli* (Jayaram, 2006). Similarly, emamectin benzoate 5 SG was found to be most effective against *Spodoptera litura* in soybean (Harish *et al.*, 2009), *Helicoverpa armigera* in groundnut (Gadhiya *et al.*, 2014) and chickpea (Kambrekar *et al.*, 2012). These findings confirm the efficacy of new molecules used in the present investigation.

#### **Safflower leaf eating caterpillar, *Perigia capensis* (Guen)**

Before the imposition of treatment, there was no statistically significant difference between the treatments with respect to mean number of larvae per plant. The larval population in different treatments was uniform and ranged from 3.00 to 3.30 per plant (Table 3).

At three DAS, there was a significant difference among the treatments where the population of larvae ranged from 0.07 to 5.50 larvae per plant. The plots sprayed with chlorantraniliprole 20 SC @ 0.15 ml/l recorded least larval population (0.07 larvae/ plant) which was on par with emamectin benzoate 5 SG @ 0.2 g/l (0.77 larvae /plant) and spinosad 45 SC @ 0.15 ml/l (1.03 larvae/plant) sprayed plots. With respect to per cent larval reduction, highest reduction of larval population (98.72%) was recorded in plots sprayed with chlorantraniliprole 20 SC @ 0.15 ml/l followed by spinosad 45 SC @ 0.15 ml/l (81.27%) and emamectin benzoate 5 SG @ 0.2 g/l (80.63%) sprayed plots which were on par with each other.

At seven days after spray the larval population ranged from 0.90 to 6.07 per plant. The least number of larvae was recorded in chlorantraniliprole 20 SC @ 0.15 ml/l (0.90 larvae/plant) sprayed plots which was on par with emamectin benzoate 5 SG @ 0.2 g/l (0.91 larvae/plant) and spinosad 45 SC @ 0.15 ml/l (1.31 larvae/plant) sprayed plots. Similarly the highest per cent larval reduction (85.17%) was recorded in the plots sprayed with chlorantraniliprole 20 SC @ 0.15 ml/l (85.17%) followed by emamectin benzoate 5 SG @ 0.2 g/l (85.00%) and spinosad 45 SC @ 0.15 ml/l (78.98%) sprayed plots. At 10 and 15 DAS, similar trend in efficacy of insecticides was observed where, least larval population was registered in plots sprayed with chlorantraniliprole 20 SC @ 0.15 ml/l followed by spinosad 45 SC @ 0.15 ml/l and emamectin benzoate 5 SG @ 0.2 g/l sprayed plots. Similarly, in these treatments highest per cent larval reduction was also recorded.

The present results are in accordance with Mohan (2015) who reported that chlorantraniliprole 20 SC recorded highest per cent reduction (68.19%) of larvae *Perigia capensis* followed by emamectin benzoate 5SG (65.16%), flubendiamide 480 SC (55.70%) and spinosad 45 SC (55.08%).

#### **Seed yield and cost economics**

The data pertaining to seed yield of safflower and economics of different treatments are presented in Table 4. The seed yield obtained from different insecticides sprayed plots was significantly higher compared to unsprayed control. Among the different treatments, chlorantraniliprole 20 SC @ 0.15 ml/lit sprayed plots registered higher seed yield (12.65 q/ha) followed by thiamethoxam 25 WG @ 0.2 g/l (11.51 q/ha) and emamectin benzoate 5 SG @ 0.2 g/l (10.63 q/ha) sprayed plots which were statistically on par with each other. Whereas, least seed yield was observed in plots sprayed with spinetoram 12 SC @ 0.2 ml/l (8.19 q/ha) followed by spinosad 45 SC @ 0.15 ml/l (8.94 q/ha) and buprofezin 50 SC @ 0.2 ml/l (10.00 q/ha) sprayed plots.

The economics of different treatments revealed that, among different chemicals highest net return was realized in the treatment with chlorantraniliprole 20 SC @ 0.15 ml/lit (₹ 29577 ha<sup>-1</sup>) followed by thiamethoxam 25 WG @ 0.2 g/l (₹ 26702 ha<sup>-1</sup>) and emamectin benzoate 5 SG @ 0.2 g/l (₹ 22775 ha<sup>-1</sup>). Whereas, least net returns of

**Table 4. Seed yield and economics of safflower crop as influenced by different insecticides**

T. No.	Treatments	Dosage (ml/g/ha)	Yield (q/ha)	Gross income (₹/ha)	Cost of cultivation (₹/ha)	Net income (₹/ha)	B: C ratio
1	Buprofezin 50 SC	0.25 ml	10.00	36,000.00	14,318.42	21,681.58	2.51
2	Thiamethoxam 25 WG	0.2 g	11.51	41,448.98	14,747.30	26,701.68	2.81
3	Spinetoram 12 SC	0.2 ml	8.19	29,469.39	15,640.00	13,829.39	1.88
4	Emamectin benzoate 5 SG	0.2 ml	10.63	38,265.31	15,490.30	22,775.01	2.47
5	Spinosad 45 SC	0.15 ml	8.94	32,183.67	15,940.30	16,243.37	2.01
6	Chlorantraniliprole 20 SC	0.15 ml	12.65	45,557.82	15,981.25	29,576.57	2.85
7	Untreated check	-	4.13	14,863.95	14,140.30	723.65	1.05
	S.Em ±		0.75	27,17.49	-	-	-
	CV (%)		13.86	13.86	-	-	-
	CD @ 5%		2.20	8373.84	-	-	-

₹ 13830 per hectare was realized in spinetoram 12 SC @ 0.2 ml/l followed by spinosad 45 SC @ 0.15 ml/l (₹ 16243 ha<sup>-1</sup>) and buprofezin 50 SC @ 0.2 ml/l (₹ 22775 ha<sup>-1</sup>).

The results on the benefit cost ratio revealed that, among the chemical treatments, highest benefit cost ratio was obtained in chlorantraniliprole 20 SC @ 0.15 ml/lit (2.85) followed by thiamethoxam 25 WG @ 0.2 g/l (2.81), buprofezin 50 SC @ 0.2 ml/l (2.51) and emamectin benzoate 5 SG @ 0.2 g/l (2.47). While, least benefit cost ratio was recorded in spinetoram 12 SC @ 0.2 ml/l (1.88) followed by spinosad 45 SC @ 0.15 ml/l (2.01) (Table 4)

In general in minimizing the population of safflower aphids, systemic insecticides were found to be effective among the tested insecticides *i.e.* thiamethoxam 25 WG @ 0.2 g/l, buprofezin 50 SC @ 0.25 ml/l and spinetoram 12 SC @ 0.2 ml/l. However, contact insecticides *i.e.* chlorantraniliprole 20 SC @ 0.15 ml/l, emamectin benzoate 5 SG @ 0.2 g/l and spinosad 45 SC @ 0.15 ml/l were effective against safflower capsule borer and leaf eating caterpillar.

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