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Bio efficacy of Newer Insecticide Molecules against Safflower Capsule Borer, *Helicoverpa armigera* (Hubner)

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A B S T R A C T

A field experiment was conducted during *rabi* season of 2013-14 at Agricultural College Farm, Vijayapur by using a safflower variety Annigeri-1. The results indicated that, among different insecticides tested against capsule borer, the lowest capsule borer per plant was recorded in rynaxypyr 20 SC @ 0.15 ml/l and was on par with emamectin benzoate 5% SG @ 0.20 gm/l, novaluron 10 EC @ 0.75ml/l. The highest yield and benefit cost ratio was recorded in rynaxypyr 20 SC @ 0.15 ml/l followed by emamectin benzoate 5% SG @ 0.20 gm/l and spinosad 45 SC @ 0.1 ml/l. The maximum number of predators *Viz*., *C. zastrowi* and coccinellids was noticed in Biodigester @ 1:3 ratios, NSKE 5%, NPV @ 250 LE/ha, Btk @ 1 gm/ha.

Introduction

Safflower (*Carthamus tinctorius* Linn.) is an important *rabi* oilseed crop in semi arid areas of India. Apart from India, it is cultivated in Mexico, Australia, Mediterranean Europe, California valley, China and Africa (Anon, 1995). In India, safflower production remained stagnant at about 554 thousand tones. In India, Maharashtra is the highest producer of safflower (63%) from the largest growing area (67%) followed by Karnataka in production 32% and in area 27% (Jadhav *et al.*, 2012).

Among the several factors responsible for low production of safflower, insect pests have been considered as one of the important biotic factors. A total of 101 pests are known to attack the safflower at different stages of crop growth (Patil and Halolli, 2005). The important insect pest includes capsule fly (*Acanthiophilus helianthi* Rossi), capsule borer (*Helicoverpa armigera* Hub.) and safflower aphid (*Uroleucon carthami* L.) (Karve *et al.*, 1978). The damage caused by capsule borer (*H. armigera*) surpass the loss caused by all insect pests together by their direct damage to the economically important parts (capsule and leaf) of plant and it has been claimed that the loss due to this pest range from 62.6 to 100 per cent (Sekhar and Rai, 1989).

The liberal use of many chemical insecticides led to problems like toxic residues, elimination of natural enemies, environmental disharmony and development of resistance. Hence, the present study was carried out to evaluate the efficacy of some newer insecticides against *H. armigera* in safflower along with available conventional insecticides.

Materials and Methods

A field trial was conducted during *rabi* season of 2013-14 at Agricultural College Farm, vijayapur by using a safflower variety Annigeri-1. Randomized block design was followed with 14 treatments and 3 replications. The crop was sown at a spacing 60 x 30 cm over a plot size of 5 x 4.8 sq. m by following all the agronomic practices. Application of botanicals, bioagents and chemical insecticides was taken up by using high volume knapsack sprayer at the rate of 500 liters of spray fluid per hectare. The incidence of *H. armigera* was recorded as number of larvae per plant at one day before treatment while post-treatment counts were taken at 3, 10 and 15 days after spraying of insecticides. The grain yield was recorded from each plot separately and converted to per hectare. The data on incidence of *H. armigera* and yields were subjected to suitable statistical analysis. The mean values of the treatments were statistically analyzed and then separated by Duncan`s Multiple Range Test (DMRT).

Results and Discussion

The results revealed that during *rabi* 2013-14, All the insecticidal treatments, including organic products were significantly effective than untreated control in reducing the larva of capsule borer population (Table 1). 3 days after first spray (DAS) lowest incidence of *H. armigera* larva was recorded with rynaxypyr 20 SC @ 0.15ml/l (0.18/plant) and it was significantly superior over all other treatments. The next best treatments were novaluron 10 EC @ 0.75ml/l, emamectin benzoate 5 SG @ 0.2g/l, spinosad 45 SC @ 0.10ml/l and flubendiamide 480 SC @ 0.075ml/l recorded 0.19 larvae per plant when compared to 1.10 larvae per plant in control plot (Table 1). Same trend was observed during 10 DAT and 15 DAT.

This finding is in agreement with the results of Satpute and Barkhade (2012) who reported that rynaxypyr 20 SC was found effective in reducing larval population in pigeon pea. Deshmukh *et al.,* (2010) opined that insecticidal treatments with flubendiamide @ 0.007 per cent gave significantly highest mortality of the pest in chickpea. Patil *et al.,* (2007) suggested that emamectinbenzoate was very effective in reducing the larval population in chickpea. Rajesh *et al.,* (2010) recorded that rynaxypyr 20 SC @ 30 g a.i /ha and rynaxypyr 20 SC @ 20 g. a.i/ha were superior in recording the less larval population of fruit borer in okra.

All treatments proved profitable over control and increase in yield varied from the maximum of 10.68 q ha^{-1} in rynaxypyr to the minimum of 7.65 q ha^{-1} in biodigester treatment (Table 2). The gross income incurred due to the different treatments was the highest (Rs. 34176) in case of rynaxypyr while it was the lowest (Rs 24480) in biodigester. Remaining treatments occupied intermediate position yet with wide difference in respect of gross income. The net profit derived out of different treatments got affected since the cost of production in the these treatments ranged from a minimum of Rs. 10620 ha^{-1} in case of acephate to the maximum of Rs. 11452 ha^{-1} in case of rynaxypyr.

Table.1 Bioefficacy of different insecticides against capsule borer in safflower

Tr. No.	Treatment		Mean larval population of capsule borer per plant			
		Dosage	1DBT	3 DAT	10 DAT	15 DAT
T_1	Profenophos 50 EC	2ml/ l	0.83 (1.15)	0.22 $(0.85)^{abc}$	0.23 $(0.85)^{ab}$	0.23 $(0.85)^{abc}$
T_2	Acephate 75 SP	1 gm/l	0.97 (1.21)	0.23 $(0.85)^{abc}$	0.24 $(0.86)^{abc}$	0.26 $(0.87)^{abc}$
T_3	NSKE 5%	5ml/l	0.91 (1.19)	0.43 $(0.96)^{c}$	0.44 $(0.97)^{c}$	0.47 $(0.98)^{bc}$
T_4	Deltamethrin 10EC	0.5ml/l	0.83 (1.15)	0.24 $(0.86)^{abc}$	0.25 $(0.87)^{abc}$	0.27 $(0.88)^{abc}$
T_5	NPV 2.0% AS	250 LE/ha	0.79 (1.14)	0.39 $(0.94)^{bc}$	0.41 $(0.95)^{bc}$	0.44 $(0.97)^{bc}$
T_6	Btk 0.5% WP	1gm/l	0.82 (1.15)	0.41 $(0.95)^{bc}$	0.44 $(0.97)^{c}$	0.46 $(0.98)^{bc}$
T_7	Novaluron 10 EC	0.75ml/l	0.82 (1.15)	0.19 $(0.83)^{ab}$	0.19 $(0.83)^{a}$	0.21 $(0.84)^{ab}$
T_8	Rynaxypyr 20 SC	0.15ml/l	0.75 (1.12)	0.18 $(0.82)^{a}$	0.18 $(0.82)^{a}$	0.19 $(0.83)^{a}$
T_9	Spinosad 45 SC	0.1ml/l	0.83 (1.15)	0.19 $(0.83)^{ab}$	0.2 $(0.84)_{ab}$	0.2 $(0.84)^{ab}$
T_{10}	Indoxacarb 14.5 SC	0.3ml/l	0.95 (1.20)	0.22 $(0.85)^{abc}$	0.23 $(0.85)^{ab}$	0.25 $(0.87)^{abc}$
T_{11}	Emamectin benzoate 5SG	0.2g/l	0.90 (1.18)	0.19 $(0.82)^{ab}$	0.19 $(0.83)^{a}$	0.21 $(0.84)^{ab}$
T_{12}	Flubendiamide 480 SC	0.075ml/l	0.89 (1.18)	0.19 $(0.83)^{ab}$	0.2 $(0.84)^{ab}$	0.22 $(0.85)^{abc}$
T_{13}	Control	---	0.91 (1.19)	1.1 $(1.26)^{e}$	1.24 $(1.35)^{e}$	1.35 $(1.36)^{e}$
T_{14}	Biodigester	1:3 (Biodigester :water)	0.94 (1.20)	0.72 $(1.10)^{d}$	0.84 $(1.16)^{d}$	0.89 $(1.18)^{d}$
	S.Em±			0.042	0.040	0.045
	CD @5%		NS	0.12	0.11	0.13
	CV(%)			7.97	7.35	8.11

NS – Non-significant, Means followed by same letter in a column do not differ significant by DMRT at 5% level DBT-Days Before Treatment, DAT – Days After Treatment

Table.2 Economics of insecticidal treatments on safflower capsule borer

Tr. No.	Treatment	Yield (q/ha)	Gross income (Rs./ha)	Net income (Rs./ha)	Cost of protection (Rs./ha)	Cost of production (Rs./ha)	BC ratio
T_1	Profenophos 50 EC	9.83^{ab}	31456	20416	740	11040	1:1.85
T_2	Acephate 75 SP	9.56^{ab}	30592	19972	320	10620	1:1.88
T_3	NSKE 5%	7.76^{cd}	24832	14032	500	10800	1:1.30
T_4	Deltamethrin 10EC	9.68^{ab}	30976	20246	430	10730	1:1.89
T_5	NPV 2.0% AS	7.92^{cd}	25344	14494	550	10850	1:1.34
T_6	Btk 0.5% WP	7.70^{cd}	24640	13830	510	10810	1:1.28
T_7	Novaluron 10 EC	10.43^{a}	33376	21472	1604	11904	1:1.80
T_8	Rynaxypyr 20 SC	10.68^{a}	34176	22724	1152	11452	1:1.98
T_9	Spinosad 45 SC	10.47^{a}	33504	22054	1150	11450	1:1.93
T_{10}	Indoxacarb 14.5 SC	8.96^{bc}	28672	17472	900	11200	1:1.56
T_{11}	Emamectin benzoate 5SG	10.38^{a}	33216	22086	830	11130	1:1.96
T_{12}	Flubendiamide 480 SC	10.11^{ab}	32352	21247	805	11105	1:1.91
T_{13}	Control	6.12^{e}	19584	9284	0	10300	1:0.90
T_{14}	Biodigester	7.65^{d}	24480	13580	600	10900	1:1.25
	S.Em±	0.46					
	CD @5%	1.35					
	CV(%)	8.83					

Means followed by same letter in a column do not differ significant by DMRT at 5% level,
Market price of safflower: 3200/q, cost of cultivation: 10300

Table.3 Population of coccinelids in chemical sprayed plot in safflower

Tr. No.	Treatment		Mean larval population of coccinelid per plant			
		Dosage	DBT	3 DAT	10 DAT	15 DAT
T_1	Profenophos 50 EC	2ml/ l	0.51 (1.00)	0.33 $(0.91)^{b}$	0.33 $(0.91)^{b}$	0.31 $(0.90)^{c}$
T_2	Acephate 75 SP	1 gm/l	0.48 (0.99)	0.35 $(0.92)^{b}$	0.34 $(0.92)^{b}$	0.32 $(0.91)^{bc}$
T_3	NSKE 5%	5ml/l	0.56 (1.03)	0.48 $(0.99)^{ab}$	0.48 $(0.99)^{ab}$	0.47 $(0.98)^{bc}$
T_4	Deltamethrin 10EC	0.5ml/l	0.43 (0.96)	0.37 $(0.93)^{b}$	0.36 $(0.93)^{b}$	0.35 $(0.92)^{bc}$
T_5	NPV 2.0% AS	250 LE/ha	0.49 (0.99)	0.43 $(0.96)^{ab}$	0.43 $(0.96)^{ab}$	0.41 $(0.95)^{bc}$
T_6	Btk 0.5% WP	1gm/l	0.47 (0.98)	0.42 $(0.96)^{ab}$	0.41 $(0.95)^{ab}$	0.41 $(0.95)^{bc}$
T_7	Novaluron 10 EC	0.75ml/l	0.53 (1.01)	0.32 $(0.91)^{b}$	0.30 $(0.89)^{b}$	0.30 $(0.89)^{c}$
T_8	Rynaxypyr 20 SC	0.15ml/l	0.59 (1.04)	0.35 $(0.92)^{b}$	0.33 $(0.91)^{b}$	0.31 $(0.90)^{c}$
T_9	Spinosad 45 SC	0.1ml/l	0.56 (1.03)	0.32 $(0.91)^{b}$	0.31 $(0.90)^{b}$	0.31 $(0.90)^{c}$
T_{10}	Indoxacarb 14.5 SC	0.3ml/l	0.51 (1.00)	0.36 $(0.93)^{b}$	0.34 $(0.92)^{b}$	0.33 $(0.91)^{bc}$
T_{11}	Emamectin benzoate 5SG	0.2g/l	0.48 (0.99)	0.33 $(0.91)^{b}$	0.32 $(0.91)^{b}$	0.31 $(0.90)^{c}$
T_{12}	Flubendiamide 480 SC	0.075ml/l	0.53 (1.01)	0.32 $(0.91)^{b}$	0.32 $(0.91)^{b}$	0.31 $(0.90)^{c}$
T_{13}	Control	---	0.46 (0.98)	0.58 $(1.04)^{a}$	0.63 $(1.06)^{a}$	0.75 $(1.12)^{a}$
T_{14}	Biodigester	1:3 (Biodigester :water)	0.55 (1.02)	0.49 $(0.99)^{ab}$	0.53 $(1.01)^{ab}$	0.53 $(1.01)^{b}$
	S.Em±			0.033	0.033	0.035
	CD @5%		NS	0.10	0.11	0.11
	CV(%)			6.05	6.16	6.40

Table.4 Population of *Chrysoperla zasrteowi* sillemi in chemical sprayed plot in safflower

Tr. No.	Treatment		Mean larval population of *C. zasrteowi* per plant			
		Dosage	DBT	3 DAT	10 DAT	15 DAT
T_1	Profenophos 50 EC	2ml/ l	0.53 (1.01)	0.32 $(0.91)^{b}$	0.32 $(0.91)^{b}$	0.30 $(0.89)^{b}$
T_2	Acephate 75 SP	1 gm/l	0.47 (0.98)	0.31 $(0.90)^{b}$	0.29 $(0.88)^{b}$	0.28 $(0.88)^{b}$
T_3	NSKE 5%	5ml/l	0.51 (1.00)	0.45 $(0.98)^{ab}$	0.44 $(0.97)^{ab}$	0.43 $(0.97)^{ab}$
T_4	Deltamethrin 10EC	0.5ml/l	0.58 (1.04)	0.35 $(0.92)^{b}$	0.34 $(0.92)^{b}$	0.34 $(0.92)^{b}$
T_5	NPV 2.0% AS	250 LE/ha	0.48 (0.99)	0.44 $(0.97)^{ab}$	0.42 $(0.96)^{ab}$	0.42 $(0.96)^{ab}$
T_6	Btk 0.5% WP	1gm/l	0.56 (0.93)	0.45 $(0.97)^{ab}$	0.44 $(0.97)^{ab}$	0.43 $(0.97)^{ab}$
T_7	Novaluron 10 EC	0.75ml/l	0.49 (0.99)	0.31 $(0.90)^{b}$	0.29 $(0.88)^{b}$	0.28 $(0.88)^{b}$
T_8	Rynaxypyr 20 SC	0.15ml/l	0.47 (0.98)	0.30 $(0.89)^{b}$	0.28 $(0.88)^{b}$	0.27 $(0.88)^{b}$
T_9	Spinosad 45 SC	0.1ml/l	0.52 (1.01)	0.32 $(0.91)^{b}$	0.30 $(0.89)^{b}$	0.28 $(0.88)^{b}$
T_{10}	Indoxacarb 14.5 SC	0.3ml/l	0.57 (1.03)	0.34 $(0.92)^{b}$	0.33 $(0.91)^{b}$	0.33 $(0.91)^{b}$
T_{11}	Emamectin benzoate 5SG	0.2g/l	0.51 (1.00)	0.32 $(0.91)^{b}$	0.29 $(0.88)^{b}$	0.30 $(0.89)^{b}$
T_{12}	Flubendiamide 480 SC	0.075ml/l	0.55 (1.02)	0.33 $(0.91)^{b}$	0.31 $(0.90)^{b}$	0.31 $(0.90)^{b}$
T_{13}	Control	---	0.58 (1.04)	0.69 $(1.09)^{a}$	0.74 $(1.11)^{a}$	0.82 $(1.15)^{a}$
T_{14}	Biodigester	1:3 (Biodigester :water)	0.52 (1.01)	0.49 $(0.99)^{ab}$	0.48 $(0.99)^{ab}$	0.48 $(0.99)^{ab}$
	S.Em±			0.035	0.035	0.033
	CD @5%		NS	0.11	0.10	0.10
	CV(%)			6.41	6.54	6.20

Consequently the net profit derived out of different treatments was the highest Rs. 22724 to the lowest Rs. 13580 in rynaxypyr and biodigester, respectively. The highest B:C ratio was registered in rynaxypyr 20 SC @ 0.15ml/l (1:1.98) followed by 1:1.96 in emamectinbenzoate 5% SG @ 0.20gm/l and 1:1.93 in spinosad 45 SC @ 0.10ml/l. In the control plot, the lowest B:C ratio of 1:0.90 was recorded.

Deshmukh *et al.,* (2010) who reported the highest grain yield of 1850 kg/ha in flubendiamide 0.007% and 1665 kg /ha in emamectin benzoate @ 0.00015 % treated chickpea plots and gave the highest benefit cost ratio of 6.10 and 4.24, respectively. The rynaxypyr 20 SC recorded the high yield of pigeonpea as reported by Satpute and Barkhade (2012). Patil *et al.,* (2007) reported that the application of emamectin benzoate recorded higher cost benefit cost ratio of 2.27 in chickpea.

The data on the natural enemy population revealed that good numbers of coccinellids and *C. zastrowi* Sillemi population in all organic product treatments. The highest population of natural enemies was noticed in biodigester treatment followed by NSKE 5%, NPV @ 250 LE/ha, Btk @ 1ml/l (Table 3). Even though slightly higher natural enemy population was observed in untreated control, there was no significant difference when compared with any of the organic treatments (Table 4).

The present findings are in line with Hanamantharaya *et al.,* (2008) who reported that number of natural enemies (coccinelid and *C.carnea*) population in absolute control was 3.0 per plant which was superior over in profenophos treated safflower plot (0.90/plant).

From the above conducted experiment, it can be concluded that rynaxypyr, emamectinbenzoate, novaluron and flubendiamide were very effective against *H. armigera* on safflower with reduced damage and enhanced seed yields. The predatory population (Coccinellids and *C.zasrteowi* sillemi) in organic treated plots was statistically on par with control plot.

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