Efficacy of newer insecticides against defoliators and capsule borer in castor

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Abstract

Field experiments were conducted during Kharif *2012 and 2013 to evaluate the efficacy of four newer insecticides (flubendiamide, chlorantraniliprole, emamectin benzoate and lufenuron) with two conventional insecticides (lambda-cyhalothrin and profenofos) against defoliators (semilooper and tobacco caterpillar) and capsule borer in castor. Among the insecticides, flubendiamide @ 48 g a.i./ha and chlorantraniliprole @ 30 g a.i./ha were very effective in suppressing the larval population of semilooper during 2012 and tobacco caterpillar (0.0 to 0.1 and 0.0 to 0.3 larva/plant, respectively) during 2013 and significantly superior to emamectin benzoate and lufenuron (0.1 to 0.7 and 0.7 to 3.3 larvae/plant, respectively) and untreated control (1.9 to 2.4 and 4.3 to 5.3 larvae/plant, respectively). Capsule damage due to capsule borer during both the years was lowest in flubendiamide (5.0 to 9.3%) and chlorantraniliprole (4.9 to 9.8%) treatments compared to 11.0 to 17.3% in control. Highest seed yield was recorded with flubendiamide (2111 kg/ha) followed by chlorantraniliprole (2018 kg/ha) as against 1613 kg/ha in untreated control. The maximum incremental cost-benefit ratio of 1:3.04 was obtained with application of flubendiamide followed by lambda-cyhalothrin (1:2.95) and profenofos (1:2.77).*

Keywords: Newer insecticides, bioefficacy, lepidopteran pests, castor

Introduction

Castor (*Ricinus communis* L.) is an industrially important oilseed crop in India. The current castor production in the country is 13.37 lakh tonnes from 8.85 lakh hectares with a productivity of 1512 kg/ha in 2012-13 (DAC, 2013). One of the major constraints that limit castor productivity is the excessive damage caused by lepidopteran pests, the major ones being castor semilooper, *Achaea janata* L. (Noctuidae: Lepidoptera); tobacco caterpillar, *Spodoptera litura* F. (Noctuidae: Lepidoptera) and capsule borer, *Conogethes punctiferalis* Guenee (Pyralidae: Lepidoptera). Semilooper and tobacco caterpillar are active during the vegetative stage and over 50% defoliation is common in certain favourable years. Infestation of *C. punctiferalis* starts from flowering stage onwards and the yield loss due to the pest is to the tune of 50% in recent years (Lakshminarayana *et al*., 2013).

Flubendiamide, chlorantraniliprole, emamectin benzoate and lufenuron are new molecules with novel mode of action and very effective against lepidopteran pests in different crop ecosystem (Sandip *et al*., 2012; Sreekanth *et al.*, 2014; Gadhiya *et al.*, 2014). However, information on the efficacy of these insecticides against lepidopteran pests of castor is very limited (Lakshminarayanamma *et al*., 2013). Hence, the present study was undertaken to find out the field efficacy of these newer insecticides for the management of major lepidopteran pests in castor.

Materials and methods

Field experiments were carried out at Research Farm, Directorate of Oilseeds Research, Hyderabad to evaluate the efficacy of newer insecticides against defoliators (semilooper and tobacco caterpillar) and capsule borer of castor during *Kharif* 2012 and 2013. For this purpose, castor hybrid DCH-519 was raised in plots of size 6.3 × 5.4 m with a spacing of 90 × 90 cm with recommended agronomic practices except for insect-pest management. The experiment was laid out in a randomized block design (RBD) with seven treatments including untreated control and replicated three times. The insecticidal treatments included four newer insecticides *viz*., flubendiamide 39.35 SC @ 48 g a.i./ha, chlorantraniliprole 18.5 SC @ 30 g a.i./ha, emamectin benzoate 5 SG @ 11 g a.i./ha, lufenuron 5.4 EC @ 30 g a.i./ha and two conventional insecticides, lambda-cyhalothrin 5 EC @ 25 g a.i./ha and profenofos 50 EC @ 250 g a.i./ha. Two sprays were imposed using high volume knapsack sprayer (500 l/ha) during vegetative and capsule development stage against defoliators and capsule borer, respectively. Observations on semilooper and *S. litura* larvae were recorded from five randomly selected plants from each replication at one day before, 3, 7 and 14 days after spraying and the mean larvae per plant was worked out. Number of capsules damaged by the capsule borer was recorded from five randomly selected plants from each treatment at one day before, 7 and 14 days after spraying and then capsule damage (%) was calculated. The yield was recorded on the net plot area basis which was converted to kg/ha for statistical interpretations. The monetary returns and incremental cost-benefit ratios of treatments were assessed based on the yield and cost of plant protection. The data on numbers were transformed into square root values and per cent transformed into arc sine values and subjected to statistical analysis using AGRES statistical software. Following ANOVA, differences between datasets were determined using least significant difference at P = 0.05 in all instances.

Results and discussion

Efficacy against semilooper

The semilooper, *A. janata* population was uniform in all the treatments before spray as treatment difference was non-significant ranging from 1.7 to 2.9 larvae/plant during *Kharif* 2012 (Table 1). There was a significant reduction in semilooper population after spraying of the insecticides over untreated control. Flubendiamide and chlorantraniliprole recorded significantly lower infestation of semilooper (nil larval population and 0 to 0.1 larva/plant up to 14 days after spray, respectively) over other treatments (0.1 to 0.7 larva/plant) and untreated control (1.9 to 2.4 larvae/plant). The results from the pooled mean data after spray revealed that flubendiamide and chlorantraniliprole were superior and showed 100% reduction in larval population of semilooper over untreated check followed by profenofos (95.2%). All other treatments *viz*., emamectin benzoate, lambda-cyhalothrin and lufenuron effected 81 to 90.5% reduction in semilooper population over untreated control. These findings were similar to that reported by Lakshminarayanamma *et al*., (2013), who found maximum reduction of semilooper population in castor by flubendiamide and chlorantraniliprole over conventional insecticide, acephate. Similar reports on the effectiveness of flubendiamide and chlorantraniliprole against lepidopteran pests like *Helicoverpa armigera* on pigeonpea (Sreekanth *et al*., 2014), *Plutella xylostella* on cabbage (Sandip *et al*., 2012) and *Cnaphalocrocis medinalis* on rice

Table 1. Effect of different insecticides on semilooper and capsule borer damage in castor (*Kharif* 2012)

	Semilooper (larvae/plant)*						% Capsules damaged by capsule borer**				
	First spray						Second spray				
Treatments	Before	3 days after	7 days after	14 days after	Mean	% Reduction over control	Before	7 days after	14 days after	Mean	% Reduction over control
Flubendiamide 39.35 SC @ 48 g a.i./ha	2.4 (1.7)	0.0 (0.7)^{a}	0.0 (0.7)^{a}	0.0 (0.7)^{a}	0.0	100	8.9 (17.3)	5.6 (13.7)^{ab}	4.3 (11.9)^{a}	5.0	54.6
Chlorantraniliprole 18.5 SC@ 30 g a.i./ha	2.9 (1.8)	0.1 (0.8)^{a}	0.0 (0.7)^{a}	0.0 (0.7)^{a}	0.0	100	8.1 (16.5)	5.0 (12.9)^{a}	4.7 (12.6)^{b}	4.9	55.5
Emamectin Benzoate 5 SG @ 11 g a.i./ha	1.8 (1.5)	0.3 (0.9)^{a}	0.1 (0.8)^{ab}	0.15 (0.8)^{ab}	0.2	90.5	9.2 (17.5)	6.2 (14.4)^{bc}	5.5 (13.6)^{bc}	5.8	47.3
Lufenuron 5.4 EC @ 30 g a.i./ha	1.7 (1.5)	0.7 (1.1)^{b}	0.3 (0.9)^{b}	0.1 (0.8)^{a}	0.4	81.0	7.5 (15.8)	7.2 (15.5)^{cd}	6.1 (14.3)^{cd}	6.7	39.1
Lambda-Cyhalothrin 5 EC @ 25 g a.i./ha	2.2 (1.6)	0.1 (0.8)^{a}	0.2 (0.8)^{ab}	0.3 (0.9)^{b}	0.2	90.5	9.3 (17.7)	8.3 (16.7)^{d}	6.6 (14.8)^{d}	7.5	31.8
Profenofos 50 EC @ 250 g a.i./ha	2.5 (1.7)	0.1 (0.8)^{a}	0.2 (0.8)^{b}	0.1 (0.8)^{ab}	0.1	95.2	7.3 (15.6)	5.1 (13.0)^{ab}	5.8 (13.9)^{cd}	5.5	50.0
Untreated control	1.9 (1.6)	2.4 (1.7)^{c}	2.1 (1.6)^{c}	1.9 (1.5)^{c}	2.1	-	8.5 (16.9)	11.2 (19.5)^{e}	10.7 (19.1)^{e}	11.0	-
SEm (±)	-	0.10	0.06	0.06	-	-	-	0.6	0.6	-	-
CD (P=0.05)	NS	0.23	0.13	0.12	-	-	NS	1.4	1.2	-	-
CV (%)	-	13.3	7.8	7.7	-	-	-	5.2	4.7	-	-

* Figures in parentheses are square root transformed values; **Figures in parentheses are angular transformed values
Figures followed by the same letter did not differ significantly

(Suresh *et al*., 2011) were also documented.

Efficacy against tobacco caterpillar

During *Kharif* 2013, the population of tobacco caterpillar, *S. litura* recorded before initiation of spray was uniform with a range of 3.3 to 5.7 larvae per plant (Table 2). Application of insecticides was effective in decreasing the population of *S. litura* in castor. Among the insecticides, chlorantraniliprole and flubendiamide significantly reduced the *S. litura* population and recorded nil larval population and 0 to 0.3 larva/plant up to 14 days after spray, respectively. Next to these treatments, profenofos recorded lower infestation of 0.7 to 1.3 larvae/plant up to 14 days after spray over other treatments (0.7 to 3.3 larvae/plant) and untreated control (4.3 to 5.3 larvae/plant). The pooled mean data on the effect of treatments on the larval population of *S. litura* revealed that chlorantraniliprole and flubendiamide were superior and effected 100% and 97.9% reduction in *S. litura* larval population over untreated check, respectively. The treatments profenofos, emamectin benzoate, lambda-cyhalothrin and lufenuron effected 50 to 79.2% reduction in larval population over untreated control and found in descending order of their efficacy. The results are in agreement with the findings of Lakshminarayanamma *et al*., (2013) who reported that chlorantraniliprole and flubendiamide were found to be the most effective chemicals for the control of *S. litura* in castor. Similarly, results are also in agreement with the works of Patil *et al.*, (2013) and Gadhiya *et al.*, (2014) who found that the chlorantraniliprole and flubendiamide were superior in reducing the incidence of *S. litura* in chilli and groundnut.

Efficacy against capsule borer

The per cent capsule damage due to capsule borer (*C. punctiferalis*) was uniform before imposing treatments ranging from 7.3 to 9.3% during *Kharif* 2012 and 12.6 to 15.0% during *Kharif* 2013 (Tables 1 and 2). Capsule damage recorded at different intervals after spray revealed that flubendiamide and chlorantraniliprole significantly excelled over other treatments in reducing the capsule damage. During *Kharif* 2012, flubendiamide and chlorantraniliprole respectively with 4.3 to 5.6% and 4.7 to 5.0% capsule damage were found to be significantly superior to other treatments (5.1 to 8.3%) and untreated control (10.7 to 11.2%). During *Kharif* 2013 too, flubendiamide and chlorantraniliprole respectively with 7.8 to 10.8% and 9.7

Table 2. Effect of different insecticides on *Spodoptera litura* and capsule borer damage in castor (*Kharif* 2013)

	Spodoptera litura (Larvae/plant)*						% Capsules damaged by capsule borer**				
	First spray						Second spray				
Treatments	Before	3 days after	7 days after	14 days after	Mean	% Reduction over control	Before	7 days after	14 days after	Mean	% Reduction over control
Flubendiamide 39.35 SC @ 48 g a.i./ha	4.7 (2.3)	0.3 (0.9)[a]	0.0 (0.7)[a]	0.0 (0.7)[a]	0.1	97.9	15.0 (22.8)	10.8 (19.2)[ab]	7.8 (16.3)[a]	9.3	46.0
Chlorantraniliprole 18.5 SC@ 30 g a.i./ha	5.7 (2.5)	0.0 (0.7)[a]	0.0 (0.7)[a]	0.0 (0.7)[a]	0.0	100	14.2 (22.1)	9.7 (18.1)[a]	9.8 (18.3)[b]	9.8	43.6
Emamectin Benzoate 5 SG @ 11 g a.i./ha	3.7 (2.0)	2.3 (1.7)[bc]	1.3 (1.3)[b]	0.7 (1.1)[b]	1.4	70.8	13.8 (21.8)	10.8 (19.2)[ab]	11.2 (19.5)[c]	11.0	36.4
Lufenuron 5.4 EC @ 30 g a.i./ha	4.3 (2.2)	3.3 (2.0)[cd]	1.7 (1.5)[bc]	2.3 (1.7)[c]	2.4	50.0	12.9 (21.1)	11.4 (19.7)[b]	11.9 (20.3)[c]	11.7	32.4
Lambda-Cyhalothrin 5 EC @ 25 g a.i./ha	3.3 (1.9)	1.7 (1.5)[b]	2.3 (1.7)[c]	2.0 (1.6)[c]	2.0	58.3	12.6 (20.8)	11.1 (19.5)[b]	10.9 (19.3)[bc]	11.0	36.2
Profenofos 50 EC @250 g a.i./ha	5.0 (2.3)	1.3 (1.3)[b]	1.0 (1.2)[b]	0.7 (1.1)[b]	1.0	79.2	14.8 (22.6)	10.7 (19.1)[ab]	11.7 (20.0)[c]	11.2	35.2
Untreated control	4.3 (2.2)	4.7 (2.3)[d]	5.3 (2.4)[d]	4.3 (2.2)[d]	4.8	-	13.2 (21.2)	16.5 (23.9)[c]	18.1 (25.2)[d]	17.3	-
SEm ±	-	0.18	0.12	0.15	-	-	-	0.59	0.57	-	-
CD (P=0.05)	NS	0.40	0.26	0.32	-	-	NS	1.29	1.24	-	-
CV (%)	-	15.4	10.5	14.2	-	-	-	3.68	3.51	-	-

*Figures in parentheses are square root transformed values; **Figures in parentheses are arcsin transformed values
Figures followed by the same letter did not differ significantly

to 9.8% capsule damage were found superior when compared to all other treatments (10.7 to 11.9%) and control (16.5 to 18.1%). The pooled mean data showed that flubendiamide and chlorantraniliprole effected a maximum reduction of 46 to 54.6% and 43.6 to 55.5% in damage over control, respectively. Profenofos, emamectin benzoate, lufenuron and lambda-cyhalothrin effected 35.2-50%, 36.4-47.3%, 32.4-39.1% and 31.8-36.2% reduction in damage over control, respectively. Earlier flubendiamide and chlorantraniliprole were evaluated against many lepidopteran borers like okra fruit borer (Chowdary *et al*., 2010), rice yellow stem borer (Suresh *et al*., 2011), tomato fruit borer, brinjal shoot and fruit borer (Chatterjee and Mondal, 2012), chilli fruit borer (Patil *et al.*, 2013), gram pod borer (Sreekanth *et al*., 2014) and found to be effective.

Effect on yield and economics

Data on yield over years (*Kharif* 2012 and 2013) revealed that there was significant impact of insecticidal treatments on seed yield of castor (Table 3). Higher seed yield (2237 kg/ha) was resulted with application of flubendiamide, followed by chlorantraniliprole (2152 kg/ha) as against the lowest yield (1782 kg/ha) in untreated control during *Kharif* 2012-13 (Table 3). Flubendiamide and chlorantraniliprole maintained their superiority during *Kharif* 2013 too, with a significantly higher seed yield (1985 kg/ha and 1884 kg/ha, respectively) as against 1443 kg/ha in control. Pooled data revealed that highest seed yield was recorded in flubendiamide (2111 kg/ha) with 30.9% increase over control, followed by chlorantraniliprole (2018 kg/ha) with 25.1% increase over control as against the lowest seed yield of 1613 kg/ha in the untreated control. Net profit was higher in flubendiamide application (Rs.11992/ha) followed by chlorantraniliprole (Rs.7780/ha) over untreated control. The cost effectiveness of flubendiamide was high with incremental cost-benefit ratio (ICBR) of 1: 3.04, followed by lambda-cyhalothrin (1: 2.95) and profenofos (1: 2.77) (Table 3). Sreekanth *et al.*, (2014) reported the highest IBCR of 1:4.50 in pigeonpea plots treated with flubendiamide. Patil *et al.*, (2013) reported that, among newer and conventional insecticides evaluated in chilli, flubendiamide was economically the most viable treatment with cost: benefit ratio of 1:7.12. This study also showed the highest ICBR obtained in treatment of flubendiamide as report-ed by the other workers.

New generation of insecticides, more selective than conventional ones have been developed to be more safer and fit well into IPM and IRM as resistance development occurred due to limited number of target sites exploited by conventional insecticides. One such group of insecticides is the diamides, which includes flubendiamide and

Table 3. Effect of different insecticides on yield and economics of castor

Treatments	Yield (kg/ha) *Kharif*			Increase in yield over control		Cost of increased yield (₹)	*Plant protection cost (₹/ha)	Net profit (₹/ha)	ICBR
	2012	2013	Mean	kg/ha	Per cent				
Flubendiamide 39.35 SC @ 48 g a.i./ha	2237[a]	1985[a]	2111	498	30.9	15936	3944	11992	1: 3.04
Chlorantraniliprole 18.5 SC@ 30 g a.i./ha	2152[ab]	1884[a]	2018	405	25.1	12960	5180	7780	1: 1.50
Emamectin benzoate 5 SG @ 11 g a.i./ha	1913[cd]	1824[ab]	1869	256	15.9	8192	4140	4052	1: 0.98
Lufenuron 5.4 EC @ 30 g a.i./ha	2075[abc]	1665[bc]	1870	257	15.9	8224	5840	2384	1: 0.41
Lambda-cyhalothrin 5 EC @ 25 g a.i./ha	2052[abc]	1507[cd]	1780	167	10.4	5344	1352	3992	1: 2.95
Profenofos 50 EC @ 250 g a.i./ha	1974[bcd]	1567[cd]	1771	158	9.8	5056	1340	3716	1: 2.77
Untreated control	1782[d]	1443[d]	1613	-	-	-	-	-	-
SEm ±	105	79.0	-	-	-	-	-	-	-
CD (P=0.05)	228	172.2	-	-	-	-	-	-	-
CV (%)	6.3	-	-	-	-	-	-	-	-

Market price of castor: ₹32/- per kg; *Labour charges included chlorantraniliprole. These molecules are described as ryanodine receptor modulators and affect nerve and muscle action (IRAC Mode of Action Working Group, 2009; Hardke *et al*., 2011). In the present study, the newer insecticides *viz*., flubendiamide and chlorantraniliprole showed greater efficacy than standard insecticides currently recommended for the management of defoliators (semilooper and *S. litura*) and capsule borer (*C. punctiferalis*) in castor ecosystem. Based on the efficacy and economics, the study suggests that flubendiamide 39.35 SC @ 48 g a.i./ha can be opted for inclusion in IPM programme against the lepidopteran pests in castor.

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