Field efficacy of newer insecticides against sucking insect pests in castor

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Abstract

Field experiments were conducted during 2014, 2015 and 2016 to evaluate the efficacy of four newer insecticides (clothianidin 50WG @ 25 g a.i./ha, flonicamid 50WG @ 50 g a.i./ha, acetamiprid 20SP @ 20 g a.i./ha, thiamethoxam 25WG @ 50 g a.i./ha) along with two conventional insecticides (profenofos 50EC @ 250 g a.i./ha and dimethoate 30EC @ 250 g a.i./ha) against sucking insect pests viz.*, leafhopper (*Empoasca flavescens*) and thrips (*Retithrips syriacus*) in castor. Based on pooled analysis of three years data, per cent reduction of leafhopper was found to be higher in clothianidin (99.2% reduction over untreated control) followed by acetamiprid (97.6%) and dimethoate (97.2%). Clothianidin provided 95.1 per cent reduction in thrips population followed by dimethoate (89.4%) and acetamiprid (86.6%). Significantly highest seed yield was harvested from the clothianidin treated plots (1116 kg/ha) followed by profenofos (1017 kg/ha) and acetamiprid (1012 kg/ha), which were at par with each other, whereas the lowest yield was recorded in untreated control (729 kg/ha). The maximum net return (₹ 16068/ha) and benefit-cost ratio (1.70) was obtained with application of clothianidin followed by acetamiprid (₹ 13548/ha and 1.62) and profenofos (₹ 13443/ha and 1.61).*

Keywords: Bioefficacy, castor, insecticides, sucking pests

Introduction

Castor (*Ricinus communis* L.) is known for its diversified uses in industrial, medical, agriculture and domestic sectors. India accounts for nearly 66.5 and 82.9 per cent of world's castor area and production, respectively. The current castor production in the country is 17.52 lakh tonnes from 10.61 lakh hectares with a productivity of 1652 kg/ha (DES, 2016). Though castor productivity in India is more than the world average (1345 kg/ha), there are several production constraints in the rainfed castor growing areas, of which insect pests play a major role (Lakshminarayana and Duraimurugan, 2014). Among the insect pests, leafhopper (*Empoasca flavescens* F.) and thrips (*Retithrips syriacus* (Mayet) are the most important sucking pests during both *Kharif* and *Rabi* seasons. Nymphs and adults of leafhopper suck sap from the under surface of the leaves and inject toxin causing hopper burn symptoms resulting in loss of vitality, stunted growth and poor formation of capsules. Thrips damage tender leaves and floral parts resulting in characteristic wrinkling of plants and withering of developing spikes. Insecticides have been used widely to control the insect pests on castor because of their easy adaptability, effectiveness and immediate control. So far, the use of organophosphorus insecticides has been the major approach for controlling the sucking pests in castor. However, repeated applications of broad spectrum insecticides with similar mode of action may result in development of resistance (Saha and Mukhopadhyay, 2013) and less effective control. To overcome the problems of resistance, identification of new chemical molecules with better insecticidal properties, lower dosage with selective action is a continuous process for integration in IPM strategies. Of the new generation insecticide molecules, flonicamid and clothianidin are new molecules with novel mode of action and effectiveness against sucking insect pests in different crop ecosystems (Babu *et al*., 2012; Pachundkar *et al.,* 2013; Chaudhari *et al.,* 2015; Chandi *et al*., 2016). However, information on the efficacy of these insecticides against sucking pests of castor is very limited. Keeping this in view, the present study was taken up to find out the field efficacy of these newer insecticides for the management of leafhopper and thrips in castor.

Materials and methods

The field experiment was conducted at the research farm of ICAR-Indian Institute of Oilseeds Research, Hyderabad consecutively for three years during *Kharif* 2014, 2015 and 2016. Castor cultivar DCS-107 was raised in plots of size 4.5 × 6.0 m with a spacing of 90 × 60 cm with recommended agronomic practices except for insect-pest management. The experiment was laid out in a Randomized block design with seven treatments including untreated control replicated thrice. The insecticidal treatments included four newer insecticides *viz*., clothianidin 50WG @ 25 g a.i./ha, flonicamid 50WG @ 50 g a.i./ha, acetamiprid 20SP @ 20 g a.i./ha, thiamethoxam 25WG @ 50 g a.i./ha and two conventional insecticides profenofos 50EC @ 250 g a.i./ha and dimethoate 30EC @ 250 g a.i./ha. Two sprays were imposed using high volume knapsack sprayer (500 l/ha) at 15 days interval during primary spike development and secondary spike initiation stages of the crop coinciding with incidence of leafhopper on leaves and thrips on immature spikes. Observations on leafhopper and thrips were recorded from five randomly selected plants per plot before spraying and 3, 7 and 14 days after each application. The population of nymphs and adults of leafhopper was recorded on top, middle and bottom leaves of randomly selected plants. Absolute population of thrips per spike was recorded by tapping the immature spikes onto a white cardboard. The yield was recorded on net plot area basis, which was converted to kg/ha for statistical interpretations. The economics of different treatments were worked out. Pooled data for three years were subjected to statistical analysis with MSTAT-C software.

Results and discussion

Efficacy against leafhopper

The pooled mean incidence of leafhopper over three years of observation indicated that variability in leafhopper population due to treatments was significant (Table 1). Among the different insecticides tested after first spray, clothianidin 50WG @ 25 g a.i./ha was significantly superior to all other treatments, which is evident from the minimum leafhopper population of 1.1, 2.4 and 9.9 leafhoppers/3 leaves/plant at 3, 7 and 14 days after treatment (DAT), respectively. This was followed by acetamiprid 20SP @ 20 g a.i./ha (2.2, 3.6 and 11.4 leafhoppers/3 leaves/plant at 3, 7 and 14 DAT, respectively) as against 58.9 to 64.5 leafhoppers/-3 leaves/plant in untreated control. The mean per cent reduction over untreated control after first spray was 92.7 and 90.7 per cent by clothianidin and acetamiprid respectively, while it was 79.8 and 88.3 per cent in case of standard checks profenofos 50EC @ 250 g a.i./ha and dimethoate 30EC @ 250 g a.i./ha, respectively. The mean leafhopper population after the second spray was lowest in the clothianidin treated plots (0.5, 0.2 and 0.9 leafhoppers/3 leaves/plant at 3, 7 and 14 DAT, respectively) followed closely by acetamiprid (0.9 to 2.2 leafhoppers/3 leaves/plant) and dimethoate (0.9 to 2.1 leafhoppers/3 leaves/plant) as against 58.1 to 66.0 leafhoppers/ 3 leaves/plant in untreated control. The maximum mean per cent reduction in leafhopper over untreated control was 99.2 per cent in clothianidin followed by acetamiprid (97.6 %) after second spray. Flonicamid 50WG @ 50 g a.i./ha and thiamethoxam 25WG @ 50 g a.i./ha recorded 93.5 and 91.6 per cent mean reduction in leafhopper population, respectively, compared to 97.2 and 93.2 per cent reduction in the standard checks, dimethoate and profenofos, respectively (Table 1). Earlier clothianidin has been evaluated and found effective against several species of leafhoppers *viz*., *Amrasca biguttula biguttula* in cotton (Patil *et al*., 2007; Kadam *et al*., 2014), *Nephotettix virescens* in rice (Misra, 2009), *Empoasca fabae* in wine grapes (Van Timmeren *et al.*, 2011), *Empoasca kerri* in Indian bean (Chaudhari *et al*., 2015) and cluster bean (Pachundkar *et al*., 2013). Efficacy of acetamiprid against leafhopper, *A. biguttula biguttula* has been documented by Gaurkhede *et al*. (2015) and Suganya Kanna *et al*. (2007) in cotton and by Janghel (2015) in case of okra. Hence, the present findings are in close agreement to earlier findings in terms of efficacy of the newer molecules against castor leafhopper, *Empoasca flavescens*.

Efficacy against thrips

The results of pooled data of the three years (2014-16) on the efficacy of insecticides against thrips are shown in Table 1. The mean population of thrips recorded before initiation of spray was uniform ranging from 14.3 to 16.5 thrips per spike. Application of all test insecticides decreased the population of thrips in castor, though clothianidin was most effective in significantly reducing the thrips population after first spray (0.9, 0.4 and 1.7 thrips/spike at 3, 7 and 14 DAT, respectively) followed by dimethoate (1.4, 0.8 and 2.3 thrips/spike at 3, 7 and 14 DAT, respectively) and acetamiprid (2.2, 1.2 and 2.7 thrips/spike at 3, 7 and 14 DAT, respectively). Profenofos with infestation of 2.1 to 3.0 thrips/spike was next in terms of efficacy compared to other treatments (2.3 to 4.1 thrips/spike) and untreated control (15.1 to 19.0 thrips/spike). The mean per cent reduction of thrips over untreated control after first spray revealed that clothianidin and dimethoate were superior and resulted in 94.0 and 91.0 per cent reduction in thrips population over

Table 1. Effect of different insecticides on leafhopper and thrips in castor (pooled data of *Kharif* seasons of 2014, 2015 and 2016)

Treatment	Mean population of leafhopper (No./3 leaves/plant)[#]											
	First spray						Second spray					
	PTC	3 DAT	7 DAT	14 DAT	Mean	Reduction over control (%)	PTC	3 DAT	7 DAT	14 DAT	Mean	Reduction over control (%)
Clothianidin 50WG @ 25 g a.i./ha	44.8 (6.7)	1.1 (1.3)	2.4 (1.7)	9.9 (3.1)	4.5	92.7	14.6 (3.9)	0.5 (1.0)	0.2 (0.8)	0.9 (1.1)	0.5	99.2
Flonicamid 50WG @ 50 g a.i./ha	44.2 (6.6)	4.8 (2.3)	9.7 (3.1)	15.6 (4.0)	10.0	83.7	21.0 (4.6)	6.7 (2.6)	1.8 (1.5)	3.6 (2.0)	4.0	93.5
Acetamiprid 20SP @ 20 g a.i./ha	47.9 (6.9)	2.2 (1.6)	3.6 (2.0)	11.4 (3.4)	5.7	90.7	18.2 (4.3)	1.5 (1.4)	0.9 (1.2)	2.2 (1.6)	1.5	97.6
Thiamethoxam 25WG @ 50 g a.i./ha	45.6 (6.7)	4.9 (2.3)	10.2 (3.2)	14.3 (3.8)	9.8	84.0	20.7 (4.6)	7.4 (2.7)	2.8 (1.8)	5.5 (2.4)	5.2	91.6
Profenofos 50EC @ 250 g a.i./ha	45.0 (6.7)	6.4 (2.6)	12.6 (3.6)	18.2 (4.3)	12.4	79.8	25.1 (5.1)	5.3 (2.3)	2.3 (1.6)	5.1 (2.4)	4.2	93.2
Dimethoate 30EC @ 250 g a.i./ha	47.4 (6.9)	2.9 (1.8)	6.0 (2.5)	12.7 (3.6)	7.2	88.3	17.5 (4.2)	2.0 (1.5)	0.9 (1.1)	2.1 (1.6)	1.7	97.2
Untreated control	45.8 (6.8)	60.8 (7.7)	58.9 (7.7)	64.5 (8.0)	61.4	-	70.0 (8.4)	66.0 (8.1)	60.6 (7.8)	58.1 (7.6)	61.6	-
CD (P=0.05)	NS	0.42	0.34	0.31	-	-	0.17	0.18	0.17	0.21	-	-
	Mean population of thrips (No./spike)[#]											
Clothianidin 50WG @ 25 g a.i./ha	14.8 (3.9)	0.9 (1.1)	0.4 (0.9)	1.7 (1.5)	1.0	94.0	4.9 (2.3)	0.4 (0.9)	0.3 (0.9)	1.3 (1.4)	0.7	95.1
Flonicamid 50WG @ 50 g a.i./ha	14.3 (3.8)	3.4 (2.0)	2.3 (1.7)	3.7 (2.0)	3.1	81.4	8.0 (2.9)	2.0 (1.6)	3.3 (1.9)	4.0 (2.1)	3.1	78.2
Acetamiprid 20SP @ 20 g a.i./ha	14.4 (3.8)	2.2 (1.6)	1.2 (1.3)	2.7 (1.8)	2.1	87.4	7.4 (2.8)	1.1 (1.2)	1.2 (1.3)	3.5 (2.0)	1.9	86.6
Thiamethoxam 25WG @ 50 g a.i./ha	15.5 (4.0)	4.1 (2.1)	3.1 (1.9)	3.4 (2.0)	3.5	79.0	8.7 (3.0)	2.2 (1.6)	3.4 (1.9)	5.2 (2.4)	3.6	74.7
Profenofos 50EC @ 250 g a.i./ha	15.3 (4.0)	2.9 (1.8)	2.1 (1.6)	3.0 (1.9)	2.7	83.3	10.1 (3.3)	1.7 (1.5)	2.7 (1.8)	4.6 (2.2)	3.0	78.9
Dimethoate 30EC @ 250 g a.i./ha	16.5 (4.1)	1.4 (1.4)	0.8 (1.1)	2.3 (1.7)	1.5	91.0	6.9 (2.7)	0.8 (1.1)	1.5 (1.4)	2.3 (1.7)	1.5	89.4
Untreated control	14.4 (3.9)	15.1 (3.9)	16.0 (4.0)	19.0 (4.4)	16.7	-	14.2 (3.8)	14.9 (3.9)	13.6 (3.7)	14.2 (3.8)	14.2	-
CD (P=0.05)	0.37	0.18	0.13	0.22	-	-	0.15	0.19	0.23	0.25	-	-

= Mean of three replications; PTC = Pre-treatment count; DAT = Days after treatment; Figures in parentheses are square root transformed values

untreated control, respectively. The treatments acetamiprid, profenofos, flonicamid hand thiamethoxam in descending order of efficacy effected 79.0 to 87.4 per cent reduction in thrips population over untreated control. The trend of efficacy of different treatments against thrips after second spray followed similar trends with clothianidin recording the lowest population of 0.4, 0.3 and 1.3 thrips/spike at 3, 7 and 14 DAT, respectively followed by dimethoate (0.8, 1.5, and 2.3 thrips/spike at 3, 7 and 14 DAT, respectively) and acetamiprid (1.1, 1.2 and 3.5 thrips/spike at 3, 7 and 14 DAT, respectively) compared to 13.6 to 14.9 thrips/spike in untreated control. In terms of mean reduction in thrips population over untreated control after the two sprays, clothianidin recorded the maximum reduction of 95.1 per cent followed by dimethoate (89.4%), acetamiprid (86.6%), profenofos (78.9%), flonicamid (78.2%) and thiamethoxam

Table 2. Effect of different insecticides on yield and economics of castor (pooled data; *Kharif* 2014, 2015 and 2016)

Treatment	Seed yield (kg/ha)	Gross returns (₹/ha)	Cost of cultivation (₹/ha)	Net returns (₹/ha)	B:C ratio
Clothianidin 50WG @ 25 g a.i./ha	1116	39060	22992	16068	1.70
Flonicamid 50WG @ 50 g a.i./ha	886	31010	23452	7558	1.32
Acetamiprid 20SP @ 20 g a.i./ha	1012	35420	21872	13548	1.62
Thiamethoxam 25WG @ 50 g a.i./ha	995	34825	22952	11873	1.52
Profenofos 50EC @ 250 g a.i./ha	1017	35595	22152	13443	1.61
Dimethoate 30EC @ 250 g a.i./ha	970	33950	22107	11843	1.54
Untreated control	729	25515	20512	5003	1.24
CD (P=0.05)	75.5	-	-	-	-

Market price of castor (2016): ₹ 35/kg

(74.7%). The results are in agreement with the findings of Chaudhari *et al*. (2015), Deosarkar *et al.* (2011) and Pachundkar *et al.* (2013) who had reported clothianidin effective in reducing the incidence of thrips in Indian bean, cotton and cluster bean. Similarly, acetamiprid had also been reported to be effective against thrips in cotton and mungbean (Abbas *et al.*, 2012; Singh *et al.*, 2016).

Effect on yield and economics

Pooled yield data over three years (*Kharif* 2014-16) revealed that there was significant impact of insecticidal treatments on seed yield of castor (Table 2). Highest mean seed yield was recorded in clothianidin (1116 kg/ha) followed by profenofos (1017 kg/ha) and acetamiprid (1012 kg/ha). The mean seed yield of 995, 970 and 886 kg/ha was recorded in thiamethoxam, dimethoate and flonicamid treated plots, respectively whereas the lowest yield of 729 kg/ha was recorded in untreated control. Net return was higher in clothianidin treatment (₹ 16068/ha) followed by acetamiprid (₹ 13548/ha) and profenofos (₹ 13443/ha) treatments. Likewise, the cost effectiveness of clothianidin was high with benefit-cost ratio of 1.70, followed by acetamiprid (1.62) and profenofos (1.61) (Table 2). The effectiveness of clothianidin followed by acetamiprid and profenofos in terms of higher seed yield in mungbean has also been reported by Singh *et al.* (2016) and Kavita *et al.* (2014). Similarly, the influence of clothianidin and acetamiprid in maximizing seed yield and highest cost benefit ratio has been reported by Patil *et al*. (2007), Deosarkar *et al.* (2011), Ghosal *et al.* (2013) and Patil *et al.* (2016); thus, supporting the present findings.

Chemical control, being rapid method of pest control, is an important practice of IPM programme. To protect the crop from the attack of sucking pests, farmers generally depend on organophosphorus insecticides which are environmentally hazardous. The new chemistry molecules such as neonicotinoids, which are required in lesser quantities to control the insect pests, comparatively safer to the environment and economically viable for the management of sucking pests in several crop ecosystems (Deosarkar *et al.,* 2011; Ghosal *et al.*, 2013; Pachundkar *et al*., 2013; Chaudhari *et al*., 2015; Patil *et al.,* 2016) are potential alternates. The newer neonicotinoid insecticides *viz*., clothianidin and acetamiprid showed greater efficacy in the present study, than standard insecticides currently recommended for the management of sucking pests *viz.,* leafhopper and thrips in castor ecosystem; hence, these can be opted for inclusion in IPM programme against the sucking pests in castor.

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