AATCC Review

14 March 2025: Received
05 May 2025: Revised
12 May 2025: Accepted
15 June 2025: Available Online

https://aatcc.peerjournals.net/

Original Research Article | Open Access

Assessment of New Insecticides for the management of Leafhopper (*Empoasca flavescens*) in Castor (*Ricinus communis* L.)

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ABSTRACT

A field trial was conducted during rabi 2020-21, 2021-22 and 2022–23 at Palem to assess the efficacy of newer insecticides against leafhopper (Empoasca flavescens) in castor (Ricinus communis L., cv. PCH-111). The tested insecticides included Spinetoram 11.70% SC @ 1 ml/L, Thiacloprid 21.70% SC @ 1 ml/L, Cyantraniliprole 10.26% OD @ 1 ml/L and Profenofos 50EC @ 2 ml/L. Pooled efficacies of these treatments revealed that, Cyantraniliprole was the most effective in reducing leafhopper populations (16.6 leafhoppers/3 leaves/plant), followed by Profenofos (21.5), Thiacloprid (35.6), and Spinetoram (51.0), while the untreated control recorded the highest infestation (108.8). All treatments significantly increased seed yield compared to the control, with Cyantraniliprole yielding the highest (2257 kg/ha), followed by Profenofos (2000 kg/ha), Thiacloprid (1852 kg/ha), and Spinetoram (1710 kg/ha). The highest incremental cost-benefit ratio (1:8.3) was also recorded for Cyantraniliprole. These results suggest that Cyantraniliprole is the most effective and economical option for managing leafhopper infestations in castor.

Keywords: *Castor (Ricinus communis), Leafhopper (Empoasca flavescens), Insecticide efficacy, Cyantraniliprole.*

Introduction

Castor (*Ricinus communis* L., Family: Euphorbiaceae) is a highly valued and economically important oilseed crop (Ma *et al.,* 2016). The oil content of castor seeds can reach 41–64 % (Olivares *et al*., 2013), and it is a raw material of industrial, agricultural, domestic, medical and chemical products (Agyenim-Boateng *et al*., 2018). India leads the globe in total castor seed production (FAO, 2020) with 70 percent and 87 percent of world area and production, respectively followed by Brazil and China (Agyenim-Boateng *et al*., 2018). India is the largest producer of castor seed in the world and meets most of the global demand for castor oil. In India, castor is cultivated in an area of 1.02 M ha with production and productivity of 1.98 Mt and 1900 kg ha^{-1}, respectively (INDIA STAT, 2022-23). The major castor growing states in India are Gujarat, Rajasthan, Telangana, Andhra Pradesh, Karnataka, Tamil Nadu and Odisha. In Telangana castor crop is cultivated in an area of 5000 ha with an average production of 5000 t and productivity of 984 kg ha^{-1} (INDIASTAT, 2022-23). There is an increasing demand for castor leaf biomass as well as seed for the industries. However, the area under castor cultivation is continuously declining in Telangana and Andhra Pradesh due to crop shift, reduced yields and diseases (Ramanjaneyulu *et al.,* 2014). In this context, a deeper understanding on the growth and development of castor plant is necessary to promote its productivity in per unit area. The production of castor is affected by several biotic and abiotic factors. One of the major constraints to achieving higher productivity in castor cultivation is the significant damage caused by insect pests. Sucking pests such as leafhoppers (*Empoasca flavescens*), whiteflies (*Trialeurodes ricini*), and thrips (*Scirtothrips dorsalis*) are also major threats to castor, causing substantial grain yield loss (Patel *et al*., 2015). In Gujarat, India, a 14-15% yield loss due to sucking pests was recorded (Khanpara *et al*., 2002). Leafhoppers, both nymphs and adults, suck sap from the undersides of leaves, disrupting the plant's normal processes. This causes leaf margins to yellow (chlorosis) and eventually curl and distort. Severe infestations lead to "hopper burn," marked by extensive yellowing, browning, and drying of leaves, which reduces the plant's photosynthetic ability, weakens it, and diminishes its vigor and yield. (Agyenim-Boateng *et al*., 2018, Shambhavi *et al*., 2023). Insecticides have been extensively utilized for controlling insect pests in castor crops due to their adaptability, effectiveness, and immediate pest control. Historically, organophosphorus insecticides have been the primary choice for managing sucking pests in castor ecosystems. However, repeated applications of broad-spectrum insecticides with similar modes of action have led to resistance development, reducing their efficacy over time and threat to natural enemies (Singh *et al.,* 2020). To address resistance issues, the identification and integration of new chemical molecules with enhanced insecticidal properties, lower dosages, and selective action are essential components of Integrated Pest Management (IPM) strategies. However, there is a significant gap in knowledge regarding the effectiveness of newer insecticides against sucking pests in castor crops. In light of this, the present study was initiated to evaluate the field efficacy of these newer insecticides for managing leafhoppers in castor.

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DOI: https://doi.org/10.21276/AATCCReview.2025.13.03.213

Materials and Methods

The field experiment was conducted over three consecutive years (*rabi* seasons of 2020–21 to 2022–23) at the Regional Agricultural Research Station, Palem. Castor cultivar PCH-111 was cultivated in plots measuring 4.5 × 6.0 m with a spacing of 90 × 60 cm, following recommended agronomic practices except for insect-pest management. The experiment followed a Randomized Block Design (RBD) with five treatments, including an untreated control, and each treatment was replicated three times.

The insecticidal treatments included three newer insecticides Spinetoram 11.70% SC @1 ml/L, Thiacloprid 21.70% SC @1 ml/L, and Cyantraniliprole 10.26% OD @ 1 ml/L along with one conventional insecticide, Profenofos 50EC @ 2ml/L. Two spray applications were performed using a high-volume knapsack sprayer (500 L/ha) at 15-day intervals during the primary spike development and secondary spike initiation stages, coinciding with leafhopper infestation on leaves

Leafhopper populations, including both nymphs and adults, were monitored on the top, middle, and bottom leaves of 25 randomly selected plants per plot. Observations were recorded before spraying and at 7 and 14 days after each application to assess the efficacy of the treatments. The yield was recorded based on the net plot area and converted to kg/ha for statistical analysis. The economic viability of different treatments was assessed, and pooled data from three years were analyzed statistically.

Results and discussion

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, Cyantraniliprole 10.26% OD @ 1 ml/L was significantly superior to all other treatments, which is evident from the minimum leafhopper population of 20.6 and 12.8 leafhoppers/3 leaves/plant at 7 and 14 days after treatment (DAT), respectively after first spray. This was followed by Thiacloprid 21.70% SC @1 ml/L (52.9 and 39.6 leafhoppers/3 leaves/plant at 7 and 14 DAT, respectively) as against 83.0 to 93.8 leafhoppers/ 3 leaves/plant in the untreated control. The mean per cent reduction over untreated control after first spray was 86.3 and 57.7 per cent by Cyantraniliprole and Thiacloprid respectively, while it was 81.8 per cent in case of standard check profenofos 50EC @ 2ml/L. The mean leafhopper population after the second spray was lowest in the Cyantraniliprole 10.26% OD @ 1 ml/L treated plots (20.9 to 16.6 leafhoppers/3 leaves/ plant) and Profenofos (28.4 to 21.5 leafhoppers/3 leaves/ plant) as against 102.1 to 108.8 leafhoppers/3 leaves/ plant in untreated control. The maximum mean per cent reduction in leafhopper over untreated control was 84.7 per cent in Cyantraniliprole followed by Thiacloprid (67.2 %) after second spray compared to 80.2 per cent reduction in the standard check Profenofos, respectively (Table 1). All the treatments evaluated resulted in significantly higher seed yield over untreated control in the management of leafhoppers. The highest seed yield was obtained with Cyantraniliprole (2257 kg/ha) followed by Profenofos (standard check) (2000 kg/ha), Thiacloprid (1852 kg/ha) and Spinetoram (1710 kg/ha) as compared to untreated control (1547 kg/ha). Highest incremental cost-benefit ratio was realized with Cyantraniliprole (1:8.3) Profenofos (1: 7.2) followed by Thiacloprid (1:3.4) (Table 2). These findings are consistent with those of Shambhavi et al. (2023), who reported that cyantraniliprole 10.26% OD was the most effective treatment, achieving a 90.97% reduction over control (ROC) by decreasing the leafhopper population from 9.33 to 0.87 leafhoppers per three leaves per plant.

Table.1. Evaluation of newer insecticides against leafhopper (Empoasca flavescens) in castor (pooled from Rabi,2020-21 to 2022-23

S.No	Treatment	First Spray (Leafhoppers/3 leaves/plant)				Second Spray (Leafhoppers/3 leaves/plant)			
		PTC	7 DAT	14 DAT	PRC	PTC	7 DAT	14 DAT	PRC
1	Spinetoram 11.70% SC @ 1 ml/l	85.1	58.6	51.5	45.0	82.7	55.3	51.0	53.0
2	Thiacloprid 21.70% SC @ 1 ml/l	78.4	52.9	39.6	57.7	74.8	41.8	35.6	67.2
3	Cyantraniliprole 10.26% OD @ 1 ml/l	88.4	20.6	12.8	86.3	80.2	20.9	16.6	84.7
4	Profenofos 50EC @ 2 ml/l	70.8	19.9	17.0	81.8	86.2	28.4	21.5	80.2
5	Untreated control	82.2	83.0	93.8	-	91.1	102.1	108.8	-
	CD (*P=0.05*)	4.3	10	19	-	NS	12.1	10.3	-
	CV (%)	3.5	14	12	-	7.3	16.2	14.3	-

DAT- Days after treatment; PTC - Pre treatment count

Table.2. Evaluation of newer insecticides against leafhopper (Empoasca flavescens) on yield and economics in castor (pooled from Rabi, 2020-21 to 2022-23)

S.No	Treatment	Seed yield (kg/ha)	Increase in yield over control (kg)	Increase in yield over control (%)	Cost of increased (Rs.) (A)	Plant protection cost (Rs.) (B)	Net profit (Rs.) A-B	ICB Ratio
1	Spinetoram 11.70% SC @ 1 ml/l	1710	163	10.5	8,313	7,557	756	1:0.1
2	Thiacloprid 21.70% SC @ 1 ml/l	1852	305	19.7	15,555	3,513	12,042	1:3.4
3	Cyantraniliprole 10.26% OD @ 1 ml/l	2257	710	46.0	36,210	3,873	32,337	1:8.3
4	Profenofos 50EC @ 2 ml/l	2000	453	29.2	23,103	2,817	20,286	1:7.2
5	Untreated control	1547	-	-	-	-	-	-
	CD (0.05)	54	-	-	-	-	-	-

Market price of castor: Rs.51.00/kg;
Standard spray volume: 500 lit/ha.
Labour charges included: ICBR = Net Profit/Plant protection cost.

Conclusion

A new insecticide has been added to the sucking pest (leafhopper) management basket of Castor, which has aided not only in effective leafhopper management but also in achieving an Incremental Cost Benefit Ratio of 1:8.3 with Cyantraniliprole 10.26% OD @ 1 ml/L.

Acknowledgement

The authors are thankful to the Regional Agriculture Research Station, Palem and Indian Institute of Oilseeds Research, Rajendranagar for providing the necessary facilities and the moral support to carry out this study

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