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Management of potato shoot borer (*Leucinodes orbonalis*) using newer insecticide molecules

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Abstract
Potato (*Solanum tuberosum* L.) is a high-yielding and nutritionally important crop widely grown across India. Among its major pests, the shoot borer (*Leucinodes orbonalis*) significantly reduces shoot growth and tuber yield. A field study was conducted during *Kharif* 2024 at AICRP on Potato, MARS, Dharwad, using variety Kufri Jyothi, to evaluate the bioefficacy and economic viability of newer insecticides. Nine treatments, including Chlorantraniliprole 18.5% SC, Emamectin benzoate 5% SG and Spinosad 45% SC, were applied in two sprays at 20-day intervals. Chlorantraniliprole consistently recorded the lowest shoot damage (9.68%) and the highest tuber yield (13.31 t/ha), followed by Emamectin benzoate and Spinosad. Conventional insecticides were less effective and untreated plots showed the highest damage. Economic analysis revealed Chlorantraniliprole as the most profitable (B:C 2.11; net return Rs. 1,40,086/ha), followed by Emamectin benzoate (B:C 2.02). The results indicate that Chlorantraniliprole and other newer molecules offer effective, sustainable and economically viable management of shoot borer in potato, enhancing crop productivity and profitability.

Keywords: Potato, *Leucinodes orbonalis*, Chlorantraniliprole, bioefficacy, tuber yield, economics

Introduction

Potato (*Solanum tuberosum* L.) is one of the world's most important high-yielding horticultural food crops. It is native to the Peru-Bolivia region of the Andes in South America and was introduced to India from Europe by the Portuguese in the early 17th century. Initially, potato was cultivated as a cool-season crop in the hills and plains, but today it is grown across almost all states of India under diverse agro-climatic conditions. Among major food crops, potato is unique for its ability to produce the highest nutrition and dry matter per unit area and time. Recognizing this, FAO declared potato as the "future food security crop" in 2008 to address global hunger and poverty alleviation. The domestic demand for potato in India is projected to reach 122 million tons by 2050. Globally, potato ranks as the third most important food crop for human consumption, after rice and wheat. India and China together account for one-third of global potato production, making Asia a leading contributor. Within India, potato is the most predominant vegetable, consumed widely in households and processed food industries. Currently, around 68% of domestic potato production is consumed fresh, 7.5% is used for processing, 8.5% is retained as seed, while nearly 16% is lost due to post-harvest wastage (Singh, 2023). Economically, potato contributes 2.86% to India's agricultural GDP from just 1.32% of cultivable land. In comparison, rice and wheat occupy far more land but their GDP contribution per unit land is much lower, making potato about 3.7 times more efficient than rice and 5.4 times more than wheat in terms of land productivity. In India, the major potato-growing states are Uttar Pradesh, Assam, West Bengal, Punjab, Madhya Pradesh and Karnataka. Specifically, Karnataka is a key potato-growing state where the crop is cultivated mainly in Hassan, Dharwad, Belgaum, Chikkaballapur and Kolar districts.

Among the infesting pests, the shoot *Leucinodes orbonalis* poses a serious threat to potato cultivation. The larvae bore into tender shoots, leading to drooping, withering and drying, while the bored holes are typically sealed with excreta. Conventionally, insecticides have been the primary means of managing this pest. So, the present study was carried out to assess the bioefficacy of newer insecticide molecules against *L. orbonalis*.

Materials and Methods

Field experiment was conducted at AICRP on Potato, MARS, Dharwad during *kharif* 2024. Variety *Kufri Jyothi* was planted in a plot size of 5.0 x 4.0 sq.mt with 60 X 20 sq.cm spacing. The experiment was laid out in Randomized Block Design with nine treatments replicated thrice. Two sprays were given at an interval of 20 days, starting from 45 days after planting. Observations on the incidence of shoot borer, in terms of the number of caterpillars or bore holes, were recorded on five randomly selected tagged plants from each plot. The number of shoots showing wilting symptoms due to shoot borer damage and the number of healthy shoots per plot were recorded and the percent shoot damage was calculated. Observations on the incidence of shoot borer damage were recorded one day before and 5, 10 and 15 days after each spray. The total yield (kg/plot) was recorded at harvest. Crop yield was recorded at harvest and the treatment cost, cost of cultivation, gross and net returns were estimated based on local market prices. Using these values, the benefit-cost (B:C) ratio was computed to evaluate the economic viability of each treatment.

Results and Discussion

The data regarding the efficacy of insecticides in managing shoot borer in potato, along with the cost economics, are presented in Tables 1 and 2, respectively.

At first spray, a significant reduction in shoot damage was observed among the treatments. The lowest shoot damage was recorded in chlorantraniliprole 18.5% SC (9.94%). This high efficacy of chlorantraniliprole 18.5% SC can be attributed to its ability to activate ryanodine receptors, disrupting calcium regulation in insect muscle cells, which leads to paralysis and death in lepidopteran larvae. Additionally, its translaminar movement allows the chemical to penetrate leaf tissues, providing protection to both sprayed and unsprayed surfaces, thereby effectively controlling shoot borer larvae feeding within the shoots, which was followed by emamectin benzoate 5% SG (13.26%) and spinosad 45% SC (13.46%). Moderate levels of shoot infestation were noticed with chlorpyriphos (14.66%), Indoxacarb (15.30%) and Malathion (15.54%), while relatively higher shoot damage occurred in profenophos (15.78%) and fipronil (16.15%). The maximum infestation was observed in the untreated control (18.42%).

A similar trend was noted after the second spray, where chlorantraniliprole (8.04%) remained the most effective treatment, followed by emamectin benzoate (8.87%) and spinosad (12.91%). Treatments with chlorpyriphos (16.34%) and indoxacarb (16.51%) showed moderate shoot infestation, whereas higher shoot damage was observed in malathion (19.90%), Fipronil (20.45%) and Profenophos (22.83%). The highest shoot infestation continued to be in the untreated control (26.42%).

These differences in pest suppression were also reflected in the yield, where chlorantraniliprole-treated plots recorded the highest tuber yield (13.31 t/ha), followed by emamectin benzoate (12.85 t/ha) and spinosad (11.25 t/ha). In contrast, the lowest yield (6.38 t/ha) was obtained in the untreated control. Thus, Chlorantraniliprole emerged as the most effective treatment, both in terms of minimizing shoot damage and maximizing yield, indicating its superiority over other tested insecticides.

The present findings are well supported by earlier studies highlighting the efficacy of insecticides against *Leucinodes orbonalis* in brinjal. Yadav *et al.* (2025) [6] reported that Chlorantraniliprole 18.5 SC (0.4 ml/l) was the most effective, achieving an 83.04% reduction in infestation, followed by spinosad 45 SC and emamectin benzoate 5 SG with 70.12% and 59.17% efficacy, respectively. Similarly, Niranjana *et al.* (2017) [2] also observed that chlorantraniliprole 18.5% SC was highly effective in minimizing shoot and fruit infestation, with minimal harm to natural enemies, while spinosad 2.5% SC and flubendiamide 20 WG also showed significant effectiveness. Udikeri *et al.* (2024) [5] confirmed that among tested insecticides, Chlorantraniliprole 18.5 SC and spinosad 45 SC performed best in reducing infestation. Supporting this, Singh *et al.* (2021) found that spinosad 45 SC @ 0.5 ml/l resulted in the lowest shoot and fruit damage and highest yields over two years, followed by Chlorantraniliprole 20 SC @ 0.4 ml/l and emamectin benzoate 5 SG @ 0.5 g/l. Additionally, Natikar *et al.* (2022) [1] reported spinosad 45 SC @ 0.20 ml/l provided 51.96% protection against shoot borer in potato.

Table 1: Efficacy of insecticides against shoot borer (*Leucinodes orbonalis*) in potato during *kharif* 2024

S. No	Treatments	Percent shoot damage									Yield (t/ha)	Percent reduction over control
		1st SPRAY				2nd SPRAY				Mean		
		1 DBS	5 DAS	10 DAS	15 DAS	1 DBS	5 DAS	10 DAS	15 DAS			
1	Chlorpyriphos 50%EC @ 2.0ml/lt	15.59 (23.25)	14.66 (22.51)^{b}	14.2 (22.13)^{bc}	15.24 (22.98)^{abc}	18.76 (25.67)^{bc}	16.34 (23.84)^{bc}	14.27 (22.19)^{bc}	14.61 (22.47)^{bc}	15.46 (23.15)^{bc}	10.54^{c}	32.44
2	Profenophos 50% EC @ 2.0ml/lt	16.58 (24.03)	15.78 (23.41)^{bc}	17.19 (24.49)^{de}	21.39 (27.55)^{ef}	24.39 (29.59)^{d}	22.83 (28.54)^{de}	23.56 (29.04)^{ef}	24.8 (29.87)^{ef}	20.82 (27.14)^{ef}	8.13^{de}	9.01
3	Emamectin benzoate 5%SG @ 0.4 gm/lt	16.03 (23.6)	13.26 (21.35)^{b}	11.7 (20)^{b}	11.85 (20.14)^{a}	12.73 (20.9)^{a}	8.87 (17.33)^{a}	6.6 (14.89)^{a}	8.38 (16.83)^{a}	11.18 (19.53)^{a}	12.85^{ab}	51.14
4	Indoxacarb 14.5% SC @ 1ml/lt	15.95 (23.54)	15.3 (23.03)^{bc}	15.17 (22.93)^{cd}	16.68 (24.1)^{bcd}	18.4 (25.4)^{bc}	16.51 (23.98)^{bc}	17.41 (24.66)^{cd}	20.89 (27.2)^{cd}	17.04 (24.09)^{cd}	9.58^{cd}	25.52
5	Spinosad 45% SC @ 0.3ml/lt	16.14 (23.69)	13.46 (21.52)^{b}	12.76 (20.93)^{bc}	15.58 (23.25)^{abc}	16.16 (23.7)^{b}	12.91 (21.05)^{b}	10.42 (18.83)^{b}	11.36 (19.69)^{b}	13.6 (21.64)^{b}	11.25^{bc}	40.56
6	Chlorantraniliprole 18.5% SC @ 0.3 ml/lt	15.73 (23.37)	9.94 (18.38)^{a}	8.89 (17.35)^{a}	12.81 (20.97)^{ab}	11.79 (20.09)^{a}	8.04 (16.47)^{a}	5.78 (13.91)^{a}	4.44 (12.17)^{a}	9.68 (18.13)^{a}	13.31^{a}	57.69
7	Fipronil 5% SC @ 1.0ml/lt	17.26 (24.55)	16.15 (23.69)^{bc}	15.45 (23.15)^{cd}	17.6 (24.81)^{bc}	21.17 (27.4)^{cd}	20.45 (26.88)^{cd}	19.34 (26.09)^{de}	19.78 (26.41)^{de}	18.4 (25.4)^{de}	9.53^{cd}	19.56
8	Malathion 50% EC @ 2 ml/lt	16.74 (24.15)	15.54 (23.22)^{bc}	17.88 (25.02)^{de}	20.98 (27.26)^{cde}	21.91 (27.91)^{cd}	19.9 (26.49)^{cd}	21.81 (27.84)^{de}	24.97 (29.98)d^{e}	19.97 (26.54)^{e}	8.27^{de}	12.72
9	Control	14.73 (22.57)	18.42 (25.42)^{c}	20.02 (26.58)^{e}	24.2 (29.47)^{def}	24.54 (29.7)^{d}	26.42 (30.93)^{e}	27.37 (31.55)^{f}	27.3 (31.5)^{f}	22.88 (28.57)^{f}	6.38^{e}	--
	S.Em ±	0.68	0.84	0.73	1.10	0.82	1.02	1.16	1.16	0.09	0.62	
	CD (5%)	NS	2.53	2.18	3.30	2.47	3.05	3.48	3.48	0.27	1.87	

DBS: Days before Spray, DAS: Days after Spray, *Figures in parenthesis are arc sin transformed values

Table 2: Cost economics of different insecticides against potato shoot borer (*Leucinodes orbonalis*) in potato

S. No	Treatments	Dosage	Cost effectiveness of Insecticides					
			Yield (t/ha)	Treatment cost (Rs/ha)	Cost of cultivation (Rs/ha)	Gross return (Rs/ha)	Net return (Rs/ha)	B:C ratio
1	Chloropyrifos 50% EC	2.0 ml/l	10.54	3396.00	128396.00	210866.67	82470.67	1.64
2	Profenophos 50% EC	2.0 ml/l	8.13	2240.00	127240.00	162666.67	35426.67	1.28
3	Emamectin benzoate 5% SG	0.4 gm/l	12.85	2112.00	127112.00	256933.33	129821.33	2.02
4	Indoxacarb 14.5% SC	1.0 ml/l	9.58	3994.00	128994.00	191600.00	62606.00	1.49
5	Spinosad 45% SC	0.3 ml/l	11.25	6936.00	131936.00	224981.83	93045.83	1.71
6	Chlorantraniliprole 18.5% SC	0.3 ml/l	13.31	1114.00	126114.00	266200.00	140086.00	2.11
7	Fipronil 5% SC	1.0 ml/l	9.53	730.00	125730.00	190666.67	64936.67	1.52
8	Malathion 50% EC	2.0 ml/l	8.27	1300.00	126300.00	165466.67	39166.67	1.31
9	Control	--	6.38	0.00	125000.00	140866.67	15866.67	1.13

Market price of potato/kg = Rs. 20,000/ton, Cost of production = 125000 Rs/ha
Cost of insecticides
Chloropyrifos 50% EC-Rs.1699/1litre Spinosad 45% SC-Rs.23120/1litre
Profenophos 50% EC-Rs.939/1litre Chlorontriniliprole 18.5% SC-Rs.3712/1litre
Emamectin benzoate 5% SG-Rs.5280/1 kg Fipronil 5% SC-Rs.730/1litre
Indoxacarb 14.5% SC-Rs.3995/1litre Malathion 50% EC-Rs.650/1litre
a B:C ratio of 2.02 and a net return of Rs. 1,29,821/ha, indicating that newer insecticide molecules provided superior economic benefits.

Cost-benefit (B:C) analysis of different insecticidal treatments revealed significant variation in their economic returns. Among the tested insecticides, Chlorantraniliprole 18.5% SC proved to be the most economically viable, recording the highest B:C ratio of 2.11, with a tuber yield of 13.31 t/ha and a net return of Rs. 1,40,086/ha, despite its relatively low treatment cost of Rs. 1,114/ha. Emamectin benzoate 5% SG was the next most profitable treatment, with.

Conclusion

The study reveals that among the tested insecticides, Chlorantraniliprole 18.5% SC was the most effective in managing *Leucinodes orbonalis* in potato, consistently reducing shoot damage and achieving the highest tuber yield. Emamectin benzoate 5% SG and spinosad 45% SC also provided significant pest suppression and satisfactory yields. The effectiveness of these newer insecticide molecules was further reflected in their economic returns, with Chlorantraniliprole recording the highest B:C ratio (2.11) and net profit, followed by Emamectin benzoate (B:C 2.02). Conventional insecticides and the untreated control were comparatively less effective. Overall, the findings highlight that chlorantraniliprole and other newer insecticides offer a sustainable and economically viable approach for managing brinjal shoot, combining high efficacy with improved crop productivity and profitability.

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