Insecticide usage pattern and knowledge level of farmers on insecticides handling to manage *Leucinodes orbonalis* Guenee in brinjal across different localities

ABSTRACT

A detailed survey was carried out to record the insecticide usage pattern in brinjal and knowledge level of farmers on insecticides handling to control brinjal shoot and fruit borer, *Leucinodes orbonalis* from brinjal growing farmers of Shivamogga (Karnataka), Coimbatore (Tamil Nadu), Tirupati and Vijayawada (Andhra Pradesh), Pune (Maharashtra) and Gadwal (Telangana) Districts of India during 2020-21. The information on insecticide usage pattern was gathered from twenty progressive farmers from each selected location using well-structured questionnaire. The data revealed that farmers used eighteen different insecticides to manage *L. orbonalis* in brinjal. Among the different insecticides the highest usage of chlorantraniliprole 18.5 SC (70 %) was reported followed by emamectin benzoate (55 %) and lambda-cyhalothrin (33.33 %). The number of application of insecticides in the six locations varied from 10.8 to 22.20 per cropping season at an interval ranging from 7.0 to 12.4 days. In order to get information on insecticide recommendation, 48.33 per cent of brinjal farmers approached pesticide dealer shops and 78.33 per cent farmers did not pay attention towards label information given in pesticide containers. In different localities, around 51.67 per cent of farmers sprayed insecticides at recommended dose and nearly 71.67 per cent of farmers did not follow any safety measures while undertaking spraying operation. In all the locations (83.33 %) farmers relied only on Insecticides and only around 10.0 per cent famers followed cultural control methods for *L. orbonalis* control.

Keywords: Brinjal, *Leucinodes orbonalis,* Survey, Insecticide usage pattern

1. INTRODUCTION

Brinjal (*Solanum melongena* L.), which is native to India is one of the popular and widely cultivated vegetable in many countries especially across South East Asia and Central America (Tsao and Lo, 2006; Harish *et al*., 2011; Kariyanna *et al*., 2020). India is one of the leading producers with 0.74 million hectares of cultivated area with a production of 12.77 million tonnes (Anon., 2022). Numerous insect-pests are known to infest brinjal (Subbaratnam and Butani, 1982) of which brinjal shoot and fruit borer, *Leucinodes orbonalis* Guenee takes pole position by inflicting severe damage to the crop. This pest is known to inflict yield losses to the tune of 10 to 72 per cent (Mall *et al*., 1992;

Jagginavar *et al*., 2009; Jat and Shrivatsava, 2022). Initially the larvae of *L. orbonalis* bore into the tender shoots resulting in wilting and withering of infested shoots and prefer to bore into the fruits during later stages causing cosmetic damage on fruits (Mishra and Dash, 2007). This pest is a chronic pest of brinjal and omnipresent throughout the cropping season causing severe damage (Eswarareddy and Srinivas, 2004; Kariyanna *et al*., 2020). Farmers usually go for regular application of insecticides due to insect-pest's cryptic nature as the larvae tend to hide within shoots and fruits. There are reports wherein farmers are taking up 15-84 sprays within single cropping season (Ranjith *et al*., 2020; Kariyanna *et al*., 2020) to manage *L. orbonalis*. This has led to injudicious application of insecticides, repetitive usage of single insecticide leading to the problems like insecticide resistance (Kodandaram *et al*., 2013; Kaur *et al*., 2014), resurgence and residue in or on the marketable fruits (Iqbal *et al*., 2009).

Generally, farmers decision to spray with insecticides mainly depends on visual presence of *L. orbonalis* rather than following methodology based on Economic Threshold Levels (ETL). This reliance leads to injudicious use of insecticides, higher insecticide residues and also negative impact on the health of the farmers taking up the spray (Choudhary and Gaur, 2009). Consequently, monitoring insecticide usage patterns against crop pests and assessing the knowledge level of the farmers with respect to usage of insecticides and handling at the time of application become important not only to protect human and environmental health by maintaining food safety, but also to avoid resistance evolution in insect-pests. Keeping these things in mind, the present study was undertaken to understand the status of farmer's management practices against *L. orbonalis* and to explore their knowledge on insecticide usage pattern in brinjal crop ecosystems of Shivamogga (Karnataka), Coimbatore (Tamil Nadu), Tirupati and Vijayawada (Andhra Pradesh), Pune (Maharashtra) and Gadwal (Telangana) Districts of India.

2. MATERIAL AND METHODS

Roving survey was conducted as per the methodology suggested by Ranjith *et al*. (2020) with some modifications. In our study, detailed survey on insecticide usage pattern in brinjal to control *L. orbonalis* was undertaken from brinjal growing farmers of Shivamogga district of Karnataka, Vijayawada and Chittoor districts of Andhra Pradesh, Gadwal district of Telangana, Coimbatore district of Tamil Nadu and Pune district of Maharashtra state in India. The information on insecticide usage pattern was gathered from twenty farmers from each selected district. The data was collected

by interviewing the individual farmer using questionnaire. The data included educational status of the farmer, land holding, types of insecticides used, numbers and frequency of insecticides along with their rotation pattern, personal protection equipment and damage percentage by the shoot and fruit borer in a cropping season. The scope of the present study was explained to the farmers for their fair cooperation. The information was gathered from the same areas as that of field populations of *L. orbonalis* were collected in order to monitor the insecticide resistance. The collected data was analysed through tabular method using percentage, average and ratio.

3. RESULTS AND DISCUSSION

3.1. Insecticides usage pattern against *Leucinodes orbonalis* on brinjal across different localities

The assessment of five different states of India covering six districts showed that farmers applied insecticide at an interval of 7.0 to 12.4 days. Highest spray interval was noticed in Pune and Coimbatore where farmers applied the insecticides at an interval of 12.4 and 12.2 days, respectively and lowest spray interval of 7.0 and 7.2 days was recorded from farmers of Vijayawada and Gadwal locations, respectively (Table 1). The number of application of insecticides in the six locations varied from 10.8 to 22.20 per cropping season in brinjal against shoot and fruit borer. Maximum number of sprays *i.e*., 22.2 and 21.6 were recorded from Vijayawada and Gadwal, respectively. Whereas, the least number of sprays (10.8) was recorded in Coimbatore. In Shivamogga, farmers preferred to take 16.4 sprays per cropping season at an interval of 9.7 days. Our results are in conformity with those of Beena *et al*. (2019) who reported that the average number of sprayings in one season was maximum in Dindigul (12 to 15) followed by Coimbatore (10 to 12) and the average number of sprayings ranged from 8 to 15 across different locations of Tamil Nadu state of India to manage *L. orbonalis* in brinjal. Ranjith *et al*. (2020) recorded the average spray interval of 6.48 to 9.10 days in ten different location and total number of sprayings per brinjal cropping season ranged from 16.10 to 28.32. The variation in total number of insecticides application and spray interval was mainly due to the differences in hybrids/varieties of brinjal as well as farmers perception regarding insect-pests and taking up the spray as per the suggestions of local pesticide dealers.

Table 1. Insecticides usage pattern against *Leucinodes orbonalis* on brinjal across different localities

Sl. No.	Location	Insecticides used		No. of sprays/crop season * (Mean ± SE)	Spray interval (days) (Mean ±SE)
		Commonly	Rarely		
1	Shivamogga	Chlorantraniliprole 18.5 SC, Emamectin benzoate 5 SG, Lambda-cyhalothrin 4.6 + Chlorantraniliprole 9.3 ZC, Chlorpyrifos 20 EC	Phenthoate 50 EC, Indoxacarb 14.5 SC, Spinetoram 11.7 SC, Profenophos + Cypermethrin, Imidacloprid 17.8 SL, Novaluron 5.25+ Emamectin benzoate 0.9 SC	16.4 ± 1.5	9.7 ± 1.5
2	Coimbatore	Chlorantraniliprole 18.5 SC, Emamectin benzoate 5 SG, Chlorpyrifos 20 EC, Spinetoram 11.7 SC, Spinosad 45 SC	Imidacloprid 17.8 SL, Indoxacarb 14.5 SC, Lambda-cyhalothrin 5 EC, Lambda-cyhalothrin 4.6 + Chlorantraniliprole 9.3 ZC	10.8 ± 0.8	12.2 ± 1.3
3	Tirupati	Chlorantraniliprole 18.5 SC, Emamectin benzoate 5 SG, Chlorpyrifos 20 EC, Profenophos 40 + Cypermethrin 4 EC, Lambda-cyhalothrin 5 EC	Chlorpyrifos 35 + Fipronil 3.5 EC, Imidacloprid 17.8 SL, Indoxacarb 14.5 SC	17.8 ± 2.5	8.7 ± 1.9
4	Pune	Indoxacarb 14.5 SC, Spinetoram 11.7 SC, Chlorantraniliprole 18.5 SC, Imidacloprid 17.8 SL	Profenophos 50 EC, Thiamethoxam 12.6 + Lambda-cyhalothrin 9.5 ZC, Thiodicarb 75 SP, Chlorpyrifos 20 EC	13.6 ± 1.2	12.4 ± 1.4
5	Vijayawada	Chlorantraniliprole 18.5 SC, Emamectin benzoate 5 SG, Lambda-cyhalothrin 5 EC, Chlorpyrifos 20 EC, Thiodicarb 75 SP	Profenophos 40 + Cypermethrin 4 EC, Thiamethoxam 12.6 + Lambda-cyhalothrin 9.5 ZC, Imidacloprid 17.8 SL	21.6 ± 2.3	7.0 ± 0.7
6	Gadwal	Emamectin benzoate 5 SG, Chlorantraniliprole 18.5 SC, Chlorpyrifos 20 EC, Lambda-cyhalothrin 5 EC, Flubendiamide 39.35 SC, Spinetoram 11.7 SC	Profenophos 40 + Cypermethrin 4 EC, Thiodicarb 75 WP, Phenthoate 50 EC	22.2 ± 1.4	7.2 ± 0.9

*Mean of twenty farmers

3.2. Different insecticides used by farmers against *Leucinodes orbonalis* in brinjal during 2020-21 in surveyed area

The survey data revealed that, the usage pattern of selected insecticides to manage *L. orbonalis* across different locations varied from 5 to 70 per cent (Table 2). Farmers used eighteen different insecticides to manage *L. orbonalis* in brinjal. Among the different insecticides the highest usage of chlorantraniliprole 18.5 SC (70 %) was reported followed by emamectin benzoate (55 %), lambda-cyhalothrin (33.33 %) and lowest usage (5 %) of fipronil 80 WG. These results are in accordance with those of Beena *et al*. (2019) who reported that eight insecticides *viz.,* chlorpyriphos, dimethoate, quinalphos, thiacloprid, emamectin benzoate, flubendiamide, thiodicarb and lambda-cyhalothrin were prominently used to manage *L. orbonalis* in different locations of Tamil Nadu state of India. Kariyanna *et al*., (2020) reported that emamectin benzoate was the most commonly used insecticide (12 %) in all the locations followed by chlorantraniliprole (10 %). Similarly, insecticides belonging to organophosphates and amide group were used to manage insect pests in eggplant and cauliflower as per the earlier reports (Kumar *et al*., 2017 and Gaganpreet *et al*., 2018).

3.3. Knowledge level of brinjal farmers on insecticides handling and safety measures taken in the surveyed area

In order to get information on insecticide recommendation 48.33 per cent of brinjal farmers approached pesticide dealer shops and 41.67 per cent preferred to select the insecticides based on the discussions with the fellow farmers (Table 3). Our results are in confirmation with the previous findings that the major source of information on pesticide recommendation was pesticide dealers (Mahantesh and Singh, 2009; Jamali *et al*., 2014 and Ranjith *et al*., 2020). In the present study, 78.33 per cent of farmers did not pay attention towards label information given in pesticide containers and could not understand the toxicity level after reading the colour code given on the pesticide bottle. Ranjith *et al*. (2020) reported that nearly 90.50 farmers failed to understand the information given on the label pasted on pesticide bottle. This necessitates the importance of training to farmers with respect to insecticides handling, the label claim, the information that is written and what exactly the different colours indicate with respect to toxicity towards persons handling insecticides.

Table 2. Different insecticides used by farmers against *Leucinodes orbonalis* in brinjal during 2020-21 in surveyed area

Insecticides	Farmer respondents (%)						
	Shivamogga	Tirupati	Coimbatore	Gadwal	Pune	Vijayawada	Mean* (%)
Chlorantraniliprole 18.5 SC	90	80	60	70	50	70	70.00
Emamectin benzoate 5 SG	60	70	40	80	30	50	55.00
Lambda cyhalothrin 5 EC	20	40	10	60	20	50	33.33
Flubendiamide 39.35 SC	0	20	10	30	20	20	16.67
Profenophos 50 EC	20	10	0	20	30	20	16.67
Indoxacarb 14.5 SC	30	30	20	10	60	20	28.33
Novaluron 5.25 + Emamectin benzoate 0.9 SC	20	0	10	0	0	10	6.67
Spinosad 45 SC	10	20	30	0	10	0	11.67
Spinetoram 11.7 SC	10	20	40	20	50	10	25.00
Thiamethoxam 12.6 + Lambda-cyhalothrin 9.5 ZC	0	10	0	20	30	30	15.00
Imidacloprid 17.8 SL	20	30	20	40	30	20	26.67
Fipronil 80 WG	0	20	10	0	0	0	5.00
Chlorpyrifos 20 EC	30	50	30	60	20	50	40.00
Profenophos 40 + Cypermethrin 4 EC	20	50	10	30	0	30	23.33
Thiodicarb 75 WP	0	20	10	40	20	50	23.33
Lambda-cyhalothrin 4.6 + Chlorantraniliprole 9.3 ZC	30	30	20	10	10	30	21.67
Chlorpyrifos 35 + Fipronil 3.5 EC	30	40	0	20	30	0	20.00
Phenthoate 50 EC	20	0	0	30	0	20	11.67

*Mean of twenty farmers

The survey data also revealed that, 90 per cent of the farmers used container caps containing measurement mark provided along with insecticide bottle for measuring insecticide and around 51.67 per cent of farmers sprayed insecticides at recommended dose and remaining followed approximate doses (Table 3). Majority of the farmers from Coimbatore and Shivamogga applied the insecticides at recommended dosages, unlike farmers of Vijayawada where majority of the farmers applied the insecticides at approximate dosages and also most of the farmers (71.67 per cent) did not follow any safety measures while undertaking spraying operation. Only around 23 per cent farmers preferred to wear mask during spraying. These results are in agreement with the findings where only very few vegetable and fruit growers used protective clothing during spraying (Devi, 2010; Ranjith *et al*., 2020). Majority of the farmers irrespective of the locations carried spraying operations during morning hours. Similar findings were also recorded by Ranjith *et al*. (2020) where nearly 90.50 per cent farmers preferred to take the sprays in the morning hours. Nearly 70 per cent of farmers gone for spraying only after observing initial symptoms and only (15 %) done spraying above ETL and nearly 15 per cent of the sprayers adopted blanket spraying wherein they preferred to take up the sprays as a precautionary measure without observing the presence or absence of the insect-pests (Table 3). Also, most of the farmers (65 %) preferred to spray the insecticides alone without any tank mix. These results are in accordance with Gaganpreet *et al*. (2018) and Ranjith *et al*. (2020) who reported that 70 and 82 per cent of the farmers preferred to take up the spray after observing damage symptoms in brinjal crop, respectively.

Majority of the farmers (91.67 %) sprayed the insecticides with the help of power sprayer compared to traditional hand sprayers in all the surveyed locations. In the same way 51.67 per cent of farmers thrown the empty insecticide containers in neglected areas after their use and 43.3 per cent of the farmers preferred to throw away the containers in neglected areas and only few farmers (5 %) buried the insecticide containers in soil (Table 3). These results are in agreement with earlier work where around 50 per cent of empty pesticide containers were buried in the field itself by the farmers (Reddy *et al*., 2011). However, Ranjith *et al*. (2020) reported that nearly 86.5 per cent of the farmers preferred to throw the used insecticidal containers in neglected area but again only 3.5 per cent farmers properly disposed the containers by burying deep into the soil.

Table 3. Knowledge level of brinjal farmers on insecticides handling and safety measures taken in the surveyed area

Sl. No.	Particulars	Farmer respondents (%)						Mean* (%)
		Shivamogga	Tirupati	Coimbatore	Gadwal	Pune	Vijayawada	
1) Source of information on insecticide usage								
a	Govt officials	0	10	10	0	10	0	5.00
b	Fellow farmers	70	40	30	30	20	60	41.67
c	Dealers	30	40	50	60	70	40	48.33
d	Company persons	0	10	10	10	0	0	5.00
2) Attention towards label information								
a	Yes	40	20	20	0	40	10	21.67
b	No	60	80	80	100	60	90	78.33
3) Measurement of insecticides								
a	Bottle cap	100	90	100	80	90	80	90.00
b	Approximate	0	10	0	20	10	20	10.00
4) Dosage								
a	Recommended	70	40	80	40	60	20	51.67
b	Approximate	30	60	20	60	40	80	48.33
5) Safety measures taken at the time of spray								
a	No measures taken	80	90	60	60	60	80	71.67
b	Hand gloves only	0	0	20	0	10	0	5.00
c	Mask alone	20	10	20	40	30	20	23.33
6) Time of application								
a	Morning	90	80	100	100	70	80	86.67
b	Evening	10	20	0	0	30	20	13.33

*Mean of twenty farmers

Contd.....

Sl. No.	Particulars	% Farmer respondents						Mean (%)*
		Shivamogga	Tirupati	Coimbatore	Gadwal	Pune	Vijayawada	
1) Decision of spraying								
a	Based on ETL	30	10	20	0	30	0	15.00
b	Blanket spraying	10	10	0	40	10	20	15.00
c	Observing initial symptoms	60	80	80	60	60	80	70.00
2) Insecticide used								
a	Sole	70	60	80	40	80	60	65.00
b	Tank mix	3	40	20	60	20	40	35.00
3) Disposal of insecticidal containers								
a	Buried in soil	0	0	20	0	10	0	5.00
b	Leaving them in field	60	30	40	60	60	60	51.67
c	Throw in neglected area	40	70	40	40	30	40	43.33
4) Waiting period								
a	No waiting period	20	40	20	40	10	60	31.67
b	One day	80	60	80	60	90	40	68.33
c	As per recommended on leaflet	0	0	0	0	0	0	0
5) Type of sprayer used								
a	Hand operated	10	0	20	0	20	0	8.33
b	Power operated	90	100	80	100	80	100	91.67
6) Control methods adopted								
a	IPM	0	0	20	0	20	0	6.67
b	Insecticides alone	90	100	40	100	70	100	83.33
c	Cultural control	10	0	40	0	10	0	10.00

* Mean of twenty farmers

Surprisingly, 68.33 per cent of farmers gave only one day waiting period (after insecticide application) before sending the harvested fruits to the local markets and rest of the farmers applied the insecticides and sent the fruits to the markets on the same day. Not even a single farmer maintained the waiting period as recommended on the leaflets. These results in accordance with those of Gaikwad and Jirali (2016) who reported that farmers didn't have any idea about what waiting period is and its importance in good agricultural practices. Around 83.33 per cent farmers relied only on Insecticides and only ten per cent famers followed cultural control methods for *L. orbonalis* control. These findings are in line with previous findings that 99.0 percent farmers relied solely on spraying of pesticides for the control of brinjal insect pests and the remaining one per cent used a combination of sanitation, which consists of prompt removal of damaged shoot, coupled with pesticide sprays (Rashid *et al*., 2008).

4. CONCLUSION

In our study farmers used both CIBRC recommended and non-recommended insecticides to manage *L. orbonalis* in brinjal. Novel insecticides as well as mixed formulations of insecticides were preferred over conventional insecticides. However, farmers applied insecticides higher than recommended dose and didn't give enough waiting period resulting in higher insecticide residues which is a major concern for consumers as it may lead to potential harmful effects. There is huge scope to increase the farmer's knowledge level in choosing recommended insecticides, their dosage, waiting period, label claim and personnel protection during spray operation. Our study necessitates the importance of training to the farmers by means of field demonstrations and also to consult subject matter specialists or trained extension workers instead of pesticide dealers and company representatives to get proper information about pest management. Information and recommendations need to be quickly disseminated through strengthened research-extension ties for upgrading the methodologies which are sound and sane to humans, non-target organisms and environmental health but highly effective in managing brinjal shoot and fruit borer.

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