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PATTERNS OF INSECTICIDE USE AND FARMERS' KNOWLEDGE LEVEL IN MANAGING *LEUCINODES ORBONALIS* GUENEE IN TAMIL NADU

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ABSTRACT

A study was conducted to record the pattern of insecticide usage and knowledge level of farmers in handling insecticides to control shoot and fruit borer *Leucinodes orbonalis* Guenee from major brinjal growing districts of Tamil Nadu during 2022 -2023. This study found that, 22 different insecticides were imposed for the management of *Leucinodes orbonalis* and among them chlorantraniliprole 18.5% SC (83.00%) was recorded as the highest usage insecticide followed by spinetoram 11.7% SC (72.00%). The number of insecticide applications among various districts varied from 9.9 to 24.7 per cropping season at an interval ranging 4.9 to 12.3 days. The major source of information regarding pesticides to the farmers were pesticide dealers (65.00%) and about 98.00% of the farmers did not pay attention towards label on pesticide containers. Only around 40.00% of farmers followed recommended dose and nearly 60.00% did not follow any safety measures while spraying. Study inferred that, more than 84.00% brinjal growing farmers completely relay on pesticides for the management of *Leucinodes orbonalis* in brinjal.

Key words: *Leucinodes orbonalis*, brinjal, survey, safety measures, knowledge level, insecticides, farmers, management, pesticides, usage pattern, control

Brinjal (*Solanum melongena* L) commonly known as eggplant has been reported to be affected by more than 36 pests on a regular and simultaneous basis from the nursery stage to harvest (Regupathy et al., 1997). Among all the insect pests, brinjal shoot and fruit borer (BSFB) *Leucinodes orbonalis* (Lepidoptera: Crambidae) is the major pest that damages shoots, buds, stems and fruits in brinjal. The larvae of this pest burrow within the shoots, petioles and fruits (Abhishek and Dwivedi, 2021). The insect causes considerable crop loss ranging from 37-63% in various Indian states (Dhankar, 1988) and as high as 70-92% in Tamil Nadu (Dhandapani et al., 2003). Synthetic pesticides act as first line of defence for the management of this pest and consumption of pesticide in brinjal was very high among vegetable crops (4.60 kg a.i./ ha) after chilli (Sharma and Choudhury, 2018). The indiscriminate application of pesticides leads to the development of resistance in insect pests, pesticide residues in products and also complete eradication of natural enemies of insects. Thus, continuous monitoring of insecticide usage patterns against crop pests as well as assessing farmers' knowledge level regarding insecticide usage and handling at the time of application will be the most important step in protecting human and environmental health by maintaining food safety by reducing residues and avoiding resistance evolution in insect pests. Present study was carried out to investigate the *L. orbonalis* management practices followed by farmers as well as their understanding of pesticide usage in brinjal ecosystems in major brinjal growing areas of Tamil Nadu.

MATERIALS AND METHODS

Roving survey was carried out using the methodology suggested by Beena et al., 2019 with minor adjustments. Detailed survey on insecticide usage pattern and knowledge level of farmers in brinjal to control *L. orbonalis* was undertaken from farmers of major brinjal growing districts Villupuram, Thiruvannamalai, Dharmapuri, Salem, Namakkal, Coimbatore, Dindigul, Tiruchirappalli, Madurai and Theni covering the geographical zones of Tamil Nadu during 2022 and 2023. During the survey the information was gathered from ten progressive farmers from each district individually during the study period using well-structured standard questionnaire. The data includes source of information on insecticide usage, attention towards label information, measurement of insecticides dosage, safety measures followed during spray, time of application, decision of spraying, type of sprayer,

disposal of used insecticidal containers, waiting period and the methods adopted for controlling shoot and fruit borer. The interview was conducted in farmer's native language. The collected data was analysed and means, percentage and standard deviation was calculated.

RESULTS AND DISCUSSION

The survey data revealed that the usage pattern of insecticides to manage *L.orbonalis* across the major growing regions varied from 2.00 to 83.00% (Table 1). Farmers used 22 different insecticides to manage this pest and among the different insecticides the highest usage (83.00%) of chlorantraniliprole 18.5% SC was recorded followed by spinetoram 11.7% SC (72.00%) and Spinosad 45% SC (67.00%) and lowest usage (2.0%) of natural products like brahmastra and neemastra. These findings are in line with those of Beena et al. (2019) who reported that chlorpyriphos, dimethoate, quinalphos, thiacloprid, emamectin benzoate, flubendiamide, thiodicarb and lambda-cyhalothrin were the widely used insecticides to manage this pest in Tamil Nadu, India during 2018-2019. According to Gaikwad and Jirali. (2016) the most often used pesticides by farmers were indoxacarb and rynaxypyr. The highly used about more than 70.00% class of insecticides to control this pest were anthralinic diamides (Premlatha and Basavaraja, 2018; Gaddanakeri et al., 2023). The study from Ranjith et al. (2020) observed the highest usage of insecticide chlorantraniliprole 18.5% SC (37.50%) followed by emamectin benzoate 5 SG (34.0%) and the lowest usage (6.50%) of chlorpyriphos 20 EC, tolfenpyrad 15 EC and neem oil (1%) EC in Andhra Pradesh. Same trend was reported by Baral et al. (2006). In a study done across India's brinjal growing regions, emamectin benzoate was found to be the most widely used insecticide (12.0%) by farmers followed by chlorantraniliprole (10.0%) to control *L.orbonalis* (Kariyanna et al., 2020). The data shows that farmers were using both CIBRC recommended and non-recommended insecticides too, indicating lack of knowledge in pest management practices and majority of the farmers were found to prefer novel insecticides over conventional ones. This reveals, willingness of farmers to adopt new and potentially more effective pest management strategies.

The present survey on pesticide application revealed that most of the farmers sprayed insecticides at the interval of 4.9 to 12.3 days (Fig. 1). Highest spray interval 12.3 and 8.5 days was noticed in Namakkal and Madurai districts, and lowest of 4.9 and 5.9 days

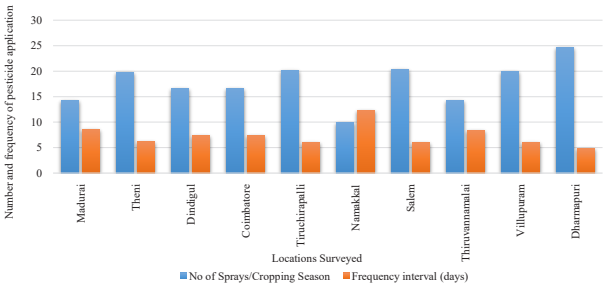

Fig. 1. Pesticide application by brinjal growers in Tamil Nadu

was recorded from Dharmapuri and Salem districts, respectively. The number of sprays in the ten locations varied from 9.9 to 24.7/ cropping season in brinjal. Maximum number of sprays (24.7 and 20.4) were recorded from Dharmapuri and Salem districts, whereas least number of sprays (9.9) in Namakkal district respectively (Fig. 1). These findings are consistent with the findings of Dhas and Srivastava (2010) who stated that the number of sprays in brinjal to prevent *L.orbonalis* ranges from 15 to 40 in a single crop season. Gaikwad and Jirali (2016) and Premlata and Basavaraja (2018) revealed that farmers use 28-30 sprays during the crop growth period of 180 days with a frequency of six days interval. Chandi and Chandi (2019) and Sutharsan et al. (2014) also reported that farmers follow the pattern of 8.71 and more than 22 sprays in every cropping season. About 36.35 to 57.33 times spray can occur depending on the regions (Mannan et al., 2021). According to Kariyanna et al. (2020) farmers from Dharmapuri region followed 22.6 sprays followed by Raichur and Guntur area with 21.6 and 21.4 sprays, respectively and concluded that the variance in total amount of pesticides applied and spray interval was mostly due to change in brinjal hybrids/varieties as well as farmers' assessment of insect pests and spraying according to the recommendations of local pesticide dealers.

From the data collected, in order to get information on insecticide recommendation, 65.00% of brinjal growing farmers approached pesticide dealer shops and 27.00% preferred to select based on the discussions with the fellow farmers (Table 2). Majority of the farmers from Villupuram (100%) and Dharmapuri (90%) districts approached dealers to get information. Our results are in confirmation with the previous findings (Rashid et al., 2008; Gaikwad and Jirali, 2016; Ranjith et al., 2020; Baral et al., 2006) who also reported that the major source of information was pesticide dealers. In the current study 98.00%, farmers did not pay attention to label information provided on pesticide

Table 1. Insecticide use pattern by brinjal farmers for controlling *L. orbonalis* in Tamil Nadu

Pesticide	% of farmers participation										
	L1	L2	L3	L4	L5	L6	L7	L8	L9	L10	Mean
Cartap hydrochloride 50SP	50.0	20.0	40.0	10.0	20.0	0.0	20.0	40.0	50.0	20.0	27.0
Chlorantraniliprole 18.5SC	100.0	70.0	100.0	80.0	70.0	80.0	80.0	100.0	70.0	80.0	83.0
Chloropyriphos 50 EC	10.0	10.0	30.0	0.0	20.0	0.0	10.0	0.0	10.0	0.0	9.0
Emamectin benozoate 5SG	40.0	40.0	80.0	30.0	60.0	40.0	50.0	50.0	60.0	40.0	49.0
Fipronil 5SC	10.0	0.0	20.0	0.0	0.0	0.0	10.0	20.0	0.0	20.0	8.0
Flubendiamide 39.35SC	40.0	30.0	60.0	40.0	20.0	10.0	20.0	40.0	40.0	30.0	33.0
Fluxametamide 10 EC	40.0	0.0	30.0	0.0	0.0	0.0	0.0	30.0	20.0	0.0	12.0
Indoxacarb 14.5SC	20.0	20.0	30.0	0.0	10.0	0.0	0.0	0.0	20.0	0.0	10.0
Monocrotophos 36SL	10.0	10.0	30.0	0.0	20.0	10.0	0.0	0.0	0.0	10.0	9.0
Profenophos 50EC	40.0	30.0	60.0	40.0	40.0	30.0	0.0	20.0	30.0	60.0	35.0
Spinetoram 11.7SC	50.0	60.0	100.0	80.0	60.0	70.0	90.0	80.0	40.0	90.0	72.0
Spinosad 45SC	60.0	40.0	100.0	70.0	70.0	70.0	60.0	50.0	50.0	100.0	67.0
Thiacloprid 21.7SC	40.0	50.0	80.0	50.0	40.0	30.0	60.0	60.0	60.0	50.0	52.0
Insecticide mixtures											
Cloropyriphos 5%SC+ cypermethrin	0.0	0.0	20.0	0.0	0.0	0.0	20.0	0.0	0.0	0.0	4.0
Novaluron 5.25 + indoxacarb 4.5SC	0.0	0.0	30.0	0.0	0.0	0.0	10.0	0.0	0.0	0.0	4.0
Novaluron 5.25 + emamectin benozoate 0.9SC	70.0	0.0	30.0	0.0	0.0	0.0	10.0	0.0	0.0	70.0	18.0
Profenophos 40 +cypermethrin 4EC	0.0	30.0	40.0	0.0	30.0	10.0	20.0	10.0	0.0	0.0	14.0
Pyriproxifen 5 + fenpropathrin 15EC	0.0	0.0	30.0	0.0	0.0	0.0	30.0	0.0	0.0	30.0	9.0
Organic products											
Brahmastra	0.0	0.0	0.0	10.0	0.0	0.0	0.0	10.0	0.0	0.0	2.0
Neemastra	0.0	0.0	0.0	10.0	0.0	0.0	0.0	10.0	0.0	0.0	2.0
Neem oil	0.0	20.0	0.0	10.0	10.0	0.0	0.0	10.0	0.0	0.0	5.0
Panchagavya	0.0	20.0	0.0	10.0	10.0	0.0	0.0	10.0	0.0	0.0	5.0

L1 - Villupuram, L2 - Thiruvannamalai, L3 - Dharmapuri, L4 - Salem, L5 - Namakkal, L6 - Coimbatore, L7 - Dindigul, L8 - Tiruchirapalli, L9 - Madurai, L10 – Theni

Table 2. Knowledge level of brinjal farmers on insecticides handling and safety measures taken in major brinjal growing regions of Tamil Nadu

Usage pattern	Farmer respondents (%) (n=10)										Mean
	L1	L2	L3	L4	L5	L6	L7	L8	L9	L10	(%)
Source of information on insecticide usage											
Horticulture officers	0.0	0.0	0.0	0.0	20.0	0.0	10.0	0.0	0.0	20.0	5.0
Dealers	100.0	80.0	90.0	80.0	40.0	60.0	60.0	60.0	50.0	30.0	65.0
Fellow farmers	0.0	10.0	10.0	20.0	30.0	30.0	30.0	40.0	50.0	50.0	27.0
Company persons	0.0	0.0	0.0	0.0	10.0	0.0	0.0	0.0	10.0	0.0	2.0
Attention towards label information											
Reading label before use	0.0	0.0	0.0	0.0	0.0	10.0	0.0	0.0	10.0	0.0	2.0
No attention	100.0	100.0	100.0	100.0	100.0	90.0	100.0	100.0	90.0	100.0	98.0
Measurement of insecticides											
Bottle cap	50.0	100.0	40.0	100.0	90.0	50.0	30.0	40.0	30.0	20.0	55.0
Approximate	50.0	0.0	60.0	0.0	10.0	50.0	70.0	60.0	70.0	80.0	45.0
Dosage											
Recommended	40.0	60.0	30.0	40.0	50.0	60.0	40.0	30.0	50.0	40.0	40.0
Approximate	60.0	40.0	70.0	60.0	50.0	40.0	60.0	70.0	50.0	60.0	60.0
Safety measures taken at the time of spray											
No measures taken	100.0	100.0	100.0	100.0	100.0	90.0	80.0	100.0	80.0	90.0	94.0
Hand gloves only	0.0	0.0	0.0	0.0	0.0	10.0	20.0	0.0	20.0	10.0	6.0
Mask alone	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Time of application											
Morning	90.0	80.0	100.0	100.0	100.0	70.0	60.0	80.0	80.0	70.0	83.0
Evening	10.0	20.0	0.0	0.0	0.0	30.0	40.0	20.0	20.0	30.0	17.0
Decision of spraying											
Based on ETL	0.0	20.0	0.0	0.0	0.0	20.0	0.0	0.0	0.0	0.0	4.0
Initial symptoms	90.0	60.0	90.0	50.0	60.0	40.0	70.0	60.0	30.0	50.0	60.0
Blanket spraying	10.0	20.0	10.0	50.0	40.0	60.0	30.0	40.0	70.0	50.0	38.0
Disposal of insecticidal containers											
Buried in soil	0.0	0.0	0.0	0.0	10.0	10.0	0.0	0.0	10.0	20.0	5.0
Leaving in field	10.0	30.0	10.0	40.0	20.0	80.0	60.0	70.0	90.0	70.0	48.0
Throw in neglected area	90.0	70.0	90.0	60.0	70.0	10.0	40.0	30.0	0.0	10.0	47.0
Waiting period											
No waiting period	30.0	10.0	70.0	0.0	0.0	10.0	10.0	20.0	0.0	0.0	15.0
One day	70.0	90.0	30.0	100.0	100.0	90.0	90.0	80.0	100.0	100.0	85.0
As per recommended on leaflet	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Type of sprayer used											
Hand operated	20.0	20.0	30.0	20.0	10.0	0.0	20.0	0.0	0.0	20.0	14.0
Power operated	80.0	80.0	70.0	80.0	90.0	100.0	80.0	100.0	100.0	80.0	86.0
Control methods adopted											
Plant products & Entomopathogens	0.0	30.0	30.0	20.0	40.0	0.0	0.0	20.0	0.0	20.0	16.0
Synthetic pesticides	100.0	70.0	70.0	80.0	60.0	100.0	100.0	80.0	100.0	80.0	84.0

L1 - Villupuram, L2 - Thiruvannamalai, L3 - Dharmapuri, L4 - Salem, L5 - Namakkal, L6 - Coimbatore, L7 - Dindigul, L8 - Tiruchirapalli, L9 - Madurai, L10 - Theni

containers and had no awareness of the colour code provided for toxicity level on the pesticide container and similar results were reported by Ranjith et al. (2020) as 90.50% farmers did not read the labels on pesticide containers. This highlights the significance of providing comprehensive education to farmers about pesticide handling, label information and the meaning of toxicity indicators for promoting a safe, environmentally friendly and sustainable approach to agriculture.

The survey data also revealed that 55.00% of the farmers used insecticide container caps having measurement mark for measuring insecticide and only 40.00% of farmers sprayed insecticides at recommended dose (Table 2). Majority of the farmers from Dharmapuri and Tiruchirappalli have applied the insecticides at approximate dosages and also 94.00% farmers did not follow any safety measures while undertaking spraying operation. Only 6.0% of the farmers preferred to wear hand gloves during spraying. These findings are in line with the reports of Ahire et al. (2021) and Singh et al. (2020), who also found that about 48.34% of farmers were not following recommended dose. Rashid et al. (2008) indicated that 45.00% of the respondents did not take any safety measures. Only few farmers utilise face masks, helmets, gloves, and hand washing during spray operations (Kavipriya and Kumar, 2021). These findings highlight that there is a significant threat to effective pest management and also there is a need of educating farmers on recommended dose and safety considerations during pesticide application.

Majority of the farmers (83.00%) irrespective of the survey location carried out spraying operations during morning hours, nearly 60.00% of farmers spray pesticides after observing initial symptoms, only 4.0% farmers have followed ETL and 38.00% of farmers adopted blanket spraying (Table 2). These findings are in line with reports of Ranjith et al. (2020) and Ahire et al. (2021) who noted that approximately 53.33 to 92.50% of farmers conducted spraying operations at morning hours. These findings highlight the lack of knowledge on economic threshold level of pest infestation to farmers. In our study most of the farmers (86.00%) sprayed insecticides with the help of power sprayer and 47.00% of farmers dispose the empty containers in neglected area after their use and only few farmers (5.0%) buried the containers in soil (Table 2). According to Raut et al. (2016) and Abdelbagi et al. (2022) about >(94.00%) of the farmer's were not aware of the proper way to dispose of leftover pesticide bottles. This highlights that majority farmers were interested to use power sprayers as they provide higher pressure allowing for better penetration, quick coverage and also reduced physical effort.

Surprisingly 85% of farmers gave only one day waiting period after insecticide application and rest of the farmers (15.00%) applied the insecticides and sent the fruits to the markets on the same day (Table 2). Not even a single farmer maintained the waiting period as recommended on the leaflets. These results are in accordance with those of Gaikwad and Jirali (2016) who reported that farmers didn't have any idea about what is waiting period. Waiting period varies with the crop and as well as the insecticide as CIBRC recommends about 3 days for the spinosad and emamectin benzoate and 5 days for thiacloprid and about 22 days for chlorantraniliprole in brinjal. For controlling the insect around 84.00% farmers relied only on synthetic insecticides and only 16.00% famers followed cultural and organic farming using natural products like neem oil, neemastra, bhrahmastra and panchagavya. According to Kumar et al. (2018) and Arvind Kumar Singh et al. (2020) >50% respondents had medium level of knowledge on recommended brinjal production. Only one third of respondent farmers were aware of the negative impact of pesticide residues (Achhami et al., 2013). The present study reveals that farmers did not adhere to the recommended waiting period after insecticide application, which can result in higher insecticide residues on brinjal fruits which may have adverse effects on both human health and the environment.

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AUTHOR CONTRIBUTION STATEMENT

K. S conducted the study, analysis, interpretation of data and drafting the manuscript. K.N. R, S.V. K, T. S, V. B and B.V corrected the drafted manuscript.

CONFLICT OF INTEREST

No conflict of interest.

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