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RESEARCH ARTICLE

A survey on insecticide usage patterns in Jasmine crops in Tamil Nadu, India

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Abstract

Jasmine (*Jasminum* spp.) plays an important cultural and economic role in India, with Tamil Nadu leading its production, contributing over two-thirds of the national output. The insecticide use pattern study explores how jasmine farmers across nine key districts in the state manage pest control, focusing on the types of insecticides they use and where they get their information. Based on field surveys with 170 farmers conducted between 2024-2025, the findings show that most growers (85.93 %) are marginal farmers with less than one hectare of land and 42 % have only a middle school education. Low-volume power sprayers were the most widely used equipment (71.48 %), pointing to a preference for efficient and easy-to-use tools. When it comes to insecticides, broad-spectrum and mixed compound products dominate in the jasmine crop. The most widely used insecticide was Spirotetramat + Imidacloprid SC (29.81 %), especially in Krishnagiri (46.15 %) and Coimbatore (40 %). Commonly used single-compound choices include Alphamethrin 10 % EC (10.60 %) and Imidacloprid 70 % WG (8.66 %). On the other hand, newer, potentially safer alternatives like diamides (1.78 %) and spinosyns (0.62 %) saw very limited use. Most farmers relied on local input dealers for guidance (51.86 %), while trained extension officials were rarely approached (8.14 %). Heavy dependence on familiar chemical solutions and culminating point the need for better outreach, education and access to safer pest management options to support the long-term sustainability of jasmine farming.

Keywords: agro-ecological zones; floriculture entomology; mixed insecticide compounds; *Jasminum sambac*; socio-economic status

Introduction

Jasmine (*Jasminum* spp.), part of the Oleaceae family, is one of the most treasured flowering plants found across tropical and subtropical regions of the world. Often, it is called the "Queen of Fragrance," loved not only for its captivating scent but also for its deep cultural ties. It's long been a symbol of love, purity and devotion in many societies (1). The word "jasmine" has its roots in the Arabic term *Jessamine* and Persian; it is known as *Yasmin* or *Yasmyn*, both meaning "fragrance." Globally, the genus includes over 200 species, but only about 90 are widely accepted as valid (2). India alone accounts for 72 of them, with 20 species grown in South India (3). *Jasminum sambac*, *J. grandiflorum and J. auriculatum* are the most commonly cultivated and commercially valuable.

Jasmine flowers are a part of daily life in many Indian households, used in garlands, worn in hair, offered in temples, or processed for their fragrant oils. These oils are vital to the perfume and cosmetics industries and jasmine tea, from the dried flowers, is appreciated for both its aroma and health benefits (4). India is a key player in the global jasmine trade and exports to countries such as U.S.A, Japan, the U.K. and the Gulf nations, to the tune of 241 thousand tonnes, with Tamil Nadu alone contributing more than two-thirds of jasmine flower (180 thousand tonnes) of the total andhra Pradesh and Karnataka are also major producers in India (5). Jasmine is grown in 255 million hectares and Tamil Nadu contributes over 11000 hectares with the production of 88000 tonnes (6).

With the rise of commercial jasmine cultivation in Tamil Nadu, the application of chemical insecticides has increased substantially. Jasmine farmers frequently encounter serious pest issues such as whiteflies, thrips, budworms and gall midges, often leading to repeated and sometimes indiscriminate pesticide use (7). Broad-spectrum insecticides, including pyrethroids, neonicotinoids and organophosphates, are widely used due to their fast-acting nature and satisfy the consumers' quality requirement by appearance, with more than 85 % of farmers regularly depending on these chemicals (8). Regarding plant protection practices (POP), a significant portion of farmers utilize low-volume power sprayers and apply insecticides multiple times throughout the growing season (8). Despite the availability of safer and more advanced options like diamides and spinosyns, their usage remains minimal, below 2 % (9). This uneven adoption pattern highlights challenges related to awareness, accessibility and affordability of eco-friendly alternatives. Overall, while pesticide usage is high due to the absence of maximum residue limit (MRL) in the floriculture sector, the lack of informed decision-making calls for focused interventions, farmer training and strengthened extension services to support safer and more effective pest control strategies.

In recent years, as demand for jasmine flowers has surged due to global markets and rising incomes, jasmine has shifted from being a backyard plant to a serious commercial crop (10, 11). Unfortunately, this overuse has created new challenges of pesticide residues, resistance to pests and threats to both human health and the environment (7). There's still very little research on the health risks and long-term effects of pesticide exposure of pesticides to human beings (12, 13) .

Pesticide usage patterns have ecological and economic consequences. The predominance of broad-spectrum insecticides -such as pyrethroids, neonicotinoids and organophosphates- poses serious ecological threats to agroecosystems in India. These chemicals, while offering immediate pest control, are notorious for their non-selectivity, harming beneficial arthropods, including pollinators like bees and predatory insects essential for natural pest suppression. For instance, neonicotinoids have been shown to impair honeybee foraging, navigation and colony reproduction (14). Furthermore, the chronic use of such compounds fosters the development of pesticide-resistant pest populations, leading to a vicious cycle of increased application and diminishing returns (15). The jasmine ecosystem, once a diverse floral niche, is now at risk of ecological imbalance due to the widespread elimination of natural enemies and soil microflora from repeated chemical exposure. This trajectory undermines long-term pest regulation and degrades soil and floral biodiversity, as echoed in recent Indian studies showing underutilization of safer insecticides like diamides and spinosyns, which together account for less than 2 % of total usage (9).

Economically, the heavy reliance on mixed and broad-spectrum insecticides significantly raises the input costs for marginal jasmine farmers, who constitute over 85 % of the surveyed population in Tamil Nadu. Many of these farmers operate on less than one hectare and have minimal formal education, leaving them vulnerable to input dealers who often promote costly chemical solutions for short-term gains (16). Repeated applications not only burden farmers financially but also fail to deliver sustained efficacy due to pest resistance and resurgence. Moreover, the absence of Maximum Residue Limits (MRLs) for floricultural crops like jasmine in India hampers export potential, as importing countries increasingly scrutinize floral products for pesticide contamination (17). This jeopardizes India's reputation in the global fragrance and ornamental flower market. Transitioning to integrated pest management (IPM) or biopesticide-based systems would offer long-term cost savings and enhance market access, but current adoption remains low due to affordability and awareness barriers.

This study was undertaken with the hypothesis that jasmine farmers in Tamil Nadu depend predominantly on broad -spectrum insecticides due to limited access to advisory services, lack of awareness about safer alternatives and socio-economic constraints. Consequently, their insecticide usage patterns may not align with recommended plant protection protocols and could lead to inefficiencies or health and environmental risks.

The present study aims to systematically analyze the insecticide usage patterns among jasmine growers across major agro-ecological zones in Tamil Nadu. In particular, the study investigates the socio-economic characteristics of farmers that influence pesticide adoption decisions, the types and insecticide usage patterns and the nature of plant protection appliances utilized for spray operations.

Materials and Methods

A survey on insecticide usage patterns in jasmine was carried out during 2024-2025 in nine major jasmine-growing districts of Tamil Nadu by using a well-structured questionnaire. The districts were selected based on the extent of jasmine cultivation, with data sourced from the Department of Horticulture, Government of Tamil Nadu and the 2024 Horticulture database.

The primary aim of this study was to examine the intensity and nature of insecticide use across the selected districts, namely Coimbatore, Dharmapuri, Dindigul, Erode, Krishnagiri, Madurai, Salem, Theni and Virudhunagar, as shown in Fig 1.

The study employed a multistage random sampling technique to ensure regional representation proportional to the area under jasmine cultivation. Data were collected from a total of 170 randomly selected jasmine farmers across nine key jasmine producing districts in Tamil Nadu, which consist of 30 respondents each from the major districts Dindigul, Erode, Krishnagiri and Madurai and 10 farmers each from Coimbatore, Dharmapuri, Salem, Theni and Virudhunagar as shown in Table 1. Data were gathered through direct interviews conducted during field visits, minimizing response bias and enhancing data reliability. A structured questionnaire served as the primary tool for data collection, designed to comprehensively capture the socio-economic background of farmers, insecticide usage patterns and plant protection practices. The questionnaire included both closed- and open-ended questions to allow for quantitative analysis and qualitative insights and it was pre-tested with a small group of jasmine growers to ensure clarity,

Table 1. Survey location for characterization of insecticide usage Pattern in jasmine growers in Tamil Nadu

Name of the agroecological zone	District	Name of the village/ block	No. of respondents
North - Western Zone	Krishnagiri	Kaveripattinam	10
		Thimmapuram	10
		Paiyyur	10
	Dharmapuri	Paparapatty	5
		Pallipatty	5
Western Zone	Salem	Thalaivasal	5
		Santhiyur	5
	Erode	Sathyamangalam	15
		Bhawanisagar	15
	Coimbatore	Karamadai	3
		Annur	4
		SS kulam	3
Southern Zone	Dindigul	Nilakottai	20
		Oddanchatram	10
	Theni	Periyakulam	6
		Uthamapalayam	4
	Virudhunagar	Aruppukottai	7
		Kariapatti	3
	Madurai	Thirumangalam	10
		Usilampatti	10
		Melur	10
Total	**9**	**21**	**170**

Source: Primary Data.

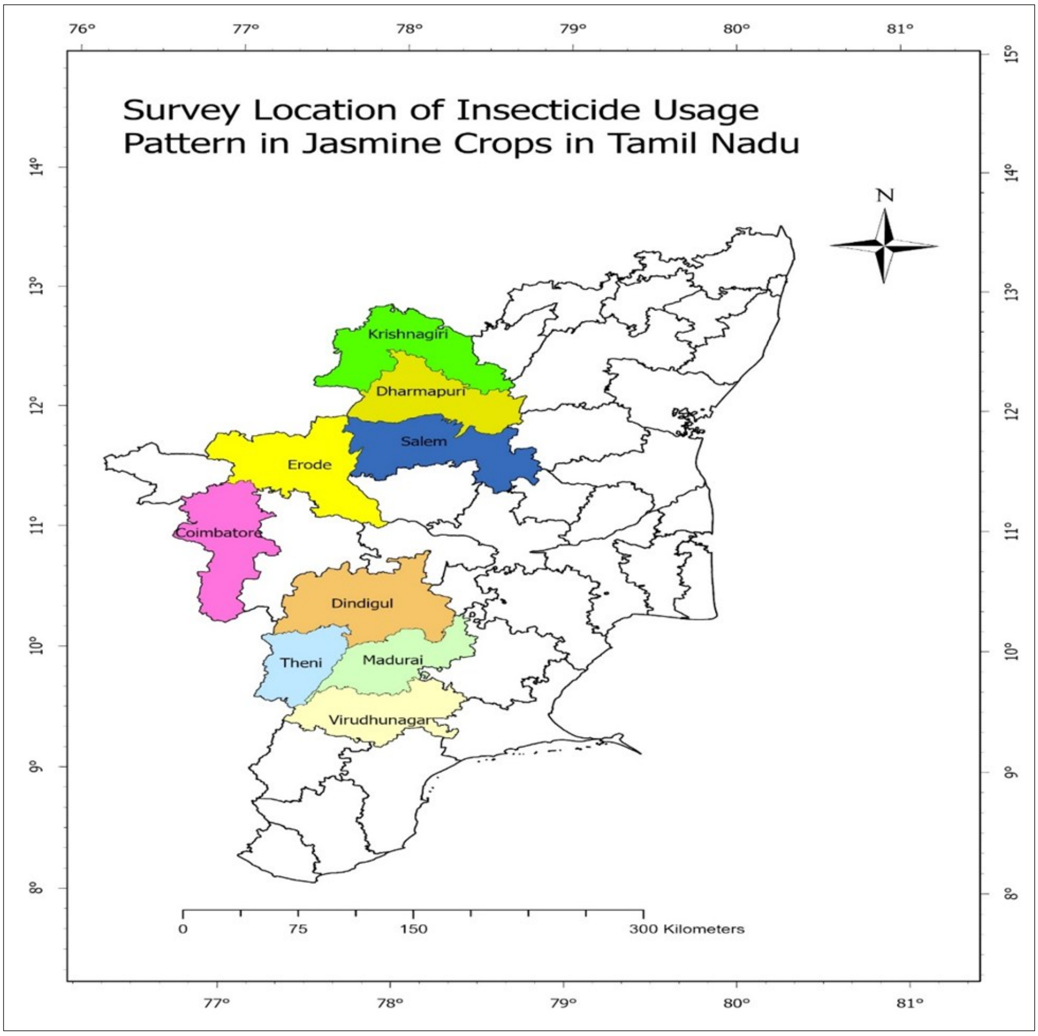

Fig. 1. Survey location of insecticide usage pattern in jasmine crop in Tamil Nadu.

relevance and consistency before large-scale administration. Descriptive statistics such as means, percentages and standard deviations were used to analyze the socio-economic profiles and insecticide usage patterns of the respondents.

Results and Discussion

Socio-economic status of Jasmine farmers

It could be inferred from Table 2 that most sample farmers had middle school education (41.85 %), followed by secondary (19.63 %) and primary levels (16.67 %). A smaller proportion had collegiate education (12.22 %), while 9.63 % were illiterate. In terms of land holding, a vast majority (85.93 %) were marginal farmers owning less than one hectare, followed by small (10.37 %) and semi-medium (2.96 %) farmers were few. Only 0.74 % of the farmers belonged to the medium category (4-10 ha). These findings suggest that jasmine cultivation is predominantly carried out by resource-constrained smallholders, emphasizing the need for cost-effective and accessible pest management interventions.

The dominance of farmers with basic education and small landholdings suggests potential challenges in adopting advanced plant protection practices (18). Lower educational levels may limit understanding of newer technologies or safety measures, while smaller land sizes reduce economic flexibility for investments. These findings are consistent with former

Table 2. Socio-economic status of Jasmine farmers (percentage) in Tamil Nadu

S.No.	Particulars	Erode	Krishnagiri	Madurai	Dindigul	Coimbatore	Virudhunagar	Dharmapuri	Theni	Salem	Mean
Education (years of schooling)											
1	Illiterate	6.67	13.33	10.00	6.67	0.00	10.00	30.00	0.00	10.00	**9.63**
2	Primary	6.67	23.33	23.33	16.67	10.00	40.00	10.00	0.00	20.00	**16.67**
3	Middle	50.00	40.00	33.33	43.33	60.00	20.00	50.00	50.00	30.00	**41.85**
4	Secondary	20.00	10.00	10.00	16.67	20.00	20.00	10.00	50.00	20.00	**19.63**
5	Collegiate	16.67	13.33	23.33	16.67	10.00	10.00	0.00	0.00	20.00	**12.22**
Category of farmer based on size (ha)											
1	Marginal (Less than one ha)	66.67	83.33	100	93.33	90.00	100.00	80.00	90.00	70.00	**85.93**
2	Small (1 to 2 ha)	26.67	13.33	0.00	3.33	10.00	0.00	10.00	10.00	20.00	**10.37**
3	Semi-Medium (2 to 4 ha)	0.00	3.33	0.00	3.33	0.00	0.00	10.00	0.00	10.00	**2.96**
4	Medium (4 to10 ha)	6.67	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**0.74**

Source: Primary data.

studies reported that farmers' education and landholding size significantly influenced their adoption of plant protection practices (19). This underlines the need for targeted extension programs and custom hiring services to support marginal and less-educated farmers.

Plant protection appliances

The types of spraying equipment adopted by farmers is given in Table 3. Among the surveyed districts, low volume sprayers, particularly power sprayers/mist blowers, were most used (71.48 %), with the highest adoption in Coimbatore (100 %) and Madurai (96.67 %). High volume sprayers like hand sprayers (4.44 %) and rocker sprayers (5.19 %) showed minimal usage. Battery-operated high-volume and motor-operated power sprayers/mist blowers were adopted by only 10 % of sample respondents, reflecting the labour-intensive nature and inefficiency of these tools for commercial jasmine farming. The overall mean usage of several types of appliances was 19.78 % with a standard deviation of 28.99, indicating variability in adoption levels.

The dominance of low-volume power sprayers suggests a preference for efficient, time-saving equipment suited for larger farm areas. Their ease of handling and coverage efficiency can explain this trend. Limited use of high-volume sprayers could be due to labour intensity or maintenance challenges.

These results are consistent with the findings of former studies (20), who observed that the use of motorized sprayers by horticultural farmers in Tamil Nadu notably improved operational efficiency, reduced the need for manual labour and enhanced pest management outcomes. Furthermore, the widespread preference for power-operated sprayers among jasmine growers corroborates earlier studies (8), which emphasized their superior spray uniformity, reduced application time and increased effectiveness in controlling pests in high-value floricultural crops such as jasmine.

Insecticide use patterns

The study revealed that farmers predominantly used a few key insecticides (Table 4), with the highest mean usage observed for Alphamethrin 10 % EC (10.60 %) followed by Imidacloprid 70 % WG (8.66 %), Quinalphos 25 % EC (8.43 %) and Lambda-cyhalothrin 5 % SC (8.34 %). These insecticides were consistently reported across most of the districts, particularly in Coimbatore, Madurai and Salem. In contrast, newer or more targeted formulations like Tolfenpyrad 15 % EC, Spinetoram 11.7 % SC and Spiromesifen 22.9 % SC showed minimal usage (<0.5 %) by jasmine growers.

The dominance of broad-spectrum insecticides such as Alphamethrin, Lambda-cyhalothrin and Imidacloprid suggests that farmers prioritize immediate pest knockdown and easy availability over selectivity. This trend may be driven by limited awareness or access to alternative pest management tools.

Similar observations were reported earlier that cost, effectiveness and local dealer influence were key factors in spray technology and chemical adoption among Indian jasmine farmers (8). The under use of newer, potentially safer insecticides also highlights a need for targeted extension and awareness programs to improve sustainable and informed pesticide use. The usage pattern of mixed compounds of

Table 3. Plant protection appliances usage by Jasmine farmers of Tamil Nadu

S. No	Name of the plant protection appliances used	Erode		Salem		Dharmopuri		Krishnagiri		Dindigul		Theni		Madurai		Virudhnagar		Coimbatore		Average (n=170)
		Respondents (n=30)		Respondents (n=10)		Respondents (n=10)		Respondents (n=30)		Respondents (n=30)		Respondents (n=10)		Respondents (n=30)		Respondents (n=10)		Respondents (n=10)		
		Nos.	(%)	Nos.	(%)	Nos.	(%)	Nos.	(%)	Nos.	(%)	Nos.	(%)	Nos.	(%)	Nos.	(%)	Nos.	(%)	(%)
I	**High volume sprayer**																			
1.	Hand sprayer	2	6.67	1	10.00	1	10.00	0	0.00	1	3.33	1	10.00	0	0.00	0	0.00	0	0.00	4.44
2.	Battery operated sprayer	6	20.00	3	30.00	2	20.00	5	16.67	0	0.00	0	0.00	1	3.33	1	10.00	0	0.00	10.00
3.	Rocker sprayer	0	0.00	1	10.00	1	10.00	2	6.67	3	10.00	1	10.00	0	0.00	0	0.00	0	0.00	5.19
II	**Low volume sprayer**																			
1.	Power sprayer	15	50.00	5	50.00	3	30.00	18	60.00	26	86.27	8	80.00	29	96.67	9	90.00	10	100.00	71.48
III	**Both low- volume sprayer and high-volume sprayer**																			
1.	Battery + motor operated sprayer	7	23.33	0	0.00	3	30.00	5	16.67	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	10.00
	Mean	6	20.00	2	20	2	20	6	20.00	6	20.00	2	20	6	20.00	2	20	2	20	19.78
	S D	5.79	19.29	2.00	20.00	1.00	10.00	7.04	23.45	11.25	37.49	3.39	33.91	12.86	42.88	3.94	39.37	4.47	44.72	28.99

Source: Primary data.

Table 4. District-wise insecticide usage pattern in percentage for jasmine growers in Tamil Nadu - single insecticide

S. No.	Insecticides	Krishnagiri	Dharmapuri	Salem	Erode	Coimbatore	Dindigul	Maduari	Theni	Virudhunagar	Mean
1	Acephate-75 % SP	2.01	6.98	4.65	4.41	9.68	5.43	1.8	4.55	0.00	4.39
2	Acetamiprid-20 % SP	0.00	0.00	2.33	1.47	0.00	2.33	4.50	0.00	2.56	1.47
3	Alphamethrin 10 % EC	14.77	18.6	4.65	4.41	19.35	10.08	4.50	11.36	7.69	10.60
4	Bifenthrin-10 % EC	10.07	6.98	0.00	0.74	0.00	2.33	9.91	6.82	2.56	4.38
5	Buprofezin-25 % SC	0.00	0.00	0.00	1.47	0.00	0.78	0.00	0.00	0.00	0.25
6	Carbosulfan 25 % EC	0.00	0.00	0.00	0.74	0.00	0.00	5.41	0.00	0.00	0.68
7	Cartap-hydrochloride-50 % SP	0.67	2.33	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.33
8	Chlorantraniliprole 18.5 % SC	0.00	0.00	0.00	4.41	12.9	0.00	2.7	0.00	0.00	2.22
9	Clorfenapyr10 % SC	0.00	0.00	0.00	10.29	12.9	2.33	0.00	0.00	0.00	2.84
10	Chlorpyriphos 20 %EC	0.67	2.33	0.00	1.47	0.00	0.78	0.00	0.00	0.00	0.58
11	Cyclaniliprole 9.3 % DC	0.00	0.00	0.00	0.00	0.00	1.55	0.00	0.00	7.69	1.03
12	Cyenopyrafen 30 % SC	0.00	0.00	0.00	2.21	0.00	0.00	0.00	0.00	0.00	0.25
13	Cypermethrin-25 % EC	2.01	2.33	4.65	1.47	12.9	6.98	9.91	9.09	0.00	5.48
14	Deltamethrin-11 % EC	0.00	0.00	0.00	0.00	0.00	1.55	0.00	0.00	7.69	1.03
15	Diafenthiuron-50 % WP	0.00	0.00	4.65	0.00	0.00	0.78	0.00	0.00	7.69	1.46
16	Dimethoate 30 % EC	1.34	2.33	0.00	1.47	0.00	0.00	1.80	0.00	2.56	1.06
17	Emamectin benzoate 5 %SC	2.68	0.00	4.65	11.03	0.00	8.53	8.11	18.18	0.00	5.91
18	Ethion 50 % EC	0.00	0.00	0.00	2.94	0.00	0.00	0.00	0.00	0.00	0.33
19	fenazaquin 10 % EC	0.67	2.33	4.65	2.94	0.00	0.78	0.00	0.00	0.00	1.26
20	Fenpropathrin 10 %EC	2.01	6.98	11.63	0.00	0.00	0.00	0.00	0.00	2.56	2.58
21	Fipronil 5 % SC	2.01	0.00	0.00	0.00	0.00	0.00	3.60	0.00	0.00	0.62
22	Flumioxazin 50 % SG	0.00	0.00	0.00	0.74	0.00	0.00	0.00	0.00	0.00	0.08
23	flubendiamide 20 % WG	0.00	0.00	6.98	2.21	0.00	0.00	0.00	0.00	0.00	1.02
24	Fluxametamide 10 % EC	0.00	0.00	0.00	2.21	0.00	0.00	0.00	0.00	0.00	0.25
25	Imidacloprid-70 % WG	14.09	6.98	11.63	6.62	3.23	8.53	2.7	11.36	12.82	8.66
26	Indoxacarb 14.5 % SC	0.00	0.00	0.00	0.00	0.00	0.78	0.00	0.00	2.56	0.37
27	Lambda-cyhalothrin 5 % SC	16.11	16.28	4.65	4.41	3.23	7.75	7.21	0.00	15.38	8.34
28	Monocrotophos-36 % SL	1.34	4.65	4.65	5.15	3.23	3.88	5.41	6.82	5.13	4.47
29	Permethrin 25 % EC	4.70	6.98	6.98	5.15	0.00	9.30	14.41	4.55	0.00	5.79
30	Phenthoate-50 % EC	3.36	0.00	9.30	0.00	6.45	5.43	0.00	0.00	7.69	3.58
31	Profenofos 50 % EC	2.68	6.98	4.65	3.68	0.00	0.78	0.00	4.55	0.00	2.59
32	Propargite-57 % EC	6.71	4.65	0.00	2.94	0.00	2.33	4.5	11.36	0.00	3.61
33	Quinolphos 25 % EC	4.03	2.33	4.65	12.5	22.58	7.75	8.11	11.36	2.56	8.43
34	Spinosad 45 % SC	0.00	0.00	0.00	0.00	6.45	1.55	0.00	0.00	0.00	0.89
35	Spinetoram 11.7 % SC	0.00	0.00	0.00	0.00	0.00	2.33	0.00	0.00	0.00	0.26
36	Spiromesifen-22.9 % SC	0.00	0.00	0.00	0.74	0.00	0.00	0.00	0.00	0.00	0.08
37	Thiacloprid 21.7 % SC	3.36	0.00	0.00	1.47	0.00	0.00	0.00	0.00	0.00	0.54
38	Thiamethoxam 25 % WG	4.70	0.00	4.65	0.00	0.00	4.65	5.41	0.00	10.26	3.30
39	Tolfenpyrad-15 % EC	0.00	0.00	0.00	0.74	0.00	0.78	0.00	0.00	2.56	0.45

Source: Primary data.

Note: SP - Soluble Powder, WP- Wettable Powder; EC - Emulsifiable Concentrate; SG - Water-Soluble Granules; WG - Water-Dispersible Granules; SC - Suspension Concentrate

insecticides varied significantly across districts (Table 5). The most widely used mixed insecticides among jasmine growers were Spirotetramat 11.01 % + Imidacloprid 11.01 % SC, with the highest average adoption (29.81 %) across all districts, especially in Krishnagiri (46.15 %) and Coimbatore (40 %). This was followed by Thiamethoxam + Lambda-cyhalothrin (21.57 %) and Beta-cyfluthrin + Imidacloprid (12.20 %). Other combinations like Phenthoate + Cypermethrin (9.71 %) and Emamectin benzoate + Thiamethoxam (10.29 %) also showed notable use in certain districts. Several insecticide mixtures, including Dinotefuron + Acephate, Profenophos + Fenpyroximate and Pyriproxyfen-based compounds had limited or localized adoption, each with a mean usage below 1 %.

The strong preference for Spirotetramat + Imidacloprid and Thiamethoxam + Lambda-cyhalothrin suggests that jasmine growers are favouring broad-spectrum combination insecticides that can control a variety of pests with a single spray. These mixtures are particularly effective against common jasmine pests such as whiteflies, thrips, budworm and gall-midge, which justifies their popularity. Higher usage in districts like Krishnagiri, Coimbatore and Dindigul may be due to better access to agro-dealers, advisory services and training programs, which influence both awareness and availability. On the other hand, the low adoption of newer combinations might indicate knowledge gaps, affordability issues, or limited market penetration of those products. These observations align with previous studies that perceived effectiveness, local dealer recommendations and ease of use were key factors shaping pesticide adoption among Indian farmers (9). The data highlights the need for targeted extension outreach to promote both safe use and diversified pest management strategies.

In our study, it was observed that farmers avoid safer compounds despite their availability. We ascertained the following reasons for them:

Lack of awareness and knowledge gaps

Many Indian farmers, especially in states like Tamil Nadu, rely on agrochemical dealers for pesticide advice rather than government extension services. Retailers often promote chemical pesticides due to higher commissions, while safer options like biopesticides (e.g., *Trichoderma*, neem-based products), spinosyn and diamide are rarely highlighted.

Perceived efficacy and immediate results

Chemical pesticides are viewed as faster-acting against pests like jasmine budworm (*Hendecasis duplifascialis*). In contrast, biopesticides require longer application windows and consistent use, which smallholders with immediate cash-flow needs cannot afford.

Table 5. District-wise insecticide usage pattern in percentage for jasmine growers in Tamil Nadu (Mixed Compound)

S.No.	Name of the insecticide	Krishnagiri	Dharmapuri	Salem	Erode	Coimbatore	Dindigul	Maduari	Theni	Virudhanagar	Mean
1	Acephate50 %+Imidacloprid-1.8 % SP	0.00	0.00	15.79	2.02	0.00	0.00	0.00	0.00	0.00	1.98
2	Beta-cyfluthrin 8.49 % and imidacloprid 19.81 % 300 OD	23.07	10.00	0.00	30.3	16.00	11.59	2.67	16.13	0.00	12.20
3	Buprofezin 15 % + Acephate 35 % WP	0.00	0.00	0.00	4.04	0.00	4.34	0.00	0.00	22.22	3.40
4	Chlorpyriphos-50 % + Cypermethrin 4 %EC	0.00	0.00	0.00	0.00	0.00	1.44	0.00	0.00	5.56	0.78
5	Dinotefuron40 % + Acephate-50 % SG	0.00	0.00	0.00	1.01	0.00	0.00	0.00	0.00	0.00	0.11
6	Emamectin benzoate3 % + Thiamethoxam 12 % WG	11.53	25.00	21.05	0.00	0.00	8.70	0.00	9.68	16.67	10.29
7	Fipronil 4 % + Thiamethoxam 4 % SC	0.00	0.00	0.00	0.00	0.00	4.34	0.00	16.13	0.00	2.27
8	Imidacloprid-40 % + Fipronil-40 % WG	0.00	0.00	0.00	6.06	0.00	0.00	0.00	0.00	0.00	0.67
9	Phenthoate45 % + Cypermethrin-6 % EC	1.92	2.00	15.79	12.12	0.00	7.24	38.67	9.68	0.00	9.71
10	Profenophos 40 % + Cypermethrin 4 % EC	0.00	5.00	10.53	1.01	0.00	2.89	0.00	0.00	0.00	2.16
11	Profenophos40 % +Fenpyroximate2.5 % EC	1.92	0.00	0.00	0.00	0.00	1.44	0.00	0.00	0.00	0.37
12	Propargite-42 %+Hexythiazox-2 % EC	0.00	0.00	0.00	0.00	0.00	0.00	6.67	0.00	0.00	0.74
13	Pyriproxyfen 50 %+Fenpropatrin-15 % EC	0.00	0.00	0.00	0.00	0.00	0.00	5.33	0.00	0.00	0.59
14	Pyriproxyfen 50 %+Diafenthiuron-2.5 %EC	0.00	0.00	0.00	4.04	0.00	0.00	0.00	0.00	0.00	0.45
15	Pyriproxyfen 8 % + Dinotefuron 5 % + Deltamethrin-18 % SC	0.00	0.00	0.00	0.00	8.00	4.34	0.00	0.00	5.56	1.99
16	Spirotetramet 11.01 % + Imidacloprid 11.01 % SC	46.15	40.00	15.79	12.12	40.00	30.43	29.33	32.26	22.22	29.81
17	Thiamethaxam12.6 % + Lamba-cyhalothrin 9.5 % ZC	15.38	10.00	21.05	27.27	36.00	23.18	17.33	16.13	27.78	21.57

Source: Primary data.
Note: SP - Soluble Powder, OD- Oil Dispersion; WP- Wettable Powder; EC - Emulsifiable Concentrate; SG - Water-Soluble Granules; WG - Water-Dispersible Granules; SC - Suspension Concentrate; ZC - Mixed Formulation (Suspension Concentrate + Capsule Suspension).

Access and affordability

Safer alternatives like biopesticides are often costlier or unavailable locally. For example, only 5-9 % of India's cropped area uses biopesticides, partly due to supply chain gaps.

Strengthening extension services, subsidizing safer alternatives and regulating regulators can improve the status of the use of safer chemicals by the farmers to some extent.

District-wise insecticide usage by jasmine farmers in Tamil Nadu

Table 6 shows that farmers across the study area are dependent heavily on a mixed compound of insecticides (36 %), followed by pyrethroids (24 %), especially in districts like Erode, Coimbatore and Madurai. These products are likely favoured for their broad effectiveness and ease of use. Older insecticides such as organophosphates (15 %) and neonicotinoids (9 %) are

Table 6. Group-wise insecticides used by the Jasmine farmers of Tamil Nadu

S.No.	Insecticides group	Krishnagiri		Dharmapuri		Salem		Erode		Coimbatore		Dindigul		Theni		Virudhunagar		Madurai		Total	
		No.	(%)	No.	(%)	No.	(%)	No.	(%)	No.	(%)	No.	(%)	No.	(%)	No.	(%)	No.	(%)	No.	(%)
1	Organophosphate	23.0	11.4	11.0	17.46	12.0	19.4	43.0	18.3	13.0	23.1	3.0	15.7	12.0	16.0	7.0	12.3	19.0	10.2	171.0	15.09
2	Neonicotinoid	33.0	16.4	3.0	4.76	8.0	12.9	13.0	5.5	1.0	1.8	20.0	10.1	5.0	6.7	10.0	17.5	14.0	7.5	107.0	9.44
3	Pyrethroid	74.0	36.8	25.0	39.7	14.0	22.6	22.0	9.4	11.0	19.6	49.0	24.8	14.0	18.7	14.0	24.6	51.0	27.4	274.0	24.18
4	Diamide	0.0	0.0	0.0	0.0	3.0	4.8	9.0	3.8	0.0	0.0	2.0	1.0	0.0	0.0	3.0	5.3	3.0	1.6	20.0	1.77
5	Spinosyn	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.0	3.6	5.0	2.5	0.0	0.0	0.0	0.0	0.0	0.0	7.0	0.62
6	Pyrrole	0.0	0.0	0.0	0.0	0.0	0.0	14	6.0	4.0	7.1	3.0	1.5	0.0	0.0	0.0	0.0	0.0	0.0	21.0	1.85
7	Pyrazole	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.4	0.0	0.0	1.0	0.5	0.0	0.0	1.0	1.8	0.0	0.0	3.0	0.26
8	Thiourea	0.0	0.0	0.0	0.0	2.0	3.2	0.0	0.0	0.0	0.0	1.0	0.5	0.0	0.0	3.0	5.3	0.0	0.0	6.0	0.53
9	Avermectin	4.0	2.0	0.0	0.0	2.0	3.2	15	6.4	0.0	0.0	11.0	5.6	8.0	10.7	0.0	0.0	9.0	4.8	49.0	4.32
10	Quinazoline	1.0	0.5	1.0	1.6	2.0	3.2	4.0	1.7	0.0	0.0	1.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	9.0	0.79
11	Phenylpyrazole	3.0	1.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.0	2.2	7.0	0.62
12	N-Phenyl-phathalamide	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.09
13	Isoxazoline	0.0	0.0	0.0	0.0	0.0	0.0	3.0	1.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.0	0.26
14	Oxadiazine	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.5	0.0	0.0	1.0	1.75	0.0	0.0	2.0	0.18
15	Tetronic acid derivative	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.09
17	METI	0.0	0.0	0.0	0.0	0.0	0.0	3.0	1.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.0	0.26
18	Sulphite ester	10.0	5.0	2.0	3.2	0.0	0.0	4.0	1.7	0.0	0.0	3.0	1.5	5.0	6.7	0.0	0.0	5.0	2.7	29.0	2.56
19	Mixed Compound	52.0	25.9	20	31.2	19.0	30.7	99.0	42.1	25.0	44.6	69.0	34.9	31.0	41.3	18	31.58	75.0	40.3	408.0	36.01
	Total (n)	201	100	63	100	62	100	235	100	56	100	198	100	75	100	57	100	186	100	1133	100

Source: Primary data.
Note: METI- Mitochondrial Electron Transport Inhibitor

still in regular use, suggesting that many growers continue to depend on familiar chemistries. On the other hand, newer and more selective insecticides like diamide, pyrrole and avermectin groups are being used much less frequently in districts, such as Dindigul and Erode are showing early signs of adoption. Interestingly, Erode and Coimbatore displayed the widest range of insecticides used, while districts like Krishnagiri and Dharmapuri leaned more heavily on traditional types.

This usage pattern reflects jasmine farmers' preference for broad-spectrum and fast-acting insecticides. Mixed compounds and pyrethroids are favoured for their effectiveness and affordability, especially in areas with high pest incidence like Erode and Dharmapuri. However, the continued reliance on older groups like organophosphates and neonicotinoids raises concerns about pest resistance and environmental impact. The low adoption of newer and safer insecticides suggests knowledge gaps and limited market access. Studies show that most jasmine farmers have significant technological gaps in proper chemical use, especially in applying correct dosages and adopting eco-friendly methods (21). Extension services and pesticide dealers are often their only source of information, which may explain the heavy reliance on familiar brands and mixtures (9).

Regional variations of insecticide groups usage in Tamil Nadu

The data reveals that mixed compounds are the most used insecticides among jasmine growers (36.40 %), with the highest use in the Western Zone (40.00 %), followed by the Southern (39.24 %) and North-Western Zones (28.09 %). Pyrethroids (24.44 %) ranked second due to their quick action and availability, while organophosphates (15.25 %) and avermectins (4.37 %), despite their toxicity, continue to be widely used. In contrast, safer and modern insecticides like diamides (1.78 %), spinosyns (0.62 %) and isoxazolines (0.27 %) saw minimal adoption (Fig. 2) (Table 7).

This skewed usage highlights farmers' reliance on older, broad-spectrum chemicals, likely influenced by dealer recommendations, limited awareness and cost barriers. The continued use of hazardous insecticides raises concerns over health and environmental safety, while the poor uptake of eco-friendly options signals a need for stronger extension services, safety training and access to affordable alternatives. These findings align with previous studies noted that over 80 % of farmers in Tamil Nadu depend solely on chemical insecticides, often without proper knowledge of dosage or safety (20). Structured interventions are essential to shift practices toward safer, knowledge-based pest management in jasmine farming.

Information sources for jasmine farmers in Tamil Nadu

Analysis of advisory sources consulted by jasmine growers across nine districts in Tamil Nadu revealed a predominant reliance on input dealers (mean = 51.86 %), especially in Dharmapuri (60 %), Virudhunagar (60 %) and Madurai (50 %). This group emerged as the most frequently consulted resource for pesticide and crop protection information. Agri-clinics represented the second most utilized source (mean = 15.19 %), with comparatively higher engagement in Krishnagiri (20 %), Theni (20 %) and Dindigul (16.67 %). Neighbours and fellow farmers accounted for an average of 19.26 %, showing stronger reliance in Dharmapuri (30 %) and Madurai (23.33 %). In contrast, extension officials, who are trained agricultural professionals, were least consulted (mean = 8.14 %), with zero responses in Dharmapuri and Coimbatore. Media, including print, radio and television, showed limited usage with an overall mean of 5.57 % (Table 8).

The dominance of input dealers as a primary information source for jasmine growers aligns with findings by (22) and (16), who observed that dealers are often the first point of contact for farmers due to their accessibility, established rapport and dual role as suppliers and advisors. However, such dealer dependency can lead to skewed or commercially driven advice, particularly in the absence of regulated training or standard guidelines (23). This raises concerns regarding misuse, overuse, or incorrect use of pesticides, which can increase health risks and pest resistance.

The modest uptake of agri-clinics suggests a growing trust in semi-formal advisory structures, particularly in districts like Krishnagiri and Dindigul. With proper institutional support, agri-clinics can play a vital role in bridging the advisory gap, as noted, especially when supported by skilled entrepreneurs and linked to extension systems (24). The underutilization of extension officials (8.14 %) highlights long-standing challenges in the public extension system, including low farmer-to-officer ratios, inadequate outreach and declining institutional credibility (25).

Table 7. Insecticides group usage by Jasmine farmers in different agro-ecological zones of Tamil Nadu

S. No.	Insecticides-group	North-Western Zone		Western Zone		Southern Zone		Mean	
		No.	(%)	No.	(%)	No.	(%)	No.	(%)
1	Organophosphate	46	14.20	99	17.68	26	10.97	57.00	15.25
2	Neonicotinoid	44	13.58	39	6.96	24	10.13	35.67	9.54
3	Pyrethroid	113	34.88	96	17.14	65	27.43	91.33	24.44
4	Diamide	3	0.93	11	1.96	6	2.53	6.67	1.78
5	Spinosyn	0	0.00	7	1.25	0	0.00	2.33	0.62
6	Pyrrole	0	0.00	21	3.75	0	0.00	7.00	1.87
7	Pyrazole	0	0.00	2	0.36	1	0.42	1.00	0.27
8	Thiourea	2	0.62	1	0.18	3	1.27	2.00	0.54
9	Avermectin	6	1.85	34	6.07	9	3.80	16.33	4.37
10	Quinazoline	4	1.23	5	0.89	0	0.00	3.00	0.80
11	Phenylpyrazole	3	0.93	0	0.00	4	1.69	2.33	0.62
12	N-Phenylphathalamide	0	0.00	1	0.18	0	0.00	0.33	0.09
13	Isoxazoline	0	0.00	3	0.54	0	0.00	1.00	0.27
14	Oxadiazine	0	0.00	1	0.18	1	0.42	0.67	0.18
15	Tetronic acid derivative	0	0.00	1	0.18	0	0.00	0.33	0.09
16	METI	0	0.00	3	0.54	0	0.00	1.00	0.27
17	Sulphite ester	12	3.70	12	2.14	5	2.11	9.67	2.59
18	Mixed compound	91	28.09	224	40.00	93	39.24	136.00	36.40

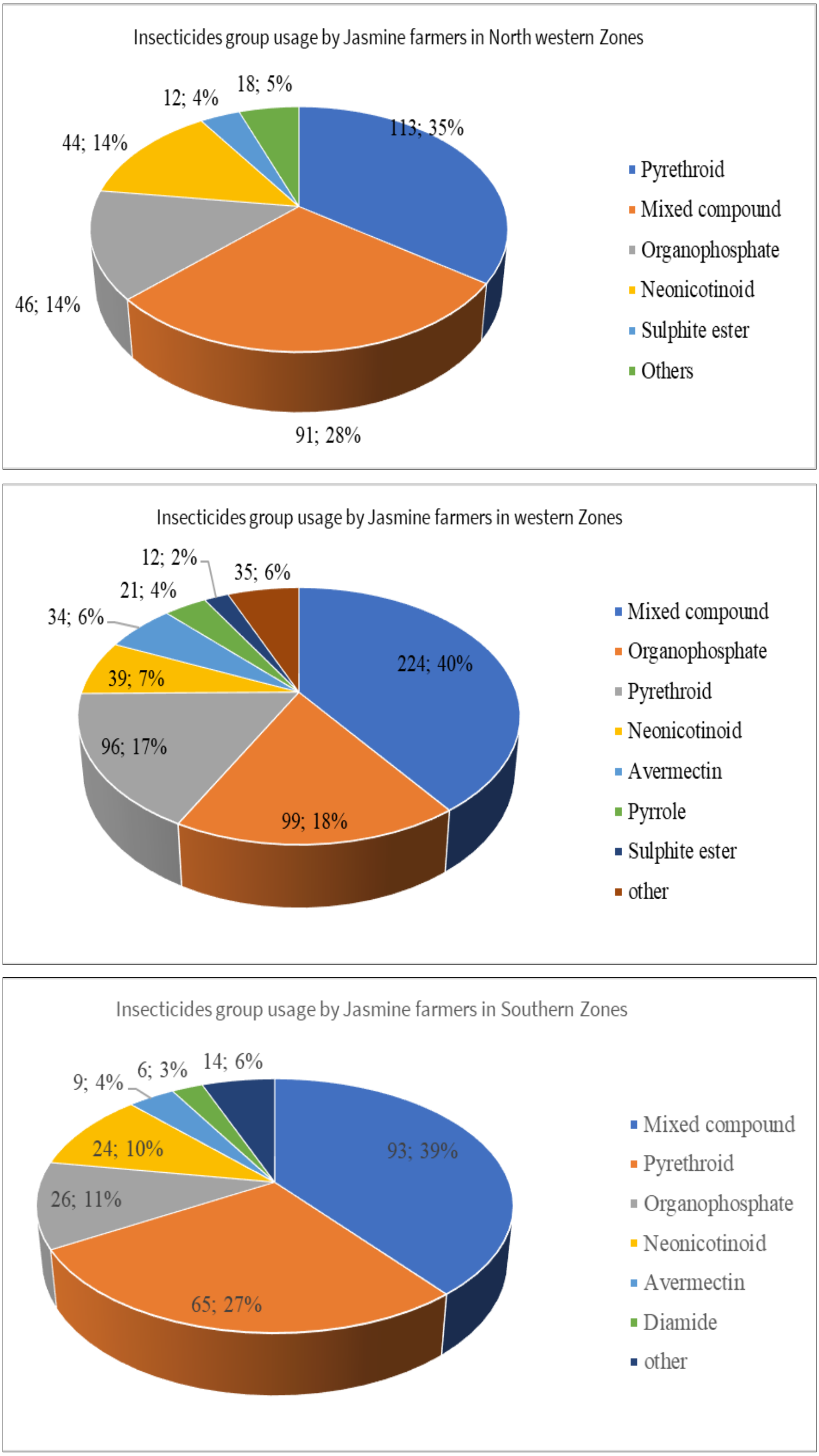

Fig. 2. Insecticides group usage by Jasmine farmers in different agro-ecological zones of Tamil Nadu.
Source : Primary data.

Table 8. Resource person assessed by jasmine growers of Tamil Nadu

S. No.	Resource persons	Erode		Salem		Dharmapuri		Krishnagiri		Dindigul		Theni		Madurai		Virudhunagar		Coimbatore		Average (n=170)
		Respondents (n=30)		Respondents (n=10)		Respondents (n=10)		Respondents (n=30)		Respondents (n=30)		Respondents (n=10)		Respondents (n=30)		Respondents (n=10)		Respondents (n=10)		
		Nos.	(%)	Nos.	(%)	Nos.	(%)	Nos.	(%)	Nos.	(%)	Nos.	(%)	Nos.	(%)	Nos.	(%)	Nos.	(%)	(%)
1	Extension Officials	3	10.0	2	20.0	0	0.0	4	13.3	2	6.7	1	10.0	1	3.3	1	10.0	0	0.0	8.14
2	Agri. Clinic	5	16.7	1	10.0	1	10.0	6	20.0	5	16.7	2	20.0	4	13.3	1	10.0	2	20.0	15.19
3	Input dealers	17	56.7	4	40.0	6	60.0	14	46.7	16	53.3	5	50.0	15	50.0	6	60.0	5	50.0	51.86
4	Neighbours	3	10.0	2	20.0	3	30.0	4	13.3	5	16.7	2	20.0	7	23.3	2	20.0	2	20.0	19.26
5	Media	2	6.7	1	10.0	0	0.0	2	6.7	2	6.7	0	0.0	3	10.0	0	0.0	1	10.0	5.57
	Mean	6.0	20.0	2.0	20.0	2.0	20.0	6.0	20.0	6.0	20.0	2.0	20.0	6.0	20.0	2.0	20.0	2.0	20.0	
	S D	6.24	20.82	1.22	12.25	2.55	25.50	4.69	15.63	5.79	19.29	1.87	18.71	5.48	18.26	2.35	23.45	1.87	18.71	

Source: Primary data.

Conclusion

The present study provides a detailed understanding of insecticide usage patterns and plant protection practices among jasmine growers in Tamil Nadu. Most growers are marginal farmers with limited formal education, which makes accessing and understanding safe pest management options more difficult. The results indicate a predominant reliance on broad-spectrum insecticides such as pyrethroids, neonicotinoids and organophosphates, largely due to their availability, familiarity and influence of local input dealers. Mixed compound formulations were the most used, reflecting a preference for multi-pest control with fewer applications. Despite the availability of newer and safer insecticides like diamides and spinosyns, their adoption remains extremely limited. This suggests a lack of awareness and access, pointing to a critical gap in extension support. Most farmers utilized low-volume power sprayers, which, while efficient, may lead to over-application if not properly managed. District-wise variations in insecticide use patterns further highlight the role of localized pest pressure, cultivation intensity and socio-economic factors. The dominance of non-institutional advisory sources, particularly pesticide dealers, over formal extension systems raise concerns about the scientific accuracy and sustainability of pest control practices. To ensure sustainable jasmine production, there is a need to strengthen extension services, promote IPM practices and encourage the use of selective and bio-rational insecticides. Policy efforts should also focus on dealer training and district-specific advisory systems. These measures will help reduce health and environmental risks while enhancing productivity and profitability for jasmine growers.

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Authors' contributions

All authors contributed to the study's conception, design and manuscript preparation. AK carried out the experiments, recorded and analysed the data and wrote the manuscript. KG supervised the experiments and edited the manuscript. MM, MS, RPS and MG critically reviewed the manuscript. All authors provided feedback on earlier manuscript versions and read and approved the final version.

Compliance with ethical standards

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