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RESEARCH PAPER

Study of insecticide usage pattern on tomato in Deccan region of India

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Abstract: Tomato (*Solanum lycopersicum* L.) cultivation in Deccan region is severely affected by two major pests, *Tuta absoluta* Meyrick and *Helicoverpa armigera* Hubner, which cause significant yield losses. Farmers primarily rely on intensive insecticide applications to manage these pests. Surveys conducted from August 2023 to February 2025 across eight major tomato-growing locations in Karnataka, Maharashtra, Telangana and Andhra Pradesh documented active ingredients, spray frequency, and application practices. In Karnataka, Kolar recorded the highest number of sprays per season (9-15), with repeated use of neonicotinoids and pyrethroids, while Belagavi and Ballari reported 8-12 and 6-10 sprays, respectively, with frequent application of diamides and neonicotinoids. Maharashtra districts recorded 6-10 sprays per season, mainly using diamides, spinosyns, neonicotinoids and organophosphates, while Telangana and Andhra Pradesh reported 5-10 sprays. Across all regions, chlorantraniliprole, imidacloprid and lambda-cyhalothrin were the most consistently applied insecticides. Repeated use of the same active ingredients or multiple compounds from the same group increased insecticide load and selection pressure, indicating a high risk of resistance development.

Key words: Insecticide usage pattern, Indiscriminate use, Rotation of insecticides, Resistance development, Tomato

Introduction

Tomato (*Solanum lycopersicum* L.) is an important vegetable crop in India. The Deccan region alone contributes nearly 50 per cent of the national production and therefore represents a major hub for its cultivation (Anon, 2024). Its production is primarily challenged by two major pests, the South American tomato leafminer (*Tuta absoluta* Meyrick) and the fruit borer (*Helicoverpa armigera* Hubner), which cause significant yield losses (Assaf *et al*., 2013). To mitigate these threats, farmers largely depend on intensive insecticide applications across different crop stages. A wide spectrum of chemical groups such as pyrethroids, organophosphates, neonicotinoids, diamides, and spinosyns are frequently used either as solo formulations or in combination products. The choice of insecticides is influenced by pest pressure, perceived effectiveness, cost and availability in local markets.

Understanding insecticide usage patterns is important because they directly determine the effectiveness and sustainability of pest management (Mall *et al*., 2018). Indiscriminate and repeated use of the same molecules or chemical groups accelerates the development of insecticide resistance, particularly in pests like *T. absoluta* and *H. armigera*, which have a history of rapidly evolving resistance mechanisms (Guedes *et al*., 2019). Such resistance compromises field efficacy, increases input costs, and limits available chemical options. Moreover, injudicious use of insecticides can lead to secondary pest outbreaks, residue accumulation in produce and ecological imbalances (Yarahmadi and Rajabpour, 2024). Therefore, systematic study of usage patterns provides critical insights into how farmers' practices shape resistance dynamics and influence the long-term success of integrated pest management strategies.

Material and methods

Surveys on insecticide usage were conducted from August 2023 to February 2025 in major tomato-growing regions of South and Central India, including Belagavi (BLG), Ballari (BLR) and Kolar (KLR) districts of Karnataka; Chatrapati Sambhaji Nagar (CSN), Pune (PNE) and Nashik (NSK) regions of Maharashtra; Rangareddy (RNG) district of Telangana and Chittoor (CHR) district of Andhra Pradesh. In each location, a peripheral area of approximately 10 km² was surveyed to obtain representative information on farmers' pest management practices. Data were collected using a structured questionnaire through direct interviews of 10 farmers from each location. Information was recorded on farmer and village details, geographical coordinates, stage of the crop, major insect pests observed and plant protection measures adopted. Details on the number of insecticide applications, application schedule, dosage used, and reliance on technical information or pesticide dealers for advice were documented. Further, aspects relating to the purchase and source of pesticides were also noted to understand local usage trends.

Data management involved immediate entry of responses into standardized spreadsheets, verification of active ingredients against label photographs and classification of insecticides according to their mode-of-action (IRAC groups). Analyses comprised descriptive statistics of use patterns, calculation of spray intensity metrics, and assessment of potential selection pressure by quantifying repeated use of the same IRAC groups and combination products. Geographical coordinates were used to map spatial trends in spray intensity.

Results and discussions

The survey on insecticide usage in major tomato-growing regions of South and Central India revealed substantial variation in active ingredients and spray frequency across districts. In Karnataka, Kolar recorded the highest number of sprays per season, ranging from 9 to 15. Farmers repeatedly applied neonicotinoids (thiamethoxam and imidacloprid) and pyrethroids (beta-cyfluthrin, lambda-cyhalothrin and cypermethrin). Other chemistries such as broflanilide (meta-diamide), indoxacarb (oxadiazine) and profenofos (organophosphate) were also used. In Belagavi, sprays ranged from 8 to 12 per season, with repeated use of diamides (chlorantraniliprole) and neonicotinoids (thiamethoxam and imidacloprid), along with pyrethroids (lambda-cyhalothrin). In Ballari, 6–10 sprays per season were reported, where multiple neonicotinoids (thiacloprid, imidacloprid and thiamethoxam) and a diamide (flubendiamide) were applied repeatedly (Table 1).

In Maharashtra (Table 2), Chatrapati Sambhaji Nagar farmers applied 6–10 sprays per season, mainly using a diamide (chlorantraniliprole), a spinosyn (spinetoram), and an avermectin (emamectin benzoate). Pune also recorded 6–10 sprays, with repeated applications of diamides (chlorantraniliprole) and spinosyns (spinetoram and spinosad), along with emamectin (avermectin) and thiamethoxam (neonicotinoid). In Nashik, 6–10 sprays per season were applied, with multiple neonicotinoids (imidacloprid), pyrethroids (beta-cyfluthrin and cypermethrin) and organophosphates (profenophos and chlorpyrifos). In Andhra Pradesh and Telangana, Rangareddy farmers applied 6–10 sprays per season, repeatedly using neonicotinoids (imidacloprid) and pyrethroids (lambda-cyhalothrin and beta-cyfluthrin), along with a diamide (chlorantraniliprole) and an avermectin (emamectin). In Chittoor, 5–7 sprays were applied per season, with pyrethroids (lambda-cyhalothrin, deltamethrin) used multiple times, alongside a diamide (chlorantraniliprole), a spinosyn (spinetoram), and a neonicotinoid (thiamethoxam) (Table 3).

Across the surveyed tomato-growing regions, chlorantraniliprole (diamide), imidacloprid (neonicotinoid), and lambda-cyhalothrin (pyrethroid) were the most consistently used insecticides, often applied in mixtures targeting multiple pests. Other groups such as spinosyns, avermectins and organophosphates were important regionally, while plant extracts were used sparingly and at comparatively higher doses. Intensive tomato-growing districts such as Kolar, Belagavi, Pune and Nashik reported the highest spray frequencies, indicating strong selection pressure for resistance. Repeated

Table 1. Insecticide usage pattern on tomato across selected locations of Karnataka state

Location	Coordinates	Trade name	Active ingredient	Dose (ml or g / L)		Number of sprays /season	Average sprays
				CIBRC rec.	Farmers practice		
BELAGAVI (BLG)	15.806° N74.722° E	Coragen	Chlorantraniliprole 18.5% SC	0.30	0.50	2-3	8-12
		Kalia	Chlorantraniliprole 8.8% + Thiamethoxam 17.5% SC	0.20	0.50	1	
		Confidor	Imidacloprid 17.8% SL	0.30	0.50	1-2	
		Ampligo	Chlorantraniliprole 10% + Lambda-cyhalothrin 5% ZC	0.40	0.50	2-3	
		Lesenta	Fipronil 40% + Imidacloprid 40% WG	0.30	0.50	1	
		Plant extract	Unknown	-	5.00	1-2	
KOLAR (KLR)	13.096° N78.212° E	Actara	Thiamethoxam 25% WG	0.25	0.50	1-2	9-15
		Confidor	Imidacloprid 17.80% SL	0.30	0.50	1-2	
		Solomon	Beta-cyfluthrin 08.49% + Imidacloprid 19.81% w/w OD	0.50	0.50	1-2	
		Plant extract	Unknown	-	5.00	1	
		Alika	Thiamethoxam 12.6% + Lambda cyhalothrin 9.5% ZC	0.25	0.50	1-2	
		Exponus	Broflanilide 300 g/l SC	0.09	0.20	1	
		Jashn Super	Profenofos 40%+Cypermethrin 4% EC	2.00	2.50	1-2	
		Karate	Lambda Cyhalothrin 5 % EC	0.50	1.00	1-2	
		JU-indoxa	Indoxacarb 14.50 % SC	0.50	0.50	1	
BALLARI (BLR)	15.231° N77.033° E	Belt expert Thiacloprid	Flubendiamide 19.92% + 19.92% w/w SC	0.50	1.00	1-2	6-10
		Confidor	Imidacloprid 17.80% SL	0.30	0.50	2-3	
		Actara	Thiamethoxam 25 % WG	0.25	0.50	1	
		Plant extract	Unknown	-	5.00	1-2	
		Ulala	Flonicamid 50% WG	0.40	0.50	1-2	

Table 2. Insecticide usage pattern on tomato across selected locations of Maharashtra state

Location	Coordinates	Trade name	Active ingredient	Dose (ml or g / L) CIBRC rec.	Dose (ml or g / L) Farmers practice	Number of sprays\season	Average sprays
CHATRAPATI SAMBHAJI NAGAR(CSN)	20.081°N 75.338° E	Simodis	Isocycloseram 9.2%+ Isocycloseram10% DC	0.40	0.50	1	6-10
		Coragen	Chlorantraniliprole 18.5% SC	0.30	0.50	1-2	
		Coro Indica	Azadirachtin 1500 ppm	3.00	3.00	1	
		Syndicate	Spinetoram 11.7%SC	0.75	1.00	1-2	
		Proclaim	Emamectin Benzoate 5% SG	0.40	0.50	1-2	
		Plant extract	Unknown	-	5.00	1-2	
PUNE (PNE)	18.883° N 73.841° E	Encounter	Emamectin Benzoate 3% + Thiamethoxam 12% WG	0.40	0.50	1	6-10
		Jump	Fipronil 80% WG	0.25	0.30	1	
		Delegate	Spinetoram 11.7% SC	0.75	1.00	1-2	
		Spinosher	Spinosad 45% SC	0.30	0.50	1	
		Ampligo	Chlorantraniliprole 10% + Lambda-cyhalothrin 5% ZC	0.40	0.50	1-2	
		Shefa Neem	Azadirachtin 1500 ppm	3.00	4.00	1-2	
		Coragen	Chlorantraniliprole 18.5% SC	0.30	0.50	2-3	
NASHIK (NSK)	20.169° N 74.002° E	Solomon	Beta-cyfluthrin 08.49% + Imidacloprid 19.81% w/w OD	0.35	0.50	1	6-10
		Jashn super	Profenofos 40%+Cypermethrin 4% EC	2.00	3.00	1-2	
		Fotis	Chlorpyrifos 20% EC	2.00	2.50	1-2	
		Novadok	Novaluron 5.25% + Indoxacarb 4.5% SC	1.50	2.00	1	
		Neem extract	Azadirachtin (NSKE)	50	50	1-2	
		Confidor	Imidacloprid 17.80% SL	0.30	0.50	2-3	
		Jashn super	Profenofos 40%+Cypermethrin 4% EC	2.00	2.50	1	

Table 3. Insecticide usage pattern on tomato across selected locations of Andhra Pradesh and Telangana state

Sr.No.	Location	Coordinates	Trade name	Active ingredient	Dose (ml or g/L) CIBRC rec.	Dose (ml or g/L) Farmers practice	Number of sprays/season	Average sprays
1.	RANGAREDDY (RNG)	17.400° N 78.226° E	Barazide	Novaluron 5.25% + Emamectin benzoate 0.9% SC	1.50	2.00	1	6-10
			Lesenta	Imidacloprid 40% + Fipronil 40% ww WG	0.20	0.25	1	
			Karate	Lambda Cyhalothrin 5% EC	0.50	1.00	1-2	
			Curacron	Profenofos 50% EC	2.00	3.00	2-3	
			Solomon	Beta-cyfluthrin 08.49% + Imidacloprid 19.81% w/w OD	0.35	0.50	1	
			Neem extract	Azadirachtin (NSKE)	50	50	1-2	
			Coragen	Chlorantraniliprole 18.5% SC	0.30	0.50	1-2	
2.	CHITOOR (CHR)	13.188° N 79.128° E	Raise	Chlorantraniliprole 18.5% SC	0.30	0.30	1-2	5-7
			Karate	Lambda Cyhalothrin 5% EC	0.50	1.00	1-2	
			Decis	Deltamethrin 02.80% EC	0.25	0.50	1	
			Largo	Spinetoram 11.70% SC	0.75	1.00	1	
			Thiano	Thiamethoxam 12.60% + Lambda cyhalothrin 9.50% ZC	0.25	0.30	1-2	

application of the same active ingredient or multiple compounds from the same group within a single crop season increases the overall insecticide load, and proper rotation of insecticides across different mode-of-action groups was not observed. Furthermore, many sprayed insecticides were not even recommended by concerned authorities for control of these two pests.

Previous studies have reported similar patterns of intensive insecticide use in tomato cultivation, with repeated applications of the same active ingredients or multiple compounds from the same group contributing to high selection pressure on pest populations. In Ghana, Danquah *et al.* (2009) observed that farmers applied 10 different insecticides, nearly half of which were not recommended for vegetable crops. In India, Tyagi *et al.* (2015) found that cypermethrin and profenofos were widely used by tomato and cauliflower growers, with over 70 per cent of farmers applying pesticides more than four times per season and some continuing sprays even during harvest. Honnakerappa and Udikeri (2018) reported heavy reliance on emamectin benzoate, rynaxypyr, and profenofos against *H. armigera* in Karnataka, showing that both newer and conventional insecticides are applied repeatedly. More recent work highlights that such intensive practices persist. Bandanaa *et al.* (2024) documented that tomato farmers in Ghana used 15 different insecticides, including unregistered products, with lambda-cyhalothrin-based chemicals being the most frequent, and that farmer training strongly influenced spraying decisions. Adjei *et al.* (2024) reported that a majority of farmers applied pesticides reactively upon pest appearance, often combining two or more products in a single application. Similarly, Mohan *et al.* (2024) noted that South Indian growers repeatedly sprayed multiple rounds of insecticides to manage *T. absoluta*, resulting in moderate to very high resistance against compounds such as flubendiamide and chlorantraniliprole. These studies collectively indicate that repeated and overlapping use of insecticides is common across regions, creating strong selection pressure and increasing the risk of resistance development in major tomato pests. This trend is largely attributed to a lack of technical knowledge among farmers and reliance on advice from resource persons from private companies and local shops.

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