AATCC Review

28 September 2024: Received
01 November 2024: Revised
20 November 2024: Accepted
06 December 2024: Available Online

https://aatcc.peerjournals.net/

Original Research Article

Open Access

Indiscriminate insecticides use in chilli exacerbates T. parvispinus infestation: A case study in major chilli growing areas of Telangana State, India

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ABSTRACT

A survey was conducted in major chilli growing districts of Telangana in India during 2022-24 to assess the land holdings of the farmers, the commonly cultivated chilli varieties/hybrids, insecticide usage and use of different groups of insecticide molecules against T. parvispinus in predominantly chilli growing areas of Telangana state of India. The results revealed that the highest average land holding (7.44 acres/ farmer) was documented in Khammam district with the highest (87.50%) cultivation under Teja segment (F1 hybrid) under 93.75% flood irrigation. Regarding insecticide usage, the highest number of insecticide sprays (29.88) with the lowest waiting period of 7.25 days were observed in the Khammam district, while it was lowest in the Jagtial district with 12.63 days waiting period between the sprays and 9.38 total number of applications. It was also noted that, the highest average spray fluid was used in Khammam district (253.75 litres/acre), followed by Mahabubabad (241.25 litres), Peddapalli (239.38 litres), Nagarkurnool (237.50 litres) and J. Gadwal (227.25 litres), while lowest spray fluid was used in Jagtial district (211.63). Regarding the usage of insecticide molecules, a total of 23.00 insecticide molecules were used in chilli. The highest number of insecticide molecules (23.00) were used in Khammam district, followed by Mahabubabad (20.00), Peddapalli (18.00), Nagarkurnool (17.00) and the lowest number in Jagtial district (14.00). Among the insecticide molecules, the highest usage of fipronil 5 SC to an extent of 64.58% was observed, followed by diafenthiuron 50 WP (58.33%), imidacloprid 17.8SL (56.25%), thiamethoxam 25 WG (54.17%) and dimethoate 30 EC (39.58%). Among the insecticide molecules, 34.78 % of insecticides come under highly toxic and moderately toxic categories. The survey results concluded that, the highest usage of insecticide molecules was found in Khammam district which recorded the highest incidence of T. parvispnus (56.75%), whereas, lowest usage of insecticides were reported from Jagtial district, which recorded lowest incidence (20.25%) of thrips and it was also observed that most of the farmers were ignorant of the use of recommended insecticides, pesticide residues, pesticide safety measures and eco-friendly pest management practices of chilli in the survey locations.

Keywords: *Teja, Insecticide usage, T. parvispinus, fipronil, awareness, Khammam, India*

1. Introduction

Chilli, *Capsicum annuum* L. (Solanales: Solanaceae) is one of the oldest indispensable spice cum vegetable crops grown widely in the world. The berry fruits commonly called as peppers are used to add pungency in culinary dishes. The pungency is due to several capsaicinoids especially, capsaicin. This crop is believed to be originated in Central or South America and was cultivated for the first time in Mexico. The crop is not only economically important for culinary dishes but also medicinally valuable for curing human ailments (3). India is the world's largest producer, consumer and exporter of chillies. It has the largest area of 8.44 lakh ha, accounting for 51.27 per cent of the world cultivable area with a total production of 22.79 lakh tonnes and productivity of 2.70 tonnes ha^{-1} (Indiastat, 2024).

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DOI: https://doi.org/10.21276/AATCCReview.2024.12.04.599

Telangana ranks second in chilli area, production and productivity with 1.13 lakh ha, 5.07 lakh tonnes and 4.5 tonnes ha^{-1}, respectively. In Telangana, chilli area and production accounts for 13.38 per cent and 22.24 per cent, respectively (5). The chilli crop is encountered by 57 insect and non-insect pests (13). Among the insect pests, thrips, *Scirtothrips dorsalis* Hood (Thripidae: Thysanoptera) and tarsonemid mite, *Polyphagotarsonemus latus* (Banks) (Tarsonemidae: Acari) are considered as the most destructive and major pests. Thrips are found to be notorious pests as well as *tospovirus* vectors (12). Due to mono culturing of chilli crop in many areas of Telangana district, the population build up of thrips has increased to a greater extent. Earlier, among the thrips species, *S. dorsalis* was the dominant species and this was the only species found in chilli leaves in India and it causes both quantitative and qualitative losses accounting for 11-75% and 60-80%, respectively (4). In India, theinvasive *Thrips parvispinus* was reported on Carica *papaya* L. (Caricaceae) from Bengaluru (18) and later this pest has been observed causing extensive damage in thousands of acres of chilli in different south Indian states causing up to 100 per cent damage in some of the fields during

October-December, 2021 and it has completely replaced the native thrips (15). To control the new invasive thrips the farmers are resorting to heavy use of insecticides. Indiscriminate use of insecticides not only results in pest resistance and resurgence it also increases the pesticide residue issues. (10)concluded that sundried red chilli powder consists of insecticidal residues of ethion (1.41 mg/kg), cypermethrin (0.15 mg/kg), and miticides like dicofol (4.03 mg/kg) which are greater than the Maximum Residual limit (MRL). Though the pesticide usage has been increasing year after year on chilli crop very little information is available on the use of different insecticide molecules, pesticide consumption scenarios and other safety measures taken by chilli farmers in Telangana after the incursion of the invasive thrips. In this present context, survey was taken up in the major chilli growing districts of Telangana state during 2022-24 to understand the status of *T. parvispinus* incidence, pesticide usage and other safety measures being followed by the chilli farmers of Telangana state.

2. Material and Methods

A roving survey was taken up in a total of six districts based on area of dry chillies production and agro climatic conditions of Telangana in India during 2022-24. The survey was taken up in all the three major chilli growing of the zones *viz.,* Central Telangana, Sothern Telangana and Northern Telangana zones of the state by selecting two districts fromeach zone (Jagtial and Peddapalli from Northern Telangana Zone, Khammam and Mahabubabad from Central Telangana Zone and Jogulamba Gadwal and Nagarkurnool from Southern Telangana Zone), 2 mandals from each district, 2 villages in each mandal, and 2 farmers from each village. Likewise, a total of 48 chilli-growing farmers were selected for the survey (Plate 1).

The information on crop production and crop protection details was collected in the selected districts using a standard questionnaire as described by (9),(2)and (16). The information on average land holding, soil type, varieties, season, irrigation methods and usage of sustainable management practices like bio pesticides, traps reflective mulches etc., were collected.

The pesticide usage information like volume of spray fluid, dosage, insecticides used, number of pesticidal applications, interval between the applications, safety methods, mixing of the chemical pesticides, measuring devices used for the chemicals, usage of pesticide mixtures, eco-friendly pest management practices were collected. Apart from the insecticide usage pattern, the per cent flower infestation by *Thrips parvispinus* was also estimated in the surveyed districts. The information was collected through direct interaction with the farmers

3. Results and Discussion

3.1. Crop production details of chilli farmers in the surveyed locations

The survey results revealed that the average land holdings used for chilli cultivation was 3.62 acres/farmer in the surveyed locations. Among them, Khammam district had the highest average land holding of 7.44 acres per farmer, followed by Peddapalli (4.25 acres), Jagtial (3.19 acres), Mahabubabad (2.94 acres) and Nagarkurnool (2.19 acres) and the lowest average landholding was in Jogulamba Gadwal with 1.69 acres per farmer. Regarding, soil type, 39.58 per cent of the farmers are cultivating chilli in red soils, while 60.42% in black soils during the survey period. Among the chilli farmers cultivating the crop in black soils, the highest (14.58%) percentage of the farmers were present in Khammam district followed by Jagtial and Mahabubabad (12.50%), Peddapalli 10.42%), Nagarkurnool (6.25%) and J. Gadwal (4.17%) districts. The information on chilli varieties cultivated by the farmers revealed that, 87.50% comprised *Teja* (F1 hybrid) (characterized by thin pods and high pungency, with small flower size), followed by *Byadagi* (known for bold pods with negligible pungency) (8.33%) and local land races such as Warangal Chapata (4.17%). Among the preferences of the hybrids/varieties cultivated by the farmers, the farmers belonging to Khammam and Mahabubabad districts cultivated all the three types of varieties. In terms of irrigation methods, 93.75% of the farmers followed flood irrigation, while, 6.25% used drip irrigation (Mahabubabad (4.17%) and Khammam (2.08%)). Notably, none of the farmers adopted sprinkler irrigation and all the farmers have cultivated chilli during *kharif* season only. Regarding the use of UV reflective mulches, only Khammam (4.17%) and Mahabubabad (2.08%) farmers used the mulches and other farmers were not aware of its use (Table 1).

During this study period, the majority of the farmers were interested to cultivate *Teja* segment hybrid, due to its higher yield and pungency compared to *Byadagi* and local land races. (7) also reported in their survey that, *Teja* segment varieties were cultivated in higher acreage in Telangana state and (8)reported in his survey that, 80 % of the farmers using improved *teja* segment hybrids. Majority of the land holding used for chilli production in Khammam district might be due to the suitability of black soils and climatic conditions for chilli cultivation in this district. Additionally, many chilli farmers are not only cultivating in their own land but also leasing land from neighbouring farmers for chilli cultivation. Many farmers rely on flood irrigation because of its easy adaptability.

3.2. Insecticide usage pattern of chilli farmers in the surveyed locations

The information on insecticide usage pattern revealed that, the highest (54.17%) number of farmers were dependent on pesticide shop dealers as their primary source of information for the usage of pesticides, followed by the neighbouring farmers advice (27.08%) and very few (18.75%) farmers were contacting the agriculture department officials for plant protection related advices. Among the farmers dependent on pesticide shop dealers, the highest percentage of the farmers belonged to Khammam and Mahabubabad (10.42%), followed by Jagtial, Peddapalli, Nagarkurnool and J. Gadwal with 8.33%. Regarding the spraying appliances used by farmers, 64.58 % of the farmers were using power sprayers and 35.42 % of the farmers were using battery-operated knapsack sprayers. Among the farmers using power sprayers, the highest per cent (14.58%) of the farmers belonged to Mahabubabad followed by Khammam and Jagtial (12.50%) followed by Peddapalli, Nagarkurnool and J. Gadwal with 8.33% (Table 2).

The information regarding the usage of pesticide mixtures revealed that majority (43.75%) of the farmers were using single insecticide molecules, while 35.42% were using insecticide + insecticide mixtures and few, (20.83%) of the farmers were using insecticide + fungicide mixtures. Among the single insecticide molecules used by the farmers, Peddapalli district farmers (10.42%) stood first, followed by Nagarkurnool and J. Gadwal (8.33%) and Mahabubabad and Jagtial with 6.25% and the lowest per cent (4.17) of the farmers belonged to Khammam district (Table 2).

A total of 70.83% of farmers were not having awareness on pesticide residues with the highest (14.58) percentage of the farmers belonging to Peddapalli district followed by Jagtial and Mahabubabad (12.50%) and Khammam, Nagarkurnool and J. Gadwal comprising10.42% farmers. Regarding the usage of recommended pesticides on chillies, 79.17% of the farmers were not aware of the recommended pesticides on chilli with the highest per cent (16.67) belonging to Peddapalli, followed by, J. Gadwal with 14.58%, Mahabubabad, Nagarkurnool and Jagtial with 12.50% and the lowest with Khammam district farmers (10.42%).

The information on measurement of pesticides revealed that majority (85.42%) of the farmers were using the pesticide bottle cap for measuring the pesticide and only 14.58% of the farmers were approximately measuring the pesticide. Among them, the highest percentage (16.67) of the farmers using the measuring cylinders belonged to Khammam and the lowest in Nagarkurnool and J. Gadwal district farmers (12.50%) and all the farmers stated that they were exposed to pesticide spray, while applying them in the field (Table 2).

The results regarding the usage of empty bottles revealed that, 87.50 % of the farmers were not using the empty bottles for home purpose and only 12.50% farmers were using the empty bottles for home purpose. Among the farmers who were not using empty bottles, the highest per cent (16.67) belonged to Mahabubabad and the lowest were from Jagtial district (12.50%). Regarding the disposal method of empty bottles, 66.67% of the farmers sold theEmpty pesticide bottles to scrap buyers, followed by 25.00% of the farmers who burnt them in the field itself, while 8.33% of the farmers buried the containers in the soil. Among the farmers who sold the bottles, the highest, (14.58) percent of the farmers belonged to Mahabubabad and the lowest (8.33%) were from Jagtial and J. Gadwal districts. It was noted that, none of the farmers were mixing the spray fluid solution using bare hands and almost all of them were using sticks to mix the pesticide with water before applying in the field (Table 2).

The results regarding safety aspects followed by the farmers while spraying the insecticides revealed that majority of the farmers (89.58%) neither used masks nor gloves, and only 10.42% farmers used towels as masks while applying the pesticide. Among the masks used, 4.17% of the farmers belonged to Khammam district and 2.08% of the farmers were from Peddappalli, Mahabubabad and Nagarkurnool districts. The number of pesticide sprays applied by the farmers in chilli crop revealed that the average gap between the two sprays of pesticide application was 9.86 days with a total of 18.67 spray applications during entire crop growth period in the surveyed districts. Among them, the lowest average gap was observed in Khammam district with 7.25 days between the sprays and 29.88 total applications, followed by Mahabubabad (8.25 days with 23.38 number of applications), Nagarkurnool (9.13 days with 15.13 number of applications), Peddapalli (10.13 days with 20.38 number of applications) and J. Gadwal with 11.75 days with 13.88 number applications during entire crop growth period and the lowest was observed in Jagtial (12.63 days with 9.38 number of applications) (Table 2).

It was also noted that, the highest average spray fluid volume was used in Khammam district with 253.75 litres per acre, followed by Mahabubabad (241.25 litres/acre), Peddapalli (239.38 litres/acre), Nagarkurnool (237.50) and J. Gadwal (227.25 litres/acre). The lowest spray fluid was used in Jagtial district with 211.63 litres per acre (Table 2).

Majority of the farmers accepted that they followed the recommendations given by pesticide shop dealers for purchasing the insecticides and total sprays used in the crop. This might be due to their close association with them for many years and credit based purchase of the chemicals. Due to easy and high efficiency, most of the farmers were using power sprayer/ mist blowers for spraying the pesticides. Majority of the farmers were not aware of the recommended pesticides, pesticide residues and safety measures. Similar findings were reported by(11), (6), (19), (8)and(17). They reported that all the respondents were taking recommendations from pesticide shop dealers for the crop protection chemicals in chilli crop. (20)and (8)reported that only 25.00% of respondents were aware of pesticide recommendations and also reported that none of the respondents used bare hands for mixing of the spray fluid in Telangana and Karnataka states respectively.

The survey results regarding, eco-friendly pest management practices followed by the farmers in chili crop revealed that, the highest per cent (70.83) of farmers were not aware of the eco-friendly pest management practices and only 29.17% of the farmers were having an idea about these practices. The information collected on the installation of different traps revealed that, 20.83% of the farmers were using blue sticky traps, followed by 12.50% of the farmers using yellow sticky traps and few farmers were using white sticky traps (8.33%). Regarding different traps used, the highest percentage (4.17) of the farmers belonged toKhammam and Mahabubabad used yellow sticky traps, followed by Peddapalli and Jagtial (2.08%). None of the farmers belonging to Nagarkurnool and J. Gadwal used yellow sticky traps. The highest percentage (6.25) of the farmers who belonged to Mahabubabad district were using blue sticky traps, followed by Khammam, Peddapalli and Nagarkurnool (4.17%). While none of the farmers from J. Gadwal were using blue sticky traps. Regarding the use of white sticky traps, Only, Khammam (4.17%), Mahabubabad (2.08%) and Nagarkurnool (2.08%) district farmers were using white sticky traps. Regarding light traps, only Mahabubabad (2.08%) district farmers were using light traps and border crops and only Khammam districts farmers (2.08%) were using pheromone traps. The results regarding the bio pesticides usage revealed that only 6.25% of the farmers from Khammam district were using bio pesticides and botanicals (8.33%) for pest management (Table 2).

It was noted that none of the farmers were aware of the natural enemies and their use in the chilli crop. The similar results were also documented by (20), (8) and (17) in Telangana and Karnataka, respectively in chilli crop. They revealed that none of the chilli farmers used pheromone traps, light traps, yellow sticky/blue sticky traps, bio pesticides and entomophages (Parasitoids and predators), but few respondents (16.67%) adopted eco-friendly measures in chilli crop.

3.3. Usage of insecticide molecules against *T. parvispinus*

The survey results revealed that, the farmers were using insecticides belonging to wide range of groups accounting to a total of 23.00 insecticide molecules (acephate 75SP, profenophos 50EC, dimethoate 30 EC, monocrotophos 36SL, cypermethrin 10EC, azadirachtin 0.15%, fipronil 5 SC, imidachloprid 17.8SL, thiacloprid 21.7SC, acetamiprid 20SP, thiamethoxam 25 WG, dinotefuron 20SG, diafenthiuron 50 WP, spiromesifen 22.9SC, flubendimide 39.3SC, chlorantraniliprole 18.5 SC, spinosad 45SC, spinotoram 11.7SC, broflanilide 300 G/L SC, spirotetramat 11.01 + imidacloprid 11.01 SC, fipronil

40+imidachloprid 40WG, EPF-*Beauveria bassiana* and EPF-*Lecanicillium lecanii*) during 2022-23 against *T. parvispinus*. Among them, 26.08% were older molecules, 65.21% were novel group of molecules and 8.60 % were bio pesticides. Among the districts surveyed, Khammam district farmers used highest number of insecticide molecules (23.00), followed by Mahabubabad (20.00), Peddapalli (18.00), Nagarkurnool (17.00) and the lowest number of insecticide molecules were used by Jagtial district farmers (14.00). Among the insecticides used, highest number of insecticide molecules were under Highly Toxic (HT) (34.78%) and Moderately Toxic (MT) (34.78%) categories, followed by the slightly toxic (ST) category (26.08 %) and only one insecticide was Extremely Toxic (ET) insecticide *i.e.* monocrotophos 36SL (4.30%) (Table 3).

Regarding the usage of different groups of insecticides, majority (64.58%) of the farmers used fipronil 5 SC against *T. parvispinus*, followed by diafenthiuron 50 WP (58.33%), imidacloprid 17.8SL (56.25%), thiamethoxam 25 WG (54.17%) and dimethoate 30 EC (39.58%). The insecticides like acephate 75SP, thiacloprid 21.7SC, acetamiprid 20SP, flubendimide 39.3SC and chlorantraniliprole 18.5 SC were used by 37.50% of the farmers while, 35.42% of the farmers used broflanilide 300 G/L SC and 33.33% of the farmers used spiromesifen 22.9SC. The insecticides like dinotefuron 20SG, spinosad 45SC, spinotoram 11.7SC, spirotetramat 11.01 SC + imidacloprid 11.01 SC, fipronil 40 WG + imidacloprid 40WG were used by 29.17% of the farmers. Azadirachtin 0.15%, a botanical insecticide wasused by only 25.00% of the farmers and 20.83% of the farmers used monocrotophos 36SL, whereas 16.67% used profenophos 50EC and cypermethrin 10EC against *T. parvispinus* during the survey period (Fig.1).

The results on pesticide usage by chilli farmers clearly indicated the heavy usage of broad range of 23 molecules of insecticides against *T. parvispinus*. Among them, majority belong to the newer molecules category. The farmers believed that, insecticides sold in small size containers possess more efficacy against the pests. It was also observed that initially at the vegetative stage the farmers used older group of pesticide molecules on the crop. This might be due to the lower incidence of this pest in nursery and early vegetative stages. All the farmers have given least priority to botanicals and bio pesticides. This might be due to less efficacy and lack of availability. These results are in line with the work done by(20), (8)and (17)who reported that among the respondents, the highest per cent of respondents used novel group of insecticides. Among them, significant usage was found with emamectin benzoate 5 SC and chlorantraniliprole 18.5 SC, flubendiamide 39.35% SC, spinosad 2.5%SC, chlorantraniliprole 18.5%SC, imidacloprid 70%WG and acetamiprid 20%SP, which come under novel group of insecticides for the sucking pest management in chilli crop.

3.4. Incidence of *T. parvispinus* in the surveyed locations

The survey results regarding the incidence of *T. parvispinus* revealed that the highest per cent flower infestation by *T. parvispinus* was documented in Khammam district (56.75%), followed by Mahabubabad (41.50%), Peddapalli (34.63%), Nagarkurnool (31.00%), J. Gadwal (22.50%) and the lowest was in Jagtial district with 20.25%. Though, the Khammam district farmers used wide range of insecticide molecules and sprays against this notorious pest the pest caused maximum incidence in this district. The application of higher doses and more number of sprays of insecticides might have lead to the resistance and resurgence of this pest.(20), (1), (14), (8) and (17)also opined that higher doses with more applications will lead to insecticide resistance and resurgence, causes pest flare up in chilli crop in open field and poly house conditions. (19) reported that, , *S. dorsalis* population from Guntur district in chillies has developed high degree of resistance to various insecticides *viz.,* monocrotophos, acephate, dimethoate, phosalone, carbaryl and triazophos due to their high usage and more frequency.

Conclusion

The results obtained from the incidence and pesticide usage against chilli thrips provided a clear picture of insecticide usage across different districts of Telangana state and highlighted the districts applying the high and heavy use of pesticides against *T. parvispinus* (Karny). The results indicated the continued heavy incidence of the invasive thrips with the damage ranging from 20.25% to 56.75% in chilli growing districts of Telangana. Among the districts, Khammam stood first in terms of incidence of the pest, and usage more no. of insecticides with more frequency followed by Mahabubabad, while it was lowest in Jagtial district. The study revealed the lack of awareness regarding use recommended pesticides, pesticide residues, label claim, safe waiting periods, safety measures and eco-friendly pest management practices against chilli thrips. Hence, it is essential to educate the farmers on the above aspects through extensive training programmes and awareness campaigns.

Acknowledgement

The authors are highly indebted to the host organization *i.e.* PJTSAU for the execution of the experiment and providing required budget for the completion.

Conflict of interests

The authors don't have any conflict of interest regarding above research work and results discussed

Future scope of study

The present investigation contributing the information on insecticide usage pattern in different districts of Telangana, India. Based on this information insecticide resistance and residues studies in chilli crop may be taken up.

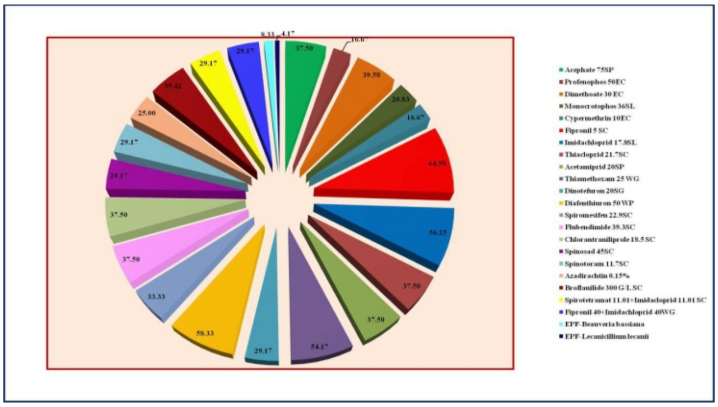
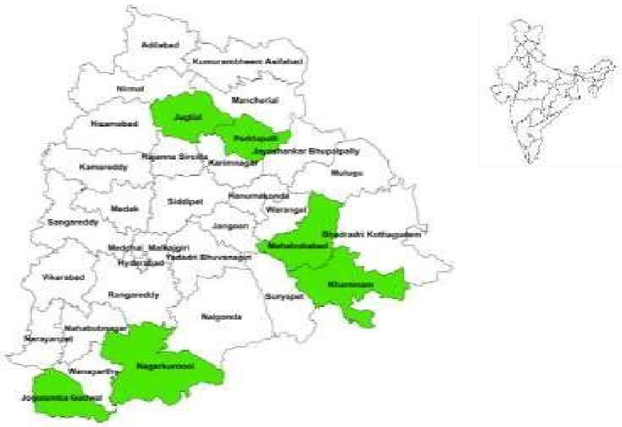


Fig.1. Per cent usage of different insecticide molecules in the surveyed locations

T. parvispinus infestation in flowers

Severely infested flower by T. parvispinus

Plate 1. Survey locations of chilli growing areas in Telangana state and flower infestation caused by T. parvispinus



Survey locations

Collection of information

Table 1. Crop production details of chilli farmers in the surveyed locations of Telangana during 2022-2024

S. No.	Parameter	Character	JGL	PPI	KMM	MBD	NKL	JWL	Overall
1.	Average land holding under chilli cultivation*		3.19	4.25	7.44	2.94	2.19	1.69	3.62
2.	Soil	Red	4.17	6.25	2.08	4.17	10.42	12.50	39.58
		Black	12.50	10.42	14.58	12.50	6.25	4.17	60.42
3.	Hybrid/Variety	*Teja* segment	12.50	14.58	14.58	12.50	16.67	16.67	87.50
		Byadagi segment	2.08	2.08	2.08	2.08	0.00	0.00	8.33
		Local land race	0.00	0.00	2.08	2.08	0.00	0.00	4.17
4.	Irrigation	Flood	16.67	16.67	14.58	12.50	16.67	16.67	93.75
		Drip	0.00	0.00	2.08	4.17	0.00	0.00	6.25
		Sprinkle	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5.	Season	Kharif	100.00	100.00	100.00	100.00	100.00	100.00	100.00
		Rabi	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6.	Usage of UV reflective mulches		0.00	0.00	4.17	2.08	0.00	0.00	6.25

*JGL: Jagtial; PPI: Peddapalli; KMM: Khammam; MBD: Mahabubabad; NKL: Nagarkurnool; JWL: Jogulamba Gadwal; * Mean of 8 farmers in each district*

Table 2. Pesticide usage pattern of chilli farmers against T.parvispinus in surveyed locations of Telangana during 2022-24.

S.No.	Parameter		Percent usage of the farmers in the surveyed locations						
			JGL	PPI	KMM	MBD	NKL	JWL	Over all
1.	Source of information	Agri. Dept.	2.08	4.17	2.08	4.17	2.08	4.17	18.75
		Dealer	8.33	8.33	10.42	10.42	8.33	8.33	54.17
		Neighbour	6.25	4.17	4.17	4.17	4.17	4.17	27.08
2.	Spraying appliance	Knapsack sprayer	4.17	8.33	4.17	2.08	8.33	8.33	35.42
		Power sprayer	12.50	8.33	12.50	14.58	8.33	8.33	64.58
3.	Pesticide mixture	Insecticide + Fungicide	2.08	0.00	6.25	6.25	2.08	4.17	20.83
		Insecticides + Insecticide	8.33	6.25	6.25	4.17	6.25	4.17	35.42
		Insecticide only	6.25	10.42	4.17	6.25	8.33	8.33	43.75
4.	Awareness on pesticide residues	Yes	4.17	2.08	6.25	4.17	6.25	6.25	29.17
		No	12.50	14.58	10.42	12.50	10.42	10.42	70.83
5.	Awareness on recommended pesticides	Yes	4.17	4.17	6.25	4.17	4.17	2.08	25.00
		No	12.50	16.67	10.42	12.50	12.50	14.58	79.17
6.	Measurement of the pesticide	Bottle cap	14.58	14.58	16.67	14.58	12.50	12.50	85.42
		Approx.	2.08	2.08	0.00	2.08	4.17	4.17	14.58
7.	Are you being exposed to pesticide spray	Yes	16.67	16.67	16.67	16.67	16.67	16.67	100.0
		No	0.00	0.00	0.00	0.00	0.00	0.00	0.00

8.	Do you use the empty bottles for the home purpose	Yes	12.50	14.58	14.58	16.67	14.58	14.58	87.50
		No	4.17	2.08	2.08	0.00	2.08	2.08	12.50
9.	Disposal method of empty bottles	Burning	6.25	4.17	2.08	2.08	4.17	6.25	25.00
		Burying in soil	2.08	0.00	2.08	0.00	2.08	2.08	8.33
		Sale to shop keeper	8.33	12.50	12.50	14.58	10.42	8.33	66.67
10.	Mixing	Stick	16.67	16.67	16.67	16.67	16.67	16.67	100.0
		Bare hand	0.00	0.00	0.00	0.00	0.00	0.00	0.00
11.	Safety	Mask	0.00	2.08	4.17	2.08	2.08	0.00	10.42
		Gloves	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		None	16.67	14.58	12.50	14.58	14.58	16.67	89.58
12.	Average gap (days) between sprays*		12.63	10.13	7.25	8.25	9.13	11.75	9.86
S.No.	Parameter		**Percent usage of the farmers in the surveyed locations**						
			JGL	PPI	KMM	MBD	NKL	JWL	Over all
13.	Volume of spray fluid used per acre*		211.63	239.38	253.75	241.25	237.50	227.25	235.13
14.	Average no. of applications in a crop period*		9.38	20.38	29.88	23.38	15.13	13.88	18.67
15.	Awareness on eco-friendly pest management practices	Yes	4.17	6.25	6.25	4.17	4.17	4.17	29.17
		No	12.50	10.42	10.42	12.50	12.50	12.50	70.83
16.	Light traps		0.00	0.00	0.00	2.08	0.00	0.00	2.08
17.	Pheromone traps		0.00	0.00	2.08	0.00	0.00	0.00	2.08
18.	Yellow sticky traps		2.08	2.08	4.17	4.17	0.00	0.00	12.50
19.	Blue sticky traps		2.08	4.17	4.17	6.25	4.17	0.00	20.83
20.	White sticky traps		0.00	0.00	4.17	2.08	2.08	0.00	8.33
21.	Boarder crops/Trap crops		0.00	0.00	0.00	2.08	0.00	0.00	2.08
22.	Bio pesticides (EPB/EPF/EPV/EPN)		0.00	2.08	6.25	4.17	0.00	0.00	12.50
23.	Botanicals		2.08	4.17	8.33	6.25	2.08	2.08	25.00
24.	Natural enemies (Parasitoids/Predators)		0.00	0.00	0.00	0.00	0.00	0.00	0.00
25.	Per cent flower infestation		20.25	34.63	56.75	41.50	31.00	22.50	34.44

**Mean of 6 districts farmers; JGL: Jagtial; PPI: Peddapalli; KMM: Khammam; MBD: Mahabubabad; NKL: Nagarkurnool; JWL: Jogulamba Gadwal.*

Table 3. List of insecticides used by chilli farmers against Thrips parvispinus (Karny) in Telangana state during kharif, 2022-24

S. No.	Insecticide	Toxicity level	Category	Insecticide usage						Type of Molecule
				JGL	PPI	KMM	MBD	NKL	JWL	
1.	Acephate 75SP	MT	OP	+	+	+	+	+	+	Older (26.08%)
2.	Profenophos 50EC	HT	OP	+	+	+	+	+	+	
3.	Dimethoate 30 EC	HT	OP	+	+	+	+	+	+	
4.	Monocrotophos 36SL	ET	OP	+	+	+	+	+	+	
5.	Cypermethrin 10EC	HT	SP	+	+	+	+	+	+	
6.	Azadirachtin 0.15%	ST	B	+	+	+	+	-	-	
7.	Fipronil 5 SC	HT	PP	+	+	+	+	+	+	Novel (65.21%)
8.	Imidachloprid 17.8SL	HT	NN	+	+	+	+	+	+	
9.	Thiacloprid 21.7SC	HT	NN	+	+	+	+	+	+	
10.	Acetamiprid 20SP	HT	NN	+	+	+	+	+	+	
11.	Thiamethoxam 25 WG	MT	NN	+	+	+	+	+	+	
12.	Dinotefuron 20SG	MT	NN	-	+	+	+	+	+	
13.	Diafenthiuron 50 WP	MT	TD	+	+	+	+	+	+	
14.	Spiromesifen 22.9SC	MT	K	-	+	+	+	+	+	
15.	Flubendimide 39.3SC	ST	D	+	+	+	+	+	+	
16.	Chlorantraniliprole 18.5 SC	ST	D	+	+	+	+	+	+	
17.	Spinosad 45SC	MT	S	-	+	+	+	+	-	
18.	Spinotoram 11.7SC	ST	S	-	+	+	+	+	-	
19.	Broflanilide 300 G/L SC	MT	MD	-	-	+	-	-	-	
20.	Spirotetramat 11.01+Imidacloprid 11.01 SC	HT	K + NN	-	-	+	-	-	-	
21.	Fipronil40+Imidachlopri d 40WG	MT	PP + NN	-	-	+	+	-	-	
22.	EPF-*Beauveria bassiana*	ST	BP	-	-	+	+	-	-	Bio pesticide (8.60%)
23.	EPF-*Lecanicillium lecanii*	ST	BP	-	-	+	-	-	-	
	Grand total	-	-	14	18	23	20	17	15	-

ET: Extremely Toxic; HT: Highly Toxic; MT: Moderately Toxic; ST: Slightly Toxic;
JGL: Jagtial; PPI: Peddapalli; KMM: Khammam; MBD: Mahabubabad; NKL: Nagarkurnool; JWL: Jogulamba Gadwal;
OP: Organophosphorus; SP:Synthetic pyrethroids; PP: Phenyl Pyrazoles; NN: Neonicotinoids; TD: Thiourea derivatives; K: Ketoenols; D: Diamides; S: Spinosyns; B: Botanicals; BP: Bio pesticides

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