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Study on use of insecticides on cauliflower crop in Chittoor district of Andhra Pradesh

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Abstract
The cruciferous vegetables (cauliflower and cabbage) are part of the major vegetables produced in India. Due to intensive cultivation, the insect pest incidence and indiscriminate use of pesticides has been increased over the years. A roving survey was conducted among the cruciferous growing farmers' of different mandals in Chittoor district and Chintapalle region in Visakhapatnam District of Andhra Pradesh during *rabi*, 2017-18 and 2018-19, to get overall information on insecticide usage pattern and awareness among the farmers. The survey results revealed that, Kuppam Mandal of Chittoor District recorded highest consumption of insecticides and 43.75 per cent of total insecticides used, were belong to moderately hazardous class and only 6.25 per cent of belong to highly hazardous class and slightly hazardous class, whereas in Chintapalle region, of Visakhapatnam District there was no record of insecticide application. The results on insecticide usage and awareness confirms that, majority of the farmers prefer to spray insecticides weekly once (51.66%), 71.66 per cent per cent of the farmers were not taking any precautionary measures while application and 84.99 per cent of the farmers were disposing the insecticide containers unscientifically.

Keywords: Cauliflower, insecticide use and awareness, who hazard class, precautions during insecticide application

1. Introduction
In India cauliflower is one of the major vegetables grown which accounts for around five per cent of the total vegetable production, with an area, production and productivity of 4.30 lakh hectare (ha), 8.67 million tonnes and 19.10 tonne/ha respectively after China (indiastat.com) [1]. In Andhra Pradesh the area and production were 2,410 ha and 32,200 tonnes respectively in 2016-17 (indiastat.com) [1]. It faces threat from numerous insect pests such as Diamondback moth (DBM), Tobacco caterpillar, Aphids, Leaf Webber *etc* (Mahendran *et al*., 2016) [2]. Farmers have adapted chemical method of control of insect pests because of its immediate effect, availability in the nearby market and recommendation by dealers (Weinberger and Srinivasan, 2009; Zhou *et al*., 2011) [3, 4]. However, due to indiscriminate use of insecticides the insect, DBM has developed insecticide resistance to almost all groups of insecticides (Oliveira *et al*., 2011) [5] and it has also resulted in increased cost of production (Weinberger and Srinivasan, 2009) [3]. The use of precautionary measures are important in preventing insecticide exposure, majority of the farmers are not using any prescribed safety measures during application and leads to many health hazards (Abhilash and Singh, 2009) [6]. Hence, to know about the insecticide knowledge and awareness among cauliflower farmers, the survey was conducted.

2. Materials and Methods
Roving survey was conducted on cauliflower crop in five mandals of Chittoor district of Andhra Pradesh *viz*., Ramasamudram, Punganur, Gangavaram, V. Kota and Kuppam and Chintapalle region (High Altitude Tribal Zone) of Visakhapatnam District during *rabi* season of 2017-18 and 2018-19.

2.1 Selection of Villages
Based on data obtained from Horticulture Department regarding area of cruciferous vegetables, in each mandal two villages were chosen. In each village two farmer fields were selected for survey.

2.2 Collection of data
The information on the major insecticides used during vegetative stage and curd formation stage were collected along with insecticide usage practices like spray schedule, source of insecticide selection, dosage selection, type of sprayer, mixing of pesticide formulation before spraying, precautionary measures followed while application and disposal of insecticide containers used followed by farmers during the survey. The farmers were asked to show the containers of the insecticide sprayed to get the accurate information on insecticide label and formulation. The information was recorded in the survey pro-forma and later used for analysis.

2.3 Analytical tools and techniques employed
Simple statistical functions like mean, frequency and percentage were used to analyse the data using Microsoft Excel 2010 spreadsheet.

3. Results and Discussion
3.1 Insecticides used by farmers on cauliflower crop to control different insects during *rabi*, 2017-18 and 2018-19
The insecticides used to control insect pests in different mandals of Chittoor district are mentioned in the Table 1. A total of 16 insecticides were used in Kuppam mandal on cauliflower crop in two growing seasons, eight were used in the vegetative stage namely Imidacloprid 17.8% SL, Thiamethoxam 75% SG, Chlorpyrifos 20% EC, DDVP 76% EC, Acetamiprid 20% SP, Pyridalyl 10% EC, Cartap hydrochloride 50% SP and Thiamethoxam 12.6%+λ-cyhalothrin 9.5% ZC (combination insecticide) and nine were sprayed during curd formation stage namely Cartap hydrochloride 50% SP, Spinosad 45% SC, Emamectin Benzoate 5% G, Chlorantraniliprole 18.5% SC, Tolfenpyrad 15% EC, Chlorpyrifos 50%+Cypermethrin 5% EC, Prophenofos 50%+Cypermethrin 4% EC, Novaluron 5.25%+Indoxacarb 4.5% EC and Abamectin 1.9% EC, whereas in Ramasamudram mandal, 14 variety of insecticides were used, six were used in vegetative stage namely Acephate 50%+Imidacloprid 1.8% WG, Thiamethoxam 75% SG, Imidacloprid 17.8% SL, Spirotetramat 15.31% EC, Cartap hydrochloride 50% SP, Chlorpyrifos 50%+Cypermethrin 5% EC and eight were used during the curd formation stage Novaluron 5.25%+Emamectin Benzoate 0.9% SC, Cartap hydrochloride 50% SP, Chlorantraniliprole 18.5% SC, Spinosad 45% SC, Emamectin Benzoate 5% G, Phenthoate 50% EC, DDVP 76% EC and Prophenofos 50%+Cypermethrin 4% EC. Out of 16 insecticides used in Kuppam mandal, seven (43.75%) insecticides were moderately hazardous (Class II) (Imidacloprid, Chlorpyrifos, Cartap hydrochloride, λ-cyhalothrin, cypermethrin, profenophos, indoxacarb), two insecticides (12.50%) were unlikely to be Hazardous in normal use (UH) (Chlorantraniliprole and Novaluron), one (6.25%) was slightly hazardous (Class III) (Spinosad),and only dichlorvos (6.25%) was highly hazardous (Class 1b) insecticide, whereas in in Ramasamudram mandal six insecticides (46.15%) used were belong to Class II (acephate, imidacloprid, cartap hydrochloride, chlorpyrifos, cypermethrin and Phenthoate), two (15.38%) were of Class III (spirotetramat and Spinosad), two (15.38%) were of Class UH (Chlorantraniliprole and Novaluron) and one (7.60%) was Class 1b (Dichlorvos) (WHO, 2010) [7]. In V. Kota total of 12 insecticides were used in two cropping seasons five were used in vegetative stage *viz*., imidacloprid 17.8% SL, acetamiprid 20% SP, chlorpyrifos 20% EC, chlorpyrifos 50%+cypermethrin 5% EC, and DDVP 76% EC and seven different insecticides were during curd formation and development stage namely cartap hydrochloride 50% SP, fipronil 5% SC, novaluron 5.25%+emamectin benzoate 0.9% SC, Spinosad 45% SC, chlorantraniliprole 18.5% SC, tolfenpyrad 15% EC and emamectin benzoate 5% G. However in Punganur a total of nine insecticides were used four during vegetative growth period *viz*., imidacloprid 17.8% SL, acephate 50%+ imidacloprid 1.8% SP, spirotetramat 15.31% EC and chlorpyrifos 20% EC and five different insecticides were used during curd formation stage namely cartap hydrochloride 50% SP, chlorantraniliprole 18.5% SC, *Bacillus thuringiensis* var. kurstaki, chlorpyrifos 50%+cypermethrin 5% EC, tolfenpyrad 15% EC and Spinosad 45% SC. In V. Kota mandal, out of 12 insecticides used, four insecticides (33.33%) were of Class II (Imidacloprid, chlorpyrifos+ cypermethrin, cartap hydrochloride and fipronil), two insecticides (16.66%) were UH (chlorantraniliprole and Novaluron), one insecticide (8.33%) was Class III (Spinosad) and one (8.33%) was Class 1b (Dichlorvos), however in Punganur mandal five (50.00%) insecticides sprayed were belong to Class II (imidacloprid, Acephate, chlorpyrifos, cypermethrin and cartap hydrochloride), three insecticides (30.00%) to class III (spirotetramat, *Bacillus thuringiensis* var. kurstaki and Spinosad), one insecticide (10.00%) to Class UH (Chlorantraniliprole), and one (10.00%) was Class 1b (Dichlorvos). In Gangavaram mandal, four insecticides were used in vegetative stage namely thiamethoxam 75% SG, chlorpyrifos 50%+cypermethrin 5% EC, imidacloprid 17.8% SL and cartap hydrochloride 50% SP and four insecticides were used during curd formation and development stage *viz*., novaluron 5.25%+emamectin Benzoate 0.9% SC, cartap hydrochloride 50% SP, Spinosad 45% SC and chlorpyrifos 50%+cypermethrin 5% EC. Whereas no insecticides were used in Chintapalle region. Out of six insecticides sprayed on cauliflower crop, three (50.00%) insecticides belong to class II (chlorpyrifos + cypermethrin, imidacloprid and cartap hydrochloride), one (16.66%) to Class UH (Novaluron) and one (12.5%) to Class III (Spinosad) in Gangavaram mandal. During the survey the information gathered were similar to the survey conducted by Weinberger and Srinivasan (2009) [3], who reported that the use of insecticides as the major control strategy followed and 55 types of active ingredients were used on cauliflower itself and the most used insecticides were chlorpyrifos, cypermethrin, indoxacarb, dichlorvos, triazophos, Spinosad, methomyl, and the insect growth regulator, novaluron in the three states Karnataka, Gujarat and West Bengal. Grzywacz *et al*. (2010) [8] reported that farmers in India, Malaysia and Indonesia used to spray even eleven insecticides per crop season and spraying interval varies between two to three days.

Table 1: Locations of survey in Chittoor district of Andhra Pradesh during *rabi* of 2017-18 and 2018-19.

District	Mandal	Village	Coordinates (Latitude, Longitude)
Chittoor	Kuppam	Cheldiganipalle	12.928099, 78.467068
		Konganapalle	12.9352710, 78.4241150
		Sivanikuppam	12.9330764, 78.4374680
		Nalagampalle	12.793700, 78.358799
	Ramasamudram	Chembakur	13.4293990, 78.4131180
		Balijapalle	13.4427570, 78.4196540
		Opireddiganipalle	13. 5577737, 78.6037381
	V. Kota	Kaigallu	13.0691190, 78.5605720
		Gandlapalle	12.989401, 78.4840206
		Baireddipalle	13.0709613, 78.5816652
	Punganur	Somala	13.4842760, 78.7659060
		Chowdepalle	13.4623020, 78.7552250
		Mettimanda	13.457884, 78.744484
	Gangavaram	Keelapatla	13.239566, 78.779433
		Kothapalle	13.237853, 78.757724
Visakhapatnam	Chintapalle	Pentapadu	17.8574370, 82.3290620
		Chowdepalle	17.8915313, 82.3459189

Table 2: Insecticides used by farmers on cauliflower crop to control different pests during *rabi*, 2017-18 and 2018-19.

Mandal	Stage of application	Insecticides		WHO Hazard Class*
		Active ingredient	Trade name	
Kuppam	Vegetative	Imidacloprid 17.8% SL	Confidor	Class II
		Thiamethoxam 75% SG	Capcadis	NA
		Chlorpyrifos 20% EC	Hexaban	Class II
		DDVP (Dichlorvos)76% EC	Nukem	Class 1b
		Acetamiprid 20% SP	Bright	NA
		Pyridalyl 10% EC	Sumipleo	NA
		Cartap hydrochloride 50% SP	Caldan, Compass, Mortar	Class II
		Thiamethoxam 12.6%+λ-cyhalothrin 9.5% ZC	Alika	NA+Class II
	Curd formation	Cartap hydrochloride 50% SP	Caldan, Compass, Mortar	Class II
		Spinosad 45% SC	Taffin	Class III
		Emamectin Benzoate 5% G	Fitrest, Xplode, Amnon	NA
		Chlorantraniliprole 18.5% SC	Coragen	UH
		Tolfenpyrad 15% EC	Keefun	NA
		Chlorpyrifos 50%+Cypermethrin 5% EC	Naga, Koranda, Anaconda	Class II+Class II
		Profenofos 50%+Cypermethrin 4% EC	Rocket	Class II
		Novaluron 5.25%+Indoxacarb 4.5% EC	Plethora	UH+Class II
		Abamectin 1.9% EC	Abacin	NA
Ramasamudram	Vegetative	Acephate 50%+Imidacloprid 1.8% WG	Lancer gold	Class II+Class II
		Thiamethoxam 75% SG	Actara	NA
		Imidacloprid 17.8% SL	Cofidor	Class II
		Spirotetramat 15.31% EC	Movento	Class III
		Cartap hydrochloride 50% SP	Sumi Taz, Boregon	Class II
		Chlorpyrifos 50%+Cypermethrin 5% EC	Naga, Koranda	Class II
	Curd formation	Novaluron 5.25%+Emamectin Benzoate 0.9% SC	Barazide	UH+NA
		Cartap hydrochloride 50% SP	Sumi Taz	Class II
		Chlorantraniliprole 18.5% SC	Coragen	UH
		Spinosad 45% SC	Charge	Class III
		Emamectin Benzoate 5% G	EM-1, Fitrest	NA
		Phenthoate 50% EC	Pendal	Class II
		DDVP 76% EC	Nukem, Speed, Paramar	Class 1b
		Prophenofos 50%+Cypermethrin 4% EC	Slash	Class II+Class II
V. Kota	Vegetative	Imidacloprid 17.8% SL	Cohigan	Class II
		Acetamiprid 20% SP	Sharp	NA
		Chlorpyrifos 20% EC	Hexaban,	Class II
		Chlorpyrifos 50%+Cypermethrin 5% EC	Koranda, Anaconda	Class II+Class II
		DDVP 76% EC	Nukem	Class 1b
	Curd formation	Cartap hydrochloride 50% SP	Sumi Taz,	Class II
		Fipronil 5% SC	Regent	Class II
		Novaluron 5.25%+Emamectin Benzoate 0.9% SC	Barazide	UH+NA
		Spinosad 45% SC	Taffin	Class III
		Chlorantraniliprole 18.5% SC	Coragen	UH
		Tolfenpyrad 15% EC	Keefun	NA
		Emamectin Benzoate 5% G	Amnon	NA
Punganur	Vegetative	Imidacloprid 17.8% SL	Confidor	Class II
		Acephate 50%+ Imidacloprid 1.8% SP	Victor Gold	Class II+Class II
		Spirotetramat 15.31% EC	Movento	Class III
		Chlorpyrifos 20% EC	Hexaban	Class II

	Curd formation	Cartap hydrochloride 50% SP	Mortar	Class II
		Chlorantraniliprole 18.5% SC	Coragen	UH
		Bacillus thuringiensis var. kurstaki	Di Pel	Class III
		Chlorpyrifos 50%+Cypermethrin 5% EC	Koranda, Anaconda	Class II+Class II
		Tolfenpyrad 15% EC	Keefun	NA
		Spinosad 45% SC	Taffin	Class III
Gangavaram	Vegetative	Thiamethoxam 75% SG	Actara	NA
		Chlorpyrifos 50%+Cypermethrin 5% EC	Naga	Class II+Class II
		Imidacloprid 17.8% SL	Confidor	Class II
		Cartap hydrochloride 50% SP	Caldan	Class II
	Curd formation	Novaluron 5.25%+Emamectin Benzoate 0.9% SC	Barazide	UH+NA
		Cartap hydrochloride 50% SP	Caldan, Mortar	Class II
		Spinosad 45% SC	Taffin,	Class III
		Chlorpyrifos 50%+Cypermethrin 5% EC	Koranda	Class II+Class II
Chintapalle	Vegetative	NIL	NIL	NIL
	Curd formation			NIL

*WHO Hazard Classes: Class 1b- Highly Hazardous, Class II-Moderately Hazardous, Class III- Slightly Hazardous, UH-Unlikely to be Hazardous in normal use, NA- Not Available

3.2 Insecticide usage awareness by farmers of different mandals of Chittoor district on cauliflower during *rabi*, 2017-18 and 2018-19

The information on spray schedule, source of insecticide selection, dosage selection, dosage of application, type of sprayer used, disposal of insecticide containers and precaution measures followed while application were collected in the course of survey in *rabi*, 2017-18 and 2018-19 and represented in the Table 3 and the results are discussed under below titles.

3.2.1 Spray schedule of insecticides

Around 53.33 per cent of the farmers sprayed insecticides once in a week followed by 40.00 per cent sprayed insecticides weekly twice and 6.66 per cent of farmers were not sprayed any insecticides in *rabi*, 2017-18. However in *rabi*, 2018-19 50.00 per cent of the farmers sprayed insecticide once in a week and 43.33 per cent sprayed weekly twice and only 6.66 per cent farmers not sprayed any insecticide (Table 3). The survey results from Weinberger and Srinivasan (2009) [3] reveals that, around 78 per cent of farmers from West Bengal, 70 per cent farmers from Karnataka and 43 per cent of farmers, sprayed insecticides more than once in a week.

Table 3: Insecticide usage awareness by farmers of different mandals on cauliflower during *rabi*, 2017-18 and 2018-19

S. No	Particulars	*rabi*, 2017-18 (n=30)		*rabi*, 2018-19 (n=30)		Mean per cent
		Frequency	Percentage	Frequency	Percentage	
1	**Spray schedule**					
	Weekly twice	12	40.00	13	43.33	41.66
	Weekly once	16	53.33	15	50.00	51.66
	No sprays	2	6.66	2	6.66	6.66
2	**Source of insecticide selection**					
	By dealers/salesman	25	83.33	26	86.66	84.99
	By Scientists or Agricultural Officer (AO)	5	17.85	4	13.33	15.59
3	**Dosage selection**					
	As recommended by dealer/salesman	24	80.00	25	83.33	81.66
	As recommended by Scientist or AO	4	13.33	3	13.33	13.33
	No sprays	2	6.66	2	6.66	6.66
4	**Dosage of application**					
	Higher than the recommended	16	53.33	17	56.66	54.99
	Approximately	14	46.66	13	43.33	44.99
5	**Type of sprayer used**					
	Knapsack	7	23.33	5	16.66	19.99
	Power (Battery/Petrol) operated	23	76.66	25	83.33	79.99
6	**Mixing of pesticide formulation before spraying**					
	Insecticide + Insecticide + Adjuvant	21	70.00	23	76.66	73.33
	Insecticide + Fungicide + Adjuvant	18	60.00	19	63.33	61.66
	No sprays	2	6.66	2	6.66	0.00
7	**Precaution measures followed while application**					
	Use of face masks, gloves and shoes	0	0.00	0	0.00	0.00
	Use full sleeve shirts and covering face with cloth	20	66.66	23	76.66	71.66
	No precautionary measures	8	26.66	5	16.66	21.66
	No sprays	2	6.66	2	6.66	6.66
8	**Disposal of insecticide containers**					
	Burying under soil/Burning	2	6.66	3	10.00	8.33
	Throwing near border of the crop	26	86.66	25	83.33	84.99
	No sprays	2	6.66	2	6.66	6.66

3.2.2 Source of insecticide selection
The majority of the farmers selected insecticides based on recommendation of dealers/salesman (83.33%) and very few farmers followed recommendation of Scientists or Agricultural Officer (AO) (17.85%) and no insecticides sprayed by 6.66 per cent farmers in 2017-18. Whereas in 2018-19, 86.66 per cent of the farmers selected insecticides as suggested by dealers/salesman and only 13.33 per cent approached Scientists or Agricultural Officer (AO) and 6.66 per cent of farmers not sprayed any insecticides.

3.2.3 Dosage selection
During *rabi*, 2017-18 majority of the farmers (80.00%) selected dosage as recommended by dealer and only few (13.33%) selected dosage as recommended by Scientist or Agriculture Officer and only 6.66 per cent farmers not sprayed any insecticide However during *rabi*, 2018-19 the majority of the farmers selected dosage as recommended by dealer/salesman (83.33%) followed by as recommended by Scientist or AO (13.33%) and 6.66 per cent farmers not sprayed insecticide. The survey on reveals that there is there is severe lack in knowledge on selection and dose of application of pesticides. The survey results were in similarity with the studies conducted by Shetty *et al*. (2010) [9] who reported that around 80 per cent of the farmers use information from unreliable sources which includes dealers (40%), company representatives (10%), progressive farmers (9%) and media (18%). Only 20.00 per cent of the farmers gather information on spraying from technical officer and spraying insecticides indiscriminately (Zhou *et al.*, 2011) [4].

3.2.4 Dosage of application
The 53.33 per cent of the farmers used dosages higher than the recommended and 46.66 per cent used approximate dosages in *rabi*, 2017-18 whereas in *rabi*, 2018-19, farmers using dosages higher than the recommended slightly increased to 56.66 per cent and 43.33 per cent farmers used approximate dosage.

3.2.5 Type of sprayer used
About 76.66 per cent farmers applied insecticide through Power (Battery/Petrol) operated and 23.33 per cent farmers applied using Knapsack sprayer during *rabi*, 2017-18. During *rabi*, 2018-19 survey, about 83.33 per cent farmers used Power (Battery/Petrol) operated sprayer and 16.66 per cent farmers used Knapsack sprayer. In contrary to present investigation Ntow *et al*. (2006) [10] reported that majority of the farmers used (83.20%) knapsack sprayer and only few members (13.10%) used motorised sprayers and Weinberger and Srinivasan (2009) [3] also reported that the cost of cauliflower production increased due to use of sprayers on hire basis, fuel used for spraying (kerosene, petrol, diesel and electric charge) and cost of labours employed.

3.2.6 Mixing of pesticide formulation before spraying
During the survey, most of the farmers used to mix any pesticide and adjuvant while spraying. Around 70.00 per cent of the farmers used mixture of insecticide + insecticide + adjuvant and 60.00 per cent of the farmers' sprayed insecticide + fungicide + adjuvant and only 6.66 per cent of them not involved in any spraying activity during *rabi*, 2017-18. During *rabi*, 2018-19, the farmers used mixture of insecticide + insecticide + adjuvant to the extent of 76.66 per cent followed by 63.33 per cent farmers used mixture of insecticide + fungicide + adjuvant and 6.66 per cent not sprayed any pesticide formulation (Table 3). According to Shetty *et al*. (2010) [9] and Weinberger and Srinivasan (2009) [3], about 2/3rd of the farmers use cocktail of pesticide mixtures before spraying which are not recommended.

3.2.7 Disposal of insecticide containers
Many farmers dispose the containers by throwing along border of the crop (86.66%) and the containers were buried/burnt by only 6.66 per cent of the farmers and 6.66 per cent farmers not used any insecticides, during *rabi*, 2017-18. In *Rabi*, 2018-19 survey, most of the farmers (83.33%) choose to throw the containers near border of the crop and 10.00 per cent of them burying under soil and 6.66 per cent of them not used any insecticides (Table 3). The lack of knowledge about environment and water contamination and illiteracy leads farmers to dispose and reuse of pesticide containers unscientifically, Bagheri *et al*. (2018) [11] reported that disposal methods practiced were dumping in farm (32.8%), burying (30.2%), throwing in canals (10.00%), burning (17.00%) and washing and using for animal watering (10.00%) and survey by Mohanty *et al*. (2013) [12] confirms that farmers throw indiscriminately (50.00%), bury (28.5%), burn (11.9%) and wash and reuse (4.8%) the pesticide containers.

3.2.8 Precaution measures followed while application
During the survey any of the farmers were not taking any prescribed precautionary measures to avoid insecticide exposure. Survey during *rabi*, 2017-18 revealed that 66.66 per cent of the farmers preferred use of full sleeve shirts and covering face with cloth while spraying, whereas 26.66 per cent of the farmers not used any precautionary measures and 6.66 per cent of the farmers not done any spraying. Majority of the farmers used full sleeve shirts and covering face with cloth during spraying (76.66%) and only few of the farmers (16.66%) not used any precautionary measures and 6.66 per cent of the farmers not used any insecticides (Table 3). Since farmers lack in awareness and training about use of pesticides usage, poor literacy rate and ignorance about potential threat to health and environment farmers are not using any precautionary measures during application (Abhilash and Singh, 2009) [6]. As per observations of Singh and Gupta (2009) [13], 93 per cent of the farmers were not using goggles, 35 per cent were barefooted while spraying and 33 per cent were using slippers.

4. Conclusion
The survey findings reveal that, intensive cultivation of the crop has resulted in dependence of the farmers on single management practice *i.e*., insecticide application, among the all insecticides applied majority of them belong to moderately hazardous and most of the farmers were not approaching any scientific source for dose recommendation and for selection of insecticides and not taking any precautionary measures while insecticide application. Hence, proper extension methodologies are required to create awareness among farmers so that farmers can avoid the indiscriminate application of insecticides and also adopt the other means of Integrated Pest Management practices for pest control.

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