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INSECTICIDE USAGE PATTERN AND KNOWLEDGE LEVEL OF FARMERS ON INSECTICIDES HANDLING TO MANAGE *SPODOPTERA LITURA* (FAB.) ACROSS DIFFERENT LOCATIONS OF SOUTH INDIA

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ABSTRACT

Detailed survey was conducted to record the insecticide usage pattern to control tobacco caterpillar, *Spodoptera litura* and knowledge level of farmers on insecticides handling from farmers of Belagavi, Shivamogga and Mysore (Karnataka), Coimbatore and Dindigul (Tamil Nadu), Kurnool and Chittoor (Andhra Pradesh) and Kolhapur and Pune (Maharashtra) districts of south India during 2022-23. The information on insecticide usage pattern was gathered from ten progressive farmers from each location through questionnaire. Farmers used nineteen different insecticides against *S. litura*. Among these, highest usage of emamectin benzoate 5 SC (46.67 %) was reported followed by chlorpyriphos 20 EC (44.44%) and chlorantraniliprole 18.5 SC (41.11 %). The average number of insecticides application ranged from 1.30 to 5.7 sprays. Maximum number of 5.7 sprays were recorded in Belagavi with spray interval of 10.2 days followed by Kolhapur (5.4 sprays and 10.6 days interval). 46.67 per cent farmers approached pesticide dealer shops to get information on insecticide recommendation and 78.89 per cent farmers did not pay attention towards label information given on pesticide containers. 37.78 percent farmers sprayed pesticides at recommended dose, 91.11 per cent farmers carried spraying during morning hours and 75 percent of the farmers used single insecticide.76.67 percent farmers done spraying only after observing initial symptoms and 14.44 per cent farmers fallowed ETL. Nearly 84.44 per cent farmers relied only on insecticides and 5.56 per cent farmers adopted IPM against *S. litura*.

Key words : Insecticides, Tobacco caterpillar, *Spodoptera litura*, Usage pattern, Questionnaire.

Introduction

Tobacco caterpillar, *Spodoptera litura* (Fab.) (Lepidoptera: Noctuidae) is a destructive polyphagous pest on wide range of host plants like tobacco, cabbage, cauliflower, groundnut, chilli *etc.* and causes considerable damage. The young larvae first feed gregariously and scrape the leaves. Older larvae spread out and completely devour the leaves resulting in poor growth of plants. This pest breeds throughout the year with six larval instars which accounts for 15-30 days. The full-grown larva enters the soil for pupation and the life cycle is completed in 32-60 days with eight generations in a year. Significant attention in toxicological studies has been received as this pest has a potential to develop insecticide resistance to most of the insecticides. When an insect population is exposed to an insecticide, individuals with resistance genes survive and reproduce. In this context, detailed survey was carried out to know the insecticide usage pattern by the farmers against *S. litura* in different crop ecosystem.

Materials and Methods

A field survey was conducted during the *Kharif* 2021-22 to record the insecticide usage pattern against *S. litura*

in major vegetables, tobacco and groundnut growing areas of South India *viz*., Karnataka, Maharashtra, Tamil Nadu and Andhra Pradesh. In each location, two districts were surveyed for collection of the data on the insecticide usage pattern against *S. litura*. A total of ten (10) farmers were randomly selected for survey through the questionnaire in the villages of each district. The questionnaire includes: trade name/common name of the insecticide, active ingredients of the insecticides, dosage of the insecticide used, time of spraying, frequency of spraying in a growing season, efficacy of the insecticides, type of sprayer used, spraying intervals, safety precautions adopted and waiting period (between last spraying and harvesting) and the opinion from the farmer was collected. The data obtained from the survey was statistically analysed.

Results and Discussion

Status of insecticide usage pattern against *S. litura*

The survey data revealed that, the mean of different insecticides used to manage *S. litura* among farmers of different districts of various locations varied from 3 to 47 per cent (Table 2). Farmers used nineteen different insecticides to manage *S. litura* on various hosts. Among the different insecticides the highest usage of emamectin benzoate 5 SG (46.67%) was recorded followed by chlorpyriphos 20 EC (44.44%), chlorantraniliprole 18.5 SC (41.11%), lambda cyhalothrin 5 EC (34.44 %) and flubendimide 39.5 SC (31.67%). Lowest usage of 2.78% was recorded for broflanilide 20 SC (Table 1). Similar results were reported by Gangaraju *et al*. (2020), who reported that, total of 29 different types of insecticides were used by farmers to control insect pests in cabbage. Further, 58 per cent of the farmers used newer insecticides *viz*., flubendimide, chlorantraniliprole, emamectin benzoate, indoxacarb *etc*. for controlling insect pests of cabbage in both Karnataka and Andhra Pradesh. The frequent use of similar insecticides with same mode of action has results in selecting resistant population of *S. litura* besides elimination of natural enemies. Fact that, majority of the farmers was greatly influenced by the dealer's recommendations and repeatedly used the same insecticides as recommended by the pesticide dealers. The main reason for this dependence appeared to be that most farmers were economically poor and depended on the dealers for credit, these results are in line with the reports of Lingappa *et al*. (1993).

Spray interval and the number of application of insecticides

Data collected from four different states covering nine districts showed that farmers applied insecticide at an interval of 10.2 to 19.5 days (Table 3). Longer spray interval was noticed in Kurnool and Chittoor districts of Andhra Pradesh where farmers applied the insecticides at an interval of 18.7 and 19.5 days, respectively and shorter spray intervals of 10.2 and 10.6 days were recorded from farmers of Belagavi and Kolhapur districts of Karnataka and Maharashtra, respectively. The number of application of insecticides in nine locations varied from

Table 1 : Questionnaire used during insecticides usage pattern survey against *S. litura.*

Farmer/Dealer Name:
Insects observed:
Insecticides used (Trade name/ common name and dosage):
Active ingredients of insecticides used:
No. of sprays/crop season:
Spray Interval:
No. of Pesticides used:
Type of sprayer used: Hand/ Power
Source of information on usage of insecticides: Dealers/Fellow farmers/Govt. officials/Company persons
Attention towards label information: Yes/No
Measurement of insecticide: Bottle cap/Approximate
Safety measures taken at the time of spray: No measures/Hand gloves only/Mask alone
Dosage: Recommended/ Higher dose
Disposal of pesticide container: Buried in soil/ Throw in neglected area/ Leaving them in field
Time of application: Morning/ Noon/Evening
Pesticide used: Sole/ Tank mix
Waiting period: No waiting period/ As recommended on leaflet
Decision of spraying: Blanket spraying/Initial symptom/ Looking into ETL
Control methods followed: Insecticides alone/Cultural control/IPM

Table 2 : Insecticides used by farmers against *Spodoptera litura.*

S. no.	Insecticides	Farmers (%)									
		Karnataka			Tamil Nadu		Maharastra		Andhra Pradesh		
		Belagavi	Shivamogga	Mysore	Coimbotore	Dindagul	Kolhapur	Pune	Kurnool	Chittoor	Mean
1	Chlorantraniliprole 18.5 SC	90	60	50	40	20	30	40	20	20	**41.11**
2	Emamectin benzoate 5 SG	65	80	60	40	40	40	45	25	25	**46.67**
3	Lambda cyhalothrin 5 EC	50	50	30	20	40	30	50	20	20	**34.44**
4	Flubendiamide 480 SC	45	50	40	20	20	30	30	30	20	**31.67**
5	Profenophos 50 EC	20	10	10	0	10	20	10	10	0	10.00
6	Chlorantraniliprole 5.25 + Lambda-cyhalothrin 0.9 SC	10	10	10	0	0	10	10	0	15	7.22
7	Novaluron 5.25 + Emamectin benzoate 0.9 SC	25	10	15	0	10	0	15	15	0	10.00
8	Spinosad 45 SC	40	30	20	40	20	40	45	0	25	**28.89**
9	Spinetoram 11.7 SC	10	0	20	10	20	20	15	15	20	14.44
10	Thiamethoxam 12.6 + Lambda-cyhalothrin 9.5 ZC	0	0	10	0	10	20	20	0	0	6.67
11	Chloropyriphos 50 +cypermethrin 5EC	10	10	20	0	0	0	0	0	0	4.44
12	Chlorpyriphos 20 EC	55	50	45	20	50	30	45	50	55	**44.44**
13	Profenophos 40+Cypermethrin 4EC	0	10	0	10	10	0	10	0	0	4.44
14	Thiodicarb 75 WP	0	0	10	0	10	10	0	0	0	3.33
15	Lambda-cyhalothrin 4.6 + Chlorantraniliprole 9.3 ZC	0	0	20	10	15	10	15	0	10	8.89
16	Broflanilide 20 EC	15	10	0	0	0	0	0	0	0	2.78
17	Cypermethrin 10 EC	10	0	10	0	15	0	0	0	15	5.56
18	*Bacillus thurigiensis*	10	0	15	0	25	0	25	15	25	12.78
19	Monocrotophos 36 SL	10	0	10	0	15	0	10	20	15	8.89

*Mean of ten farmers.

Table 3 : Insecticides usage pattern against *Spodoptera litura* across different location.

S. no.	Location		Frequently used insecticides	No. of sprays/ crop season (Mean ± SE)	Spray Interval (days) (Mean +SE)
1	**Karnataka**	**Belagavi**	Chlorantraniliprole 18.5 SC, Emamectin benzoate 5 SG, Lambda cyhalothrin 5 EC, Flubendiamide 480 SC, Novaluron 5.25 + Emamectin benzoate 0.9 SC, Spinosad 45 SC and Chlorpyriphos 20 EC	5.7 ± 0.49	10.2 ± 0.33
		Shivamogga	Chlorantraniliprole 18.5 SC, Emamectinbenzoate 5 SG, Lambda cyhalothrin 5 EC, Flubendiamide 480SC, Spinosad 45SC and Chlorpyriphos 20EC	4.4 ± 0.63	12.5 ± 0.45
		Mysore	Chlorantraniliprole 18.5 SC, Emamectin benzoate 5 SG, Lambda cyhalothrin 5 EC, Flubendiamide 480 SC, Spinosad 45 SC, Spinetoram 11.7 SC, Chlorpyriphos 20 EC and Lambda-cyhalothrin 4.6 + Chlorantraniliprole 9.3 ZC	2.7 ± 0.72	15.7 ± 0.37
2	**Maharashtra**	**Kolhapur**	Chlorantraniliprole 18.5 SC, Emamectin benzoate 5 SG, Lambda cyhalothrin 5 EC, Flubendiamide 480 SC, Spinosad 45 SC, Spinetoram 11.7 SC, Chlorpyriphos 20 EC and Thiamethoxam 12.6 + Lambda-cyhalothrin 9.5 ZC	5.4 ± 0.34	10.6 ± 0.42
		Pune	Chlorantraniliprole 18.5 SC, Emamectin benzoate 5 SG, Lambda cyhalothrin 5 EC, Flubendiamide 480 SC, Spinosad 45 SC, Novaluron 5.25 + Emamectin benzoate 0.9 SC, *Bacillus thurigiensis* and Chlorpyriphos 20 EC	4.2 ± 0.73	12.4 ± 0.39
3	**Tamil Nadu**	**Coimbotore**	Chlorantraniliprole 18.5 SC, Emamectin benzoate 5 SG, Lambda cyhalothrin 5 EC, Flubendiamide 480 SC, Spinosad 45 SC and Chlorpyriphos 20 EC	2.3 ± 0.67	16.1 ± 0.43
		Dindagul	Chlorantraniliprole 18.5 SC, Emamectin benzoate 5 SG, Lambda cyhalothrin 5 EC, Flubendiamide 480 SC, Chlorpyriphos 20 EC and *Bacillus thurigiensis*	2.5 ± 0.73	17.5 ± 0.50
4	**Andhra Pradesh**	**Kurnool**	Chlorantraniliprole 18.5 SC, Emamectin benzoate 5 SG, Lambda cyhalothrin 5 EC, Flubendiamide 480 SC, Chlorpyriphos 20 EC and Monocrotophos 36 SL	1.3 ± 0.59	18.7 ± 0.70
		Chittoor	Chlorantraniliprole 18.5 SC, Emamectin benzoate 5 SG, Lambda cyhalothrin 5 EC, Flubendiamide 480 SC, Chlorpyriphos 20 EC, *Bacillus thurigiensis* and Spinosad 45 SC	1.5± 0.31	19.5 ± 0.81

*Mean of ten farmers.

1.5 to 5.7 per cropping season. Higher number of sprays *i.e.*, 5.7 and 5.4 sprays recorded from Belagavi and Kolhapur, respectively followed by Shivamogga (4.4 sprays) were and districts, respectively. Whereas, the least number of sprays *i.e.*, 1.3 and 1.5 sprays were recorded in Kurnool and Chittoor districts of Andhra Pradesh (Table 3). Similar findings were reported by Nikita (2022), who stated that among various locations, farmers from Belagavi district used more number sprays on cabbage (5-6 numbers of spray). Rubesh *et al*. (2023) reported that 10 per cent of farmers applied pesticides once a week, 90 per cent of farmers applied pesticides at every 10 to 15 days. Honnakeerappa and Udikeri (2018) revealed that the farmers sprayed an average of

Table 4 : Categorization of various locations based on insecticide usage pattern.

S. no.	Location		No. of sprays/crop season (Mean ± SE)	Spray Interval (days) (Mean +SE)	Categorization
1	**Karnataka**	**Belagavi**	5.7 ± 0.49	10.2 ± 0.33	High pressured area
		Shivamogga	4.4 ± 0.63	12.5 ± 0.45	High pressured area
		Mysore	2.7 ± 0.72	15.7 ± 0.37	Medium pressured area
2	**Maharashtra**	**Kolhapur**	5.4 ± 0.34	10.6 ± 0.42	High pressured area
		Pune	4.2 ± 0.73	12.4 ± 0.39	High pressured area
3	**Tamil Nadu**	**Coimbotore**	2.3 ± 0.67	16.1 ± 0.43	Medium pressured area
		Dindagul	2.5 ± 0.73	17.5 ± 0.50	Medium pressured area
4	**Andhra Pradesh**	**Kurnool**	1.3 ± 0.59	18.7 ± 0.70	Low pressured area
		Chittoor	1.5± 0.31	19.5 ± 0.81	Low pressured area

*Mean of ten farmers.

1.0 to 3.0 rounds of newer insecticides to combat *H. armigera* in tomato.

Categorization of locations based on insecticide usage pattern

Among different districts covered four districts were fall under high insecticide pressured area *viz*., Belagavi, Kolhapur, Shivamogga and Pune since farmers have taken 4-6 times spray on their respective crops. Mysore district of Karnataka, Coimbatore and Dindigul district of Tamil Nadu categorized as medium insecticide pressured area where farmers have taken 2-3 times of sprays on their respective crops. Kurnool and Chittoor districts of Andhra Pradesh were categorized as low insecticide pressured area where farmers used less than 2 times sprays on host crops (Table 4). Variation in number of sprays against *S. litura* in different districts of South India might be due to feeding on different host plants during particular cropping season and exposer of *S. litura* populations to different insecticides. The host plants which were preferred more by *S. litura* demanded high pesticide sprays to manage it and also exert high selection pressure on *S. litura* populations. Further, those crops which received less pesticide have minimum selection pressure. These results are in accordance with Nikita (2022) who categorized Belagavi and Yadgir under the high pesticide pressured area because farmers used 4-6 times of spray on their respective crops.

Knowledge level of farmers on Insecticides handling and safety measures

Source of information on insecticide usage and attention towards label information

The survey data revealed that, about 46.67 per cent farmers approached pesticide dealer shops and 38.89 percent farmers preferred the insecticides based on the discussions with the fellow farmers (Table 5). Similar findings were reported by Rubesh *et al*. (2023), who reported that 13.33% of farmers contact Department of agriculture for pesticide advice, 76.66% of farmers spray pesticides based on recommendations from dealers and only 3% of farmers contact scientists. Sachin and Suchitakumari (2016) reported that about 29 percent of farmers obtained the information from private pesticide dealers. The main reason for this dependence appeared to be that most farmers were economically poor and depended on the dealers for credit.

About 78.89 per cent of farmers did not pay attention towards label information given with pesticide containers and could not understand the toxicity level after reading the colour code given on the pesticide bottle. Ranjith *et al*. (2020) reported that nearly 90.50 farmers failed to understand the information given on the label pasted on pesticide bottle.

Measurement of insecticides and their dosage

Data revealed that, 93.33 per cent of the farmers used container caps containing measurement mark provided along with insecticide for measuring insecticide and only 6.67 percent of farmers approximately measured the insecticide and around 62.22 per cent farmers sprayed insecticides at approximate dose and remaining followed recommended doses (Table 5). Similar results were reported by Rubesh *et al*. (2023) who stated that 63.33 per cent of farmers used bottle cap to measure chemicals and 30 per cent of farmers measure chemicals using the approximately. This might be due to the lack of technical knowledge and socio-economic conditions. Some farmers thought that high pesticide usage results in high yield.

Table 5 : Knowledge level of farmers on insecticides handling and safety measures.

S. no.	Particulars	Farmers respondents (%)									
		Karnataka			Tamil Nadu		Maharastra		Andhra Pradesh		
		Belagavi	Shivamogga	Mysore	Coimbotore	Dindagul	Kolhapur	Pune	Kurnool	Chittoor	Mean
1) Source of information on insecticide usage											
a	Govt officials	0	0	0	10	0	0	0	10	0	2.22
b	Dealers	70	60	50	30	30	60	50	30	40	46.67
c	Fellow farmers	30	40	40	50	40	40	30	40	40	38.89
d	Company persons	10	0	0	10	0	10	10	0	0	4.44
2) Attention towards label information											
a	Yes	30	60	20	20	10	20	10	10	0	20.00
b	No	70	40	80	80	90	80	90	90	90	78.89
3) Measurement of insecticides											
a	Bottle cap	100	100	100	100	100	90	90	80	80	93.33
b	Approximate	0	0	0	0	0	10	10	20	20	6.67
4) Dosage											
a	Recommended	40	30	50	20	30	30	40	40	60	37.78
b	Approximate	60	70	50	80	70	70	60	60	40	62.22
5) Safety measures taken at the time of spray											
a	No measures taken	90	80	80	60	60	80	80	60	70	73.33
b	Hand gloves only	0	0	10	20	10	0	0	10	0	5.56
c	Mask only	10	20	10	20	30	20	20	20	30	20.00
6) Time of application											
a	Morning	90	90	100	100	100	80	90	90	80	91.11
b	Evening	10	10	0	0	0	20	10	10	20	8.89

*Mean of ten farmers

Table 5 continued...

Table 5 contdinued....

S. no.	Particulars	Farmers respondents (%)									
		Karnataka			Tamil Nadu		Maharastra		Andhra Pradesh		
		Belagavi	Shivamogga	Mysore	Coimbotore	Dindagul	Kolhapur	Pune	Kurnool	Chittoor	Mean
7) Decision of spraying											
a	Based on ETL	10	10	10	20	10	10	10	30	20	14.44
b	Blanket spraying	0	0	10	0	0	0	0	10	10	3.33
c	Observing initial symptoms	90	40	80	80	90	90	90	60	70	76.67
8) Insecticide used											
a	Sole	80	70	80	80	70	80	90	70	60	75.56
b	Tankmix	20	30	20	20	30	20	10	30	40	24.44
9) Disposal of insecticidal containers											
a	Buried in soil	0	0	0	20	10	0	10	0	0	4.44
b	Leaving them in field	90	60	50	40	40	70	50	60	60	57.78
c	Throw in neglected area	10	40	50	40	50	30	40	40	40	37.78
10) Waiting period											
a	No waiting period	10	20	30	20	20	10	20	60	50	26.67
b	One day	90	80	70	80	80	90	80	40	50	73.33
c	As per recommended on leaflet	0	0	0	0	0	0	0	0	0	0.00
11) Type of sprayer used											
a	Hand operated	10	10	0	20	10	10	10	0	0	7.78
b	Power operated	90	90	100	80	90	90	90	100	100	92.22
12) Control methods adopted											
a	IPM	0	0	0	20	20	0	10	0	0	5.56
b	Insecticide alone	90	90	90	60	60	90	80	100	100	84.44
c	Cultural control	10	10	10	20	20	10	10	0	0	10.00

*Mean of ten farmers.

Safety measures taken at the time of spray and time of application

Study revealed that, about 73.33 per cent farmers did not follow any safety measures during spraying operation and 20.00 per cent farmers used mask during spraying (Table 5). Only 5.56 per cent farmers used hand gloves during spraying. Majority of the farmers are not using any safety measures, such as the use of protective clothing and nose respirators during spraying of insecticides. Only few farmers were using simple nose masks (sometimes wet rags or hand kerchiefs) during spraying. Most of them were also not aware of the effect of wind direction and spray drift. Similar results also by Very few vegetable and fruit growers used protective clothing during spraying as reported by Ranjith *et al*. (2020). Rashid *et al.* (2008) reported that 29 per cent of growers covered their face and body during spraying, 17 per cent covered their body and 17 per cent covered their face. This might due to cost factor, poor awareness and the discomfort associated with protective gadgets during its use.

Maximum farmers (91.11 per cent) carried spraying operations during morning hours and only 8.89 per cent farmers preferred spraying during evening time. Similar findings were also recorded by Ranjith *et al*. (2020) where nearly 90.50 percent farmers preferred to take the sprays in the morning hours.

Decision on spraying and insecticides used

Data revealed that, maximum farmers (76.67%) had taken up spraying only after observing initial symptoms and nearly 14.44 per cent of farmers had done spraying based on ETL and only 3.33 percent of the farmers adopted blanket spraying as a precautionary measure without observing the presence or absence of the insect-pests (Table 5). Maximum farmers (75.56%) preferred to spray the insecticides alone and around 24.44 per cent farmers used insecticides as mixtures. Similarly, Ranjith *et al*. (2020) reported that 70 and 82 percent of the farmers preferred to take up the spray after observing damage symptoms in brinjal crop. Many farmers have a predetermined assumption that, if they grow vegetables, repeated application of insecticide is inevitable. Choice of specific insecticides by farmers is mostly depends on the availability and the suggestions of the dealers. Many farmers purchase the insecticide based on the advice from the neighbor farmers, price, brand name and farmer's experience.

Disposal of insecticidal containers and adopting waiting period

In the present study, majority of the farmers (57.78%) thrown the empty insecticide containers in field after their use and 37.78 per cent of the farmers preferred to throw away the containers in neglected areas and only few farmers (4.44%) have buried the insecticide containers in soil (Table 5). Also, majority of the farmers (73.33%) gave only one day waiting period before harvest of vegetables and rest of the farmers (26.67%) applied the insecticides and harvested vegetables on the same day. None of the farmer have maintained the waiting period as recommended on the leaflets. The farmers did not wait for the safety harvest period since they do not want insect damage on crop, which reduces market price. The results are in agreement with earlier work that around 50 per cent of farmers buried empty pesticide containers in the field itself (Reddy *et al*., 2011). Ranjith *et al*. (2020) reported that nearly 86.5 per cent of the farmers preferred to throw the used insecticidal containers in neglected area but again only 3.5 per cent farmers properly disposed the containers by burying deep into the soil. Also, Rubesh *et al*. (2023) reported that the majority of farmers (73.33%) throw away containers, 20 per cent sell bottles and 6.66 per cent buried them in the ground.

Types of sprayers and control methods adopted

Majority of the farmers (92.22%) preferred power sprayer for insecticides application and only 7.78 per cent farmers sprayed with traditional hand operated sprayers in all the surveyed locations. Around 84.44 percent farmers relied only on chemical management and 10 percent famers followed cultural control methods and only 5.56 per cent of farmers adopted IPM for the management of *S. litura* (Table 5). The findings were in accordance with previous findings of Rashid *et al*. (2008) who reported that 99.0 percent farmers relied solely on spraying of pesticides for the control of brinjal insect pests and the remaining 1.0 per cent used a combination of sanitation, which consists of prompt removal of damaged shoot, coupled with pesticide sprays. Gandhi (2015) reported that farmers were unable to read the instructions given by manufactures on the label of containers, difficulty to diagnosis of insect pests, adulteration and inefficacy of insecticides, lack of knowledge about IPM technology, insecticides application equipment, mixing of two or more insecticides and technical guidance made them to deviate from optimum use of insecticides.

Conclusion

Insecticides are the most effective and commonly used tool for managing insect pests. But an over-reliance on pesticides has resulted in a number of adverse consequences, including the development of insecticide

resistance, the emergence of secondary pests, adverse effects on non-target organisms, health risks and other issues relating to environmental contamination. In order to protect those insecticides and postpone the development of resistance, it's necessary to conduct periodical survey on the pattern of insecticide usage against *S. litura*. This data will help to detect resistance level and it forewarns the farmers about the development of resistance to that particular insecticides and helps to take the appropriate action to prevent or delay the resistance development.

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