Trends in insecticide usage among bitter gourd farmers of central Kerala: An investigative study

Vineetha V.*, Mani Chellappan and Berin Pathrose

**College of Agriculture, Vellanikkara, Thrissur 680 656*

Received 17 July2023 ; received in revised form 26 November 2023; accepted 10 December 2023

Abstract

The wide usage of insecticides by farmers in Kerala to improve the quality and production of crops has become a prevailing practice. The urgency to safeguard their crops from detrimental infestations has driven farmers to rely heavily on these chemical interventions. The findings of a survey conducted among 120 farmers from four districts of central Kerala to know the insecticide usage pattern and the preferred insecticides of bitter gourd farmers revealed a significant reliance on insecticides, and farmers often resort to the liberal application of insecticides to safeguard their crops and ensure high yields. The results indicated that the farmers relied heavily on insecticides to control the insect pests of cucurbits. Farmers undertook an average of 5.00-7.00 sprays per crop season at intervals between12.00 and15.00 days, with the least interval being in Palakkad and Thrissur districts. Farmers in Ernakulam district carried out the least number of sprays. Also the results underscore the urgent need for interventions to promote sustainable and responsible insecticide use by implementing educational initiatives, disseminating information on alternative pest management strategies, and fostering a culture of environmental stewardship. The most preferred insecticides among the bitter gourd farmers were chlorantraniliprole, thiamethoxam, malathion, flubendiamide, and dimethoate.

Key words: Bitter gourd farmers, Insecticide use pattern, Mostly used insecticides, Survey

Introduction

Cucurbits have emerged as a significant crop, captivating the attention of farmers across the regions. The cucurbitaceous plant family, popularly known as the gourd family or cucurbits, has about 965 species in about 95 genera (Christenhusz and Byng, 2016). This diverse group of plants, including cucumbers, pumpkins, melons, gourds and squash, have gained remarkable popularity due to their numerous benefits and suitability for cultivation in Kerala's tropical climate. Bitter gourd cultivation holds profound importance in Kerala, not only for its economic viability and nutritional benefits but also for its role in crop diversification and adaptability to the local agricultural landscapes. Also, bitter gourd has significant demand in local markets within Kerala and other parts of the world. Moreover, bitter gourd also hold export potential, contributing to the state's agricultural exports.

The prevalent pest attacks in the crops have led to the widespread use of insecticides by farmers as insecticides have been seen as a practical solution providing immediate control from detrimental infestations and mitigating potential yield losses. Thus, farmers rely heavily on chemical interventions to safeguard their crops and ensure high yields. However, this approach raises sustainability concerns due to the insecticides' non-specific impact on both harmful pests and beneficial insects. Pollinators like bees, butterflies, and other beneficial insects are exposed to many insecticides while foraging in agro-ecosystems that lack

*Author for correspondences: Phone :9744259517, E-mail:vineethavenugopal72@gmail.com

scientific management. This exposure can lead to reduced pollination rates hampering the reproductive success of crops that depend on these beneficial insects for fruit set and yield. The indiscriminate use of insecticides also disrupts the delicate balance of predator-pest relationship, potentially resulting in increased pest outbreaks over time. A study by Peshin et al. (2020) reported that, various hazardous and riskiest pesticides are applied by farmers to save crops from the ravages caused by insect pests and diseases, putting the lives of farmers, applicators, and consumers at risk. Thus, even though insecticides can effectively suppress pests and enhance crop production in the short term, their indiscriminate and excessive uses poses significant risks to human health, the environment, and overall sustainability of agricultural systems. Hence, this study aimed to investigate the insecticide usage patterns among bitter gourd farmers in central districts of Kerala *viz.,* Malappuram, Palakkad, Thrissur, and Ernakulam, to understand their knowledge of insecticides and assess the extent of their reliance on these chemicals.

Materials and Methods

A survey was conducted in the bitter gourd fields of Thrissur, Palakkad, Malappuram, and Ernakulam districts to understand the commonly used insecticide pattern of the farmers. A multistage stratified random sampling method was adopted for this and it offers a more focused approach to gather information, catering to specific research needs and facilitating a deeper understanding of the targeted group. A semi-structured pretested type interview was conducted for gathering the required information using a survey proforma prepared earlier. The insecticide usage history in cucurbit fields was documented by interviewing 30 farmers from each district. The details of the cucurbit type, variety cultivated, area under cultivation, insecticides used, number of sprays and the frequencies of spray, time of spraying, guidance for pesticide use, precautions used while spraying and other management options adopted by farmers were enquired. The data obtained during the survey were tabulated with the normal frequency-average method, and percentage rates were calculated.

Results and Discussion

Varieties preferred by the farmers

The survey data revealed that farmers engaged in cultivating various cucurbits with bitter gourd as the most dominant and preferred choices. The bitter gourd varieties preferred by farmers were Maya, Preethi, Hybrid Monalisa, and some local varieties (Table 1). Maya was the most cultivated hybrid by farmers in all districts contributing 60 per cent in Malappuram, 50.00 per cent in Ernakulam, 46.67 per cent in Thrissur, and 43.33 per cent in Palakkad. The variety Preethi was the second most cultivated variety, with 40 per cent in Malappuram, 36.67 per cent in Ernakulam and Palakkad and 33.33 per cent in Thrissur district. Farmers prefer hybrid Maya over other varieties due to its exceptional characteristics such as good plant vigour, dense growth, high yield potential, early maturity, and moderately thick spines, which aid in good transportability (Product catalogue, 2014). Also, the outstanding features of the KAU released variety Preethi is its high yielding capacity, less susceptibility to the attack of fruit fly and are well suited for growing in Palakkad, Thrissur, and Ernakulam districts (KAU AgriInfotech Portal). Both Maya and Preethi exhibits excellent adaptability to the local climatic conditions of Kerala, making it a reliable and profitable choice for the farmers in the region.

Number of sprays and spray intervals

Based on the data on the number of sprays per

Table 1. Preference of bittergourd varieties by the farmers of central districts of Kerala

Districts	Varieties (%)			
	Maya	Preethi	Hybrid Monalisa	Local
Malappuram	60.00	40.00	0.00	0.00
Palakkad	43.33	36.67	16.67	3.33
Thrissur	46.67	33.33	13.33	6.67
Ernakulam	50.00	36.67	13.33	0.00

*Mean per cent of 30 farmers

season, it was observed that on average, about 5 - 7 sprays were done by farmers at intervals of 12 to 15 days (Table 2). Ernakulam district was found to be the one with the least number of sprays as the area of cultivation was less as most of the farmers were following homestead cultivation, whereas in Thrissur and Palakkad, large-scale cultivation of cucurbits was noticed, and farmers were forced to give around 7 insecticide sprays for profitable cultivation. Hajong et al. (2021) reported that in bitter gourd production, different insecticides are applied to a farmer's field on an average of 11.19 times every season, with usage rates ranging from 5 to 18 sprays. According to Rijal et al. (2018), insecticide spraying patterns in vegetables varied from 1- 3 times to more than 6 times per season among farmers. Meenambigai et al. (2017) revealed that okra farmers in six districts of Tamil Nadu primarily followed a spraying interval of 7 to 10 days (53.33 %) between two rounds of spraying, and a pre-harvest interval of 1 day (65.0 %). Farmers in Nadia district of West Bengal sprayed insecticides on bitter gourds every 4 to 7 days (Jana et al., 2014). The state wise report on pesticide application frequency by Weinberger and Srinivasan (2009) revealed that In West Bengal, a quarter of farmers engaged in spraying activities every 2-3 days, whereas in Gujarat, less than 5% of farmers followed such a frequency. In West Bengal, 78% of farmers sprayed on a weekly basis or even more frequently, while in Karnataka, the corresponding figure was 70%. In Gujarat, 43% of farmers adopted a weekly or more frequent spraying schedule. The extensive cultivation of bitter gourd as monocrop can create a higher risk of pest outbreaks requiring more frequent use of insecticides. Additionally, the relative market demand and profitability of bitter gourd in Thrissur and Palakkad districts might incentivise farmers to aggressively protect their crops with insecticides to avoid potential losses due to pest attack.

Table 2.Number of insecticide sprays and the spray intervals in bitter gourd fields of central districts of Kerala

Sl. No.	Districts surveyed	Number of sprays (Mean ± SE) (days)	Spray intervals (Mean ± SE) (days)
1	Malappuram	6.00± 0.33	13.00± 0.45
2	Palakkad	7.00 ± 0.39	12.00± 0.50
3	Thrissur	7.00± 0.36	12.00± 0.54
4	Ernakulam	5.00± 0.21	15.00± 0.37

*Mean of 30 farmers

Source of information regarding insecticides and their usage

Additional information gathered on the use of insecticides and sources of information regarding its use (Table 3) showed that 46.67 % of the farmers were approaching the pesticide dealers directly for insecticides and their use whereas 42.50 % of the farmers were seeking the help from the officials of the agricultural department for the selection of insecticides and its related usage information. It was also noticed that 8.33 per cent of farmers sought an opinion from neighboring fellow farmers, and 2.5 per cent of the farmers had a tie-up with the pesticide company dealers in conducting trials and seeking their advice about spraying the insecticides in the field. The ease and accessibility of pesticide dealers in local markets and the established relationships of farmers with pesticide dealers over time might be a contributing factor of farmers approaching pesticide sellers directly on an extensive basis. Also, seeking help from agricultural officials indicated that farmers recognized the importance of receiving expert advice and regulatory compliance from trained personnel knowledgeable about pest management practices.

According to a survey conducted by Jana (2014), every farmer surveyed (100%) obtained information about insecticide application from agricultural input retailers during the purchase process. It was found that 75.83% of okra farmers in Tamil Nadu sought information on pesticide recommendations by visiting pesticide retail shops (Meenambigai et al., 2017). Brar et al. (2018) reported similar results, with approximately 57% of respondents primarily relying on advice from pesticide dealers, followed by advice from fellow farmers and agricultural extension staff while Shetty et al. (2010) observed that only a small portion, specifically 20%, of the

individuals surveyed relied on the agricultural extension officer for knowledge about plant protection measures. The remaining 80% of farmers relied on unreliable information regarding crop production in the surveyed areas and based on the opinions expressed by the respondents in the study regions, it was believed that chemical approaches to pest control are highly effective when dealing with severe pest infestations.

Insecticide dose, time of spraying, and measurement of the insecticide

In our survey (Table 3), majority of the farmers (95 %) were spraying the insecticides at the recommended doses only, and remaining 5 per cent farmers followed spraying more than the recommended dose. This data revealed that most farmers were trying to follow the practice of spraying at the recommended dose only. Whereas a few large-scale farmers of Palakkad and Thrissur districts were found spraying insecticides massively during heavy pest infestation, especially for managing sucking pests. The unexpected rise in the insect population made them spray insecticides in large amounts. Proper guidance and timely need-based sprays had to be scheduled with the help of agricultural experts to overcome the excessive use of insecticides among the farmers. According to Shetty et al. (2010), majority of the participants of the survey programme (71 %) deviated from the recommended optimum dose or number of sprays due to the ineffectiveness of the current dosages in managing the occurrence of pests in agro-ecosystems. Another report by Meenambigai et al. (2017) stated that approximately 20.83 % of okra growers in six districts of Tamil Nadu adhered to the recommended dose when spraying pesticides, while the majority used approximate doses.

Similarly, 87.5 per cent of farmers preferred to spray insecticides during morning hours, and 12.5 per cent were found to take sprays in the evening (Table 3). It was noticed that only 34.17 per cent of farmers followed the practice of accurately measuring the required insecticide quantity and the remaining group of farmers (65.83 per cent) preferred taking approximate doses. Time constraints could be one of the reasons for not prioritizing accurate measurements. Farmers often have many works and may need to cover large areas within limited time frames. So taking precise measurements can slow down the spraying process, leading to estimation of guesswork which may result in inconsistent application. It is worth noting that the improper use of insecticides can have negative consequences such as ineffective pest control, development of insecticide resistance, and potential health hazards. Encouraging proper training, awareness programs, access to measuring tools, and clear guidelines on accurate insecticide application can help address this issue. A report by Meenambigai et al. (2017) showed that almost 96.96% of farmers conducted their spraying operations in the morning and no farmers preferred the afternoon time for spraying activities.

Precaution and safety measures during insecticide spray

It was noted that 78.33 per cent of farmers carried out the spraying operations without any safety precautionary measures, and only 21.67 per cent of farmers reported using face masks while spraying (Table 3). No farmers were found using hand gloves while performing the spraying operations. Many farmers expressed discomfort and found restrictive while using face masks and gloves to spray. Language barriers, lack of attention to labels could be other reasons for farmers not following the recommended safety measures. Also, some may not be aware of the potential health risks associated with insecticides. As a result, they might not prioritize or understand the importance of precautionary measures. A similar statement was made by Brar et al. (2018) that 36 per cent of farmers used self-protective measures while the remaining applicants did not use gloves or masks.

Decision of spraying insecticides in the field and other control methods

The data on the decision to spray (Table 3) revealed that most of the farmers (71.67 %) started spraying

after the initial symptoms appeared. Few farmers (22.50 %) made the spraying decision after considering the economic threshold level (ETL), and only a small number of farmers from the Palakkad district (5.83 %) used a blanket application strategy, where they chose to spray as preventative measures without monitoring the presence or absence of pests. The reason for the blanket application might be due to their lack of knowledge in pest biology and ETLs. Similar findings were reported by Rijal et al. (2018) that 54 per cent of farmers sprayed pesticides as soon as they noticed an initial pest attack whereas 18 per cent of farmers applied insecticides even before pest emergence. Another report by Weinberger and Srinivasan (2009) revealed that approximately 36.6 % of farmers implemented a preventive measure by spraying pesticides before any signs of pest damage. Moreover, a significant majority of farmers (86.9 %) conducted pesticide applications when pest damage was still at a low level. Only a mere 8 % of farmers reported taking into consideration the level of pest incidence or the severity of the attack prior to initiating spraying activities.

It was also investigated whether farmers used any integrated pest management strategies besides spraying insecticides. Integrated pest management (IPM) practices were adopted by about 36.67 per cent of farmers only, and the remaining 63.33 per cent respondents sprayed insecticides alone to control the insect pests. The indiscriminate application of insecticides without proper knowledge or adherence to recommended dosages can lead to environmental contamination, ecosystem disruption, and health hazards for both farmers and consumers. As such, there is a pressing need to balance pest control and responsible insecticide usage, promoting integrated pest management strategies that minimize reliance on chemicals and encourage sustainable agricultural practices in Kerala. The findings of Brar et al. (2018) that IPM practices were known to almost 36.33 per cent of the studied farmers substantiated our present findings. He also added that the farmers' desire to switch to safer pest management methods was encouraging for environmentally friendly farming. According to Rijal et al. (2018), nearly 17 per cent of farmers attended atleast one training in IPM, yet none of them were aware of the negative imapcts of pesticide residues or followed the right disposal techniques.

Farmers should abstain from frequent insecticide spraying behavior and restrict their usage only when insect-pest attacks reach the economic threshold level (ETL) otherwise, this could harm sustainability challenges and diminish the profit margin. The government extension agencies and pesticide firms should realign their extension efforts in light of the findings of the present investigation. The findings also demonstrated the necessity for farmers to adopt additional safety precautions to maintain a healthy environment and their well-being. Peshin et al. (2018) stated that despite the implementation of integrated pest management (IPM) and pesticide reduction programs, pesticides continue to be the main pest management tactics in developing and developed countries.

Different insecticides used by bitter gourd farmers of central Kerala

From the data collected during the purposive survey, 26 different types of insecticides were noticed in cucurbit fields by farmers of central Kerala, and the per cent use varied from 1.67 per cent to 50.83 per cent (Table 4). Among the insecticides, chlorantraniliprole was found to be the one with the highest usage at 50.83 per cent among farmers, followed by thiamethoxam (49.17 %), malathion (46.67 %), flubendiamide (40.83 %), and dimethoate (35.00 %). The lowest usage of 1.67 per cent was noticed with the insecticides *viz.,* acephate 50 WP + imidacloprid 18 WP, acetamiprid, and novaluron, respectively. Fifteen out of the 30 surveyed farmers were found to use chlorantraniliprole in Malappuram. The top four insecticides used by farmers in Palakkad district were malathion (63.33 %) > flubendiamide (53.33 %) > thiamethoxam (46.67 %) > chlorantraniliprole

Table 3.Information on insecticide usage and handling by bitter gourd farmers in central districts of Kerala

Sl.. No	Particulars	Farmer respondents (%)				Mean*(%)
		Malappuram	Palakkad	Thrissur	Ernakulam	
1.	Guidance for insecticide usage					
	a Agriculture officials	43.33	40	33.33	53.33	42.50
	b Other farmers	10.00	13.33	10	0.00	8.33
	c Pesticide dealers	46.67	36.67	56.67	46.67	46.67
	d Insecticide company representatives	0	10	0	0	2.5
2.	Dose employed					
	a Recommended dose	100	93.33	86.67	100	95
	b More than the recommended dose	0	6.67	13.33	0	5
3.	Time of spraying					
	a Morning	86.67	100	100	63.33	87.5
	b Noon	0	0	0	0	0
	c Evening	13.33	0	0	36.67	12.5
4.	Measurement of insecticide					
	a Accurate/syringe	26.67	33.33	36.67	40.00	34.17
	b Approximate	73.33	66.67	63.33	60.00	65.83
5.	Precaution & safety measures					
	a No measures	93.33	80.00	73.33	66.67	78.33
	b Hand gloves	0.00	0.00	0.00	0.00	0.00
	c Face mask	6.67	20.00	26.67	33.33	21.67
6.	Decision of spraying					
	a When initial symptom appears	80.00	76.67	70.00	60.00	71.67
	b Looking the ETL	20.00	10.00	20.00	40.00	22.50
	c Blanket application	0.00	13.33	10.00	0.00	5.83
7.	Control methods					
	a Insecticide alone	60.00	56.67	66.67	70.00	63.33
	b IPM	40.00	43.33	33.33	30.00	36.67

*Mean per cent of 120 farmers from four districts

(43.33 %). In Thrissur district, 20 farmers were found to use malathion, thiamethoxam by 18 farmers, chlorantraniliprole by 16 farmers, lambda cyhalothrin by 15 farmers, and dimethoate and flubendiamide by 13 farmers respectively out of the thirty farmers surveyed. In Ernakulam district, chlorantraniliprole was preferred by 17 farmers in Ernakulam district and thiamethoxam by 16 farmers. Fourteen farmers were observed to use imidacloprid, 9 were using flubendiamide, and 8 preferred dimethoate out of the 30 surveyed farmers (Table 4). Thus, among the 26 insecticides, the top five preferred insecticides by the farmers were *viz.,* chlorantraniliprole, thiamethoxam, malathion, flubendiamide and dimethoate. The availability and accessibility of various insecticides, coupled with the perception that higher insecticide application leads to better crop outcomes, might have contributed to the widespread usage of such chemicals. A study by Sonali et al. (2018) substantiated that 3 spray application of chlorantraniliprole was the best treatment among the studied insecticides, followed by malathion and spinosad against thrips in bitter gourd. This highlighted the preference for chlorantraniliprole by farmers. According to the Meenambigai et al. (2017), a survey study among 120 farmers in six okra growing districts of Tamil Nadu showed the most commonly used pesticides by farmers were imidacloprid (36.67%), acephate (33.33%), exodus (15.00%), flubendiamide (14.17%), and dimethoate (14.17%) among the 24 pesticides identified as belonging to the mildly to very hazardous toxicity class.

Conclusion

Though the frequency of insecticide application and the spray intervals depend on the crop and the target insect, we intended to find out the general baseline

Table 4. List of insecticides used by bitter gourd farmers of central Kerala

Sl.. No	Insecticides	Farmer respondents								Mean*(%)
		Malappuram		Palakkad		Thrissur		Ernakulam		
		Frequ-ency	Per cent	Frequ-ency	Per cent	Frequ-ency	Per cent	Frequ ency	Per cent	
1	Acephate 50 WP + Imidacloprid 18 WP	0	0.00	0	0.00	0	0.00	2	6.67	1.67
2	Acetamiprid	1	3.33	1	3.33	0	0.00	0	0.00	1.67
3	Chlorantraniliprole	15	50.00	13	43.33	16	53.33	17	56.67	50.83
4	Chlorantraniliprole+ Lambda cyhalothrin	2	6.67	11	36.67	7	23.33	0	0.00	16.67
5	Clothianidin	3	10.00	11	36.67	6	20.00	0	0.00	16.67
6	Cyantraniliprole	1	3.33	10	33.33	7	23.33	0	0.00	15
7	Cypermethrin	1	3.33	4	13.33	0	0.00	0	0.00	4.17
8	Dimethoate	11	36.67	10	33.33	13	43.33	8	26.67	35
9	Emamectinbenzoate	6	20.00	8	26.67	4	13.33	0	0.00	15
10	Fenpyroximate	1	3.33	2	6.67	1	3.33	0	0.00	3.33
11	Fenvalerate	2	6.67	0	0.00	3	10.00	4	13.33	7.5
12	Fipronil	6	20.00	5	16.67	3	10.00	0	0.00	11.67
13	Flonicamid	7	23.33	11	36.67	6	20.00	0	0.00	20
14	Flubendiamide	11	36.67	16	53.33	13	43.33	9	30.00	40.83
15	Imidacloprid	6	20.00	11	36.67	5	16.67	14	46.67	30
16	Indoxacarb	1	3.33	4	13.33	2	6.67	0	0.00	5.83
17	Lambda cyhalothrin	7	23.33	11	36.67	15	50.00	2	6.67	29.17
18	Malathion	13	43.33	19	63.33	20	66.67	4	13.33	46.67
19	Novaluron	1	3.33	0	0.00	1	3.33	0	0.00	1.67
20	Pegasus	11	36.67	10	33.33	6	20.00	1	3.33	23.33
21	Quinalphos	1	3.33	6	20.00	11	36.67	4	13.33	18.33
22	Spinetoram	0	0.00	4	13.33	1	3.33	0	0.00	4.17
23	Spinosad	1	3.33	0	0.00	5	16.67	0	0.00	5
24	Spiromesifen	1	3.33	7	23.33	1	3.33	0	0.00	7.5
25	Thiamethoxam	11	36.67	14	46.67	18	60.00	16	53.33	49.17
26	Thiodicarb	0	0.00	0	0.00	0	0.00	3	10.00	2.5

*Mean per cent of 120 farmers from four districts

data and trend of insecticide use among cucurbit farmers through this survey. The findings thus shed light on the farmers' practices, highlighting both their exploitation of insecticides and the potential for excessive and injudicious usage. Recognizing the importance of crop yield and market competitiveness, farmers often resort to insecticides as a primary tool for pest control. By identifying these patterns, the study provides valuable insights into the current state of insecticide usage in bitter gourd farming, emphasizing the need for targeted interventions, educational programs, and sustainable agricultural practices to promote responsible insecticide use and mitigate the environmental and health risks associated with their misuse.

References

Brar, G. S., Patyal, S. K., Dubey, J. K., and Singh, G. 2018. Survey on Pesticide Use Pattern and Farmers Perceptions in Cauliflower and Brinjal Growing Areas in Three Districts of Himachal Pradesh, India. Int. J. Curr. Microbiol. App. Sci. 7(03): 2417-2423.

Christenhusz, M. J. M. & Byng, J. W. (2016). "The number of known plants species in the world and its annual increase". Phytotaxa. 261 (3): 201-217.

Hajong, P., Rahman, M. S., Islam, M. A., and Biswas, G. C. 2021. Study of pesticide use on bitter gourd production atJashore district. Int. J. Agric. Res., Innovation Technol. 10(2): 110-115.

Jana, H. 2014. Bitter gourd growers' pesticides use pattern in controlling insect-pests and diseases in Nadia district of West Bengal. Agric. Update 9(3):

320-326.

KAU Agri-Infotech Portal. Centre for E-learning. KAU. [Onlne] http:// www.cellkau.in [5 June 2020].

Meenambigai, C., Bhuvaneswari, K., MohanKumar, K., and Sangavi, R. 2017.Pesticides usage pattern of okra, Abelmoschusesculentus (L) Moench in Tamil Nadu. J. Entomol. Zool. Stud. 5(6): 1760-1765.

Peshin, R., Hansra, B. S.,Nanda, R., Singh, K., Sharma, R., Garg, L., Bajiya, M. R., Showkat, A., Kumar, R., and Yangsdon, S. 2020. Pesticides Hazardous Hotspots: Empirical Evidences from North India. Environ. Manag. 66: 899-915.

Product catalogue. 2014. Better seeds for better yield. East-West seed International Limited. Thailand. 56p.

Rijal, J. P., Regmi, R., Ghimire, R.,Puri, K. D., Gyawaly, S., and Poudel, S. 2018. Farmers' knowledge on pesticide safety and pest management practices: a case study of vegetable growers in Chitwan, Nepal. Agric. 8(1): 16.

Shetty, P.K., Murugan, M.,Hiremath, M. B. and Sreeja, K. G. 2010. Farmers' education and perception on pesticide use and crop economies in Indian agriculture. J. Expt. Sci. 1(1): 03-08.

Sonali, S. L., Naik, K. V., Karmarkar, M. S., and Golvankar, G. M. 2020. Bio-efficacy of insecticides against thrips infesting bitter gourd. International J. Chem. Stud. 9(1): 166-170.

Weinberger, K and Srinivasan, R. 2009. Farmers' management of cabbage and cauliflower pests in India and their approaches to crop protection J. Asia-Pacific Entomol. 12: 253-259.