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Spinach growers' knowledge and perception about insecticide usage in Ahmednagar, Nashik and Pune

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Abstract
A survey conducted in the Ahmednagar, Pune and Nashik district of Western Maharashtra to study the insecticides usage pattern in spinach during 2019 to 2020. The survey revealed that majority of spinach growers relied on novel insecticides (52.95%) followed by conventional (37.84%) and biopesticides (9.21%). As regard awareness and farmer perception, 68.50% farmers knew severity of insect pest problems in spinach, nearly 58% farmers were aware about the natural enemies, 68.66% know about biopesticides usage and very less *i.e.*, 26.66% growers of spinach know about the harmful effect of insecticides and they did not follow any precautions to avoid harmful effects. Majority of the farmers did not know about safe waiting period for harvesting of spinach after application of insecticides.

Keywords: insecticides, novel insecticides, organophosphate, biopeptides, spinach and natural enemies

Introduction
Among the leafy vegetable, spinach is a valuable crop for food, medicinal and nutritional purposes (FAO, 2018) [8]. It is rich in iron (10.9 mg) and calcium and one of the best sources of fiber, vitamins A, B and C than most cultivated greens hence called "Mines of minerals" (Geetha *et al.*, 2017a: Roughani *et al.*, 2011) [9, 28]. As the richest source of folic acid, spinach is a very valuable food during pregnancy and lactation. (Roughani *et al.*, 2011; Verma, 2018) [28, 35]. In the world the spinach production of over 26 million tonnes over an area of about 9.21 lakh ha (FAO, 2018) [8].
On spinach number of sucking pests are attack *viz.*, aphids, thrips, leaf miner and other insect pests (Yadav and Rathee, 2020) [37] and to control of these pest spinach growers mainly relied on insecticides. Now a days, use of novel as well as conventional insecticides mainly used by the farmers because of there were easily available and highly effective. But at present, there are no insecticides registered and recommended by CIB and RC to control the pests of spinach (CIB&RC, 2021) [5].
Farmers are frequently using non-recommended insecticides, a higher dose than recommended one, non-observance of the prescribed waiting period, use of sub-standard pesticides, wrong disposal of leftover and cleaning of plant protection equipment, pre-marketing pesticide application are measure reasons for the occurrence of high pesticide residues on vegetables in India (Kuruganti *et al.*, 2005) [17].
In addition to leaving residues in the environment, the continued use of pesticides to manage pests and disease vectors has a negative impact on non-target organisms. These disadvantages have consequently overshadowed the benefits of pesticides, necessitating the search for alternatives (Sharma *et al.*, 1999) [32]. Chemical pesticide use is more dangerous in veggies. As a result, the goals of this study were to document the intensity, farmer perspective, and various pesticides used by farmers in cultivation of spinach.

Material method
A field survey was carried out in Ahmednagar, Nashik and Pune district of Western Maharashtra during 2019-20. The structure quaternary was used for this purpose. Fifty farmers of spinach growers were randomly selected and interviewed from each selected district of Western Maharashtra. The format of the questionnaire (Table 1) was in the form of closed and multiple-choice format questions with Yes/No as answers. Interviews were carried out in the appropriate local language *i.e.*, Marathi. A record of all collected information was compiled to an appropriate format properly analysed and compared for their knowledge and perception regarding insecticides usage.

Result discussion

Usage pattern of insecticides in spinach in western Maharashtra

The survey was conducted to collect the information regarding usage pattern of insecticides in Western Maharashtra. The collected data presented in Table 2 revealed that irrespective of district 52.95% insecticides used by spinach growers belonged to novel insecticides followed by conventional insecticides (37.84%) and biopesticides (9.21%).

Ahmednagar district

It was observed that in Ahmednagar district, novel insecticides (54.52%) were most commonly used by spinach growers followed by conventional (33.61%) insecticides and biopesticides (11.76%). Further, it was revealed that among the conventional insecticides the share of organophosphate insecticides was 29.32% which was more as compared to the pyrethroids (2.52%) and carbamates (1.68%). In novel insecticides, the share of the neonicotinoids was 27.73%, which was more as compared to diamides (23.56%) and phenyl pyrazole (2.52%). Neem-based products i.e., nimbecidime (8.85%) and azadirachtin (3.36%) were used to some extent by spinach growers.

Pune district

It was found that in Pune district, the novel insecticides (52.22%) were most commonly used by spinach growers followed by conventional (40%) insecticides and biopesticides (7.78%). Further, it was revealed that among the conventional insecticides the share of organophosphate insecticides was 26.67%, which was more as compared to pyrethroids (11.11%) and carbamates (2.22%). In novel insecticides, the share of neonicotinoids was (26.67%) which was more preferred by spinach growers as compared to diamides (24.44%) and phenyl pyrazole (1.11%). Neem-based products, i.e., Nimbecidime (6.11%) and azadirachtin (1.67%) were used to some extent.

Nashik district

It was found that in Nashik district, the novel insecticides (52.01%) were most commonly used by spinach growers followed by conventional (39.89%) insecticides and biopesticides (8.09%). Among the conventional insecticides, the share of organophosphates was 28.32%, followed pyrethroids (10.40%) and carbamates (1.16%). In novel insecticides, the share of diamides insecticides was 26.01% which was more as compared to neonicotinoids (24.28%) and phenyl pyrazole (1.73%). Neem-based products, i.e., Nimbecidime (5.20%) and azadirachtin (2.89%) were used to some extent.

The above results are in the line with earlier research. In cabbage, average insecticides usage of 0.563 g a.i. ha^{-1} was reported in Belagavi district of Karnataka (Nagendra, 2009) [21]. Holland and Rahman (1999) [13] reported insecticide usage of 1.30 Kg a.i. ha^{-1} $annum^{-1}$ (potato), 2.10 Kg a.i. ha^{-1} $annum^{-1}$ (onion), 2.8 Kg a.i. ha^{-1} $annum^{-1}$ (brassica) and 0.02 Kg a.i. ha^{-1} $annum^{-1}$ (tomato), respectively. Similar studies on insecticide usage were also conducted in brinjal (Dhore, 2016, tomato Sali, 2016) [7] chilli (Raut, 2016) [26] Ahmednagar district of Maharashtra, Similarly, in brinjal and tomato (Patil, 2017 with 2.99 & 3.07 Kg a.i. ha^{-1}, respectively) and cabbage (1.65 Kg a.i. ha^{-1}) at Ahmednagar, Pune and Nasik regions of western Maharashtra, India.

Studies conducted at Dindigul reveal that the insecticide usage pattern in chilli (5.13 Kg of a.i. ha^{-1}), brinjal (4.64 Kg of a.i. ha^{-1}) and okra (3.71 Kg of a.i. ha^{-1}). Further, a comparison of pesticide-use intensity revealed highest use in chillies followed by brinjal and okra, respectively. In cauliflower, even though number of pesticide applications were more, pesticide-use intensity was low (Jeyanthi and Kombairaju, 2005) [14]. Guru *et al.* (2018) [10] conducted a survey of polyhouse and open field capsicum growers of Western Maharashtra and reported that the share of conventional insecticides (65-72%) was more as compared to novel insecticides (22-25%) and biopesticides (3-13%) in both polyhouse and open field capsicum growers, respectively.

Similarly, Sawant *et al.* (2018) [30] reported that the share of conventional insecticides was more as compared to novel insecticides and biopesticides in cabbage growing area of western Maharashtra. Although chemical control is the principal pest control method followed by the farmers in the study area, biopesticides are also applied by a limited number of growers.

General awareness of spinach growers about pest management

The data on general awareness of spinach growers regarding insect pests their natural enemies and their management are presented in Table 3.

Awareness about pests' problem

The extensive information gathered through a survey of Ahmednagar, Pune and Nashik districts indicated that the spinach growers of Pune district were well aware of the pest problems as compared to the spinach growers of Nashik and Ahmednagar districts. The spinach growers from the Pune district (72%) were more aware of pest problems as compared to Nashik, (70.50%) and Ahmednagar (66%) district. It was observed that nearly 69.50% of spinach growers were aware of the severity of pest problems and were able to differentiate between the insect pests of spinach.

Further, it was observed that sucking pests were the most frequently occurring insect pests. Aphids were more problematic as compared to leaf miner in the growing stages of the crop, which was the main constraint in spinach cultivation. Many growers were also aware of the minor pest problems like thrips, defoliators, etc. Malgie *et al.* (2015) [19] reported that the farmer's knowledge about pest problems is the basic need to start over the management practices and borers and whiteflies were the most troublesome pests according to the majority of the respondents in all three stages of several vegetable crops, including tomato, cabbage, string beans and lettuce.

Munyuli *et al.*, (2017) [20] observed that 71.5% of farmers were not able to correctly identify insect pest species. According to studies conducted by Badii *et al.* (2013) [2] in cabbage, it was observed that farmers ranked *Plutella xylostella* as the main pest throughout the growing period with population abundance being 43% and 65% during the vegetative and heading stage of the crop, respectively. In a survey conducted by Brar *et al.* (2018) [4], it was observed that 52.33% of respondents were aware of pest problems. Guru *et al.* (2018) [10] reported that 73.23% polyhouse and 21.33% open field capsicum growers were well aware of the pest problems.

Awareness about natural enemies

The survey data indicate that the majority of spinach growers (58.66%) of Ahmednagar, Pune and Nashik districts were aware of the natural enemies of insect pests in their respective fields. Further, the information obtained through the survey indicated that 66, 62 and 48% of growers of Pune, Nashik and Ahmednagar districts, were aware of natural enemies of insect pests of spinach.

The present findings are in agreement with Baral *et al.* (2006) [3] who reported that nearly 49% of the farmers were aware of beneficial insects in eggplant fields. 45.33 58.66. Mahantesh and Alka Singh (2009) [18] reported that 41.5% of vegetable cultivating farmers had knowledge about natural enemies of respective pest. However, only 16% farmers knew about natural enemies in curry leaf according to Ramakrishnan *et al.* (2015) [25].

Similarly, in tomato, brinjal, cabbage & capsicum growers of Western Maharashtra were aware about the natural enemies of respective insect pest encountered in their field (Patil *et al.*, 2018; Sawant *et al.*,2018; Guru *et al.* 2018) [10, 30]. According to Yadav *et al.* (2018) [36] on an average, 60.0% of the farmers were aware of natural enemies.

Awareness about biopesticides

It was found that the neem-based products were one of the commercial biopesticides, which farmers commonly used to control insect pests. These products contain an *azadirachtin* alkaloid with the capability to suppress insect pests without destroying beneficial insects. Unfortunately, lack of knowledge and about the benefits of biopesticides and less promotion of their usage was the main reason for the heavy reliance of growers on conventional and novel insecticides to manage insect pests of spinach.

The data revealed that irrespective of the district 68.66% spinach growers knew about biopesticides. Further, the survey indicated that 78, 74 and 54% of spinach growers of Pune, Nashik and Ahmednagar districts were aware about the biopesticides and their benefits. Present findings are in line with the Kamarulzaman *et al.* (2012) [15] reported that 54.3% vegetable farmers sprayed biopesticides in their farms. Further, it was concluded that great challenges in promoting biopesticide usage among vegetable farmers though it could control the pest. Only 4.23% biopesticides were used by the farmers in cabbage growing areas as reported by Odhiambo *et al.* (2014) [22].

Similarlly Sawant *et al.*, 2018 and Guru *et al.*, 2018 [10, 30] reported that majority of the cabbage and capsicum growers of Ahmednagar, Pune and Nashik districts were aware about the application of biopesticides. According to Yadav *et al.* (2018) [36] Only 40.0% respondents were found having knowledge of biopesticides, indicating their poor perception of biopesticides and hazards of pesticides.

Awareness about recommended insecticides in spinach

The data also revealed that the spinach growers from the survey region did not know about recommended insecticides against any particular insect pest of spinach. Also, there is no insecticide recommended by the Central Insecticides Board and Registration Committee (CIB-RC) for controlling insect pests of spinach.

Awareness about the harmful effect of insecticides residues

The data from the survey region indicate that awareness regarding the harmful effect of insecticide residues irrespective of the district was 26.66%. It means large number of spinach growers was not well aware about the harmful effect of pesticides and some of them were aware but not follows the precautionary or protective measure. Majority of the spinach growers in Pune (32%) in Ahmednagar (24%) and in Nashik (20%) were aware of the harmful effects of insecticide residues on human health.

Survey carried out by earlier workers support the present findings. It revealed that the higher percentage of respondents were aware of hazards caused by insecticides, during different stages of application. Nearly, 62.33% (Brar *et al*., 2018) [4], 65.33% (Singh *et al*., 2016), 74.5% (Sharma *et al*., 2014) [32], 79% (Hashemi and Damalas, 2010) [12] and in some cases, almost all farmers (99% as per Damalas *et al*., 2006; 99.4% as per Karunamoorthi, 2012) [16] were aware of the fact that pesticides can have serious adverse effects on users' health.

In mustard crop, 77.5% of the farmers were aware of pesticidal hazards (Yadav *et al.*, 2018) [36]. Forty one percent farmers were aware about hazards of pesticide as reported by Mahantesh and Singh (2009) [18]. Similarly, Abbassy (2017) [1] reported that 58.1% participant know about adverse health effect pf pesticides and Sneha *et al.* (2017) [34] reported that 16.66% of the farmers were aware of the fact that pesticide residues are found in vegetables.

According to Sawant *et al*, (2018) [30] 25% cabbage growers, Guru *et al.* (2018) [10] 76.67% polyhouse and 40 percent open field capsicum growers of Ahmednagar, Pune and Nashik of Western Maharashtra know the residual effects of insecticides.

Table 1: Prepared questionnaire for collecting the data on insecticides usage pattern

S.N.	Particular	Answers Y/N
1	Name of Farmer	
2	Address	
3	Season	
4	Total cultivable land	
5	Area under leafy vegetable (Spinach)	
6	Area under others crop	
7	Pest occurrence	
8	Insecticides used against aphids and leaf miner	
9	Name of insecticide	
10	Volume of spray	
11	Frequency of spray	
12	Information on application of Biopesticides (if any)	
13	Do you know about natural enemies?	
14	Do you know about recommended pesticides in leafy vegetables?	

15	How do you measure pesticides (bottle/ top approximately)?	
16	How do you mix the pesticides in the water –bare hand/sticks?	
17	Source of information for recommended pesticides – Agril. Dept/ Neighbors/Media / Dealers/Scientists/University.	
18	Do you know safe waiting period?	
19	Do you know about effects of pesticide residue?	
20	Signature of farmer and Date	
21	Signature of Surveyor and Name	
22	Mob. No. of Farmer	

Table 2: Insecticide usage pattern of Spinach in Western Maharashtra

Sr. No.	Major group of insecticides	Chemical group	% share insecticides used by individual growers		
			Ahmednagar	Pune	Nasik
1.	Conventional insecticides (37.84%)	Organophosphates	29.41	26.67	28.32
		Carbamates	1.68	2.22	1.16
		Pyrethroids	2.52	11.11	10.40
		Total	33.61	40.00	39.89
2.	Novel insecticides (52.95%)	Neonicotinoids	27.73	26.67	24.28
		Diamides	23.56	24.44	26.01
		Phenyl Pyrazole	3.36	1.11	1.73
		Total	54.62	52.22	52.01
3.	Bioinsecticides (9.21%)	*Azadirachtin*	3.36	1.67	2.89
		Nimbecidine	8.85	6.11	5.20
		Total	11.76	7.78	8.09

Table 3: Awareness of farmers about pest management in spinach (% respondents)

Sr. No.	Particulars	Ahmednagar	Pune	Nasik	Mean
1.	Awareness about pest problems	66.00	72.00	70.50	69.50
2.	Awareness about natural enemies	48.00	66.00	62.00	58.66
3.	Awareness about biopesticides	54.00	78.00	74.00	68.66
4.	Awareness about recommended insecticides in spinach	00.00	00.00	00.00	00.00
5.	Awareness about the effects of insecticides residues	28.00	32.00	20.00	26.66

Conclusion

The insecticide usage patterns of chosen farmers from the Western Maharashtra districts *Viz.*, Ahmednagar, Pune, and Nashik revealed that spinach growers mainly relied on novel insecticides followed by conventional insecticides and very few growers use biopesticides to control spinach insect pests. Survey also revealed that the majority of spinach growers aware about the insect pest problem in spinach, use of biopesticides and natural enemies of sucking pests of spinach but very few number of spinach growers know about harmful effect of insecticides on human health and no one knows about recommended insecticides in spinach or but farmers still used some systemic insecticides for control of insect pests of spinach.

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