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Insecticide usage pattern of sweet orange, *Citrus sinensis* L. Osbeck in Maharashtra

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Abstract
Investigation was undertaken at Department of Agricultural Entomology, Post Graduate Institute, MPKV, Rahuri during 2021-2022 to study the insecticide usage pattern of sweet orange growers in Ahmednagar, Jalgaon, Aurangabad and Jalna districts of Maharashtra. The selected farmers were interviewed based on the questionnaire prepared to assess their general awareness on insecticide use, doses of application and frequency of application. Survey results indicated that farmers relied mostly on chemical insecticides to control the pest of sweet orange. The insecticides viz., chlorpyriphos, quinalphos, profenophos, cypermethrin, lambda-cyhalothrin, fenpropathrin and bifenthrin were the most widely used by the farmers for insect control. It was also observed that the majority of the growers from all four district followed routine or calendar spraying pattern. Majority of the farmers did sprayings at an interval of 15 to 30 days giving maximum 5 to 10 sprays. Most of the sweet orange farmers contacted pesticide retailers for recommendations. Very few farmers knew about the recommended insecticides and their doses, pesticide residues and related issues.

Keywords: Sweet orange, pesticide use pattern, synthetic pyrethroid, neonicotinoid, Maharashtra

Introduction
Citrus (sweet orange) is one of the popular and remunerative fruit crops of the country. It ranks third in area and production after banana and mango in India. Sweet orange (*Citrus sinensis* L. Osbeck) is the second largest citrus fruit, cultivated in tropical and subtropical regions of the country. The average yield of sweet orange fruit in India is low (11.6 t/ha) compared to other developed countries like USA and Brazil (22-35 t/ha). In India, sweet orange was cultivated on area of 187 thousand ha with total production of 3266 thousand MT and productivity of 17.7 MT/ha (Anonymous, 2018) [2]. The major sweet orange producing states in India are Andhra Pradesh, Maharashtra, Telangana, Madhya Pradesh, Punjab, Himachal Pradesh, Jammu & Kashmir and Mizoram. Andhra Pradesh ranks first in area (82.89 thousand ha) and production (2003.10 thousand MT) whereas, Maharashtra ranks second in area (55.20 thousand ha) and production (684.80 thousand MT) (Anonymous, 2018) [2]. In Maharashtra, sweet orange is mainly concentrated in Jalgaon, Jalna, Aurangabad, Ahmednagar, Parbhani, Nanded, Nagpur and Amaravati, districts.

The crop posses huge domestic requirement and cultivators face several problems responsible for productivity. The chief constraint in the production of sweet orange is damage caused by pest right from seedling to harvesting stage. In India, citrus crops were found to be infested by 250 pests (Butani, 1979) [3]. Under Maharashtra condition, sweet orange crop was found to be infested by 24 insects and mite pests (Koli *et al*., 1981) [5]. The most common are leaf miner (*Phyllocnistis citrella* Stainton) fruit sucking moth (*Ophederes* sp. *Achaea janata* L.) and mites (*Eutetranychus orientalis* Klien). Due to infestation of these pests, farmers get lesser price for their produce by reduction in yield and quality of fruit. Hence, they tend to use chemical insecticides for its management. Several chemical pesticides have been recommended for combating these pests.

Considering above facts, the present investigation was undertaken to study the pesticide usage pattern against Pest in Ahmednagar, Jalgaon, Aurangabad and Jalna districts of Maharashtra.

Material and Methods
Insecticide usage pattern in sweet orange against different pest was studied during Rabi 2021-22 through questionnaire survey. Extensive sweet orange growing districts of Maharashtra *viz*., Ahmednagar, Jalgaon, Aurangabad and Jalna were selected for the survey. In each growing area, 50 farmers were randomly selected and interviewed.

Survey questionnaire covered type of insecticide used to control pest, active ingredient of the insecticide, dosages of application, frequency of spraying, etc.

Results and Discussion

Results of the field survey covering the type of insecticides used in suppression of sweet orange pest, spraying intervals and dosage of insecticide application followed by the sweet orange farmers from different locations are presented in Table 1-4.

Table 1: Insecticides registered in India for control of pest on sweet orange

Chemical group	Active ingredient	No. of Registered insecticides
Bioinsecticides		
Trichoderma	*Trichoderma Harzianum*	1
Verticillium	*Verticillium lecanii*	1
Chemical Insecticides		
Carbamate	Carbofuran	1
Organophosphate	Chlorpyrifos, Dimethoate, Monocrotophos, Quinalphos	4
Organochlorine	Dicofol	1
Diafenthiuron	Diafenthiuron	1
Neonicotinoid Group	Imidacloprid, Thiamethoxam	2
Molluscicide	Metaldehyde	1
	Total registered insecticides	12

Type of insecticides used

From the survey, it could be seen that farmers relied mostly on chemical insecticides to control the pests on sweet orange. Though there are total 12 chemical insecticides representing various chemical groups are registered in India for the control of pests (Table 1), farmers reported to use as many as 13 different active ingredients of insecticides to control this pest in sweet orange. All the insecticides were stated by their trade names without any awareness of the common names. The most widely used insecticides to control different pests on sweet orange in the survey areas are shown in Table 2. When all the insecticides were grouped into their various classes, the results showed that the farmers mostly used the insecticides belonging organophosphate, synthetic pyrethroid, organochlorine and neonicotinoid group (Table 3).

The outcome of the survey indicated that majority of farmers (92.00) from Jalgaon location used the synthetic pyrethroids as their first choice to control pests followed by organophosphate (86.00%) and acaricides (52.00%). The use of oranochlorines, neonicotinoids, spinosyns and other groups was 46.00, 34.00, 21.00 and 10.00 percent, respectively. As regards the Aurangabad location, majority of farmers (86.00%) used synthetic pyrethroids followed by organophosphate (69.50%), acaricides (42.00%), organochlorines (31.00%) and neonicotinoids (24.00%). However, the insecticides from other group viz., spinosyns and other group were preferred by less than twenty percent farmers.

The farmers from Jalna location used synthetic pyrethroids (89.00%) preferentially followed by organophosphate (65.00%) and acaricides (34.00%). Other groups of insecticides viz., organochlorine (24.00%), Neonicotinoid (14.00) spinosyn (11.00) and other groups (08.00) were used. In the Ahmednagar location, organophosphate (90.00%) was predominant in usage pattern of the farmers. Based on percent farmers usage the descending order of other groups was synthetic pyrethroids (82.00%), acaricides (28.00%), organochlorine (28.00%), neonicotinoid (12.00%) spinosyns (07.00%) and other groups (11.00%). The results of present studies are in line with the results of Meenambigai *et al*. (2017) [6], who reported the pesticide usage profile in okra growing districts of Tamil Nadu depicts that the use of imidacloprid was maximum (36.67%) followed by acephate (33.33%), exodus (15%); flubendiamide and dimethoate (14.17%). Other pesticides were chlorpyriphos + cypermethrin (10.83%); propargite (10.00%); acetamiprid and chlorantraniliprole (9.1%); triazophos + deltamethrin (8.33%); fenazaquin (7.50%); flonicamid (6.67%); profenophos + cypermethrin (5.00%); thiamethoxam, encounter (5.00%); monocrotophos, profenophos and quinolphos (4.17%); triazophos (3.33%); emamectin benzoate, mite care and acephate + imidacloprid (2.50%); spiromesifen and azadirachtin (1.6%) for management of sucking pests and borer complex. Similar study conducted by Deore *et al*. (2017) [4] the result of the survey shows that majority of the farmers (73.33%) from Dhule location used organophosphates as their first choice to control DBMfollowed by synthetic pyrethroids (53.33%) and diamide (40.00%). The use of carbamates, botanicals, oxadiazines, acylurea and actinomycete toxins was 3.33, 16.67, 16.67, 3.33 and 3.33 percent, respectively.

Table 2: Insecticides commonly used to control pests on sweet orange by the farmers in surveyed area

S.N.	Common name	Insecticide group
1	Chlorpyrifos	Organophosphates
2	Dimethoate	
3	Profenophos	
4	Malathion	
5	Ethion	
6	Acephate	
7	Dicofol	Organochlorine
8	Thiamethoxam	Neonicotinoid
9	Imidacloprid	
10	Cypermethrin	Synthetic pyrethroid
11	Fenpropathrin	
12	Propargite	Acaricides
13	Spinosad	Spinosyns

Frequency of spraying

In Jalgaon district, 10% farmers take 1 to 3 sprays, 24% farmers take 3 to 5 sprays and maximum farmers (66%) take 5 to 10 sprays. In Aurangabad district, most of the farmers (74%) take 3 to 5 sprays whereas only 12 % and 14% farmers take 1 to 3 sprays and 5 to 10 sprays respectively. 70% farmers in Jalna district take 1 to 3 sprays and only 8% farmers take 5 to 10 sprays .3 to 5 sprays are taken by 22 % farmers in Jalna. Maximum farmers in Ahmednagar district (72%) take 3 to 5 sprays. 1 to 3 sprays are taken by 20% farmers and 8% farmers take
5 to 10 sprays.

Table 3: Group wise insecticide usage by the farmers in the surveyed area

S. No.	Insecticides group	Number of farmers (%)			
		Jalgaon	Aurangabad	Jalna	Ahmednagar
1.	Organophosphate	73.00	69.50	65.00	90.00
2	Synthetic pyrethroids	92.00	86.00	89.00	82.00
3	Acaricides	52.00	42.00	34.00	28.00
4	Organochlorine	46.00	31.00	24.00	28.00
5	Neonicotinoid group	34.00	24.00	14.00	12.00
6	Spinosyns	21.00	14.00	11.00	07.00
7	Others	10.00	06.00	08.00	11.00

Application dosage of insecticides used by the farmers

Survey results, indicated that majority of farmers from all the four locations did not follow the current optimum dose as per recommendation, as they assume that current dosages are not effective to control increased intensity and incidence of different pests of sweet orange. Irrespective to chemical class, the insecticides were used far in excess (2-5 times) of recommended dose. Only 32, 14, 38 and 40 percent farmers from Aurangabad, Jalgaon, Ahmednagar and Jalna, respectively recorded to use the insecticides at recommended dosages (Table 4). None of the farmers used dosages of insecticides below the recommended rate of application to control pests of sweet orange. In similar studies, Amoako *et al*. (2012) [1] reported that only 25 percent of the farmers used recommended dosages of various pesticides for the control of insect pests on their cabbage farms. Majority (55%) of them, however, used dosages above the recommended rate which is in agreement with the present findings. Only around 20.83 percent of farmers sprayed pesticides at recommended dose and remaining followed approximate doses (Meenambigai *et al*. 2017) [6]. These results are in close vicinity with present investigation.

Table 4: Spraying intervals and dosage of insecticide application followed by the farmers in the surveyed area

Sr. No.	Variable	Farmers adopted (%)			
		Jalgaon	Aurangabad	Jalna	Ahmednagar
1.	Frequency of spraying				
	1-3 sprays	10	12	22	20
	3-5 sprays	24	74	26	72
	5-10 sprays	66	14	52	08
2.	Application dosage of insecticides				
	Recommended dose	14	32	40	38
	Above recommendation	86	68	60	62
	Below recommendation	0.00	0.00	0.00	0.00

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