

VEGETABLE FARMERS PERCEPTION OF PESTICIDE USE PRACTICES IN THANH HOA PROVINCE, VIETNAM

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Abstract: *Pesticide use practices among smallholder vegetable farmers in Thanh Hoa province were investigated through field surveys, questionnaires, and interviews. This study was carried out to assess the knowledge and perception of vegetable growers regarding the appropriate knowledge on safe handling and proper use of pesticides. The results revealed that farmers' choices of pesticides was strongly influenced by both authorized pesticide dealers and neighboring farmers. In addition, Over 87% farmers did not read written information on pesticide label before use. Consequently, most farmers applied pesticides in violation of the recommendations: they overused, misused, and abused pesticides for pest control, ignore risks and safety instructions, they did not respect pre-harvest interval and dispose containers unsafely. Improved safety training and provided further information on technical aspects of pesticide use would be a cost-effective solution to raise awareness of vegetable farmers about negative impact of pesticides on population health and the environment.*

Keywords: *Pesticide use, pesticide application, environment, agriculture, Thanh Hoa province.*

1. Introduction

Pesticides are widely used in agricultural production to control insects, diseases, weeds and other undesirable pests, thus constitute one of the most important inputs in crop production [3], [5], [12]. However, the increased use and misuse of pesticides have negative health effects on farmers, traders and consumers, and threaten the natural environment. Unsafe and indiscriminate use of pesticides is common in tropical agricultural systems of developing countries including Vietnam due to farmers poor knowledge on the hazards of pesticide use, risks of hazardous agrochemicals and ineffective governmental enforcement of pesticides' regulations [2], [6]. There are about 80% of Vietnamese farmers using pesticides incorrectly (i.e. violating the '4Rright' principles) causing environmental damage and a number of human health effects [11]. Besides, the types of pesticides and the active ingredients (AI) of pesticides of toxic categories II (moderately hazardous), III (slightly hazardous), and U (unlikely to present acute hazard) have increased considerably (7.4-, 5.9- and 9.1-fold, respectively) from 2002 to 2013 in Vietnamese pesticide market [1]. Recently, low-quality pesticides and counterfeit pesticide is also a major problem for farmers, food

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consumers and the environment. Consequently, more than 7000 cases of pesticides residue poisoning were reported in 2002 in Vietnam [10].

In Thanh Hoa province, where the people living by agriculture account for 85 % of the population, the production areas of vegetable had expanded remarkably to 38762 ha by 2014, leading to a rapidly increase of total quantity of pesticides used for managing insects, weeds and diseases. 110 tone of pesticides with 420 different types of pesticides were applied in field to protect crop production in 2015. It has been shown that more and more local vegetable farmers are now applying pesticides intensively to their crops and relying heavily on the use of pesticides in order to improve vegetable production to meet local market and export market demand. These might pose threats to population health, vegetable consumers, and the environment. Thus, the purpose of this study is to investigate into pesticide knowledge, attitudes related the use of pesticide, safety practice pesticides among vegetable farmers in Thanh Hoa province. The study provided information about pesticide use practices including the types of pesticides used, factors that influence pesticide selection and use, ability to read and understand information written on the label and pesticide safety training. This information will be useful for pesticide policy enforcement and development of more sustainable pesticides use practices by vegetable farmers.

2. Material and methods

Selection method of research area: Interviews and surveys were conducted in Thanh Hoa province, which is located in the North Central Coast region of Vietnam, in December 2017. We selected 450 vegetable farmers for interviews from 5 districts which represent 3 specific areas, includes: Thieu Hoa and Thanh Hoa city represent the dental region; Hoang Hoa, Tinh Gia represents the coastal region and Tho Xuan represents the mountainous region.

Methods of collecting information: Primary data collection: qualitative and quantitative data were collected from vegetable growers through farm survey by face-to-face interviews with vegetable farmers/sprayers, in-depth interviews managers, group discussions Participatory Rural Appraisal (PRA) and field observations. A questionnaire containing structured closed-ended questions was designed based on relevant published literature. Secondary data were collected from the legislation and the provisions of plant protection in Thanh Hoa province. Data were analysed by Microsoft EXCEL and Statistical Package for Social Sciences (SPSS) software 22.0.

3. Results

Pesticide use and safety training: The result of table 1 indicates that vegetable crops area is approximately 38432 ha in 2015 in Thanh Hoa province. Pesticide consumption per year continuously reduced by 110 tons in 2015. Likewise, pesticide use per hectare also decreased by 0.27 kg/ha in 2015. However, the number of cases of pesticide poisoning incidents did not significantly reduce from 2013 to 2015 suggesting the main reason causing pesticide poisoning to farmers and consumers in Thanh Hoa province in 2015 which possibly related to pesticide use practices (Table 1). In addition, 25.11% of vegetable growers reported that they did not received any training or technical support on safe pesticide use. Besides, the safety training frequency for farmers differed significantly among regions. 18.33 % of

vegetable growers in delta areas (n =180) received frequently pesticide safety training while the percentage of farmers coastal areas and attended frequently pesticide safety training were 5% and 4.44% respectively (table 2). In terms of training content, approximately 50% of respondents participated in pesticide products, which mainly focused on advertising and selling pesticides products, but not pesticide use practice (table 2).

Table 1. The 2013-2015 report on Pesticide use in Thanh Hoa

Item	Unit	2013	2014	2015
1. Annual crop area	ha	447102	448928	443680
Rice	ha	256300	258600	257000
Vegetable	ha	38100	38762	38432
2. Pesticide consumption	ton	290	146	110
3. Pesticide use per hectare	kg/ha	0,648	0,325	0,247
4. Pesticide poisoning incidents	Number of cases	17	14	15

Table 2. Training received by farmers on safe pesticide use in studied locations

Unit: (%) percentage of household

Variable	Delta areas (n=180)	Coastal areas (n=180)	Inland areas (n=90)	Mean (n=450)
1. Safety training frequency				
Frequently	18,33	5,00	4,44	10,22
Sometimes	80,56	63,33	35,56	64,67
Not yet	1,11	31,67	60,00	25,11
2. Training contents				
Pesticide products	45,56	51,67	56,67	50,22
Pesticide use	54,44	48,33	43,33	49,78

Pesticide use practices: The list of pesticides used by farmers in surveyed locations is showed in Supplementary Table 1. The data show that insecticides (61.81%) are the most used pesticides, follows by fungicides (30.9%) and herbicides (7.2%) usage. There were no pesticides classified as extremely hazardous (Ia) or highly hazardous (Ib) being applied based on the WHO guidelines to classification of pesticides by hazard (2009). However, 28 out of 55 (50.9 %) of pesticides were unregistered for use on vegetables. Moreover, 17 out of 55 (30.9 %) of pesticides classified as moderately hazardous (II) were widely applied in the vegetable production area (Supplementary Table 1) because they found them very effective.

Supplementary Table 2 presents the fact of pesticide use practices of vegetable growers in surveyed locations. 33.78% of vegetable farmers selected pesticides according to neighbour's recommendation. Over 60% of farmers were directly influenced by authorized dealer recommendations, while 30.89% followed extension worker's recommendation. For pesticide application timing, spraying in the afternoon was the most common (45.33%). 10.44% of farmers sprayed pesticide in early morning while 8.44% of those applied pesticide at any time of the day. Most farmers applied pesticide was based on noticing crop damage

(43.33%) and neighbour's recommendation (45.56%). Few (11.11%) farmers followed extension worker's recommendation to apply pesticide at right time in their crop. 80.22% of farmers interviewed in surveyed areas applied pesticide at higher rate (from 1.5 to 2 times) than permitted by the label on the pesticide product. They assumed that applying pesticide at higher dose would achieve greater effectiveness to control pests and diseases in their crop, without considering the effects on their health, vegetable consumers and the environment.

For pesticide spraying techniques in the field, the results of Supplementary Table 2 shows that 24.67% of farmers sprayed pesticides with the wind direction to minimize their exposure to toxic pesticide, while 6.22% did not consider wind direction when spraying pesticide. Over 87% of the farmers did not read written information on pesticide label before use, including the direction on how to mix, apply in the field, because they were unable to read and understand the meaning of the label. Few (12.44%) farmers read and understood pesticide labels correctly. Besides, often two or more pesticides were mixed together in the sprayer tank without consideration of pesticide compatibility or effects on workers. Those farmers reasoned that mixtures would result in higher effectiveness of pest control and control more than one pest with the same application. According to Ngowi et al. (2007), mixing more than two different types of pesticides possibly causes interactions between fungicides, insecticides and water mineral content, resulting in reduction of pesticide efficacy, the mixture could be less effective to pests, more toxic to sprayers and the environment.

For pre-harvest interval (PHI), 51.78% of interviewed vegetable growers still harvested vegetables before the pre-harvest interval written on the label expires due to their economic profit, 7.78 % of respondents did not check the label of pesticide products for pre-harvest interval. For protective measures during spraying, 90.44% of respondents used mask, gloves (11.78%), boots (25.33%), hat (69.11%), and raincoat or safety clothes (7.11%).

Farmers' attitudes toward effect of pesticides on the environment: The most common way of disposing of leftover pesticides were spraying until no pesticide left (91.56%). For disposal empty pesticide containers after use, 48.44% of vegetable growers reported to throw them in the field. Alternatively, 47.78% gathered and kept in safe places. Most farmers (86.89%) cleaned pesticide application equipment after use, including spray tanks, valves, booms, nozzles in the field without concerning about contamination of water by rinse water and the remains of pesticide.

4. Discussion

Pesticide use practices and pesticide knowledge among smallholder vegetable farmers in Thanh Hoa province were surveyed. This study indicated that most of vegetable farmers apply pesticides indiscriminately in violation of the recommendations: they still relied heavily on and overused pesticides, moderate hazardous (II) pesticides were still used widely in the vegetable production area, used unregistered pesticides for use on vegetables, ignore risks and safety instructions and did not use protective devices when applying pesticides. These problems can be possibly attributed to farmers' lack of pesticide knowledge and pesticide safety training. Similarly, the study of Mengistie et al. (2017) revealed that training on safe pesticide use significantly influences on the knowledge, attitudes, and practices concerning pesticide use of vegetable farmers. Lack of technical pesticide knowledge, the

absence of extension services and lack of pesticide safety training results in pesticide misuse (abuse and overuse) by farmers. On the other hand, Nguyen et al. (2018) reported that though a high number of vegetable farmers receive training on pesticide use, most of them still violated pesticide recommendations, applied widely moderate hazardous (II) and unregistered pesticides for vegetable production that affect the safety of vegetables for consumption.

Our study shows that the choice of pesticides to be used by vegetable growers was strongly influenced by both authorized pesticide dealers and neighboring farmers. This is also common in developing countries including Ethiopia central rift valley [6]. Farmers generally use a higher dosage of pesticides than recommended in their crops because they want to reduce spraying frequency and eliminate pests at once. Excessive pesticides use may lead to high residue levels on plants, which may be toxic to vegetable consumers and the environment [14]. Mengistie et al. (2017) reported that 87% of farmers mix two pesticides without considering undesirable interactions between pesticides in mixture which may lead to reducing active ingredient effectiveness or adverse effects to the pests, damaging their health or the environment [6], [7], [13]. Our survey showed that many vegetable farmers did not use protective equipment such as gloves, boots, hat and safety clothes during spraying due to lack of availability and affordability. The use of protective equipment makes farmers feel uncomfortable under local hot and humid climates and cumbersome during working, while some consider it too expensive to access [9], [6].

Most of farmers in surveyed location did not read the pesticide label carefully before applying. Consequently, they did not follow pre-harvested interval written on the pesticide label or consider pre-harvest interval when they applied pesticides. Another reason mentioned for not respecting recommended pre-harvested interval was economic profit in which harvest time was almost determined by vegetable dealers and market demand. The study of Nguyen et al. (2017) also showed that 98% of farmers were aware of recommended pre-harvested interval written on pesticide label, but they did not always follow it. According to Jeyanthi and Kombairaju (2005), the level of pesticide residues still greatly remained on vegetable products before with holding period.

5. Conclusion

The study revealed that vegetable farmers in surveyed location including 5 districts (Hoang Hoa, Thieu Hoa, Tinh Gia, Tho Xuan and Thanh Hoa city) in Thanh Hoa province apply pesticides indiscriminately in violation of the recommendations. They often overuse, misuse, abuse pesticides for pest control in their crops without considering potential threats to their health, vegetable consumers and the environment. The farmers' choices of pesticides was strongly influenced by both authorized pesticide dealers and neighboring farmers, and most of the farmers did not read written information on pesticide label before use was possibly an important reason for indiscriminate use and improper application of pesticides by vegetable farmers. Providing further information and safety training courses on the economic, scientific, legal and technical aspects of pesticides could be feasible solutions for raising awareness among vegetable growers about potential hazards of pesticides to their health, consumers and the environment.

Supplementary Table 1. List of pesticides used by farmers in vegetable production in Thanh Hoa province, Vietnam

Types of Pesticides	Trade name	Active ingredients (Ai)	Registered for use on	Toxic class (by WHO*)	Original pesticides
Insecticide (61.81%)	Acinosin 50WP	Nitenpyram; Fipronil; Dinotefuran	Rice	III	Synthetic pesticide
	Amico 10EC	Imidacloprid	Rice	III	Synthetic pesticide
	Anvado 100WP	Imidacloprid	Rice	II	Synthetic pesticide
	Bafurit 5WG	Emamectin benzoate	Rice, vegetables, tea	III	Bio-pesticide
	Bemab 52WG	Emamectin benzoate	Rice, vegetables	II	Bio-pesticide
	Bestox 5EC	Alpha_cypermethrin	Rice, soybean	II	Synthetic pesticide
	Binova 45WP	Acetamiprid; Buprofezin	Rice	II	Synthetic pesticide
	Blugent 75SC	Fipronil; Indoxacarb	Rice	II	Synthetic pesticide
	Calira 555WP	Imidacloprid; Acetamiprid; Buprofezin	Rice	III	Synthetic pesticide
	Checsura 500WP	Chlorpyrifos Ethyl; Acetamiprid	Rice	II	Synthetic pesticide
	Conphai 15 WG	Imidacloprid	Rice, coffee	II	Synthetic pesticide
	Dofaben 100WG	Emamectin benzoate	Rice, vegetables	II	Bio-pesticide
	Dylan 2EC	Emamectin benzoate	Rice, vegetables, fruits	III	Synthetic pesticide
	Ema aici 50WG	Emamectin benzoate	Rice, vegetables	III	Bio-pesticide
	Fm-Tox25EC	Alpha cypermethrin	Rice, vegetables, coffee	II	Synthetic pesticide
	Goldra25 0WG	Thlamethoxam; Acetamiprid	Rice, sugarcane	II	Synthetic pesticide
	Golnitor 50WDG	Emamectin benzoate	Rice, vegetables, fruits	III	Bio-pesticide
	Goltoc 250EC	Quinalphos; Fipronil	Rice	II	Synthetic pesticide

Types of Pesticides	Trade name	Active ingredients (Ai)	Registered for use on	Toxic class (by WHO*)	Original pesticides
	Marshal 200SC	Carbosulfan	Various crops	II	Synthetic pesticide
	Motsuper 36.0WG	Acetamiprid	Rice, vegetables	II	Synthetic pesticide
	Peran 50 EC	permethrin	Rice, vegetables	II	Synthetic pesticide
	Picmec 666 EC	Chlorpyrifos Ethyl; Alpha -Cypermethrin ; Quinalphos	Rice	II	Synthetic pesticide
	Regent 800WP	Fipronil;	Rice	II	Synthetic pesticide
	Rholam Super 50SG	Emamectin benzoate; Matrine	Rice, vegetables	III	Bio-pesticide
	Sieufatoc 36EC	Abamectin; Emamectin benzoate	Rice, vegetables, fruits	II	Synthetic pesticide
	Sokupi 0,5SL	Martrine	Rice, vegetables	IV	Bio-pesticide
	Spaceloft 595EC	Alpha_cypermethrin; Chlorpyrifos Ethyl; Imidacloprid	Various crops	II	Synthetic pesticide
	Scorpion 36EC	Abamectin; Fipronil	Rice, vegetables	II	Synthetic pesticide
	TaSieu 5WG	Emamectin benzoate	Rice, vegetables	III	Synthetic pesticide
	Tomuki 50 EC	Hexy thiazox	Flowers, vegetables	IV	Synthetic pesticide
	Tungent 5SC	Fipronil	Various crops	II	Synthetic pesticide
	Clothion 55EC	Chlorpyrifos Ethyl; Cypermethrin	Rice, vegetable	II	Synthetic pesticide
	V.K 16WP	<i>Bacillus thuringiensis</i>	Vegatable, cotton	IV	Bio-pesticide
	Virtako 40WG	Cholrantraniliprole; thiamethoxam	Rice, vegetables, maize	IV	Synthetic pesticide
Fungicide (30.9%)	Agofast 80WP	Fosetyl aluminium	Various crops	IV	Synthetic pesticide
	Aliette	Sosetil aluminium	Rice, vegetables	III	Synthetic pesticide
	Carozate 72WP	Mancozeb; cymoxanil	Rice, vegetables	III	Synthetic pesticide

Types of Pesticides	Trade name	Active ingredients (Ai)	Registered for use on	Toxic class (by WHO*)	Original pesticides
	Cythala 75WP	cymoxanil;	Rice, water melon	IV	Synthetic pesticide
	Daconil 40WG	Chlorothalonil	Rice, vegetables	III	Synthetic pesticide
	Kasumin 2SL	Kasugamycin	Rice, vegetables, fruits	IV	Synthetic pesticide
	Mexyl MZ 72WP	Metalaxyl;	Rice, fruits	IV	Synthetic pesticide
	Ricide 72WP	Mancozeb	Fruits	IV	Synthetic pesticide
	Rido Xanil 750WP	Metalaxyl;			
		Mancozeb	Rice, vegetables	III	Synthetic pesticide
	Score 250EC	Cymoxanil;			
		Mancozeb	Vegetables, fruits	III	Synthetic pesticide
	Strepa 150WP	Difenoconazole	Rice, vegetables	IV	Synthetic pesticide
	Topsin M 70WP	Streptomycinsulfate	Rice, vegetables, fruits	III	Synthetic pesticide
	Totan 200 WP	Thiophanate Methyl	Rice	III	Synthetic pesticide
	Validan 3SL	Bronopol	Rice, vegetables	IV	Synthetic pesticide
	Validacin 5L	Validamycin A	Rice, vegetables	IV	Synthetic pesticide
	ZIMVIL 720 WP	Validamycin A	Rice, vegetables, fruits	IV	Synthetic pesticide
	Zithane Z 80 WP	MEtalaxyl;	Tomato, grape	III	Synthetic pesticide
		Mancozeb			
Herbicide (7.2%)	Fansipan 200SL	Zinneb	Various crops	II	Synthetic pesticide
	Gfaxone 20 SL	Paraquat ion	Various crops	II	Synthetic pesticide
	Power up 275 SL	Paraquat ion	Rice	II	Synthetic pesticide
	Vocal 276 SL	Paraquat Dichloride	Various crops	II	Synthetic pesticide

*WHO: World Health Organization; II – moderately hazardous; III – slightly hazardous; IV-unlikely to present acute hazard in normal use.

Supplementary Table 2. Pesticide use practices of vegetable growers in studied locations

Unit: (%) percentage of household

Survey question	Delta areas (n=180)	Coastal areas (n=180)	Inland areas (n=90)	Mean (n=450)
1. Selecting a pesticide				
Extension workers' recommendation	34,44	27,78	30,00	30,89
Neighbours' recommendation	36,11	18,89	58,89	33,78
Authorized dealer	56,67	63,33	76,67	63,33
Personal experience	78,89	45,00	53,33	60,22
2. Pesticide application timing				
Early morning	13,33	11,67	2,22	10,44
Moring	36,11	35,00	36,67	35,78
Afternoon	41,11	44,44	55,56	45,33
Other	9,44	8,89	5,56	8,44
3. Decision to apply pesticide				
Extension worker's recommendation	13,33	10,00	8,89	11,11
Noticing crop damage	39,44	41,67	54,44	43,33
Neighbour's recommendation	47,22	48,33	36,67	45,56
4. Apply pesticide at higher rate than permitted by the label				
Yes	77,78	81,01	83,33	80,22
No	22,22	18,99	16,67	19,78
5. Pesticide spraying techniques in the field				
Spray with the wind direction	27,22	23,33	22,22	24,67
Spray with zig zag model	69,44	68,33	70,00	69,11
Other	3,33	8,33	7,78	6,22
6. Read pesticide label carefully before mixing and applying				
Yes	21,11	6,11	7,78	12,44
No	78,89	93,89	92,22	87,56
7. Respect the recommended pre-harvested interval written on package label				
unnoticed	6,67	8,33	8,89	7,78
No	47,78	51,11	61,11	51,78
Yes	45,56	40,56	30,00	40,45
8. Protective measures during spraying				
8.1. Mask				
Never	1,11	0,00	0,00	0,44

Rarely	2,22	2,78	2,22	2,44
Occasionally	6,11	6,11	8,89	6,67
Regularly	90,56	91,11	88,89	90,44
8.2. Gloves				
Never	22,22	21,11	16,67	20,67
Rarely	30,56	31,11	25,56	29,78
Occasionally	39,44	33,89	42,22	37,78
Regularly	7,78	13,89	15,56	11,78
8.3. Boots				
Never	2,78	21,11	12,22	12,00
Rarely	10,00	50,00	23,33	28,67
Occasionally	34,44	25,56	50,00	34,00
Regularly	52,78	3,33	14,44	25,33
8.4. Hat				
Never	7,22	5,56	3,33	5,78
Rarely	10,00	7,78	5,56	8,22
Occasionally	20,00	16,11	12,22	16,89
Regularly	62,78	70,56	78,89	69,11
8.5. Raincoat or safety clothes				
Never	21,11	24,44	26,67	23,56
Rarely	50,00	43,33	42,22	45,78
Occasionally	21,11	23,33	28,89	23,56
Regularly	7,78	8,89	2,22	7,11
9. Leftover pesticides				
Spray until no pesticide left	88,89	94,44	91,11	91,56
Dump in the field	8,89	5,56	1,11	6,00
Spray other crops	2,22	0,00	7,78	2,44
10. Disposal empty pesticide containers are				
Kept in safe place	62,78	38,89	35,56	47,78
Left in field	37,22	55,56	56,67	48,44
other	0,00	5,56	7,78	3,78
11. Cleaning pesticide application equipment				
In field	75,00	97,22	90,00	86,89
In safe place	21,11	2,78	6,67	10,89
House	3,89	0,00	3,33	2,22

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