# Assessment of pesticide residues in vegetables in the Inle Lake region in Myanmar

Sai Kham Thi<sup>1</sup>, Floris Van Ogtrop<sup>1</sup>, Liam Southam-Rogers<sup>1,2</sup>, Daniel K.Y. Tan<sup>1</sup>

<sup>1</sup>The University of Sydney, Sydney Institute of Agriculture, School of Life and Environmental Sciences, Faculty of Science, Sydney, NSW 2006, Australia <sup>2</sup>Applied Horticultural Research, Biomedical Building C81, The University of Sydney, Sydney, NSW 2006, Australia Tel: 61 2 8627 1052 Email: daniel.tan@sydney.edu.au

Abstract

Pesticide use by farmers in Myanmar is increasing to protect crops from pest infestation. The increased use of pesticides has the potential to cause environmental contamination and poses a health risk to growers and consumers. This study focused on the analysis of pesticide residues in five vegetables grown in the Inle Lake region of Myanmar: cabbage, cauliflower, tomato, Chinese kale and pepper derived from five villages (Taung Po Gyi, Tha Pyay Pin, Nga Phae Chaung, Mwe Pway and Taung Che) and from three different markets (Thirimingalar, Nyaung Shwe and Aung Ban). The analyses were conducted using a quick test tool kit. In addition to these chemical analyses of vegetable samples, a survey was undertaken on farmers' knowledge, attitude and practice toward the safe use of pesticides. Over 75% of vegetables sampled from both villages and markets had detectable insecticide residues. Only 38% of growers reported receiving training on safe use of pesticides from agrochemical companies and 62% of interviewees did not receive any training. For pesticide selection and use, 33% of farmers received information from agrochemical company staff, followed by 32% from pesticide retailers, 30% from peer farmers, 3% by self-decision and 2% from government. In terms of using protective equipment during pesticide application, 18% of farmers did not use any protective equipment, 10% wore only a mask and 72% wore a mask, gloves, long sleeve shirt and trousers. The implications of this work for the future safe and responsible use of pesticides on vegetable crops in Myanmar are discussed.

## **Key Words**

Insecticide residues, carbamate, organophosate, knowledge, practice.

## Introduction

Inle Lake, the second largest lake in Myanmar is situated in Nyaung Shwe Township, Southern Shan State, Myanmar and is one of the largest vegetable production areas in the country. People living around Inle Lake use natural resources such as grasses, reeds, sedges, duckweeds and other aquatic vegetation to form floating gardens. A floating garden is 2 m wide and the length can vary from 100 to 200 m. Farmers grow various cash crops such as cabbage, cauliflower, pepper, eggplant and tomato on these floating gardens, with tomato being the major crop produced. During the cultivation and processing stage, vegetables may be infected by pests and diseases and farmers use pesticides to reduce the potential for economic loss and to maintain quality (Santarelli et al., 2018). Agricultural work in the Inle Lake area is very labour intensive and there is a potential risk to the health of people because of the reliance upon, and high use of pesticides. Therefore, the aim of this study was to detect the presence of insecticide residues in vegetables in the Inle Lake region, to elucidate the pesticide handling practices of farmers in this region and to recommend alternatives to current practices used for protecting vegetables from pest infestation.

## Methods

*Farmer survey.* After receiving the approval from the University of Sydney Human Research Ethics Committee (HREC) (2017/975), the survey was conducted during January 2018 in six villages (Taung Po Gyi South, Tha Pyay Pin, Nga Phae Chaung, Tone Hle, Mwe Pway and Taung Che villages in the Inle Lake region, Nyaung Shwe Township Myanmar. A total of sixty vegetable growers (10 growers from each village) were interviewed. The survey form was prepared in English with 14 questions and translated to the Myanmar language. Knowledge, attitude and practice of pesticide use were surveyed in the questionnaires. The interviewees were randomly selected and all were vegetable growers and pesticide users. Most of the farmers grew their vegetables on floating gardens and used chemical pesticides to protect their crops from pests.

*Crop sampling.* Three crops (tomato, cauliflower and pepper) were sampled in the villages and five crops (tomato, cabbage, cauliflower, pepper and Chinese kale) were available from three markets, Nyaung Shwe market, Aung Ban Market and Thirimingalar wholesale market. In the study, a total of 130 vegetable samples

were used: 15 samples of each vegetable (cauliflower, tomato and pepper were collected across the five villages; and 17 samples of each vegetable (cabbage, cauliflower, tomato, Chinese kale and pepper were collected across the three markets.

*Analyses of pesticide residues.* For pesticide residue testing in vegetables, small quick testing tool kits (manufactured by Institute of Biochemical Engineering and Professional Materials, Ministry of Public Security, Vietnam) were utilised. This test tool kit can detect organophosphate and carbamate residues at levels higher than 0.5 ppm, which is similar to the harmonised maximum residue limits (MRLs) across ASEAN (Association of Southeast Asian Nations). The result indicates only positive or negative for pesticide residue in vegetables. Presence or absence of pesticide residues is by colour change in the test vials after 3-5 minutes.

## **Results and Discussion**

### Farmer survey

Most of the respondents had completed a primary school education but very few respondents had studied at university. The survey data indicated that 100% of farmers in the Inle Lake used synthetic pesticides to control pests and insects in their vegetable farms. The main insecticides used in the Inle Lake area were monocrotophos, cypermethrin, endosulfan, carbaryl and methomyl. Metalaxyl, mancozeb and chlorothalonil were the main fungicides used in the Inle Lake area for tomato cultivation. Pepper was the major crop harvested at the time of the survey. Chinese kale and cabbage were not available in villages because most of the farmers have only recently started growing them. Generally, male farmers applied the pesticides on the vegetable farms.

Category	Yes (%)	No (%)
Farmers who received training on safely used of pesticide	23 (38.33)	37 (61.67)
Farmers who used insecticides	60 (100)	0 (0)
Farmers who used fungicides	40 (66.67)	20 (33.33)
Farmers who have awareness on their health impacts	30 (50)	30 (50)
Farmers who have awareness on the environmental impacts	20 (33.33)	40 (66.67)
Farmers who use natural pesticides	27 (45)	33 (55)

#### Table 1. Knowledge, Attitudes and Practice of farmers regarding pesticide use.

#### Table 2. Farmers who use safety equipment during handling chemical pesticides

Protective equipment used during application	Frequency (%)	
Nothing	11 (18.33)	
Mask only	6 (10)	
Mask, glove, long sleeve shirt, trouser	43 (71.67)	

#### Table 3. Information sources for pesticide use

Source of information for pesticides used	Frequency (%)
From peer farmers	18 (30)
From pesticide retailers	19 (31.67)
From agrochemical staff	20 (33.33)
From government department	1 (1.67)
Decide by themselves	2 (3.33)

The highest frequency of pesticide was used on the tomato farms with a 10-day interval between applications, from the early stage of plant till harvest. Most farmers lacked sufficient knowledge on the safety of pesticide use since they had not received proper training from either the Department of Agriculture or from the staff of agrochemical companies. Of the farmers surveyed, 38% of farmers reported receiving training on the safe use of pesticides, sufficient to know what type of protective equipment should be worn (Table 1). Overall, 18.3% of farmers did not wear any protective equipment. 10% of interviewees used only a mask and 71.7% of interviewees used protective equipment (i.e. mask, gloves, long sleeve shirt, trousers but no glasses, hat and boots) (Table 2). Most farmers received information regarding safe use of pesticide from agrochemical

company staff and agrochemical sellers. 30% of interviewees received information about using pesticides from their peer farmers (Table 3). While 50% of respondents have awareness of the adverse effects of pesticides on their health, only 20% of respondents have awareness of environmental adverse effects from pesticides (Table 3).

Many farmers in the Inle Lake area did not know about any environmental impact due to overuse of pesticides. The village elders reported that in the past, water in Inle Lake was very clean and drinkable but nowadays, it is not drinkable because of chemical pollution (Soe, 2012). Some farmers were not even aware of the effects of pesticide use on their health but some interviewees do suffer from symptoms such as dizziness, shortness of breath, muscle and body pain, vomiting and stomach pain, headache and hand/feet numb and tingling. These symptoms may be the consequences of overuse and misuse of pesticide in the agricultural industry in the Inle Lake area. Farmers used higher rates of pesticide in the monsoon (rainy) season than dry season since pest infestation is higher and tomatoes are intensively grown in the monsoon season.

Insecticides are the main chemical pesticides used in Inle Lake and all tomato growers use fungicides to protect tomato from blight diseases. Herbicides are rarely used in this area. Some farmers use different kinds of insecticides together as a cocktail during application. For example, some farmers mix at the same time powder and liquid chemical which have different modes of action. For pest control in the Inle Lake region, the main option is using chemical pesticides. Nearly half (45%) of the respondents use natural pesticides such as neem oil and tobacco liquid (Table 1). However, there were no respondents who used natural pesticides only. Based on the response of the interviewees, they did not want to use natural pesticides (e.g. neem oil) because they are quite expensive compared with the chemical pesticides and they may lose effectiveness in killing the pests soon after application. Farmers also believed that using natural pesticides. Farmers did not have knowledge about integrated pest management since they did not have much contact with the Department of Agriculture staff in Nyaung Shwe township, who did not visit their villages. Therefore, the farmers in the Inle Lake region depended more on the agrochemical sales staff for the technical knowledge. Studies in many developing countries show that farmers receive the information regarding pesticides mainly from retailers and from their neighbours; neither group may have a good knowledge about pesticide risks (Lekei et al., 2014).

## Insecticide residues

The frequency of pesticide use varies from twice to 10 times in a season. For cabbage and cauliflower, farmers applied pesticides at the early age of plant but for tomato, farmers applied pesticides every 10-day interval, from transplanting until the last fruit was harvested. Among the five vegetables, a high percentage of pesticide residues was found in tomato and cauliflower samples from markets and cauliflower and pepper samples from villages (Fig. 1a and 1b).



Figure 1. Presence of detectable insecticide residues (in blue) of (a) five vegetables from three markets and (b) three vegetables from five villages.



Figure 2. The presence of detectable insecticide residues between villages and markets (1 = + residue, 0 = - residue).

In general, the presence of pesticide residue in the five vegetables (Figure 1a) and three markets (Figure 1b) was consistently greater than 75% of the samples collected. Residues were found in 79 samples out of 130. While more produce was tested in the markets, the proportion of the residue detected in the produce was similar in the villages compared to the markets (Figure 2).

## Conclusions

The assessment of the insecticide residues in vegetables in the Inle Lake region showed pesticide residues were present in more than 75% of the sampled vegetables. Pesticide residues were frequently found in tomato and cauliflower from the market samples and in pepper from village samples. Although farmers in the surveyed villages had some knowledge about safe use of pesticides, they did not always wear protective equipment during pesticide application and some farmers did not follow the instructions in the pesticide label for mixing pesticides. Since staff from Department of Agriculture cannot access all villages in the Inle Lake region, farmers depend mainly on the agrochemical staff for their pesticide information. Nearly half (45%) of all farmers applied natural pesticide (e.g. neem oil) but this was not their major pesticide for pest protection. Farmers health in the Inle Lake region is at risk due to the potential misuse and lack of the use of personal protection equipment during administering of insecticides and fungicides. Better public-private partnership with training provided by the Department of Agriculture to the input suppliers and farmers is needed to promote improved food safety outcomes for farmers and consumers.

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