App. Envi. Res. 37 (3): 103-109

Applied Environmental Research

Journal homepage : http://www.tci-thaijo.org/index.php/aer

Carbamate and Organophosphate Contamination in Soil, Rice, and Water Samples from Rice Paddy Fields in Nakhon Nayok Province

Sirikul Thummajitsakul [1*], Hathaichanok Praditpol [1], Julaluck Poolaoi [1], Kun Silprasit [2]

[1] Faculty of Health Science, Srinakharinwirot University, Ongkharak, Nakhon Nayok 26120 Thailand
[2] Faculty of Environmental Culture and Ecotourism, Srinakharinwirot University, Bangkok 10110 Thailand
[*] Corresponding author: Email: sirikul.thum@gmail.com

Article History
Submitted: 10 September 2015/ Accepted: 13 November 2015/ Published online: 30 November 2015

Abstract

This study purposes to determine pesticides of carbamate and organophosphate group found in soil, rice, and water samples from rice paddy fields in Village number (Moo) 4, Banpraw Sub-district, Banna District in Nakhon Nayok Province. The sampling sites were selected in 27 agricultural areas using Global Positioning System (GPS). It was found that 42.3 % of all surveyed farmers had used pesticides in their rice paddy fields between June 2014 to January 2015. Moreover, the soil (n=27), water (n=10) and rice (n=27) samples were tested using a GT test kit. This study reports that 77.78%, 85.18% and 70% of soil, rice and water samples respectively were contaminated with carbamate and organophosphate pesticides. It demonstrated that more than 60% of the collected samples were contaminated with the pesticides, at the significance level of (p=0.001). Herbicides were most frequently used (62.20%), followed by insecticides (26.83%) and chemical control of plant diseases (10.98%). Organophosphate group was an insecticide that mostly used up to 50% of the total used. Therefore, the obtained data may be further applied to improve the natural environment and to programs for health promotion of farmers.

Keywords: Carbamate and Organophosphate; rice paddy fields; rural communities

Introduction

There are approximately 6 million people in Thailand holding agricultural land for cultivating their crops, rearing livestock and culturing fresh water products [1]. The trend of pesticide imports for Thai agriculture will be increased during 2013-2017 from 109,908 to 164,383 metric tonnes, valued at 19,182 and 22,044 million Thai Bath, respecitvely [2]. Among pesticides, the organophosphate group is the highest frequently

used in rice fields by farmers to increase yield and quality, e.g. acephate, azinphos-methyl, bensulide, parathion-methyl and chlorethoxy- phosa [3, 4], followed by carbamate group e.g. methomyl, mancozeb and fenobucarb [4]. Furthermore, organophosphate and carbamate groups have been revealed to be toxic in inhibition of cholinesterase (ChE) enzyme activities involving nervous system of human [3, 5].

More than 80% of agricultural areas in Nakhon Nayok province are paddy fields [6]. Nowadays, the pesticides are still used in farm areas to increase agricultural productivity. However, they can have an effect on environment and human health; especially persons who incorrectly handle them and are exposed are at risk [7, 8]. Therefore, our goal was to determine carbamate and organophosphate pesticides found in soil, rice, and water sources in Village number (Moo) 4, Banpraw Sub-district, Banna District in Nakhon Nayok province. The obtained data may be useful for environmental management and health promotion of farmers.

Materials and methods

This study was carried out in Village number 4, Banpraw Sub-district, Banna District in Nakhon Nayok province. Twenty seven rice-paddy fields owned by 20 farmers, taken from the records of Banna district Agricultural Extension were surveyed and recorded GPS data. Then, the soil, rice, and water samples were collected from each paddy field (Figure 1).

1) Sampling

All samples from the 27 areas were surveyed and collected between December 2014 and March 2015. Water sampling were conducted at 10 cm depth from each sampling stations in paddy fields located in Village number 4, and kept in clean polyethylene tubes (n=10) at 4^{o}C until analysis [7]. In each paddy field, soil subsamples at 15 cm depth from the surface were collected from 15 locations using sampling tools (Figure 2) and mixed before kept in plastic bags of approximately 500 grams each (n=27) at 4 ^{o}C [9]. After that, rice leaves and kernel parts of Khao Dawk Mali 105 (n=27) were collected from each sampling area and kept in plastic bags at 4 ^{o}C prior to use.

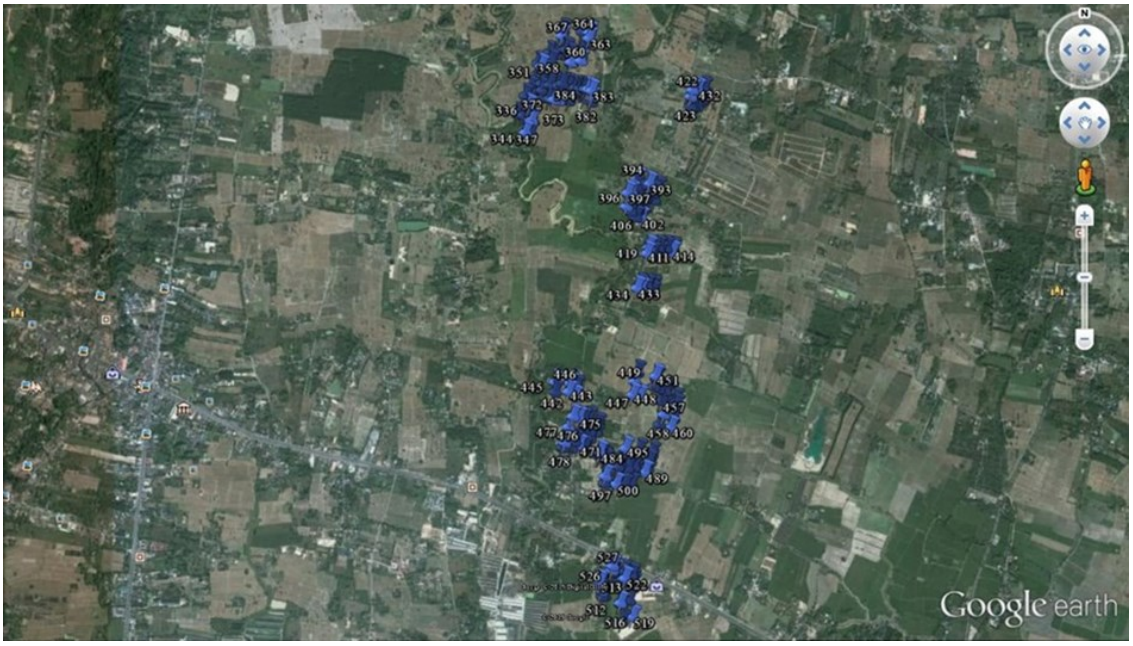

Figure 1 Sampling areas presented with GPS (Global Positioning System) using Google earth program (version 7.1.2.2041)

Figure 2 Sampling sites of soil subsamples taken from 10 locations within the sampling area presented with GPS (Global Positioning System) using Google earth program (version 7.1.2.2041)

2) Pesticides determination

To preliminarily lay bare the samples contaminated with pesticides, the pesticides were detected with GT-pesticide residual test kit (Higher Enterprises Co., LTD., Thailand) according to the protocol of Thoophom in 1998 [10]. Rice leaves and kernel samples (5 gram) were finely grinned, then extracted with the GT solvent and shaken for 15 minutes. After that, 1 ml of the extract was evaporated in an evaporation basin, then added GT-1 solvent (0.50 ml) with incubation for 10 minutes, and mixed with 0.25 ml of the mixed GT-2 solvent and incubated at 37^{o}C for 30 minutes. Next, the mixed GT-3 solvent was added for 1 ml, followed by 0.5 ml of GT-4, then added GT-5 (0.5 ml), and compared the colors with control and critical solution. Pesticides in the soil samples (5 gram) and water samples (30 ml) were detected by the protocol described above. The safety levels of the pesticide found in environmental samples were analyzed by comparing the color level of sample solutions with the control and critical solution (Table 1).

Table 1 Contamination levels of pesticides in carbamate and organophosphate groups

Color level of sample solutions	Pesticide contamination
Less color than or equal to control solution	Not detected
Less color than critical solution, but greater color than control solution	Detected but safe to be consumed
Greater color than critical solution	Detected and not safe

Data analysis

The proportions of the number of each environmental samples which were no contaminated or contaminated with organophosphate and carbamate pesticides were analyzed using the Chi square statistical test. One-sample z test was used to analyze for proportions of total samples contaminated with organophosphate and carbamate pesticides by defining null hypothesis (H_0) $\leq$ 60% and alternative hypothesis (H_1) > 60% [11].

Results and discussion

In this study, carbamate and organophosphate pesticides were determined in environment samples from paddy fields in Village number 4, Banpraw Sub-district. The soil (n=27), rice (n= 27) and water (n=10) samples from 27 sampling areas in the community were surveyed and collected. The result reveal that proportions of soil, rice, and water contaminated with organophosphate and carbamate pesticides at safety level were 77.78%, 85.18% and 70%, respectively, and the results show insignificant differences among the proportions, *P-value* > 0.05 (Table 2).

Furthermore, the results show that more than 60% of the collected samples were contaminated with organophoshate and carbamate pesticides, at the significantce level of (*P-value* < 0.05), as shown in Table 3.

However, several chemicals were used in the surveyed paddy fields. Herbicides were the most frequently used (62.20%); followed by insecticides (26.83%) and chemical control of plant diseases (10.98%). Among these chemicals the target pesticides in organophosphate groups, e.g. Organophosphate + Pyrethroid, Organophosphorus and Organophosphate were the most popular insecticides. Nevertheless, carbamate pesticide was not found to be used (Table 4)

Table 2 Number and proportions of no contamination and contamination of organophosphate and carbamate pesticides of each environmental sample analyzed by the Chi square test

Environmental samples	Number of samples (%)		Total	*P-value*
	Not contaminated with pesticides	Contaminated with pesticides at safety level		
Soil	6 (22%)	21 (77.78%)	27 (100%)	
Rice	4 (14.81%)	23 (85.18%)	27(100%)	0.564
Water	3 (30%)	7 (70%)	10 (100%)	

Table 3 One-sample z test for proportions of all samples contaminated with organophoshate and carbamate pesticides by defining null hypothesis (H_0) $\leq$ 60% and alternative hypothesis (H_1) > 60%

Environmental samples	Number of total samples (soil, rice and water)	Test Prop.	*P-value*
Contaminated with pesticides in safety level	51	0.6	0.001
Not contaminated with pesticides	13		

Table 4 Types of chemical used in paddy fields

Pesticide groups	Chemical types	Number of chemicals used in paddy fields	%
Herbicides			
	Glycine derivative	12	14.63
	Quinolinecarboxylic acid	3	3.66
	Oxadiazole	8	9.76
	Pyrimidinyloxybenzoic	8	9.76
	Phenoxyearboxylic acid	2	2.44
	Chloroacetamide	2	2.44
	Pyrimidinyloxybenzoic	3	3.66
	Sulfonylurea	5	6.10
	Phenoxyearboxylic acid	2	2.44
	Chloroacetanilide	6	7.32
Insecticides			
	Organophosphate + Pyrethroid	7	8.54
	Pyrethroid	4	4.88
	Phenylpyrazole	2	2.44
	Organophosphorus	2	2.44
	Pyridine Azomethiness	2	2.44
	Organophosphate	2	2.44
	Avermectin	3	3.66
Control of plant diseases			
	Triazole	3	3.66
	Phenoxycarboxylic acid + Anilide	3	3.66
	Cyanoacetamide oxime + Alkylenebis	3	3.66
	Total	**82**	**100**

The organophosphate and carbamate compounds are insecticides that are commonly used in Thailand. They are popular and used to control pests on plants in agricultural areas to increase commercial products [7]. Our results show that more than 60% of the collected samples from surveyed 27 paddy fields were contaminated with organophosphate and carbamate pesticides. Similarly, Paipard et al. [12], found that soil samples from paddy fields in Rong Kham district, Kalasin province, were contaminated with organophosphate pesticides (5.21 mg/kg), and that 68% of the analysed vegetables were also contaminated with pesticide residues at safety level. Moreover, it was discovered that 27 water samples from paddy and vegetable fields contained organophosphate pesticides beyond the safety level [7].

In our results, it was found that at least 2 types of chemicals were used in the paddy fields involving herbicides, insecticides, and chemical control of plant diseases. Similar to the previous report [13] this shows that herbicides are the most commonly used chemical in Thailand. However, the commonly used insecticides in the surveyed paddy fields were organophosphate

groups, corresponding to Plianbangchang et al. (2009) [4] who showed that organophosphate groups were the most commonly consumed insecticide by farmers. Nevertheless, carbamate pesticides were not used by farmers in surveyed paddy fields in our results. Thus, the pesticides can have a direct or indirect effect on human and pollute environment if pesticides released into the environment is not controlled [14]. Specifically, farmers who work in agricultural areas may incur higher health risks than non-farmers who live around the rice-paddy areas [15].

Conclusion

The study reports that 77.78%, 85.18% and 70% of soil, rice, and water samples collected from paddy fields in Banpraw Sub-district, Banna District in Nakhon Nayok province are contaminated with carbamate and organophosphate pesticides. Moreover, the results show that proportions of all samples contaminated with organophoshate and carbamate pesticides area greater than 60%, at the significance level of (P-value < 0.05). Pesticides in organophosphate groups e.g. Organophosphate + Pyrethroid, Organophosphorus and Organophosphate are the most popular insecticides. However, carbamate pesticide was not found to be used.

Therefore, this indicates that pesticides are existent in agricultural areas of Banpraw Sub-district, Banna District in Nakhon Nayok province. It is necessary to provide knowledge and control the utilization of pesticides by farmers to reduce health and environmental problems in this community.

Acknowledgements

This research was carried out with a grant from the Faculty of Health Science, Srinakharinwirot University (Grant number: 235/2558). We would like to thank the Faculty of Environmental Culture and Ecotourism of Srinakharinwirot University for providing facilities for this research. The authors have no conflicts of interest in this research.

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