*Research article*

# Environmental Risk Assessment of Agrochemical Packaging Waste in Northeast Thailand

**PRAWEENA BOONYOTHA**
*Faculty of Agriculture, Khon Kaen University, Thailand*
*E-mail: praweena1985@gmail.com*

**CHULEEMAS BOONTHAI IWAI**
*Faculty of Agriculture, Khon Kaen University, Thailand*

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**Abstract** Thailand is a predominantly agricultural country where the majority of people earn a living by agriculture. Rapid agricultural growth in recent decades leads to high use of agrochemical. Lack of packaging management has created an environmental risk from pesticide residues. The objective of this study was to monitor the environmental risk from agrochemical packaging waste in Northeast, Thailand. Farmers from 4 villages in Bung-nium, Khon Kaen Province were interviewed using a questionnaire together with the study of diffuse pollution from agrochemical waste in soil and water. The pesticides used in every step of agricultural production followed in decreasing order: organophosphate, pyrethroid, carbamate, organochlorine, thiocarbamate, paraquat, and others, respectively. Agrochemical package waste investigated included foil bags, glass bottles, gallon plastic containers, plastic bottles, paper bags, carton, aluminum bottles and woven sacks. Glass bottle and plastic container were found in higher proportion. Most of agrochemical package waste was disposed in unattended repositories in the field such as under trees or in pits. The outcome of this study is useful for agrochemical waste management and seeks to reduce the diffuse pollution of agrochemical waste to environment.

**Keywords** environmental risk assessment, agrochemical packaging waste

## INTRODUCTION

Thailand is a predominantly agricultural country, at majority people earns a living by agriculture such as rice, flowering plant, the garden tree, fruit, and vegetables. Land use for agriculture area in Northeast Thailand covered approximately 77.58% of the total area. Dominant land use includes rice of about 55.12% and other crops of about 22.03% (by visual interpretation form Landsat in 2000-2002) (Mongkolsawat, 2006). The agricultural growth leads to high use of agrochemical which is significant and necessary for crop production to fulfill the requirement of consumer. The first synthetic pesticides became available during the 1940s, generating large benefits in increased food production. Concern about the adverse impacts of pesticides on the environment and human health started being voiced in the early 1960s (Carson, 1962)

The total amount of imported agrochemicals of Thailand in 2007 and 2008 are 67,895 and 66,563 tons, respectively (Department of Agriculture, 2009). The more pesticide use, the more the waste or agrochemical package waste, as it large amounts of hazard waste and difficult to management such as glass bottle, gallon, plastic bucket, paper box and sack. The lack of management in Thailand and uncontrolled discharge of package waste with a burn can release a green house gas and hazardous gas into the air and influence on climate change. Agrochemical packaging waste is considered as hazardous material containing agrochemical residues that would not be used. Therefore, most of agrochemical packaging wastes were disposed unattended. Agrochemical waste includes surplus spray solutions, agrochemical leftover which remains in the application equipment after use, pesticide contaminated water produced by cleaning the application equipment or from rinsing the empty pesticide containers, agrochemical contaminated materials generated from cleaning up spilled pesticides, empty (unrinsed) pesticide containers, and old pesticide products (Nesheim and Fishel, 2005).

Therefore, the study to environmental risk assessment of agrochemical packaging waste using questionnaire was monitored cooperate with survey and soil, sediment and water analysis in order to the best management and reduce the diffuse pollution from agrochemical package waste residue.

## MATERIALS AND METHODS

### Sampling Area

Field study areas were conducted in Bung-niam sub-district, Muang district, Khon Kaen province. The Bung-niam is located at the part of Pong watershed in Northeast Thailand**,** covers a total area of 41.233 $km^2$, and has a population of 7,273 habitants and 1,576 household (1,171 household of agriculture) and Global Positioning System (GPS) location is 16º24'23"E, 102º56'50"N (Fig.1).

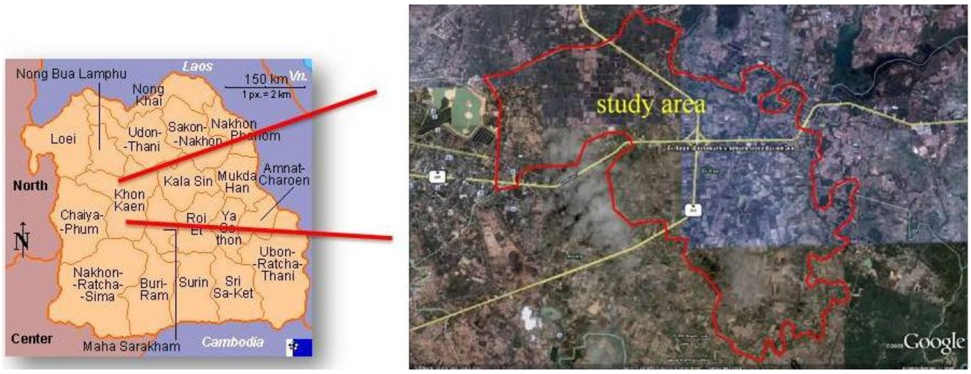


**Fig. 1 Map of the location of Bung-niam**

### Analytic methods

The survey was used with the questionnaire from four villages in Bung-niam. The environmental risk assessment of agrochemical packaging waste was studied. The soil and water quality were analyzed. The water samples were collected by grab sampling, and analyzed for the physical and chemical parameters such as pH, electrical conductivity (EC), dissolved oxygen (DO), total dissolved solids (TDS) and temperature. And sediment samples were collected at random, and analyzed for the physical and chemical parameters such as soil texture, pH, EC, organic matter and pesticide residue.

### Water chemical analysis

Water pH, EC and temperature were measured with a pH, EC meter and thermometer respectively, DO was measured by Winkler (Azide modification) by adding $MnSO_4$ following AIA (Alkali-iodide-azide) and then titrated with standard 0.025 N sodium thiosulfate. The measurement of TDS was determined gravimetcically by filtering and drying at 103-105 °C and then weighing. Samples were analysed according to the last edition of the Standard method for Examination of Water and Wastewater procedure (APHA, AWWA and WEF, 1992).

### Sediment sampling physical and chemical analysis

Soil sample was mixed and sieved (2 mm). Soil pH and EC were measured in a 1:5 soil to water solution using a glass electrode. Particle size analysis was done by pipette method. Organic matter was analyzed by dichromate oxidation method, pesticides residue: Carbamate group was analysed in method based on QuEChERS by HPLC/ Postcolumn derivatizer, Organochlorine group and Pyrethroid group were in house method based on QuEChERS by GC-μECD, and Organophosphate was in house method based on QuEChERS by GC-FPD.

### Statistical analysis

Statistical analysis including calculation of average values, standard deviation (S.D.) and regression was performed on the data obtained in the tests with Microsoft Excel.

## RESULTS

Pesticide residues in the sediment in the study area were shown in Table 1. The result showed that the organophosphate group of pesticides was found too much in sediment. This finding was correlated with the pesticide uses in this area (from the survey data).

**Table 1 Pesticide residue in sediment**

| Pesticides residue | Pesticides in sediment | Pesticides residue | Pesticides in sediment |
|---|---|---|---|
| **Carbamate group (μg/kg)** | | **Organochlorine group (μg/kg)** | |
| Aldicarb sulfoxide | 0.013 | alpha-HCH | 0.0002 |
| Aldicarb sulfone | 0.012 | beta-HCH | 0.0002 |
| Oxamyl | 0.016 | gamma-HCH | 0.0002 |
| Methomyl | 0.010 | Heptachlor | 0.0002 |
| 3-Hydroxy Carbofuran | 0.021 | Aldrin | 0.0002 |
| Aldicarb | 0.014 | Dicofol | 0.0024 |
| Carbofuran | 0.021 | Heptachlor Epoxide | 0.0002 |
| Carbaryl | 0.010 | gamma-chlordane | 0.0002 |
| Fenobucarb | 0.018 | 2,4-DDE | 0.0003 |
| Methiocarb | 0.023 | alpha-Endosulfan | 0.0002 |
| | | alpha-chlordane | 0.0002 |
| **Organophosphate (μg/kg)** | | Dieldrin | 0.0001 |
| Dichlorvos | 0.546 | 4,4-DDE | 0.0003 |
| Methamidophos | 2.077 | 2,4-DDD | 0.0003 |
| Mevinphos | 0.708 | beta-Endosulfan | 0.0002 |
| Omethoate | 5.031 | Endrin | 0.0002 |
| Diazinon | 0.389 | 2,4-DDT | 0.0007 |
| Dicrotophos | 1.877 | 4,4-DDD | 0.0024 |
| Monocrotophos | 4.958 | Endosulfan sulfate | 0.0004 |
| Dimethoate | 1.676 | | |
| Pirimiphos-methyl | 0.441 | **Pyrethroid group (μg/kg)** | |
| Chlorpyrifos | 0.483 | Bifenthrin | 0.0008 |
| Parathion-methyl | 1.238 | Cyhalothrin | 0.0003 |
| Pirimiphos-ethyl | 0.434 | 1 Permethrin I | 0.0021 |
| Malathion | 0.961 | 1 Permethrin II | 0.0021 |
| Fenitrothion | 0.874 | 2 Cyfluthrin I | 0.0004 |
| Parathion-ethyl | 0.454 | 2 Cyfluthrin II | 0.0004 |
| Prothiophos | 0.530 | 2 Cyfluthrin III | 0.0004 |
| Methidathion | 2.834 | 2 Cyfluthrin IV | 0.0004 |
| Profenofos | 1.141 | 3 Cypermethrin I | 0.0006 |
| Ethion | 0.335 | 3 Cypermethrin II | 0.0006 |
| Triazophos | 0.953 | 3 Cypermethrin III | 0.0006 |
| EPN | 1.021 | 3 Cypermethrin IV | 0.0006 |
| Phosalone | 4.662 | 4 Fenvalerate I | 0.0006 |
| | | 4 Fenvalerate II | 0.0006 |
| | | Deltamethrin | 0.0007 |

The surveying study with questionnaire to the farmers from 4 villages in Bung-nium district, Khon Kean found that the most use of pesticide was organophosphate, followed by pyrethroid, carbamate, organochlorine, thiocarbamate, paraquat, and others. The pesticide was used in every step of agricultural crop production. Agrochemical package waste was found in different form of container such as foil bags, paper bags, plastic bags or plastic sacks, glass bottle, plastic bottles, tank or gallon plastic, carton and aluminum bottles. Glass bottle and plastic container were found in higher proportion compared with other types. Most of agrochemical package waste was dispose unattended in the field such as under the tree or dig under the ground (Table 2). The meteorology of study site, characteristics of sediment and water were shown in Table 3.

**Table 2 The management of agrochemical packaging waste**

| Agrochemical package waste | Embedded (%) | Sell (%) | Reuse (%) | Discard (%) | Waste into the water (%) | Burn (%) |
|---|---|---|---|---|---|---|
| 1. Foil bags | 11 | 4 | 11 | 6 | - | 18 |
| 2. Paper bags | 13 | 7 | - | 10 | - | 36 |
| 3. Plastic bags or woven sacks | 13 | 7 | 44 | 16 | - | 27 |
| 4. Glass bottles | 16 | 24 | 11 | 26 | - | - |
| 5. Plastic bottles | 18 | 19 | 11 | 23 | - | - |
| 6. Gallon plastic | 7 | 10 | 22 | 3 | - | - |
| 7. Carton | 11 | 12 | - | 6 | - | 18 |
| 8. Aluminum bottles | 11 | 16 | - | 10 | - | - |

**Table 3 Information about the field site**

| Type of data | Description | Value (average) |
|---|---|---|
| Meteorology of field site | Rainfall in 2008 (mm/month) | 141.57 |
| Characteristics of Sediment | Soil texture | Loamy sand |
| Characteristics of water | Organic matter (%) | 0.59 |
| | pH | 6.01 |
| | Temperature (ºC) | 23.8 |
| | TDS (ppm) | 101 |
| | DO (mg/L) | 1.51 |
| | pH | 8.35 |
| | EC (µS/cm) | 200 |
| | Temperature (ºC) | 33.5 |

## CONCLUSION

The disposal of agrochemical package waste is a significant problem of waste disposal in Thailand. The management of agrochemical waste disposal is needed and important part of responsible pesticide use. Improper disposal can lead to contamination of soil and water, causing serious problems for people who involved with the pesticide use. The impact of this waste on ecosystem and environment should be studied. The farmer training programs should be conducted to raise the awareness of farmers on the hazards of pesticide use and how to manage agrochemical waste properly. Damalas et al. (2008) suggested that the proper management of waste products, recycling programs and collection systems for unwanted agricultural chemicals to prevent inappropriate waste disposal, as well as improving packaging of pesticides to minimize waste production are essential for promoting safety during all phases of pesticide handling.

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