# Preliminary survey of pesticide and herbicide residues in surface and groundwater in South Rangsit irrigation project

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**Abstract**

South Rangsit irrigation project located in central Thailand basin provides a fertile land for all-year rice cultivation. Substantial herbicide and pesticide usage is, thus, inevitable to maintain high-yield short-duration rice production. Effluent discharge from paddy rice fields may contain pesticide and herbicide residues, and contaminate the nearby water sources, which serve as a supply for local water treatment plant. Four water samples from the paddy fields (n = 2), deep well (n = 1) and irrigated canal (n = 1) were collected to analyze herbicide and organophosphate pesticide residues. Residues of glyphosate and its derivatives, 2,4-D sodium salt and paraquat were not detected using the techniques with a limit of detection of 5 μg/l and that of the organophosphate group pesticide was not detected using the technique with a limit of detection of 1 μg/l. The herbicides or pesticides did not exist in the samples; or else, they may have existed in the samples in a quantity below the limits of detection.

**Introduction**

Pesticides and herbicides are used extensively to control pests and weeds, and increase crop yields. During the past decade, Thailand has experienced an approximate four-fold increase in pesticide use [1]. In 2012, Thailand imported 40,300 ton of glyphosates, 26,700 ton of paraquat, 4,500 ton of 2,4-D sodium salt [2]. Therefore, it is important to monitor the presence of pesticides and herbicides in freshwater area because the pesticides and

herbicides may drain into and pollute the freshwater area.

Department of Agriculture has annually conducted a pesticide and herbicide monitoring program in major rivers, including Chao Phraya river, Pa Sak river, Tha Chin river and Bang Pakong river, in the fiscal years of 2009-2012 [3].The concentration of the pesticides and herbicides was found at the maximum values in the rainy season because the pesticides and herbicides were directly rinsed off-and-drain out to the rivers before they had been adsorbed on the soil.

Organochlorine, organophosphate, carbamates pesticides and triazine herbicide were found in all the rivers. The concentrations of pesticides were in the safety limit; however, the concentration of triazine herbicide in Pa Sak River exceeded the World Health Organization's safety limit for drinking water of 3 μg/L.

Monitoring studies from Bangladesh, Japan and Vietnam have shown that paddy rice field cultivation are possibly the major sources of surface and ground water contamination with pesticide concentrations exceeding 0.1 μg/L, the European drinking water quality standard [4-6]. Little information is available about the pesticide and herbicides residues in irrigation canals near paddy rice fields in Thailand. Thus, Royal Irrigation Department and National Metal and Materials Technology center conducted a preliminary survey of pesticide and herbicide residues in surface and ground water in South Rangsit irrigation project. Effluent discharge from paddy rice fields may contain pesticide and herbicide residues, and contaminate the nearby water sources, which serve as a supply for a local tap water process. Survey of pesticide and herbicide residues in surface and ground water is important to determine a risk of human exposure to the pesticide and herbicide residues.

**Materials and methods**

1 Study area

South Rangsit irrigation area is located in the central Thailand basin between Chao Phraya River and Nakhon Nayok River. The irrigation area covers parts of Bangkok, Chachoengsao, Nakhon Nayok and Pathumthani provinces. The tropical monsoon climate entails a rainy season from July to September. The area provides a fertile land for all-year rice cultivation. Due to continuous land-use as paddy rice field without crop rotation, substantial herbicide and pesticide usage is inevitable to maintain high-yield short-duration rice production.

2 Field survey

Four water samples from the irrigated canal (n = 1), deep well (n = 1) and paddy fields (n = 2) were collected in May and June, 2013. A sample from the irrigated canal was collected from Khlong Saen Saep at Wat

Pai Dum Charoen Sook, Bang Nam Priao district, Chachoengsao province on May 7, 2013. The water at this location was used as water supply for local tap water process. Two samples from paddy fields were collected in Moo 9, Bueng Kho Hai subdistrict, Lum Luk Ka district, Pathumthani province. A sample from deep well was collected at the office of Bueng Kho Hai Subdistrict Administrative Organization where the groundwater was directly used as local tap water. The samples of surface water at the paddy fields and groundwater were collected on June 13, 2013.

3 Pesticide and herbicide analysis

The samples were sent to the Central Laboratory (Thailand) Co., Ltd. on the same day of collection to analyze for residues of glyphosate and its derivatives AMPA, paraquat and 2,4-D sodium salt.

The sample from the canal was also sent to check for organophosphate group pesticide, including dicrotophos, chlorpyrifos, and parathion-methyl.

High performance liquid chromatography (HPLC) with post-column derivatizer was used to determine glyphosate and its derivatives AMPA residues. Liquid chromatography coupled to tandem mass spectrometry (LC-MS/MS) was used to detect 2,4-D sodium salt. The limit of detection for the herbicides was 0.005 mg/L.

Gas chromatography with FPD was used to determine dicrotophos, chlorpyrifos and parathion-methyl residues. Liquid chromatography-mass spectrometry (LC-MS) was used to determine paraquat residue. The detection limit of organophosphate pesticide was 0.001 mg/L.

**Results and discussion**

1 Sample from the irrigated canal

Quality of surface water collected from San Saab canal at วัดไผ่ดำเจริญศุข was analyzed by the indicators shown in Table 1.

**Table 1** indicators of water quality measured from the sample collected in San Saab canal

| | |
|---|---|
| pH value | 7.7 |
| Electrical conductivity, µS/cm | 306 |
| Salinity, g/l | 0.1 |
| Turbidity, NTU | 58.6 |
| Suspended Solids (SS), mg/l | 63 |
| Total Dissolved Solids (TDS), mg/l | 208 |
| Biochemical Oxygen Demand (BOD), mg/l | 3.56 |

Values of pH, electrical conductivity, Total Dissolved Solids (TDS) and Biochemical Oxygen Demand (BOD) passed the water quality standard for agricultural use [7] while values of turbidity exceeded the limit of the water quality standard for agricultural use; however, high value of SS may have been a result of sample collection method near the canal bank. Overall, the values of indicators showed that the quality of the sample passed the water quality standard for agricultural use.

Glyphosate and its derivatives (AMPA) and paraquat were not found under a limit of detection of 5mg/l for each herbicide. Dichrotophos, chlorpyrifos and parathion-methyl were not found under a limit of detection of 1mg/l for each pesticide. The results could be interpreted into two ways; the herbicides or pesticides did not exist in the samples; or else, they existed in the samples in a quantity below the limits of detection.

2 Samples from a deep well and paddy fields

2-4 D, Glyphosate and its derivatives (AMPA) and paraquat were not found under a limit of detection of 5mg/l for each herbicide. Therefore, the herbicides did not exist in the samples; or else, they may have existed in the samples in a quantity below the limit of detection.

**Conclusions**

Four water samples from the paddy fields (n = 2), deep well (n = 1) and irrigated canal (n = 1) were collected in South Rangsit irrigation project. The preliminary survey for the pesticide and herbicide residues showed that the residues of glyphosate and its derivatives, 2,4-D sodium salt and Paraquat were not detected using the techniques with a limit of detection of 5 µg/l and that of the organophosphate group pesticide was not detected using the technique with a limit of detection of 1 µg/l. It is likely that the herbicides or pesticides did not exist in the samples; or else, they may have existed in the samples in a quantity below the limits of detection.

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