Indonesian Journal of Environmental Management and Sustainability
e-ISSN:2598-6279 p-ISSN:2598-6260

IJEMS

Research Paper

Current Management of Pesticides Wastes in Some Cultivating Models in Vietnamese Mekong Delta

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Abstract
The study was carried out to evaluate the current status of use and management of waste from pesticides on some farming models in the Mekong Delta through interviews with 140 households cultivating triple-rice, Durian Ri6 and E-dor longan. The results of the study showed that 130 types of pesticides and 99 active ingredients were used on three farming models. The study also discovered that five banned active ingredients are still used in the triple-rice practice and four banned substances in the Durian Ri6 cultivation. The proportions of toxic groups (according to WHO's classification) at levels II, III, IV were 33.3%, 29.3% and 37.4%, respectively. The triple-rice crop model used the most pesticides, but the frequency of spraying was only in the range of 6.48±1.72 to 7.33±1.82 times/crop. Meanwhile, the Durian Ri6 model, although using fewer pesticides, the frequency of spraying was very high (about 61.8±9.1 times/crop), 9 times higher than a rice crop. The cultivation of E-dor longan uses the least amount of pesticides as well as a very low frequency of spraying. The methods of handling pesticidal wastes are mainly burning, burying and these practices are not meeting the requirements for protecting health and the environment. The study provides important information for decision-making to choose a farming model and the accompanying environmental protection solutions to minimize the adverse effects of the use of pesticides.

Keywords
Pesticides, Triple-rice, E-dor Longan, Durian Ri6, Mekong Delta

Received: 14 June 2022, Accepted: 4 September 2022
https://doi.org/10.26554/ijems.2022.6.3.98-103

1. INTRODUCTION

The Mekong Delta is known as the largest producer and exporter of food and fruit trees in Vietnam. In which, the rice cultivation area accounts for 54.5% of the country's cultivated area and accounts for more than 90% of the exported rice. Along with that, the rice industry in the Mekong Delta has always improved and bred many new rice varieties with more advantages such as increased yield, increased quality of commercial rice grains and increased adaptability for rice in the future of climate change conditions. Therefore, rice production is the main livelihood of many households today. However, the current rice farming model does not guarantee economic benefits for farmers' livelihoods because many factors such as dikes reduce the amount of silt in the fields, land degradation due to continuous cultivation with high density and heavy use of fertilizers (Duyen and Tri, 2015). According to the report of An Giang Department of Agriculture and Rural Development in the period 2016-2018, production costs for plant protection accounted for 21.2% and chemical fertilizers were 27.7%, accounting for 48.9% of total costs in rice cultivating. Nam et al. (2021) reported that the profit of the three-crop rice model in Tri Ton, An Giang in the pre-flood season is only 11.4 million VND/ha/crop and 15.8 million VND/ha/crop after the flood season. The three-rice crop model in Thanh Phu, Ben Tre only got 9.04 million VND/ha/crop and two-rice crop also reached 13.03 million VND/ha/crop (Linh et al., 2021a). Thereby, as can be seen that the current traditional rice farming model has not brought high efficiency.

The models of fruit cultivation with new plant varieties that are said to be highly effective are now being converted by many households from rice or other crops with low economic efficiency to mass planting such as Durian Ri6, Green Grapefruit, King Orange, E-dor Longan. An Giang province alone has converted more than 10,000 hectares of inefficient rice farming land to fruit trees (Ministry of Agriculture and Rural Development , 2022). These models hold many positive hopes to improve the economy as well as the lives of people in the Mekong Delta. However, with the current production habits associated with the use of pesticides, the current value of agricultural products is not high. Along

with the selling price of the product, the cost of pesticides always affects the profit of farmers in agricultural production. Accompanying that is the unreasonable use of pesticides, especially intensive use, exceeding the recommended level, spraying with high frequency, using pesticides on the list of not allowed and untreated excess amount of pesticides, waste from pesticides, especially the management of pesticide packaging after use (Toan, 2013; Nhan et al., 2015). These things have caused the environment in the area to become increasingly polluted. The use of pesticides and chemical fertilizers in the Mekong Delta has been increasing in recent years. The report on the current state of the environment in 2018 showed that the issue of agricultural wastewater is currently a topic worthy of attention in the Mekong Delta, of which it is estimated that every year there are about 70,000 kg of fertilizer, more than 40,000L pesticides and about 70 thousand kg of untreated chemical packaging enter the environment, especially groundwater and surface water, increasing pollution levels (Ministry of Natural Resources Environment, 2018). This study was conducted to investigate the current status of pesticide use and waste management in some farming models in the Mekong Delta, Vietnam. The results provide important information on environmental aspects of agricultural production restructuring in the Mekong Delta.

2. MATERIALS AND METHODS

2.1 Data Collection

The study collects data through the process of field survey and direct interview with 140 households cultivating triple-rice (30 households), Durian Ri6 (70 households) and E-dor Longan (40 households) in a rural areas of Can Tho and Vinh Long province in the Mekong Delta, Vietnam (Figure 1). The collected data includes information about types of pesticides, frequency of use, level of knowledge about pesticides, methods of handling pesticidal wastes after use. The active ingredients of pesticides are used to classify the degree of toxicity according to WHO's classification. In this study, the active ingredients of pesticides were searched on the software of the Department of Plant Protection in Vietnam and the website of the United States Environmental Protection Agency based on the names of the pesticides examined. Potential impacts of pesticides on environment and human health are evaluated using toxicity data reported by the pesticide's producers and environmental toxicity database.

2.2 Classification of Pesticide Toxicity

According to the World Health Organization (WHO), the toxicity of pesticides is expressed in terms of LD50 (Lethal dose 50) which is the lethal dose for 50% of the experimental animals, expressed in milligrams (mg) of the active ingredient of the drug/kg of experimental body weight (on mice). The lower the LD50 value of a drug, the higher the acute toxicity to warm-blooded animals. This means that the drug is more dangerous and potentially deadly to humans and animals. This classification helps to identify and distinguish toxicity among pesticides on products consumed in Vietnam (Table 1).

3. RESULTS AND DISCUSSION

3.1 Current Use of Pesticides in some Agricultural Cultivating Models

The survey results in Figure 2 showed that triple-rice cultivation have been detected about 65 pesticides with 54 active ingredients, including pesticides, fungicides, herbicides, raticides and growth stimulants. The model of Durian Ri6 were found 59 pesticides used with 41 active ingredients. Meanwhile, the E-dor longan model has only detected six pesticides with 4 active ingredients which is much lower than the other two cultivating models.

The cultivation of triple-rice is often affected by erratic weather, harmful diseases and intensive farming; therefore, the use of chemical fertilizers is increasing sharply. Farmers cultivating triple-rice tended to abuse pesticides and growth stimulants, which leads to increased frequency of application and spraying, with an average value of about 6.48±1.72 to 7.33±1.82 times/crop (Figure 3). This result was similar to the previous studies of Nhan et al. (2015), reaching 7.1±1.4 to 7.9±1.5 times/crop in the period 2011-2014. In addition, the study of Nga et al. (2013) and Linh et al. (2021b) for the Triple-rice was reported that the frequency was about 7 – 10.2 times/crop in districts of Hau Giang and An Giang provinces. Farmers often change the pesticides after each crop, pesticides are provided based on the staff's experience. This can lead to farmers using pesticides that are not recommended or abused, leading to many risks of pollution to the soil and water environment.

Durian Ri6 is a tree with strong growth ability, giving fruit after about 4 years of planting, good branching, large fruit. However, this plant is often difficult to flower and susceptible to diseases and insect attacks, especially in the period from June to October when heavy rains appear (Hau and Hieu, 2019). Durian Ri6 also encounters many kinds of pests (fruit borers, planthoppers, cotton worms) and diseases (leaf burn, pink fungus, flower rot, anthracnose). Besides, Durian farmers handle the reverse season to solve the problem of "good harvest" with current technical advances (Thao et al., 2014), so the use of pesticides in the cultivation of Durian has a very high frequency. Therefore, although the pesticides and active ingredients were recorded lower than that of triple-rice, the frequency of spraying reached the threshold of 61.8±9.1 times/crop which was nearly 9 times higher than that of the triple-rice model. In which, the group of pesticides that are used the most are insecticides, insecticides and fungicides, micro-organisms with the rate of 47% and 37%, respectively. Other pesticides were also used, but to a lesser extent, at the same rate of 8%. The model of Durian Ri6 brings a lot of economic value but causes a lot of damage to environmental issues and especially to the

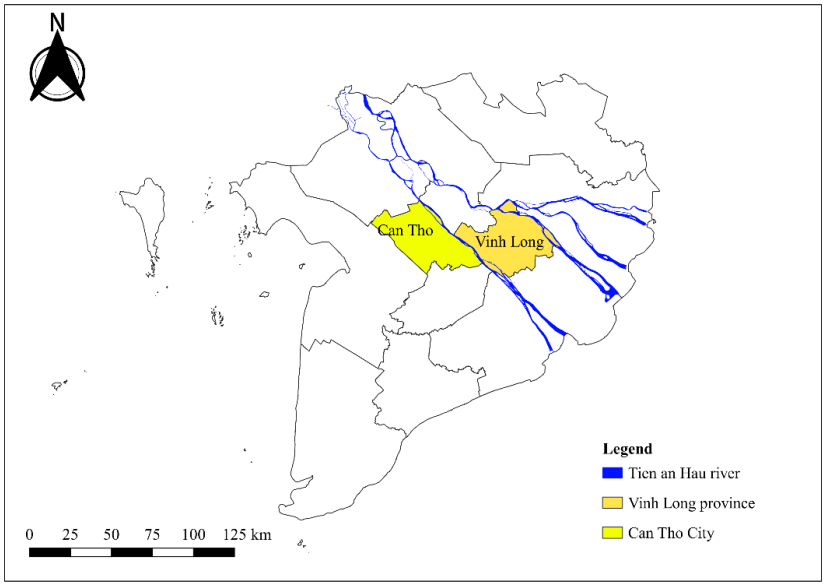

Figure 1. Map of Research Location

Table 1. Classification of Pesticide Toxicity According to WHO

Toxic group	LD50 (mg/kg)			
	Oral		Dermal	
	Solid	Liquid	Solid	Liquid
Group I (Ia, Ib)	≤50	≤200	≤100	≤400
Group II	>50-500	>200–2000	>100–1000	>400–4000
Group III	500–2000	>2000–3000	>1000	>4000
Group VI	>2000	>3000	>1000	>4000

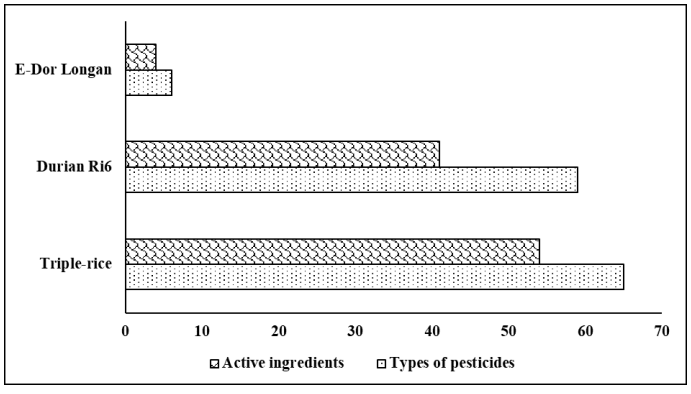

Figure 2. Types of Pesticides and Active Ingredients Used in Production Models

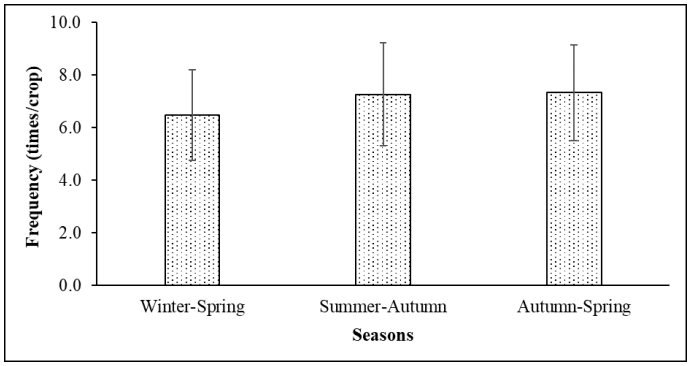

Figure 3. Average Frequency of Spraying Pesticides in Triple-rice Model

health of producers and applicators (Tuan and Diem, 2018; Shrestha et al., 2018; Utami et al., 2020; Pibul and Jawjit, 2021).

E-dor longan grows strongly, is easy to set fruit, has high yield, has few diseases, is easy to handle flowering and is less susceptible to insect damage (Tan, 2018). The E-dor longan variety suffers only from mild broom disease, which can be handled manually, pruning infected crowns, and properly handled. The time from flowering to harvesting only takes

about 126 days (Hau and Huan, 2011), so farmers can improve, process and cultivate two crops per year. For that reason, E-dor longan growers must ensure that the technical requirements for care and necessary nutrition are essential, so they do not have to use too many pesticides during their cultivation. Farmers cultivating the E-dor longan only use pesticides when there are insects and pests that currently exceed the allowable threshold and use the correct dosage of the pesticides as recommended on the product packaging.

In general, the number of active ingredients found in this study was lower than that of some previous studies (Giang, 2010; Tung, 2013; Toan, 2013). The triple-rice farming model uses a lot of pesticides, but the level of use is much lower than the model of Durian Ri6. The fruit cultivation models often use a lot of pesticides in the flowering stage and especially in the reverse season. However, the E-dor longan model uses very few active ingredients and pesticides, which is consistent with current production trends and easy to meet export standards. The limited use of pesticides not only increases the value of agricultural products due to the absence of pesticide residues, ensures the health of farmers and has a positive effect on the environment. Farmers may consider switching to a more suitable model to balance economic, environmental and household health factors.

3.2 The Level of Toxicity of the Pesticides Used

According to the classification of the World Health Organization (WHO), the toxicity of active pesticides is divided into 4 groups, including group I (very toxic), group II (high toxicity), group III (danger) and group IV (carefully). In the present study, the pesticides were classified into three groups (Figure 4). The result of study showed that there was no occurrence of toxic group I in the cultivation models. The toxic group IV accounted for the highest rate among the remaining groups with the rate of 37.4%, followed by the toxic group II (33.3%) and the lowest was the toxic group III (29.3%). In which, in the triple-rice cultivation model, there are 16 active ingredients in group II, 15 active ingredients in group III and the remaining 23 active ingredients in group IV. Durian Ri6 model recorded 15 active ingredients in group II, 12 active ingredients in group III and 14 active ingredients in group IV. For the E-dor longan model, the two active ingredients were classified into two different groups (group II and group III). Compared to Circular 10/2020/TT-BNNPTNT on the list of pesticides allowed to be used in Vietnam (Ministry of Agriculture and Rural Development , 2020), there are five banned active ingredients in the triple-rice model, namely 2.4D, Paraquat, Carbosulfan, Trichlorfon and Glyphosate. Besides that, the Durian Ri6 model also found that the pesticides used contained banned active ingredients, including Acephate and Carbofuran. In addition, Chlorpyrifos Ethyl, Fipronil has been banned under Decision 501/QD-BNN-BVTV dated February 12, 2019 of the (Ministry of Agriculture and Rural Development, 2019). Therefore, there were a total of four banned active ingredients in the Durian Ri6 model. The active ingredients used in the E-dor longan model are on the permitted list. The use of banned active ingredients will violate the regulations of the state and will cause a lot of harm to the environment and especially to human health.

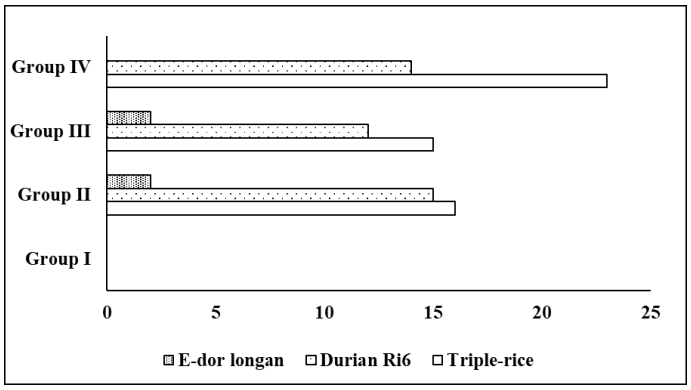

Figure 4. Classification of Toxicity Groups of Pesticides in the Study Areas

According to Phong and Thong (2018), the exposure rate of pesticides when spraying on fruit cultivation models is always higher than in rice and crop models, the vast majority of participants sprayed pesticides that are not fully equipped with protective equipment have symptoms such as fatigue, heat and itching, dizziness. At the same time, workers working at pesticide factories also contain activities toxic substances in the blood (Dasgupta et al., 2007). These things show that the potential danger of pesticides to human health is very alarming. Not only that, pesticides have a strong and especially serious impact on water resources (Tuan and Diem, 2018; Shrestha et al., 2018; Utami et al., 2020; Pibul and Jawjit, 2021; Giao, 2021). Along with the production area, agricultural farming models are the main and leading in the country, the Mekong Delta faces many problems of water pollution stemming from agricultural production activities because of the amount of pesticides used. The uses of pesticides in agricultural activities and untreated residues are easily dispersed, diluted and released into water sources (Ministry of Natural Resources Environment, 2018; Selvarajah and Thiruchelvam, 2007).

3.3 Current Management of Pesticidal Wastes

The results indicated that about 55% of people have built warehouses to store agricultural materials for production. However, the warehouses are often built temporarily in near houses or in cultivated garden. More than 38% of people have stored pesticides at home, which have many potential risks to the environment and directly affect health. Especially active ingredients that are highly toxic and difficult to decompose. Approximately 22% of the remaining households use the pesticides directly after buying it or leaving it outdoors.

The pesticide packaging after use was usually treated by burning or burying, selling bottles, and a small number of wastes being mixed with domestic waste (Nhan et al., 2015; Toan, 2013). According to the survey results, there was about 75% and 50% of farmers treated the wastes by burning and burying, respectively. These two methods were reported to be unreasonable and cause many environment consequences; however, it accounted for the highest percentage. About 22.5% of pesticide bottles and packages were collected and sold as scrap by local people and 17.5% were directly discarded into the environment without any treatment methods. The collection of pesticidal bottles has been done through local programs and companies. However, the level of effectiveness and popularity has not met expectations in many localities. For the use of pesticides left over after spraying, the majority of interviewed farmers choose to use it up and leave no residue (accounted for 70%). A small number of farmers choose to store for the next spraying (accounted for 18.3%), about 5% choose to throw away and discharge into ditches and canals. The inappropriate handling of residual pesticides by farmers leads to pesticide residues being dispersed in surface water, leading to impacts on aquatic organisms and pesticides exposure when using water for daily activities (Toan, 2013; Tuan and Diem, 2018; Shrestha et al., 2018; Utami et al., 2020).

4. CONCLUSIONS

The Triple-rice was recorded to use kind of pesticides more than that of Durian Ri6 and E-dor longan. In which, there were five banned active ingredients in each triple-rice and Durian Ri6 model. The frequency of pesticide use in the Durian Ri6 model was recorded the highest, followed by Triple-rice and E-dor longan. The proportions of groups at levels of high toxicity, danger and carefully were about 33.3%, 29.3% and 37.4%, respectively. The methods of handling pesticidal wastes are mainly burning and burying; these practices were not meeting the requirements for protecting health and the environment. Therefore, it is necessary to propagate and raise people's awareness when using, managing and handling pesticides.

5. ACKNOWLEDGMENT

The authors gratefully appreciate the time and effort of the respondents, students and staff participating in completing the study. The opinions presented in this study are the scientific views of the authors only.

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