

Insecticide Usage in Lotus-Fish Farming and Its Impact on Fish Culture and Grower Health

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Abstract. Insect pest is a major problem of lotus flower production for local markets and export. Lotus growers inappropriately use high quantity of toxic insecticides to control insect pest. Insecticides are applied all over the lotus farming and the chemical substances are not limited to lotus flowers but they leach down to the water reservoir affects fish and other nontarget living organisms in water and the environment. Therefore, the survey of insecticides usage and related information for lotus-fish farming in 3 different provinces: Chachoengsao, Suphanburi and Nakhonpathom was conducted. The result showed most growers had an elementary school certificate while the rest held a secondary school certificate. The important insect pest of lotus are thrips (*Frankliniella schultzei*) and common cutworm (*Spodoptera litura*). Lotus growers preferred organophosphate insecticides the most, followed by the avermectin group. Most growers from Chachoengsao(89.9%), Nakhonpathom(84.1%) and Suphanburi(77.4%) had insecticide application regularly. Decontamination of insecticidal residue on lotus flowers after harvest could be done by using flower dipping in water before distribution. Concerning over fish culture in lotus-fish farming, growers used the insecticide that had least effect on fish. However, the chemical application might cause the slow growth of fish. None of fish kill occurred due to insecticide application for insect control in lotus-fish farming. Repeated exposure to insecticide during application causes health problems to the growers.

1. Introduction

Lotus plant (*Nelumbo nucifera* Geartn) is a potential economic plant, since it can be used in a variety of floral ornamental plants, food and pharmaceuticals. Lotus business is a national and international business, especially *N. nucifera* is the most commercially lotus. Presently, China, Australia and Vietnam has classified lotus as one of an important plant for an export industry.

Insect pest has a huge impact on lotus production. Lotus growers are dealt with insect pest during preharvest and postharvest. *Frankliniella schultzei* (Trybom) causes damage to lotus flower while *Scirtothrips darsalis* Hood is found infested in both flowers and young leaves. These thrips are small insects and their cryptic behavior make them very difficult to detect and control [1]. Common cutworm (*Spodoptera litura* Fabricius) is a polyphagous insects which can destroy the lotus farming within a short period of time during peak season. The common cutworm is a heavy leaf feeder [2]. The cutworm larvae display resistance to pyrethroids, organophosphate, insect growth regulators and Spinosad, emamectin benzoate, indoxacarb and abamectin [3]. Thus, the chemical control of *S. litura* is increasing difficult and they have resistance to most common insecticides [4]. The insecticide resistance of cutworm populations was due to multiple resistance mechanisms, increased detoxification process and unresponsive acetyl-cholinesterase [5]. Therefore, lotus growers



inappropriately use high quantity of toxic insecticides to control these insect pest and often could not effectively eliminate the insect pest.

The main problem in lotus production is the high cost of insect pest control. In addition, they spray insecticides all over the crops to prevent production loss. The chemical substances are not limited to lotus plants but they run off to the water source. Therefore, insecticide application affects fish and other nontarget organisms living in water and its environment. Theoretically, the insecticide spray should be lethal to the target insects, not other organism and human [6]. The decision making for judicious insecticide application is necessary for the protection of agricultural crops [7]. Insecticides are used for crop protection and to suppress insect pest population which its outbreak cause production loss and lower the species diversity in the areas. Nevertheless, these insecticides especially broad spectrum pesticides had a serious negative impact on the environment.

Less than 2 % of sprayed insecticides reach target species, because the application are sprayed across the whole agricultural areas. Agrochemical substances used for pest control is hazardous to fish. When insecticides entry into aquatic systems via run off or spray drift, it had effect on nontarget organisms. Pesticide-associated fish kills are reported the incidence in the United States. These death of fish sometime involved thousands of fishes, as well as frogs, turtles, mussels, water birds, and other organisms. Pesticide contamination in water reservoirs is one of many factors contributing to the decline of fish [8]. Synthetic pyrethroids are the most toxic group of insecticides to fish and other aquatic invertebrate fauna. However, they rarely cause fish kills because of its physical and chemical properties: absorbed to bottom muds, a very short half-life in the environment, rapidly decomposition in sunlight, and lower application rates[8]. In the aspect of cytopathological studies, pesticides caused disintegration of metabolism and sometimes fish kill [9]. It effected mainly in the liver, blood vessels, kidneys, and gills. Cytoplasmic granularity and liver cell mass contraction might occur. Methoxychlor caused pathological changes of large blood vessels in bluegill by [10]. Organochlorine insecticides induced abortions in mosquito fish [11]. Continuous insecticide application on aquatic plants may pose risk to human health via consumption of contaminated fish. The adverse effect on fish and other organisms is related to the toxicity of insecticides, dosage and environmental factors [12].

Fipronil is a non selective insecticide of the phenylpyrazole class while acetamiprid is a widely used third generation pesticide of the neonicotinoid group. Acetamiprid is for sucking insect pests treatment especially thrips, plant hoppers and aphids in agricultural farming [13] and can be removed from waste water by electrocoagulation [14]. As lotus cut flowers require the use of insecticides to control thrips, which cause damage to production and marketability value. Therefore, exported cut flowers receive insecticide treatment applications prior to shipment. Maximum residue limits (MRL) for flowers is not available, unlike the food products. There is no limitation on the use of pesticides before and after harvest for cut flowers [15]. Some pesticides used are persistent and easily be absorbed through skin contact. Handling the contaminated flowers for a long period of time daily, the florists can be exposed to pesticide deposits and possibly cause illness. Health problems for florist workers included contact allergies, dermatitis and skin effects [16-17]. Neurologic expression [15,18-22]. The flower decontamination can alleviate these problems.

Few studies has been done on the insecticide used in lotus-fish farming of lotus growers in commercial lotus growing area. Therefore, the objective of the present research is conduct a survey and collect data on the education background, insecticide usage and application including the effect on fish culture and grower health from 3 different provinces in Thailand: Chachoengsao, Nakhonpathom and Suphanburi. In addition, the decontamination of insecticide after harvest by water dipping method is assessed.

2. Materials and Methods

2.1. *Insecticide usage and its impact on fish culture and grower health*

The questionnaire survey is used to collect information from lotus grower about education background, pest problem knowledge, guidance for insecticide usage, its impact on fish culture and illness of growers due to insecticide application.

Respondents were 90 lotus growers from 3 provinces: Chachoengsao, Nakhonpathom and Suphanburi (30 respondents/province). Data were collected using a pretested questionnaire via the face-to-face interviews.

2.2. *Decontamination of fipronil and acetamiprid on lotus flower by water dipping*

Two insecticides (fipronil and acetamiprid) are chosen for the experiment. The experimental design was completely randomized with 3 treatment and 5 replication as follows:

1. Lotus flower dipping in the test insecticide for a couple minutes and residue analysis on the sample was conducted.
2. Lotus flower dipping in the test insecticide for a couple minutes, 7 hours after the treatment and residue analysis on the sample was conducted.
3. Lotus flower dipping in the test insecticide for a couple minutes, 7 hours after the treatment, then water dipping before residue analysis on the sample.

The analysis of insecticidal residues were performed followed Steinwandter [23]. Universal 5 minutes online method for insecticide residues is based on the Fresenius Journal of Analytical Chemistry no 1155. The GC-MS was used to perform the analysis.

2.3. *Data Collection and Statistical Analysis*

A personal interview survey is conducted to explore the responses of lotus growers and gather more and deeper information. During the interview, insect pest is collected for further identification and insecticide containers are observed and recorded the trade names and common names. The descriptive statistics analysis was performed. ANOVA analysis was used to determine the mean difference among treatments on decontamination by flower dipping in water

3. Results and Discussion

3.1. *Insecticide usage*

Results from the survey showed that most lotus grower had elementary school certificate (100% in Chachoengsao, 76.6% from Nakhonpathom and 94.1% from Suphanburi), the rest held secondary school certificate (Table 1). All lotus growers indicated that they faced insect problems for lotus production (Table 2). These growers reported that there were two destructive insect pest caused heavy damage to lotus plants. One is the common cutworm which is known as a heavy leaf feeder. The other insect pest is the common blossom thrips (*Frankliniella schultzei*) which infested and caused black spots on lotus flowers. The common cutworm are resistance to most common insecticides [4]. Thrips control is difficult due to its small body size and the cryptic behavior [1]. The growers from these three provinces solely depend on chemical control. They use common insecticides (abamectin, carbaryl, chlorpyrifos, cypermethrin, dimethoate, endosulfan, fenobucarb, methamidophos, methyl parathion, monocrotophos) which 4 of these insecticides were banned from use by the government (Table 3). These growers preferred organophosphate insecticide group the most and followed by the avermectin, pyrethroid and carbamate, respectively (Table 4). Most growers controlled insect pests using calendar schedules for treatments (Table 5). Growers received information of insecticide knowledge from grower companion, extension agents, self trial and error, sale representatives and agrochemical retailers (Table 6). Thai farmers relied on chemical control for crop protection and pesticide usage increased up to four fold in the past decade [24].

3.2. *Decontamination of fipronil and acetamiprid on lotus flower by water dipping*

Fipronil and acetamiprid are used for thrips control in lotus flowers. The decontamination using flower dipping method in water could reduce acetamiprid residue to 0.7667 mg/kg but not for fipronil (Table 7). MRL is not required for flowers, thus no limitation on the use of pesticides for cut flowers [15]. Some pesticides used are persistent and harmful to florists and professional workers who exposed and handling the products [16-17]. Removal insecticide residue can be done in a simple way.

3.3. *Effect of insecticide usage on fish culture*

Lotus growers released various juvenile fish such as *Hypophthalmichthys molitrix*, *H.nobilis*, *Trichogaster trichopterus*, *Barbodes gonionotus*, *Oreochromis niloticus*. Two types of fish culture (semi food feeding and natural food) are located in lotus-fish farming in Chachoengsao, Nakhonpathom and Suphanburi (Table 8). Freshwater fish are benefit as insect predators which help to lower aquatic insects.

Table 1. Education background of lotus growers in selected provinces

Education level	Percentage of growers(n=30)		
	Chachoengsao	Nakhonpathom	Suphanburi
Elementary school	100.0	76.6	94.1
Secondary school	0.0	23.4	5.9
Vocational school	0.0	0.0	0.0
University	0.0	0.0	0.0
Total	100.0	100.0	100.0

Table 2. Insect pest problem of lotus production

Pest of lotus	Percentage of growers(n=30)		
	Chachoengsao	Nakhonpathom	Suphanburi
Thrips	47.6	45.0	39.4
Common cutworm	52.4	42.3	40.0
Hairy caterpillar	0.0	5.6	14.1
Red mite	0.0	7.1	6.5
Total	100.0	100.0	100.0

Table 3. Different insecticide used by growers from targeted provinces

Common names	Banned insecticide	Province		
		Chachoengsao	Nakhonpathom	Suphanburi
abamectin		/	/	/
carbaryl		/		
chlorpyrifos		/	/	
cypermethrin		/	/	/
dimethoate	/	/		
endosulfan	/	/	/	/
fenobucarb			/	/
methamidophos	/	/	/	/
methyl parathion		/	/	/
monocrotophos	/		/	

Table 4. Insecticide groups used by lotus growers

Insecticide group	Percentage of growers(n=30)		
	Chachoengsao	Nakhonpathom	Suphanburi
organochloride	11.1	0.0	1.9
organophosphate	46.7	48.4	39.4
carbamate	11.1	1.6	0.0
pyrethroid	11.1	3.2	21.2
Avermectins	20.0	46.8	37.5
Total	100.0	100.0	100.0

Table 5. Time table for insecticide application by growers(in percentage)

Time frame	Percentage of growers(n=30)		
	Chachoengsao	Nakhonpathom	Suphanburi
Calendar spray	89.9	84.1	77.4
Insect infestation	11.1	15.9	22.6
recommendation	0.0	0.0	0.0

Total	100.0	100.0	100.0
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Table 6. Source of insecticide knowledge

Source of knowledge	Percentage of growers(n=30)		
	Chachoengsao	Nakhonpathom	Suphanburi
Grower companion	0.0	39.9	56.1
Extension agent	0.0	0.0	0.0
Trial and error	47.2	19.1	2.8
Sale representative	0.0	5.4	5.9
Chemical retailers	52.8	35.6	35.2
Total	100.0	100.0	100.0

Table 7. Decontamination of insecticidal residue on lotus flowers

treatment	Fipronil ¹ (mg/kg)	Acetamidrid ¹ (mg/kg)
0 hr	0.1933a	3.4067a
7 hrs	0.0933a	2.2133ab
7 hrs and water dipping	0.0900a	0.7667b

¹Means followed by same letter do not significantly differ (P=.05, DMRT)

Some growers used light traps to attract insects for fish food. Only 4 growers indicated insecticide spray had effect of fish growth (Table 9). stated that Some insecticides had negative effects on the growth and reproduction of fish [25-26]. Nile tilapia raised alone in pond had significantly growth more than co-cultured with lotus [27]. Epiphytic algae which are fish food used lotus plant as substrate [27-28]. The lotus-fish farming can recycle nutrient effectively [27].

3.4. Effect of insecticide application on growers

Lotus growers prefer power sprayers more than knapsack sprayers to spray pesticides over the crop plants on a small boat or spray and walk through the lotus farm. Chemical drift always occurs during the spray application [29]. All of them do not use protective clothes during the spray. Some of them use a small piece of clothes to cover their mouths and noses during the application. Although, they try to clean up themselves right away after the spray, insecticides are toxic and potentially hazardous to farmers and other organisms, including the environment. Farmers who regularly spray insecticides to protect their crops, insecticide droplets come in contact with them. Insecticide poisoning has been reported by lotus growers (10% in Chachoengsao, 19.9% in Nakhonpathom and 24.3% in Suphanburi) (Table 10). The common symptoms are often headache and/or dizziness, excessive salivation, difficult breathing, sweating and skin irritation. However, most growers are not affected by insecticide handling and practice. Both organophosphates and carbamates could lead to eye tearing, unclear vision, enormous saliva, more sweating, coughing and regurgitation. Pyrethrins group can cause similar symptoms including infrequent difficulty breathing [6]. Illness due to organophosphorus insecticide contact did not differ significantly between spraying and nonspraying periods [30]. Health factors related to insecticide exposure, poor handling practices, and contamination in environment that could cause poisoning cases among farmers [31]. Long time exposure to combination of pesticides may result in unknown adverse health effects, therefore new low risk and cleaner agriculture practice should be urgent implemented for human health [32].

Table 8. Type of lotus-fish farming

Type of fish culture	Percentage of growers(n=30)		
	Chachoengsao	Nakhonpathom	Suphanburi
Semi food feeding	55.5	43.4	47.1
Natural food	44.5	56.6	52.9
Total	100.0	100.0	100.0

Table 9. Effect of insecticide application on fish

Fish symptom	province		
	Chachoengsao	Nakhonpathom	Suphanburi
Slow growth		/	/
Fish kill			

Table 10. Characteristics of illnesses associated with insecticide application

Symtoms	Percentage of growers(n=30)		
	Chachoengsao	Nakhonpathom	Suphanburi
Headache and/or dizziness	6.7	3.3	6.7
Bowel movements and urination	0.0	0.0	0.0
Muscles twitch	0.0	0.0	0.0
Excessive salivation	3.3	10.0	3.3
Difficult breathing	0.0	3.3	6.7
Sweating	0.0	3.3	3.3
Skin irritation	0.0	0.0	3.3
None	90.0	80.1	76.7
Total	100.0	100.0	100.0

4. Conclusions

Information on insect pest problems and control management from government sectors, is not available for lotus growers. Knowledge and practice of insecticide usage is from trial and error, chemical merchants and grower companion. All lotus growers primarily use insecticides to suppress insect population. Some insecticides banned or prohibited for use in agricultural areas by the government are still used in some areas. A simple method using flower dipping in water would decrease insecticidal contaminants. Chemical control is unavoidable for lotus production. Rational decision making process to determine the use and select insecticides wisely will minimize the impact on non targeted organism and environment. Lotus growers' awareness and safe use of insecticides should be implemented. The coupling of lotus farming with fish production could be established in commercial lotus growing areas because it increase the growers' income.

5. References

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