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The Use and Potential Impacts of Pesticides in Chili Farming in the Thanh Binh District, Dong Thap Province, Vietnam

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ABSTRACT

The study aimed to evaluate the current status and potential risks of pesticide use of 23 chili growing households in the Thanh Binh district, Dong Thap province, Vietnam. The result shows that farmers used a total of 40 commercial pesticide names with 43 active ingredients, of which two active ingredients, i.e. Benomyl and Fipronil, were banned. The frequency of pesticide spraying for chili protection averaged at 8.93 times/crop, for weed control at 1.83 times/crop, for pests at 12.43 times/crop, for disease control at 14.48 times/crop and for chili growth promoting at 4.82 times/crop. Farmers sprayed pesticides with higher doses than recommended on the labels when pests and diseases occurred on chili farm. The active ingredients in powder and liquid pesticides of Mancozeb, Metalaxyl, Propined, Difenoconazole, Abamectin and Azoxystrobin have been frequently used with estimated concentrations of 5023±3886.36, 337.71±237.50, 4093.92±3628.57, 289.27±264.73, 31.60±29.02 and 652.57±468.35 g/L/ha, respectively. The predicted amounts of ineffective use of such pesticides as Benomyl, Cypermethrin, Fosetyl-aluminium, Propiconazole, Tebuconazole, Buprofezin, Chlorfenapyr and Difenoconazole, could pose great risks to the environment and humans. Burning is the main method chosen by chili farmers in the treatment of pesticide packaging after use. The study suggests local environmental managers should train farmers in the use and management of pesticide wastes more appropriately.

Keywords: frequency, chili farming, potential risks, pesticides, Dong Thap province.

INTRODUCTION

In order to ensure crop productivity, and prevent the destruction by pests that are increasingly extreme due to the effects of climate change, farmers have increasingly used pesticides [Toan et al. 2014]. Moreover, in order to control pests and diseases, farmers often have the habit of unnecessary spraying of pesticides, indiscriminately mixing several different pesticides, which increases production costs [Nhan et al. 2015]. According to Pingali & Roger [2012], it is stated that indiscriminate use of pesticides can lead to one or more effects, such as deterioration of health due to direct or indirect exposure to hazardous chemicals, water and soil pollution through surface runoff and leaching, pesticide residues through the food chain affecting public health, an increase in the resistance of pest populations to pesticides (resistance), thereby reducing their effectiveness and causing disease outbreaks. The reduced beneficial insect species (natural enemies) decreases number of microorganisms in the soil which help increase soil fertility and improve soil naturally. The Mekong Delta has 6 provinces that grow chili with a large area, which are Dong Thap, An Giang, Tien Giang, Soc Trang, Vinh Long and Tra Vinh [An & Loc, 2017]. Dong Thap is the province with the largest chili growing area with the natural conditions suitable for the development and high quality of chili plants, especially the land of Thanh Binh with a relatively large and fertile alluvial land area [Loc et al. 2015]. In particular, Thanh Binh chili is considered to be the largest chili pot in the west, popular in the domestic market and exported to countries such as Cambodia and South Korea with a different taste and spiciness from other regions, bringing high economic efficiency [Dinh, 2017]. In order to achieve high yield and quality in the chili cultivation process, the annual amount of pesticides applied by farmers and their packaging after use is very large. These are released into the local environment, which would lead to environmental pollution and public health risks. Taking the above-mentioned issues into consideration, the study to assess the current status and potential environmental risks of using pesticides on chili cultivation model in the Thanh Binh district, Dong Thap province was carried out. The findings could provide more scientific data on the potential risks of pesticides in farming to the environment and people, thereby helping local environmental managers to efficiently control pesticides.

MATERIALS AND METHODS

The study collected primary data by interviewing 23 chili farmers in two islet communes, i.e. Tan Hue and Tan Hoa, Thanh Binh district, Dong Thap province, based on pre-designed questionnaires. To assess the current production status, the research collected the information related to the cultivation area, education level, and production experience. The data of current status of pesticide use, types, and doses were also collected through the interview. The status of management of pesticide packaging after use was also collected. From the current situation of using pesticides, the research conducted to look up the names of the corresponding active ingredients of each pesticide using the national pesticide database. The actual content of active ingredients used by farmers was estimated and the potential impact of these active ingredients on the environment and human health were evaluated using scientific information on the integrated risk information system (IRIS US EPA).

The formula for calculating the actual active ingredient content used by farmers is as follows:

$$\textit{Actual content} = \textit{Theoretical amount} \times \times \textit{Actual dose} \times S \quad (1)$$

where: *Actual content* (g/kg/Ha or g/L/ha) – is the active ingredient content listed on the national information system (g/L or g/kg); the actual dose is the dose used by the farmer (liters/ha or kg/ha) and *S* is the cultivated area (ha).

RESULTS AND DISCUSSION

Brief information of interviewed farmers

Table 1 shows that out of a total of 23 samples studied, there are 20 male farmers, accounting for 86.96%, and 3 female farmers, accounting for 13.04%. It can be seen that in the study area men are still the main labor force in agricultural cultivation, they capture a lot of information, so when interviewing men, they will exploit a lot of important data necessary for research. The age and educational level of the farmers in the study area are quite diverse and rich. The concentration age ranges between 40–50 years old, accounting for 53.17% (12 households) and 51–60 years old accounting for 39.13% (9 households). At the same time, the education level of farmers is mainly primary (17.39%) and lower secondary school (52.17%). In general, the education level of the people is low. These two things can be detrimental to information capture as well as the ability to access new scientific and technical advances in production. In agriculture, experience is one of the most influential factors on production efficiency [Nam & Hoang, 2019]. The results showed that the households with less than 10 years of farming experience account for 17.39%, the range from 10–20 years is 26.09%, from 20–30 years is 52.17% and over 30 years is 4.35%. Most of the farmers' experience in chili cultivation here is over 20 years, accounting for 56.52% of the total. Therefore, the experience in seed selection,

Table 1. General information on gender, age, education and farming experience

Characteristics	Description	Frequency	Percentage (%)
Gender	Male	20	86.96
	Female	3	13.04
Age	< 40	2	8.70
	40-50	12	53.17
	51-60	9	39.13
	> 60	-	-
Education	Illiteracy	3	13.04
	Primary	4	17.39
	Secondary	12	52.17
	High school	4	17.39
	University	-	-
Farming experience	< 10 years	4	17.39
	10 – 20 years	6	26.09
	20 – 30 years	12	52.17

planting schedule, weather and even the selection of pesticides in cultivation would also be accumulated [Giao et al. 2020].

The interview results also showed that the cultivation area of chili less than 1 ha accounted for a large proportion of 95.65% and only 4.35% of the cultivated area is larger than 1 ha. The cultivated area fluctuates to a relatively small extent. For the most part, people do not only cultivate one type of farming, but also divide the area to grow other vegetables such as corn, broccoli, green onions, and fruit trees like mango. The chili varieties used by farmers included Nong Hoi, An Phu Nong, Chanh Phong, Hai Mui Ten Lua and Van Phat. The reasons why these chili varieties are often used were their high disease resistance (43.48%), high yield (26.08%), large market (17.39%) and high price (13.04%).

Current pesticides use in chili farming

Types of pesticides

The results of the survey and interviews showed that farmers used a total of 40 commercial pesticides with 43 active ingredients with the main use being insecticides and diseases that frequently occur on chili plants (Table 2).

The pesticides used by farmers mainly include the group of pesticide with toxicity from II to III according to the classification of the World Health Organization (accounting for 55%), group IV only accounts for a small part with 35% and up to 10% of pesticides used have not been identified with toxicity according to the classification of the World Health Organization. In particular, according to Decisions 03/QD-BNN-BVTV and 501/QD-BNN-BVTV, during the cultivation of chili, two banned active ingredients were identified, Benomyl and Fipronil, which are still used by farmers to prevent disease damage (accounting for 5%). Using highly toxic pesticides is considered a potential cause of great health and environmental risks [Tuan & Diem, 2018]. The results also showed that most of the pesticides used by farmers are not on the list of pesticides for chili (accounting for 90%). There are only four types of pesticides including Amistar 250SC, Agiaza 4.5EC, Flint pro 648WG, and Radiant 60SC are indicated for use in chili farming. This can be the cause of resistance and reduced effectiveness of pesticides use. Inappropriate pesticide use can negatively impact crops, human health and ecosystems [Utami et al. 2020]. Besides, the use of many pesticides in cultivation can lead to high residues of pesticides in chili [Ramadan et al. 2020]. Compared with the study of Selvarajah & Thiruchelvan [2007], the average amount of pesticides used on chili in the study area was estimated at 11.5 kg/ha/year and nearly 50% of the pesticides used were in the categories I and II according to the World Health Organization, i.e. highly toxic and relatively toxic to humans. In the Upper Citarum basin, farmers used about 13 pesticides in chili cultivation with insecticides, fungicides and growth regulators, notably active ingredients such as Abamecetin, Mancozeb and Profenofos [Utami et al. 2020]. In general, most pesticides used by farmers are not recommended for use on chili and still have some banned active ingredients.

Frequency and dose of pesticide use

The frequencies of spraying pesticides for each use such as herbicides, insecticides, disease control and growth stimulating were 1.83±0.94 times/crop, 12.43±5.53 times/crop, 14.48±6.34 times/crop and 4.82±3.89 times/crop crops with an average frequency of sprays of about 8.93 times/crop. Farmers said that weed control was only applied in the early stages before planting seedlings. In addition, there are frequent pests and diseases on chili, such as stem borers, green worms, planthoppers, thrips and especially anthracnose that cause fruit rot, leaf spot so the frequency of spraying is relatively high. Pesticides have been used every 5–7 days to protect the crop yield. In the Central Java chili cultivation area, during a period of three to four months, farmers sprayed with the frequency of about 23 times/crop against the top three insect pests, including thrips, ticks, whitefly and three diseases comprising Anthracnose, Gemini virus and Phytophthora [Mariyono, 2017]. Furthermore, chili growers mainly rely on the use of pesticides for pest control with a high frequency of two to three sprays per week [Nasruddin et al. 2020]. Besides, farmers tend to spray at the time when pests are detected (accounting for 78.26%) and only 21.74% farmers choose to spray periodically. The study results also showed that 17.39% of farmers chose to spray in the early morning, 39.13% sprayed in the afternoon and 43.48% of farmers chose to spray in the early morning and late afternoon. In addition, farmers also added, that they do not choose a hot noon time, since the pesticides would evaporate quickly, thereby reducing the effectiveness of the chemicals. Similarly, the farmers avoid using pesticides during rain, since the rain water could wash away the chemicals.

As for the dosage of the pesticides, the majority of farmers sprayed with a higher dose than indicated on the instructions. The main reason for using a higher dose than directed may be

Table 2. Names of pesticides and active ingredients used by farmers

No.	Trade names	Active ingredients	Function	Toxic group	Allow/Ban
1	Acetapro 500 WP	Acetamiprid 250 g/kg + Buprofezin 250 g/kg	Pest control	3	Allowed
2	Aliette 800 WG	Fosetyl-aluminium	Disease control	-	Allowed
3	Amistar 250 SC	Azoxystrobin (min 93%)	Disease control	3	Allowed
4	Amistar top 325 SC	Azoxystrobin 200 g/l + Difenoconazole 125 g/l	Disease control	3	Allowed
5	Antracol 70 WP	Propineb (min 80%)	Disease control	4	Allowed
6	Anvil 5 SC	Hexaconazole (min 85%)	Disease control	4	Allowed
7	Atonik 1.8 SL	Sodium-5-nitroguaiacolate 3 g/l + Sodium-O-Nitrophenolate 6 g/l + Sodium-P-Nitrophenolate 9 g/l	Growth regulating	4	Allowed
8	Benevia 100 OD	Cyantraniliprole (min 93%)	Pest control	4	Allowed
9	Elsin 600 WP	Nitenpyram (min 95%)	Pest control	3	Allowed
10	Chlorferan 240 SC	Chlorfenapyr (min 94%)	Pest control	2	Allowed
11	Comcat 150 WP	Dịch chiết từ cây Lychnis viscaria	Growth regulating	44	Allowed
12	Confitin 18 EC	Abamectin 17.5 g/L + Chlorfluazuron 0.5 g/L	Pest control	2	Allowed
13	Copper-B 75 WP	Benomyl 10% + Bordeaux 45% + Zineb 20%	Disease control	2	Banned
14	Dual Gold 960 EC	S-metolachlor 960 g/l	Weed control	3	Allowed
15	Prevathon 5 SC	Chlorantraniliprole (min 93%)	Pest control	4	Allowed
16	Agiaza 4.5EC	Azadirachtin	Pest control	4	Allowed
17	Fier 500 SC	Diafenthiuron (min 97%)	Pest control	3	Allowed
18	Filia 525 SE	Propiconazole 125 g/l + Tricyclazole 400 g/L	Disease control	2	Allowed
19	Flint pro 648 WG	Propineb 613 g/kg + Trifloxystrobin 35 g/kg	Disease control	3	Allowed
20	Kasumin 2SL	Kasugamycin (min 70%)	Disease control	4	Allowed
21	Katana 20 SC	Fenoxanil (min 95%)	Disease control	3	Allowed
22	Manozeb 80 WP	Mancozeb (min 85%)	Disease control	4	Allowed
23	Mataxyl 500 WP	Metalaxyl (min 95%)	Disease control	4	Allowed
24	Nativo 750 WG	Tebuconazole 500 g/kg + Trifloxystrobin 250 g/kg	Disease control	3	Allowed
25	Physan 20 SL	Quaternary ammonium salts	Disease control	3	Allowed
26	Pompom 3.9 EC	Abamectin 4 g/l + Methylamine avermectin 35 g/L	Pest control	-	Allowed
27	Proclaim 1.9 EC	Emamectin benzoate (Avermectin B1a 90% + Avermectin B1b 10%)	Pest control	3	Allowed
28	Radiant 60 SC	Spinetoram (min 86.4%)	Pest control	-	Allowed
29	Regent 800 WG	Fipronil (min 95%)	Pest control	2	Banned
30	Ridomil Gold 68 WP	Metalaxyl M 40 g/kg + Mancozeb 640 g/kg	Disease control	4	Allowed
31	Rocksai super 525 SE	Propiconazole 125 g/l + Tricyclazole 400 g/L	Disease control	-	Allowed
32	SecSaiGon 25 EC	Cypermethrin (min 90%)	Pest control	2	Allowed
33	Sulfaron 250 EC	Carbosulfan 200 g/L + Chlorfluazuron 50g/L	Pest control	2	Allowed
34	Tarang 280 SL	Glufosinate ammonium	Weed control	4	Allowed
35	Tilt Super 300 EC	Difenoconazole 150 g/l + Propiconazole 150 g/l	Disease control	3	Allowed
36	Upper 400 SC	Azoxystrobin 250 g/L + Difenoconazole 150 g/L	Disease control	3	Allowed
37	Usatabon 17.5 WP	Imidacloprid 2.5% + Pyridaben 15%	Pest control	3	Allowed
38	Vali 5 SL	Validamycin (Validamycin A) (min 40%)	Pest control	4	Allowed
39	Validacin 5L	Validamycin (Validamycin A) (min 40%)	Disease control	4	Allowed
40	Yamida 100 EC	Imidacloprid (min 96%)	Pest control	3	Allowed

to ensure an effect after spraying [Toan, 2013]. Besides, farmers added, if sprayed according to the dosage instructions, the concentration is very low, not high enough to kill pests, as well as time and labor consuming. The farmer's choice of the dosage is mainly based on personal experience. Spraying at the wrong dose or arbitrarily increasing the dose is the cause of increasing disease resistance, resulting in the increasing use of pesticides in farming [Nhan et al. 2015]. This is also the cause of more and more toxic substances accumulating in the environment, causing long-term pollution of soil, underground water, surface water, air and having adverse effect on human health [Sharma et al. 2012, Joko et al. 2017, Marsala et al. 2020]. Some pesticides were found with high residues on agricultural products and were detected frequently, such as methomyl, imidacloprid, metalaxyl and cyproconazole, profenofos [Ramadan et al. 2020, Megawatil et al. 2021].

Current status of pesticide packaging management after use

The results on the methods of handling pesticide packaging by farmers (Figure 1), such as discarding together with household waste, throwing it right at the cultivated land and placing it in a chemical container had the same ratio of 4.35%, scrap collection accounts for 13.04% and packaging is collected and burned by farmers in the field accounted for 73.91%, this is also the method chosen by farmers for treatment in many other study areas [Nhan et al. 2015, Giao et al. 2021]. It can be seen that farmers' handling of expired pesticide packaging is improper and creates great risks of environmental pollution, as it can enter water sources, seep into the soil, and enter atmosphere. Depending on the direction of the wind and the degree of strength, the pesticides are dispersed far or near [Chau et al. 2019]. Burning pesticide packaging and bottles in open air or with domestic waste without proper treatment system will produce harmful emissions into the environment, including dioxin [Nhan et al. 2015]. According to Hai [2009], only high-temperature kilns can destroy pesticide wastes so open burning should be avoided since it could result in toxic fume dispersed and transported to where it could cause health and ecosystem impacts.

Potential impact of pesticides on ecosystems and human health

Actual concentrations of active ingredients used by farmers in chili farming

On the basis of the interview data on cultivated area, used dose and frequency of spraying pesticides, and combined with the results of looking up the active ingredient concentration of pesticides, the study estimated the concentration of pesticides actually used by farmers on the whole crop is detailed in Table 3.

The results showed that each pesticide active ingredient has a diverse content, with relatively large fluctuations. Of the total 43 active ingredients found in the chili cultivation, there are 15 active ingredients, such as Acetamiprid, Azadirachtin, Benomyl, Bordeaux, Buprofezin, Chlorantraniliprole (min. 93%), Cyantraniliprole (min. 93%), Fenoxanil (min. 95%), Glufosinate ammonium, Methylamine avermectin, Nitenpyram (min. 95%), Pyridaben, Quaternary ammonium salts, S-metolachlor and Zineb occur only once. This result showed that pesticides containing the above-mentioned active ingredients are only used by a few farmers. In addition, the active ingredients of the powder pesticides chosen by farmers the most were Mancozeb,

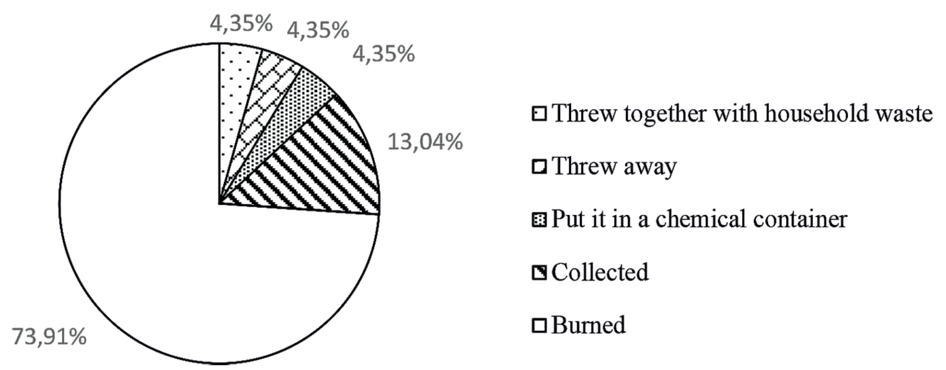

Figure 1. Farmers' treatment of pesticide packaging

Metalaxyl (min. 95%) and Propined (min. 80%) with average content of 5023±4013.81 g/kg/ha, 337.71±246.46 g/kg/ha and 4093.92±3776.74 g/kg/ha, respectively. the active ingredients of the liquid pesticides with the highest frequency of use include Difenoconazole, Abamectin and Azoxystrobin (min. 93%) with concentrations corresponding to 289.27±277.65 g/L/ha, 31.60±30.78 g/L/ha, and 652.57±505.87 g/L/ha, respectively. In addition, two banned active ingredients, Benomyl and Fipronil (min. 95%) with estimated concentrations per crop were used by farmers at about 90 g/kg/ha and 6933.33±6745.35 g/kg/ha, respectively. According to Table 3, for water pills, the active ingredient Fenoxanil has the highest concentration with 30,000 g/L/ha and the

Table 3. Actual concentration of pesticides used by farmers

No.	Active ingredients	Unit	TB	SD	Min	Max
1	Abamectin	g/L/ha	31.60	30.78	7.00	105.00
2	Acetamiprid	g/kg/ha	1250.00	-	-	-
3	Azadirachtin	g/L/ha	5.40	-	-	-
4	Azoxystrobin (min 93%)	g/L/ha	652.57	505.87	240.00	1600.00
5	Benomyl	g/kg/ha	90.00	-	-	-
6	Bordeaux	g/kg/ha	405.00	-	-	-
7	Buprofezin	g/kg/ha	1250.00	-	-	-
8	Carbosulfan	g/L/ha	1140.00	763.68	60.00	168.00
9	Chlorantraniliprole (min 93%)	g/L/ha	66.00	-	-	-
10	Chlorfenapyr (min 94%)	g/L/ha	702.40	380.02	240.00	1152.00
11	Chlorfluazuron	g/L/ha	57.79	135.61	0.20	420.00
12	Cyantraniliprole (min 93%)	g/L/ha	225.00	-	-	-
13	Cypermethrin (min 90%)	g/L/ha	25890.00	60808.21	250.00	150000.00
14	Difenoconazole	g/L/ha	289.27	277.65	40.50	1000.00
15	Diafenthiuron (min 97%)	g/L/ha	1000.00	707.11	50.00	150.00
16	Dịch chiết từ cây Lychnis viscaria	g/kg/ha	87.43	45.81	18.00	162.00
17	Emamectin benzoate	g/L/ha	22.42	16.66	1.06	3.42
18	Fenoxanil (min 95%)	g/L/ha	30000.00			
19	Fipronil (min 95%)	g/kg/ha	6933.33	6745.35	2880.00	14720.00
20	Fosetyl-aluminium	g/kg/ha	2290.00	892.86	1600.00	3600.00
21	Glufosinate ammonium	g/L/ha	112.00			
22	Hexaconazole (min 85%)	g/L/ha	417.33	399.33	50.00	1035.00
23	Imidacloprid (min 96%)	g/kg/ha	496.79	277.78	87.50	800.00
24	Kasugamycin (min 70%)	g/L/ha	181.50	172.88	18.00	414.00
25	Mancozeb	g/kg/ha	5023.00	4013.81	640.00	11776.00
26	Metalaxyl (min 95%)	g/kg/ha	337.71	246.46	40.00	736.00
27	Methylamine avermectin	g/L/ha	63.00	-	-	-
28	Nitenpyram (min 95%)	g/kg/ha	240.00	-	-	-
29	Propiconazole	g/L/ha	336.19	345.18	40.50	1125.00
30	Propined (min 80%)	g/kg/ha	4093.92	3776.74	210.00	11200.00
31	Propineb	g/kg/ha	4904.00	2550.40	2758.50	7723.80
32	Pyridaben	g/L/ha	525.00	-	-	-
33	Quaternary ammonium salts	g/L/ha	920.00	-	-	-
34	S-metolachlor	g/L/ha	2880.00	-	-	-
35	Sodium-5-nitroguaiacolate	g/L/ha	1.07	1.21	0.12	3.36
36	Sodium-O-Nitrophenolate	g/L/ha	2.14	2.42	0.24	6.72
37	Sodium-P-Nitrophenolate	g/L/ha	3.21	3.63	0.36	10.08
38	Spinetoram (min 86.4%)	g/L/ha	95.25	40.72	72.00	156.00
39	Tebuconazole	g/kg/ha	1387.50	754.34	690.00	2400.00
40	Tricyclazole	g/L/ha	2000.00	1442.22	800.00	3600.00
41	Trifloxystrobin	g/kg/ha	516.43	356.52	157.50	1200.00
42	Validamycin (min 40%)	g/L/ha	5438.75	10374.56	140.00	21000.00
43	Zineb	g/kg/ha	180.00	-	-	-

active ingredient Sodium-5-nitroguaiacolate has the lowest concentration of 1.07 g/L/ha. As for powder pesticides, the banned active ingredient Fipronil (min. 95%) had the highest concentration (6933.3±6745.35 g/kg/ha) and the lowest concentration corresponded to Benomyl (90 g/kg/ha). The analysis results also showed that the concentration of pesticides has a relatively large fluctuation between the minimum and maximum values. The reason for this difference is mainly due to the relatively different dosage of farmers, as well as the cultivation area of each household.

Table 4. Potential impacts of pesticides on the ecosystems and humans

No.	Active ingredients	Potential impacts	
		Ecosystems	Human
1	Abamectin	- Insignificant bioaccumulation in fish and mammals. - Slightly soluble in water. Capable of combining with sediment, reducing water concentration. - Slow biodegradation in soil. - Low to moderate mobility in soil. - Very toxic to aquatic invertebrates, highly toxic to larval/embryonic stages of mollusks, bees and birds. - LD50 rat skin ≥ 5000 mg/kg. - LD50 rat oral 50 mg/kg. - LD50 bee skin 0.41 µg/con.	- Non-cancer.
2	Acetamiprid	- Low bioaccumulation in aquatic organisms. - Moderate to high mobility in soil. - Half-life in soil < 18 days. - Selectively toxic to arthropods and relatively non-toxic to vertebrates. - Harmful to aquatic life with lasting effects. - LD50 rat skin > 2000 mg/kg. - LC50 rat inhale > 1.15 mg/L/4h. - LD50 rat oral 314-417 mg/kg.	- Harmful if swallowed. - Poisoning causes symptoms such as nausea, muscle weakness, hypothermia, convulsions, tachycardia, hypotension, ECG changes, hypoxia, and thirst. - Causes chromosomal aberrations in lymphocytes and micronucleus formation at concentrations of 30-40 g/mL.
3	Azadirachtin	- Low bioaccumulation in aquatic organisms. - High mobility in soil. - Very toxic to aquatic life with long lasting effects. - LD50 rat oral > 5000 mg/kg. - LD50 rabbit oral > 2000 mg/kg. -LD50 rabbit skin > 2000 mg/kg.	- May cause skin allergies. - Causes diarrhea, nausea and discomfort. - Formation of diseases such as eye abnormalities, congenital malformations of limbs, sinus thinning.
4	Azoxystrobin	- Low bioaccumulation in aquatic organisms. - Has mobility in medium to low soil. - Half-life from 8 to 12 weeks. - Capable of absorbing suspended solids and sediments. - When heated to decomposition, emits toxic vapors/nitrous oxide. - LD50 rat oral > 500 mg/kg. - LD50 rat skin > 2000 mg/kg.	- Chromosomal aberrations in human lymphocytes. - Some diseases such as edema, sugar intolerance, hyperglycemia, insulin resistance, obesity and teratogenicity,…
5	Benomyl	- Low bioaccumulation in aquatic organisms. - Light mobility in soil. - Capable of absorbing suspended solids, sediments. - Insoluble in water. - When heated, it produces toxic fumes of nitrous oxide. - Very toxic to aquatic life. - LD50 rat oral 10000 mg/kg. - LC50 rat inhale > 20000 mg/kg. - LC50 rat skin > 10000 mg/kg.	- Causes skin irritation. - Respiratory tract irritation. - Eye irritation. - Causes germ cell mutations, genetic defects. - Harm to fertility, teratogenic. - Causes cancer in humans.
6	Bordeaux	N/A	N/A
7	Buprofezin	- Bioaccumulation in aquatic species is highly. - Survive in the air. - Has slight mobility in soil. - Capable of absorbing suspended solids, sediments. - Long-lived in the soil. - When heated to decomposition, emits toxic fumes of nitrous oxide and sulfur oxide. - LD50 rat skin and oral > 5 g/kg. - LD50 rat ingest 2198-2355 mg/kg. - LC50 rat inhale > 2.2 mg/L (4h).	- Low toxicity, no proliferation of abnormal cells and chromosomal aberrations.

Table 4. Cont. Potential impacts of pesticides on the ecosystems and humans

8	Carbosulfan	- Decomposes slowly in water. - LD50 rat oral 74-51 mg/kg. - LD50 rat skin > 2 gm/kg. - LC50 rat inhale 1530 mg/m^3/1h.	
9	Chlorantraniliprole	N/A	N/A
10	Chlorfenapyr	- Insoluble in water. - Moderate to high bioaccumulation in aquatic life. - Immobilized in the ground. - Long-lasting in soil with a biodegradation half-life of 230-250 days. - Capable of absorbing suspended solids, sediments. - When heated to decomposition, emits toxic vapors of hydri chloride, hydrogen fluoride and nitrogen oxides. -LD50 rat ingest 441-1152 mg/kg. - Acute toxicity to birds ranges from high to very high. - Very toxic to fish and aquatic invertebrates, LC50 from 7.4-500 ppb/24-96h.	- Moderate but reversible eye irritant, no skin irritation. - Has anti-estrogenic activity. - Does not cause cancer in humans.
11	Chlorfluazuron	- LD50 rat oral 445 mg/kg. - LD50 rat skin 720 mg/kg. - LC50 rat inhale 590 mg/m^3.	- Causes serious eye irritation.
12	Cyantraniliprole	N/A	N/A
13	Cypermethrin	- Bioaccumulation in aquatic organisms is high. - Immobilized in the ground. - Capable of absorbing suspended solids, sediments. - When heated to decomposition, emits toxic fumes of cyanide, nitrous oxide and chloride. - LD50 rat ingest 14.9-250 mg/kg. - LD50 rat oral 4123 mg/kg.	- May cause cancer. - Mild skin and eye irritation. - Respiratory symptoms such as cough, dizziness, headache, nausea, difficulty breathing,.. - Skin symptoms such as burning, redness, tingling,… - Eye symptoms such as redness, pain. - Symptoms of swallowing include abdominal pain, convulsions, vomiting.
14	Difenoconazole	- Bioaccumulation in aquatic organisms is high, relatively toxic to fish. - Mobility in light or non-moving soil. - Decomposes slowly in soil and water environments. - Capable of absorbing suspended solids, sediments. - When heated to decomposition, emits toxic vapors of nitrous oxide and chloride. - LD50 rat oral 1453 mg/kg. - LC50 rat inhale > 45 mg/m^3/4h.	- Harmful when inhaled or absorbed through the skin. - Moderate eye irritation. - Causes related disorders and diseases such as aneuploidy, embryo loss, fetal growth retardation and musculoskeletal abnormalities.
15	Diafenthiuron	- Very toxic to aquatic life. - LD50 rat oral 2068 mg/kg. - LC50 rat inhale 558 mg/m^3/14h/ - LD50 rat skin > 2000 mg/kg.	- Toxic if inhaled. - Causes damage to organs with prolonged exposure.
16	Extract from *Lychnis viscaria*	N/A	N/A
17	Emamectin benzoate	- Very toxic to aquatic life.	- Toxic if swallowed. - Toxic on skin contact. - Causes serious eye damage. - Toxic if inhaled. - Causes damage to organs with long-term exposure.
18	Fenoxanil	N/A	N/A
19	Fipronil	- Mobility in low or no soil. - Capable of absorbing suspended solids, sediments. - Very toxic to aquatic life, birds and bees. - Easy entry into the environment. - LD50 rat ingest 92-100 mg/kg.	- Type A gamma-aminobutyric acid receptor blocker. - Nervous effects such as headache, dizziness and paresthesia. - Eye, digestive, respiratory and skin irritation.

Table 4. Cont. 2. Potential impacts of pesticides on the ecosystems and humans

20	Fosetyl-aluminium	- Soluble in water. - Toxic to fish, less toxic to bees. - LD50 rat skin >3200 mg/kg. - LD50 rat oral 3700 mg/kg.	- Carcinogen. - Causes serious eye damage.
21	Glufosinate ammonium	- Low bioaccumulation in aquatic organisms. - Mobility in soil from low to high. - Soluble in water. - Capable of absorbing suspended solids, sediments. - Less toxic to fish, non-toxic to bees. - LD50 rat ingest 1620-2000 mg/kg. - LD50 rat skin > 4000 mg/kg.	- Harmful if swallowed. - Harmful in contact with skin. - Harmful when inhaled. - Harm the reproductive process. - Causes damage to organs with prolonged exposure. - Clinical signs such as confusion, convulsions, apnea.
22	Hexaconazole	- Slightly soluble in water. - Less toxic to fish and bees. - LD50 rat oral 2189 mg/kg. - LD50 rat skin > 2 gm/kg.	- May cause skin allergies.
23	Imidacloprid	N/A	N/A
24	Kasugamycin	N/A	N/A
25	Mancozeb	- Insoluble in water. - Less toxic to fish, non-toxic to bees. - LD50 rat oral 11200 mg/kg. - LD50 rat skin > 15000 mg/kg.	
26	Metalaxyl	- Low bioaccumulation in aquatic organisms. - Moderate to very high soil mobility. - Soluble in water. - When heated to decomposition, emits toxic fumes of nitric oxide. - Harmful to aquatic life. - LD50 rat oral 566 mg/kg. - LD50 rat skin > 3100 mg/kg.	- Harmful if swallowed. - Causes skin allergies. - Does not cause cancer.
27	Methylamine avermectin	N/A	N/A
28	Nitenpyram	N/A	N/A
29	Propiconazole	- Bioaccumulation in aquatic organisms is very high. - Mobility in medium to immobile soil. - When heated to decomposition, emits toxic vapors of nitrous oxide and hydrogen chloride. - Dissolves slowly in water. - Toxic to aquatic life. - LD50 rat oral 1517 mg/kg. - LC50 rat inhale 1264 mg/m^3/4h. - LD50 rat skin > 4000 mg/kg.	- May harm the unborn baby. - Causes cancer in humans.
30	Propined	N/A	N/A
31	Propineb	N/A	N/A
32	Pyridaben	- Bioaccumulation in aquatic organisms is high. - Survive in the atmosphere. - Immobilized in the soil. - Capable of absorbing suspended solids, sediments. - Very toxic to aquatic life. - LD50 rat oral 205-570 mg/kg. - LD50 rat inhale 620 mg/m^3.	- Toxic if swallowed. - May be fatal if inhaled. - Moderate eye irritation. - Does not cause cancer.
33	Quaternary ammonium salts	N/A	N/A
34	S-metolachlor	- Very toxic to aquatic life.	- Causes skin allergies.
35	Sodium-5-nitroguaiacolate	- LD50 rat oral 716 mg/kg. - LD50 rat skin > 2000 mg/kg.	- Serious damage to eyes.
36	Sodium-O-Nitrophenolate	- LD50 rat oral 960 mg/kg. - LD50 rat skin > 2000 mg/kg.	- Causes eye irritation.
37	Sodium-P-Nitrophenolate	- LD50 rat oral 345 mg/kg. - LD50 rat skin > 2000 mg/kg.	- Causes eye irritation.
38	Spinetoram	N/A	N/A

Table 4. Cont. 3. Potential impacts of pesticides on the ecosystems and humans

39	Tebuconazole	- Bioaccumulation in aquatic organisms is high. - Moderate mobility to immobility in the ground. - Capable of absorbing suspended solids, sediments. - When heated to decomposition, emits toxic vapors of hydrogen chloride and nitrous oxide. - Very toxic to aquatic life. - LD50 rat oral 1615-3352 mg/kg. - LC50 rat inhale > 800 mg/m^3/4h. - LD50 rat skin > 5000 mg/kg.	- Harmful if swallowed. - Toxicity to reproduction. - Liver damage. - Diarrhea. - Causes cancer in humans.
40	Tricyclazole	- Slightly soluble in water. - Less toxic to fish, non-toxic to bees. - LD50 rat oral 245-250 mg/kg. - LC50 rat inhale 3030 mg/m^3/1h. - LD50 rat skin > 5000 mg/kg.	- Harmful if swallowed.
41	Trifloxystrobin	- Bioaccumulation in aquatic organisms is high. - Moderate mobility to immobility in the soil. - On decomposition, hazardous gases such as carbon oxide, nitrous oxide, hydrogen fluoride are produced. - Very toxic to aquatic life. - LD50 rat oral > 4000 mg/kg. - LD50 rat skin >2000 mg/kg.	- May cause skin allergies. - Moderate eye irritation. - Does not cause cancer.
42	Validamycin	- Soluble in water. - LD50 rat oral > 20000 mg/kg. - LD50 rat skin > 50000 mg/kg.	
43	Zineb	- Slightly soluble in water. - Less toxic to fish, non-toxic to bees. - LD50 rat oral > 5200 mg/kg. - LD50 rat skin > 10000 mg/kg.	

Potential risks of pesticides to the ecosystems and human

On the basis of the results of looking up data on the integrated risk information system IRIS US EPA, the potential impacts of each pesticide active ingredient on the ecosystems and humans are detailed in Table 4. The analysis results showed that a total of 43 active ingredients were found during the use of farmers, up to 13 active ingredients (accounting for 30.25 percent) had no data to assess their potential risks. It can be seen that the use of pesticides is not a sufficient basis to assess the environmental and human impact as really dangerous. Among the active substances evaluated for high bioaccumulation potential, there were Buprofezin, Chlorfenapyr, Cypermethrin, Difenoconazole, Propiconazole, Pyridaben and Tebuconazole. The active substances with high mobility in the soil include Acetamiprid, Azadirachtin, Glufosinate ammonium and Metalaxyl. There are two active substances that can exist in the air, including Buprofezin and Pyridaben. Among the investigated active ingredients, 12 are toxic to aquatic life, including Abamectin, Azadirachtin, Benomyl, Chlorfenapyr, Difenoconazole, Diafenthiuron, Emanectin benzoate, Fipronil, Metalaxyl, Pyridaben, S-Metolachlor, Tebuconazole and Trifloxystronbin. Moreover two active ingredients are highly toxic to birds, i.e. Chlorfenapyr and Fipronil. Besides, there are three active substances that persist in soil for a long time, namely Buprofezin, Chlorfenapyr and Difenoconazole. In addition, when these active ingredients are heated to decompose, they will produce toxic gases, such as Azoxystrobin, Benomyl, Buprofezin, Chlorfenapyr, Difenoconazole, Cypermethrin, Metalaxyl, Propiconazole Tebuconazole and Trifloxystrobin. In particular, the active ingredients Benomyl, Cypermethrin, Fosety-aluminium, Propiconazole and Tebuconazole have the potential to cause cancer in humans. The conducted analysis shows that using pesticides is an effective method to kill pests, but at the same time, it has a great potential impact on the ecosystems and human health.

CONCLUSIONS

The results showed that in the process of cultivating chili in the Thanh Binh district, Dong Thap province, farmers use about 40 commercial pesticides with 43 corresponding active ingredients, two of which, i.e. Benomyl and Fipronil, are banned. The average frequency of spraying is about 8.93 times/crop, with doses higher than recommended in instructions. The active ingredients of powder pesticides used most by farmers were Mancozeb, Metalaxyl and Propined with average concentrations of 5023±3886.36 g/kg/ha, 337.71±237.50 g/kg/ha and 4093.92±3628.57 g/kg/ha, respectively. The active ingredients of the liquid pesticides with the highest frequency of use include Difenoconazole, Abamectin and Azoxystrobin with concentrations of 289.27±264.73 g/L/ha, 31.60±29.02 g/L/ha and 652.57±468.35 g/L/ha, respectively. The active ingredients found in this study pose potential hazardous impact on the environment and human beings. In particular, there are active substances that are capable of causing cancer to humans, such as Benomyl, Cypermethrin, Fosety-aluminium, Propiconazole and Tebuconazole, which are extremely dangerous. In addition, farmers choose the common form of burning to treat pesticide packaging after use, causing negative impacts on the environment and human health. The results can provide more scientific data to help local environmental managers more closely determine the current status of pesticides use, as well as aid in the management of pesticide packaging in the locality. It is very urgent to propagate the potentially harmful effects of pesticides on ecosystems and human health.

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