Knowledge and Behaviour of Agrochemical Usage and Effect on Farming Area: Case Study in Chiang Mai, Thailand

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ABSTRACT

The perception of farmworkers' knowledge, attitude, and behaviour on agrochemicals usage is vital to the safety of farmworkers. This study aimed to evaluate that perception as well as the effect of agrochemical usage on non-agrochemical farming in the surrounding area of Muang Kaen Pattana Municipality, Chiang Mai Province. The population of the study was 1,350 farmworkers, the sample size was determined from the sampling formula of Taro Yamane to 309 farmworkers, purposive selection from agrochemical and non-agrochemical in areas. Data were collected by questionnaires with 4 parts. Item-Objective Congruence (IOC), evaluated from three experts was 0.87. The reliability calculated by Cronbach's alpha reliability coefficient was 0.90. The difference in physicochemical properties and number of cultivatable bacteria was tested by means of the analysis of variance (one-way ANOVA). It was found that the level of knowledge attitude among farmworkers in terms of agrochemical usage was in medium and high level. Inadequate protective behaviour and inappropriate agrochemical management were mainly caused by insufficient knowledge and pursuit of maximized profit and remuneration from agrochemical compensation. The physicochemical parameters in non-chemical usage soil were similar to those of chemical usage soil, except potassium level, which was higher. Meanwhile, the number of bacteria from non-chemical usage soil was higher than that of the chemical usage soil. A pair level of paraquat residue could be detected from both soils. The contamination of agricultural chemicals presented in non-chemical farming may be due to cross-contamination from inappropriate agrochemical usage and waste management. Most farmworkers acknowledge the harmful of agrochemicals on health and the environment but agree to use them because of an effective, convenient, and quick method of pest control. Thus, intensive instruction on agrochemical usage is required.

1. INTRODUCTION

Each year, accidental poisonings kill was globally estimated as 355,000 people. In developing countries, approximately 228,000 deaths/year are intensively related with disproportionate contact to, and inappropriate practice of, toxic chemicals. Those toxic chemicals may be released to soil, air, and water – from many human activities, especially agriculture [1].

Many countries have been criticized the usage of agrochemicals due to their negative effects, especially Thailand. Recently, Thai government's National Hazardous Substances Committee decided to stop glyphosate, paraquat and chlorpyrifos usage from end of the year 2019 [2]. However, other than ban those toxic chemicals, education of farmworkers regarding the proper agrochemical handling are also important. Agrochemicals have been widely applied in Thailand for decades. Although government and agrochemical selling companies have continuously educated farmworkers, the knowledge, attitude and behaviour of agrochemical usage and handling of Thailand farmer are still questioned.

Muang Kaen Pattana Municipality, Chiang Mai Province, Thailand is an agricultural community. Some farmworkers in this area are interested in changing their farm practices to organic agriculture, while a few of them have already started to use non-agrochemical practices. However, they are being faced with cross-contamination by agrochemical use surrounding their farms. The former study found that farmworkers' knowledge level on potential risks of pesticide is a critical in avoiding pesticide exposure and contamination [3]. Therefore, this area is

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interesting to survey for farmworkers' knowledge, attitude and behaviour of agrochemical usage, to evaluate their practice on the effects of agrochemical contamination as well as the physicochemical and biological properties in soil of this farmland area. The results could be used to educate farmworkers and be a model for promoting non-agrochemical or organic farming in other areas.

2. MATERIALS AND METHODS

Population and sample

Population of the studied was 1,350 farmworkers in Muang Kaen Pattana Municipality, Chiang Mai Province, Thailand. The sampling formula of Taro Yamane [4] was used to determine the sample size of the research. From its error rate at 5%, 309 farmworkers from agrochemical and non-agrochemical in areas were interviewed.

Research instrument

The research instrument is the questionnaire had 4 parts. First, part A was the background information of the farmworkers regarding sex, age, educational level, average income per year, land rights, agricultural use time length, type of crop, agricultural area and type and frequency of agricultural usage. Second, part B, the knowledge of farmworkers for agrochemical usage and waste management measurement items, used correct and wrong answer. Third, part C, the attitude of farmworkers for agrochemical usage and waste management, measurement items, used a three point interval scale ranging from 1 to 3 agree opinion. Fourth, part D, the behaviour of farmworkers for agrochemical usage and waste management, measurement items, used a checklist item. The validity of the questionnaire, to find the content validity, was evaluated by three experts, including, one agricultural expert and two environmental experts using the Item-Objective Congruence (IOC) [5]. The Item-Objective Congruence were scored as 0.87, that could be categorised as a high score. The reliability was calculated by Cronbach's alpha reliability coefficient [6] and found that the score for Cronbach's Alpha was 0.90, so the questionnaire was highly reliable.

Data collection

The questionnaires were collected by the researcher to analyse and interpret data from a survey of 309 farmworkers during September 2017 in Muang Kaen Pattana Municipality, Chiang Mai Province, Thailand (Fig. 1).

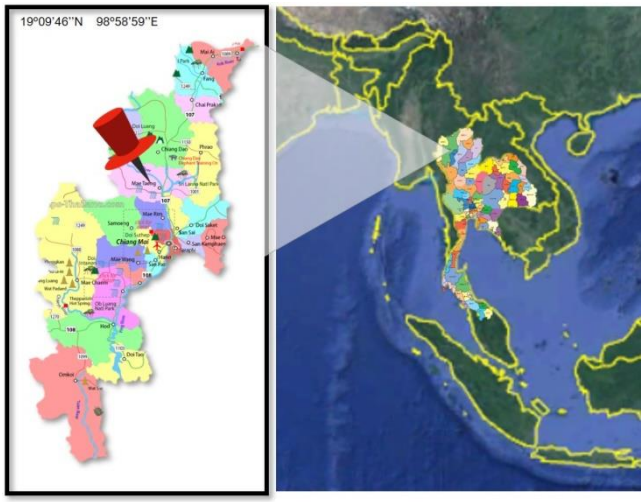

Fig. 1. Location of Muang Kaen Pattana Municipality, Chiang Mai Province, Thailand.

Soil samples from agrochemical and non-agrochemical use fields in the same geographic area of Muang Kaen Pattana Municipality, Chiang Mai Province, Thailand were collected during September 2017. Five replicates of soil per field were sampled from 10-15 cm below the surface of the soil using an auger covered with a polyethylene bag. The soil samples were analysed for their physicochemical properties, total bacteria colony counts, and residual agrochemicals, as follows.

The soil samples were analysed for soil texture, pH, organic matter, total nitrogen, available phosphorus and exchangeable potassium by following standard methods [7-10].

The total bacterial population was determined using serial dilution and the plate method on a Plate Count Ager [11].

According to the same agrochemical groups used by farmworkers, the three following compound groups were tested: total carbamate group (insecticide), glyphosate, and paraquat (herbicides). Five replicates for soil samples from agrochemical and non-agrochemical use fields were dried, ground and mixed. Solid phase extraction was used for separation, purification and pre-concentration of agrochemical residues before their detection by HPLC or GC, according to their appropriate standard method [12].

Data analysis

The quantitative data was analysed by using Statistical Program for Social Sciences (SPSS). Descriptive statistics including frequencies, mean, and measure of dispersion standard deviation were the most appropriate statistics for analysed the quantitative data. The knowledge of farmworkers analysed by frequencies and percentage of correct and wrong answer and analysed interval of mean scores in high medium and low knowledge level. The attitude of farmworkers analysed by frequencies, percentage and interval of mean is in high medium and low

attitude level. The behaviour of farmworkers are analysed by frequencies and percentage.

The difference in physicochemical properties and amount of cultivatable bacteria was tested by means of analysis of variance (one-way ANOVA). When the difference was significant, the means were compared by post hoc Duncan. All statistical analyses were performed using SPSS Version 21. Significance was set at p-value <0.05.

3. RESULTS AND DISCUSSION

Characteristics of the interviewees

The majority of the interviewees (n = 309) were male (58.90%). Most of them were more than 51 years old (70.55%). In the study of Öztaş et al., who evaluate farmworkers' knowledge, attitudes and behaviours about pesticide storage conditions, and safe use in Kayseri/Turkey, the manager of the farmworkers, found that average age of the famers in that study was 51.3 ± 8.6 year [3], which similar to our study. Age is a main factor for farmers' consciousness on the chemicals prohibition and approval. Aged farmers may not be cognizant of chemicals effects due to lack of knowledge [13]. The interviewees in this study were educated to at least primary school (73.47%). The result was similar to the study of Kalıpcı et al. [14], who investigate educational status, level of knowledge, and environmental sensitivity of the farmworkers in Konya. They reported that most of the farmworkers in that survey (55.8%) were primary school. The yearly per capita income was less than 50,000 baht or less than 1544.71 US$ per year (approximated from 32.37 baht: 1 US$) (Table 1). Most of them farmed in small areas (1-5 Rai or 0.16-0.80 Hectare; 65.06%) and most also did not own the land used for farming (67.96%). Most of them were traditional farmworkers with more than 20 years of agrochemical usage experience (48.54%). Farming experience is a main factor for increase production, effective input use, improve amount and quality of output, and successful costs mangament. Normally, it is predictable that the management ability of a farmer will be positively impacted by experience [3]. However, experience may also come with carefree and ignorane habit.

In Muang Kaen Pattana Municipality, Chiang Mai Province, Thailand, cropping intensity mainly involved cultivating different crops in a sequence over the course of a year (crop rotation). The major crops included rice, tobacco, corn, cassava, garlic and lettuce (Table 2). However, agrochemical usage in this area was not various. The main herbicides are glyphosate (50.81%) and paraquat (19.42%) and no uses herbicides (29.77%), while mainly insecticide is only carbamate, and fungicides farmworkers in Muang Kaen Pattana Municipality preferred to use dithiocarbamates over difenoconazole (Table 3).

Table 1: Farmworkers basic characteristics

Items	Details	n	(%)
1. Sex	Male	182	58.90
	Female	127	41.10
2. Age (years old)	Less than 40	23	7.44
	41 - 50	68	22.01
	Over 51	218	70.55
3. Highest educational level	Uneducated	47	15.21
	Primary school	227	73.46
	High school	12	3.88
	Diploma	23	7.44
4. Average income (USD per year)	Less than 1,600	106	34.30
	1,600 – 3,200	98	31.72
	3,201 – 6,400	42	13.59
	Over 6,400	63	20.39

Table 2: Occupational characteristics of farmworkers

Items	Details	n	(%)
1. Land right	Rent	210	67.96
	Own land	99	32.04
2. Area (hectare)	0.16 – 0.80	201	65.05
	0.81 – 1.60	57	18.45
	Over 1.61	51	16.50
3. Agrochem. use (years)	Over 20	150	48.54
	16 – 20	101	32.69
	10 – 15	51	16.51
	less than 10	7	2.26
4. Crops	Rice	119	38.51
	Tobacco	96	31.07
	Corn	87	28.16
	Cassava	79	25.57
	Garlic	62	20.06
	Lettuce	54	17.48
	Thai eggplant	23	7.44
	Yard long bean	22	7.12
	Sugar cane	22	7.12
	Soybean	20	6.47
	Others	3	1.29

Note: Sorted in percent ascending order.

Table 3: Agrochemicals usage of farmworkers

Agrochemicals	Company	n	(%)
1. Herbicides Glyphosate	Round up	157	50.81
Paraquat	Gramoxone	60	19.42
No used		92	29.77
2. Insecticides Carbamate	Lannate	300	97.08
	Sevin 85	9	2.92
3. Fungicides Dithiocarbamates	Dithane NT M-45	197	63.75
Difenoconazole	Score	112	36.24

Knowledge, Attitude and Behaviour, of Farmworkers

The interviewees were well informed that agrochemicals farmworkers have knowledge and attitude in medium and high level (Table 4 - 6). Most of them have correct answers about knowledge for agrochemicals usage, Knowledge for agrochemicals protection and Knowledge for agrochemicals and environment. However, some of them also lacked knowledge on how to use personal protection equipment and misunderstood the cross-contamination of agrochemicals spreading to surrounding areas. Although, some interviewees have showed concerns about toxic and harmful agrochemicals, intending to change to non-agrochemical methods. Only a few interviewees always behaved carefully in terms of agrochemical usage and waste management. Event for attitude of farmworkers, most of them agree with, although utilization of agricultural chemicals is an effective, convenient and quick method of pest control, it harmful to the health of users and causes residues in soil water and the environment. (Tables 7 and 8). It was the same phenomenon with the previous study found that farmworkers' attitudes on behavior was greatly influenced by their knowledge of pesticide hazards and the attitudes towards pesticide use was positively related with their knowledge of pesticide risks [15].

The label on the pesticide encourages in the appropriate manner of the pesticide [16]. The survey found that only 45.95% of the farmworkers in this study follow the label/instructions of the pesticide usage, which is relatively low compared to farmworkers in other areas. In the study by Gaber and Abdel-Latif, only 33.0% of the farmworkers in Mahmoudiya region, Egypt read the instructions before using pesticides [17], while 71.4% of the farmworkers in West Bank, Palestine and 73.0% of the farmworkers in Kayseri/Turkey always read the instructions [3].

The good practices for the harmless spraying of agrochemicals are rely on the right method of application, suitable protection equipment, and proper personal hygiene [20]. Unfortunately, most farmworkers in our survey still misunderstood about knowledge and practice for agrochemicals usage. Some of them ever used bare hands to mix the agrochemicals (21.36%). The chance of poisoning can be decreased by about 44%, if the person uses the protection equipment [21]; while, applying agrochemicals without protection causes significant negative impacts on the health of farmer [22]. Fortunately, most of the farmworkers in this study washed with soap immediately when agrochemicals contamination their body (74.11%). Previous study found that body cleaning after the application of agrochemicals can prevent the poisoning of farmer [21]. However, only two third of farmworkers in this study is checked wind direction before spraying and approximately half of them spay agrochemical in higher recommendation concentration. The most worrisome was almost of them never noticed other people after applying agrochemicals. These inappropriate practices may lead to dangerous for themselves, other nearby people, and environment. These results are similar to another study performed in other countries near Iran. Yilmaz [19] found that farmers in those area lacking in necessary knowledge or misunderstand on the agricultural chemical usages.

Storage and transport of pesticide together with food are strictly regulated by law in many countries. [23]. However, the farmworkers in our study showed that they are not only inappropriate agrochemical practices, but they also lack appropriate agrochemical waste management. Some of them reuse agrochemical containers. Most of them sell the empty container to garbage sorter or discard in the farm area.

In the developing countries, especially Thailand, the agrochemicals usage under unsafe conditions and inappropriate disposal of empty pesticide containers may lead to cause serious damage on agricultural workers' health. In order to mitigate this problem, it is necessary to educate them to improve attitudes and behaviors.

Effect of cross-contamination on non-agrochemical farming in the area

A few farmworkers in Muang Kaen Pattana Municipality tried to adapt their agriculture method without agrochemical usage. However, they struggled with cross-contamination from agrochemical use by other farmworkers' behaviour surrounding their farm area. One of the non-agrochemical use fields was located surrounded by agrochemical use fields (Fig. 2). Thus, this field was selected to study the effect of cross-contamination.

Fig. 2. Non-agrochemical use field located adjacent to an agrochemical use field.

It was found that the physicochemical parameters of soil from both fields were not significant except for exchangeable potassium in the non-agrochemical use field (99.48±0.11 mg/kg soil), which was significantly higher than that of the agrochemical use field (70.88±1.52 mg/kg soil) (Table 9). This may be because, in a non-agrochemical field, farmworkers use organic fertiliser rather than chemical fertiliser. The organic fertiliser is derived from the fermentation of bacteria consortium using organic matter. Some of the bacteria contain potassium solubilising properties, which may enhance exchangeable potassium in the soil [24]. This result was also supported by the number of cultivatable bacteria in non-agrochemical used field, which was significantly higher than that of the agrochemical use field (Table 10).

Table 4: Level of knowledge for agrochemicals usage of farmworkers

Knowledge interval scores	n	%	Level of Knowledge
5-10	145	46.93	Medium
11-15	164	53.07	High
Total	309	100	

Min score = 7, Max score = 14, Average score = 11

Table 5: General Knowledge of farmworkers for agrochemicals usage

Items	Answers	
	Correct	Wrong
1. Knowledge for agrochemicals usage		
1.1 Pest should be correctly identified before deciding on type of agrochemical	296 (95.79)	13 (4.21)
1.2 Mixing agrochemicals can enhance pesticide efficiency	258 (83.50)	51 (16.50)
1.3 Expired agrochemicals could be reused	238 (77.02)	71 (22.98)
1.4 Remained mixed agrochemicals could be used next time	120 (38.83)	189 (61.17)
1.5 Increasing of agrochemicals concentration could prevent and resolve pesticide resistance problem	103 (33.33)	206 (66.67)
2. Knowledge for agrochemicals protection		
2.1 Agrochemicals should be kept in close area and out of children's reach	294 (95.15	15 (4.85)
2.2 Inappropriate agrochemical practices may harm user health	271 (87.70)	38 (12.30)
2.3 Agrochemicals can enter body through skin, ingestion, or inhalation.	251 (81.23)	58 (18.77)
2.4 Position for agrochemicals spraying is not limited from wind direction	229 (74.11)	80 (25.89)
2.5 Protective equipment should be used only when spraying agrochemicals	149 (48.22)	160 (51.78)
3. Knowledge for agrochemicals and environment		
3.1 Wash or discard agrochemical containers in natural resources may affect aquatic organisms	308 (99.68)	1 (0.32)
3.2 Using agrochemical may lead to natural soil infertility	273 (88.35)	36 (11.65)
3.3 Empty agrochemical containers should not be used to store food or drinking water	269 (87.06)	40 (12.94)
3.4 Long-term using agrochemicals may cause agrochemicals remaining in soil and water	262 (84.79)	47 (15.21)
3.5 Agrochemicals contamination may occur only in spraying area	86 (27.83)	223 (71.17)

Min score = 7, Max score = 14, Average score = 11

Table 6: Level of attitude of farmworkers for agrochemicals usage

Items	Farmworkers Opinion			$\bar{X}$ ±S.D.	Level of Attitude
	Agree	Not sure	Not agree		
1. Use of agricultural chemicals is an effective, convenient and quick method of pest control.	295 (95.47)	11 (3.56)	3 (0.97)	2.94 ±0.05	High
2. Improper use of agricultural chemicals is harmful to the health of users.	271 (87.70)	0 (0)	38 (12.30)	2.75 ±0.24	High
3. Correct use of agricultural chemicals will not be detrimental to the health of users.	230 (74.43)	79 (25.57)	0 (0)	2.74 ±0.25	High
4. The use of large quantities of agricultural chemicals causes residues in soil and water.	235 (76.05)	35 (11.35)	39 (12.06)	2.63 ±0.30	High
5. All kinds of agricultural chemicals are toxic to the human and the environment.	222 (71.84)	13 (4.21)	74 (23.95)	2.48 ±0.46	High
6. The use of large amounts of agricultural chemicals yields good yields.	180 (58.25)	58 (18.77)	71 (22.98)	2.35 ±0.63	High
7. Wearing a mask, gloves, and clothing completely while spraying chemicals makes it gulp.	103 (33.33)	194 (62.78)	12 (3.88)	2.29 ±0.54	Medium
8. The use of agricultural chemicals resulted in a high yield, on-toxic.	143 (46.28)	38 (12.30)	128 (41.42)	2.05 ±0.94	Medium
TOTAL	1,679 (67.92)	428 (17.31)	365 (14.77)	2.53 ±0.42	High

Table 7: Behaviour of farmworkers for agrochemicals usage

Items	n	%
1. How to know the method for use of new agrochemical		
- Use old experience	157	50.81
- Read the label	142	45.95
- Ask some friend	10	3.24
2. Have you ever mixed agrochemicals by bare hand		
- Never	243	78.64
- Sometime	43	13.92
- Frequently	23	7.44
3. Have you ever mixed agrochemicals for one spraying		
- Never	202	65.37
- Sometime	85	27.51
- Frequently	22	7.12
4. When agrochemical contaminate your body while mixing you will		
- washed with soap immediately	229	74.11
- clean with cloth or tissue paper	55	17.80
- leave it	25	8.09
5. Have you ever checked wind direction before spraying the agrochemicals?		
- Always	207	66.99
- Sometime	102	33.01
- Never	0	0
6. How many amount of agrochemical was use in each spraying ?		
- Equal to the recommendation	167	54.05
- More than the recommendation	141	45.63
- Less than the recommendation	1	0.32
7. After spraying agrochemical, have you placed the notice board to other people		
- Always	0	0
- Sometime	2	0.65
- Never	307	99.35

Table 10: Number of bacteria and agrochemical residue in soil from agrochemical and non-agrochemical use fields

Parameters	Agrochemical used field	Non-agrochemical used field
Number of cultivatable bacteria $x10^6$ (CFU/g soil)*	0.7-3.0 (1.94 ± 0.89)[a]	7.6-52.3 (18.88 ± 4.98)[b]
Paraquat (mg/kg soil)	4.61	5.47
Glyphosate (mg/ kg soil)	<0.003	ND
Carbamate group (mg/ kg soil)	ND	ND

*Data represented in min-max and (mean±SD, n = 5), while a and b indicate the significant difference of mean value at $p<0.05$ by one-way ANOVA using post hoc Duncan test. ND = non-detectable.

It must be noted, however, that paraquat could be detected in both the agrochemical and non-agrochemical use fields, while glyphosate could be detected only in the agrochemical use field. However, carbamate groups were not detected in either the agrochemical or non-agrochemical use fields (Table 7). Previous study estimated paraquat half-life in the soil of Thailand was 36-46 days. Thus, the paraquat residue in both fields should be recently contaminated for control of weeds in the fields. The low concentration of glyphosate residue in the agrochemical use field may be from previous usage. The typical half-life of glyphosate in soil is 151 days and has been reported elsewhere [24]. Carbamate groups include rapid degradation agrochemicals. The half-lives of carbaryl in soil are only 8 to 18 days. Perceived from Figure 3, the rice in those fields was not invaded by pests. Consequently, insecticide had not yet been applied. Thus, it was the reason for non-detect carbaryl group in those fields.

It was clear that some agrochemicals could contaminate the surrounding area. This may be the effect from cross-contamination due to lack of knowledge and good practices on agrochemical usage. Most of farmworkers acknowledge harmful of agrochemicals to health and environment, but agree to use them because of an effective, convenient and quick method of pest control. The result was congruent with the study of farmworker's behaviour in agrochemical use in China, which found that older farmworkers had more difficulty following instructions on agrochemical use, leading to incorrect behaviour [25]. Most of the young people in Thailand currently do not prefer to work in agriculture and leave the elderly to work in the fields. It should be concerning that the elderly farmworkers who had limits on education and economic status tended to be less willing to reduce or even be concerned about appropriate use of pesticides. This is likely because of the fear of low profits and strong behaviour by the perception of the consequences of their habituation.

Table 8: Behaviour of farmworkers for agrochemicals waste management

Items	n	%
1. Reuse of agrochemical containers		
- Always	15	4.96
- Sometime	42	13.59
- Never	252	81.45
2. Discard in a special area for agrochemical containers		
- Always	8	2.48
- Sometime	75	24.27
- Never	226	73.25
3. Destroy and bury underground		
- Always	1	0.32
- Sometime	25	7.98
- Never	283	91.69
4. Sell to garbage sorter		
- Always	143	46.39
- Sometime	86	27.83
- Never	80	25.78
5. Discard with household garbage		
- Always	50	16.29
- Sometime	209	67.75
- Never	49	15.97
6. Discard in the farm area		
- Always	86	27.94
- Sometime	132	42.83
- Never	90	29.23
7. Burning		
- Always	82	26.54
- Sometime	42	13.48
- Never	185	59.98

To diminish such dilemmas, previous studies have proposed excessive training and supervising for local agrochemical retailers, educating farmworkers, and improving information transparency among farmworkers, local retailers and the staff of the Government Agricultural Service. In addition, they also recommended promoting the use of protective behaviours and good agrochemical practices among farmworkers [26]. Besides personal education, land management should be processed concurrently. The impact of alternative land management on increasing production and paying attention to the environment as well as the profitability of commercial

agriculture were reported by others [27]. Computational modelling of land management found that changes in land use and agricultural practices could result in environmental improvements while also making economic sense. However, the research of this topic requires a significant amount of multidisciplinary information, including social and environmental aspects of the watershed, which comprises several studies carried out in Thailand.

Table 9: Physicochemical parameters of soil from agrochemical and non-agrochemical use fields

Parameters	Agrochemical used field	Non-agrochemical used field
Temperature (°C)	30±0.50[a]	28±0.50[a]
pH	5.18±0.01[a]	5.10±0.01[a]
Organic matter (%)	2.70±0.01[a]	2.46±0.01[a]
Total nitrogen (%)	0.14±0.01[a]	0.12±0.01[a]
Available phosphorus (mg/kg soil)	34.19±0.39[a]	34.71±0.29[a]
Exchangeable potassium (mg/kg soil)	70.88±1.52[a]	99.48±0.11[b]

*Data represented in mean±SD (n=3), while a and b indicate the significant difference of the mean value±SD at $p<0.05$ by one-way ANOVA using post hoc Duncan test.

4. CONCLUSION

Carefree knowledge attitudes and behavior of agrochemical use may result in risk to unsafe work habits and harm to farmworkers' health as well as the surrounding environment. The result analysis of soil sample from agricultural area showed that chemical usage made exchangeable potassium reduce in the soil as well as number of cultivatable bacteria. Inadequate protective behaviour and inappropriate agrochemical management were mainly caused by insufficient knowledge and pursuit of maximised profit and remuneration from agrochemical compensation. The important in protection form pesticide exposure are using of protective equipment and habit in good personal hygiene. In this regard, it should be ensured that farmworkers are provided with personal protective equipment as suitable on each pesticide. The easy-to-understand guidelines on protective measures must be available in the pesticide boxes holding hazardous substances, dangerous goods. Farmworkers should receive health education on safe use of pesticides. Furthermore, the farmworkers in our study recommended that the additional solid waste collection systems are also necessary for local administrations to work through healthy and safe disposal of pesticide wastes. It should be noted that knowledge attitude and behavior of farmworkers may cause cross-contamination from inappropriate agrochemical usage and waste management. It may affect to unsustainability of non-agrochemical or organic farming in those areas. To solve this problem, community education on agrochemical usage and management, along with area organization in land use or agricultural practices, should be performed simultaneously.

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