KNOWLEDGE, ATTITUDE AND PRACTICES IN INSECTICIDE USE, SERUM CHOLINESTERASE LEVELS AND SYMPTOM PREVALENCES AMONG SHOGUN ORANGE FARMERS IN KHAO-PHANOM DISTRICT, KRABI PROVINCE THAILAND, 2012

Paisit Boonyakawee[1, 2], Surasak Taneepanichskul[1, *], Robert S. Chapman[1]

[1]College of Public Health Sciences, Chulalongkorn University, Bangkok 10330, Thailand
[2]Songprage Health Center, Muang District, Krabi 81000, Thailand

ABSTRACT: A cross-sectional study was conducted among Shogun orange farmers in Khao-phanom district, Krabi province in April 2012. The study aims were to study the association between insecticide-related symptoms with socio-demographic characteristics and insecticide use and to understand the association between insecticide-related knowledge, attitude, and practices with symptoms and serum cholinesterase (SChE) levels. The study population included 128 Shogun orange farmers and from this the sample size was calculated as 68 to detect the observed differences with alpha = 0.05 and power = 80 %, used open Epi version 2 based on a previous study. Ninety two subjects were included and this was sufficient to detect most of the pesticide exposure-related differences in health effects (neuromuscular symptoms). The questionnaire was modified from those used in the Agricultural Health Study in America and in another local study and the reliability of the instrument tested. The survey had four parts - 1) Socio-demographic characteristics, 2) 15 close-ended questions regarding knowledge in insecticide use 3) 26 questions regarding attitude in insecticide practice and 4) 34 questions regarding practices in insecticide use. The farmers were also screened for serum cholinesterase levels which were graded as- normal (≥ 100 units/ml), safe (87.5-99.9 units/ml), risky (75-87.4 units/ml) and unsafe (≤75 units/ml) levels. The chi square test was used to evaluate the relationship between knowledge, attitude and practices and cholinesterase levels. The survey revealed that 51.1% of farmers used insecticides for more than 5 years, and 56.5% used insecticide more than 15 times a year, dissolved in water on average of 252.17 cc/rai. 62.0% sprayed insecticide > 4 hrs a day and 88.0% had most recently contacted insecticides < 7 days ago. 83.7% of subjects had unsafe SChE levels and 85.9% of farmers used carbamates. Farmers who usually used personal protective equipment had better SChE levels than those who did not (negatively association, p=0.001). Knowledge and practice of insecticide use had limited association with symptoms but good attitude had lower insecticides related symptoms than average or low attitude (negatively association) - neuromuscular (p=0.008), respiratory (p=0.047), eyes (p=0.021) and skin (p=0.028). Practice of insecticide use and attitude were positively associated (p<0.001) but knowledge was not associated with practice (p=0.529). The study reveals that Shogun orange farmers in Khao-Phanom district, Krabi province, were exposed to high levels of pesticides. Although they had knowledge about insecticides, they did not have safe practices. In order to promote farmers' health, personal protective equipment use, and safe practices in insecticide use should be reinforced.

Keywords: Insecticide, Insecticide-related symptoms, Serum cholinesterase, Health effects, Orange farmers

INTRODUCTION

Exposure to insecticides through consumption of fruits is widespread, either as a result of direct application or due to environmental cross contamination. Fruits are often subjected to pre and post-harvest treatment with insecticides, particularly organophosphates, carbamates and pyrethroids are routinely applied to fruit crops to achieve broad spectrum insect control [1]. Citrus fruit crops like mandarin oranges, shogun oranges, lemons and pomelo are some of the most economical fruit crops grown in many regions of Thailand but the problem of pests exist.

The insect pests that commonly affect citrus crops in Thailand are composed of 23 species in 6 orders-

* *Correspondence to: Surasak Taneepanichskul*
E-mail: surasakta@yahoo.com

Thysanoptera, Homoptera, Hemiptera, Coleoptera, Lepidoptera and Dipteral and vary according to the kind of citrus fruit and area of cultivation [2]. Citrus growers regularly use chemicals to control pests. Repeated usage can cause resistance, leading to increased amounts of insecticide use.

Shogun oranges are one of the most common products seen in the One Tumbol One Product (OTOP) project shops in Krabi province. In the Khao-phanom district of Krabi, 80% of the plantation area was used to produce Shogun oranges. In the year 2000, the surveillance report from the province showed that people from this region were getting ill from their occupation [3]. According to the Epidemiological Surveillance Report released by the Department of Epidemiology, occupation related illness was seen in 4337 patients and insecticide related poisoning was the cause in 71.68% of nationwide cases [3]. The 2001 Fiscal Year Report by the Department of Sanitation reported that there were 21 deaths due to pesticide poisoning and the morbidity ratio from pesticide poisoning was 15.43:100,000 [4]. In 2001-2002, there were two patients in Krabi province [4] and thirteen patients among Shogun orange farmers in Khao-phanom district [5]. In the year 2011, the report "Healthy Farmers & Safety Consumers", from the Public Health Office in Krabi province showed unsafe levels of serum cholinesterase [6], that farmers were screened for serum cholinesterase levels by reactive paper test {sensitivity in field=77.04%, specificity in field=90.01% and Positive Predictive Value in field=90.38%} [7]. Out of 743 Krabi farmers screened, 204 (27.46%) had unsafe cholinesterase levels [6]. These reports suggest that the farmers are at risk of both short term and long term health impairment due to exposure to insecticides.

In recent years though there have been efforts to improve food safety and improve public health both of the farmers and consumers, high insecticide use still exists. The health risks to the farmers (high pesticides use) and health risks to consumers (due to high residue levels in the produce) are important public health problems. To develop effective solutions for this, we need to understand the knowledge, attitudes and practices of the farmers regarding insecticide use.

Since reports showed that insecticide-related illnesses were common in Shogun orange farmers, this study was conducted in that population. The aim of this study was to understand the attitude, perceptions and knowledge of the Shogun farmers towards insecticide use, understand the health effects of insecticide use, and to explore the association of health symptoms to insecticide levels using serum cholinesterase.

MATERIALS AND METHODS

This cross sectional study was conducted in Krabi province among the Shogun orange growing farmers. Preliminary data were collected from the website of the Krabi Agricultutal Office Registry. There were a total of 9 Shogun orange farms, and the information of all the farmers working or employed in these farms were retrieved. The study population included 128 farmers in 4 districts in Krabi province (Muang, Klong Thom, Khao-Phanom, Nuea Klong) Shogun orange farmers and from this the sample size was calculated based on a previous study [8] to detect differences with alpha = 0.05 and power = 80%, using OpenEpi version 2 program. Though the sample size needed was sixty eight, 92 subjects from Khao-Phanom district were included and the remaining farmers from the other areas were excluded. This sample size was sufficient to detect most of the pesticide exposure-related differences in health effects that had been observed in previous studies. The study consisted of a questionnaire survey and measurement of serum cholinesterase levels. The questionnaire was adapted from the Agricultural Health Study in America [9] and a local study [8]. The questionnaire was validated with pilot testing for clarity and reliability on 30 farmers in Prasang district, Suratthani province, by the first author. Pilot testing showed good reliability with Cronbach's alpha value of 0.881. The survey of the farmers was conducted by a team of 8 members which included health officers and researchers from the District. All participants signed an informed consent form, and the study protocol was approved by the Institutional review board of the College of Public Health Sciences, Chulalongkorn University.

The survey had four parts (a) socio-demographic characteristics - gender, age, education, smoking history, drinking alcohol, health status, work characteristics, duration of work, duration of insecticide use (b) knowledge of insecticide was assessed using 15 close-ended questions (c) attitude to insecticide practice had 26 questions in a rating scale of 1-5 (points were given for positive direction; 1mark-totally disagree to 5marks-totally agree, for negative direction; 1mark-totally agree to 5marks-totally disagree) (d) practices in insecticide use was analyzed using 34 questions in a rating scale of 1-5 (never, rarely, sometimes, often, usually with 1-5 points respectively, alternated when negative direction) and then classified as good (<80% score), need to improve (60-79%) and

Table 1 Participants' descriptive characteristics (N=92)

General information	Total (N=92)	%	General information	Total (N=92)	%
Age group (year)			**Insecticide use**		
≤ 34	30	32.6	Do not use	11	12.0
35 – 44	28	30.4	Only sprayed or mixed	35	38.0
45 – 54	22	23.9	Both mixed and sprayed	5	5.4
≥ 55	12	13.0	Do not spray/mix but go into pesticides using area	64	69.6
Mean =40.92, SD. =12.082 , Minimum =18 , Maximum =70			**Duration of insecticide use (in years)**		
Gender			1 – 5	45	48.9
Male	49	53.3	6 – 10	29	31.5
Female	43	46.7	≥ 11	7	7.6
Domicile (Region of Thailand)			Mean=5.58, SD. =4.608 (Min= 1, Max = 20)		
Northern	3	3.3	**Trained in insecticide use**		
Central	7	7.6	Yes	12	13.0
Northeast	80	87.0	No	80	87.0
Southern	2	2.2	**Insecticide use- frequency (no of times per year)**		
Education			1-3	4	4.3
No formal education	14	15.2	4-6	5	5.4
Grade 4	32	34.8	10-12	8	8.7
Grade 5 or 6	35	38.0	13-15	12	13.0
Grade 7 and above	11	12.0	> 15	52	56.5
Smoking history			**Pesticide types used**		
Current smoker	38	41.3	Insecticides	79	85.9
Ever smoker	7	7.6	Herbicides	14	15.2
Non smoker	47	51.1	Fungicides	31	33.7
Quantity (no/day)			Rodenticides	10	10.9
≤ 10 cigarettes	20	44.4	None	11	12.0
≥ 11 cigarettes	25	53.5	**Quantity of insecticide used each time (approx cc/rai)**		
(Mean =6.62, SD. =8.283, Minimum =0, Maximum =30)			1 – 500	35	76.0
Drinking alcohol			≥ 501	11	24.0
Never or < once a month	47	51.1	Mean=252.17, SD.=408.825, (Min=200, Max=2,200)		
1-3 times/month	17	18.5	**Time of insecticide spraying**		
At least Once/week	10	10.9	Before 8 am.	24	34.8
2-4 times per week	9	9.8	8 am.-12 pm.	24	34.8
Daily	9	9.8	12 pm.-4 pm.	3	4.3
Quantity of alcohol			After 4 pm.	18	26.1
None	39	42.4	**Contact with insecticides (hrs/day)**		
1 or 2 drinks/day	44	47.8	None	28	30.4
3 – 4 drinks/day	4	4.3	< 2 hrs	1	1.1
≥5 drinks/day	5	5.4	2-4 hrs	6	6.5
SchE levels			>4 hrs	57	62.0
Risky (75-87.4 units/ml)	15	16.3	**Last contact with insecticides (no of days ago)**		
Unsafe (< 75 units/ml)	77	83.7	1 – 7	81	88.0
Other illness			≥ 8	11	12.0
None	81	88.0	Mean =4.51, SD.=4.754, (Min=1, Max=30)		
Getting ill	11	12.0	**Chemical fertilizer use**		
Work characteristic			Yes	74	80.4
Self cultivation	10	10.9	No	18	19.6
Employee	92	100.0	**Use mosquito coils**		
Growing other crops (apart from Shogun orange)			Yes	17	18.5
Paddy field	3	3.3	No	75	81.5
Oil Palm	26	28.3	**Spray insecticide at home**		
Para Rubber	1	1.1	Yes	42	45.7
No of years in agriculture			No	50	54.3
1 – 10	54	58.7			
11-20	30	32.6			
≥ 21	8	8.7			
Mean =11.66, SD. =6.594, Minimum = 2, Maximum =35					

Table 2 Relationship between insecticide attitude and insecticide practice

Attitude	Practice			
	Have to Improve or Average		Good	
	(n=73)	(%)	(n=19)	(%)
Have to improve or Average	65	89.0	**7**	36.8
Good	8	11.0	12	63.2

$p < 0.001$* by Fisher's Exact Test.

Table 3 Relationship between wearing PPE and SChE level

SChE level	Wearing PPE						*p-value*
	Never/Rarely/ Sometimes (n=44)		Often (n=30)		Usually (n=18)		
	N	%	N	%	N	%	
Risky	1	2.3	8	26.7	6	33.3	0.001*
Unsafe	43	97.7	22	73.3	12	66.7	

* Fisher's Exact Test.

poor (<60%). The farmers were also screened using a colorimetric reactive paper test to measure serum cholinesterase levels and were graded as - normal (≥ 100 units/ml), safe (87.5-99.9 units/ml), risky (75-87.4 units/ml) and unsafe (≤75 units/ml) levels.

Descriptive statistics were used to describe the mean, frequency, percentage, standard deviations for data on general information, knowledge, attitude, behavior and symptoms. Inferential statistics were used to compare symptoms at different levels of exposure, to examine symptoms in relation to general characteristics and to relate knowledge, attitude, and practice about insecticide use with SChE level was done by Chi-square test (for categorical dependent variables). P-values < 0.05 were considered statistically significant. Data analysis was conducted using SPSS (version 17).

RESULTS

General data: Table 1 summarizes characteristics of the study subjects. All the farmers were employed only in agricultural sector and 58.7% had done agriculture less than 10 years. The average age of the subjects was 40.92 years, 67.4% were older than 34 years, 87% came from the northeast of Thailand, 38 % had education level of 6^{th} grade and 58.7% were current non smokers. About 53.5% of current smokers consumed an average of >10 cigarettes per day. Over a half of subjects (51.1%) drank any kind of alcoholic beverage less than one time in a month.

Insecticide use: Most of the farmers (88%) used insecticides, 51.1% had used insecticide for more than 5 years and 56.5% had used insecticides >15 times in a year. Most of them (80.4%) used chemical fertilizers, 15.2% used herbicides and 45.7% sprayed insecticide at home. Eighty eight percent of farmers had used insecticide in the last 7 days. Only 13% of the farmers had been trained in insecticide use. Seventy six percent of farmers dissolved insecticide in water and the mean amount sprayed was 252.17 cc/rai (SD 408.82 cc/rai), and most usually sprayed insecticide before 12.00 noon. SChE levels were high in this group. 83.7% had unsafe levels and none had normal or safe levels.

Knowledge attitude and practice: Table 2 shows that attitude was positively and statistically significantly associated with insecticide practice ($p<0.001$). But the chi-square test between knowledge in insecticide use and attitude towards insecticide use showed no relationship ($p = 0.613$) and knowledge in insecticide practice had no significant relationship with practice ($p = 0.529$).

Health effects of insecticide use: A total of 30 symptoms were considered as potentially related to pesticide exposure. These were classified into 5 groups according to body system – a) digestive symptoms: stomach ache, diarrhea, numbness of tongue, nausea, vomiting, b) respiratory symptoms: difficulty in breathing, runny nose, dry throat, sore throat, cough, chest pain and wheezing, c) neuromuscular symptoms: headache, twitching of muscles, sweating, excess salivation, weakness, muscle cramps, staggering gait, dizziness, urination, tremors, numbness in arms/legs, slow heart beat, d) eyes: irritation, watering of eyes, blurred vision and e) skin: rashes, itching. Headache was the most common symptom, seen in 69.6% of subjects.

Table 3 shows that subjects who usually or often wore Personal Protective Equipment (PPE) while using insecticides had negative, significant association with SChE levels ($p = 0.001$) and suggests that orange farmers who wore PPE had lower prevalence of unsafe SChE than those

Table 4 Relationship between symptoms and attitude towards insecticide use

Symptoms	Attitude towards insecticide use				*p-value*
	Have to improve to Average (n=72)		Good (n=20)		
	N	%	N	%	
Neuromuscular	65	90.2	12	60.0	0.008
Respiratory	57	79.1	11	55.0	0.047
Digestive	32	44.4	7	35.0	0.329
Eyes	54	75.0	9	45.0	0.021
Skin	54	75.0	10	50.0	0.028

who did not.

Table 4 shows relationship between insecticides related symptoms and attitude in insecticide use. The results show that insecticide related symptoms had a negative significant relationship with attitude in insecticide use. Persons who had better/good attitude level had lower insecticide-related symptoms than those who had average or low attitude. The most significant association was seen with neuromuscular symptoms (p=0.008) but eye symptoms (p=0.021), respiratory symptoms (p=0.047) and skin symptoms (p=0.028) were also significant but digestive symptoms did not show any relationship towards attitude in insecticide practice level (p=0.329).

DISCUSSION

The use of insecticides was high among the shogun orange farmers and only 13% of the farmers did not use them. Many of them were not trained in proper use of insecticides (87%) and frequency of use was also high (15 times or more per year). The study shows that knowledge about insecticides had little or no relationship towards attitude of insecticide and practice among the Shogun orange farmers. But farmers with good attitude towards insecticides followed better practices and this suggests that, in this group at least, practice (behavior) is controlled more by attitude than by knowledge. But one more factor plays an important role in the influencing knowledge attitude and behavior. Education level of the farmers had significant association with knowledge of insecticide use (p<0.001), but did not seem to have any meaningful influence over attitude (p= 0.431) or practice (p=0.287) of insecticide use. This is consistent with an earlier study by Thepsiri that education was related to knowledge and attitude but not related to practice [10].

Many of the Shogun orange farmers were in the agricultural sector for more than 10 years and were being exposed to insecticides. But many of the famers who have been in agriculture for less than 10 years also faced symptoms due to insecticide use and this was related to the quantity of insecticide used. Farmers who mixed more than 500 cc. of insecticides per rai had significantly higher pesticide-related symptoms than farmers who mixed less. The major symptoms seen in the farmers were headache (47.8%), and itching/rashes (27.2%).

Apart from the quantity of insecticide another factor of which caused more ill effects was the manner in which the insecticides were applied. Farmers who sprayed insecticides had significant symptoms like neuromuscular and eye symptoms compared to farmers who did not spray but used other forms of insecticide application. The symptom prevalence was generally directly associated with duration of using insecticides. Subjects who had long using insecticides had more symptoms than using insecticides a few years. The highest percentage of symptoms was found in the farmers who used or were in contact with insecticides within 1-7 days. The latest time that used and/or contacted insecticides had association with symptoms in accordance with Yassin et al. [11], Farahat et al. [12] and Thepsiri [10] that the insecticide-related symptoms was dependent on time and frequency of insecticide usage in a year. Therefore the quantity and methods of insecticide application are important factors that affect the health of the farmers.

The study also underscores that many of the farmers (77%) had unsafe levels of serum cholinesterase levels and 15% had risky levels. The use of personal protective equipment (PPE) during insecticide application was also low - only 20% used every time and 32% used sometimes, the rest of the farmers were inconsistent with PPE usage. Farmers who wore full PPE while applying insecticides had better levels of SChE and had fewer insecticide related symptoms than farmers who did not use PPE. Wearing hat (p=0.003), mask (p=0.047) and rubber napkin (p=0.004) had negatively significant relationship with SChE levels and shows that wearing hat, mask, rubber napkin while applying insecticides are protective

to health of the farmers.

The Shogun orange farmers in Khao-phanom district are exposed to substantial levels of insecticide and need to be protected from their ill effects. Though knowledge is important but a good attitude can have a stronger influence on behavior than knowledge. Perhaps a positive attitude reinforces knowledge by enabling individuals to think more carefully before they act and protect themselves from insecticide exposure. Using personal protective equipment is extremely important especially in the farmers who are in direct contact with the insecticides while using sprayers.

CONCLUSION

In order to promote safe farming, personal protective equipment use, safe practices and attitude in insecticide use should be reinforced to promote better health of the farmers. Apart from imparting knowledge, training models which incorporates components like behavior need to be delivered to bring about behavioral change.

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