Journal of Pakistan Association of Dermatologists. 2022;**32(3)**:517-525.

Original Article

Pesticide management knowledge, attitude and practices in Indonesian vegetable farmers with Occupational Skin Disease in Magelang, Central Java

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Abstract

Background Agriculture is a significant sector in Indonesia with almost 35.76 million labors involved and pesticides are widely used to increase yields. However, pesticide exposure due to improper application, inappropriate storage practices and substandard use of protective equipment may produce a number of occupational skin problems. This study aims to assess the knowledge, attitude, and practices (KAP) of pesticide management and the prevalence of occupational skin diseases related to pesticide exposure in Ngablak, Magelang.

Methods We conducted a cross-sectional study involving 105 vegetables farmers from 3 hamlets. Data were collected through workplace observation, guided interviews by questionnaires, and dermatology examination.

Results Most of the farmers (89.5%) sprayed pesticide in the morning and 89.5% farmers spent less than five hours of spraying. Majority of farmers (64.8%) mentioned not to spray pesticide against wind directions. The percentage of respondents who comprehend the information listed in pesticides labels are low (22.8%). The prevalence of skin disease related to the pesticide was 42.9% of the farmers with 11.4% had pesticide contact dermatitis. The moderate of farmers are aware of dosage and direction of use, but they do not acknowledge emergency information, approval number, the date of manufacture and expiry date as listed in pesticide labels.

Conclusion The KAP of pesticide management among vegetable farmers is low with high prevalence of occupational skin disease related to pesticide exposure in Ngablak, Magelang.

Key words
Occupational skin disease, pesticide, KAP, personal protective equipment, vegetable farmers.

Introduction

Indonesia, the largest archipelago in the world, has more than a quarter of its total area as agricultural land.[1] According to Indonesian Ministry of Agricultural Strategic Plan 2015-2019, agriculture has continuously become an important sector for nation development. Agriculture had generated 35.76 million labors, that is 30.2% of total nation labors.[2] In Magelang regency, Central Java, agriculture is the main industry where 35.8% population aged 15 years and over are farmers, alongside with

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forestry labor, hunter and fish farmer. One of the agricultural areas of Magelang is Ngablak with 28,860m^2 of farming fields.[3]

In order to improve the yield and maintain the quality of product, pesticides are widely used in most sectors of agricultural production.[4] The total of world pesticide usage in 2012 spent nearly $56 billion or equivalence to 6 billion pounds. Herbicides was the largest portion of the global usage of pesticide in 2008-2012 (50%), followed by fumigants, insecticides and fungicides, respectively.[5] In 2016, there are 3.207 pesticides registered in Indonesian Ministry of Agriculture which have grown from 1.577 in 2006.[6,7]

Despite the substantial benefit of pesticide usage to the yield production, extensive and inappropriate use of pesticide has become serious concern to human health. Insecticides, herbicides, molluscicides and fungicides that are widely used in developing agricultural countries are toxic to humans.[8] Incompliance usage of banned hazardous chemical, improper application and storage and inadequate spraying equipment produce a number of poisonings. Routine usage of pesticides poses major health risks to farmers both in short and long term period.[4] Study in United States from 1998-2005 showed that among 3.271 acute pesticide poisoning cases in agricultural farmers, 87% cases were eye, skin, and upper respiratory irritation, 12% cases were systemic illness and required medical treatment, 0.6% cases were life-threatening illness which required hospitalization, and there was one fatal case caused by methomyl, suspected due to the violation of safety pesticide regulation.[9]

Pesticides are irritant, sensitizer, photohapten and carcinogenic agents which may cause skin problems. Pesticide-related occupational skin diseases (OSDs) include chemical burns, irritant contact dermatitis (ICD), phototoxic contact dermatitis, allergic contact dermatitis (ACD), photoallergic contact dermatitis, urticaria, erythema multiforme, ashy dermatosis, porphyria cutanea tarda, pigmentation disorders, nail disorders, hair disorders, non-melanoma skin cancer and melanoma.[10] Statistical data from 1975 to 2000 by Department of Dermatology, Saku Central Hospital, Japan obtained 394 pesticide related dermatitis in which 54% of them were acute contact dermatitis and 21% were chronic dermatitis.[11]

The aim of this study is to assess the knowledge, attitude, and practice (KAP) of pesticide management and the prevalence of OSDs related to pesticide exposure among vegetable farmers in Ngablak district, Central Java.

Methods

We conducted an observational cross-sectional study in Seloprojo village in Ngablak districts, Magelang, Central Java, Indonesia. We recruited 105 vegetable farmers from three hamlets of Seloprojo village: Ngaglik, Pernolo, and Seloprojo. The inclusion criteria were vegetable farmers who used pesticides in their routine. Data were collected through workplace observation, guided interviews by questionnaires, and dermatology examination.

The routines of vegetable farmers who used pesticide were observed including preparation which consisted of the mixing and loading process, spraying process in the crop field, cleaning and disposing after finishing the pesticide management. All data during observation were documented by research team.

Guided interviews were conducted with two type of questionnaires. The first questionnaire consisted of points related to demographic data and KAP regarding pesticides and pest

management. The second interview was a translated and modified version of the standard Nordic Occupational Skin Questionnaire NOSQ-2002. Dermatological examinations and guided interview were carried out by dermatologist and trained team to assess OSDs. Any skin problems related or non-related to pesticides were noted and documented.

The interpretation of farmers' knowledge regarding pesticide management was based on to Prijanto study in 2009.[12] Sufficient knowledge in this study was attributed to vegetable farmers who could answer accurately at least 75% of total items in each group of questions.

Results

Of the 105 vegetable farmers, the majority (24.8%) were between the ages of 30 and 39, and 20% farmers were older than 59 years old. There were 75.2% male farmers and 24.8% female farmers in this study. Most vegetable farmers in this study were elementary school graduate (n=64.61%). Summary of demographic data in this study can be seen in **Table 1**.

Table 1 Subject characteristics.

	N	*%*
Gender		
Male	79	75.2
Female	26	24.8
Age range (years)		
20-29	5	4.8
30-39	26	24.8
40-49	33	31.4
50-59	20	19
60-69	13	12.4
70-79	4	3.8
80-89	3	2.9
90-99	1	1
Educational level		
Illiterate	12	11.4
Elementary	64	61
JHS	22	21
SHS	7	6.7
Marital		
Single	1	1
Married	104	99

Table 2 Active ingredients of pesticide frequently use among vegetable farmers in Ngablak collected by integrated interview

Pesticide	*Active Ingredients*	*Type of pesticide.*	*n*	*%*	*WHO Classification**
Insecticide	Cypermethrin	Tiosianat	12	11.4	II
	Chlorpyrifos	Organofosfat, piridin	10	9.5	II
	Lambda cyhalothrin	Piretroid, trinlarometil	26	24.8	II
	Profenofos	Organofosfat	23	21.9	II
	Methomyl	Karbamat	1	1	Ib
	Abamectin	Avermektin	6	5.7	Not listed
	Imidacloprid	Neonicotinid	5	4.8	II
	Deltamethrin	Piretroid	2	1.9	II
	Emamectin benzoat	Avermektin	3	2.9	Not listed
	Lufenuron	Urea	3	2.9	Not listed
	Chlorantraniliprole	Urea, trifluorometil	2	1.9	IV
	Acephate	Organofosfat	1	1	II
	Cartap hydrochloride	Karbamat	1	1	II
	Dimehypo	Neristoksin	1	1	Not listed
Fungicide	Propineb	Karbamat, organoseng	16	15.2	IV
	Mefenoxam	Pirimidin	3	2.9	Not listed
	Cymoxanil	Triazol; organo-silikon Urea	2	1.9	II
	Famoxadone	Oksazolidinedion	2	1.9	IV
	Chlorothalonil	Karbamat	1	1	IV
Herbicide	Paraquat dichloride	Bipiridilium	1	1	II
Others	ATONIK		3	2.9	
	Goat urine		1	1	
	Unknown		23	21.9	

*The WHO recommended classification of pesticides by hazard: Ib = Highly hazardous; II = Moderately hazardous; III = slightly hazardous; U = Unlikely to present acute hazard in normal use

Table 3 Vegetable farmers (n=105) who informed continuously applying Protective Personal Equipment (PPE) during pesticide management.

PPE in use	*n*	*%*
Hats	92	(87.6%)
Googles	5	(4.8%)
Oral-nasal mask	41	(39%)
Gloves	28	(26.7%)
Long sleeves shirts	89	(84.8%)
Long pants	89	(84.8%)
Apron	7	(6.7%)
Boots	68	(64.8%)

All interviewed farmers (n=105) used various type of pesticide. Eighty-two (78.1%) farmers could recall the brands of the pesticide. **Table 2** lists the type of pesticides, active ingredients, and classification of hazardous based on WHO and Globally Harmonized System (GHS). The most frequent insecticide used were Lambda cyhalothrin (n=26, 24.8%) and Profenofos (n=23, 21.9%), while 16 farmers (15.2%) used Propineb as a fungicide.

Personal protective equipment (PPE) frequently worn by vegetable farmers were hats (n=92, 87.6%), long sleeves shirts (n=89, 84.8%), long pants (n=89, 84.8%), boots (n=68, 64.8%) and oral-nasal masks (n=41, 39%). However, only five farmers put on goggles (4.8%) and seven farmers wore apron (6.7%) during the pesticide management. Summary of PPE used by farmers in this study is seen in **Table 3**.

Attitude of pesticides management practices among vegetable farmers are listed in **Table 4**. Among all 105 interviewed farmers, most of them (89.5%) sprayed pesticide in the morning, five farmers sprayed in the midday (4.8%), and one farmer sprayed in the afternoon. Total 94 farmers (89.5%) spent <5 hours during spraying and 11 (10.5%) farmers took >5 hours for spraying. Eighty-nine farmers (84.8%) did not perform any other activity during the pesticide management, while the others (n=16, 15.2%) stated smoking, eating or drinking alongside the application of pesticide.

Table 4 Attitude of pesticides management practices among vegetable farmers

Variable	*n*	*%*
Duration of each spraying		
< 5 hours	94	89.5
> 5 hours	11	10.5
Time of spraying		
Morning	94	89.5
Midday	5	4.8
Afternoon	1	1
Morning and midday	1	1
Morning and afternoon	4	3.8
Other activity during spraying		
Smoking, eating, or drinking	16	15.2
None	89	84.8
Aware of wind direction		
Yes	68	64.8
No	37	35.2
Spraying when high speed wind		
Yes	30	28.6
No	75	71.4
Mixing with tool		
Yes	70	66.7
No	35	33.3
Disposal of leftover pesticide or waste packaging		
Buried or burned	31	29.5
Trash can, house yard, or river	73	69.5
Unknown	1	1

Sixty-eight vegetable farmers (64.8%) sprayed pesticide in line with wind direction, whereas 37 farmers (35.2%) sprayed against wind direction. Followed by 75 (71.4%) farmers discontinued spraying when the wind was strong and 30 farmers (28.6%) kept spraying in the strong wind condition. In addition, 70 (66.7%) farmers used the applicator during mixing process for steering thoroughly the pesticide formulation. Furthermore, 73 farmers (69.5%) disposed the left-over pesticide liquor and packages into the trash can, house yard, or river, while 31 (29.5%) farmers chose to bury or burn the left-over products.

A comprehensive dermatological examination was done for all farmers to find the diagnosis of skin disease (n=105). In general, the prevalence of skin disease related to pesticide was 42.9% (n=45) among farmers. About 12 of 105 farmers

Table 5 Prevalence of occupational skin diseases related to pesticide among 105 vegetable farmers.

Occupational Skin Disease	*n*	*%*
Contact dermatitis	11	10.5
Hypopigmentation	4	3.8
Nail discoloration	30	28.6
Onycholysis	23	21.9
Nail deformity	9	8.6

(11.4%) had pesticide contact dermatitis. Nail dystrophy was the most common skin disease in this study (29.8%) which consist of nail discoloration (14.4%), nail deformity (4.3%) and onycholysis (11.1%) **(Table 5)**.

The variables of knowledge regarding to pesticide in vegetable farmers are listed in **Table 6**. The numbers of farmers who had sufficient knowledge about pesticide disposal, storage, and cleaning process are 4 (3.8 %), 14 (13.3%), and 13 (12.4%), respectively.

Table 6 Knowledge of the vegetable farmers about pesticide

Variable of knowledge	*n*	*%*	*Minimum score per total items*	*Sufficient knowledge n (%)*
Function of pesticide			4/5	18 (17.1)
To kill the pests	81	77.1		
To control the pests	27	25.7		
To prevent the pests	28	26.7		
To eradicate the pests	48	45.7		
To eradicate or prevent the household pests	27	25.7		
Do not know	3	2.8		
Type of pesticide formulations			3/4	15 (14.3)
Dust	46	43.8		
Poisonous bait	4	3.8		
Granule	34	32.4		
Solution	98	93.3		
Do not know	1	0.9		
Information listed on pesticide label			5/6	24 (22.8)
Direction of use or dosage	72	68.6		
First aid direction for pesticide poisoning	43	40.9		
Toxicity symptoms	33	31.4		
Antidote	24	22.8		
Approval number	26	24.8		
Expiry date	29	27.6		
Do not know	27	25.7		
PPE usage			5/6	29 (27.6)
Hat	75	71.4		
Oral-nasal mask	66	62.8		
Apron and overall shirts	47	44.8		
Glove	54	51.4		
Boots	61	58.1		
Goggle	28	26.7		
Do not know	7	6.7		
Possibility exposure to pesticide for non-pesticide operator				
Know	50	47.6		50 (47.6)
Do not know	55	52.4		
Entry route of pesticide to human body				
Mouth	61	58.1	4/5	15 (14.3)
Skin	47	44.8		
Nose	70	66.7		
Eyes	36	34.3		
Skin lession	16	15.2		
Do not know	15	14.3		

Variable of knowledge	*n*	*%*	*Minimum score per total items*	*Sufficient knowledge n (%)*
Adverse health effects of pesticide exposure to human body			6/8	5 (4.8)
Headache	67	63.8		
Nausea	42	40.0		
Vomiting	41	39.0		
Seizure	9	8.6		
Hypersalivation	8	7.6		
Hyperhydrosis	12	11.4		
Diarrhea	6	5.7		
Blurry vision	14	13.3		
Do not know	29	27.6		
Management of pesticide poisoning			5/6	6 (5.7)
Cleansing eye with water	41	39.0		
Run into the open-air environment	10	9.5		
Drink a plenty of milk	14	13.3		
Refer to health care facility	37	35.2		
Rinsing the exposure skin	22	20.9		
Take off the contaminated shirt	14	13.3		
Do not know	30	28.6		
Disposal of empty pesticide packaging				
Buried	51	48.6	2/2	4 (3.8)
Burn	30	28.6		
Do not know	20	19.0		
Storage of pesticide packaging				
Inside the pesticide packaging	50	47.6	5/6	14 (13.3)
Storage room with ventilation	40	38.1		
Avoid from direct sun exposure	45	42.9		
Separated from food products	45	42.9		
The storage room always locked	20	19.0		
Separated from kitchen	54	51.4		
Do not know	8	7.6		
Cleaning used tools				
Washing with soap	54	51.4	3/4	13 (12.4)
Washing with water	63	60		
Avoid from water source contamination	67	63.8		
Avoid from river contamination	15	14.3		
Do not know	6	5.7		
Overall knowledge (from 53 items)				
Sufficient	7	6.7		
Insufficient	98	93.3		

Discussion

The majority of vegetable farmers in this study (71.8%) could recall the name of pesticide they use in daily practice. The most used active ingredient was Lambda cyhalothrin (24.8%), followed by profenofos (21.9%), propineb (15.2%), cypermethrin (11.4%) and chlorpyrifos (9.5%), respectively. A study in Gaza Strip also showed the extensive use of chlorpyrifos (41.0%) and cypermethrin (40.4%) for the crop protection, yet mancozeb (63.4%) and methamidophos (59.6%) were the most used fungicide and insecticide.[13] Besides propineb, all frequently used ingredients in present study are categorized as moderately hazardous WHO Class II. Lambda cyhalothrin, cypermethrin, and chlorpyrifos are listed as category 3 in Globally Harmonized System (GHS) Acute Toxicity Hazard Category which is toxic if ingested,

inhaled, contacted to the skin and may cause mild skin irritation as well.[14-16]

The percentage of respondents who comprehend the information in pesticide labels are low (22.8%). This finding was in line with previous study in Nepal, where 64% females and 38% males were not attentive of pesticide labels.[17] In present study, although moderate percentage of vegetable farmers understood the dosage and direction of use (68.6%), they do not aware of the emergency information, approval number, the date of manufacture or expiry date as registered in pesticide labels. Despite the sufficient educational background of the respondents, the small fonts, long instructions and complicated information made the label difficult to understand and reluctant to read.[18] Incapability to comprehend the entire information on labels lead to inappropriate practice that increase chemical hazard exposure to human health and environment.

The farmer's knowledge of pesticide entry route to human body was low (14.3%). Most respondents knew that pesticide poisoning possibly occurred through mouth (58.1%), nose (66.7%), or dermal (44.8%) exposure while skin lesion (15.2%) and eye (34.3%) exposure are less recognizable. A study in Ecuador also showed farmers were more aware of dermal (79.4%) and inhalation absorption (67.8%) than other routes of exposure.[19] The farmer's knowledge regarding pesticide associated toxicity symptoms in this study are mostly headache (63.8%), nausea (40.0%), and vomiting (39.0%). Headache (58.8%) was the most frequently self-reported toxicity symptoms related to pesticides in previous study, as well as salivation or vomiting (38.2%) and nausea (36.5%).[20]

Knowledge about the universal use of PPE during pesticide handling was low (27.6%). The main vegetable farmers merely consider hats (71.4%) and oral-nasal masks (62.8%), while gloves (51.4%) and shoes (58.1%) were considered as moderately important. In addition, knowledge of protective clothes including long sleeved shirts, long pants, and apron were moderate-low. However, majority of farmers did not acknowledge the importance of goggles (26.7%).

Practically, the percentage of farmers wearing hats (87.6%), long-sleeved shirts (84.8%), long pants (84.8%) and boots (64.8%) were high. Nevertheless, the use of goggles (4.8%), apron (6.7%), gloves (26.7%) and oral-nasal masks (39%) were low. This finding had also been reported among Ethiopian and Greek tobacco farmers.[21,22] The farmers were reluctant to wear standard PPE due to unavailability of universal PPE, high cost of the standard PPE, discomfort as hot condition, and having insignificant complaints in spite of their unsafe PPE practice. The majority of farmers tend to use modest materials to substitute the standard PPE, for instance oral-nasal masks from fabric scarfs or dust masks that are not enough to prevent inhalation and ingestion exposure. This practice had also been reported by a study in Tanzania.[23]

PPE used to prevent dermal exposure depends on the toxicity of pesticides and environmental situation.[24] Some other influencing factors were personal desire to prevent injury and exposure, current health problems, time required, cost, convenience of storage location, warning stickers/ labels, government regulations, and the concerns of other family members.[25] In tropical countries, hot and humid environments were also the reason of farmers not wearing PPE.[22]

Interview in this study indicate empty pesticide packaging are often buried (48.6%) rather than burnt (28.6%). In practice, 69.5% of farmers disposed empty packaging or leftover pesticide

in local waste container or threw them to the river. Moreover, safe combustion of empty pesticide packaging required a good comprehension of pesticide chemistry, while safe burial also needed sufficient knowledge of local hydrology.[26]

Dermatology examination found that the prevalence of pesticide related OSDs in vegetable farmers were moderate, in which 10.5% of them had contact dermatitis. This number in accordance with the study in North Carolina, California and Italy where the prevalence of contact dermatitis in farmworkers are 5.6%, 2% and 12%, respectively.[27] Exogenic agents such as chemicals may damage the skin barrier and cause toxic reactions following skin absorption.[28] We also discovered that the majority of farmers in this study had nail dystrophy which consist of nail discoloration (28.6%), onycholysis (21.9%) and nail deformity (8.6%).[10] This finding in accordance with a study at South India where nail dystrophy was the most frequent skin conditions among 341 paddy field workers, in which 15% cases were fingernails dystrophy and 57% cases were toenails dystrophy. This may be secondary to chronic paronychia, a type of hand dermatitis precipitated by environmental exposure.[29]

Acknowledgments

We thank the study participants who willingly took part in this study and Diana Hesti as the field research manager. This research is funded by Skema Penelitian Dasar Unggulan Perguruan Tinggi Kemenristek Dikti (Higher Education Basic Research Scheme, Ministry of Research, Technology and Higher Education).

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