Journal of
Environmental & Analytical Toxicology

Abbassy, J Environ Anal Toxicol 2017, 7:5
DOI: 10.4172/2161-0525.1000510

Research Article Open Access

Farmer's Knowledge, Attitudes and Practices, and their Exposure to Pesticide Residues after Application on the Vegetable and Fruit Crops. Case Study: North of Delta, Egypt

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Abstract

The objective of this study is to assess farmers' awareness on the safely use of pesticides and field spraying practices that might potentially expose them to chemical hazards. The level of farmer's knowledge towards the negative effects of pesticides on the human health and environment was evaluated. A pilot survey was also carried out for assessing the potential residual levels of chlorpyrifos cypermethrin and lambda-cyhalthrin pesticides (which are commonly applied on the vegetable and fruit crops in the study area) in the feet, hands and face washing water of sprayers after application. The study was carried out among smallholder farmers of intensive vegetable and fruit production zones at northern delta, Egypt. Data was based on a random sample of 86 farmers using structured interviews and direct field observations. The obtained results showed that in spite of the farmers have good knowledge about the potential negative effects of pesticides on the human and for somewhat on the environment, lack of their following safety measures was dominant. All of the pesticide applicators investigated did not wear any protective clothing during spraying. Although they knew about the potential human health risks of pesticides, the precautionary measures taken against exposure were very rare. The study also found that there are no any farmer's obligations with the pre-harvest interval (PHI). No existence of agricultural extension in the study area. The results about exposure of the farmers to residues of chlorpyrifos cypermethrin and lambda-cyhalthrin pesticides level in the washing water of their feet, hands and face found that the feet washing was at higher residual levels and frequencies (11-131 µg, 80-100%) of these pesticides, for face (<4.5 ng-125 µg, 0-100%) and for hands (1.3-78 µg, 80-100%). Using of high pressure motor machines was showed at high contribution for the workers contamination (12-131 µg) compared with the backpack manual sprayer (<4.5 ng-114 µg). Washing water of the sprayer's top clothes was found at about thousand times higher residue levels (1.5×10^3-102×10^3 µg) of the tested pesticides than those levels determined on the surface of the feet, hands and face of the farmers investigated. These findings might be referred to the wide spread distribution of the spray solution by the high pressure motor. Chlorpyrifos residues were detected at high levels and frequencies, while another two insecticides at lower values. This study suggested that great efforts to reduce potential health risks from chemicals should be implemented to improve farmer awareness against pesticides application and its hazards. Agricultural extension should be existed to play an effective and responsible role in these efforts. An improved approaches including integrated pest management (IPM) and, in general, good agricultural practices (GAPs) must be followed as a strategy for continued crops production with minimal risks of pesticides to the environment and human health.

Keywords: Egypt; Exposure; Farmers' awareness; Hazards; Pesticide residues

Introduction

Although the unsafe and indiscriminate use of pesticides in agriculture represents a major hazard to the human and environment [1], changes in legislation, integrated pest management (IPM) and genetically modified crops are till to now not serving the reduction of pesticides use. However, population growth, pesticides resistance and economic factors strongly suggest the continuation of, and possible growth in, pesticides use. By their nature, many pesticides may pose some risk to humans, animals, and the environment. At the same time, pesticides are often useful because of their ability to control disease-causing organisms. Whether pesticides risk or benefit, and they are considered major contaminant of our environment, it will continue, to meet the high request for vegetables and fruits, worldwide farmers apply large quantities of pesticides not only to prevent pests and diseases but also to boost their production, with continuous growth of the environmental impact and health risk consequences [2]. In another meaning, it will continue to play a role in pest management for the foreseeable future, in part, because the benefits of pesticide usage are high relative to risks or there are no practical alternatives [3].

In agricultural occupations, typically about 10% of the total pesticides exposure occurs via the respiratory route, with the rest through either dermal absorption or ingestion. For non-volatile pesticides, respiratory inhalation also occurs when pesticides are sprayed at an inhalable form [4,5]. Exposure to pesticides is one of the most important occupational risks among farmers in developing countries. The World Health Organization and United Nations Environmental Program have estimated one to five million cases of pesticide poisoning among agricultural workers each year with about 20,000 fatalities, the majority in developing countries [6,7].

Dermal absorption occurs through direct skin contact with pesticides or from clothing and tools that are contaminated with

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Received September 20, 2017; **Accepted** September 26, 2017; **Published** September 29, 2017

Citation: Abbassy MMS (2017) Farmer's Knowledge, Attitudes and Practices, and their Exposure to Pesticide Residues after Application on the Vegetable and Fruit Crops. Case Study: North of Delta, Egypt. J Environ Anal Toxicol 7: 510. doi: 10.4172/2161-0525.1000510

pesticide residues. Dermal exposure and ingestion may also be relevant for systematic inflammation or sensitization after high level exposures to pesticide at the workplace Maestrelli et al. The physiochemical properties of the particular pesticide, temperature, humidity, weather conditions, personal hygiene (e.g., hand and face washing), and use of personal protective equipment are all factors associated with pesticide exposures. For example, organophosphate and carbamate insecticides can be efficiently absorbed by the skin due to their high lipid solubility. In contrast, due to the low lipid solubility, pyrethroid insecticides are poorly absorbed though intact skin, but can be efficiently absorbed through inhalation and ingestion [8,9].

During the early 2000s, the EPA began phasing out residential uses of the two primary organophosphorus insecticides (OPs); diazinon, and chlorpyrifos. EPA's decision to eliminate certain uses of the OP insecticides because of their potential for causing toxicity in people, especially children, has led to their gradual replacement with another class of insecticides, the pyrethroids [10]. Unlike the OPs that act on the central nervous system as a cholinesterase inhibitor in experimental animals, pyrethroid insecticides such as cypermethrin and lambda-cyhalothrin disrupt the normal function of the peripheral nervous system. In general, exposure to toxic doses of these compounds causes incoordination, convulsions, and paralysis [11]. Many researches in some of Arabic countries including Egypt, as well as in other regions around the world were carried out for assessing the farmer's knowledge, attitudes and practices regarding pesticide use. The general trend as worldwide, level of knowledge about pesticide safety is insufficient, and educational sessions can improved it, hence, higher internal beliefs for the farmers investigated were significantly related to higher knowledge and behavior scores. The majority of the farmers acknowledged that pesticides were harmful to their health and the environment. Also, farmer's knowledge for pesticide hazards was high, while the reported safety measures were poor [12-25].

The present study is objected for measuring the level of farmer's awareness on the safely use of pesticides with no or minimal health and environmental adverse effects. Unlike many of the similar previous studies regarding farmers' awareness on the safely use of pesticides were measured by only questionnaire-based approaches, the present study is also subjected to evaluate the potential exposure extent of the farmers investigated after application of certain pesticides; Chlorpyrifos cypermethrin and lambda-cyhalthrin on vegetables and fruit crops by determination of its residues on the sprayer's feet, hands, face and top clothes.

Materials and Methods

Description of study area

The study was carried out among smallholder farmers in selected of intensified fields of vegetable and fruit crops (1-5 feddan each) located among the extended strip along about 10 km of the Northern west of Rosetta Nile branch, Rosetta, El-Behera governorate, Egypt. Soil types of the represented fields are clay in certain sites and sand in another. These areas are characterized by intensive application of different types of pesticides on vegetables and fruits due to the diversity of crops such as vegetables (e.g., tomato, cucumber, potatoes, eggplant, watermelon and capsicum), and fruits such as guava, orange, dates, apple, peach and mango. The type and dose of pesticides used (mainly organophosphorus, pyrethriod and neonicotinoid insecticides) has been decided by the farmers themself and not subjected for any of agricultural extension or governmental supervision or policy. As a result, the nonsystematic approaches in a given region studied for pesticides use has been followed.

Samples selection

A total represented sample of 86 farmers was participated in this study. All participants were of age between 30 and 57 years. They were directly involved with pesticides field application. The interviews and data collection were conducted by the author through a farm survey face to-face interviews with farmers, beside field observations during farming activities. The interview questionnaire was designed based on the related published literature as well as, the author experiences in the different agricultural practices. A verbal approval was obtained from the participants after describing the aim of the study. The questionnaire was applied for assessing the farmer's knowledge, behaviors to pesticide use and their health. It includes: 1- Knowledge of the farmers regarding types and information about pesticides commonly used, health effects, route of entry into body, and residues fate, 2-Safety label functions for farmer's behavior and awareness toward safely application of pesticides, and 3- Function dimensions for methods of remaining pesticide storage and disposal of empty containers.

Determination of pesticide residues on sprayer feet, hands, face and top clothes

Selected group (15 farmers) of the participants investigated were subjected for collecting washing water of their feet, hands, face (including mouth and nose rinsing) and top clothes (trouser and shirt) after pesticides application for two times during vegetables growing season and fruiting period of the fruits at Summer, 2016. Three pesticides were specified for analysis; Chlorpyrifos, cypermethrin and lambda-cyhalothrin. Backpack and high pressure motor sprayers were used for pesticides application on vegetables, while only high pressure sprayer used for fruits. Feet, hands, face and top clothes of the sprayers after pesticides application (ten sprayers for vegetables and five for fruits) were washed using 2000, 1000, 1500 and 3000 ml tap water, and collected separately in pre-cleaned stainless dishes, respectively. Then, each sample was transferred to cleaned glass bottle, and then screwed tight. The samples were stored in a refrigerator at 4°C prior to being subjected for extraction procedure up to one day after sampling.

Solid phase extraction (SPE) method using 500 mg C-18 bonded silica cartridge was applied to separate the tested insecticide residues from washing water of the pesticide sprayers [26]. Prior to extraction, the C-18 cartridge was washed under vacuum with 10 ml of acetone, followed by 3 ml acetonitrile and 3 ml of distilled water, with avoiding the cartridge was become dry. Sub-samples at volumes ranged from 10 to 100 ml, depending on the expected degree of pesticide exposure and contamination were taken for extraction from the raw washed water samples. Each sub-sample was percolated through the cartridge under controlled flow-rate at 1.5 ml/min using suction of water pump. After extraction, the pesticide residues trapped on the silica cartridge was eluted using 10 ml of acetone. The extract was evaporated to 1 ml under gentle stream of nitrogen before being injected into the gas chromatograph; thermo scientific (2009) fitted with tri-plus auto-sampler equipped with ^{63}Ni micro-electron capture detector (μ-ECD) under the following optimum conditions: Ultra 2 capillary column; 30.0 m (length) × 0.32 mm (i.d) and stationary phase (crosslinked 5% phenyl methyl siloxane) film thickness of 0.25 μm was used. Nitrogen (GC grade) was applied as the carrier and detector makeup gases at 1 and 35 ml/min flow rate, respectively. Splitless injection mode at temperature of 250°C, detector temperatures were 300°C for the ECD base and 310°C for the cell. Oven program: initial temp; 100°C, initial hold for 1 min, ramp 1: 4.0°C/min to 180°C, hold for 1 min, ramp 2: 2.0°C/min to 220°C, hold for 0.0 min, ramp 3: 10.0°C/min to 280°C, hold for 3 min.

The calibration standard (2,4,10,20,40 pg/μl) of each pesticide was prepared in acetone. The average recovery percentages from spiked tap water with the three tested pesticides were determined as the same method as for field samples extraction. The method detection limits (MDLs) were specified. The average recoveries of chlorpyrifos, cypermethrin and lambda-cyhalthrin were 93, 76 and 88%, and the minimum method detection limits (MDLs) at 2.2, 6.7 and 4.5 pg/injected volume (μl), respectively. Retention time and peak area of the resolved peaks were used as the basis for qualitative and quantitative analysis of the analytes, respectively. Residue levels were expressed as μg/ washed water sample. So, the final extracts of all samples were diluted at 5 to 50 × 106 times before injection into GC to meet the optimum ECD detection range (5-20 pg/μl). Reported concentrations have been adjusted on the basis of percent recoveries [27].

Results and Discussion

Farmer's knowledge for pesticides information, health effects, route of entry into the body, and residues fate

The results obtained from the interview questionnaire applied on the smallholder farmers in selected agricultural areas to measure their knowledge, behavior to pesticides use are described in Tables 1-3. Concerning farmer's knowledge about pesticides information, health effects, route of entry into the body, and residues fate, the listed results in Table 1 indicated that all the farmers investigated knowing the name of pesticides used (formulated name), only 2.3% partially read labels or instructions which listed on the pesticide containers (the pesticide label is a guide to using pesticides safely and effectively). This behavior might be due to illiteracy or they are just ignorant or not interested to read it. Although all the participants knew that the exposure to pesticide cause adverse health effects on human health, 58.1% of them have general knowledge about the adverse health effects of pesticide exposure on human health. The difference was specially noticed in knowledge about that all pesticides have not same health effects (32.6%). No one of the farmers investigated has followed the recommended pre-harvest no spray interval (PHI) (the period between last application and harvest).

Pesticide sprayers with knowledge	Number	Frequency (%)
Pesticides used Information		
Knowing the name of pesticides used (formulated name)	86	100
Read labels or instructions on the pesticide containers	2	2.33
follow the recommended pre-harvest no spray interval (PHI)	0	0
Knowing that the exposure to pesticide cause adverse health effects on human health	86	100
*Knowing the adverse health effects of pesticide exposure on human health	50	58.1
Knowing not all pesticides have the same adverse health effects	28	32.6
Knowing biological and natural control	5	5.81
Knowledge about fate and route of pesticide residues		
Inhalation (nose), skin and mouth	86	100
Air, soil and groundwater	83	96.5
Edible parts of vegetables and fruits	86	100
Hazardous to animals	78	90.7
Harmful to fish and flowing rivers	66	76.7

*General knowledge

Table 1: Farmer's knowledge for pesticides Information, health effects, route of entry into the body, and residues fate (sample size=86).

As mentioned before that no any governmental obligations or control for types and doses specification of the applied pesticides in vegetable and fruit fields of the study area. The pesticides usage, perceptions, practices and health effects among farmers in north Gaza, Palestine was investigated [28]. The study demands that the governmental, the nongovernmental organizations and the interested parties should cooperate to minimize the environmental and health risks caused by the misuse of pesticides. In Uganda's, there is wide spread pesticide misuse behavior amongst tomato farmers owing to different social, economic and regulatory factors. This misuse includes among others inadequate personal protection and failure to follow the recommended PHI [24]. Concerning knowledge about fate and route of pesticide residues entry into the body and environment, All the participants investigated in the present study know that pesticide residues entry into the body through inhalation (nose), skin and mouth, 96.5% air, soil and groundwater, 100% edible parts of vegetables and fruits, 90.7% hazardous to animals, and 76.7% know that pesticides are harmful to fish and flowing rivers.

Farmer's behavior and awareness toward safely application of pesticides

Regarding farmer's behavior and awareness toward safety label functions investigated. The interview results were generally found that all participants didn't use pesticides protective devices (PPDs). In details, most of the pesticide sprayers (88.4-96.5%) have knowledge and awareness toward safely application of pesticides and not use, such as wear glasses to protect eyes, put on leg boots, put on hand gloves, or protect mouth and nose when spraying (Table 2). These reasons for not using safety label items investigated could be due to their low level of knowledge about the safety measures.

This behavior is in consistent with the results of many studies conducted in many parts of the world [12,13,17,19,20] and other agricultural areas in Egypt [7,14,15]. As in many developing countries, majority of pesticides users, being unaware of pesticide types, their mode of action, potential hazards and safety measures. The data obtained from this study indicated that great majority (90.7%) of the participants wash their hand and face after pesticides spraying, and only two of the farmers investigated were rarely used their hands for mixing the diluted pesticide solution. 91.9% keep securely out of reach of children, and 96.5% have knowledge and not eat or drink during pesticides application. This behavior is not mainly related to the farmer's awareness but for that the period of spraying normally not long (about 1-3 hrs. using backpack sprayer, and 0.5-1.5 hr. by motor), there are the most common two methods for pesticides spraying in the study regions. Similar finding as the previous study [29] was also noticed that 76.8% of the farmers investigated have knowledge and cleared the nozzle with their mouth or hand if there was blockage in the spray nozzle during field application, as well as, 97.67% of the participants using the packaged product lid for pesticide(s) preparation instead of a measuring cup. Farmers' behaviors when using pesticides in Iran was investigated [23]. The study found that the majority of them (94%) had washed their hands after spraying the pesticides. In general, the interaction between use of protective measures and awareness of farm workers towards these measures showed that most farm workers were aware of the protective measures to be used during application of pesticides, but no one took precautions.

Farmer's awareness toward the methods of pesticide storage and disposal

The present study was also subjected for certain function dimensions related to the storage of remaining pesticides and disposal

Safety label functions	Have knowledge and use	Have knowledge and not use	Have either no knowledge or use
Wear glasses to protect eyes	0 (0)	76 (88.4)	10 (11.6)
Put on leg boots	0 (0)	83 (96.5)	3 (3.5)
Put on hand gloves	0 (0)	81 (94.2)	5 (5.8)
Protect mouth and nose	0 (0)	78 (90.7)	8 (9.3)
Wash hand and face after pesticides operation	78 (90.7)	8 (9.3)	0 (0)
**Handling of concentrated liquids or dry pesticide formulations	2 (2.33)	84 (97.67)	0 (0)
Cleaning the nozzle by mouth or hand	66 (76.8)	20 (23.2)	0 (0)
Keep securely, out of reach of children	79 (91.9)	7 (8.1)	0 (0)
Conducting pesticide preparation using the packaged lid instead of a measuring cup	84 (97.67)	2 (2.33)	0 (0)
Eat and or dink during pesticides application	0 (0)	83 (96.5)	3 (3.5)

*Data are presented as No. (%); **Noted as rarely occurring for mixing the diluted pesticides

Table 2: Function dimensions of farmer's behavior and awareness toward safely application of pesticides (Sample size=86*).

Function	Rarely	Sometime	Always
Stored remaining pesticide on the farm	3 (3.5)	3 (3.5)	80 (93.0)
Left empty containers in the field	0 (0)	0 (0)	86 (100)
Used within household	86 (100)	0 (0)	0 (0)
Washed and sold	86 (100)	0 (0)	0 (0)
Packed and burnt	86 (100)	0 (0)	0 (0)
Buried in the soil	86 (100)	0 (0)	0 (0)

*Data are presented as No. (%).

Table 3: Function dimensions for methods of remaining pesticide storage and disposal of empty containers (sample size=86)*.

of empty containers. The results obtained showed that the majority of farmers investigated (93.0%) stored remaining pesticide quantities on the farm, while only 7% store it always or sometime at home until reuse it (Table 3). The farmers always disposed the empty pesticide containers by themself at farm without washing for reusing it for various household purposes. In contrast, assessing the knowledge and practices of Ethiopian farmers about pesticide management revealed that 77.2% of the farmers investigated make use of the empty pesticide containers for various household purposes [20].

Pesticides residue levels on feet, hands, face and top clothes after application

Occupational exposure to pesticides takes place during the production, transportation, preparation and application of pesticides in the workplace. Factors involved in occupational pesticide exposures usually include application intensity, frequency, duration and method, safety behaviors (e.g., use of personal protective equipment), as well as the physiochemical and toxicological profiles of the pesticides in use. Compared to environmental exposures where levels of exposure tend to be fairly low, occupational exposures to pesticides are often at relatively high doses, whether acute or chronic [30,31].

Chlorpyrifos, cypermethrin and lambda-cyhalothrin are the predominant insecticides applied on the most of vegetables and fruit crops in the study region. Some of the pesticide sprayers seeking to apply cypermethrin or lambda-cyhalothrin in a mixture with one of organophosphorus insecticides including chlorpyrifos on vegetables against many insects such as leaf hoppers and aphids, and on fruit crops pre and during the maturity period of fruits mainly to control Mediterranean fruit fly and peach fruit fly. So as stated in agricultural research recommendations that mixtures of organophosphate insecticides enhance pyrethroid toxicity [32]. The data listed in Tables 4 and 5, revealed that these sprayers were significantly exposed to pesticide residues during spray. The pesticide residues which topically washed from the sprayer's feet and face (including mouth and nose rinsing) were shared with the most residue levels using high pressure motor comparing with their hands, while using backpack the pesticide residues on feet and hands were at high levels than for the face. In details, residues of the applied pesticides on vegetables were at higher levels in the feet, hand and face washing water using high pressure motor (12-117 µg) than in the case of using backpack manual sprayer (<4.5 ng-114 µg), with the frequencies of (60-100%) and (20-100%), respectively. On the other side, using high pressure motor sprayer, the residue levels washed from feet were at higher levels and frequencies (15-117 µg, 100%) followed by face (13-102 µg, 80-100%), then, hand washing (12-56 µg, 60-100%). The same trend was found for using backpack sprayer except face washing residues at lower values (<4.5 ng- 7.6 µg, 0-20%) than for hand washing (1.3-39 µg, 40-100%), and feet washing kept at higher levels and frequencies at (11-114 µg, 80-100%). Concerning the detected residue of the sprayed insecticides; Chlorpyrifos, cypermethrin and lambda-cyhalthrin on feet, hands and face of the farmers after its application on fruits using high pressure motor sprayer were at levels and frequencies in washed water from feet (16-131 µg, 100%) followed by face (18-125 µg, 100%), and then for hands (14.7-78 µg, 60-80%).

The same pattern of the detected pesticide levels was also found in washing water of the sprayer's top clothes (trouser and shirt), but it at thousand times higher residue levels of the tested pesticides than those determined on the surface of the feet, hands or face of the farmers under investigation. Chlorpyrifos was detected at higher levels (1.7×10^3 µg and 13.4×10^3 µg) than another two pesticides; cypermethrin (0.51×10^3 µg and 8.1×10^3 µg), then for ʎ- cyhalothrin (0.11×10^3 µg and 1.5×10^3), using backpack and high pressure motor sprayers on vegetables, respectively. While using high pressure motor on fruit crops, the residual levels of chlorpyrifos, cypermethrin and lambda-cyhalothrin in washing water of sprayer's top clothes were at about 3-5 times more than for vegetables, with overall averages of 102×10^3, 43×10^3 and 7.8×10^3 µg, respectively.

Pesticides applied	Average pesticides residue and frequency (µg (%))							
	Backpack sprayer (n= 5)				High pressure sprayer (n= 5)			
	Feet	Hands	*Face	Top clothes	Feet	Hands	*Face	Top clothes
Chlorpyrifos	114 (100)	39 (100)	7.6 (20)	1.7×10^3 (100)	117 (100)	56 (100)	102 (100)	13.4×10^3 (100)
Cypermethrin	39 (100)	10 (60)	**<6.7 (0)	0.51×10^3 (100)	44 (100)	32 (60)	36 (80)	8.1×10^3 (100)
ʎ- Cyhalothrin	11 (80)	1.3 (40)	**<4.5 (0)	0.11×10^3 (100)	15 (100)	12 (60)	13 (100)	1.5×10^3 (100)

*Including mouth and nose rinsing; **The minimum method detection limits (MDLs) were expressed as ng/final extract (1 ml).

Table 4: Average pesticides residue and frequency (µg (%)) in the feet, hands, face and top clothes washing water of farmers after application using backpack and high pressure motor on vegetable crops.

Pesticides applied	Average pesticides residue and frequency (µg (%))			
	Feet	Hands	*Face	Top clothes
Chlorpyrifos	131 (100)	78 (80)	125 (100)	102×10^3 (100)
Cypermethrin	61 (100)	40 (60)	67 (100)	43×10^3 (100)
ʎ- Cyhalthrin	16 (100)	14.7 (60)	18 (100)	7.8×10^3 (100)

* Including mouth and nose rinsing

Table 5: Average pesticides residue and frequency (µg (%)) in the feet, hands face and top clothes washing water of sprayers after application using high pressure motor sprayer on fruit crops (n=5 Sprayers).

The applicators and technicians of chlorpyrifos in Egyptian cotton fields were observed to have relatively high levels of skin or clothing contact with pesticide-treated foliage as they walked through the fields. Both dermal patch loadings of chlorpyrifos and measurements of a chlorpyrifos-specific metabolite in urine confirmed substantial exposure to and skin absorption of chlorpyrifos [33]. Generally, the obtained results revealed that using high pressure motor sprayer contribute high exposure levels for workers to pesticides spray than for backpack sprayer. This finding might be referred to the wide spread distribution of the spray solution by the high pressure motor. Chlorpyrifos residues were detected at high levels and frequencies, while the two pyrethroid insecticides at lower values. The reason might be due to that the tested formulated insecticides has been applied at different concentrations based on their active ingredient (A.I) percentages; Chlorpyrifos (48%), cypermethrin (25%) and lambda-cyhalthrin (5%).

In a Chinese cotton grower survey, shoes and trousers of the cotton farmers were contaminated with deltamethrin, fenvalerate and cypermethrin residues; in 93.1% and 65% of the workers, respectively, with body contamination reaching nearly 30% of the total skin surface. The occurrence of hand contamination reached 92% of the workers. Adverse effects of pyrethroid exposure were found in 26.8% of the farmers manifested as abnormal facial sensations, dizziness, headache, fatigue, nausea, or loss of appetite. Measurements of pyrethroid concentrations in the air of the breathing zone, in skin pads, and in urine samples showed that dermal contamination is the main route of exposure to pyrethroids [29]. Due to variations in exposure magnitude and duration, routes of absorption (skin, respiratory tract, gastrointestinal tract), and physiological variability between exposed individuals, it is often difficult to quantitatively assess the effective dose of a pesticide an individual has received either by measuring working hours or by monitoring the contamination level of the workplace. An adverse effect of pesticide exposure on human respiratory health such as asthma was associated with occupational pesticide exposures. Impaired lung function was also often observed among people occupationally exposed to pesticides [31].

Conclusion

The present study concluded that there is considerable matching was confirmed between the results of residual pesticides determined at levels ranged between 1.3 µg and 102 mg on the feet, hands, face and top clothes of the farmers investigated after application and the interview results which revealed the lack of the farmer's awareness and commitment to the safe use of pesticides in the study area. They didn't use PPDs during pesticides application or any role of the agricultural extension in the delivery of information regarding good agricultural practices including how to deal with pesticides and their application. The farmers are seeking for pesticides information from other trustworthy sources mostly relatives, friends, neighbors, personal experiences and traders selling of pesticides. Generally, the pesticides used incorrectly and unhealthy when preparing of spraying, and do not adhere to the recommended indications and contraindications. Unfortunately, most interviewees had only finished primary or preparatory school education, but no positive response for them was noticed regarding the negative effects of pesticides on health and routes of contamination with pesticides. For example, many of educated farmers read labels of pesticides containers but no or very rare taking precautions after coming in contact with pesticides. Finally, the study suggested that great efforts regarding pesticide management and regulations programs on safety precautions, reinforcement of safety behaviors, to reduce potential health risks and improve farmer awareness against pesticides application and its hazards should be implemented.

Acknowledgements

The author thanks and places on record his gratitude to all the farmers investigated and their neighbors for co-operating the field sampling and data collection during this study.

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