

**INDISCRIMINATE USE AND IMPROPER APPLICATION OF PESTICIDES  
BY JORDANIAN VEGETABLE AND FRUIT FARMERS**

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**ABSTRACT**

The majority of Jordanian farmers do not understand the harmful effects that pesticides have on health and environment. The fate and impact of pesticide application in Jordan remain unknown in the public and farmer eye. For this purpose, Jordanian farmers were questioned about their social aspects, types of pests encountered, and pesticide knowledge, practices, safety and resources by conducting a country-wide survey of farmers during 2014. The results revealed that 66% of respondents had good knowledge of pesticide use, and 85% of them read the label before applying pesticides. Approximately 56% of the farmers applied pesticides when necessary, while 29% applied pesticides weekly. A very high percentage (93%) of farmers believed that they will still apply pesticides in the coming years. Almost 74% of the farmers were found to use both preventive and cure pesticide, 73% applied pesticide at the morning and only 39% at the evening. Medium pesticide' rate was applied by 59% and higher rate by 38% of the farmers. The data indicated that a wide variety of chemicals were being applied by the farmers. Using bio-pesticide had less importance by farmers. The farmers had faced many pesticide-related illnesses and injuries. About 14% of farmers did not wear protective cloths during application, 11% stored pesticide in house, 58% burned empty containers, and 39% did not keep any records. Private consultants and pesticide' companies (42%) were the most popular source of information. Almost 25% of farmers had been involved in pesticide' training program, and 78% reported seeking for information about pesticide. On the other hand, education was positively and significantly correlated with knowledge of pesticide use and farmers involvement in pesticides training programs, while reading label was positively and significantly correlated with education and negatively with age. There was a positive and significant correlation between involvement in pesticides training program and knowledge of pesticides use. In conclusion, farmers depend heavily on pesticides use for pest control, and the survey has shown some overuse, misuse and abuse of pesticides.

**Key words:** *pesticides, indiscriminate use, improper application, vegetables, fruit trees, environment, human health, Jordan.*

**1. INTRODUCTION**

Quality and quantity of agricultural crops are affected by hundreds of pests found in the agro-ecosystem. Pests cause a loss of half of the world's food crops (Sheikh *et al.*, 2011). The increasing global food demands have led to a constant battle for higher crop yields. The main method of pest control adopted by the majority of farmers is often the erroneous and abusive application of pesticides (Song and Swinton, 2009., Naveed, 2011., Al-Zyoud, 2014). Pesticides helped the world meets growing food demand by increasing agricultural productivity

through controlling pests. The global market of pesticides was over 52 billion US dollars in 2009 (Market Study-Crop Protection, 2012). Furthermore, there were more than 1,055 active ingredients registered as pesticides (Goldman, 2007). The number of pesticides registered and imported in Jordan is 506 with a total quantity of 2,055 metric tons (Jordan Statistical Yearbook, 2012).

The complete dependency, extensive and massive use of pesticides in modern agriculture caused their widespread diffusion to all environmental compartments including a wide

range of organisms up to the humans (Samiee *et al.*, 2009., Abang *et al.*, 2013). Ideally, a pesticide must be lethal to the target pests, but not to non-target organisms. Unfortunately, this is not the case, so the controversy of use and abuse of pesticides has surfaced. On the other hand, it has been estimated that 3 million cases of pesticide poisoning, 220,000 of which are fatal, occur world-wide every year (Raipulis *et al.*, 2009). Exposure to pesticides is increasingly linked to human health effects, *i.e.* immune suppression, reproductive abnormalities, nervous system disorders (Hanke and Jurewicz, 2004; Frazier, 2007), cancer (Weichenthal *et al.*, 2010; Amanullah and Hari, 2011), asthma and diabetes (Lee *et al.*, 2006; Jayashree and Singhi., 2011). It is reported that transport of pesticides by surface runoff during rainfall is a major process contributing to pesticide contamination of rivers (Morohashi *et al.*, 2012), and groundwater (Sorensen *et al.*, 2011). Almost high doses and frequent pesticide applications have adversely affected natural enemies (Al-Zyoud, 2012, 2014), birds (Tanabe *et al.*, 1998), wildlife (Espin *et al.*, 2010), beneficial soil microorganisms, plant yields (Glover-Amengor and Tetteh, 2008), caused phytotoxicity (Fishel, 2011), and contributed to ozone depletion (Giri, 1998). The pesticides' misuse can also cause undesirable residue accumulation in food crops (Caldas *et al.*, 2011), acute and chronic health problems to human (Firestone *et al.*, 2005).

Farmers use pesticides without full understanding of the impact on human health and environment (Ngowi, 2003). While, for instance, it is doubtful whether farmers follow the recommended application rate of pesticides. In addition, their observation of the pre-harvest spraying time interval, proper disposal of agrochemical wastes and empty containers are questionable. They also lack the appropriate knowledge on safe handling and use of pesticides (Ngowi *et al.*, 2007). Extensive use of pesticides with residual contents exceeding the maximum residue limits on produce, urged many European countries to ban certain agricultural exports from several Arab countries (Bashour, 2008). In Jordan, like other Arab countries, the uncontrolled use, handling and misuse of pesticides are well known. Several studies on various awareness aspects associated with pesticide use have been conducted among farmer populations worldwide including the developing countries (Clarke *et al.*, 1997; Wesseling *et al.*, 1997; Perry *et al.*, 2000 ;Yassin *et al.*, 2002).

However, pesticide use comes at a significant cost. What is required is to weight all the risks against the benefits to ensure a maximum margin of safety. Our approach to the use of pesticides should be pragmatic. In other words, all activities concerning pesticides should be based on scientific judgment, not on commercial considerations. The problem is all the more serious as this field of knowledge has significant gaps, not only as regards Jordan literature but also on a global scale. It is to be mentioned that the majority of Jordanian farmers do not understand the harmful effects that pesticides have on health and environment. They overestimate their benefits and use higher doses and more frequent than necessary (Al-Zyoud, 2014). The fate and impact of pesticide application in Jordan remain unknown in the public and farmer eye. Thus, farmers' perception of pesticide practices and, their level of awareness of adverse effects on the environment and human health needs to be determined. For this purpose, Jordanian vegetables and fruit trees' farmers were questioned about their social aspects, types of pests encountered, and pesticides knowledge, practices, safety and resources by conducting a country-wide survey. This study highlights some aspects on the side effects of pesticides and raise directions deserving further development to create a better understanding of safe application of pesticides in agriculture.

## **2. MATERIALS AND METHODS**

### **2.1. Questionnaire development**

For the questionnaire, proposed questions were developed in Arabic language and sent to a various pesticides' specialists for their critique and suggested additions. After responses were received from the specialists, their suggestions and comments were utilized in developing the final questionnaire. The survey questionnaire instrument was developed to document the current indiscriminate use and improper application of pesticides by vegetables and fruit trees' farmers in Jordan. The questionnaire was sent to 120 randomly selected vegetables and fruit trees' farmers to determine to what extent they used pesticides. Although sampling was random, an effort was made to ensure that the selected farmers represented different locations, age groups, farm sizes and literally levels. The paper format questionnaire was accompanied by a cover letter. The target of the study was explained to these respondents through the cover

letter to seek their consent. This was done in order to ensure their cooperation, which was very important for the study. In addition, follow-up phone calls and visits, when necessary, to non-respondents were done to encourage their participation. Also, several phone calls were made to the participants to explain any unclear question in the questionnaire. The study was carried out by survey during 2014.

## **2.2. Structure of the survey data**

For addressing the indiscriminate use and improper application of pesticides by vegetables and fruit trees' farmers, the questionnaire used in this survey consisted of three main parts; demographics of the farmers, main pest problems occurring in the farmers' farms, and the indiscriminate use and improper application of pesticides. The first five questions in the questionnaire determined the demographics of the farmers, *i.e.* location, age, agricultural experience and educational level of the farmers, and the number of greenhouses/farm size. Question seven probed into main pest problems (diseases, insects, mites and nematodes) occurring in the farmers' farms. Questions eight through forty one were divided into five subsections, and addressed pesticides' applications, types of pesticides used, pesticides' safety, records and resources, respectively. Subsection 1 (question eight to sixteen) determined some issues on pesticides' applications such as reading label carefully before applying pesticides, number of pesticides' applications per growing season/year, location of purchasing pesticides, type of pesticides used whether it preventive or curative, time and rate of application, meteorological considerations during application. Subsection 2 (questions seventeen to twenty) addressed the most commonly used pesticides by farmers, time of purchasing pesticides, amount of money spent for pesticides' purchases and the most types of pesticides used by the farmers. Subsection 3 on pesticides' safety (question twenty one to thirty four) asked farmers about care of side effects of pesticides on human health, environmental and groundwater. In addition, in the 3<sup>rd</sup> subsection, farmers were also asked in details about toxicity level of the pesticides used, resistance management, using selective, non-persistence, systemic and bio-pesticides, time of application and wait for the safety period of pesticides. Furthermore, the farmers were asked if they have faced pesticide-related illnesses/injuries

after applying pesticides, or have heard about the side effects of extensive use of pesticides, and where they store pesticides? and the fate of empty containers. Subsection 4 (question thirty five) on pesticides' records asked farmers if they keep records of pesticide use in their farms. Subsection 5 (question thirty six to forty one) addressed farmers' resources of pesticides, involvement in training pesticides' workshop/program, if they seek for pesticides information and how they would like to have these information? A series of yes/no answers, agree/disagree answers, and never, seldom, sometimes, often and always answers were included in the questionnaire.

## **2.3. Response outcome and statistical analysis**

One hundred and four completed questionnaires were returned undergone an initial evaluation of the returned surveys for completeness, and farm specific identification information were removed. Data obtained from all completed questionnaires were compiled in a spreadsheet, and were coded. In order to code the data, the respondents reported answers of implementation (that is, not implementing a practice = 0 or implementing a practice = 1). Respondents were asked how frequently or intensively each item was practiced. A codification manual was prepared and numbers ranging from 1 to 5 were assigned to the possible responses, never, seldom, sometimes, often and always, respectively. The final point value of each item was obtained by multiplying the assigned value by the number of responses, and because multiple choices could be checked by each respondent in some questions, percentages do not sum to 100. The data were analyzed using descriptive and inferential statistics such as mean, standard error mean, percentages and frequencies (Samiee *et al.*, 2009). On the other hand, descriptive analysis provides statistics that are used to describe the basic features of the data in the study. For correlation of education level with other variables, the illiterate, schooling, tawjihi, diploma, BSc and MSc were assigned values of 1, 2, 3, 4, 5 and 6, respectively. The spearman's correlation analysis procedure was used to examine pair-wise associations between demographics' variables of the farmers (age, experience, education and farm size) and particular pesticides practice (Zar, 1999). All analyses were performed using the Proc GLM of the statistical package SigmaStat version 17.0 (SPSS, 1997).

### 3. RESULTS

#### 3.1. Demographics of the respondents

##### 3.1.1. Respondents' geographical distribution and their age

Survey responses were obtained from 104 respondents representing seven governorates in Jordan. The highest percentage of responses was obtained from Balqa (36.54%), meanwhile the lowest responses' percentage was recorded for Madaba with only 1.92% (Table 1). These data revealed a satisfactory cross-section through the country. The overall average farmers' age was estimated at  $43.86 \pm 1.08$  years old, in which the youngest farmer was 22 years old and the eldest was 75 years old. Splitting the farmers age into groups (Table 1) showed that the majority of farmers is in their forties (41.35%), while the minority of the farmers was in their seventies (2.88%). On the average, survey respondents were middle-aged.

##### 3.1.2. Farm size and agricultural experience of respondents

The overall total area owned by respondents was 6,163 dunums with an overall average of  $59.26 \pm 10.57$  dunums/farmer. Of this area, 2,063.5 dunums (33.48%) were protected (4,127 greenhouses). Splitting the farm size into groups showed that the majority of farmers (78.85%) owned an average of  $21.20 \pm 1.53$  dunums/farmer (Table 2). In contrast, only 6.73% of the farmers had an average area of  $411.71 \pm 61.25$  dunums/farmer. The total number of years of farmers experience in agriculture was 1,803 years with an overall average of  $17.34 \pm 0.89$  years/farmer. The majority of the farmers (almost 44%) had an average of 16.1 years of experience, while only 6.73% of respondents had an average experience of  $36.86 \pm 1.12$  years/farmer (Table 2).

**Table (1): Geographical representation of respondents (n=104) according to governorate, and groups for respondents' age.**

Governorate	Frequency of farmers	% of farmers	Age interval (years)	Frequency of farmers	% of farmers
Balqa	38	36.54	< 20	00	00.00
Karak	28	26.92	20-29	05	04.81
Mafraq	21	20.19	30-39	27	25.96
Irbid	07	06.73	40-49	43	41.35
Amman	04	03.85	50-59	18	17.31
Jarash	04	03.85	60-69	08	07.69
Madaba	02	01.92	$\geq 70$	03	02.88

**Table (2): Groups for farm size owned by respondents (n=104) and their agricultural experience.**

Farm size (dunum)	Aver. farm size (dunum)	Frequency of farmers	% of farmers
1-50	$21.20 \pm 1.53$	82	78.85
51-100	$92.07 \pm 3.51$	14	13.46
101-200	$200.00 \pm 0.00$	01	00.96
$\geq 201$	$411.71 \pm 61.25$	07	06.73
Experience interval	Aver. no. of years	Frequency of farmers	% of farmers
1-10 years	$06.96 \pm 0.53$	28	26.92
11-20 years	$16.09 \pm 0.42$	46	44.23
21-30 years	$26.52 \pm 0.65$	23	22.12
Above 30 years	$36.86 \pm 1.12$	07	06.73

Educational level of schooling was the most dominant among the farmers with 28.85%, followed by Tawjihi (25.0%) and BSc University graduate (21.15%) (Table 3). Meanwhile, university graduates of M.Sc. level (2.88%) was the lowest among the respondents.

**3.2. Occurrence of main pest problems in the respondents' farms**

Pests occurred intensively in the respondents' farms during the survey period. On vegetables,

about 70% of interviewed farmers cited whiteflies, spider mites and powdery mildew as the most important pests in their farms (Table 4).

While, Verticillium wilt (15.38%) was the least cited by farmers. On fruit trees, olive fruit fly (35.58%) and grape powdery mildew (31.70%) were the most cited pests by the farmers.

In contrast, apple's scab (9.62%) and fire blight (6.73%) were the least reported pests (Table 4).

**Table (3): Educational level of farmers (n=104).**

Education level	Frequency of farmers	% of farmers
Illiterate	06	05.77
Schooling	30	28.85
Tawjihi*	26	25.00
Diploma	17	16.35
University graduate, BSc	22	21.15
University graduate, MSc	03	02.88

\*Finishing the secondary school successfully.

**Table (4): Pests present reported by respondents (n=104).**

Pest species (Vegetables)	Frequency of farmers	Pest occurrence (%)*	Pest species (Fruit trees)	Frequency of farmers	Pest occurrence (%)*
Whiteflies	73	70.19	Olive fruit fly	37	35.58
Spider mites	73	70.19	Grape powdery mildew	33	31.70
Powdery mildew	73	70.19	Olive psylla	28	26.92
Aphids	68	65.38	Fruit fly	27	25.96
Leafminers	63	60.58	Grape black rot	27	25.96
Thrips	59	56.73	Gummosis of citrus trees	27	25.96
Downey mildew	57	54.81	Olive mites	25	24.04
Early blight	56	53.85	Grape berry moth	24	23.08
Fusarium wilt	51	49.04	Grape mites	24	23.08
Late blight	45	43.27	Olive verticillium wilt	21	20.19
Root knot nematodes	43	41.35	Apple stem borer	20	19.23
Fruit rot	39	37.50	Golden aphids	20	19.23
Virus diseases	38	36.54	Capnodius	19	18.27
Bacterial diseases	21	20.19	Peach leaf curl	19	18.27
Damping-off	20	19.23	Olive branch knot	17	16.35
Verticillium wilt	16	15.38	Apple powdery mildew	15	14.42
			Apple fruit moth	15	14.42
			Olive leaf spot	15	14.42
			Citrus scales	14	13.46
			Citrus mealy bugs	12	11.54
			Apple scab	10	09.62
			Apple fire blight	07	06.73

\*Because multiple choices could be checked by each respondent, percentages do not sum to 100.

### 3.3. Indiscriminate use and improper application of pesticides

#### 3.3.1. Pesticides' applications

High percent of farmers (66.35%) reported that they have good knowledge of pesticide use. Almost 85% of the farmers read the label before applying pesticides. More than half of the farmers (55.77%) applied pesticides when necessary, while 28.85% applied pesticides weekly (Table 5). A very high percentage (93.27%) of the farmers purchased pesticides from local markets, and believed that they will still apply pesticides in the coming years. In

regards to the type of pesticide used, 74% of the farmers applied both curative and preventive pesticides. Almost 73% of the farmers applied pesticides at the morning and only 39.42% at the evening. Medium pesticides' rate was applied by 58.65% and higher rate by 37.50% of the farmers. Wind speed and direction (84.62%) and temperature (80.77%) were the most meteorological considerations taken into account during pesticides' application. A high percentage (75.96%) of farmers believed that chemicals have rapid action, and enable high level of control of most pests (72.12%) (Table5).

**Table (5): Some issues related to pesticides' applications as reported by respondents (n=104).**

	Item	Frequency of farmers	% of farmers
Knowledge of pesticides use	Good knowledge	69	66.35
	Poor knowledge	35	33.65
Reading label before application		88	84.62
Number of pesticides' applications *	When necessary	58	55.77
	Weekly	30	28.85
	Every two weeks	11	10.58
	Once a month	06	05.77
	Twice a week	04	03.85
	Three times a week	02	01.92
	Daily	01	00.96
	None	01	00.96
Location of buying pesticides*	Local markets	97	93.27
	Agricultural stations	05	04.81
	Others	04	03.85
I will still apply pesticides in the coming years		97	93.27
Type of pesticide used	Both	77	74.04
	Curative	21	20.19
	Preventive	06	05.77
Application time*	Morning	76	73.08
	Evening	41	39.42
	No specific time	11	10.58
	Mid-day-Afternoon	06	05.77
Application rate*	Middle rate	61	58.65
	Higher rate	39	37.50
	Lower rate	07	06.73
Meteorological considerations during application*	Wind speed and direction	88	84.62
	Temperature	84	80.77
	Rainfall	68	65.38
	Relative humidity	52	50.00
Reasons of using pesticides?*	Rapid action	79	75.96
	Enable high level of control of most pests	75	72.12
	The only control method when population approach	70	67.31
	ETL		
	Applicable to most pests	69	66.35
	Farmer may apply when and where required	56	53.85

\*Because multiple choices could be checked by each respondent, percentages do not sum to 100.

### 3.3.2. Commonly used pesticides

Almost 40% of the farmers indicated that they buy pesticides after the appearance of pests, and about 44% of them paid more than 2,000 JD for purchasing pesticides yearly (Table 6).

The most used agrochemicals by respondents were the insecticides: chlorpyrifos (63.46%),

methomyl (54.81%) and cypermethrin (49.04%), the fungicides: sulphur (56.73%), zineb (40.38%), and carbendazim (39.42%), the herbicides: glyphosate (31.73%) and paraquat (30.77%), and the acaricides: abamectin (54.81%) and omite (40.38%) (Table 7).

**Table (6): Time of purchasing pesticides and amount of money spent on pesticides' purchase as reported by respondents (n=104).**

	Item	Frequency of farmers	% of farmers
Time of purchasing pesticides*	After the appearance of pests	42	40.38
	Both At the beginning of the growing season	37	35.58
		25	24.04
Amount of money spent on pesticides' purchase each year (JD)	Less than 100	27	25.97
	100-499	15	14.42
	500-999	09	08.65
	1,000-1,999	07	06.73
	More than 2,000	46	44.23

\*Because multiple choices could be checked by each respondent, percentages do not sum to 100.

**Table (7): Types of agrochemicals used in Jordan by respondents (n=104).**

Group	Pesticide name	Frequency of farmers	% of farmers*
Insecticides	Chlorpyrifos (Dursban®)	66	63.46
	Methomyl (Lannate®)	57	54.81
	Cypermethrin (Cymbush®)	51	49.04
	Imidacloprid (Confidor®)	50	48.08
	Deltamethrin (Decis®)	50	48.08
	Oxamyl (Vydate®)	42	40.38
	Methidathion (Supracide®)	40	38.46
	Lambda-cyhalothrin (Karate®)	36	34.62
	Diazinon (Diazinon®)	32	30.77
	Dimethoate (Cygon®)	29	27.88
	Malathion (Malathion®)	28	26.92
	Aldicarb (Temik®)	19	18.27
	Methiocarb (Mesuro®)	16	15.38
	Carbofuran (Furadan®)	14	13.46
	Propoxur (Baygon®)	13	12.50
	Permethrin (Ambush®)	13	12.50
	Methyl parathion (Parathion®)	12	11.54
	Fenvalerate (Pydrin®)	08	07.69
	Carbaryl (Sevin®)	07	06.73
	Mevinphos (Phosdrin®)	06	05.77
Fenitrothion (Sumithion®)	05	04.81	
Fungicides	Sulphur	59	56.73
	Zineb	42	40.38
	Carbendazim (Carbendamil®)	41	39.42
	Mancozeb (Mancothane®)	33	31.73
	Benomyl (Benomyl®)	32	30.77
	Metalaxyl (Vacomil®)	27	25.96
Herbicides	Glyphosate (Roundup®)	33	31.73
	Paraquat (Gramoxone®)	32	30.77
	2,4-D (Esterdefore®)	24	23.08
Acaricides	Abamectin (Vertimec®)	57	54.81
	Omite (Propargite®)	42	40.38
	Fluazuron	23	22.12

\*Because multiple choices could be checked by each respondent, percentages do not sum to 100.

### 3.3.3. Safety of pesticides

Respondents reported that they are very highly interested in production quality and quantity (98%). In addition, more than 90% of farmers had concern about human health, try to decrease pesticide use and environmental pollution (Table 8). Almost 79% of the respondents checked the pesticides' level of toxicity before using it.

pesticides (2.16) had the least concern by farmers.

The most faced pesticide-related illnesses and injuries reported by respondents are headache/dizziness (42.31%), allergy (34.62%), breathing difficulty (29.81%), skin irritation (27.88%), and chest discomfort (26.92%). It is well known for respondents that extensive use of pesticides in agriculture can affect natural enemies, birds and wildlife (70.19%),

**Table (8): Some issues related to safety of the pesticides reported by the respondents (n=104).**

Task	Frequency of farmers	% of farmers*
<b>General</b>		
Interest in production quality and quantity	102	98.08
Care about human health	98	94.23
Interest in production quantity	97	93.27
Interest in production quality	97	93.27
Try to decrease pesticide use	96	92.31
Care about environmental pollution	93	89.42
Care about pesticide effects on groundwater	82	78.85
<b>Do you check the pesticide level of toxicity before using it?</b>	<b>82</b>	<b>78.8</b>

\*Because multiple choices could be checked by each respondent, percentages do not sum to 100.

Respondents indicated that they have a high level of concern about resistance management by rotating pesticides (mean of 4.06 out of 5) and waiting for safety period of pesticides before harvesting (4.01) (Table 9). Moderate concern was shown by respondents for using adjuvant to improve safety and efficacy of applications (mean: 3.63). Less concern was paid to spraying the same pesticide to the same crop during the season, pesticides combined with non-chemical methods, using selective pesticides and spot spraying for pests (mean: 2.4-2.9). Using bio-

contaminate air, soil and water (66.35%), and cause death to humans (62.05%) (Table 10). However, only 14% of the farmers know that pesticides can cause diabetes.

The most protective cloths reported by the farmers were nose mask (77.88%), washable hat (71.15%) and goggles (69.23%). Almost 72% of respondents stored pesticides in special store, while 10.58% stored them in house. In addition, the majority of the farmers (57.69%) burned empty containers, and only 3.85% recycled them (Table 11).

**Table (9): Respondents' knowledge of some selected tasks of pesticides (n=104).**

Task	Final point value (Mean of 5)
Resistance management by rotating pesticides	4.06
Wait for safety period of the pesticide before harvesting	4.01
Using adjuvant to improve safety and efficacy of applications	3.63
Using systemic pesticides	3.27
Notified people that pesticides are being used?	3.12
Using non-persistence pesticides	3.00
Spray the same pesticide to the same crop during the season	2.78
Pesticides combined with non-chemical methods	2.63
Using selective pesticides	2.62
Spot spraying for pests	2.43
Time of application depend on traps	2.25
Using bio-pesticides	2.16

**Table (10): Related pesticides illnesses and injuries reported by respondents (n=104) and knowledge of side effects of extensive use of pesticides in agriculture.**

	Task	Frequency of farmers	% of farmers*
Pesticide-related illnesses and injuries faced by respondents	None	44	42.31
	Headache or dizziness	42	40.38
	Allergy	36	34.62
	Breathing difficulty	31	29.81
	Skin irritation	29	27.88
	Chest discomfort	28	26.92
	Blue-red vision	20	19.23
	Secretions from mouth and nose	19	18.27
	Excessive sweating and salivation	19	18.27
	Stomach cramps	16	15.38
	Unable to walk and weakness	10	09.62
	Muscle twitches	09	08.65
Have you heard that extensive use of pesticides in agriculture causes?	Kill natural enemies, birds and wildlife	73	70.19
	Contaminate air, soil and water	69	66.35
	Death	65	62.05
	Cancer	61	58.65
	Asthma	58	55.77
	Pests resistance	57	54.81
	Destruction of soil microorganisms	57	54.81
	Causing plant injury	47	45.19
	Immune suppression and hormone disruption	44	42.31
	Decrease plant yield	38	36.54
	Reproductive abnormalities	36	34.62
	Diabetes	15	14.42

\*Because multiple choices could be checked by each respondent, percentages do not sum to 100.

**Table (11): Protective clothing used, storage of pesticides and fate of empty containers as reported by respondents (n=104).**

	Task	Frequency of farmers	% of farmers*
Protective clothing used during pesticides' application	Nose mask	81	77.88
	Washable hat	74	71.15
	Goggles	72	69.23
	Rubber boot	61	58.65
	Thick rubber gloves	56	53.85
	Washable overall	41	39.42
	Waterproof overall	38	36.54
	Respirator	24	23.08
	None	15	14.42
Storing pesticides' place	Special store	75	72.12
	Agricultural field	20	19.23
	House	11	10.58
Fate of empty containers	Burning	60	57.69
	Thrown away	41	39.42
	Recycling	04	03.85

\*Because multiple choices could be checked by each respondent, percentages do not sum to 100.

### 3.3.4. Pesticides' records

According to respondents, records related to application date and time (54%) and pesticide name used and rate (50%) were the most kept data. Nearly 49% of respondents said that they kept data on treated crop and pest species. Almost 39 of the farmers did not keep any records (Table 12).

### 3.3.5. Pesticides' resources

There is no single source of information which farmers rely upon for pesticides in their farms although private consultants and pesticides' companies (42%) were the most popular (Table 13). Other sources formed less than one-fourth of the information sources for farmers. Only 25% of those responding had been

**Table (12): Keeping records by respondents (n=104).**

IPM practice	Item	Frequency of farmers	% of farmers*
Keeping records	Application date and time	56	53.85
	Pesticide name used and rate	52	50.00
	Treated crop	51	49.04
	Pest species	51	49.04
	None	41	39.42
	Adjuvant used	36	34.62
	Meteorological conditions at spraying	30	28.85
	Equipment used	27	25.96
	Operator's name	24	23.08
Personal protective cloths used	20	19.23	

\*Because multiple choices could be checked by each respondent, percentages do not sum to 100.

**Table (13): Pesticides' resources and required information indicated by respondents (n=104).**

	Item	Frequency of farmers	% of farmers*
Pest management resources	Private consultant	44	42.31
	Pesticides' companies	44	42.31
	Extension meetings, workshop and newsletters (MOA)	28	26.92
	None	20	19.23
	Websites and books	12	11.54
	Commercial media (television, radio, newspaper, leaflets)	07	06.73
	Other resources	04	03.85
	Involvement in pesticides training or workshop	26	25.00
Seeking for pesticides information	81	77.88	
Type of information needed	Pesticide usage and application	68	65.38
	Pesticide safety	37	35.58
	Others	07	06.73
How would you like to have information about pesticides?	Extension meetings, workshop and newsletters (MOA)	43	41.35
	Written manuals	42	40.38
	Training	23	22.12
	Continuing education	18	17.31
	Commercial media (television, radio, newspaper, leaflets)	16	15.38
	Online Information	14	13.46
	Phone calls	12	11.54

\*Because multiple choices could be checked by each respondent, percentages do not sum to 100.

involved in pesticides’ training program. Almost 78% reported seeking for information about pesticides. The most common type of information they looked for is pesticide usage and application (65.38%) (Table 13). Almost 41% of the respondents would like to have information about pesticides through MOA or as written manuals.

**3.4. Correlation analysis**

The results indicated that farmer’s age is correlated significantly and positively with experience ( $r = 0.624, P < 0.01$ ), and negatively with education ( $r = -0.180, P > 0.05$ ) (Table 14). There was a positive and significant correlation between education of the farmers and knowledge of pesticides use ( $r = 0.215, P < 0.05$ ). Involvement in pesticides training programs was positively and significantly correlated with education ( $r = 0.170, P = 0.05$ ) and farm size ( $r = 0.205, P < 0.05$ ). Reading label was positively and significantly correlated with education ( $r = 0.230, P < 0.05$ ) and negatively with age ( $r = -0.183, P < 0.05$ ). There was a positive and significant correlation between involvement in pesticides training and knowledge of pesticides use ( $r = 0.317, P < 0.01$ ).

European Union (Dimitri and Oberholtzer, 2005). What is required is to weigh all the risks against the benefits to ensure a maximum margin of safety. This study was set out to analyze farmer beliefs and perceptions in relation to pesticide use for pest control by Jordanian farmers. The current data also discuss issues and trends on various aspects of awareness among farmers toward pesticide use in Jordan. The long experience period in farming (aver. 17 years/farmer) could strengthen our results and give a wider view on awareness of farmers toward pesticide use in Jordan. The present data showed that there is an adequate representation of responses based on cross-section throughout the country, age, experience and education level of farmers and farm size.

In the present study, age (aver. 44-year-old) has negatively and significantly correlated with reading pesticide label. In contrast, education level had a positive and significant correlation with knowledge of pesticides use, reading label and involving in pesticides training programs. In addition, involving in pesticides training has positively and significantly correlated with knowledge of pesticides use. In the same line

**Table (14): Some important correlations’ analysis between demographics variables of the farmers and particular pesticides’ practices/issues (n=104).**

<b>Correlated variables</b>	<b>r</b>	<b>Significance</b>
Age vs. experience	<b>0.624**</b>	<b>0.000</b>
Age vs. education	<b>-0.180</b>	<b>NS</b>
Knowledge of pesticides use vs. age	<b>0.071</b>	<b>NS</b>
Knowledge of pesticides use vs. education	<b>0.215*</b>	<b>0.029</b>
Knowledge of pesticides use vs. experience	<b>0.020</b>	<b>NS</b>
Knowledge of pesticides use vs. farm size	<b>0.063</b>	<b>NS</b>
Involving in pesticides training vs. age	<b>0.157</b>	<b>NS</b>
Involving in pesticides training vs. education	<b>0.170*</b>	<b>0.050</b>
Involving in pesticides training vs. experience	<b>0.143</b>	<b>NS</b>
Involving in pesticides training vs. farm size	<b>0.205*</b>	<b>0.037</b>
Reading label vs. age	<b>-0.183*</b>	<b>0.050</b>
Reading label vs. education	<b>0.230*</b>	<b>0.019</b>
Reading label vs. experience	<b>-0.140</b>	<b>NS</b>
Reading label vs. farm size	<b>0.087</b>	<b>NS</b>
<b>Involving in pesticides training vs. knowledge of pesticides</b>	<b>0.317**</b>	<b>0.010</b>

NS,\* and \*\* Not significant, significant at 0.05 and 0.01 respectively.

**4. Discussion**

Pesticides are considered a quick and easy solution for controlling agricultural pests. However, pesticide use comes at a significant cost. The economic impact of pesticides on non-target species including humans has been estimated at approximately 8 billion Dollars annually in developing countries, 10 billion Dollars in the USA and 13 billion Dollars in

with our results, Anger *et al.* (1997) mentioned that the effects of pesticides have been found to vary according to age and education. Our data indicated that a high percent of farmers (66%) have good knowledge of pesticide use. Good knowledge may be linked to the level of educational attainment (Owusu-Boateng and Amuzu, 2013). Also, Abd Rabou *et al.* (2002) and Yassin *et al.* (2002) stated that farmers who

finished their University level of education were found to have the highest percentage of good knowledge on pesticide use. Farmers with good pesticide knowledge were more inclined to use pesticides according to the recommended guidelines. Farmers with higher education attended training courses on pesticide use and having good communication capabilities with agricultural officials and environmental institutions. Moreover, the highly educated farmers have the ability to fully read the instructions of pesticide use. Abd Rabou *et al.* (2002) stated that 30% of farmers have good knowledge of pesticide use, which is lower than what we found. Yassin *et al.* (2002) stated that younger farmers have the highest good knowledge. This could be attributed to their chance in attending training courses on pesticide use and dealing with pesticides' effectiveness and safety measures.

Our results showed that respondents are very highly interested in production quality and quantity (98%). In addition, more than 90% of farmers had concern about human health, environmental pollution and try to decrease pesticide use. It is clear that farmers' perception of harmful effects of chemicals did not influence farmers' decisions in regard to actual decrease of pesticide use. In this regard, Bonabana-Wabbi (2002) mentioned that although 84% of farmers agreed that pesticides were harmful to crops, animals and humans, 93% applied pesticides on crops they grew. A possible explanation would be that farmers do not consider health and environmental impacts important considerations when choosing a control approach. Farmers indicated that they have a high concern level about resistance management by rotating pesticides and waiting for safety period of pesticides before harvesting. Our data agree with Owusu-Boateng and Amuzu (2013) who stated that 93% of farmers waiting for safety period of pesticides before harvesting. In contrast, Al-Saed *et al.* (2011) mentioned that most of the farmers seldom followed the instructions of safety period.

The data showed that 85% of the farmers read the label before applying pesticides. In contrast, low percentage of 25% was reported by Abd Rabou *et al.* (2002) and only 14% mentioned by Al-Saed *et al.* (2011). Low level of education seems to promote risk of pesticide abuse. This may possibly be attributed to difficulties in understanding of use instructions and safety procedures on the product labels

(Owusu-Boateng and Amuzu, 2013). In addition, the reason is that many farmers are careless and others are illiterate. Our data showed that 29% of the farmers apply pesticides weekly, which in agreement with the findings of Abang *et al.* (2013). This will promote the misuse of these chemicals and will put both human and environment at risk. Thus, overuse and/or misuse of pesticides by farmers are obvious in the improper estimation of the timing and frequency of application. Irrespective of their health and accumulation of pesticide residues on crops, farmers believe that more spraying of pesticides means more agricultural yield (Wesseling *et al.*, 1997; Abd Rabou *et al.*, 2002). The current results showed that a very high percent (93%) of farmers purchased pesticides from local markets, which is in line with the findings of Abd Rabou *et al.* (2002) who stated a percent of 87%. The majority of farmers (93%) believed that they will still apply pesticides in the coming years. In regards to type of pesticide used, 74% of the farmers applied both curative and preventive pesticides against pests, which is close to what Abd Rabou *et al.* (2002) found (71%). Our data showed that 73% of farmers apply pesticides at the morning, while, only 46% were reported by Abd Rabou *et al.* (2002). Middelium pesticides' rate was applied by 59% and higher rate by 38% of the farmers. In this regard, Al-Saed *et al.* (2011) stated that farmers are rarely committed with the recommended doses of the pesticides.

The current data showed that farmers purchase pesticides at the beginning of the growing season and after the appearance of pests, which is in complete agreement with findings of Owusu-Boateng and Amuzu (2013). The results of this survey indicated a wide variety of chemicals were being applied and sprayed as pesticides by the farmers. This indicated that farmers depended heavily on use of pesticides for control of different pests, which is in line with findings of Sheikh *et al.* (2011), Abang *et al.* (2013) and Owusu-Boateng and Amuzu (2013). This is probably because farmers believe that the only solution to pest problems is to spray more frequently by using different types of pesticides (Dinham, 2003).

Regarding toxicity symptoms associated with pesticides by unsafely application, the results demonstrated that the most faced pesticide-related illnesses and injuries are headache/dizziness, allergy, breathing difficulty, skin irritation, and chest discomfort. Our data

agree with the findings of many other researchers in which interviewed farmers mentioned several similar pesticide-related illnesses and injuries (Abd Rabou *et al.*, 2002; Safi, 2002., Abang *et al.*, 2013). Our data indicated that only 15% of respondents did not wear any protective clothing while the remaining observed wearing protective clothing such as nose masks, washable hat and goggles. In this regard, 75% (Owusu-Boateng and Amuzu, 2013) and 78% (Abd Rabou *et al.*, 2002) of respondents stated that they did not wear any health safety measures, which is much higher than what we found in the current study. In addition, several authors demonstrated that despite the high risk and frequency of exposure, many farmers in the developing countries were not use or partially use the protective gear while working with pesticides (Clarke *et al.*, 1997; Yassin *et al.*, 2002). The finding that farmers did not wear protective gear during pesticide application is alarm and needs farmers, environmentalists and governmental officials to stop and think.

The present results showed that 72% of respondents store pesticides in special store, 19% in fields and 11% in house. In addition, the majority of the farmers (58%) burned empty containers, 39% throw them away and only 4% recycled them. In this regard, Owusu-Boateng and Amuzu (2013) stated that the majority of farmers (85%) disposed off emptied agrochemical containers by burning them on the farm, leaving them on the farm land, digging up the soil and burying the containers or placing them in the communities' waste bins. About 19% of farmers stored pesticide containers in the agricultural field, 16% in the house and 66% in special store (Abd Rabou *et al.*, 2002). Abang *et al.* (2013) stated that 70% of farmers burned the pesticide containers or threw them away on the farm, and 25% of them store chemicals at home. These methods of disposal pose varying degrees of health risk to both humans and the environment as noted by Recena *et al.* (2006) and may affirm the exhibition of poor knowledge of issues relating to pesticides. Storage of pesticides in the home will put people at risk. Empty pesticide containers are classified as hazardous wastes and special care is required before and during their disposal. However, it is well known that mismanagement of pesticide containers is common in the developing countries (Wesseling *et al.*, 1997). The prevalence of these methods and practiced may

be rooted in low educational attainment which is reflected in poor level of knowledge of issues relating to pesticides.

There is no single source of information which farmers rely upon for pesticide use in their farms although private consultant and pesticides' companies were the most popular. This finding is in line with finding of Al-Zyoud (2014) in which private consultant was the most popular. The current data indicated that 75% of farmers have never received any training on pesticide use, which is in agreement with the finding of Abang *et al.* (2013), while Abd Rabou *et al.* (2002) stated a higher percent of 91%. The absence of farmer training further increases the danger of pesticide misuse. This suggests that designing and implementing educational programs at the sale points are likely to make huge contribution to prevention of pesticides abuse (Owusu-Boateng and Amuzu, 2013).

**In conclusion**, the results presented here display a lack in awareness of Jordanian farmers toward pesticide use and lack appropriate knowledge on the safe handling and use of pesticides, therefore, underestimated their potential human health and environmental risks. This is represented in overuse, misuse and abuse of pesticides through the improper estimation of the timing and frequency of application, not reading labels on pesticide containers, not wearing protective gear, storage of pesticide containers in home and disposal of empty pesticide containers anywhere. There are strong indications that substantial human health problems are associated with the misuse of pesticides in agriculture in Jordan. The costs of human health effects and environmental problems caused by pesticide use have not been included in the total cost of production and warrant further study to generate appropriate data on which to base policies. There is a need to intensify both extension/farmer relationships and researcher/extension linkage to improve farmers' knowledge on the use of chemicals and strengthen the role of extension services in pest control. Launch of educational and training programs for farmers, public awareness creation and enforcement of laws concerning the use of pesticides to improve safety and awareness of pesticides are of vital importance. A multi-effort from different professional groups, different sectors of the government and nongovernmental organizations is highly recommended. Alternatives to chemical control of pests should be developed, disseminated, and reinforced

through MOA in Jordan to provide a healthy environment for all.

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## الاستخدام العشوائي والرش غير الآمن للمبيدات بوساطة مزارعي الخضار والفاكهة - الأردن

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### ملخص

يجهل معظم المزارعين في الأردن الآثار الضارة التي تسببها المبيدات على صحة الإنسان والبيئة ولا يزال تأثير رش واستخدام المبيدات غير معروف لدى المستهلك والمزارع. ولهذا الغرض تم سؤال المزارعين عن الجوانب الاجتماعية، أنواع الآفات، ومدى المعرفة وأساليب وأمان ومصادر المبيدات عن طريق إجراء مسح ميداني للمزارعين على مستوى الأردن خلال عام 2014. أشارت النتائج ان 66% من أفراد العينة لديهم معرفة جيدة عن كيفية استخدام المبيدات، و 85% منهم يقرأ البيانات على العبوة قبل رش المبيدات. يرش حوالي 56% من المزارعين المبيدات عند الإصابة بالآفات، في حين أن 29% يرش المبيدات أسبوعياً. هناك نسبة عالية (93%) من المزارعين يعتقد أنهم سوف يستمروا في رش المبيدات في السنوات المقبلة. يستخدم تقريبا 74% من المزارعين كل من المبيدات الوقائية والعلاجية، و 73% يرش المبيدات في الصباح و 39% في المساء. كما أظهرت النتائج أنه يتم استخدام المعدل الوسط للمبيدات بنسبة 59% والأعلى بنسبة 38% من المزارعين. أشارت النتائج أيضاً أن هناك مجموعة كبيرة من المبيدات يتم استخدامها من قبل المزارعين. أن استخدام المبيدات الحيوية له أهمية أقل من قبل المزارعين. تعرض المزارعين للعديد من الأمراض والإصابات بالمبيدات. أظهرت النتائج ان 14% من عينة الدراسة لم يرتدوا ملابس واقية أثناء رش المبيدات، و 11% يقوم بتخزين المبيدات في المنزل، و 58% يقوم بحرق العبوات الفارغة، و 39% لم يحتفظ بأي سجلات للمبيدات. الاستشارات الخاصة وشركات المبيدات (42%) هي أكثر مصادر المعلومات عن المبيدات. 25% فقط من المزارعين شارك في برامج تدريبية عن المبيدات، و 78% منهم يبحث عن معلومات عن المبيدات. لقد ارتبط المستوى التعليمي للمزارع بشكل إيجابي ومعنوي مع المعرفة باستخدام المبيدات والاشتراك في برامج تدريبية عن المبيدات. ارتبطت قراءة الملصق إيجابياً ومعنوياً مع المستوى التعليمي للمزارع وعكسياً مع عمر المزارع. كان هناك علاقة طردية ومعنوية بين الاشتراك في برامج تدريبية عن المبيدات والمعرفة باستخدام المبيدات. في الختام، يعتمد المزارعون على المبيدات لمكافحة الآفات، وأظهرت الدراسة بعض الإفراط وسوء في استخدام المبيدات.

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