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ADOPTION OF INTEGRATED PEST MANAGEMENT AMONG FRUIT TREES' GROWERS IN JORDAN

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ABSTRACT

Integrated pest management (IPM) is used to control pests' damage by the most economical means and the least possible hazards to human and environment. Interest in measuring the degree of IPM adoption has increased over time. Extent and level of IPM adoption in Jordan are still largely unknown. Therefore, this study aimed to analyze the factors affecting IPM adoption among fruit trees' growers in Jordan. For this purpose, Jordanian fruit trees' growers were questioned about their social aspects, types of pests encountered, and IPM knowledge, practices and resources by conducting a countrywide survey of growers during 2014. The results indicated that the majority of the respondents (68%) have never heard about IPM and not sure what IPM is, and only 2.5% were regularly using IPM. Lack of growers' information and knowledge about IPM (73%) has first priority of IPM adoption. Data on how often growers monitor pests, most common methods for pests monitoring, testing soil, keeping records, reasons of using chemical control and knowledge of pesticides' side effects are herein presented. The results showed that a number of cultural and mechanical control techniques are commonly utilized by growers. Pesticides' application is a decision based on the safety period by the responedents. There is no single source of information which growers rely upon for pest management in their farms. Almost 57% of the respondents indicated that IPM is neither required nor recommended, only 20% of them had been involved in IPM training program, and 77% would like to change and adopt IPM. Familiarity with IPM had a significant negative correlation with farmer's age and a positive on with education. There was a positive significant correlation between willingness to change to IPM and involvement in IPM training. In conclusion, the findings of this study will serve as a catalyst for the adoption of IPM technology and will, therefore, contribute to the sustainability of agriculture in Jordan.

Key words: *adoption, agricultural innovations, fruit trees, growers, healthy products, Integrated pest management, Jordan, sustainable agriculture.*

1. INTRODUCTION

Fruit trees are important agricultural crops grown in Jordan with a total area of 858.6 thousand dunums producing 455.1 thousand tons. Olives, citrus, grapes, apple and bananas occupied the largest five planted areas, respectively (Jordan Statistical Yearbook, 2012). Pesticides have helped the world meets growing food demand by increasing the agricultural productivity through controlling pests infesting fruit trees. However, several negative externalities resulting from years of intense use of chemicals to control pests, increased resistance to pesticides within pest populations (Sato *et al.*, 2005), and adverse environmental and human health impacts (Samiee *et al.*, 2009). Thus, various researchers began advocating non-chemical use to control pests (Pannell *et al.*, 2006; Samiee *et al.*, 2009).

Sustainable agriculture is a key element of sustainable development and essential to the future of human being (Shojaei *et al.*, 2013). Sustainability aims to achieve adequate safe and healthy food production, and improve livelihoods of food producers (Uwagboe *et al.*, 2012). Integrated pest management (IPM) is used to manage pest damage by the most economical means and the least possible hazards to human and environment (Ofuoku *et al.*, 2009). IPM is a decision-based process involving coordinated use of multiple tactics for optimizing the control of pests in an ecologically and economically sound manner (Prokopy, 2003). IPM has gained acceptance as the most proper method of agricultural pests' control (Kogan, 1998). Since many years, university researchers and governmental extension specialists have worked together under the umbrella of IPM to establish improved pest management practices (Maupin *et al.*, 2010). Furthermore, IPM is a holistic way of thinking that improves our ability to reduce growers' reliance on chemical pesticides (Bonabana-Wabbi, 2002).

The world supports the use of IPM in agriculture as the best environmentally sound approach to pest control (Barnes *et al.*, 2012). However, despite considerable support from national and international agencies, adoption of IPM has been slow, and large areas under agricultural production in much of the world are still facing unacceptable losses due to pests or suffer from intense use of pesticides, which led scientists to suggest that new paradigms are needed (Kogan, 1998). It was found that IPM adoption leads to lower pesticide use, production cost, and risk, and higher net returns to producers (Norton and Mullen, 1994).

Interest in measuring the degree of IPM adoption has increased over the time (Bauske *et al.*, 1998). In order to promote the extent of adoption, it is essential to work out the social aspects and also the context of farming operations, which could prove useful for designing and dissemination of IPM techniques (Samiee *et al.*, 2009). Generally, researchers and extension agents are often frustrated by slower than expected adoption level of IPM. This is the main reason why so much attention has been given to understand what drives the adoption of IPM among growers (Pannell *et al.*, 2006). Speeding up the rate of IPM adoption requires knowledge of underlying factors that influence the adoption decision.

The adoption of IPM has been the subject of numerous studies, where researchers have focused on identifying the relationships between the adoption of pest control practices and the characteristics of growers (Kainea and Bewsellb, 2008). High level of grower education is likely to induce the adoption of control technologies; in contrast, lack of active information may be an obstacle to the adoption (Feder and Slade, 1984). Dasgupta *et al.* (2007) characterized IPM growers as those practicing at least one method among biological control (BC), traps, organic production, crop rotation and manual clearing. In order to effectively introduce IPM it requires researchers to understand the social, economic and control factors of targeted adopters and the institutional characteristics that might either inhibit or enhance IPM adoption.

There is no specific IPM program in the current study but the farmer is considered as an adopter if he applies two or more particular practices rather than require all components of an IPM package to be employed. Thus, the farmer is an IPM adopter if he practices two or more of the followings: cultural practices (ploughing, collection of failed and infested fruits); mechanical practices (use mechanical weed control, hand picking and killing insects); time of chemical application depends on traps (light, color or pheromone); test the soil to investigate the nutritional value in order to have healthy plants to compensate the infestation; keeping records at the farm because this is a good practice in IPM; using any pesticide that is selective, systemic, non-persistence or bio-pesticides (Bt). In addition, using insect growth regulators, applying pesticides when necessary and spot spraying for pests are expected to be followed by farmers.

Studies related to IPM in developing countries have not been as prevalent as in developed countries (Bonabana-Wabbi, 2002). Moreover, extent and level of IPM adoption in Jordan are still largely unknown. It is hypothesized that many factors (i.e. age, education level and experience of the grower, and farm size) influence IPM adoption. Therefore, the general objective of this paper was to analyze the factors affecting IPM adoption among fruit trees' growers in Jordan. The specific objectives of this study were to (1) assess the current level of IPM adoption in Jordan, (2) identify factors which influence the adoption of IPM by growers, and (3) document growers' preferences regarding sources of IPM information. For this purpose, Jordanian fruit trees' growers were questioned about their social aspects, types of pests encountered, and IPM knowledge, practices and resources by conducting a countrywide survey of growers. This study will provide guidance to IPM administrators and researchers for improving IPM adoption and use in Jordan.

2. MATERIALS AND METHODS

2.1. Questionnaire Development

In order to prepare the questionnaire, proposed questions were developed in Arabic language and sent to several IPM specialists for their critique and suggested additions. After

Questionnaire

Section 1: Demographics of the farmers

No.	Task	Answer
1.	**Governorate**	
	Karak	
	Mafraq	
	Amman	
	Madaba	
	Muann	
	Irbid	
	Balqa	
	Jarash	
2.	**Farmer age (years)**	
3.	**Area (dunum)**	
4.	**Trees grown**	
5.	**Since when are you growing? (Experience)**	
6.	**Farmer educational level**	
	Illiterate	
	Primary school	
	Secondary school	
	Tawjihi	
	Diploma	
	B.Sc.	
	M.Sc.	
	Ph.D.	

Section 2: Main pest problems occurring in your farm

2.1. Fruit trees

7. What are the main pests in your farm?

Item	Pest	Answer	Answer
Diseases	Grape powdery mildew	( ) Yes	( ) No
	Grape black rot	( ) Yes	( ) No
	Peach leaf curl	( ) Yes	( ) No
	Apple scab	( ) Yes	( ) No
	Apple powdery mildew	( ) Yes	( ) No
	Apple fire blight	( ) Yes	( ) No
	Gummosis of citrus trees	( ) Yes	( ) No
	Olive leaf spot	( ) Yes	( ) No
	Olive branch knot	( ) Yes	( ) No
	Olive verticillium wilt	( ) Yes	( ) No
	Fruit mold of pomegranate	( ) Yes	( ) No
Insects	Apple stem borer	( ) Yes	( ) No
	Apple fruit moth	( ) Yes	( ) No
	Golden aphids	( ) Yes	( ) No
	Capnodius	( ) Yes	( ) No
	Olive fruit fly	( ) Yes	( ) No
	Olive pysalla	( ) Yes	( ) No
	Grape berry moth	( ) Yes	( ) No
	Citrus scales	( ) Yes	( ) No
	Citrus mealy bugs	( ) Yes	( ) No
	Fruit fly	( ) Yes	( ) No
Mites	Olive mites	( ) Yes	( ) No
	Grape mites	( ) Yes	( ) No

2.2. Other pests not mentioned above:

1...

2...

3...

4...

5...

Section 3: Integrated pest management **knowledge, practices** and **resources**

Subsection 3.1: IPM knowledge

8. What is your level of familiarity with IPM?

( ) Never heard of IPM

( ) Not sure what IPM is

( ) Familiar with IPM concept and practice

( ) Regularly use IPM

9. Have you ever heard of?

Control method	Answer	Answer
Cultural control	( ) Yes	( ) No
Mechanical control	( ) Yes	( ) No
Resistance plant varieties	( ) Yes	( ) No
Insect attractants (pheromones, traps)	( ) Yes	( ) No
Insect growth regulators	( ) Yes	( ) No
Sterile male techniques	( ) Yes	( ) No
Biological control	( ) Yes	( ) No
Chemical control	( ) Yes	( ) No

No.	Question	Answer	Answer
10.	Are you caring about human health?	( ) Yes	( ) No
11.	Are you caring about environmental pollution?	( ) Yes	( ) No
12.	Are you caring about pesticide effects on groundwater, soil and air?	( ) Yes	( ) No
13.	Are you trying to decrease pesticide use?	( ) Yes	( ) No
14.	Are you interested in production quality?	( ) Yes	( ) No
15.	Are you interested in production quantity?	( ) Yes	( ) No
16.	Are you interested in production quality and quantity?	( ) Yes	( ) No
17.	Do you believer that the contracts between growers and customers can influence adoption of IPM?	( ) Yes	( ) No
18.	Do you believe that if your neighbors apply IPM, they will influence on you to adopt IPM technologies?	( ) Yes	( ) No
19.	Do you think that the governmental policies such as price support schemes, market structure and taxes will enhance the adoption of IPM?	( ) Yes	( ) No

20. What are the barriers to adopt IPM technologies?

Task	Answer	Answer
Lack of farmer's assurance to control pests with IPM	( ) Yes	( ) No
Lack of farmer's information and knowledge about IPM	( ) Yes	( ) No
Complexity and difficulty of IPM	( ) Yes	( ) No
IPM is expensive	( ) Yes	( ) No
IPM reduces production	( ) Yes	( ) No
IPM need to have exact discipline and scheduling	( ) Yes	( ) No
Lack of government's support for IPM	( ) Yes	( ) No
Lack of tools used in IPM	( ) Yes	( ) No
Lack of good price and marketing	( ) Yes	( ) No
Weak extension service	( ) Yes	( ) No

Subsection 3.2: IPM practices

3.2.1. General IPM practices

21. How often you monitor pests?

( ) Once a day
( ) Once a week
( ) Once a month
( ) Once during growing season
( ) During specific pest outbreaks
( ) None

22. Which pest monitoring methods used inside your farm?

( ) Visual inspection
( ) Colored traps
( ) Sticky traps
( ) Light traps
( ) Pheromone traps
( ) None

23. Are you testing soil for fertilizer and pH recommendations?

( ) Every year
( ) Every 2 years
( ) Every 3 years
( ) More than 3 years
( ) None

24. Which of the following pest management records you are keeping in your farm?

( ) Pest species
( ) Pesticide applications
( ) Control practices
( ) Crop variety
( ) Crop yields
( ) Calibrate pesticide and fertilizer equipment?
( ) Pest monitoring data
( ) Pesticides protecting clothing
( ) Other

3.2.2. Cultural control practices

25. What are the cultural control methods that you are applying in you farm?

Task	Answer	Answer
Collection of fallen and infested friuts	( ) Yes	( ) No
Systematic cutting and removal of infested parts	( ) Yes	( ) No
Pruning of dried branches of trees	( ) Yes	( ) No
Ploughing	( ) Yes	( ) No

3.2.3. Mechanical control practices

26. Are you doing the following tasks in you farm?

Task	Answer	Answer
Hand picking and collection with nets and killing insects	( ) Yes	( ) No
Use mechanical weed control	( ) Yes	( ) No
Shaking the trees by which the insects fall to the ground and they can be collected.	( ) Yes	( ) No

3.2.4. Chemical control practices

27. Why are you using chemical control?

Task	Answer	Answer
The only control method when population approach ETL	( ) Yes	( ) No
Applicable to most pests	( ) Yes	( ) No
Rapid action	( ) Yes	( ) No
Grower may apply when and where required	( ) Yes	( ) No
Enable high levels of control of most pests	( ) Yes	( ) No
Has a wide range of properties, uses and methods of applications	( ) Yes	( ) No

28. Have you heard of the following side effects of pesticides?

Task	Answer	Answer
Pest resistance to pesticides	( ) Yes	( ) No
Outbreaks of secondary pests	( ) Yes	( ) No
Adverse effects on non-target organisms	( ) Yes	( ) No
Hazards of pesticide residues	( ) Yes	( ) No
Direct hazard from pesticide uses	( ) Yes	( ) No
Contaminate water, air and soil	( ) Yes	( ) No

29. Are you doing the following tasks?

Task	Never	Seldom	Sometimes	Often	Always
Pesticides chosen for efficacy rather than cost					
Pesticides chosen based on pest identification					
Routine preventative applications					
Resistance management by rotating pesticides					
Soil fumigation					
Adjust pesticide application rates					
Using adjuvants to improve safety and efficacy of applications					
Spot spraying for pests					
Using selective pesticides					
Using non-persistence pesticides					
Using systemic pesticides					
Using bio-pesticides					
Time of application depend on traps					
Applying pesticides when necessary?					
Notified people that pesticides are being used?					
Pesticides only after non-chemical methods					
Pesticides combined with non-chemical methods					
Spray the same pesticide to the same field during the growing season					
Wait for the safety period of the pesticide before harvesting					
Clean equipment when moving from place to another to prevent pest spread?					
Equipment calibration and maintenance					
Worker protection clothing					
Pesticides never used in my farm					

3.2.5. Biological control practices

30. Why you are not using BC to suppress pests in your farm?

Task	Agree	No opinion	Disagree
Costs of BC is too high			
Biological control is not effective			
BC results in lower yields			
Biological control is too labor intensive			
The use of biological controls is not practical to implement in my farm			
The use of BC requires special skills and knowledge that I do not have			

Subsection 3.3: IPM resources

No.	Question	answer
31.	Do you rely on one or more of these IPM resources?	( ) Universities
		( ) Extension meetings, training and workshops (MOA)
		( ) Extension newsletters
		( ) Private consultant
		( ) Trade publications
		( ) Websites and Books
		( ) IPM Farmer Field Schools
		( ) Radio/Television programs
		( ) Other resources
		( ) None
32.	Does the Ministry of Agriculture require or recommend the use of IPM from you?	( ) IPM is required
		( ) IPM is recommended
		( ) IPM is neither required nor recommended
33.	Have you been involved in training or practical agriculture workshop about IPM?	( ) Yes ( ) No
34.	Would you like to change to adopt IPM techniques in your farm?	( ) Yes ( ) No
35.	Are you looking for IPM Information?	( ) Yes ( ) No
36.	If you answered yes to the previous question, please select the choice(s) that best describes	( ) General Information
		( ) Principles Information
		( ) Technical Information
		( ) Other Information
37.	How would you like to have information about IPM?	( ) Extension meetings, training and workshop on IPM (MOA)
		( ) Written manuals
		( ) Continuing education
		( ) Phone calls
		( ) Online Information
		( ) Radio/Television programs
		( ) Newspapers

responses were received from the specialists, their comments and suggestions were utilized in developing the final questionnaire. The survey questionnaire instrument was developed to better understand and document the current IPM practices used by fruit trees' growers in Jordan. By design, the questionnaire was kept short and simple. The questionnaire was sent to 110 randomly selected fruit trees' growers during 2014 to determine whether and to what extent they practiced IPM. Although sampling was random, an effort was made to ensure that the selected growers represented different governorates, age groups, farm sizes and literally levels. The paper format questionnaire was accompanied by a cover letter. The goal of the study was explained to the 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. Furthermore, several phone calls were made to the participants to explain any unclear question in the questionnaire.

2.2. Structure of the Survey Data

For documenting the adoption of IPM techniques and practices by fruit trees' growers, the IPM measurement method used in this survey consisted of three major parts; demographic characteristec of the growers, main pest problems occurring in the growers' farms, and IPM knowledge, practices and resources. The first six questions in the questionnaire determined the demographic variables of the growers including location, age, experience and educational level, as well as farm area. Questions seven probed into main pest problems (diseases, insects and mites) occurring in the growers' farms. Questions eight through thirty seven were divided into 3 subsections, and addressed IPM knowledge, practices and resources, respectively. Subsection 1 determined the growers' IPM knowledge such as familiarity with IPM and IPM different control methods, care about human health and environmental risk, decreased pesticide use, and barriers to adopt IPM technologies. Subsection 2 addressed the growers' IPM practices such as monitoring pests, testing soil and keeping records. Also, this subsection asked growers about cultural, mechanical and biological practices used in their farms. Furthermore, in the 2nd subsection the growers were also asked in details about chemical control; why they are using pesticides? and the side effects of using such chemicals. Subsection 3 addressed the growers' IPM resources and asked about growers' pest management resources, and if IPM is required or recommended by the Ministry of Agriculture (MOA), involving in training IPM programs, and required IPM information. A series of yes/no answers, and never, seldom, sometimes, often and always answers, were included in the questionnaire.

2.3. Response Outcome and Statistical Analysis

Eighty one completed questionnaires were returned, where an initial evaluation of the returned surveys for completeness, was undertaken. Data obtained from all completed questionnaires were compiled in a spreadsheet, and then data 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 each item was practiced. The possible responses, never, seldom, sometimes, often and always, were assigned values of 1, 2, 3, 4 and 5, as well as disagree, no opinion and agree were coded 1, 2 and 3, respectively. The final point value of each item was obtained by multiplying the assigned value by the number of responses. Because multiple choices could be checked by each respondent in some questions, percentages do not sum to 100. Data were analyzed using descriptive and inferential statistics such as mean, standard error mean, percentages and frequencies (Samiee *et al.*, 2009). Descriptive analysis provides statistics that were used to describe the basic features of the data in the study. For correlation of education with other variables, the illiterate, schooling, tawjihi, diploma, BSc and MSc were assigned values of 1, 2, 3, 4, 5 and 6, respectively. Spearman's correlation analysis procedure was used to examine pair-wise associations between demographics' variables of the growers (age, agricultural experience, education and farm size) and particular IPM tasks (Zar, 1999). All analyses were performed using the Proc GLM of the statistical package SigmaStat version 17.0 (SPSS, 1997).

3. RESULTS

3.1. Demographic characteristics of the Respondents

3.1.1. Geographical Distribution of the Respondents and their Age

Eighty one responses representing 8 governorates in Jordan were obtained. The highest percent of responses was obtained from Karak (30.86%); meanwhile the least responses' percent was recorded for Muaan with only 1.23% (Table 1). These data reveal a satisfactory cross-section through the country. The overall average growers' age was 46.23±1.37 year old, in which the youngest grower was 25 year old and the eldest was 75-year-old. Splitting the growers age into groups (Table 1) showed that the majority of the growers is in the forties of age (34.57%), while the minority of the growers was in the twenties (3.70%) and seventies (6.17%) of age.

3.1.2. Farm Size and Agricultural Experience of Respondents

The overall total farm size owned by respondents was 8,249 dunums with an overall average of 101.84±22.09 dunums/grower.

Splitting farm size into groups showed that the majority of the growers (76.54%) owns on the average 24.60±1.74 dunums/grower. In contrast, 12.35% of the growers have above 200 dunums/grower (aver. 554.0±88.16) (Table 2). Overall, the total number of years of the growers experience in agriculture was 1,526 with an overall average of 18.84±1.05 years/grower. The majority of the growers (37.04%) has an average of 16.40±0.62 years of experience, while 9.87% of them have an experience above 30 years (aver. 38.00±1.25) (Table 2). The data indicated that agriculture has been practiced since long time in the country.

the least among the respondents (Table 3).

3.2. Occurrence of Main Pest Problems in the Respondents' Farms

The results indicated that insects, mites and diseases occur intensively in the respondents' farms during the survey period. About 66% of the respondents cited olive fruit fly as the most important pest problem in their farms (Table 4). This was followed by grape powdery mildew (56.79%), gummosis of citrus trees (55.56%), Mediterranean fruit fly and olive pysalla (50.62%) for each. Meanwhile, apple fire blight and apple scab (14.81%) for each, were the least cited by growers.

Table (1): Geographical representation of respondents (n=81) according to governorate, and groups for respondents' age.

Governorate	Frequency of growers	% of growers	Age interval (years)	Frequency of growers	% of growers
Karak	25	30.86	< 20	00	00.00
Irbid	21	25.93	20-29	03	03.70
Mafraq	18	22.22	30-39	21	25.93
Balqa	10	12.35	40-49	28	34.57
Jarash	02	02.47	50-59	17	20.99
Amman	02	02.47	60-69	07	08.64
Madaba	02	02.47	≥ 70	05	06.17
Muann	01	01.23			

Table (2): Groups for farm size owned by respondents and agricultural experience of respondents (n=81).

Farm size (dunum)	Aver. of farm (dunum)	Frequency of growers	% of growers
1-50	24.60±1.74	62	76.54
51-100	71.50±9.95	04	04.94
101-200	180.0±12.25	05	06.17
≥201	554.0±88.16	10	12.35
Experience interval	**Aver. no. of years**	**Frequency of growers**	**% of growers**
1-10 years	08.29±0.50	21	25.93
11-20 years	16.40±0.62	30	37.04
21-30 years	25.27±0.62	22	27.16
≥ 31 years	38.00±1.25	08	09.87

3.1.3. Educational Level of Respondents

School level of education was the most dominant among the growers with 25.93%, followed by BSc University graduate and Tawjihi with 24.69% for each. Meanwhile, graduated University of M.Sc. level (1.23%) was

3.3. IPM Knowledge, Practices and Resources

3.3.1. IPM Knowledge

The results indicated that the majority of the respondents (67.9%) have never heard about IPM and not sure what IPM is prior to completing the survey (Table 5). However,

Table (3): Educational level of growers (n=81).

Education level	Frequency of growers	% of growers
Illiterate	10	12.35
Schooling	21	25.93
Tawjihi*	20	24.69
Diploma	09	11.11
University graduate, BSc	20	24.69
University graduate, MSc	01	01.23

*Finishing the secondary school successfully.

Table (4): Occurrence of main pest problems in the respondents' farms (n=81).

Pest species	Frequency of growers	Pest occurrence (%)*
Olive fruit fly	53	65.62
Grape powdery mildew	46	56.79
Gummosis of citrus trees	45	55.56
Miditraenean fruit fly	41	50.62
Olive pysalla	41	50.62
Grape berry moth	36	44.44
Olive mites	30	37.04
Grape black rot	30	37.04
Citrus mealy bugs	28	34.57
Grape mites	27	33.33
Olive branch knot	25	30.86
Golden aphids	25	30.86
Apple stem borer	24	29.63
Apple fruit moth	23	28.40
Peach leaf curl	23	28.40
Pomegranate fruit mold	22	27.16
Citrus scales	22	27.16
Olive leaf spot	21	25.93
Capnodius	20	24.69
Olive verticillium wilt	20	24.69
Apple powdery mildew	19	23.46
Apple fire blight	12	14.81
Apple scab	12	14.81

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

33.33% of respondents indicated that they were familiar with IPM concepts and practices. Only 2.47% of the respondents were regularly using IPM. Almost 94% of the respondents have heard about chemical control (Table 5), while only 26% of the growers interviewed have heard about insect growth regulators. In addition, the data showed that respondents interested in production quality and/or quantity, care about human health and risk of environmental pollution and tried to decrease pesticide usage as indicated by 99% (for each), of the growers. Meanwhile, around 67% of them believed that contracts between growers and customers can influence IPM adoption (Table 5).

According to the growers idea, the barriers of adopting IPM are prioritized in (Table 5). That shows the lack of farmer's information and knowledge about IPM (almost 73%) has first priority of IPM adoption. Lack of governmental support for IPM, complexity and difficulty of IPM, and weak extension service have allocated priorities the from second to the fourth.

3.3.2. IPM Practices

3.3.2.1. General IPM Practices

Data on how often growers monitor pests in their farms indicated that around 26% of the respondents monitor pests once a week, and 21% of them monitor pests once during specific pest outbreaks (Table 6). In contrast, almost 15% of the growers indicated that no monitoring is done. The most common method reported for pests monitoring was visual inspection (84%). The majority of the respondents did not test their soil (82.72%) or keep records (74.07%). Very low percent (11-17%) of respondents said that they kept pesticide application, pest species, crop variety and crop yield data (Table 6).

3.3.2.2. Cultural and Mechanical Controls

Data showed that a number of cultural and mechanical control approaches are commonly utilized by growers. Almost 91% of the growers ploughed their farms, and about 70% controlled weeds mechanically (Table 7).

3.3.2.3. Chemical Control

A high percent of respondents (79%) believed that chemicals have a rapid action, and 60-67% considered that pesticides enable a high control level of most pests and can be applied when and where required. Almost 88% of the growers believed that chemical control contaminate water, air and soil. While, only 28.4% of the growers believed that chemicals can cause outbreaks of secondary pests (Table 8).

Respondents reported that they have a high level of concern about waiting for safety period of the pesticide before harvesting (mean of 4.11 out of 5) (Table 9). Moderate concern was shown by the respondents for adjusting pesticide application rates, pesticides chosen

Table (5): Level of familiarity with IPM, IPM methods and barriers, and specific IPM issues reported by respondents (n=81).

	Item	Frequency of growers	% of growers
General IPM	Not sure what IPM is?	28	34.57
	Never heard of IPM	27	33.33
	Familiar with IPM concepts and practices	27	33.33
	Regularly use IPM	02	02.47
Have you heard of the following IPM methods?*	Chemical control	76	93.83
	Cultural control	53	65.43
	Mechanical control	46	56.79
	Resistant plant varieties	45	55.56
	BC	43	53.09
	Insect attractants (traps)	31	38.27
	Sterile male technique	27	33.33
	Insect growth regulators	21	25.93
Specific IPM issues*	Interest in production quantity	80	98.77
	Interest in production quality and quantity	80	98.77
	Interest in production quality	80	98.77
	Care about human health	80	98.77
	Care about environmental pollution	80	98.77
	Try to decrease pesticide usage	80	98.77
	Care about pesticide effects on groundwater	79	97.53
	Think that the governmental policies will enhance the adoption of IPM	70	86.42
	Believe that if their neighbors apply IPM, they will influence on them to adopt IPM	66	81.48
	Believe that the contracts between growers and customers can influence adoption of IPM	54	66.67
Barriers*	Lack of farmer's information and knowledge about IPM	59	72.84
	Lack of governmental support for IPM	52	64.20
	Complexity and difficulty of IPM	48	59.26
	Weak extension service	47	58.03
	Lack of farmer's assurance to control pests with IPM	45	55.56
	IPM is expensive	45	55.56
	IPM needs to have exact discipline and scheduling	43	53.09
	Lack of tools used in IPM	42	51.85
	Lack of good price and marketing	40	49.38
	IPM reduces production	15	18.52

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

Table (6): Monitoring pests and testing soil inside farm, and keeping records by respondents (n=81).

IPM practice	Item	Frequency of growers	% of growers*
How often pests are monitored?	Once a week	21	25.93
	During specific pest outbreaks	17	20.99
	None	12	14.81
	Once a day	11	13.58
	Once a month	10	12.35
	Once during growing season	10	12.35
How pests are monitored?*	Visual inspection	68	83.95
	None	12	14.81
	Pheromone traps	07	08.64
	Colored traps	05	06.17
	Sticky traps	04	04.94
	Light traps	01	01.23
How often soil is tested?	None	67	82.72
	Every 3 years	06	07.41
	Every year	05	06.17
	More than 3 years	03	03.70
	Every 2 years	00	00.00
Keeping records*	None	60	74.07
	Pesticide application	14	17.28
	Pest species	11	13.58
	Crop variety	10	12.35
	Crop yield	09	11.11
	Other	07	08.64
	Calibrate pesticide equipment	05	06.17
	Control practices	04	04.94
	Pest monitoring data	04	04.94
	Pesticides protecting clothing	03	03.70

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

Table (7): Cultural and mechanical control methods applied by respondents (n=81).

Control method	Item	Frequency of growers	% of growers*
Culture	Ploughing	74	91.36
	Pruning of dried branches of trees	60	74.07
	Systematic cutting and removal of infested parts	56	69.14
	Collection of failed and infested fruits	46	56.79
Mechanical	Use mechanical weed control	57	70.37
	Hand picking and killing insects	16	19.75
	Shaking the trees by which the insects fall to the ground and they can be collected	12	14.81

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

Table (8): Reasons of using chemical control and knowledge of pesticides' side effects indicated by growers (n=81).

	Task	Frequency of growers	% of growers*
Reasons of using chemical control	Rapid action	64	79.01
	Enable a high control level of most pests	54	66.67
	Apply when and where required	49	60.49
	Applicable to most pests	46	56.79
	Has a wide range of properties, uses and methods of applications	45	55.56
	The only control method when pest population approaches ETL	43	53.09
Knowledge of pesticides' side effects	Contaminated water, air and soil	71	87.65
	Adverse effects on non-target organisms	67	82.72
	Hazard of pesticide residues	65	80.25
	Pest resistance to pesticides	61	75.31
	Direct hazard from pesticide uses	61	75.31
	Outbreaks of secondary pests	23	28.40

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

Table (9): Respondents knowledge of some selected tasks of pesticide applications (n=81).

Task	Final point value (Mean of 5)
Wait for safety period of the pesticide before harvesting	4.11
Adjust pesticide application rates	3.74
Pesticides chosen based on pest identification	3.64
Pesticides chosen for efficacy rather than cost	3.58
Clean equipment when moving from place to another to prevent pest spread?	3.42
Equipment calibration and maintenance	3.38
Notified people that pesticides are being used?	3.32
Worker protection clothing	3.27
Applying pesticides when necessary?	3.26
Using non-persistence pestiçides	3.09
Resistance management by rotating pesticides	2.96
Spray the same pesticide to the same field during the growing season	2.91
Routine preventative applications	2.84
Using adjuvant to improve safety and efficacy of applications	2.64
Using selective pesticides	2.62
Using systemic pesticides	2.52
Pesticides only after non-chemical methods	2.07
Soil fumigation	2.06
Spot spraying for pests	2.05
Pesticides combined with non-chemical methods	2.05
Time of application depends on traps	1.96
Using bio-pesticides	1.95
Pesticides never used in my farm	1.28

based on pest identification and efficacy rather than cost (mean: 3.5-3.7). Less concern (mean: 1.9-2.0) about time of application depends on traps and using bio-pesticides was indicated by the respondents. In their answers to the statement "Pesticides never used in my farm", a very low mean (1.28 out of 5) was indicated by respondents.

3.3.2.4. Biological Control

According to the growers idea the reasons for not using BC are prioritized in (Table 10). That shows that the cost of BC is too high (mean 2.4 out of 3) is the first reason. The use of BC requires special skills and knowledge that growers do not have and BC is too labour intensive, have allocated the second and third reasons. BC results in lees yields (mean: 1.82) was cited as the last reason for not adopting BC.

Table (10): Responses of the growers for not applying biological control (BC) to suppress pests in their farms (n=81).

Task	Final point value (Mean of 3)
Costs of BC is too high	2.40
The use of BC requires special skills and knowledge that I do not have	2.23
BC is too labor intensive	2.06
BC is not effective	1.99
The use of BC is not practical to implement in my farm	1.84
BC results in lower yields	1.82

3.3.3. IPM Resources

There is no single source of information which the rely upon for IPM in their farms although MOA (44.44%) and private consultant (38.27%) were the most popular (Table 11). Many other information sources were cited by the growers. Almost 57% of the respondents indicated that IPM is neither required nor recommended by MOA. Only 20% of the growers have been involved in IPM training program. Almost 77% of the respondents would like to change to adopt IPM in their farms, and 79% of them reported looking for information about IPM. The most common type of information they looked for was technical and general information (42-43%) (Table 11). Almost 63% of the respondents would like to have information about IPM through extension meetings, training and workshops through the MOA. In contrast, newspapers (8.64%) and online information (9.88%) were the least preferred by the growers.

3.4. Correlation Analysis

The results indicated that grower's age is correlated significantly and positively with experience ($r = 0.730$, $P < 0.01$), and negatively with education ($r = -0.174$, $P > 0.05$) (Table 12). Also, education had a positive significant correlation with familiarity with IPM ($r = 0.351$, $P < 0.01$). Furthermore, age was negatively correlated with familiarity with IPM ($r = -0.182$, $P > 0.05$) and positively with willingness to change to IPM and involving in IPM training ($r = 0.178, 0.203$, $P > 0.05$). There was a positive significant correlation between willingness to change to IPM and involving in IPM training ($r = 0.275$, $P < 0.05$).

4. DISCUSSION

Adoption is an outcome of a decision to accept a given innovation. It is a mental process an individual passes from first hearing about an innovation to final utilization (Feder *et al.*, 1985). The present data demonstrated that there is an adequate representation of responses based on location, age, experience and education level of growers, and farm size. The IPM technology is frequently stated to be a complex technology (Boahene *et al.*, 1999). Generally, education is thought to create a favorable mental attitude for acceptance of new practices especially of information-intensive and management-intensive practices (Waller *et al.*, 1998), and reduces the amount of complexity perceived in a technology. The present data indicated that schooling level of education is the most dominant among the growers with 51%. Thus, increasing education is expected to improve IPM adoption. Our results indicated that education has a positive significant correlation with familiarity with IPM. Several authors (Chaves and Riley, 2001; Doss and Morris, 2001; Al-Zyoud, 2014) also reported that education positively affects IPM adoption. In contrast, Grieshop *et al.* (1988) found no relationship between education and adoption of IPM among tomato growers. Age was a factor thought to affect adoption. In the present study, age was negatively correlated with familiarity with IPM, and positively with willingness to

Table (11): Integrated pest management resources, policy and required information indicated by respondents (n=81).

	Item	Frequency of growers	% of growers
Pest management resources*	Extension meetings, training and workshops (MOA)	36	44.44
	Private consultant	31	38.27
	Extension newsletters	25	30.86
	Radio/television programs	16	19.75
	None	14	17.28
	IPM farmer field schools	11	13.58
	Universities	10	12.35
	Trade publications	09	11.11
	Websites and books	09	11.11
IPM in policy	IPM is neither required nor recommended	46	56.79
	IPM is recommended	21	25.93
	IPM is required	14	17.28
Involvement in training IPM program		16	19.75
Would you like to change to adopt IPM in your farm?		62	76.54
Seeking for IPM information		64	79.01
Type of IPM information*	General information	35	43.21
	Technical information	34	41.98
	Principle information	18	22.22
	Other information	08	09.88
How you would like to have information about IPM?*	Extension meetings, training and workshop on IPM (MOA)	51	62.96
	Written manuals	30	37.04
	Radio/television programs	21	25.93
	Phone calls	19	23.46
	Continuing education	10	12.35
	Online information	08	09.88
	Newspapers	07	08.64

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

Table (12): Some important correlations' analysis between demographics variables of the growers (age, experience, education and farm size) and particular IPM tasks (n=81).

Correlated variables	R value	Significance
Age vs. experience	0.730**	0.000
Age vs. education	-0.174	NS
Education vs. experience	-0.099	NS
Education vs. involve in IPM training	0.018	NS
Education vs. change to IPM	0.077	NS
Education vs. familiarity with IPM	0.351**	0.001
Age vs. involve in IPM training	0.178	NS
Age vs. change to IPM	0.203	NS
Age vs. familiarity with IPM	-0.182	NS
Farm size vs. change to IPM	0.033	NS
Farm size vs. familiarity with IPM	0.085	NS
Farm size vs. involve in IPM training	0.179	NS
Experience vs. familiarity with IPM	-0.198	NS
Experience vs. involvement in IPM	-0.061	NS
Change to IPM vs. involvement in IPM training	0.275*	0.013

*Correlation is significant at the 0.05 level. **Correlation is significant at the 0.01 level. NS: Not significant.

change to IPM and involving in IPM training.

Our findings are in line with the result to what previous researches stated in which age has been found to be either negatively (Bonabana-Wabbi, 2002; Al-Zyoud, 2014; Ghimire and Kafle, 2014) or positively (Kabir and Rainis, 2013) correlated with adoption decisions. Our data showed that the overall average growers' age is 46 years old, which means that the growers are middle-aged. In general, younger growers are more interested in trying out new agricultural technologies because of their risk taking character. In contrast, as growers advance in age, risk aversion increased and adopting a new technology seemed less likely. Rogers (1995) stated that young growers are more willing to adopt a new innovation than elder ones.

Some researchers stated that farm size plays a significant role in IPM adoption (Chaves and Riley, 2001; Doss and Morris, 2001). However, studies into the relationship between IPM and farm size have yielded inconsistent findings. In this study, farm size was found of no significant effect on IPM. This agrees with the findings of Grieshop *et al.* (1988) and Waller *et al.* (1998) who concluded that farm size did not affect IPM adoption suggesting that IPM technologies are mostly scale neutral, implying that IPM dissemination might take place regardless of farmer's scale of operation. In contrast, the effect of farm size has been found to be positive (Fernandez-Cornejo, 1998; Chaves and Riley, 2001). However, without a significant difference in the outcomes between two options, it is less likely that growers, especially small-scale growers might adopt the new practice (Abara and Singh, 1993). This might be confirmed by the fact that the majority of growers (77%) in the present study owns an average of 24.60±1.74 dunums/grower (small-scale growers). Our results indicated that grower's agricultural experience plays also non significant role in IPM adoption. Similarly, Blake *et al.* (2007), Samiee *et al.* (2009), and Al-Zyoud (2014) stated no significant correlation between experience and adoption level of IPM.

Our data indicated that there is a positive significant correlation between willingness to change to IPM and involving in IPM training. In agreement with our results, Ghimire and Kafle (2014) stated that training is positively significant to adoption of IPM. This might be due to improving skills, increasing awareness and realization of positive benefits from the IPM adoption. Ofuoku *et al.* (2009) also mentioned that a low level of IPM adoption is due to poor frequency of extension units. The excellent way to accelerate the adoption of IPM is by means of education and training of growers about IPM (Odendo *et al.*, 2009).

The results of growers' IPM knowledge indicated that the majority of the respondents (68%) have never heard about IPM and not sure what IPM is? which is doubled of what Al-Zyoud (2014) found on IPM on vegetables (33%). Present data indicated that only 2.5% of the respondents were regularly using IPM, while Al-Zyoud (2014) mentioned 10% on vegetables. It is worth mentioing that awareness of IPM is the first step toward IPM adoption. Our results showed that respondents interested in production quality and/or quantity, care about human health and risk of environmental pollution and tried to decrease pesticide usage was indicated by 99% of the growers. It is clear that growers' perception of harmful effects of chemicals did not influence growers' decisions in regard to IPM adoption despite their very high knowledge of this issue. In this regard, Bonabana-Wabbi (2002) mentioned that although 84% of growers agreed that pesticides were harmful to crops, animals and humans, 93% applied pesticides on crops. A possible explanation would be that growers do not consider environmental and health impacts important considerations when choosing control practices.

According to growers' idea, the most important barriers of adopting IPM are lack of farmer's information and knowledge about IPM, lack of governmental support for IPM, complexity and difficulty of IPM, and weak extension service. Our data are in line with the findings of Shojaei *et al.* (2013) and Ghimire and Kafle (2014), who stated many barriers of adopting IPM such as lack of farmer's assurance to control pests with IPM, lack of farmer's information about IPM, complexity and difficulty of IPM, IPM is expensive, lack of tools used in IPM, lack of detailed knowledge about IPM, lack of market, no control of pests from IPM, and weak extension service of government organization. Researchers have suggested that financial incentives could help promote IPM use, particularly in the transition from conventional management to IPM of pests (Brewer *et al.*, 2004). Some researchers have attributed the rapid spread of IPM techniques, particularly in Asian and African countries, to novel approaches to grower education and extension (Norton *et al.*, 1999; van Mele *et al.*, 2002). Escalada and Heong (1993) attributed the slow spread of IPM among rice growers in the Philippines to a lack of knowledge among growers, and concluded that farmer field schools (FFSs) would accelerate adoption, by providing growers with the opportunity for experiential learning of IPM skills. Hence, an understanding of the context for an innovation provides a basis for drawing inferences about the reasons why growers do or do not adopt an innovation (Kainea and Bewsellb, 2008). Some authors have argued that a lack of knowledge and skills is the key obstacle to the widespread use of IPM and therefore training and extension are essential.

Adoption level of IPM in the current study was measured as the growers' percent taking on a particular practice. Therefore, rather than require that all components of an IPM package must be employed in order to consider a farmer an adopter, the discussion herein considers the adoption of each practice individually. However, cultural and mechanical control techniques are commonly utilized by the growers. Several researchers mentioned that growers used cultural and mechanical approaches intensively (Frantz and Mellinger, 1998; Bonabana-Wabbi, 2002). Our results indicated that respondents report that they have a high level of concern about waiting for safety period of the pesticide before harvesting, moderate concern about adjusting pesticide application rates, pesticides chosen based on pest identification and on efficacy rather than cost, and less concern about time of application depends on traps and using bio-pesticides. According to Al-Zyoud (2014) on vegetables IPM, respondents have a high level about chosen pesticides based on pest identification, and on efficacy rather than cost, and less concern was paid to pesticides bio-pesticides and time of chemical application, which is in agreement of the present results. In contrast, Frantz and Mellinger (1998) reported that growers have a high concern of using biologically friendly pesticides, and rotating insecticides to delay development of resistance.

Information source helps growers in the adoption and continuation of any agriculture practices. In any agricultural practice, source of information plays the most significant role. Current data on source of IPM information that growers rely upon for pest management in their farms, MOA and private consultant were the most popular. Al-Zyoud (2014) on vegetables IPM stated that private consultant was also the most popular, while Ghimire and Kafle (2014) stated that IPM FFSs are the major source of information about IPM. Our data indicated that IPM is neither required nor recommended (57%) by MOA, while Al-Zyoud (2014) on vegetables stated less than half of this percent (27%), and Gibb and Al-Fournier (2006) mentioned a percent of (42%). Only 20% of those respondings had been involved in IPM training program, while Al-Zyoud (2014) on vegetables stated that 2-fold (38%) of respondents involve with IPM training program, and Samiee *et al.* (2009) reported that 35%% of wheat growers in Iran have participated in training program on IPM, which higher than what we found in the present results. Almost 77% of the respondents would like to change to adopt IPM in their farms vs. 84% as stated by Al-Zyoud (2014). Samiee *et al.* (2009) reported that using information sources and communication channels, and viewpoint on extension agents are positively correlated with adoption of IPM by wheat growers in Iran.

As a practical example, the olive fruit fly is the most important and firstly ranked pest problems in farmers' farms (cited by 66% of the respondents). However the extension units and FFSs of the MOA in Jordan is asking the farmers since many years to apply IPM that includes systemic, non-persistence, selective and bio-pesticides as well as use of spot treatment and not spraying the whole trees to control the olive fruit fly which all are parallel with the IPM. program. Thus, this study was conducted to investigate whether and what extent the farmers apply IPM and if any more efforts should be done by MOA to redirect the framers toward the use of IPM. The olive fruit fly is a key pest and it should generally be controlled by IPM, however, the farmers still not using culture method of control (collection of failed and infested fruits), thus, the infestation present increased and more chemicals were applied. Less concern about time of application depends on traps and using bio-pesticides was indicated by the respondents. Thus, this pest should be monitored using sex pheromone traps and what the farmers done are just monitored the pest visually as indicated by 84%. Many farmers are still insisting on using contact, general and persistence insecticides to control olive fruit fly. The contact and general insecticides kill natural enemies and the persistence ones will not be degraded until the time of olive harvesting.

Nevertheless, all of these practices will have side effects on human being and its environment. Therefore, the efforts of FFSs and extension units of the MOA in Jordan should be further distributed to include the majority of farmers if not all in order to increase the education level of the farmers and let farmers to be enrolled and involved in IPM training courses and programs that will be done by MOA. It is to be mentioned that Jordan is one of the member countries of the FAO IPM regional project in the Near East since 2004, and since that time 153 IPM FFSs were organized with a total of 2,260 trained farmers (Akroush and Alhawamdeh, 2011).

In conclusion, the findings of this study might contribute to ongoing efforts to promote IPM adoption in Jordan. To accelerate the dispersal of IPM within the agricultural community, agricultural extension could also sponsor a series of IPM training courses through the off-season months which would specifically, yet simply, address IPM and how it relates to various fruits. In addition, governmental policies could enhance the adoption of IPM, which shows the important role of MOA in increasing the rate of IPM adoption in Jordan. Therefore, increased government support and investment in IPM programs (Templeton and Jamora, 2010), and efforts of extension programs are very important to promote IPM adoption (Ricker-Gilbert *et al.,* 2008; Castle and Naranjo, 2009). Furthermore, since there was a positive significant correlation between willingness to change to IPM and involving in IPM training, thus, agricultural extension/MOA could stimulate more overall IPM adoption by conducting more growers' training programs to enhance the technical skills among growers about IPM practice for best adoption. Besides the strengthening of the extension arm of the implementation model, non-formal education methods such as FFSs need to be promoted to make growers literate in IPM practice through conducting IPM workshops and presentations, IPM training programs for growers, and developing a number of resources to support IPM programs. These results will serve as a catalyst for the adoption of IPM technology and will therefore contribute to the sustainability of agriculture in Jordan.

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5. REFERENCES

Abara I.O.C. and Singh S. (1993). Ethics and biases in technology adoption: The small farm argument. Technol. Forecas. Soc. Change 43, 289-300.

Al-Zyoud F. (2014). Adoption range of integrated pest management (IPM) techniques by greenhouse vegetable growers in Jordan. Jordan J. Agric. Sci., 10, 504-525

Akroush S. and Alhawamdeh A. (2011). Acceptance and adoption of IPM techniques through farmer field schools (FFS). NCARE, Ministry of Agriculture, Jordan, pp 50.

Barnes C., Sutherl S., Brattesani M., Wilhoit L. and Messenger B. (2012). A survey of California public school districts' ant and weed management practices and a review of their use of IPM. J. Environ. Health 74, 18-22.

Bauske E.M., Zehnder G.M., Sikora E.J. and Kemble J. (1998). Southeastern tomato growers adopt integrated pest management. Horttech., 8, 40-44.

Blake G., Sandler H.A., Coli W., Pober D.M. and Coggins C. (2007). An assessment of grower perceptions and factors influencing adoption of IPM in commercial cranberry production. Renew. Agric. Food Syst., 22, 134-144.

Boahene K., Snijders T.A.B. and Folmer H. (1999). An integrated socio-economic analysis of innovation adoption: The case of hybrid cocoa in Ghana. J. Policy Model., 21, 167-184.

Bonabana-Wabbi J. (2002). Assessing factors affecting adoption of agricultural technologies: The case of integrated pest management (IPM) in Kumi District, Eastern Uganda, Blacksburg, Virginia. M.Sc. Thesis, pp 146.

Brewer M.J., Hoard R.J., Landis J.N. and Elworth LE. (2004). The case and opportunity for public-supported financial incentives to implement integrated pest management. J. Econ. Entomol., 97, 1882-1889.

Castle S. and Naranjo S.E. (2009). Sampling plans, selective insecticides and sustainability: The case for IPM as informed pest management. Pest Manag. Sci., 65, 1321-1328.

Chaves B. and Riley J. (2001). Determination of factors influencing integrated pest management adoption in coffee berry borer in Columbian farms. Agric. Ecosyst. Environ., 87, 159-177.

Dasgupta S., Meisner C. and Wheeler D. (2007). Is environmentally friendly agriculture less profitable for growers? Evidence on integrated pest management in Bangladesh. Rev. Agric. Econ., 29, 103-118.

Doss C.R. and Morris M.L. (2001). How does gender affect the adoption of agricultural innovation? The case of improved maize technologies in Ghana. J. Agric. Econ., 25, 27-39.

Escalada M.M. and Heong K.L. (1993). Communication and implementation of change in crop protection. Ciba Foundation Symposium 177. Wiley, Chichester, pp 191-207.

Feder G., Just E.R. and Zilberman D. (1985). Adoption of agricultural: Innovations in developing countries: A Survey. Econ. Develop. Cul. Change 33, 255-298.

Feder G. and Slade R. (1984). The acquisition of information and the adoption of new technology. Am. J. Agric. Econ., 66, 312-320.

Fernandez-Cornejo J. (1998). Environmental and economic consequences of technology adoption: IPM in viticulture. Agric. Econ., 18, 145-155.

Frantz G. and Mellinger H.C. (1998). Measuring integrated pest management adoption in south Florida vegetable crops. Proc. Florida State Hort. Soc., 111, 82-87.

Ghimire B. and Kafle N. (2014). Integrated pest management practice and its adoption determinants among apple farmers in Mustang district of Nepal. Sch. J. Agric. Vet. Sci., 1, 83-89.

Gibb T.J. and Al-Fournier A. (2006). Survey of Indiana public schools pest management policies and practices. Bulletin No. B17872, pp 43.

Grieshop J.I., Zalom F.G. and Miyao G. (1988). Adoption and diffusion of integrated pest management innovations in agriculture. Bull. Entomol. Soc. Am., 34, 72-78.

Jordan Statistical Yearbook. (2012). Department of Statistics/Annual Agriculture Surveys. Issue no. 63, pp 276. http://www.dos.gov.jo/dos_home_a/main/cd_yb 2012/pdf/agri.pdf.

Kabir M.H. and Rainis R. (2013). Determinants and methods of integrated pest management adoption in Bangladesh: An environment friendly approach. Am.-Euras. J. Sus. Agric., 7, 99-107.

Kainea G. and Bewsellb D. (2008). Adoption of integrated pest management by apple growers: The role of context. Int. J. Pest Manag., 54, 255-265.

Kogan M. (1998). Integrated pest management: Historical perspectives and contemporary developments. Ann. Rev. Entomol., 43, 243-270.

Maupin J., Tech V. and Norton G. (2010). Pesticide use and IPM adoption: Does IPM reduce pesticide use in the United States? Agric. Appl. Econ. Assoc., Denver, Colorado, pp 25-27.

Norton G. and Mullen J. (1994). Economic evaluation of integrated pest management programs: A literature review. Blacksburg: Virginia Cooperative Extension.

Norton G., Adamson D., Aitken L.G., Bilston L.J., Foster J., Frank B. and Harper J.K. (1999). Facilitating IPM: The role of participatory workshops. Int. J. Pest Manag., 45, 85-90.

Odendo M., Obare G. and Salasya B. (2009). Factors responsible for differences in uptake of integrated soil fertility management practices amongst smallholders in Western Kenya. Afr. J. Agric. Res., 4, 1303-1311.

Ofuoku A.U., Egho E.O. and Enujeke E.C. (2009). Integrated pest management (IPM) adoption among farmers in central agro-ecological zone of Delta State, Nigeria. Adv. Biol. Res., 3, 29-33.

Pannell D.J., Marshall G.R., Barr N., Curti A., Vanclay F. and Wilkinson R. (2006). Understanding and promoting adoption of conservation practices by rural landholders. Aust. J. Exper. Agric., 46, 1407-1424.

Prokopy R.J. (2003). Two decades of bottom-up, ecologically based pest management in a small commercial apple orchard in Massachusetts. Agric. Ecosyst. Environ., 94, 299-309.

Ricker-Gilbert J., Norton G., Alwang J., Miah M. and Feder G. (2008). Cost-effectiveness of alternative integrated pest management extension methods: An example from Bangladesh. Rev. Agric. Econ., 30, 252-269.

Rogers E.M. (1995). Diffusion of Innovations.

4th Edition, New York, the Free Press.

Samiee A., Rezvanfar A. and Faham E. (2009). Factors influencing the adoption of integrated pest management (IPM) by wheat growers in Varamin County, Iran. Afr. J. Agric. Res., 4, 491-497.

Sato M.E., Silva M.Z, Raga A. and Filho M.F. (2005). Abamectin resistance in *Tetranychus urticae* Koch (Acari: Tetranychidae): Selection, cross-resistance and stability of resistance. Neotrop. Entomol., 34, 991-998.

Shojaei S.H, Hosseini S.J.F., Mirdamadi M. and Zamanizadeh HR. (2013). Investigating barriers to adoption of integrated pest management technologies in Iran. Ann. Biol. Res., 4, 39-42.

SPSS Statistical Product and Service Solutions INC. (1997). SIGMASTAT 2.03: SigmaStat Statistical software user's manual, Chicago, United States Of America.

Templeton D.J. and Jamora N. (2010). Economic assessment of a change in pesticide regulatory policy in the Philippines. World Develop., 38, 1519-1526.

Uwagboe E.O., Akinbile L.A. and Oduwole O.O. (2012). Socio-economic factors and integrated pest management utilization among cocoa farmers in Edo State. Acad. J. Plant Sci., 5, 7-11.

van Mele P., Hai T.V. and Huis van A. (2002). Influence of pesticide information sources on citrus farmers' knowledge, perception and practices in pest management, Mekong Delta, Vietnam. Int. J. Pest Manag., 48, 169-177.

Waller B.E., Hoy C.W., Henderson J.L., Stinner B. and Welty C. (1998). Matching innovations with potential users: A case study of potato IPM practices. Agric. Ecosyst. Environ., 70, 203-215.

Zar J. (1999). Bio-statistical analysis. Prentice Hall, Upper Saddle River, NJ,ASA. pp 663.

تبني المكافحة المتكاملة للآفات بوساطة مزارعي الأشجار المثمرة في الأردن

فراس احمد الزيود

قسم وقاية النبات والمكافحة المتكاملة للآفات - كلية الزراعة - جامعة مؤتة - الكرك - الأردن

ملخص

تستخدم المكافحة المتكاملة للحد من الضرر الناتج عن الآفات وهي الأفضل من الناحية الاقتصادية والأقل ضررا على الإنسان والبيئة. لقد زاد الاهتمام في قياس مدى تبني المكافحة المتكاملة للآفات مع مرور الزمن. إن مدى ومستوى تبني المكافحة المتكاملة للآفات في الأردن لا تزال مجهولة إلى حد كبير. بناء على ذلك، هدفت هذه الدراسة إلى تحليل العوامل المؤثرة على تبني المكافحة المتكاملة للآفات من قبل مزارعي الأشجار المثمرة في الأردن. لهذا الغرض، تم سؤال مزارعي الأشجار المثمرة عن الجوانب الاجتماعية، أنواع الآفات، والمدى المعرفي وأساليب ومصادر المكافحة المتكاملة عن طريق إجراء مسح ميداني للمزارعين على مستوى الأردن خلال عام 2014. أشارت النتائج إلى أن غالبية المزارعين (68٪) لم يسمع أو غير متأكد ماذا تعني المكافحة المتكاملة، في حين أن 2.5% فقط منهم يستخدم المكافحة المتكاملة بانتظام. نقص المعلومات والمعرفة بالمكافحة المتكاملة للآفات لدى المزارعين شكلت العائق الرئيسي (73٪) لتبني المكافحة المتكاملة. كما شملت الدراسة على عرض بيانات عن عدد مرات مراقبة الآفات، الطرق الشائعة لمراقبة الآفات، اختبار التربة، حفظ السجلات، أسباب استخدام المبيدات ومعرفة المزارعين بالآثار الجانبية للمبيدات. أظهرت النتائج أن المزارعين يستخدمون العديد من الطرق الزراعية والميكانيكية، ولديهم مستوى عال من الاهتمام بفترة آمان المبيدات. لا يوجد مصدر محدد للمعلومات التي يعتمد عليها المزارعين لمكافحة الآفات في مزارعهم. أشار حوالي 57٪ من المزارعين إلي أن المكافحة المتكاملة ليست مطلوبة ولا موصى بها، و20٪ فقط منهم شارك في برنامج تدريبي عن المكافحة المتكاملة، و 77٪ من المزارعين يرغب في تبني المكافحة المتكاملة للآفات.إرتبطت المعرفة بالمكافحة المتكاملة للآفات سلبيا مع عمر المزارع وإيجابيا مع المستوى التعليمي للمزارع. كان هناك علاقة إيجابية بين الاستعداد للتغيير لتبنى المكافحة المتكاملة للآفات والاشتراك في برامج تدريبية عن المكافحة المتكاملة. الخلاصة تعتبر نتائج هذه الدراسة بمثابة محفز لتبني تكنولوجيا المكافحة المتكاملة للآفات و بالتالي ستساهم في الوصول إلى الزراعة المستدامة في الأردن.