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***(Subject Review)*** *(مراجعة موضوع)*

# Application and Usage of Pesticides in Palestine: Current and Future Outlook

نظرة حالية ومستقبلية على استعمال ورش مبيدات الآفات في فلسطين

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## Abstract

The present review paper was prepared due to the lack of reports or review articles which analyze and treat the problems resulting from the excessive use and application of pesticides in the Palestinian territories (P.T). It stated and discussed firstly the current status of pesticides application and usage in the P.T then, exposed at the problems created by the overuse of pesticides in these territories and then offered the proper solution of these problems at the present time and in perspective. Thus, it provided with a number of basic elements which may improve the present and future application and usage of pesticides in the P.T. It also urged to follow the necessary measures in order to solve the problems of pesticides overuse and hence to protect both local environment and national crop products from pesticide pollution. Moreover, certain examples were cited in this paper on fruitful regional cooperation between neighbouring countries as a solution of some cases of hard pest control on certain crops. Until present, such cases are treated only with excessive amounts of pesticides but, the proposed solution either reduces greatly the amount of applied pesticides for treating the pest or investigates non-pesticide control measure.

## ملخص

تم تحضير هذه المراجعة (Review paper) لعدم توفر التقارير أو المراجعات التي تهتم بتحليل المشاكل الناجمة عن الرش الزائد والاستعمال المتكرر للمبيدات في الأراضي الفلسطينية. لقد أوضحت وناقشت هذه الورقة في المقام الأول الوضع الحالي لاستعمال ورش المبيدات في الأراضي الفلسطينية ومن ثم تعرضت للمشاكل التي يسببها الاستعمال المفرط للمبيدات ثم قدمت حل مناسب لهذه المشاكل في الوقت الحاضر والمستقبل. لذا فقد زودت الورقة بعدد من العناصر الأساسية التي يمكن أن تؤدي إلى تحسين استعمال ورش المبيدات في الأراضي الفلسطينية حاضرا ومستقبلا، كما أنها حثَّت على اتباع الإجراءات الضرورية لحماية كل من البيئة المحلية ومنتوجات المحاصيل الوطنية من خطر التلوث بالمبيدات . لقد تم إيراد عدد من الأمثلة للتعاون الإقليمي بين الدول المتجاورة كحل للمشاكل الصعبة في مكافحة الآفات التي تهاجم عددا من المحاصيل والتي تُعالَج حتى الآن عن طريق رش كميات كبيرة من المبيدات. والحل المقترح إما أن يقلل إلى حد كبير كمية المبيدات المستعملة في المكافحة أو أنه يُقَدِّمُ بديلا للمكافحة الكيماوية باستعمال وسائل مكافحة غير كيماوية.

## 1. Introduction

Agricultural production in the Palestinian territories (P.T) is considered as the main sector of the Gross National Production (GNP). It contributes to 33 percent and 24 percent of the GNP in the West Bank and Gaza Strip, respectively [3]. Agriculture in these territories is characterized by being intensive and irrigated in certain parts (Jericho, Gaza Strip, Tulkarm and Jenin), and rainfed in the rest of these territories.

Irrigated agriculture is characterized by having high production potential, especially when used intensively under greenhouse conditions. The total area covered with plastic and glass houses in the P.T is about 9,633 dunums. The major part of this area is mainly cultivated with vegetable crops such as cucumber and tomato [2,4].

Rainfed agriculture, which comprises the largest area of cultivated lands in the P.T, has been directly affected by many social and environmental factors. The total production in this area per annum is about 164,957 tons from fruit trees such as olives, grapes, stone fruits and figs; and about 119,514 tons from field crops and vegetables [8]. Traditional and modern agricultural practices are employed in the P.T such as crop rotation, fallowing, terracing and use of fertilizers and pesticides.

Usage of pesticides and other cultural practices contributed to improving the agricultural production by many folds during the last two decades, but the intensive, non-rational and misused application of pesticides created many problems in these territories. However, no reports or review articles concerning the evaluation and analysis of pesticides application and usage in the P.T are available. Therefore, the objective of the present review paper is to provide farmers, graduate and undergraduate students, or others with the necessary informations on pesticide issues in the P.T. The following considerations in this issue are to be discussed : i) current status of pesticides application and usage in these territories; ii) problems and risks caused by the overuse of pesticides; iii) proper or possible solutions of these problems; and iv) the implications for future cooperative work in order to solve the problems.

## 2. Current Status of Pesticides Application and Usage

Chemical pesticides were not considered as a problem in the West Bank and Gaza Strip before the last two decades, but Palestinian farmers in these areas increased the usage of these pesticides, particularly, in irrigated and intensive cultures. Unfortunately, this increase has not been accomplished by full understanding of the impacts of the chemical pesticides on human health, beneficial organisms and the environment [11]. The types and extent of chemical pesticides used in the P.T, in addition to its marketing will be discussed in the following paragraphs.

### *2.1. Types of pesticides*

Many types of chemical pesticides are being used in the P.T. A total of 123 types of pesticide trade names are currently used [4, 7, 10]. The most commonly used pesticides in the P.T (active ingredients and trade names) are presented in Table 1.

### *2.2. Extent of pesticides usage*

It is estimated that 96.6 percent of the irrigated lands and 87.0 percent of rainfed lands in the P.T are treated with chemical pesticides [3]. According to Ayyash et al., 1995 [4], the average seasonal consumption of chemical pesticides was found to be 4 kg per dunum in open irrigated fields and 6.5 kg per dunum in irrigated fields covered with plastic houses or tunnels. Of the total pesticides used in the P.T, insecticides contribute at 49.4 percent, fungicides 33.7 percent, herbicides 12.8 percent and others 4.1 percent. The total quantity of chemical pesticides used in the P.T was estimated at 730 tons per year in the West Bank, and 741 tons per year in Gaza Strip [4, 9]. This includes methyl bromide which is not yet officially banned in the P.T and still be used as pre-plant treatment for soil fumigation, in addition to other pesticides used for domestic purposes such as the public health. The high consumption of pesticides in Gaza Strip is attributed to the concentration of agriculture in this area which is much more than that in the West Bank. The quantity used in the West Bank varies according to the district and the cropping pattern used in each district.

**Table 1:** Commonly used pesticides in the West Bank and Gaza Strip (adapted from Hassoun, 1991; Safi et al., 1993; and Ayyash et al., 1995).

| Insecticides | | Fungicides | | Herbicides (H), Acaricides (A) and others * | |
|---|---|---|---|---|---|
| **Common name (active ingredient)** | **Trade name** | **Common name (active ingredient)** | **Trade name** | **Common name (active ingredient)** | **Trade name** |
| Chlorpyrifos | Dursban EC400 | Sulfur | Sulfur wp | Bromacil (H) | Hyvar X |
| Cypermethrin | Titan; Cyporin; Cymbush EC100 | Mancozeb | Manzidan wp 80 | Glyphosate (H) | Roundup |
| Methomyl | Lanate | Penconazole | Ofir EC 100 | Diquat-Paraquat (H) | Dukatalon |
| Fenitrothion | Sumithion; Fenitex | Captan | Merpan Wp 50 | Diuron (H) | Diurex wp 80 |
| Fenpropathrin | Smesh | Maneb | Manebgan wp | Amitraz (A) | Mitac |
| Cyfluthrin | Baythroid | Triadimenol | Bayfidan EC250 | Abamectin (A) | Vertimec EC18 |
| Malathion | Malathion | Tebuconazole | Folicur; Silvacur | Bromopropy-late (A) | Neoron EC |
| Dimethoate | Roger EC400 | Sodium arsenate | Sodanit | Fenamiphos (N) | Nemacur |
| Carbosulfan | Marchal EC100 | Myclobutanil | Systan EC125 | Metaldehyde (M) | Metaldehyde |
| Methamidophos | Prodex SI 600; Tamaron | Triforine | Saprol EC200 | 2,4-D (H) | Albar super |
| Endosulfan | Thionex EC350 | Bitertanol | Baycor wp 25 | Atrazine (H) | Atranex |
| Pirimicarb | Pirimor wp | Copper Hydroxide | Kocide | Oxyflourfen (H) | Goal |
| Oxydemeton Methyl | Metasystox EC250 | Benomyl | Benlate | Paraquat (H) | Katalon |
| Abamectin | Vertimec EC18 | Propoxur | Afugan | Linuron (H) | Linurex |
| Imidacloprid | Confidor EC350 | Triadimefon | Bayleton wp 25 | Metribuzin (H) | Sencor |
| Azocyclotin | Peropal wp 25 | Pentachlor-ophenol | Pentaph-anate | | |

*…Continue table (1)*

| **Insecticides** | | **Fungicides** | | **Herbicides (H), Acaricides (A) and others *** | |
|---|---|---|---|---|---|
| **Common name (active ingredient)** | **Trade name** | **Common name (active ingredient)** | **Trade name** | **Common name (active ingredient)** | **Trade name** |
| Azinphos methyl | Contenion EC200 | Chlorothal-onil | Bravo EC500 | | |
| Fenthion | Lebaycid | Copper Sulfate + Calcium Hydroxide | Bordeaux mixture | | |
| Thiocyclam Hydrogen oxalate | Evisect | Fosethyl Aluminium | Aliette wp | | |
| Dinobuton | Acrex | Carebendaz-im | Bavestine wp | | |
| Methyl Parathion | Folidol | Chinometh-iona | Morestan wp | | |
| Dimecron | Phospham-idon | Metalaxyl + Mancozeb | Ridomil wp | | |
| Diazinon | Diazinon; Dizictol | Cyprodinil + Flodioxonil | Switch WG | | |
| Pirimiphos Methyl | Actellic EC500 | | | | |
| Phosphamidon | Phospham-idon | | | | |
| Mineral oil | Sun oil; Arboral | | | | |
| Etophenprox | Sensor EC300 | | | | |
| Decamethrin | Descis | | | | |
| Lambda cyhalothrin | Karate | | | | |
| Methidathion | Superacid | | | | |

* Others such as nematicides (N), molluscides (M).

### *2.3. Marketing of pesticides*

Until present, the main source of pesticides marketed in the P.T is coming from Israeli manufacturing companies of pesticides. These pesticides are sold by local distributors. Recently, some local agricultural companies were authorized by Palestinian Ministry of Agriculture to import certain pesticides directly from European or foreign manufacturing companies of pesticides. This enables the farmers and extension agents to have more technical information about marketed pesticides. This could be explained by the presence of Arabic translated labels on the imported European pesticides compared to Hebrew labels on Israeli imported pesticides. The prices of pesticides marketed in the P.T vary considerably according to their source. Polices and laws that may be in place officially seem to have little impact on marketing and handling of pesticides (stated below in section 3).

## 3. Problems and risks caused by the overuse of pesticides

The huge quantities of chemical pesticides applied in the P.T, indicated in the paragraph 2.2, show obviously the overuse of pesticides. The average seasonal consumption of chemical pesticides in the P.T (4 to 6.5 kg per dunum) is higher than that in the other countries which was rated at 1.5 to 3 kg per dunum according to the irrigation system practiced and the type of crop [6]. In addition, many and diverse types of these pesticides are being used in the territories (Table 1). This indicates that Palestinian farmers depend totally on chemical pesticides as a principal tool for the control of pests and diseases on their crops. However, the other tools or alternatives to chemical pesticides especially biological control are not usually practiced by the majority of Palestinian farmers. The integrated pest management (IPM) which aimed at reducing the environmental hazards and the frequency of pesticides application is not also familiar to the majority of Palestinian farmers.

Many problems and risks were already created from the repeated and intensive application of chemical pesticides in the P.T such as: i) the presence of excessive amounts of chemical pesticide residues on fresh commodities of fruits and vegetables which are usually much more than the tolerance limits. Such limits are usually defined according to the persistance and toxicity of applied pesticide [6]. Chemical pesticide residues presented a serious health problem to consumers of fresh fruits and vegetables and could be sometimes observed on treated commodities such as cucumbers produced under protected cultures. Farmers did not also comply with the safety period specified for each pesticide and time span between the treatment and harvesting times of treated crops [6]. Until present, there is no specialized laboratories for analyzing and measuring these residues in the P.T. In addition to the lack of any law which can limit the frequency and amount of application in the residual pesticides, otherwise the produce is subjected to be rejected by the external exporter such as citrus fruits and some vegetables; ii) pollution of the ground water which may occur in the areas where huge quantities of chemical pesticides are used. Such pollution could be usually monitored and then measured. However, to the best of our knowledge, there are no reports indicating the concentration and type of chemical pesticides or their metabolites which may cause pollution of the ground water in the P.T. Such studies should be undertaken in specialized laboratories to protect consumers from any toxic levels of pesticides in water. The study conducted by Afifi and Abu-Swareh, 1999 [1], indicated the adsorption behaviour of the two pesticide metabolites (2,4-dichlorophenol and 2,4,5-trichlorophenol) to the soil particles containing high quantities of organic matter. This adsorption was measured in heavily treated areas of Gaza Strip with the commonly used pesticides: 2,4-dichlorophenoxy acetic acid (2,4-D) and 2,4,5-trichlorophenoxy acetic acid (2,4,5-T). The same authors also concluded the possibility of the ground water pollution in the areas treated with these herbicides when the soil contains less quantities of organic matter or being sandy where percolation and leaching may take place; iii) some farmers in the P.T still continue to use certain hazardous chemical pesticides. For example, fourteen chemical pesticides out of the one hundred twenty three which are being used in the P.T are internationally suspended or restricted or banned. Six of the fourteen pesticides belong to the “dirty dozen” namely: Aldicarb, Chlordane, DDT, Lindane, Parathion and Pentachlorophenol [4, 6]. It is well-known that organochlorine insecticides such as DDT, Chlordane and Lindane will accumulate in the adipose tissues of exposed animals. Thus, they are considered carcinogenic at long term. In addition, these pesticides are considered as the most persistent in nature and may cause pollution of local environment [6, 13]; iv) effect of chemical pesticides on beneficial organisms and its natural balance. It is obvious that the intensive and repeated use of highly toxic pesticides has a serious side-effect in exterminating the natural enemies of many targeted pests especially harmful insects. Thus, the natural balance between the pest and its natural enemy will be impaired, therefore its damage is becoming more intense, in addition to acquiring resistance to the repeatedly used pesticide. For example, aphids and whiteflies are considered as a serious primary pests in the P.T especially during the last two decades due to killing their natural enemies by the overuse of highly toxic insecticides. But before that time, these pests were considered as minor secondary pests and their numbers were greatly suppressed by their natural enemies [5]. Also, the application of methyl bromide as pre-planting soil fumigant which is still used in the territories, destroys and kills harmful as well as beneficial soil microorganisms.

Thus, if soil contamination with the common soil-borne pathogens is taking place after fumigation and during the growing season, the virulence of these pathogens on cultivated plants will be more intense due to the absence of beneficial competitive or antagonistic microorganisms which were killed during fumigation; and v) other problems and risks caused by the overuse of chemical pesticides appeared due to the inadequate knowledge of the farmers about the properties of applied pesticides. Therefore, they do not follow or sometimes know, for examples, the recommended dose of pesticides at the time of application; the environmental hazards due to application of certain pesticides such as the soil-fumigant methyl bromide. This pesticide which is still used in protected culture in the P.T, has been cited by the Environmental Protection Agency (EPA) and the International Convention on Climate Control (ICCC) as Ozone-depleting substance [12].

## 4. Solution of problems caused by excessive use of chemical pesticides

The following possibilities may be offered to overcome the problems resulted from the overuse of pesticides in the P.T: i) to establish specialized laboratories for analyzing and measuring pesticide residues on treated commodities of fruits and vegetables or for detecting the degree of ground water pollution with pesticides in heavily treated soils. This establishment is very necessary to protect consumers of fresh fruits and vegetables from hazards of chemical pesticides and to protect the main sources of ground water in the P.T from pesticide pollution; ii) to apply strictly the laws which regulate pesticide application or its marketing and handling in the P.T. Recently, a law project concerning pesticides usage in the P.T was offered to the Palestinian Legislative Council (PLC) for its approval. This law, in case of its approval, will authorize the Palestinian Ministry of Agriculture to oblige the farmers to respect, for example, the safety period of pesticides after application and to decrease the frequency and amount of pesticides applied on certain commodities, otherwise their produce will not be accepted for marketing to external markets; iii) to decret laws aimed at obligation of farmers to stop using the internationally suspended or banned pesticides and to impose heavy sanctions on local agricultural companies which import the hazardous pesticides or any member of “the dirty dozen” pesticides; iv) to educate and train the Palestinian farmers through seminars, meetings, and workshops to avoid hazards of chemical pesticides. In addition to improve farmers’ awareness and knowledge about pesticides and using possible alternative methods of pest control such as biological control or integrating biological and chemical means for an effective control. Thus, Palestinian framer will understand, for example, the important role of beneficial microorganisms in the soil and the necessity for maintaining these microorganisms by decreasing the heavy application of soil pesticides such as methyl bromide; v) to train the Palestinian farmers on reducing the amount and frequency of applied pesticides in order to protect the natural enemies of harmful pests. Recently, Palestinian Ministry of Agriculture formed a national committee for preserving the natural enemies of pests (Bio-safety Committee). The main task of this committee is to preserve the natural enemies from being killed by the commonly used toxic pesticides; vi) to translate the original labels and technical sheets which are associated with the imported pesticides into arabic language. These labels should replace the non-arabic (english or hebrew) labels. Therefore, farmers will apply the pesticide correctly by following the technical information and using exactly the recommended dose in order to avoid the misuse of pesticides; vii) to use friendly environmental pesticides as alternative to methyl bromide which is considered as ozone-depleting substance. Metamore® , for example, which is soil-treating substance, is recently used to disinfect the soil in the areas where intensive cultures are practiced. Also, soil sterilization using solarization is an approach which may replace, in certain areas, the application of methyl bromide. It is noteworthy to mention that the extension agents who belong either to the departments of Palestinian Ministry of Agriculture or to non-governmental organizations, should be active and be able to convince the farmers in order to apply alternatives to repeatedly used and hazardous pesticides or to integrate several control measures including biological, chemical and cultural means to obtain an effective pest control.

## 5. Implications for future cooperation to solve the above problems

In order to achieve the objective of reducing the frequency and amount of pesticides used in the P.T, and to encourage the farmers to use alternatives to the highly toxic and hazardous pesticides, a regional effort beside the national effort may be needed for the control of common pests between neighbouring countries. For example, the necessity for regional cooperation to control the Mediterranean fruit fly (*Ceratitis capitata*) which attacks yearly many types of fruit trees grown in Palestine, Israel and Jordan causing great economic losses in produced fruits. The technique of releasing sterile males as alternative method to intensive application of insecticides may be applied collectively to control this pest. Another example which implies a future cooperative work between the countries of the region is the control of Date-palm weevil on date-palm trees. This pest may spread from a certain spot of infestation on date-palm trees growing, for example, in Jericho district to other trees growing in the P.T or in the neighbouring countries such as in Jordan across the Jordan Valley. A regional collective work including many countries is more effective in controlling this devastating pest than the single work conducted by one country. Finally, we might think of other examples where the regional collective effort is more fruitful in the control of certain common pests than single national effort. In many cases, it is possible to investigate non-pesticide solution. The implementation of this regional cooperation may be achieved through multi-lateral projects which can be supported by international financing organizations.

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