ISSN 1644-0692
www.acta.media.pl

ACTA SCIENTIARUM POLONORUM *Acta Sci. Pol. Hortorum Cultus, 14(3) 2015, 115-129*

FARM LEVEL ANALYSIS OF PESTICIDE USE IN SWEET CHERRY (*Prunus avium* L.) GROWING IN WEST MEDITERRANEAN REGION OF TURKEY

Hasan Yilmaz

Suleyman Demirel University, Isparta,Turkey

Abstract. Pesticides are chemicals that are used to control and avoid fruit losses from pests and diseases in fruit production. Various kinds of pesticides have been used in sweet cherry growing to increase yield and farm income in Turkey. This study was conducted to analyze the farm-level of pesticide use in sweet cherry growing in West Mediterranean region of Turkey. Data was collected from 89 growers using the simple random sampling method. Results of this research show that the average usage of agricultural chemicals are 53 349.50 g per hectare as an active ingredient in the sweet cherry growing. The percentages of used agricultural chemicals are 79.82, 19.11 and 1.07% copper sulphates, pesticides and winter & mineral oils +DNOC, respectively. It was calculated that economic loss was €162.92 per hectare due to overdose of agricultural chemicals. Chi square test analysis showed that, there was a significant relationship between farmers' pesticide use practices and farm size, listening agriculture related program on radio, information needs in disease, insects and pests management, applying protective pesticides and use personal protecting equipment.

Key words: pesticide use, sweet cherry growing, pesticide economics, extension, Turkey

INTRODUCTION

The geography and climate in many regions of Turkey are appropriate for cultivation of sweet cherry. Sweet cherry (*Prunus avium L.*) is a product of economic importance in both Turkey and the rest of world. According to 2011 FAO statistics, sweet cherry production in the world was 2.2 million t. The most important market share in production belongs to Turkey (21.3%), USA (17.0%), Iran (8.9%), Italy (4.6%), Spain (4.4%) and Chile (4.0%), respectively [FAOSTAT 2014].

Corresponding author: Hasan Yilmaz, Suleyman Demirel University, Agriculture Faculty, Department of Agricultural Economics, 32260, Isparta, Turkey, e-mail: hasanyilmaz@sdu.edu.tr

Sweet cherry for both fresh consumption and export is an important fruit in Turkey. The production of sweet cherry increases rapidly as the cultivation areas increase every year. If the fruit has good quality, it has also perfect market value. Production for export is often encouraged as a means of generating foreign exchange, increasing incomes to producers, and providing employment for the poor rural areas.

The most market important share in sweet cherry export belongs to USA, Chile, Turkey, Spain and Austria, respectively. According to data provided in 2011, 480 748 t of sweet cherry were produced in Turkey, of which 46 477 t (9.7%) were exported. Traditionally, sweet cherry is among the top fruits exported from Turkey. Russia, European Union countries, Middle East countries and some Far East countries, continued to be major export destinations for Turkish sweet cherry [FAOSTAT 2014]). Having a striking appearance, being pleasant to consume and being demanded in international markets, it caused an increase in sweet cherry production in recent years in Turkey.

Fig. 1.‘0900 Ziraat’, the most important sweet cherry variety grown in Turkey

The Turkish name for sweet cherry is ‘Kiraz’ while the name used for sour cherry in Turkey is ‘Visne’. Furthermore, there are a lot of cherry genotypes and several local varieties in Turkey, which is the origin of sweet cherry. The Aegean Region is the leading Turkey cherry producer with 155 777 t; Mediterranean and Eastern Marmara follows it. Isparta province is located in the inner part of West Mediterranean Region (fig. 1). It is part where the Lakes Region is. Isparta has a suitable climate for growing many fruits. In fact, fruit production has a very important share in agricultural production of the province. In the province, the most important fruits in terms of production are apples, grapes, sweet cherry and sour cherry. The Isparta province has a very high sweet cherry growing potential and with the annual production of 31 732 t in 2013, provided 6.42% of the total sweet cherry production in Turkey [TURKSTAT 2014]. Due to soil structure and climatic conditions, the sweet cherry produced in Isparta province is very tasty and sweet. The mentioned product is demanded a lot by consumers, because of its specific aroma and flavours. Approximately 80–95% of the sweet cherry (0900 Ziraat) produced in Isparta province is exported. [Demircan et al. 2004, Demirsoy et al. 2013]. Most important variety exported from Turkey and Isparta are 0900 Ziraat (fig. 2). For this reason, the whole Isparta province provides such an important contribution to the Turkish export.

Pesticides are widely used in agriculture to control crop losses caused by pests, despite the fact that pesticide usage is inevitable in modern agriculture. During the crop

production if you do not use control precautions against diseases, pests, and weeds there will be about 65% production losses [Oerke et al. 1994]. However, either crop protection against pests and diseases or human health and environment should be considered mutually in pesticide treatments.

Fig. 2. Research area

There is widespread acceptance that expansion of modern agricultural technologies led to sharp increase in pesticide use [Pingali and Rola 1995, Rahman 2003]. Therefore, with the increased diffusion of 'green revolution' technology in particularly developing country, pesticides became and will continue to be a major component of modern time agriculture. As for the record of pesticide use in Turkey, it has been a quick growth in recent years. Although the overall intensity of pesticide use is low by comparison with many developed and developing countries and in European Union countries, there are concerns over adverse impacts on human health and the environment in some regions [OECD 2008]. It was reported that average usage of pesticide is 1209 g ha^{-1} as an active ingredient in Turkey. This amount includes 47% insecticides, 24% herbicides, 16% fungicides and 13% of other groups. This figures in Netherlands (13 800 g ha^{-1}), Greece (13 500 g ha^{-1}), Italy (9 300 g ha^{-1}), Ireland (8 000 g ha^{-1}), United Kingdom (6 400 g ha^{-1}), Portugal (6 000 g ha^{-1}), Sweden and Luxembourg (4 400 g ha^{-1}), Austria (4 000 g ha^{-1}), Germany (2 600 g ha^{-1}), Spain (2 300 g ha^{-1}), Denmark (1 700 g ha^{-1}), Belgium and Finland (1 200 g ha^{-1}). It was reported that average usage of pesticide is 705 g ha^{-1} as an active ingredient in European Union [EUROSTAT 2007]. According to these results, it can be said that pesticide was used more than the average of the EU, Belgium and Finland in Turkey.

Pests and disease cause significant yield and quality losses to Turkey fruits. Pesticides, as one option to combat pest damage, have been one of the fastest growing agricultural production inputs in the last twenty-five years, and have contributed to the high productivity of Turkish agriculture. Insecticides and herbicides account for most pesticide use, but the recent increase in volume of pesticide used is mostly for fungicides and other pesticide products applied to high value fruits. Within the last twenty-five years, the Pesticide Commission of the Ministry of Agriculture and Rural Affairs has can-

celled the registration of 32 different pesticides, including mixtures, because of their toxic effects, ineffectiveness, or carcinogenic and adverse environmental effects [Harmancıoglu et al. 2001].

Pesticides will continue to play an important role in food security in Turkey due to the limited arable land resources and the increase of future population. Therefore, the only way to improve food security is to increase crop yields through the scientific use of pesticides with an emphasis on protecting the environment. Pesticides use is the most important elements in determining productivity and the level of fruits production. Pesticides have a significant impact on sweet cherry production, as a profitable economic activity. It is not possible to reach the desired quantity and quality of sweet cherry production without pesticides use. The increasing use of pesticides in sweet cherry production has been accompanied by concern over health effects associated with pesticide use and abuse. Potential food safety risks from pesticide residues are also a significant issue for importers of fresh fruits and vegetables and a market-risk factor for exporters who may have shipments detained or rejected if residues exceed allowable limits [Norton et al. 2003]. There are substantial differences between farmers' expectations and consumers' inclinations in terms of pesticide use. Consumers usually demand healthful, natural and cheap food, while farmers desire higher yield and higher market prices [Peker 2004].

In recent years, many studies have been made on knowledge, attitudes, practices, perceptions, health & environmental effects, problems and pesticide use of farmers in many different crops and countries [Fernandez et al. 1998, Pimental 2005, Falconer 2002, Kishi 2002, Rahman 2003, Van Mele et al. 2010, Hasing et al. 2012, Chalermphol and Shivakoti 2009, Atreya 2007] and also in Turkey [Karaca et al. 2005, Delen et al. 2005, Budak and Budak 2006, Isın and Yıldırım 2007, Demircan and Aktas 2004, Demircan and Yilmaz 2005, Kızılay and Akcaoz 2009, Engindeniz and Engindeniz 2006, Engindeniz 2006, Gun and Kan 2009, Altikat et al. 2009]. But, on this subject studies remain insufficient in Turkey. For this reason, there is still need for study, especially on practices of pesticide application and to estimate economic losses resulting from overdose used pesticide on sweet cherry growers' in Turkey.

The purpose of this study was to determine the amount and types of pesticides used in sweet cherry as one of the most important agricultural export products of Turkey and to analysis the farm-level economic losses resulting from overdose used pesticide. However, growers' attitudes toward their use of pesticides, their pesticide use practices and their pesticide use problems were also determined.

MATERIAL AND METHODS

In this study, 12 villages from the Atabey, Keciborlu, Senirkent and Uluborlu districts of the Isparta province (fig. 1) where there is intensive sweet cherry production were surveyed. Primary data were collected from 89 randomly selected sweet cherry growers in the villages of these districts. Districts are determined according to the sweet cherry orchard size in sampling process and villages which constituted sampling framework sweet cherry production farms that are appropriate for the purpose of this study. Sample size was determined by the simple random sampling method [Yamane

2001]. The permissible error in sample population was defined to be 10% and the sample size was calculated to be 89 for 90% reliable. A questionnaire form was prepared to collect the required information related to pesticide use. Using this form, employing a face to face questionnaire method with sweet cherry producers in the Isparta province, primary data were collected economic analysis of pesticide use in sweet cherry production for the year 2010–2011. The survey was conducted in August 2011. In addition, secondary data was obtained from similar studies and statistics by various individuals and organizations related to this subject.

Data Analysis. Descriptive and inferential statistics were used to analyze the data collected. Demographic characteristics of farmers were analyzed using percentages and frequencies. Significant relationships between selected variables were established using chi-square statistics. The data obtained from the farms analyzed with the SPSS software program and are shown in tables. The SPSS software program was also used to determine significance levels of the variables. Contingency tables were prepared to evaluate the association between the variables and Chi-square test (χ^2) was used to analyze the relationship between the socio-economic variables and farmers' pesticide use practices [Koseoglu and Yamak 2008].

The other aim of this research was to estimate economic losses resulting from overdose used pesticide in comparison with application levels used by growers and suggested in sweet cherry production by extension units. For analysis the farm-level economic losses resulting from overdose used pesticide the formula below was used (eq. 1).

$$DROUP = APAIU - APAIR \quad (1)$$

$$EL = DROUP * PPUT$$

where:

DROUP – difference resulting from overdose used pesticide,
APAIU – amount of pesticide active ingredient used (g ha^{-1}),
APAIR – amount of pesticide active ingredient recommended (g ha^{-1}),
EL – economic losses (€ ha^{-1}),
PPUPT – price of pesticide used by pesticides type (l/€).

RESULT AND DISCUSSION

Socio-demographic characteristics of surveyed sweet cherry growers. The average age of the farmers was 49.3 years and average experience of farmers in agriculture was 24.2 years. The average household size was 4.5 people. Farmers' average years of education were 8.5 (tab. 1). In terms of education, 40.9% of the growers were graduated from primary school. Nearly one-fifth (21.6%) of the growers were graduated from middle school. The ratio of sweet cherry growers having high school or university degree were 37.5%. When farmers were categorized according to farming experience, 43.2% of the farmers were between 10 and 20 years, 39.8% were 20 and over years, and 17.0% were less than 10 years.

The percentages of farmers who used agricultural credit for sweet cherry growing were 61.8%. The percentages of farmers who are memberships in agricultural cooperative were 73.0%. The average size of area in farms and cultivated area were 6.0 ha and 5.7 ha, respectively. It was found that farms that were irrigated are 43.9% of farm areas and fallow land represent 5.0%. The cultivated area of the farms was 5.7 ha of which 22.8% was devoted to sweet cherry (1.3 ha) production (tab. 1). When farmers were categorized according to sweet cherry orchard size, 32.6% of the farmers were 1.0 ha and over sweet cherry orchard size, 24.7% were between 0.5 and 1.0 ha, and 42.7% were less than 0.5 hectares. 57.3% farmers rely only on sweet cherry growing as they do not have any other occupation, while the rest of the farmers are engaged in some other professions.

Communication and extension behaviours on pesticide use of the surveyed sweet cherry growers. Farmers' were used as mainly information sources for deciding to pesticide application time (76.1%), identifying the disease or insect pest (61.4%), deciding to pesticide choice (93.2%) and deciding on pesticide application dosage (78.4%) were modern information sources. This means that farmers who used more information from extension agents, farmer cooperatives, input dealers, mass media, and the internet. Information on the label about when and how to use the pesticide was the most important sources of information that effective in improve farmer's knowledge, safety in pesticides and particularly training to improve the application of pesticides [Waichman et al. 2007]. The rate of farmers who read pesticide labels were 96.6%. In another study done by Isin and Yildirim [2007] also stated that, in Turkey, all farmers read the recommendations and instructions on pesticide label but less than 60% exactly followed the directions. Some of them prefer to use overdoses or unsuitable pesticides in order to ensure the yield and quality of fruits. Most of the farmers had contact with the public and private extension agents while (11.8 and 23.5%) indicated non-contact with extension agent. The rate of participating farmers in the extension meeting about sweet cherry production was 69.7%. The percentages of farmers who participated in the plant protection related extension program was 56.2%. The percentages of farmers who watched the agricultural related programs on television was (91.0%), while the percentage who listened the agricultural related programs on radio was (25.8%) and used the Internet for agricultural relations was (30.3%). The rate of farmers who wants to produce by using the techniques environmentally friendly was 89.7%. It was determined that 75.3% of the farmers used protector pesticide against pests and diseases (tab. 1). At present, the various TV channels have been broadcasting the effective agricultural information based program. As a result, farmers are getting the valuable information on agriculture. But this is not sufficient. The TV channels should be more conscious to broadcast more agricultural information based program to create the awareness among the farmers. It said that the contribution of television towards the dissemination of information about agriculture related programs and also the study revealed that the role of television is very high in the study area.

Pests and diseases encountered by farmers in sweet cherry growing. The major pests and diseases encountered by farmers in sweet cherry growing include; blackberry fruit fly, birds, cherry fruit fly, cherry fruit sawfly, codling moth, peach leaf curl, peach tree borer, plum curculio, diseases bacterial gummosis, black know, black rot, brown

Table 1. Technical, socio-economic, information usage and farmers awareness indicators in pesticide use in sweet cherry production

Indicators	Average	Standard deviation	%
Farmer's age (years)	49.3	12.119	–
Farmer's education (years)	8.5	3.346	–
Farmer's experience (years)	24.2	12.729	–
Number of people in family	4.5	2.001	–
The rate of the farmer membership of agricultural cooperative (%)	–	–	73.0
The number of the people working on crop production in family	2.6	1.446	–
The rate of farmer dealing with non-agricultural activity	–	–	42.7
The rate of farmers using agricultural credit	–	–	61.8
Average farm size (hectare)	6.0	12.04	100.0
Cultivated area (ha)	5.7	11.73	95.0
Fallowed area (ha)	0.3	1.66	5.0
Irrigated area (ha)	2.6	2.74	43.9
Non-irrigated area (ha)	3.4	11.23	56.1
Owned land (ha)	4.3	5.26	71.7
Rented land (ha)	1.7	9.65	28.3
Sweet cherry orchard area (ha)	1.3	1.18	22.8
Other crops production area (ha)	4.4	11.48	77.2
Farmers want to produce by using the techniques environmentally friendly (%)	–	–	89.7
Farmers listen to radio programmes related agriculture (%)	–	–	25.8
Farmers watches TV programmes related agriculture (%)	–	–	91.0
Farmers use internet for agricultural purposes (%)	–	–	30.3
Farmers subscribe for a farming magazine (%)	–	–	5.6
Farmers participated any extension meeting about sweet cherry production (%)	–	–	69.7
Farmers participated any extension programmes related with plant protection (%)	–	–	56.2
Farmers knows about biological control in agricultural combat (%)	–	–	34.8
Farmers knows useful insects (%)	–	–	40.4
Farmers use protector pesticide against pests and diseases (%)	–	–	75.3

rot, cherry elaf spot, crown rot, peach leaf curl, mildew, verticillium wilt [MARA 2011]. Table 2 shows that the major pests and diseases encountered by farmers in sweet cherry growing in research area. The research results showed that the majority of these farmers faced pests and diseases include; cherry fruit fly, myzus cerasi, codling moth, blumeriella jaapii, monilia laxa, mildew, red spider mite and cherry leafroll nepovirus, respectively. Among the pests and diseases the most commonly encountered in sweet cherry growing in the study area are cherry fruit fly and myzus cerasi. These two pests and diseases accounted for over 91.1% in sweet cherry growing in the study area.

Table 2. The major pests and diseases encountered by farmers in sweet cherry growing

Pests and diseases	N*	%	Rank
Cherry fruit fly	48	53.93	I
Myzus cerasi	33	37.08	II
Codling moth	27	30.34	III
Blumeriella jaapii	19	21.35	IV
Monilia laxa	18	20.22	V
Mildew	17	19.10	VI
Red spider mite	12	13.48	VII
Cherry leafroll nepovirus	11	12.36	VIII

* – multiple responses

Practices of pesticide use of the surveyed sweet cherry growers. Pesticide use has become an important issue in recent years. There is an increasing interest in pesticide use in worldwide and particularly the European Union. Urbanization, media, influence of civil society organizations and increase in society's education and economic level are the reasons for an increased interest in pesticide use. People started to question how and under which conditions food came to the table from farm. Pesticide registration process is carried out by Ministry of Agriculture and Rural Affairs, General Directorate of Protection and Control. There is a Directive of Registration concerning the method and principles of registration of plant protection products in Turkey. The Directive covers the qualifications, duties and responsibilities of real and legal persons and instructions which will carry out the trials that will serve as a basis for registration procedure, the rule for granting a Trial Authorization, the trials on biological efficacy, phytotoxicity, residual effects and adverse effects [FALM 2010].

Respondents were asked "Do you know biological control?" The proportion of farmers who know biological control was 34.8%. Majority of the farmers (76.1%) applied protective pesticides and those who used personal protecting equipment or clothing (77.3%). Another similar study found that 57.0% stated that farmer use personal protective equipment, while 43.0% stated they don't take any measures [Gun and Kan 2009]. About 93.2% of the farmers were on agreement to pay for agricultural extension services while 94.3% of them had agree to direct payments to environmental protection conditional. The rate of farmers who experienced health problems after exposed to pesticides were 25%. This rate in farmers who used an overdose of pesticides was higher than farmers who used recommended dose.

A further issue to take into account regarding pest management is the time span that should be left between the last pesticide application and harvest. Each pesticide has a time period when residues fall under the toleration limits. In the cases when these intervals are not followed, crops have harmful pesticide residues and constitute a danger for consumer health [Gun and Kan 2009]. Respondents were asked "Do you apply pesticide appropriate for harvest interval?" Majority of the farmers (94%) applied pesticide appropriate for harvest interval. Another similar study stated that farmers do not follow

the suggested periods that should be left between the last application and harvest [Delen and Ozbek 1990].

The result of the chi-square test analysis according to the dosages of pesticides used by farmers and categories. The following can be concluded from the chi-square (χ^2) showing associations between the dosages of pesticides used by farmers and categories. There was a significant relationship between dosages of pesticides used by farmers and farm size ($p < 0.10$), listening agriculture related program on radio ($p < 0.05$), information needs in disease, insects and pests management ($p < 0.10$), applying protective pesticides ($p < 0.10$) and use personal protecting equipment ($p < 0.05$). There was a significant relationship between dosages of pesticides used by farmers and their information needs in disease, insects and pests management. This means that lack of knowledge and traditional pesticides applications probably allow overdose use. It was suggesting that an Integrated Pest Management (IPM) extension program may be well received by the target farmers. The findings suggest that attitude has changed e.g. through discussion and learning, will need to be a major component of the extension program. The adoption of IPM principles by farmers has been found to rely heavily on education and experiential learning to allow farmers to become experts as the concept of IPM is quite complex and location-specific.

There was no significant relationship between dosages of pesticides used by farmers and farmer's age, farmer's education, farmer's experience, membership of cooperative, farm size, agricultural credit use, state of dealing with non-agricultural activity, agree to pay for agricultural extension services, agree to direct payments to environmental protection conditional, watching agriculture related program on television, using the internet for agricultural relations, agricultural extension program participated, disease, insects and pests management related extension program participated, farmers' contact with public extension agents, farmers' contact with private extension agents, frequency of farmers' contact with public extension agents, frequency of farmers' contact with private extension agents and knowing biological control.

Classification and types of the pesticides used by the farmers in sweet cherry production. Table 3 shows an overview of all types of the pesticide used by the farmers in sweet cherry growing in Isparta. Pesticides were grouped by their toxicity classification and their chemical family [WHO 2010]. Among the 89 sweet cherry growers, 19 different types of pesticide were used. The pesticides commonly used by the farmers were identified as Captan (55.06%), Thiacloprid (39.33%), Deltamethrin (29.21%), Hexaconazole (24.72%) and Parathion-methyl used by 11.24% of the farmers. Other pesticides were Diazinon (7.87%), Propineb (6.74%), Methidathion (5.62%) and Chlorpyrifos-ethyl and Phosalone (4.49%). Most pesticides used are moderately hazardous (class II). Particularly, Hexaconazole, which is unregistered pesticides for sweet cherry production was used by 24.72% of growers, followed by Diazinon (7.87%) and Propineb (6.74%) used by farmers.

The economic losses caused by excessive use of agricultural chemicals and its amounts and type in investigated farms. There are many different methods of pest and disease control in fruit production. But, chemical control is the most common control method in the research area. It is sometimes preferred and used even for problems which can be solved without it. This is because, it can be applied easily, without extra

Table 3. Type of pesticides used in sweet cherry production in research area, classified using the WHO Hazard Classifications*

	Trade name	Chemical family	Toxicity class[a]	Status[b]	Number of farmers	%[c]
Insecticides	Arrivo 25 EC	Cypermethrin	II	registered	2	2.25
	Calypso SC 480	Thiacloprid	II	registered	35	39.33
	Decis ULV 1,5	Deltamethrin	II	registered	26	29.21
	Dentis 25 EC	Deltamethrin	II	registered		
	Jetsis 2,5 EC	Deltamethrin	II	registered		
	Basudin	Diazinon	II	unregistered	7	7.87
	Confidor SC 350	İmidacloprid	II	unregistered	1	1.12
	Dursban 4	Chlorpyrifos-ethyl	not listed	registered	4	4.49
	Folidol M-EC 360	Parathion-methyl	Ia	registered	10	11.24
	Fosforin M	Parathion-methyl	Ia	registered		
	Gusathion M EC 20	Azinphos-methyl	II	registered	3	3.37
	Laser	Spinosad	III	unregistered	1	1.12
	Sumicidin % 20 EC	Fenvalerate	II	unregistered	1	1.12
	Supracide 40 EC	Methidathion	Ib	registered	5	5.62
	Zolone PM	Phosalone	II	registered	4	4.49
Fungicides	Agrofarm Captan	Captan	U	registered	49	55.06
	Antracol WP 70	Propineb	U	unregistered	6	6.74
	Anvil	Hexaconazole	III	unregistered	22	24.72
	Chorus	Cyprodinil	not listed	unregistered	3	3.37
	İlteriş Thiram	Thiram	II	unregistered	1	1.12
Acaricides	Masai 20 WP	Tebufenpyrad	II	unregistered	2	2.25
	Omite Super 570 EW	Propargite	III	unregistered	1	1.12

Source: [a] – WHO [2010], [b] – MARA [2009]. * – the WHO recommended classification of pesticides by hazard
Index. Classification of active pesticide ingredients (Ia = Extremely hazardous; Ib = Highly hazardous; II = Moderately hazardous; III = slightly hazardous; U = Unlikely to present acute hazard in normal use; FM = Fumigant, not classified; O = Obsolete as pesticide, not classified)
[c] – Multiple responses were possible as there were no limitations set up for farmers' choices

knowledge and experience and that its results can readily be seen [Karaca et al. 2005]. The amounts of agricultural chemicals used by farmers with the amount of agricultural chemicals recommended by extension units and economic lose which is caused by excessive use of agricultural chemicals were given in Table 4. It was determined that use of agricultural chemicals are 53 349.50 g per hectare as an active ingredient in the sweet cherry production**.** The percentages of used agricultural chemicals are 79.82, 19.11 and 1.07% copper sulphate, pesticides and winter & mineral oils +DNOC, respectively.

Table 4. Agricultural chemicals amounts recommend and used for sweet cherry growing and economic losses

Type of agricultural chemicals	Used amount		Recommended amount	Difference	Difference	Economic loss
	(gr-ml-cc)·ha^{-1}	%	(gr-ml-cc)·ha^{-1}	(%)	(used – recommended)	(€·ha^{-1})
Insecticides	1 958.00	19.20	928.44	110.89	1 029.56	154.42
Fungicides	8 160.60	80.04	5 925.12	37.73	2 235.48	6.34
Acaricides	77.6	0.76	322.47	-75.94	-244.87	-22.22
Total pesticides	10 196.20	100.00	7176.03	42.09	3 020.17	138.54
Total pesticides	10 196.20	19.11	7176.03	42.09	3 020.17	138.54
Copper sulphates	42 585.10	79.82	32 191.01	32.29	10 394.09	26.60
Winter & mineral oils +DNOC	568.20	1.07	1 123.60	-49.43	-555.40	-2.22
Total agricultural chemicals	53 349.50	100.00	40 490.64	31.76	12 858.86	162.92

It was determined that the use of pesticides in the research area was 10 196.20 g ha^{-1}. The percentages of used pesticides are 80.04, 19.20% and 0.76% fungicide, insecticide and acaricides, respectively. In a similar study done in Isparta, Turkey, the average usage per 1 000 m^2 as active ingredient of insecticides, fungicides, acaricides and copper sulphate were 263.73, 47.65, 26.28, and 4 240 g, respectively [Demircan and Aktas 2004]. In the research area, the excess use of pesticide was determined in the sweet cherry growing. It was calculated that economic loss was €162.92 per hectare due to overdose of agricultural chemicals. It was calculated that economic loss was €138.54 per hectare due to overdose of pesticides. It was determined that farmers were used more pesticide than recommended by extension units. This situation shows that farmers have not sufficient knowledge on the pesticide using. Farmer's major problems belonging to pesticide applications were high pesticide prices, inefficient pesticides, low education level, insufficient and ineffective extension services.

CONCLUSION

This study aimed to farm level analysis of pesticide use in sweet cherry growing in West Mediterranean Region of Turkey. Data was collected from 89 growers using the simple random sampling method. According to study results it has been determined that farmers were use agricultural chemicals more than the recommendations of extension units and depending on the prospectus of chemicals. This leads to economic loss and cost increase. It was calculated that average usage of agricultural chemicals are 53 349.50 g per hectare as an active ingredient in the sweet cherry production. The percentages of used agricultural chemicals are 79.82, 19.11 and 1.07% copper sulphates, pesticides and winter & mineral oils +DNOC, respectively. It was calculated that economic loss was €162.92 per hectare due to overdose of agricultural chemicals. This situation shows that farmers have not sufficient knowledge on the agricultural chemicals

use. The extension staff should make more emphasis on education of farming community about the recommended dosages, timings and method of pesticides applications on sweet cherry growing. The effective training and extension activities which provide farmers research results related to pesticide application should be performed.

Turkey is one of the most important countries of the world in terms of sweet cherry production and export. Moreover, Turkey is very strong exporter to European Union countries. Nowadays, government regulations, health and environmental considerations, food quality and safety requirements are playing an increasingly important role in the export markets. As a conclusion, pesticide effects include food safety, worker safety, ground water contamination, and environmental damage. It is therefore recommended that government and research institutes should strengthen extension services to deliver improved pest management technologies to the farmers. Adequate extension services will help the farmers to ensure compliance to pesticide use and management practices and rational pesticides usages. Besides, effective policies should be prepared for enforcement of registered use and sales of pesticides. The pesticide subsidy programs should be implementation to farmers who applied IPM techniques and good agricultural practices (GAP) and farmers who use harmless pesticides on environmental and human health. The number of accredited residue laboratories should be increased in order to regularly carry out pesticide residue analysis of fruits and vegetables.

ACKNOWLEDGEMENTS

This research was funded by the Scientific Research Projects Committee of Suleyman Demirel University in Turkey (SDU BAP, Project Number: 2620-M-10). The author expresses appreciation to farmers and other individuals who provided assistance. The author wants to thank also the anonymous reviewers for their suggestions and improvements on this paper.

REFERENCES

Altıkat, A., Turan, T., Torun, E.F., Bingol, Z. (2009). Use of Pesticides in Turkey and its Effects on Environment. J. Agricult. Fac. Ataturk Univ., 40(2), 87–92.

Atreya, K. (2007). Pesticide use knowledge and practices: A gender differences in Nepal. Environ. Res., 104, 305–311.

Budak, F., Budak, D.B. (2006). Farm level analysis of pesticide use in cotton production in East Mediterranean region of Turkey. J. Environ. Biol., 27(2), 299–303.

Chalermphol, J.S., Genesh, P. (2009). Pesticide use and prevention practices of tangerine growers in Northern Thailand. J. Agricult. Educat. Extens., 15(1), 21–38.

Delen, N., Ozbek, T. (1990). Pesticide usage and related problems in Turkey. Proceedings of Turkish Agricultural Engineering 3rd Technical Congress, T.M.M.O.B., January 8–12, Ankara, pp. 216–224.

Delen, N., Durmusoglu, E., Guncan, A., Gungor, N., Turgut, C., Burcak, A., (2005). Problems concerning pesticide use in Turkey, residues and reduced sensitivity in organisms. Agricultural

Engineering VI. Technical Congress, 3–7 January. Union of Chambers of Turkish Engineers and Architects, Chamber of Agricultural Engineers, Ankara, pp. 629–648.

Demircan, V., Aktas, A.R. (2004). Determination of the level of pesticide use and farmers tendency in cherry production in Isparta province. Turk. J. Agricult. Econom., 9, 51–65.

Demircan, V., Yilmaz, H. (2005). The analysis in terms of economics and environmental sensitivity of pesticide use in apple production in Isparta Province. Ekoloji, 15(57), 15–25.

Demircan, V., Hatirli, S.A., Aktas, A.R. (2004). Marketing structure and problems of sweet cherry in Isparta Province, Suleyman Demirel University. J. Inst. Nat. Sci., 8, 26–33.

Demirsoy, H., Demirsoy, L., Macit, İ., Akcay, M.E., Bas, M., Demirtas, İ., Sarısu, C., Taner, T., Kuden, A. (2013). Sweet cherry growing in Turkey – a brief overview. http://www.cherry 2013.com/sites/cherry2013.com/files/presentaciones/S2_O6_Demirsoy.pdf.

Engindeniz, S. (2006). Economic analysis of pesticide use on processing tomato growing: A case study for Turkey. Crop Protect., 25, 534–541.

Engindeniz, S., Engindeniz, Y. (2006). Economic analysis of pesticide use on greenhouse cucumber growing: A case study for Turkey. J. Plant Dis. Protect., 113(5), 193–198.

EUROSTAT (2007). The use of plant protection products in the European Union, Data 1992–2003, European Commission, Environment Statistics. http://epp.eurostat.ec.europa.eu/cache/ITY_OFFPUB/KS-76-06-669/EN/KS-76-06-669-N.PDF

Falconer, K. (2002). Pesticide environmental indicators and environmental policy. J. Environ. Manag., 65, 285–300.

FALM (2010). Working reports, general directorate of protection and control, Ministry of Food, Agriculture and Livestock (FALM) of Turkey, Ankara.

FAOSTAT (2014). The statistics division of the Food and Agriculture Organization (FAO). http://faostat.fao.org/site/567/default.aspx#ancor

Fernandez, J., Jans, S., Smith, M. (1998). Issues in the economics of pesticide use in agriculture. Rev. Empr. Evid. Rev. Agricult. Econom., 20(2), 462–488.

Gun, S., Kan, M. (2009). Pesticide use in Turkish greenhouses: Health and environmental consciousness. Pol. J. Environ. Stud., 18(4), 607–615.

Harmancioglu, N., Alpaslan, N., Boelee, E. (2001). Irrigation, health and environment: a review of literature from Turkey. Colombo, Sri Lanka: International Water Management Institute, IWMI working paper 6. 21 p.

Hasing, T., Carpio, C.E., Willis, D.B., Sydorovych, O., Marra, M. (2012). The effect of label information on U.S. farmers' herbicide choices. Agricult. Res. Econom. Rev., 41, 200–14.

Isin, S., Yildirim, I. (2007). Fruit-growers' perceptions on the harmful effects of pesticides and their reflection practices. The Case of Kemalpasa, Turkey. Crop Protect., 26, 917–922.

Karaca, İ., Ay, R., Karaca, G. (2005). Effects of pesticides on the enviroment and human health. Hasad, 21(245), 86–89

Kishi, M. (2002). Farmers' perceptions of pesticides, and resultant health problems from exposures. Internat. J. Occupat. Environ. Health, 8(3), 175–181.

Kızılay, H., Akcaoz, H. (2009). Examination of economic loss for pesticide and fertilizer application in apple production. A case study of Antalya Province. Res. J. Agricult. Sci. (TABAD), 2(1), 113–119.

Koseoglu, M., Yamak, R. (2008). Uygulamalı İstatistik. Celepler Matbaacılık, 3. Baskı. Trabzon.

MARA (2009). List of registered plant protection products. General Directorate of Protection and Control. Republic of Turkey Ministry of Agriculture and Rural Affairs (MARA). Ankara. p. 402.

MARA (2011). Combat with pests and diseases of sweet cherry and cherry. General Directorate of Protection and Control. Turkish Republic Ministry of Agriculture and Rural Affairs. Technical Bulletin, pp. 76

Norton, GW., Sanchez, G., Clarke-Harris, D., Kone Traore, H. (2003). Case study: reducing pesticide residues on horticultural crops. In Food Safety in Food Security and Food Trade, Focus 10, ed Unnevehr L (International Food Policy Research Institute, Washington, DC), pp 21–23.

OECD (2008). Environmental performance of agriculture in OECD countries since 1990. Turkey Country Section. Paris, France.

Oerke, E.C., Dehne, D.W., Schonbeck, F., Weber, A. (1994). Crop production and crop protection. Estimated losses in major food and cash crops. Elsevier Hardcover, Amsterdam, pp. 830.

Peker, K. (2004). Comparative economic analysis between chemical pesticides and bacterium using in apricot production. Die Bodenkultur, 55(2), 47–51.

Pimental, D. (2005). Environmental and economic costs of the application of pesticides primarily in the United States. Environ. Develop. Sustain., 7, 229–252.

Pingali, P.L., Rola, A.C. (1995). Impact of pesticides on farmer health and the rice environment. public regulatory roles in developing markets: the case of Philippines. In: Impact of Pesticides on Farmer Health and the Rice Environment, P.L., Pingali, P., Roger, (eds.). Kluwer Academic Publishers, Boston.

Rahman, S. (2003). Farm-level pesticide use in Bangladesh: determinants and awareness. Agricult. Ecosyst. Environ., 95, 241–252.

TURKSTAT (2014). Turkish Statistical Institute, Crop Production Statistics. http://www.tuik.gov.tr/bitkiselapp/bitkisel.zul.

Waichman, A.V., Nailson, E., Silva, N.C. (2007) Do farmers understand the information displayed on pesticide product labels? A key question to reduce pesticides exposure and risk of poisoning in the Brazilian Amazon. Crop Protect., 26, 576–583

Van Mele, P., Hai, T.V., Thas, O., Van Huis, A. (2010). Influence of pesticide information sources on citrus farmers' knowledge, perception and practices in pest management, Mekong Delta, Vietnam. Internat. J. Pest Manag., 48(2), 169–177.

WHO (2010). World Health Organization. The WHO recommended classification of pesticides by hazard and guidelines to classification. International Programme on Chemical Safety. ISSN 1684–1042.

Yamane, T. (2001). Basic sampling methods. In: Translators, A., Esin, M.A., Bakir, C., Aydin, E., Gurbuzsel (eds.). Literatur Publishing, Istanbul.

ANALIZA POZIOMU UŻYCIA PESTYCYDÓW W UPRAWIE CZEREŚNI (*Prunus avium* L.) W ZACHODNIOŚRÓDZIEMNOMORSKIM REJONIE TURCJI

Streszczenie. Pestycydy są związkami chemicznymi używanymi do zahamowania i unikania w plonie strat spowodowanych szkodnikami, chorobami i chwastami. W uprawie czereśni stosowano różnego rodzaju pestycydy w celu zwiększenia plonu i dochodu gospodarstw w Turcji. Niniejsze badanie przeprowadzono, aby przeanalizować poziom użycia pestycydów w zachodniośródziemnomorskim rejonie Turcji. Dane zebrano z 89 gospodarstw przy zastosowaniu prostej metody losowej. Na podstawie wyników badań wnioskuje się, że średnie użycie rolniczych środków chemicznych jako aktywnego elementu w uprawie czereśni wynosi 53 349,50 $g \cdot ha^{-1}$. Udział stosowanych chemicznych środków rolniczych to odpowiednio: 79,82, 19,11 i 1,07% siarczanu miedzi, pestycydów olei zimowych i mineralnych +DNOC. Obliczono, że strata ekonomiczna spowodowana

przedawkowaniem rolniczych środków chemicznych wynosiła €162,92 ha^{-1}. Analiza testu chi-kwadrat wykazała, że istnieje istotny związek między dawkami pestycydów stosowanymi przez rolników a rozmiarem gospodarstwa, słuchaniem w radiu programów związanych z rolnictwem, potrzebą posiadania informacji na temat chorób, zwalczaniem owadów i szkodników, zastosowaniem pestycydów oraz użyciem własnego sprzętu ochronnego

Słowa kluczowe: stosowanie pestycydów, uprawa czereśni, opłacalność pestycydów, rozwój, Turcja

Accepted for print: 31.03.2015

For citation: Yilmaz, H. (2015). Farm level analysis of pesticide use in sweet cherry (*Prunus avium* L.) growing in West Mediterranean region of Turkey. Acta Sci. Pol. Hortorum Cultus, 14(3), 115–129.