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ECONOMIC ANALYSIS OF INTEGRATED PEST MANAGEMENT IN CHERRY CULTIVATION

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Abstract

The present study aims to develop new suggestions by determining the implementation level of integrated pest management, awareness level regarding the integrated pest management, shortcomings in implementation and efficiency of implementation in cherry cultivation in the region that stands out in Turkey. In this context, Izmir, Manisa, Konya, Isparta, Afyon and Denizli were taken into the scope of research where intensive cultivation of cherry in Turkey takes place. According to the results of the study integrated pest management awareness is low. However, the integrated pest management methods have been implemented more since cherry started to be exported. 37.3% of farmers highly implement integrated pest management and 22.5% implements at low level. The lack of awareness at enterprise level regarding integrated pest management and warning system is the area need to be focused. At the top of the suggestions about increasing the efficiency of the system comes popularizing the training activities in the region. Overall, providing sustainability of the system, development of production and consumption culture are important areas both in public and private sectors.

Key words**:** *cherry production, IPM, Turkey*

INTRODUCTION

Pesticide use plays an important role in the increase of production. A remarkable increase was observed in 1940-1950s in the pesticide use especially in the developed countries. However, the unfavourable effects of intense input use in agricultural production on natural resources and human health have been discussed at the present time. The unfavourable effects have been observed on environment and human health in many countries since intense pesticide use. Pesticides have acute and chronic effects on human health and cause unfavourable effects on non-target organisms by contaminating the ground and surface water [17] [26]. This situation has caused the emergence of alternative spraying methods. The best known of these methods is Integrated Pest Management (IPM). IPM is described as Integrated Pest Control and defined as the management system of pests. Within the scope of this definition, IPM is the efforts for the use of all techniques and methods in harmony in order to keep pest populations under economic damage levels by taking all factors taking part in pests' population change into consideration by their environments.

Objectives of IPM are; (a) Increasing agricultural production, obtaining qualified chemical products which do not leave chemical residues, (b) protection and encouragement of natural enemies, (c) controlling field, orchard and vineyards and (d) farmers' becoming experts of their fields, orchards and vineyards [38].

The research focuses on presenting farmers'

agricultural management structure, determination and betterment of the level of farmers' accordance with the IPM program. In this context, farmers' compliance level with the IPM program existing in the region was determined and economic analysis was conducted. Additionally, cherry producers' judgment, attitude, existing knowledge and awareness levels regarding the IPM were determined.

MATERIALS AND METHODS

In this context, Denizli, Isparta, Izmir, Konya and Manisa were taken into the scope of research where intensive cultivation of cherry (41.9 percent of the cherry cultivation, 52.3 percent of planted areas, 38.5 percent of the number of trees) in Turkey takes place. The primary data constituting the main material of the research were obtained through questionnaire method from the cherry producers found in the given cities. The secondary data related to the research were obtained from institutions and organizations including Provincial and District Food, Agriculture and Livestock Directorates. Additionally, the relevant researches conducted at national and international level has been benefitted.

The sample volume was calculated as 236 farms with 95 percent confidence interval and 5 percent margin of error by applying stratified random sampling to the population obtained from Farmer Registration System of six cities. The sample farms were allocated into strata with "Neyman Method".

Four criteria were used in the determination of the implementation level of the IPM in cherry cultivation. These are; (i) the level of compliance to the IPM (the point taken according to the Likert scale) (25 points), (ii) farmers' implementation level of alternative methods to chemical fight like biological fight, cultural measures, bio-technological methods, physical and mechanical methods (the point taken according to the Likert scale) (25 points),(iii) farms' technical applications (pruning method, irrigation, fertilization dose, thinning condition, consultant status, participation in educational activities, pesticide using knowledge, fertilizer application in accordance with soil analysis results, use of suitable plant nutrients) (25 points), (iv) proper use of chemical in accordance with the integrated pest management, the recognition level of pest and disease (the point taken according to the Likert scale) (25 points),

In the study, farmers' choice of pest management system and judgment, attitude and existing knowledge level about IPM were studied. Within this scope, Likert scale was used to evaluate farmers' attitude regarding the use of agricultural pest management system in cherry cultivation. The expressions situated in attitude scale were evaluated according to 5-point scale in Likert scale. The answers; I definitely agree - I agree - I am neutral - I disagree - I definitely disagree, are found next to each question. The severity of attitude increases or decreases toward the end [6]. In the scale, farmers' answers to each attitude question were determined and how positive they are in terms of use of determined system or their attitude regarding the use of IPM were found out. The variable expense items in cherry cultivation contain temporary labour, fertilizer, drug, water expenses, fuel-repair-maintenance, rent of machinery, marketing, other changing items and working capital interest. In the farms studied in the region, fixed costs contain paid family labour, permanent foreign - family labour cost, rent-sharecropping share, depreciation period, interest period, depreciations and total debt interest. The total of equity interest, fixed cost and variable cost constitutes production costs. Profitability rates were found out in the evaluation of compliance with IPM in cherry cultivation and success rates. In the calculation of cherry's relative, gross and absolute (net) profits; Gross Profit = Gross Value of Output - Variable costs, Relative Cost = Gross Value of Output - Production Costs [1] [19] [35].

RESULTS AND DISCUSSIONS

80.5 percent of the farmers apply foliar fertilizer. Considering the size groups of farms, foliar fertilizer is applied at the lowest

level in group I, at the highest level at group IV. Regarding the number of foliar fertilizer applied to cherry orchards, it was found out that foliar fertilizer was applied 2.2 times at farmers' general average. There is a directly related statistical ($P<0.05$) relationship between size groups of farms and number of foliar fertilizer application.

In vegetable and fruit growing, application of farm manure is important besides chemical fertilization. 52.2 percent of farmers in the region apply farm manure in their cherry orchards. The application time of farm manure changes among farms. The farms generally apply farm manure in autumn and winter months (October, November and December).

Considering the farms' status of conducting soil analysis in the research area, it was found out that 57.2 percent of farms conducted soil analysis. There is a directly related statistical ($P<0.05$) relationship between size groups of farms and conducting soil analysis.

Considering farms' application of fertilizer in accordance with analysis results in cherry cultivation, 88.9 percent of the farms conducting soil analysis applied fertilizer in accordance with analysis results.

According to the study by Hasdemir and Taluğ [15], the most important source of information regarding the fertilization decision was the farmers' own knowledge with 39.71 percent for farms not conducting GAP (Good Agricultural Practices) and it was the soil analysis results with 32.35 percent for farms conducting GAP.

Pruning is a very important issue in cherry cultivation. The cultivation system differs according to the vigour of cherry's rootstocks and variety. The pruning methods in cherry orchards can be divided into three categories. These are; (i) Shape pruning is done in order to give shape to the young trees. (ii) Pruning of trees in yield era are conducted every year regularly for apple, pear and peach trees but not for cherry. Fruit trees are pruned in order to provide pre-built canopy remove diseased or damaged branches, remove branches that compact the crown and affect light exposure unfavourably, remove aged branches and voracious shoots and encourage the formation of new shoots to ensure the continuity of physiological balance. (iii) Rejuvenation pruning of the elderly trees are conducted with hard cuts in order to encourage the formation of new branches. While most of the pruning activities aim to give the tree shape, some pruning activities like Sweet Hearth are compulsory to conduct each year regularly in productive fruit-bearing trees in order to prevent the quality loss of fruits caused by increased fruit weight on branches.

In that way, new branches can form on the tree and high-quality fruits are obtained thanks to the balanced fruit weight. According to the study results, 94.5 percent of the farms conduct pruning regularly. The ratio changes between 92 percent and 100 percent in size groups of farms.

In stone fruits, such diseases-pests as brown rot (*Monilinia laxa*), Cherry fruit fly (*Rhagoletis cerasi L.*), (*Dip.:Tephritidae*), Shot hole disease *(Wilsonomyces carpophilus*) are found as significant diseases-pests in cherry research area [2].

Relevant departments of Ministry of Food, Agriculture and Livestock have taken apple scab (*Venturia inaequalis*) and powdery mildew (*Uncinulanegato*r) into the estimate and warning system. Some technical instructions and standard chemical application methods for pest control have been prepared based on the studies carried out within Plant Protection Central Research Institute.

Brown rot (*Monilinia laxa*) emerges on every diseased part of conidiophores containing asexual generation structures. Conidiophores stacks can be observed by naked eye in the form of pustules on diseased branches in early autumn and spring. Cherry fruit fly *(Rhagoleti scerasi L.)(Dip.:Tephritidae*), whose mature forms are 4-5 mm long, have a yellow triangular shape at the neb of thorax. On cherry trees, Shot hole disease (*Wilsonomyces carpophilus*) fungus lives in the form of micelle on fruit-bud and branches in winter. The primary infections take place with conidiophores and diseased fruit-bud and cancers are the sources of infection. The front wings of rose tortrix (*Archips rosanus*) butterflies have a skewed rectangles shape and its colour changes between light olive and

brown. There are descriptive spots and bands providing details in terms of shape and colour on wings [2].

In the studied region, cherry IPM project is found in the programs of Crop Production and Plant Health branches of the Ministry of Food, Agriculture and Livestock Provincial and District Directorates. The Ministry removed cherry integrated technical ordinance and determined the definitions of cherry diseases and pests, fight methods and their periods to be harmful in 2011.

It was found out that 25.8 percent of the studied farms worked with consultant(s) in the care of cherry orchards.

Considering whether farms worked with a private consultant in the disease and pest management in cherry cultivation and care of cherry orchards; 10.2 percent worked with free consultant, 20.3 percent worked with paid consultant and 69.9 percent did not work with any consultant in the disease and pest management and care of orchards.

Considering the worldwide pesticide use; a remarkable increase was observed in 1940-1950s in the pesticide use especially in the developed countries. However, the intense use had unfavourable effects on natural resources and human health. This situation has caused the emergence of alternative spraying methods. The best known of these methods is Integrate Pest Management (IPM). IPM entered the world literature at the end of 1950s and it has been still improved. Similar programs with different names have been supported and run in many countries [13].

The production methods containing intense use of input in agricultural activities in order to increase productivity have caused an increase in environmental problems. The unfavourable effects of intense input use have been discussed especially in developed countries in the recent years. There have been a demand in these countries for healthy, clean products which are produced without chemical inputs and do not damage the environment or human. This situation has provided the emergence of production techniques including integrated pest management, organic agriculture and Good Agricultural Practices. The implementation of these techniques presents a great significance for EU market which is the most important market for cherry export from Turkey. The consumers are willing to pay higher premium prices for the cherries produced with good agricultural practices [28].

Within this scope, the questions about the knowledge level of farms regarding the IPM were initially asked.

According to the findings, farms had a low level of knowledge. It was found out that 79.2 percent of the farms did not have information regarding the IPM (Table 1). Gül et al. [13], found out that 68.2 percent of the farmers did not have information regarding the IPM in their study on apple producers. Beddow [5] analysed the existing studies on environmental and economic techniques about IPM in USA and measured how IPM protocol was evaluated in the sample case of implementations on sweet corn in Pennsylvania and Massachusetts. It was found out that personal perceptions were not a measure in order to evaluate the adaptation of integrated pest management. It was because farmers had different ideas about the integrated pest management.

According to the data obtained in the research area, farmers' knowledge about good agricultural practices was studied. It was found out that average 44.5 percent of the farms had knowledge about the good agricultural practices while 55.5 percent did not have information. 78.0 percent of the studied farms had information about the organic agricultural practices. Considering farmers' knowledge about biologic agricultural practices, 30.9 percent had knowledge while 69.1 percent did not have knowledge. 58.1 percent of the studied farms had information about the official warning and practices regarding diseases and pests in cherry cultivation. Considering farms' ownership of good agricultural practices certificate; 22.9 percent of the farms had good agricultural practices certificate and 77.1 percent did not have good agricultural practices certificate.

17.1 percent of the studied farms implemented chemical control against weeds and 42.1 percent implemented mechanical control.43.2

percent of the studied farms implemented chemical control consciously, 5.5 percent implemented unconsciously and 13.1 percent implemented with increased conscious. Farms' compliance with spraying schedule of Ministry of Food, Agriculture and Livestock for brown rot (*Monilinia laxa*), and cherry fruit fly (*Rhagoletis cerasi L.), (Dip.:Tephritidae*) was studied. Accordingly, 22.2 percent of the farms had never complied with the spraying schedule and 41.5 percent had complied very carefully. Considering the farms' compliance with the proposed dosage; the majority (84.3 percent) complied with the proposed dosage. Additionally, the majority of the farms (90.7) had sufficient knowledge regarding the time that must elapse between harvesting and spraying.

The majority of the farms (86.4 percent) took measures during chemical spray preparation in cherry cultivation. However, this ratio is low, especially in the III. group farms.

The participation of farms to the IPM trainings was also low (18.6 percent). This was also caused by the fact that farms did not have a conceptual understanding of IPM (74.2 percent did not know). Farms' compliance with spraying schedule of Ministry of Food, Agriculture and Livestock for brown rot (*Monilinia laxa*), and cherry fruit fly (*Rhagoletiscerasi L.), (Dip.:Tephritidae*) was studied as those complying at high level and those complying at low level. Accordingly, 24.6 percent complied at low level with Ministry's warning system regarding brown rot (*Monilinia laxa*) and Cherry fruit fly (*Rhagoletiscerasi L.), (Dip.:Tephritidae*) 75.4 percent complied at high level.

Considering the farms' implementation level of IPM against pests, diseases and weeds; 59.3 percent implemented at low level and 40.7 percent implemented at high level.

Unconscious and excessive use of agricultural pesticides causes toxic materials to accumulate in the soil and environment to be contaminated. Farmers, who did not know the chemical pesticide, used pesticides without considering the economic harm threshold sometimes early and sometimes late with the proposal of those who were not experts in the field and used pesticides sometimes even when there was no need [16].

Pesticides used in cherry cultivation were classified as fungicides, insecticides and acaricide. The pesticides are generally used against fungal diseases in December-April months and used against pests in April-August months. It was found out that the proposals of Ministry of Food, Agriculture and Livestock Provincial/District Directorates' technical staff got 4.3 points, proposals of TARGEL consultants got 4.1 points and spraying periodically without considering whether trees had diseases or pests got 3.9 points.

Demircan and Aktaş [9] studied decision-making process of farmers regarding pesticide use against diseases and pests in cherry cultivation. In their study, they found out that, 14.13 percent of the farmers considered actual seeing of diseases and pests in their orchards, 4.35 percent considered seeing of diseases and pests in neighbour orchards, 41.31 percent considered proposals of Agriculture Provincial/District Directorates' technical staff and 34.78 percent considered seeing of diseases and pests in their orchards and proposals of Agriculture Provincial/District Directorates' technical staff. The findings of the study are similar to the present study.

Based on the Technical Guideline of Ministry published in 2011[2], farmers' approaches and proposals regarding the cultural, bio-technical, mechanical and biological management in cherry cultivation were entered to the questionnaire and asked to the studied farms. Considering farmers' cultural, biological, bio-technical implementation behaviours in pest and disease management; mechanical management got 3.1 points, cultural management took 3.0 points, bio-technical management took 1.5 points and biological management took 1.2 points.

Laborta and Swinton [21] found out that Nicaraguan bean farmers' IPM trainings resulted in increase of beneficial insect populations. Considering the sources of information regarding how to choose the insecticides, fungicides and herbicides; the farmers' own knowledge and experience got 4.4 points, technical staff of Ministry of Food, Agriculture and Livestock Provincial/District

Directorates got 4.2 points. Therefore, farmers' own experiences and Ministry's technical staff are important criteria on pesticide choice. Unlike the study of Gül et al. [13] on apple producers, the customers are also important in cherry cultivation.

The farms were studied in 3 groups according to their implementation level of the IPM by considering information obtained from farmers through questionnaire and technical staff's evaluation based on farmers' practices (Figure 1).

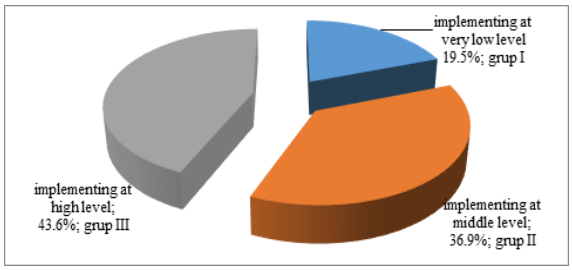

Fig. 1. Farms' compliance with the integrated pest management
Source: Own calculation.

At this point, IPM was targeted (obtaining good quality products not containing chemical residues, protection of beneficial organisms, and farmers' control of their orchards at regular intervals, bringing to the level of self-decision-making, minimizing the unfavourable effects of pesticides on environment). Additionally, scoring was made according to four criteria. These are; (i) the level of compliance to the IPM (the point taken according to the Likert scale) (25 points),(ii) farmers' implementation level of alternative methods to chemical fight like biological fight, cultural measures, bio-technological methods, physical and mechanical methods (the point taken according to the Likert scale) (25 points),(iii) farms' technical applications (pruning method, irrigation, fertilization dose, dilution condition, consultant status, participation in educational activities, chemical drug dosing knowledge, fertilizer application in accordance with soil analysis results, use of suitable plant nutrients) (25 points), (iv) proper use of drug in accordance with the integrated pest management, the recognition level of pest and disease (the point taken according to the Likert scale) (25 points), The farms were divided into three categories according to the implementation level of integrated pest management; implementing at low level (1st group; 1-39 points), implementing at middle level (2nd group; 40-69 points) and implementing at high level (3rd group; 70-100 points). The farms' compliance level with the IPM is given at Figure 1. According to the table, 43.6 percent of the farms implemented at high level, 36.92 percent implemented at middle level and 19.5 percent implemented at low level.

Considering the analysis of socio-economic variables; there is no statistical relationship between the compliance with IPM and farmers' age. As the implementation level of IPM increases, farmers' education level increases. In other words, there is a relationship between implementation level and farmers' education level. Moreover, there is no relationship between the size of household and compliance level with the integrated pest management. There is no relationship between cherry field, number of cherry parcels and implementation level of IPM (Table 1).

According to the cherry cultivation variables, there is no relationship between, cherry production (kg), cherry production (kg/ha), number of cherry trees (piece), number of cherry trees (piece/ha), number of non-cherry-bearing trees and compliance level with IPM (Table 1).

Considering the technical implementation variables; there is no relationship between the quantity of nitrogen (kg/ha), phosphor (kg/ha), potassium (kg/ha) implemented to the cherry orchards and compliance level with integrated pest management, even if they follow a parallel declining trend with IPM (Table 1).

Compliance level with IPM and herbicide (g/ha), fungicide (g/ha), insecticide (g/ha), and acaricide (g/ha) implementation to the unit area changes and can follow an increasing trend. However, there is no relationship between IPM and these variables.

Maupin and Norton [25] indicated in their study that pesticide use increased in USA from 1992 to 2000, but the most poisonous

pesticide use decreased at the same period. USDA presumes that this change was caused by the adaptation of integrated pest management. GAO (General Accounting Office) expresses that there is no sufficient data to prove this claim. In their study, they attempted to estimate the relationship between pesticide use between 1996 and 2005 and adapted IPM method. In the conclusion of the study, they found out that the pesticide use decreased dramatically with the average adaptation of integrated pest management.

There is a similarity and there is no statistical difference between farms' total labour use (hour/ha), total machinery use (hour/ha) and compliance with IPM (Table 1).

According to the findings, there is statistical relationship between farms' compliance level with IPM and soil cultivation, pruning and weeding. Accordingly, as farms' compliance level with IPM increases, the ratio of farms conducting soil cultivation, pruning and weeding every year increases (Table 1).

The obtained data indicates that as compliance with IPM increases, the ratio of working with consultant in orchard care and the ratio (percent) of farms marketing the product to the exporting merchant increase. Furthermore, there is a statistical difference among compliance level with integrated pest management, the ratio of working with consultant in orchard care and the ratio of farms marketing the product to the exporting merchant (Table 1).

According to the data, as the compliance level with the IPM increases, the ratio (percent) of farms conducting soil analysis regularly, the ratio (percent) of those conducting foliar fertilizer, the ratio (percent) of those having special consultant for disease and pests increase.

It was found out that there was a statistical relationship between the indicators of the ratio of farms conducting soil analysis regularly, the ratio of those conducting foliar fertilizer, the ratio of those having special consultant for disease and pests and compliance level with the IPM (Table 1).

As the compliance level with the IPM increases, the ratio (percent) of knowing the good agricultural practice concept, the ratio (percent) of knowing biological control concept, the ratio of (percent) conducting mechanical control against weeds and the ratio (percent) of owning spraying schedule increases. Furthermore, there are statistical differences among the compliance level with the integrated pest management, the ratio of knowing the good agricultural practice concept, the ratio of knowing biological control concept, the ratio of conducting mechanical control against weeds and the ratio of owning spraying schedule increases (Table 1).

Table 1. The evaluation of IPM in farms in terms of socio-economic criteria-1

Variables	Adoption level of IPM			Total
	I	II	III	
SOCIO-DEMOGRAPHIC VARIABLES				
Age (year)	49.3	48.9	50.8	49.7
Education (year)	7.2	7.2	7.5	7.3
Size of household (person)	3.4	3.8	3.4	3.6
CULTIVATING VARIABLES				
Cherry field (ha)	2.79	2.45	3.14	2.79
Number of cherry parcels (piece)	3.2	2.9	3.0	3.0
Cherry Production (kg)	26,119	22,730	29,130	25,887
Cherry Production (kg/ha)	9,362.9	9,260.7	9,268.7	9,285.0
Number of cherry trees (piece)	1,091.3	880.1	1,054.1	990.2
Number of cherry trees (piece/ha)	391,2	358,2	335,2	354,9
Number of non-cherry-bearing trees (piece)	259.0	158.2	212.1	199.5
TECHNICAL IMPLEMENTATION VARIABLES				
Nitrogen (kg/ha)	193.6	195.6	172.9	185.3
Phosphor (kg/ha)	169.7	157.8	138.6	151.9
Potassium (kg/ha)	63.2	57.9	60.7	60.2
Fungicide (g/ha)	5,937.6	7,294.8	6,126.0	6,510.6
Insecticide (g/ha)	1,077.9	819.4	778.4	854.2
Acaricide (g/ha)	441.2	431.0	357.0	400.9
Herbicide (g/ha)	423.7	561.2	223.5	386.4
Total labour use (h/ha)	984.8	1,036.6	969.7	997.0
Total machine power usage (h/ha)	18.6	22.6	19.9	20.6
The ratio of farms cultivating soil every year regularly (%)*	66.7	85.6	96.7	86.0
The ratio of farms pruning every year regularly (%)*	89.6	93.8	97.8	94.5
The ratio of farms weeding every year regularly (%)*	79.2	77.3	92.3	83.5
The ratio of having private consultant for the care of orchard (%)*	0.0	27.8	37.4	25.8
The ratio of drip irrigation (%)	50.0	41.2	35.2	40.7
The ratio of marketing the product directly to the exporter merchant (%)*	52.1	50.5	58.2	53.8
The ratio of conducting soil analysis regularly (%)*	29.2	58.8	70.3	57.2
The ratio of conducting foliar fertilizer regularly (%)*	68.8	74.2	93.4	80.5
The ratio of having private consultant for diseases and pests (%)*	8.3	21.6	24.2	19.9
The ratio of knowing good agricultural practice concept (%)*	25.0	38.1	61.5	44.5
The ratio of knowing biological control concept (%)*	6.3	22.7	52.7	30.9
The ratio of owning good agricultural practice certificate (%)	18.8	20.6	27.5	22.9
The ratio of owning spraying schedule (%)*	16.7	53.6	74.7	54.2
The ratio of conducting mechanical control for weed (%)*	18.8	25.8	45.1	31.8
The ratio of those having knowledge about the time that must elapse between harvesting and spraying (%)*	77.1	90.7	97.8	90.7
The ratio of those taking measures during spraying (%)*	52.1	89.7	97.8	85.2
The ratio of those taking measures during pesticide preparation (%)*	60.4	90.7	95.6	86.4
The ratio of having agricultural insurance for orchards (%)*	4.2	12.4	22.0	14.4
The ratio of those participating to the IPM training program (%)*	4.2	5.2	40.7	18.6
The compliance level with monilinia and Rhagoletiscerasi L. spraying schedule of Ministry of Food, Agriculture and Livestock Provincial/District Directorate in cherry cultivation (5-point Likert) *	2.3	3.6	4.2	3.6

Source: Own calculation.

As the compliance level with the IPM increases, the ratio of those conducting mechanical control (percent), the ratio of those having knowledge about the time that must elapse between harvesting and spraying

(percent), the ratio of those taking measures during spraying (percent) and ratio of those taking measures during pesticide preparation (percent) follow an increasing trend. There are statistical differences among the compliance level with the integrated pest management, the ratio of those conducting mechanical control, the ratio of those having knowledge about the time that must elapse between harvesting and spraying, the ratio of those taking measures during spraying and ratio of those taking measures during pesticide preparation. Mauceri et al. [22] pointed out that the potato farmers in Equator who took training about IPM techniques and therefore implemented IPM more took more measures before and during pesticide use.

The ownership of good agricultural practice certificate increased together with the compliance with the integrated pest management. However, there is no statistical relationship between the ownership of good agricultural practice certificate and compliance level with the IPM (Table 2).

As the compliance level with the IPM increases, the ratio of farms having agricultural insurance for cherry orchards increases. It was found out that there was a statistical relationship between the ratio of farms having agricultural insurance for cherry orchards and compliance level with the IPM (Table 2).

Furthermore, it was found out that as the compliance level with IPM increased, the ratio of participating into the IPM trainings increased. It was found out that there was a statistical relationship between the ratio of farms participating into IPM trainings and compliance level with the IPM (Table 2). Bayraktar [4] expresses that greenhouse tomato producers who participated into IPM program had favourable effects on product selling price, quantity of the product, number of spraying and care expenses.

As the compliance level with the IPM increases, compliance with brown rot *(Monilinia laxa*) and cherry fruit fly *(Rhagoletis cerasi L.*), (Dip.:*Tephritidae*). Spraying schedule of Ministry of Food, Agriculture and Livestock Provincial/District Directorate increases. There are statistical differences between the compliance level with the IPM and compliance with brown rot (*Monilinia laxa*) and cherry fruit fly (*Rhagoletis cerasi L.), (Dip.:Tephritidae*) spraying schedule of Ministry of Food, Agriculture and Livestock Provincial/District Directorate. In cherry cultivation, the compliance with brown rot (*Monilinia laxa*) and cherry fruit fly (*Rhagoletis cerasi L.), (Dip.:Tephritidae*) spraying schedule of Ministry of Food, Agriculture and Livestock Provincial/District Directorate changes between 2.3-4.2 points (Table 2).

In the studied farms involved in cherry cultivation, in the efficiency of information sources (5-point Likert); as compliance level with IPM increases "Merchant, Commission agent", "Ministry of Food, Agriculture and Livestock Provincial/District Directorate staff", "Pesticide dealer", "Consultant (Paid)" and "Descriptions on the package" points increase. Furthermore, it was found out that there was a statistical relationship between these variables and compliance level with the IPM (Table 3).According to the data obtained in the research area, farmers' satisfaction from the cherry cultivation increases with the compliance with IPM groups. However, there is no significant difference between farms' compliance level with IPM and satisfaction level from the cherry cultivation (Table 2).

There is statistical difference between factors effective on spraying time (5-point Likert); "proposals of Ministry of Food, Agriculture and Livestock Provincial/District Directorate staff", "Consultant (paid)" and compliance level with IPM groups (Table 2). The economic variables of cherry cultivation activity of the farms; fixed cost of the unit area, variable cost, production cost, unit cost and spraying cost decreases in parallel with the compliance level with integrated pest management. Similarly, GPV for unit area, gross profit, absolute profit, relative profit values and selling price values follow increasing trend. However, it was found out that there was not a significant statistical difference among these economic variables and compliance with IPM groups (Table 2).

Table 2. The evaluation of IPM in farms in terms of socio-economic criteria-2

Variables	Compliance level with IPM I	II	III	Total
Factors influencing the decision about when to spray in cherry cultivation (5-point Likert)				
Compliance with the proposals of Food, Agriculture and Livestock provincial/district offices technical staff (avg)*	3.5	4.3	4.7	4.3
Compliance with the proposals of pesticide dealers (avg)	3.1	3.7	4.2	3.8
Compliance with proposals of consultant (paid) (avg)*	2.5	2.8	3.1	2.9
Compliance with the proposals of consultant (Agricultural Engineers) (avg)	3.4	4.1	4.4	4.1
Spraying in accordance with the proposals of Ministry (avg)	3.4	3.8	4.4	3.9
Spraying in accordance with their own spraying schedule (avg)	3.4	3.2	3.7	3.4
Spraying in accordance with spraying schedule prepared by family-relatives (avg)	2.4	2.4	2.5	2.4
Significance level of information sources related to agricultural management (5-point Likert)				
Merchant, Commission agent (avg)*	2.6	3.6	3.7	3.4
Food, Agriculture and Livestock provincial/district offices staff (avg)*	3.1	4.5	4.6	4.2
Pesticide dealer (avg)*	3.0	4.4	3.9	3.9
Consultant (paid) (avg)*	2.3	3.1	3.0	2.9
Producers' organization (Coop or Union) (avg)	2.9	4.0	4.0	3.8
Descriptions on the package (avg)*	3.0	4.4	3.9	3.9
Satisfaction level in cherry cultivation (5-point Likert)	3.1	3.2	3.7	3.4
ECONOMIC VARIABLES OF CHERRY CULTIVATION				
Gross profit (TL/ha)	24,825	25,028	26,348	25,475
Absolute profit (TL/ha)	20,902	20,694	22,459	21,399
Pesticide cost (TL/ha)	1,906	1,935	1,751	1,860
Variable costs (TL/ha)	9,571	9,353	9,245	9,361
Share of pesticide spraying cost in variable cost (%)	19.9	20.7	18.9	19.9
Share of pesticide spraying cost in production cost (%)	14.1	14.1	13.3	13.8
Relative profit	2.6	2.6	2.8	2.7
Selling price (TL/kg)	3.8	3.9	3.9	3.9
Unit cost (kg/TL)	1.6	1.6	1.5	1.6

Source: Own calculation.

Williams [37] found out that the tart cherry producers in USA, who adapted IPM at middle level, saved $449.08 per acre (4.047 m2) in comparison with the conventional production. 7,790 acres were managed with IPM at middle level in Northern Lower Michigan in 1999. It was found out that $350,000 was saved in comparison with the conventional production. Williams [37] calculated that $708,000 was saved by farmers implementing IPM at middle level in tart cherry cultivation in all Michigan. According to the writer, the farmers who implemented IPM at low level saved most after those implementing at middle level.

Colette et al. [8] pointed out that IPM was implemented especially in sweet corn, cotton, sorghum and wheat cultivation in USA's Texas plains and this management/implementation saved expense and employee cost besides decreasing the quantity and number of implemented chemicals. According to the writers, IPM implementations decrease annual production costs more than 173 million dollars and decrease environmental costs more than 19 million dollars. 272 million dollars was saved annually from economic and environmental costs by the adaptation of IPM for basic products in Texas plains.

Hamilton [14] compared the profitability of traditional and IPM method in lettuce cultivation in test parcels in USA. He found out that production with IPM provided more profit between $0.02 and $0.08 per case and he claimed that the system could work without any productivity and quality loss.

Demircan et al. [10] stated in their studies in Isparta that relative profit was 2.54 in cherry cultivation. The findings of the study are similar to the present study. This ratio is 2.7 for the studied farms. In other words, farmers obtained 2.7 TL GPV in return for 1 TL production cost and therefore obtained 1.7 TL profit. As the farms' compliance with IPM increased, the relative profit increased.

Birari et al. [7] disclosed in their study of integrated pest management's influence on cotton production in West Maharashtra that education level of cotton farmers, size and income of farms had a substantial influence on the adaptation of integrated pest management. Furthermore, they pointed out that cotton farmers adapting IPM increased productivity by 11.0 percent and absolute (net) income by 39.0 percent. Additionally, they stated that IPM was cost-cutting and had the economic potential to replace commonly implemented chemical pest control.

Napit et al. [27] found out that the farms implementing IPM techniques obtained higher incomes in various agricultural products in 8 different states of USA.

Fernandez-Cornejo [11] explained the tomato producers' compliance level with IPM with two probit models including pest and disease management in 8 states of USA. According to his probit model, such variables as product price, having consultant, family labour use (all were statistically significant) were the factors that increased farmers' likelihood of compliance with IPM. However, risk-averse farms factor (was statistically significant) decreased the likelihood of compliance with IPM. The education level was not statistically meaningful and had a negative symbol. Besides this model, Seemingly Unrelated Regression Model (demand models of insecticide and fungicide) was developed. According to the results of this model, there was a negative statistically significant relationship between insecticide use and compliance with IPM. Similar results were

found regarding the relationship between fungicide use and compliance level with IPM. In other words, there was a statistically important and avoidant relationship. It was calculated that 10 percent increase at compliance with IPM decreased number of insecticide implementation by 4 percent and number of fungicide implementation by 1 percent. It was found out that a similar compliance with IPM would decrease number of fungicide implementation by 25 percent according to Pohronezny et al. [31] and by 15-45 percent according to Toscano et al. [36]. However, Fernandez-Cornejo [11] and Toscano et al. [36] found out that even if there was a positive relationship between compliance with IPM and productivity, this relationship was not statistically important.

Fernandez-Cornejo [11] found a positive relationship between compliance level with IPM and profitability in the Seemingly Unrelated Profitability Regression model. According to Fernandez-Cornejo [11], 10 percent increase at compliance with IPM in insecticide implementation increases profitability by 0.1 percent in tomato cultivation and 10 percent increase at compliance with IPM in fungicide implementation increases profitability by 2.7 percent.

Resosundarmo [32] informs that overdose implementation of chemical pesticide caused serious environmental problems in Indonesia in 1980s. In order to handle the problems, Indonesian government has actively employed strategies to ensure the adaptation of IPM since 1989. The IPM system decreased farmers' pesticide use by 56 percent and increased productivity by 10 percent in the years started to be implemented [29]. Resosundarmo [32] expresses that poisoning from chemical substances decreased with the increasing adaptation of IPM. He informs that the increase in the adaptation of IPM increased efficiency in agricultural production, but this increase slightly affected the incomes of both producers and consumers. Similarly, he states that the increase in IPM implementation favourably affects national GDP. Accordingly, the increase at compliance with IPM increases the agricultural and general GDP. He found out that the decrease in IPM investment or IPM's getting more expensive causes a decrease in country's growth rate. He proposes that the levies on chemicals, which would finance IPM, would decrease the number of chemical pesticide use and contribute to the economic growth rate.

Baicu et al. [3] expresses that IPM provided apple varieties to be more resistant to apple scab (Venturia inaequalis) and powdery mildew diseases and decreased the number of pesticide used trees from 15.8 to 8 in Romania. It was found out that this situation decreased spraying cost by 44.3 percent.

Williams [37] pointed out in his study comparing 4 IPM implementation level; ((i) conventional, (ii) basic implementation level of IPM (iii) middle implementation level, (iv) high implementation level) on tart cherry cultivation in Lower Michigan that middle level adaptation of IPM served best to the highest profitability, human health and environment.

According to Orr et al. [30] determined in their economic evaluation project of IPM for spineless pests in lettuce cultivation that the adaptation of IPM economically contributed to lettuce industry and lettuce farmers. The cost-benefit ratio of lettuce studies was calculated as 2.

Song and Swinton [34] predicted economic benefit of implementing IPM for soya bean aphid and calculated that IPM provided 1.3 billion dollars net profit since 2003 and project's internal rate of return was 140 percent.

Even if profitability indicators increased in parallel with the compliance with integrated pest management, this increase did not have statistical difference.

Kutlar and Ceylan [20] provided socio-economic characteristics of the farmers who participated and did not participate in Implementation and Training Project and their opinions regarding IPM in their IPM Study in Antalya. The writers pointed out that IPM was not commonly known by the farmers. Furthermore, the producers, who participated and did not participate in the project, expressed that there was not a significant difference from the methods they employed.

Singh et al. [33] studied basic socio-economic and institutional factors influencing the adaptation of IPM in cotton cultivation in Punjabi and rice plant cultivation in Haryana. IPM increased when the size of farms increased in cotton cultivation and decreased in rice plant cultivation.

The gross value of production did not increase with the implementation of integrated pest management.

Hurd [18] expressed that the uncertainty in cotton production prevents the adaptation of such methods an IPM containing less pesticide use. According to his findings, the variability in cotton productivity and pesticide use were not statistically affected from the implementation of other input methods and integrated pest management.

However, there was a statistical difference between farmers' frequency of meeting with consultant and productivity variable.

Fernandez-Cornejo et al. [12] analysed factors influencing the adaptation of IPM in vegetable cultivation from the data obtained from producers in Florida, Michigan and Texas.

According to their logit model, such variables as size of farms (for farms in Florida and Texas), family labour use, varieties of cultivated vegetables (was statistically significant) were the factors that increased farmers' likelihood of compliance with IPM. However, farms' being in the business of livestock (was statistically significant) decreased the likelihood of compliance with IPM.

When cherry farmers were asked open-ended questions regarding the steps to be taken in order to develop/popularize the integrated pest management; 37.3% of the farmers uttered the "organizing trainings for farmers" proposal. 17.8% gave the answer that "Ministry of Food, Agriculture and Livestock District Directorates should organize seminar courses" (Table 3).

12.7% of the farms expressed that "agricultural engineers should be in the field more." Furthermore, 8.9% supported the proposal that "supervisions should be popularized" (Table 3).

Table 3. Farmers' opinions regarding how to develop/popularize IPM in cherry cultivation

Proposals	Total	
	N	%
Farmer training courses should be arranged.	88	37.3
Ministry should organize courses, seminars	42	17.8
Agricultural engineers should be in the field more	30	12.7
Supervisions should be popularized	21	8.9
Management methods should be taught	16	6.8
Use of technology should be increased	15	6.4
The number of agricultural engineers should be increased	15	6.4
Compliance with the spraying schedule of Ministry should be ensured in the region	13	5.5
Land consolidation should be done	8	3.4
Consultant should be used	8	3.4
Organizing trips to sample farms	6	2.5
No idea	54	22.9

Source: Own calculation.

Maumbe and Swinton [23] pointed out in their study regarding the influence of farmer training and health risks on the adaptation of IPM in Zimbabwe that adaptation of this management was directly connected to awareness of the farmers. However, health risks of chemical spraying were not related. Maumbe and Swinton [23]; Maumbe and Swinton [24] emphasized the fact that Zimbabwe government could increase the awareness of IPM through farmer field schools and expanding their approach to producers and therefore could contribute to the adaptation of IPM by more farmers. Singh et al. [33] studied basic socio-economic and institutional factors influencing the adaptation of IPM in cotton cultivation in Punjabi and in rice plant cultivation in Haryana. They found out that product-specific IPM trainings were highly effective in terms of increasing technological awareness.

CONCLUSIONS

In the present study, İzmir, Manisa, Konya, Isparta, Afyonkarahisar and Denizli sample was studied in order to develop proposals regarding cherry producers' pest management, compliance level with IPM and betterment of compliance.

According to the results of the study, the awareness regarding IPM concept is at low level. However, the awareness of GAP is at

high level. Cherry's being a significant export product is effective on this awareness. Accordingly, it was found out that cherry producers behaved more consciously in disease-pest management.

The findings of studies conducted at national and international arena besides the present study indicate that compliance with IPM can be ensured through effective communication. The majority of the farms request more information and awareness in this subject.

The most important thing in the disease-pest management is determining the best time for spraying. If the spraying time is predicted earlier, the likelihood of becoming successful increases as the preparations is done on time. Predicting spore flying, pest concentration, having information regarding the biology of pest and phonological periods of the plant contribute to fight against disease and pests remarkably and natural balance and environmental health will be protected at a high rate with the timely and correct implementations.

Cultivation method employed in the orchards play an important role in the effective implementation of integrated pest management. Use of the relatively squat clonal rootstock, which enables the formation of homogeneous trees, should be increased and replaced with the widely used of "wild cherry" seedlings which do not form uniform trees. Furthermore, keeping size of corolla under control by pruning-giving shape can help a more effective fight against diseases and pests and decrease costs. Giving shape (cultivation system) and "orchard management" implementations should be conducted for both “0900 Ziraat” variety widely used in Turkey and other new varieties or pollinator varieties.

Within this scope, farmers should implement agricultural measures, avoid excessive nitrogenous fertilization, adapt natural enemies method against pests and take part in trainings regarding environment-friendly chemical pesticides in order for more efficient implementation of IPM in cherry cultivation in the region.

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