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Original Research

Pesticide Use in Turkish Greenhouses: Health and Environmental Consciousness

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Abstract

This paper analyzes perceptions and practice of randomly selected Turkish farmers regarding pest management on the basis of interviews and observation. The main aim of the paper is to reveal the knowledge levels and practice of farmers on various issues related to pest applications in vegetable cultivation in greenhouses. The analysis showed that there is a strong relationship between environmental consciousness and socio-economic variables and type of greenhouse, plastic or glass. Farmers know that excessive and inappropriate application of pesticides can damage crops and might be harmful to human health. However, they are not sufficiently informed about the reciprocal relationship between the environment and agricultural pesticide use.

Keywords: vegetable cultivation in greenhouses, pesticide, environmental protection

Introduction

Excessive use of pesticides has multiple adverse effects with respect to the environment as well as health of people who are exposed to pesticides directly or indirectly. Negative consequences of pesticides have attracted the attention of various disciplines such as medicine, environmental studies, development studies, etc. Even though there is a growing literature on the issue, one of the main problems in Turkey is the lack of analysis based on empirical data on farmers' attitudes. One source of research difficulties in data collection is that there are a number of actors in the process of pest management: the farmers, pest consultants, and pest marketing company representatives, government agencies and related agricultural industries. This paper focuses on analysis of farmers' perceptions as the most important actor in pest management.

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Usually, what farmers around the globe and in Turkey understand from pest management in agriculture is chemical methods of pest control. Uninformed and excessive use of pesticides is risky for the environment and human health and it diminishes agricultural sustainability by negatively affecting agricultural production [1, 2]. Various analyses in different sectors indicate that environmentally friendly methods increasingly become popular alternatives to practices such as intensive cultivation, high levels of ingredient use, inefficient resource exploitation, and, most particularly, the negative effects of agricultural chemicals on the environment [3-6]. However, there is a difference between developed and developing countries regarding current trends in pesticide usage. As argued by Carvalho, in economically advanced countries, old techniques have been replaced by new systems that are based on minimum use of chemical ingredients, and new pesticides that are less persistent in the environment. On the other hand, farmers in developing countries still use classic pesticides that are cheaper but carry more risks for the environment and health [7]. In developing countries, from the viewpoint of farmers,

pesticides continue to be regarded both as a guarantee against crop loss and maximum efficiency to be gained from cultivation [8]. There are empirical findings indicating that the conventional pesticide practices can be unnecessary and that integrated pest management practices can be adopted without sacrificing yield. Yet, as researchers underlined, for the success of such change the farmers appear as the most significant actor in this process [9].

In Turkey, covered cultivation is done at economics of scale particularly in the Mediterranean and Aegean Regions. In other words, these two regions are the most important geographical areas of the country in terms of greenhouse agricultural production. Vegetable production is dominant in places where covered cultivation is carried out, accounting for 95.0% of total greenhouse production [10]. One of the most important problems of covered cultivation is plant diseases and pests. Pest management, mostly in conventional chemical methods, is seen vastly in the greenhouse fields because the resistance of plants against diseases and pests is quite low in this type of production. Even though the amount of pesticide used in agriculture per decare[1] is low overall in Turkey in comparison to advanced industrial countries, two thirds of the total amount of pesticide is used in the Aegean and Mediterranean Regions [11]. This fact raises questions about whether there is excessive pesticide use and whether pest management is done consciously in the regions where greenhouse cultivation is widespread.

The total area of greenhouses in Turkey is 479,956 decares, and 33.9% (162,694 decares) of the total area of Turkey's greenhouses is located in Antalya [12]. Among Antalya's administrative districts, Kumluca has an important share of greenhouse vegetable cultivation and has the largest cultivation area (34,075 decare). The average size of enterprises ranges between 3-5 decares, and vegetable cultivation is done in plastic or glass greenhouses and in high tunnels. Annual average pesticide consumption in Turkey is 33,000 tons and the amount of active ingredients per hectare ranges from 400-700 grams [13, 14]. In Turkey, the proportions of agricultural chemical consumption are: 50.57% insecticides, 18.67% herbicides, 17.20% fungicide, 2.87% acaricides, 7.41% oil, and 3.28% other pesticides [15-17]. By 2000 the number of pesticides and similar chemicals used throughout Turkey is 386. There are twenty officially licensed mixed pesticides and 70.0% of the total amount is on the market [16].

As for the record of pesticide use in Turkey, there has been rapid growth since 1993. Although the overall intensity of pesticide use is low by comparison with other Mediterranean countries, there are concerns over adverse impacts on human health and the environment in some regions [18]. In this period, problems regarding the chemical importation and other problems stemming from raw material dependency on imports affect directly the quality and price of chemicals and indirectly their usage throughout the country.

[1] A decare is 1,000 square meters; 10 decares is 1 hectare.

In general, farmers in Turkey are not well informed about chemical selection and application techniques. What is more, there is a lack of information on the exact amounts of pesticides used by the enterprises in terms of region and product type. In some cases and in some places there is even lack of will to apply the necessary dosage [19]. Lastly, the harm produced by excessive and incorrect chemical use on the environment, human and animal health is not recorded sufficiently by authorized institutions such as ministries of environment and agriculture. In covered vegetable production, since plants constantly bear fruit and have a long harvest period, some farmers do not obey the rule of leaving an interval between the last pesticide application and harvest. That is to say, pesticides are applied while the harvest continues [20]. On the other hand, problems related to residues left by chemicals may cause difficulties in agricultural product exportation.

Materials and Methods

The data of this research is based on in-depth interviews with a number of agricultural enterprises that are producing vegetables for marketing in greenhouses in the Kumluca district of Antalya. The greenhouse producers were interviewed personally with a questionnaire aimed at determining information about the use of agricultural pesticides. The questionnaire is composed of three sections. The first section includes questions about the demographic characteristics of producers such as age and educational level. The second section includes questions regarding the enterprise and cultivation. Such questions provided information on greenhouse characteristics such as size of the enterprise, crops, types of pest control for product groups, cultivation techniques in the greenhouse, pre-harvesting intervals and so on. The third section consists of questions on producers' information sources and the criteria used in their decisions on pest management, their disposal of containers, and their awareness of and concern for environmental problems associated with pest management. Questions regarding measures during pesticide application and consequences of pesticides for human health are aimed at revealing the relationship between knowledge and attitudes of producers in pest management.

At this stage, for the purpose of the research, Beykonak town and the villages of Salur and Saricasu were selected, which are using greenhouses for producing vegetables for market and which can represent the district in terms of cultivation techniques, production amounts, field sizes, and geographic and ecological structures. In the selection, statistical data and the suggestions of technicians who have worked in the region for a long time are also taken into account. In these selected areas, covered production includes tomato, pepper, eggplant and cucumber.

With the aim of identifying the number of enterprises to be interviewed, official registration documents of the Kumluca Agricultural Chamber are examined and a total farmer population of 1,070 is set up. Considering the fact that enterprises that constitute the population are small-sized

and this size of enterprise has a homogenous structure, in the identification of sample volume, the simple random sampling method is used and the sample is determined by 10.0% sampling ratio. As for the evaluation of data, contingency tables were made in order to examine the association (test of association) between the variables and Fisher's Exact Test is used to analyze the relationship between the variables [21].

Results and Discussion

Sample Characteristics

Table 1 demonstrates the characteristics of farmers. The farmers are controlled in relation to their age, education level, size of household, ownership and size of greenhouse, and the type of vegetables. Most of the interviewed farmers are in the age group of 26-41 (57.1%), and 13.0% of the farmers are 50 and over.

Education is an important factor influencing the behavior and attitude of farmers and is a significant tool in increasing the awareness of individuals. It plays an important role in various issues such as introducing novelties in agriculture and pesticide application, selecting information sources on pesticides, the criteria for deciding pesticide application, and contacting agricultural assistance institutions. Research has consistently concluded that as the level of education increases, use of chemicals and fertilizers decreases [6, 9, 22]. In our case, approximately 82.2% of farmers are primary school (five-year) graduates. In general, farmers have a tendency not to continue their education after their primary education. 9.4% of farmers are high school graduates, while the percentage of university graduates is only 1.9%.

The number of people living in a household is important in terms of socio-economic indicators. A change in the number of individuals has an effect on many socio-economic features such as division of income, living standards, educational opportunities and cultural structure. In examining the number of individuals in households, it is observed that the largest group is 4-6 individuals (61.7%). Since fewer individuals in the household mean better living standards, this also has implications for the agricultural production process. The average number of household members of farmers interviewed is 4.150±0.142. The smallest number is 1 while the most crowded household is composed of 11 individuals.

Examination of greenhouse possession of farmers in the research area shows that small family enterprises are common. While 46.7% of farmers' greenhouses have a width of between 0.5-3.5 decares, 36.5% have 4 and 7 decare-wide greenhouses. Enterprises with greenhouse width between 0.5 and 7 decares is 83.2% of total enterprises under research. Average width of greenhouses of farmers is 4.8 decares. Of the 107 interviewed farmers, 72 enterprises (67.3%) have only plastic greenhouses, 3 enterprises (2.8%) have only glass greenhouses, while 31 enterprises (29.0%) possess both plastic and glass greenhouses, and only 1 enterprise (0.9%) has a high tunnel.

Table 1. Sample profile and characteristics of farmers.

Age	Number of respondents	Percentage
18-25	14	13.1
26-33	32	29.9
34-41	29	27.2
42-49	18	16.8
≥50	14	13.0
Education		
Literate	1	0.9
Primary school	88	82.2
Secondary school	16	15.0
Undergraduate	2	1.9
Size of household		
1-3 persons	37	34.6
4-6 persons	66	61.7
7-11 persons	4	3.7
Size of greenhouse		
0.5-3.5	50	46.7
4-7	39	36.5
≥7.5	18	16.8
Product type*		
Tomato	56	52.3
Pepper	73	68.2
Eggplant	36	33.6
Cucumber	20	18.7

* Some farmers produce more than one type.

The most common crops are, in amount of production order: peppers (68.2%), tomatoes (52.3%), eggplants and cucumbers. Price in the previous year might be influential in determining the proportion of crops in the cultivation pattern. Moreover, farmers might prefer to cultivate tomatoes and peppers rather than eggplants and cucumbers, which are commonly used in Turkish cuisine. One of the reasons for this choice might be that, since eggplant and cucumber have more diseases and bugs, the pest control cost for these plants is high. In other words, farmers use more pesticides in growing cucumbers and eggplants in comparison to tomato and pepper cultivation. Sometimes, farmers have a tendency toward having a variety of crops in order to protect themselves from price fluctuations throughout the year.

As can be seen in Table 2, 40.2% of farmers apply pesticide an average of 23-32 times. Most of these applications are in preventive forms (fungicide). In the research area, the most pesticide-applied crop is cucumber and it is followed

Table 2. Number of pesticide application.

Number of application	Number of respondents	Percentage
3-12	13	12.1
13-22	29	27.1
23-32	43	40.2
33-42	10	9.4
43-52	10	9.4
53-62	2	1.8
Total	107	100.0

Table 3. Pesticide dosage.

	Number of respondents	Percentage
Follow the suggested dosage	84	78.5
Apply more than suggested dosage in general	12	11.3
Sometimes apply more than suggested dosage	8	7.5
- When the suggested dosage in insufficient	*19*	*95.0*
- Vendors suggest less than the necessary amount	*1*	*5.0*
Other	3	2.7
Total	107	100.0

by eggplant and tomato. In the research area, on the basis of formulation per decare is approximately 8.2 liters + 14.85 kg for tomato, 10 liters + 9.5 kg for pepper, 9 liters + 9.9 kg for eggplant, 6.4 liters + 10.7 kg for cucumber, and 3 liters + 4.3 kg for melon insecticide, fungicide and acaricide are used. Farmers may use a little bit more pesticide in plastic greenhouses in comparison to glass ones. 63% of farmers who use more than 22 pesticides cultivate in plastic greenhouses. The reason for this might be the absence of proper air conditioning in plastic greenhouses.

Knowledge Level of Farmers on Pest Management

In order to understand whether they apply pesticides in an informed manner, farmers were asked if all insects they see in their greenhouses are harmful. 70.1% of farmers stated that all insects are harmful and they should be killed promptly. On the other hand only 29.9% reported that not all insects are harmful. Interviewees who stated that not all the insects seen in greenhouses are harmful, were asked whether they can distinguish beneficial insects. 59.4% answered positively, while 40.6% stated that they couldn't distinguish beneficial ones. Having no tolerance for any insect in a greenhouse is one of the reasons for high pesticide use and this fact shows that pest management in this area is not done in an informed manner. Farmers who know little about beneficial insects and consider all insects harmful, thus favoring their eradication, indicate the sensitivity of farmers and the undesirability of any risk on this issue. For this reason, farmers were asked whether it is necessary to apply pesticides even if they do not see bugs. The answers show that 49.5% of farmers favor pesticide application without having seen the insects (profile active behavior), while 50.5% argued that this is not necessary (adaptive behavior). Research in Antalya showed that 63.0% of greenhouse vegetable farmers reported that they apply pesticides after seeing bugs, while 37.0% apply pesticides without seeing bugs [23].

In the research area, nematodes constitute a big problem. For this reason, farmers heavily use soil fumigants, especially methyl bromide, against nematodes. Internationally, many countries have prohibited the use of methyl bromide. In Turkey, the search for other pesticides that can replace methyl bromide continues. The solarization application technique is a significant pest control instrument against insects under the soil. However, in the research area none of the farmers reported that they use the solarization technique.

Knowledge on Pesticide Application Dosage and Effectiveness

Damage stemming from the cultivation techniques used in agricultural production should be at minimum. This is a precondition of not only sustainable agriculture but also sustainable development. Pesticides are used extensively in greenhouse cultivation, which is a production branch having great risk of being affected by diseases and pests. Table 3 summarizes the responses of farmers to questions related to dosage of pesticides.

As is seen in Table 3, 78.5% of farmers apply all of the dosage instructions. The reason for this is that farmers think excessive pesticides are harmful for the crops. In addition, a rapid increase of pesticide prices in recent years has kept farmers from excessive applications. Despite this fact, 7.5% of farmers stated that sometimes they use more than the suggested dosage, while 11.3% stated they generally use more than the suggested dosage. Farmers who use more than the suggested dosage reported that the suggested dosage is not effective (95.0%), that they don't trust vendors and vendors suggest insufficient amounts (5.0%). The fact that most of the farmers who use more than the recommended dosage mention the ineffectiveness of suggested dosage suggests that pests in this region might have developed resistances to pesticide.

Table 4 shows farmers' responses to the question whether the pesticides they use leave residues harmful to human health on crops. 38.3% of farmers stated that some of the pesticides might leave residues, 20.6% said all pesticides leave

Table 4. Harmful residues of pesticides.

	Number of respondents	Percentage
Some pesticides may have harmful residues	41	38.3
All pesticides have harmful residues	22	20.6
Pesticides do not have harmful residues	22	20.6
Don't know	13	12.2
In cases of over-dosage pesticides have harmful residues	5	4.7
Harmful residues can be washed off	2	1.8
Application at the wrong time leads to residues	1	0.9
If instructions are followed, there will be no residues	1	0.9
Total	107	100.0

residues, 6.5% stated that only not using pesticide at the suggested dosage and time will result in residues. It is clear that more than half of the farmers are of the opinion that pesticides may leave residues. 20.6% of farmers reported that pesticides do not leave harmful residues, while only 1.8% said harmful residue could be removed by washing. 12.2% had no opinion on the issue.

The opinions of farmers on harmful residues of pesticides are compared with the number of their pesticide applications. Statistical analysis (Fisher Exact Test, $p = 0.96$ $p>0.05$ there is not any association) showed that farmers' opinions regarding harmful residues of pesticides do not have any impact on the number of their pesticide applications. In other words, when farmers apply pesticides, they do not consider whether they leave harmful residues on crops or not.

Knowledge on Excessive and Incorrect Pesticide Application and Environmental Damage

93.5% of farmers state that excessive and incorrect application will harm the crop, while only 6.5% believe that there will not be any harm. When asked about how excessive and incorrect pesticide application will harm the crop, 81.0% reported that it will burn leaves and fruits, 10.0% mentioned reduced productivity, and 8.0% stated that it will kill the plant. 64.5% of farmers stated that excessive and incorrect pesticide application will not harm the environment, while 35.5% have accepted the damage. Among the ones who think pesticides cause environmental damage, 76.3% mentioned environmental pollution and 23.7% stated it would harm the living creatures in the area.

We also analyzed whether or not there is an association between farmers' opinion on excessive and wrong pesticide application and their opinion on harmful pesticide residues. Statistical analysis showed an association between two variables (Fisher Exact Test, $p = 0.0278$ $p<0.05$; there is association $ø = 0.3718$). 81.6% of farmers who think that excessive and wrong pesticide application is harmful to the environment are the ones who think pesticides may leave harmful residues on crops. 77.3% of farmers who think pesticides will not leave any residue are farmers who think excessive and wrong pesticide use is not harmful to the environment. Another point to pay attention to is that 84.6% of those who don't have any opinion on whether pesticides leave harmful residues on crops, reported that excessive and incorrect pesticide use will not harm the environment. A further point that might be related to farmers' environmental consciousness is the association between their opinion about the effects of excessive and wrong pesticide use on the environment and the number of pesticide applications. Statistical analysis proved that these two factors are independent from each other (Fisher Exact Test, $p = 0{,}1793$ $p>0.05$ there is not any association). In view of this conclusion it can be claimed that farmers do not take environmental factors into consideration in deciding the number of pesticide applications.

Regarding crops for family consumption, farmers are asked whether they have a different field other than the area they cultivate for market and whether they apply a certain measure. 86.0% reported that they don't take any extra measures for their family consumption and they meet their food needs from the same crops they cultivate for market. On the other hand, 14.0% stated that they take certain measures for crops they consume. 73.3% of the farmers who take certain measures reported that they don't apply certain highly poisonous pesticides to the crops that the family consumes; 20.0% stated that they avoid using big amounts; while 6.7% said they don't consume crops for a long time from the area where they have applied highly poisonous pesticides. In order to see whether there is an association, we have compared the answers of farmers to the question whether excessive and incorrect application leaves harmful residues on crops with their tendency to take certain measures for crops cultivated for their family consumption. Results indicate a statistically significant association (Fisher's Exact Test, $p = 0.00000523$ $p<0.05$; there is association $ø = 0.4792$). Accordingly, most of the farmers who know that pesticides can leave harmful residues on crops have a tendency to take certain additional safety measures in cultivating crops for their own family's consumption.

Knowledge of Pesticide Environmental and Health Risks

Pesticide exposure is recognized as an important health risk. While virtually all persons can encounter pesticides, farmers are at particularly high risk because of occupational exposure. Farmers may be exposed to pesticides in various ways:

(a) by preparing pesticides for application, such as mixing a concentrate with water or loading the pesticide into application equipment;
(b) applying pesticides;
(c) entering the greenhouse area where pesticides have been applied to perform another task such as picking vegetables.

During pesticide applications, cultivators should take measures in order to protect themselves. As shown in Table 5, when they are asked whether they take any measures during the applications, 57.0% stated that they use personal protective equipment, while 43.0% stated they don't take any measures. The high ratio of cultivators who don't take any measures indicate increased health risks. When they are asked whether they take any measures after application, 61 farmers (98.1%) stated that they take certain measures, while 1.9% do not take any measure. These percentages are contradictory to the findings of other research carried out in the province of Izmir. In this research, 59.3% of 131 greenhouse workers producing flowers reported that they did not take any protective cautions whatsoever [24]. Those who take measures are asked what type of devices they use as a precaution. 42.6% reported that they only wear masks[2], 16.4% use both masks and gloves, 11.5% wear mask and costume, while 9.8% wear only costume. 19.7% take some other measures such as not smoking, wearing glasses, not eating or drinking, wearing bonnet and boots, etc. As is clear from these answers, the measures taken during the application are not sufficient. Regarding the measures after applications, 99.1% take a bath and change clothing, while only 0.9% reported that they eat yoğurt[3] in addition to taking a bath and changing clothes.

Considering the extensive pesticide use in greenhouses, whether or not cultivators have had any serious health problems due to pesticides also was examined. 16.8% reported that in recent years, family members or workers who work in the application process have had some health problems due to pesticide the applications, while 83.2% stated that they have not faced any problems. 66.7% of individuals who had health problems were poisoned, 16.8% had skin diseases, 5.5% had throat infection, 5.5% had asthma, and 5.5% had dizziness. Health problems caused by pesticide applications increase the worries of farmers about pesticides, and motivate them to take measures during application.

Throwing pesticide wastes into water channels kills the fish and other animals who use those channels. Farmers were asked whether animals in this area are ever poisoned or whether they have seen dead animals nearby. 17.8% of farmers stated that they have seen poisoned or dead animals. What is more, farmers state that animals die because of entering the greenhouse after application or due to the empty pesticide containers around them. Subsequently, farmers were asked whether there is apparent recent pollution in their environment. 9.3% say the pollution is obvious, while 90.7% claim there is no clear pollution. 50.0% of those who said there is obvious pollution claim that the pollution is due to throwing the containers nearby, while the other 50.0% talk about sea and drinking water pollution. Our findings support research emphasizing the need to increase the awareness of the farmers about the consequences of unsafe use of pesticides, and the importance of developing risk reduction and communication programs [25].

Table 5. Measures during and after pesticide application.

Specific measures during application	Number	Percentage
Wear mask	26	42.6
Wear mask and gloves	10	16.4
Wear mask and costume	7	11.5
Wear costume	6	9.8
Other	12	19.7
Total	61	100.0
Specific measures during application	Number	Percentage
Take a bath and change clothes	104	99.1
Take a bath and change clothing and eat yoğurt	1	0.9
Total	105	100.0

Utilization of Empty Pesticide Containers

Utilization of empty pesticide containers after application is also examined. 38.3% of farmers throw the empty containers into the garbage, 19.6% burn them, 9.4% either throw them into the garbage or burn them, 8.4% throw them to an empty field, 7.5% bury them underground or burn them, while 5.6% only bury them underground. Apart from these practices, 11.2% of farmers state that they re-utilize empty containers after cleaning them or they keep the empty containers – especially the empty cardboard boxes for use in heating greenhouses in winter. Boxes that cannot be burned are thrown into the garbage. Throwing the empty boxes into the garbage in the street has risks both in terms of environmental pollution and health safety. These empty containers are responsible for poisoning and death of nearby animals. Recent research conducted in Greece demonstrates that farmers have similar attitudes there regarding the disposal of empty containers. Greek farmers also tend to have risky behavior when disposing of pesticide waste after use, creating a potential for environmental contamination [26].

During the interviews, it was observed that farmers face problems in terms of eliminating the empty containers.

[2]Here, in addition to the special application masks other measures include wrapping the mouth with materials such as with fine muslin ('tülbent' in Turkish).
[3]In Turkey, it is believed that 'yoğurt' is effective against poisoning.

Table 6. Disposal of empty pesticide containers.

	Number	Percentage
I throw away in garbage	41	38.3
I burn	21	19.6
I throw to garbage and burn	10	9.4
I throw away in fields	9	8.4
I burry and burn	8	7.5
I burry	6	5.6
Other (I keep them and after cleaning use them again)	12	11.2
Total	107	100.0

When asked whether they would give back the containers if the pesticide company accepts the containers with a certain charge, 97.2% of farmers reported that they would return the empty containers, while only 2.8% think burning them is more advantageous. Table 6 summarizes the responses of farmers on the disposal of pesticide containers.

Interval that Farmers Leave between the Last Pesticide Application and Harvest

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. Farmers leave a time period in accordance with crop type and intervals in general vary between 1-3 and 7-9 days. In the research area, the average interval given is 6.59±0.34 days after taking all the crop groups into consideration (Table 7). Delen and Özbek found that in Turkey, for registered pesticides, the average time period that should be left between the last application and harvest for vegetable diseases is 7.46 days, while for vegetable pests it is 5.02 days [27]. Taking this study as the basis, the period in the research area is sufficient for vegetable pests, whereas it is not long enough for diseases even though it approximates it.

In their study, which was carried out in vegetable greenhouses in 1989, Delen and Özbek claim that farmers do not follow the suggested periods that should be left between the last application and harvest [27]. Rather, applications in greenhouses are carried out in general 3-5 days before and even during the harvest. Similarly, in another research that was carried out on vegetable farmers in Ankara/Sincan, Erkuş et al. observe that 37.6% of enterprises being researched leave a period of 2-3 days between the last application and harvest, 31.2% leave 3-5 days, and the rest leave 6 or more days [28].

Alternative Methods Used by Farmers in Pest Management

It is also examined whether farmers apply pest management methods other than chemicals against diseases and pests. 31.8% state that they apply other methods in addition to chemical application. These methods are applications such as cultural, physical, and biological controls using yellow sticky traps and tulle curtains. There is a growing awareness of alternative pest control, particularly in organic greenhouse production in Turkey. Research conducted in the Aegean Region of Turkey has proved that successful organic pest management can be accomplished as long as there is close monitoring and quick response [29].

Statistical analysis results show that there is a positive correlation between farmers' tendency to apply pest management methods other than chemicals and their education levels (Fisher Exact Test, $p = 0.0284$ $p<0.05$; there is association $ø = 0.3020$). Accordingly, the more educated the farmers are, the more they have a tendency to use alternative pest management methods other than chemicals.

Table 7. Pre-harvest time span by product type.

Period (day)	Product type						Total
	Tomato	Pepper	Eggplant	Cucumber	Melon	Zucchini	
1-3	16	14	13	11	1	1	56
4-6	8	15	8	4	2	0	37
7-9	21	26	10	2	3	0	62
10-12	5	10	3	2	2	0	22
13-15	3	6	1	1	1	0	12
16-+	2	2	1	0	1	1	7
Total	55	73	36	20	10	2	259
Average±	6.50±0.562	6.97±0.50	5.56±0.65	4.70±0.80	15.50±14.50	10.0±2.45	6.59±0.34
SE (Min-Max)	(1.0-20.0)	(1.0-20.0)	(1.0-20.0)	(1.0-15.0)	(1.0-30.0)	(1.0-15.0)	(1.0-30.0)

While none of the farmers, who are only literate (that is to say no schooling), use any other methods, 31.8% of primary school graduates, 33.3% of secondary school graduates, 37.0% of high school graduates and 100.0% of university graduates use pest control methods other than chemical methods. The coefficient of these two variables is 30.2%. When the association between environmental consciousness of farmers and their tendency to apply pest control methods other than chemical methods is examined, it is found out that these two variables are related statistically (Fisher's Exact Test, $p = 0.0027$ $p<0.05$; there is association $ø = 0.2901$). Accordingly, 53.9% of farmers who think that excessive and incorrect pesticide application may harm the environment, apply alternative methods other than chemical pest control methods.

Conclusions

In order to reduce environmental damage caused by incorrect and unnecessary pest control, alternative pest management methods should be given priority. One of the main conclusions of this analysis is that there is an urgent need to raise the environmental awareness of Turkish farmers in order to reduce pesticide risks and ensure economic benefits in the long run by securing export markets. In this context, farmers should primarily be trained and informed by agricultural institutions and farmers associations to assist farmers to act more consciously. These training activities should entail issues such as pesticide application dosage, application timing, what pesticide and/or technique to be used against which pest, protective measures to be taken during application, alternative pest management methods other than using chemicals. In view of the fact that there are highly active and effective private pesticide vendors in the region, training activities will be much more valuable, if the agricultural institutions and farmers associations establish a training system incorporating the private vendors. It is also necessary to secure regular information flow between the research institutions and extension institutions.

It can be comfortably argued that chemical pest management is the most common method in this region. The reason farmers perceive the chemical method as the sole solution for pest management is that they are not informed sufficiently about the effects and use of alternative methods. In order to convince the farmers to apply alternative pest management methods other than chemical ones in covered vegetable cultivation, it is necessary to perform more visual applications like demonstrations.

Farmers face a problem on the issue of what to do with empty containers of pesticides they have used during cultivation. Paper packages are by and large used for heating the greenhouse. However, farmers throw away other types of packages either nearby or in the garbage of the neighborhood since they can't utilize them in other forms. This causes environmental pollution. These packages should be collected from the farmers and should be utilized in other ways. Pesticide companies and municipalities should take the lead in such issues.

In advanced industrial countries, vending of pesticides, that have great risks for human and environmental health, is controlled. First and foremost, it is necessary to strictly control pesticides from production to vending stages, then, after vending, they should be monitored during application. However, since it is not possible to control each of the approximately 4 million farmers, the easiest solution can be "prescribed vending of pesticides." In this way, especially pesticides which affect the system as a whole and that are highly poisonous will be registered and monitored.

One of the most important health problems stemming from pesticide applications is the residue they leave on crops. The problem of not complying with the rules on intervals between the last pesticide application and harvest is the main reason for harmful residues. For this reason, there is a strong need for residue analysis laboratories, especially in the regions where there is production for export. It is necessary to have a labeling system in order to identify the people responsible for residues. Finally, it is essential to apply necessary legal sanctions in cases where analysis results show that residues are over the tolerance limits.

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