Evaluation of knowledge, attitude and behavior in agricultural pesticide use of kiwi farmers

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Abstract

In this study, it was aimed to evaluate the knowledge, attitudes, and behaviors of producers in pesticides use. The study was conducted in 7 provinces of Türkiye (Yalova, Bursa, Ordu, Rize, Mersin, Samsun and Sakarya) where are significant potential in Türkiye's kiwi production and these provinces constitute approximately 90% of Türkiye's total kiwi production in terms of production. According to the findings of study, the average age of the producers was 50.2 and the average of their agricultural activity period was 24.8. The average land size of the producers is 32.4 decares, the average fruit land is 22.9 decares and the average kiwi cultivation area is 14.7 decares. While 60% of the producers stated that they obtained pesticides and fertilizers from agrochemical dealers, 33.7% of them applied spraying when they first observed the disease, 40.1% of the producers stated that they determined the time and pesticide amounts to be used according to their own experiences. It has been determined that approximately 92% of the producers think that the agricultural pesticides used have negative effects on human health. To mitigate the negative effects of agrochemical overuse on both human health and the environment, policy makers and agricultural institutions should prioritize educational campaigns aimed at raising awareness among farmers.

Keywords: *Agrochemical, Kiwi, Knowledge, Attitude and behavior, Agricultural pests*

1. Introduction

Population has been increasing dramatically in the world especially in developing countries and this increase has been accompanied by rise in demand for food (Oluseyi and Omolara, 2021). Increasing world population is the driving force for promoting intensive land use, more irrigation and pest tolerant varieties in order to increase agricultural production together with use of agrochemicals (Omari, 2014). While agricultural development policies in many developing countries emphasize external inputs such as machinery, fertilizers and other agrochemicals as means of increasing food production, this has led to a growth in the use of synthetic agrochemicals instead of biological, cultural, and mechanical methods for boosting production, controlling pests, weeds, and diseases (Ngowi, 2003).

Agrochemicals mean a wide range of pesticides including insecticides, herbicides, and fungicides. Agrochemical term encompasses all kinds of chemicals used for preventing and controlling pests and diseases that are harmful for plants and also chemicals used for preventing yield against

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weeds, pests and diseases or used to extinguish mosquitos and acarine. Although agrochemicals (pesticides and fertilizers) are expensive inputs, they are considered as a tool for improved yield production technology. Balanced use, optimal dose, right method, and right timing of agrochemicals provide yield increase. However, most of agrochemicals are toxic and all agrochemicals that are stored and used in bulk constitutes a serious environmental and/or health risk in case of spilling. Therefore, safety and health in use of agrochemicals has been the primary concern of international institutions and many governments, employers, employees, and related associations for over twenty years (Oluseyi and Omolara, 2021). Wrong use of agrochemicals is the most important dangers faced by farmers, products, and environment. It has been indicated that wrong implementation time and dose, improper use, ignoring the security measures and use of additive-free or expired agrochemicals effects aquatic and terrestrial ecosystems and reduces the quality of underground water consumed by human (Nikolaidis *et al.*, 2007; Tekwa *et al.*, 2010).

While important steps have been taken in industrialized countries for decreasing use of agrochemicals especially the pesticides, their use has been increasing day by day in developing countries (Ngowi, 2003). All stakeholders should have knowledge about results and effects of chemicals in order to decrease use of agrochemicals in agricultural activities and therefore to decrease their effects on environment and human health. Recently, the increasing awareness of environmental consciousness has brought the preservation of human health, the environment, and biological diversity to the forefront of all endeavors. Consequently, in agricultural pest management practices, reducing pesticide consumption, considering agro-ecosystem analysis, and adopting sustainable agricultural production have become imperative. As a result, greater emphasis has been placed on alternative methods to chemical control, particularly biological control, and the integration of all methods, known as Integrated Pest Management (IPM). IPM is a sustainable pest management system that considers diseases, pests, and weeds in crop cultivation while considering economic, human health, environmental, biological diversity, and natural balance factors (Atlamaz, 2009). According to FAO and WHO reports (2014), there are various systems that classify pesticides based on their toxicities to humans and the environment. Therefore, gradually discontinuing the use of highly hazardous pesticides and replacing them with less harmful alternatives is the most obvious way to reduce the negative side effects of pesticides.

Kiwi is the best-known fruit of Actinidia (Actinidiaceae family) variety which has become a popular fruit due to its being healthy together with its nutritional and organoleptic features all over the world. This variety comes from China originally and is cultivated on large areas with tropical climate or mild-cold climate (Czyżewski *et al.*, 2021).

Türkiye which is an important fruit producer in the world ranks seventh in kiwi production in the world (FAO 2022). According to TURKSTAT data, 86.362-tons kiwi was produced on 38.844 decare area in 2021 and approximately 31% of this production was realized in Yalova province.

There have been many studies on attitudes and behaviors and environmental awareness of farmers about use of pesticides in domestic and foreign literature (Omari, 2014; Mabe *et al.*, 2017; Nwakile *et al.*, 2020; Wijethunge and Harshana, 2021; Erol *et al.*, 1998; Demircan and Yılmaz, 2005; Çelik and Karakaya, 2017; Akar and Tiryaki, 2018; Erbek *et al.*, 2018; Dilmen *et al.*, 2019; Erdil andTiryaki, 2020). In addition, Mekonnen and Agonafir (2002) emphasized the urgent requirement for widespread pesticide safety education, highlighting its pervasive nature in the practice of pesticide spraying and for pesticide use, an attitudinal change is needed, together with the provision of better facilities and infrastructure. Jambari *et al.* (2020) discussed on mitigating the potential risks associated with pesticide application and enhance the quality of life for farmers, it is imperative to undertake measures aimed at enhancing pesticide safety education. Akdemir *et al.* (2021) indicated that the possibility of taking over the family farm by descendants plays an important role in the degree of involvement of producers.

According to the findings of Li *et al.* (2022), key factors for promoting farmers' adoption of organic manure include intensifying policy pub-

licity, enhancing policy subsidies, and fostering the widespread adoption of sustainable agriculture practices and environmental awareness. Additionally, Jin *et al.* (2015) highlighted that inadequate awareness of agrochemical risks, coupled with the desire for higher profits and prevention of yield reduction, contributes to the promotion of pesticide usage among farmers.

This study has been conducted to evaluate knowledge, attitude, and behavior in pesticide use of kiwi farmers in Türkiye.

The main deficiencies in the pesticide usage of kiwi producers are closely related to both the level of pesticide use and the active role of pesticide dealers in pesticide supply. In this regard, it becomes imperative for policymakers to develop alternative solutions such as an electronic monitoring system or prescriptions for pesticide tracking. Furthermore, it is also crucial for the pesticides used in kiwi production to adhere to the legal standards set by the EU norms. From this perspective, the focus of policymakers is on the supply and implementation control of pesticides.

It has been come out of the conducted research that farmers do not give due importance during implementing pesticides and following applications; farmers conduct farming and pest control by relying on agricultural institutions and pesticide dealers and most of farmers do not wear protective materials, such as mask, glove, etc. during agricultural activities. It is emphasized in all research in general that farmers should be trained on pesticides use and their effects on environment by the related institutions and agencies; it would be fruitful to organize trainings periodically about agricultural pest control; it is necessary to provide information about existing different agrochemicals to farmers by extension staff via mass media, farm visits and pesticide dealers.

2. Material and methods

Main material of the research is the data obtained from questionnaires realized face to face with farmers in 7 provinces, namely Yalova (38,5%), Bursa (14,5%), Ordu (11,2%), Rize (7,5%), Samsun (6,9%), Mersin (5,2%) and Sakarya (5,5%), where 89,1% of kiwi production of Türkiye, 73.745 tons in 2020. However, these provinces which ranks at top of kiwi production in Türkiye have been selected on purpose and "Proportional Sampling Method" of which formula given below (1) has been used for determining sample size due to the fact that research targets a special target group (Berk, 2018; Aksoy and Yavuz, 2012). The study area was purposively selected. In this selection, it was aimed to include regions with the highest production output in the country (approximately 90%) and geographically distinct areas with varying levels of economic and social development. While the primary reason was production efficiency, the selection of different geographical regions was intended to represent diverse cultural production techniques that could influence agricultural pesticide usage. The surveyed farmers in these regions were chosen randomly.

Sampling method is a generally accepted approach commonly used in studies targeting specific target groups. Numerous studies can be found in the literature employing this method. In this study, the total number of farmers in the research area, as well as the list of kiwi-producing farmers eligible for the survey, were obtained from the Ministry of Agriculture and Forestry records. The surveyed farmers in the field were selected randomly. The response rate of farmers to the surveys was determined to be 95%. However, incomplete, or erroneous surveys were not included in the evaluation. Rate of farmers producing kiwi in selected provinces is used in sample calculation. In this context, p rate is taken as 29% in calculations, sample questionnaire number is determined as 155 in 90% confidence interval and with 6% deviation from the mean. While distributing the number of questionnaires to the provinces, kiwi production rates of provinces are taken into consideration.

$$n = \frac{Nxpxq}{(N-1)x\sigma_{P_x}^2 + pxq} \qquad (1)$$

q=p-1

$$\sigma_{P_x}^2 = \left(\frac{r}{Z_{\propto/2}}\right)^2$$

N =Population

n = Number of samples

p = Rate indicating number of young farmers in the population

q = Rate out of p
σ = Standard deviation
r = Deviation from the mean
Z = Z score

While analyzing the obtained data, demographic structure of farmers and frequency tables indicating evaluations of farmers' attitudes and behaviors in kiwi production (number, percentage, etc.) are explained with average values. In addition, chi-square analysis was carried out to highlight the relationships between some farmer behaviour and demographic characteristics. Chi-square analysis was used for categorical (ordinal or nominal) variables to test and examine the difference between expected and observed distributions (Weaver *et al.*, 2017; Niyaz and Demirbaş, 2020).

3. Results and discussion

Age average of farmers interviewed under this study is 50.2 and average year they spent with agricultural production is 24.8. Average land size of farmers is 32.4 da, average land size of fruit is 22.9 and average land size on which kiwi produced is 14.7 da.

31% of farmers are 24-44 years old and 63% of farmers are younger than 54. Also, it is founded that 37.4% of farmers are older than 55. Experience of agricultural production is 1-10 years for 18.1% of farmers and rate of farmers who have experience of agricultural production more than 30 years is 29% (Table 1).

18% of interviewed farmers has 10 years or less than 10 years' experience in agricultural production and 46% of them has 20 years or less than 20 years' experience (Table 2).

Conditions causing farmers to fight against diseases are indicated in Table 3. 33.7% of farmers expressed that they began to apply pesticides when they first observed. Kızılaslan and Kızılaslan (2005), stated in their study that 66.7% of farmers began to apply pesticides when they first observed diseases or pests. In this context, it is observed that, taking negative effects of pesticides on human health into consideration, rate of farmers began to apply pesticides when they first observed diseases is lower than the rate observed under the study of Kızılaslan and Kızılaslan (2005). This can be interpreted as consciousness of farmers has risen and also, they have not applied pesticides directly and apply in a controlled way due to market-oriented production.

Table 1 - Age groups of farmers.

	Age Groups	*Number*	*(%)*
Groups	24-44	48	31.0
	45-54	49	31.6
	55-95	58	37.4
	Total	155	100.0

Table 2 - Duration of farmers' experience in agricultural production.

	Duration	*Number*	*(%)*
Groups	(1-10)	28	18.1
	(11-20)	43	27.7
	(21-30)	39	25.2
	(30 and more)	45	29.0
	Total	155	100.0

Places where farmers deliver pesticides and fertilizers are indicated in Table 4. According to data, 60% of farmers delivers pesticides and fertilizers from agricultural pesticide dealers. Rate of farmers who deliver pesticides and fertilizers from cooperatives is relatively low (5.8%). According to another study, 75.1% of farmers deliver pesticides from pesticide dealers (Erbek *et al.*, 2018).

In case that pesticides are not applied at recommended doze and with recommended method, agricultural ecosystem will be polluted with residual caused by intensive use of pesticides. This pollution will reach to living creatures through food chain etc. and will result in serious health risks (Akar and Tiryaki, 2018).

Correlation between education levels of farmers and conditions that effect time and dosage of pesticides to be used by farmers is indicated in Table 5. According to chi-square analysis, conditions effecting selections about pesticides differs meaningfully according to education levels of farmers. While most of farmers pay attention to recommendations of cooperatives are primary school graduate (14.3%), 73% of farmers who decide by their own are high school graduate.

Table 6 indicates correlation between education levels and matters to be taken into consid-

Table 3 - Decision mechanisms effective in farmers' applying pesticides.

Decision Mechanisms	*No of observations*	*(%)*
First observed	88	33.7
According. to experiences	83	31.8
Recommendation of dealer/consultant	53	20.3
Recommendation of neighbor/relative	23	8.8
Advice of cooperative	3	1.1
Other	11	4.2
Total	261	100.0

Table 4 - Places where farmers deliver pesticides and fertilizers.

Place	*Number*	*(%)*
Pesticide-Fertilizer dealer	93	60.0
Both	53	34.2
Cooperative	9	5.8
Total	155	100.0

eration while buying pesticides and fertilizers. According to Chi-Square analysis, matters to be taken into consideration by farmers while buying pesticides and fertilizers differentiates by education levels. 41.2% of farmers who are university graduate pay attention to brand of pesticides and fertilizer while buying them.

Under this study, approximately 92% of interviewed farmers declared that pesticides have negative effects on human health (Table 7).

Under a study it is detected that most of farmers (83%) think that pesticide chemical residues on plants have negative effects on human health, but they do not have sufficient information (Kılıç *et al.*, 2018).

Table 8 indicates thoughts of farmers about negative effects of pesticides. According to the table, it is determined that rate of farmers who think that pesticides cause poisoning and are carcinogenic is 26.3%.

Omari (2014), according to the study realized by him, states that while most of farmers interviewed by him did not aware of harmful effects of chemicals used in agriculture on environment, 34% of farmers admitted the adverse effects of chemicals on environment.

Table 9 indicates the answers for the question whether farmers take precautions during or after applying pesticides. Most of farmers (96.8%) stated that they take precautions during and after applying pesticides.

Table 10 indicates the precautions that farmers take during and after application of pesticides. According to the table, the most important precautions that farmers took during and after application of pesticide is to wear mask and take

Table 5 - Correlation between education levels of farmers and conditions that effect time and dosage of pesticides to be used by farmers.*

Level of Education		*Recommend by Cooperatives*	*Experience*	*Pesticide Dealer*	*Consultant*	*Provincial and District Directorate of Agriculture*	*Chamber of Agriculture*	*Other*
Illiterate	Number	0	1	0	0	0	0	0
	%	0.0	1.0	0.0	0.0	0.0	0.0	0.0
Primary School	Number	7	27	28	7	0	7	1
	%	14.3	55.1	57.1	14.3	0	14.3	2.0
High School	Number	0	35	17	15	1	5	1
	%	0.0	72.9	35.4	31.3	2.1	10.4	2.1
University	Number	6	28	25	10	0	2	1
	%	12.0	56.0	50.0	20.0	0.0	4.0	2.0
Postgraduate	Number	0	2	3	1	1	0	1
	%	0	28.6	42.9	14.3	14.3	0.0	14.3

** Total is more than 155 since answers are multiple. Pearson Chi-Square value: 45.358; P-value: 0.020.*

Table 6 - Correlation between education levels and matters to be taken into consideration while buying pesticides and fertilizers.*

Level of Education		*Expire date*	*Disease of Pests which they effect*	*Price*	*Brand*	*Poisonousness*	*Side Effects*	*Other*
Illiterate	Number	1	0	0	0	0	0	0
	%	0.9	0.0	0.0	0.0	0.0	0.0	0.0
Primary School	Number	32	40	30	11	13	16	0
	%	30.2	31.3	33	21.6	26	29.1	0.0
High School	Number	33	41	30	17	18	17	1
	%	31.1	32.0	33.0	33.3	36.0	30.9	16.7
University	Number	35	43	27	21	18	20	3
	%	33	33.6	29.7	41.2	36	36.4	50
Postgraduate	Number	5	4	4	2	1	2	2
	%	4.7	3.1	4.4	3.9	2.0	3.6	33.3

** Total is more than 155 since answers are multiple. Pearson Chi-Square value: 35.647; P-value: 0.15.*

Table 7 - Answers of farmers for the question whether pesticides have negative effects on human health or not.

Answers	*Number*	*(%)*
Yes	143	92.3
No	12	7.7
Total	155	100.0

Table 8 - Thoughts of farmers about negative effects of pesticides.*

Effect	*Number*	*(%)*	*Rate of cases*
Cause poisoning	108	26.3	69.7
Cancinogenic	108	26.3	69.7
Cause irritation on skin	96	23.4	61.9
Cause unknown illnesses	84	20.4	54.2
Other	15	3.6	9.7
Total	411	100.0	265.2

** Total is more than 155 since answers are multiple.*

Table 9 - Do you take precautions during and after applying pesticides?

Answer	*Number*	*(%)*
Yes	150	96.8
No	5	3.2
Total	155	100.0

shower. However, the rates are not at desired level, and they are below 50%.

Şimşek *et al.* (2012) stated under their study that approximately 70% of farmers do not wear mask, 90% of them do not wear coveralls.

According to another study rate of farmers who do not wear mask, glove, etc. during application of pesticides is 53.6% (Erbek *et al.*, 2018).

Wijethunge and Harshana (2021) revealed that a small number of farmers (20%) take shower immediately after they complete spraying.

According to results of the study realized by Omari (2014), most of farmers (74.4%) do not take shower after spraying pesticides. Also, it was found that most of farmers (72.4%) have faced with several sicknesses after spraying.

Table 11 indicates the views of farmers about harm of pesticide overuse on environment. 92.3% of farmers stated that overuse of pesticides damage environment.

Bayraktar and Boz (2020) revealed with their study that 70.5% of farmers know the effects of pesticide overuse on environment and 29,5% of them does not have any knowledge about that issue.

Erbek *et al.* (2018), found as the result of their research that 63.7% of farmers think that pesticides destroy environment.

Table 12 indicates the views of farmers about damages of pesticide overuse on environment. According to answers, most common view (32.5%) is that pesticides pollute "rivers and lakes". 34% of farmers say that "overuse of pesticides damages beneficial insects and bees".

Use of improper methods for destroying empty packages after fertilization and spraying damages all living creatures, especially the human beings (Kılıç *et al.*, 2021). Use of agricultural pesticides cause environment pollution by contaminating soil, water, and air. Dosage of pesticides should be paid attention in order not to cause environmental pollution. Tools and equipment used for spraying should be cleaned after spraying. Empty packages or pesticides not to be used should be destroyed in accordance with procedures (Bayraktar and Boz, 2020).

Table 13 indicates the processes carried out by farmers for packages after they use pesticides and fertilizers. According to this table, 67% of farmers throw packages away after they use pesticides and fertilizers and 18% of them bury in the ground.

Akar and Tiryaki (2018) as the result of their study determined that 8.5% of farmers threw empty packages away, 55% burnt them, 10% buried them in the ground, 26.2% casted away by bagging and 0.3% reused them.

Bayraktar and Boz (2020), in their studies, stated that 48.2% of farmers casted empty packages away and 45.5% of them burnt them.

Omar (2014), in his study, stated that 46.5% of farmers throw empty packages away, 24.5% stored for reuse for new chemicals and 20.9% burnt in the ground.

Table 14 indicates the diseases faced by kiwi farmers during production. Most of farmers states that they do not face with any disease and the most frequent disease is stated as root rot.

There are various micro-organisms that cause diseases for kiwi plant. They can cause diseases in root, crown, offshoot, flower, leaf, and fruit (Doğu and Karakaya, 2008). Şahin and Türkkan (2020) in their study, determined that root rot and block root diseases are related to fungus.

Limiting pesticide usage to comply with European Union regulations, initiating control processes such as e-prescriptions, are the primary

Table 10 - Precautions to be taken during and after application of pesticides.*

Precaution	*Number*	*(%)*	*Rate of cases*
Wear mask	138	29.1	89.0
Take shower	119	25.1	76.8
Wear glove	112	23.6	72.3
Wear coveralls	91	19.2	58.7
Other	15	3.2	9.7
Total	475	100.0	306.5

** Total is more than 155 since answers are multiple.*

Table 11 - Views of farmers about harm of pesticide overuse on environment.

Answers	*Number*	*(%)*	*(%)*
Yes	143	92.3	92.3
No	5	3.2	95.5
I don't know	7	4.5	100.0
Total	155	100.0	

Table 12 - Damages of pesticide overuse on environment according to farmers.*

Answers	*Number*	*(%)*
Pollute rivers and lakes	120	32.5
Damages beneficial insects and bees	125	33.9
Damages birds, mammals, and reptiles	109	29.5
Other	15	4.1
Total	369	100.0

**Total is more than 155 since answers are multiple.*

Table 13 - Processes carried out by farmers for packages after they use pesticides and fertilizers.

Processes	*Number*	*(%)*
Throw away	104	67.1
Bury in the ground	28	18.1
Burn	18	11.6
Destroy the packages	4	2.6
Deliver to the municipalities' waste collection units	1	0.6
Total	155	100.0

Table 14 - Diseases faced by kiwi farmers.

Disease	*Number*	*(%)*	*Rate of case*
I did not face	54	30.5	34.8
Root rot	46	26.0	29.7
Icterus	16	9.0	10.3
Nematode	13	7.3	8.4
Crown rot disease	10	5.6	6.5
Fungus	7	4.0	4.5
Chlorosis	6	3.4	3.9
Leaf Spot	6	3.4	3.9
Botrytis	4	2.3	2.6
Aspidiotus Perniciosus	3	1.7	1.9
Fruit Fly	2	1.1	1.3
Agrobacterium Tumefaciens	2	1.1	1.3
Leaf Louse	2	1.1	1.3
Euproctis chrysorrhoea	2	1.1	1.3
Does not know	2	1.1	1.3
Fruit Worm	1	0.6	0.6
Icterus	1	0.6	0.6
Total	177	100.0	114.2

** Total is more than 155 since answers are multiple.*

constraints related to the topic. However, aging of the farmers, low educational levels, and inadequate utilization of technology can also be considered as fundamental secondary constraints.

4. Conclusions

Türkiye has developed various policies and regulations to reduce pesticide use and promote sustainable agriculture practices. As a significant consumer of pesticides in the agricultural sector, Türkiye is implementing measures to control pesticide use for the preservation of the environment and human health. In this regard, support programs and regulations are in place to encourage organic farming, promote integrated pest management practices, and minimize environmental impacts. Additionally, regulations are established to ensure the proper and safe use of pesticides, accompanied by educational initiatives targeting farmers. Türkiye continues to make progress in reducing pesticide use and advancing sustainability goals by strengthening farmer education and awareness programs, promoting alternative pest management methods, and supporting sustainable agriculture policies.

Under this paper, it is aimed to evaluate knowledge, attitude, and behaviors of kiwi producers about use of agrichemicals. 60% of farmers supplies agrichemicals and fertilizers mainly from pesticide dealers. Approximately 92% of interviewed farmers indicated that pesticides have negative effects on human health and the most important negative effect of agrochemicals is irritation on skin. 92.3% of farmers expressed that overuse of pesticides harm environment. According to farmers, the most important effect of these chemicals on human is its causing poisoning and having carcinogen effect. The primary precautions to be taken by farmers during and after spraying is to wear mask and to take shower. However, rate of farmers taking precautions is not at desired level. Nearly 67% of farmers throw empty pesticide packages to trash and 18% of farmers bury them into ground. According to research findings farmers utilize from their own experiences while determining spraying time and dose and although they are aware of harms of pesticides, they do not take necessary precautions adequately.

As recommended under other studies on this issue, to address the increasing reliance on synthetic agrochemicals and their potential environmental and health risks, there is a critical need to implement comprehensive and regular training programs for farmers. These programs should emphasize proper pesticide usage, safety measures, and the importance of adopting integrated pest management practices to promote sustainable agricultural production. In addition, farmers should be supported through effective training programs, field trainings and practical training programs to be organized on a regular basis by policy makers and extension officers to increase awareness of farmers about right and safety use of agrochemicals. In this context, it is observed that utilizing from mass media is an effective way for training and increasing awareness. Furthermore, it is recommended to organize workshops and seminars on effects of agrochemicals on health.

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