Selcuk Journal of Agriculture and Food Sciences

https://dergipark.org.tr/tr/pub/selcukjafsci

Research Article

(2024) 38(3), 368-382 DOI:10.15316/SJAFS.2024.033 e-ISSN: 2458-8377 Selcuk J Agr Food Sci

Assessment of Pesticide Selection and Application Behaviors of Sugar Beet Farmers in Konya Province

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HIGHLIGHTS

- Sugar beet farmers are mainly advised by pesticide dealers when choosing pesticides.
- Sugar beet farmers have acquired pesticides from agricultural chemical dealers.
- Farmers emphasized legality, cost-effectiveness, and efficacy when choosing pesticides.
- Sugar beet farmers need improved safety measures for pesticide use and disposal.

Abstract

This study is undertaken to determine the behaviors of sugar beet farmers regarding pesticide selection and applications in the Çumra, Altınekin, and Seydişehir districts of Konya province, where sugar beet production is concentrated in 2023. A total of 20 sugar beet farmers were randomly selected from each district through a random sampling method, and evaluations were made based on their responses to 16 face-to-face questions. The results were calculated as percentages and presented in tables. The behaviors of farmers regarding pesticide selection and application practices were assessed in two stages. It was found that sugar beet farmers often seek information from pesticide dealers when choosing and determining the dosage of agricultural chemicals, and they mainly obtain pesticides from agricultural chemical dealers. It was noted that they acquire the chemicals when they start growing the crop, do not spray regularly for pests and diseases as a preventive measure, and pay attention to the legality, cost-effectiveness, and effectiveness of the pesticides they purchase. Half of the sugar beet farmers reported conducting at least two pesticide applications during the season, and the majority stated that they perform pesticide applications in the morning and afternoon. Farmers acknowledged the importance of pesticide residues but emphasized that the effectiveness of the pesticide was more crucial. They also reported not adhering to the waiting periods between the last pesticide application and harvest. Regarding pesticide handling, application, and post-application practices, it was observed that farmers partially protected themselves. They tended to spray excess pesticide-contaminated water at the edge of the orchard or on vacant land and dispose of empty pesticide containers haphazardly on the edge of the field.

Keywords: Farmer; Konya; Pesticide; Sugar Beet, Survey Study

Citation: Duman Z, Boyraz N (2024). Assessment of Pesticide Selection and Application Behaviors of Sugar Beet Farmers in Konya Province. *Selcuk Journal of Agriculture and Food Sciences*, 38(3), 368-382. https://doi.org/10.15316/SJAFS.2024.033

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Received date: 29/01/2024

Accepted date: 19/08/2024

1. Introduction

Sugar beet (*Beta vulgaris* var. *saccharifera* L.) is one of the significant plants used in sugar production worldwide. According to statistics, 25% of the world's sugar production is obtained from sugar beets. While sugar cane was known as the raw material for sugar until the late 18th century, German Marggraf's determination in 1747 that the substance giving sweetness to beets is the same as in sugar cane-initiated efforts to produce sugar from beets. Commercial sugar production from sugar beets was realized by Marggraf's student, Franz Carl Achard, in 1802 at the factory he established with the beets he bred (Cooke and Scott 1993). The region's climatic conditions and cultivation techniques play a crucial role in obtaining income from cultivating a product. Meeting the necessary conditions for sugar beet cultivation is essential for both yield and quality (Tortopoğlu 1994). Sugar beet is a biennial plant known botanically as *Beta vulgaris* var. *saccharifera*, utilizing its root in the first year for sugar production and its above-ground organs in the second year for seed production. In the first year, it forms roots and leaves, while in the second year, it produces flowers and seeds. Sugar beet (*Beta vulgaris* var. *saccharifera* L.) is composed of water and dry matter in terms of chemical structure. Depending on climate, growing conditions, and the planted beet variety, the root contains 20-26% dry matter, and the leaves contain 11-19% dry matter. The majority of this dry matter is sugar (Anonymous 1996).

Sugar beet production takes place in 52 countries worldwide, and Turkey holds a 9.1% share in this global production. This places Turkey as the fifth-largest farmer globally, following Russia, the United States, France, and Germany. Turkey's position in this sector is unique among countries that exclusively produce sugar from sugar beets, influenced by climatic conditions (FAO 2022). Sugar beet production holds a significant place in Turkey, and according to data on sugar beet production in 2022, a total area of 2 975 096 acres was utilized for sugar beet cultivation in the country. This extensive cultivation area indicates a total sugar beet production of 19 253 962 tons in the country. Based on this production quantity, the yield obtained is 6 472 kg/ha (TÜİK 2023). The leader in sugar beet production in our country is Konya province, with a production of 1 066 371 tons (TÜİK 2022).

Plant protection products and practices play a crucial role in reducing production losses caused by harmful agents in agricultural production areas. Therefore, indiscriminate and uninformed use of agricultural chemicals in these areas poses a threat to human and environmental health. For this reason, a survey study was conducted in the sugar beet production areas of Konya province, which has significant sugar beet production potential, to determine the plant protection issues of farmers and reveal their awareness levels in the application of plant protection products. The data obtained from this study will provide valuable information for future similar studies in these areas.

2. Materials and Methods

The answers to 15 questions, obtained through face-to-face interviews, were collected from a total of 60 sugar beet farmers in Konya province, specifically in the Çumra, Altınekin, and Seydişehir districts, with an equal number of participants from each district. The farmers were selected using the Simple Random Sampling Method. These responses were then evaluated based on the percentage rates, both individually for each district and as an overall average. The assessment focused on understanding the behaviors of sugar beet farmers concerning pesticide selection and application practices.

3. Results

The behaviors of sugar beet farmers in the Çumra, Altınekin, and Seydişehir districts of Konya province regarding pesticide selection and applications were determined through a random sampling method. Evaluations were made based on the responses to 16 face-to-face questions posed to 20 sugar beet farmers selected from each district. The results are presented in tables, calculated as percentages, and provided below.

Tablo 1. Pesticide Selection and Application Behaviors of Sugar Beet Farmers in Konya Province (%)

Time of Procuring Pesticides	**Altınekin**	**Çumra**	**Seydişehir**	**Average**
A	80	30	25	45
B	20	45	45	36,66
C	0	20	25	15
D	0	5	0	1,67
E	0	0	0	0
B+C	0	0	5	1,67
(A: When starting to cultivate the crop, B: When a disease appears in the crop, C: When I see neighbors spraying, D: According to the pesticide schedule, E: Other)				
Source of Procurement for Pesticides				
A	50	65	55	56,67
B	0	0	0	0
C	0	0	0	0
D	10	15	30	18,33
E	0	0	0	0
A+B	10	5	0	5
A+D	20	15	15	16,67
A+B+D	10	0	0	3,33
(A: Agricultural Pesticide Dealer, B: Agricultural Credit Cooperative, C: Chamber of Agriculture, D: Sugar Beet Cooperative, E: Other)				
Criteria They Consider in Pesticide Selection				
A	40	15	0	18,33
B	20	10	15	15
C	0	0	0	0
D	0	10	25	11,67
E	0	0	5	1,67
F	0	0	0	0
A+B	20	0	5	8,33
A+D	0	10	0	3,33
A+E	20	0	0	6,67
B+D	0	25	25	16,67
B+E	0	0	15	5
A+B+D	0	10	0	3,32
B+C+D	0	5	0	1,67
B+D+E	0	10	10	6,67
A+B+C+D	0	5	0	1,67
(A: Having a license for the product I will use, B: Being effective, C: Compatibility, D: Economic viability, E: Being a well-known pesticide (Advertisement), F: Other)				
Number of Pesticide Applications				
A	0	10	0	3,33
B	20	60	70	50
C	60	25	30	38,34
D	20	5	0	8,33
(A:1, B:2, C:3, D:Other)				
Decision-Making on Pesticide Application Timing				
A	60	30	35	41,67
B	0	10	0	3,33
C	0	0	0	0
D	20	35	55	36,67
A+D	20	25	10	18,33
(A: Morning, B: Noon, C: Irrespective of time, D: Other)				

Behavior in the Selection of Pesticide Dosage by Farmers				
A	20	50	35	35
B	80	25	45	50
C	0	5	0	1,67
D	0	5	5	3,33
E	0	0	0	0
A+B	0	15	10	8,33
B+C	0	0	5	1,67
(A: I apply according to the label, B: I adjust according to the dealer's recommendation, C: I apply a bit more than indicated on the label, D: According to my own experience, E: I follow what other farmers do)				
Opinions on Regular Pesticide Application				
A	10	20	0	10
B	80	30	30	46,67
C	10	50	70	43,33
(A:Yes, B:Sometimes, C:No)				

Sugar beet farmers were asked the question, "When do you procure the pesticide for diseases observed or likely to be observed in your field?" The responses are provided in Table 1. According to Table 1, 45% of the farmers indicated that they procure pesticides when they start cultivating the crop, while 36.66% stated that they obtain pesticides when a disease appears in the crop. When analyzed by districts, farmers in Altınekin reported procuring pesticides at an 80% rate when starting crop cultivation, while in Çumra and Seydişehir, 45% mentioned obtaining pesticides when a disease is detected in the crop. Karataş (2009). In a study conducted in the Manisa region, the question "When were pesticides obtained against diseases or pests?" Almost all the farmers (61.3%) provide the necessary pesticides when diseases or pests occur in the products they grow. In a study by Aydın (2019) with chickpea farmers in the Elbistan district of Kahramanmaraş province, when asked about the timing of obtaining pesticides against weeds, diseases, and pests, 25 farmers among those cultivating areas of 1-10, 11-25, and 26-100 decares stated 'when pests are observed,' and 22 farmers stated, 'when pests are observed' and 'when neighbors start spraying.

The question regarding where sugar beet farmers procure agricultural pesticides was asked, and their responses are provided in Table 1. According to the table, 56.67% of the farmers reported obtaining the pesticides from agricultural pesticide dealers, while 18.33% mentioned sourcing them from the sugar beet cooperative. The survey results conducted by Akbaba (2010) with citrus farmers in Adana province revealed that 88.9% of the farmers procure the pesticides they use from agricultural pesticide dealers, while 11.1% obtain them from agricultural credit cooperatives. Aydın (2019) found that, within the scope of their study, 63 farmers cultivating on 1-10, 11-25, and 26-100 acres obtained agricultural pesticides from "Agricultural pesticide dealers," 4 individuals from the "Agricultural Credit Cooperative," and 27 individuals from both "Agricultural pesticide dealers" and the "Agricultural Credit Cooperative. Akar (2018) reported that 92.1% of farmers in Antalya province procure agricultural pesticides from agricultural pesticide dealers. Similarly, Tanrıvermiş (2000) found that 81.25% of tomato farmers in the Central Sakarya Basin, and Cevizci et al. (2012) determined that 47.9% of farmers in Çanakkale obtain their pesticides from agricultural dealers.

The criteria that farmers consider when selecting pesticides were surveyed, and the responses are provided in Table 1. Of the respondents, 18.33% mentioned that they pay attention to the product being licensed for use, 15% consider its effectiveness, and 11.67% prioritize its cost-effectiveness. Upon reviewing Table 1, it is observed that the majority of farmers primarily focus on the pesticide being licensed for the product, being cost-effective, and being effective in their selection criteria. Akar (2017) determined that farmers in Antalya province prioritize the effectiveness (77.8%) of agricultural pesticides when making purchases. Other factors, such as the pesticide being well-known (10.8%), its cost-effectiveness (5.8%), and other factors (5.6%), were also noted as considerations during the pesticide procurement process (Çalışkan 2022). As a result of the study they conducted with carrot farmers in Konya province, when buying/choosing agricultural pesticides, they

should choose a well-known pesticide (28.75%), be effective (25%), be licensed for the product to be used (21.25%) and be economical (15%) and miscibility (10%) (Kaplan and Ayaz 2023). In the province of Mardin, when cherry farmers choose (purchase) pesticides (fungicides, herbicides and insecticides) used against diseases and pests, 10% are based on whether they have been used before, 34% on the recommended active ingredient, 30% on the brand and 26% on the product. They stated that they chose it based on its cheapness.

Farmers were asked how many times they sprayed sugar beets during the season and their answers are given in table 1. 50% of the farmers stated that they sprayed the land twice, 38.34% sprayed the land three times, and 3.33% sprayed once. 8.33% of the farmers reported that they sprayed 1-3 times during the production season, depending on the disease and pest conditions, and that it varied according to season and year. Taylan (2020) determined the pesticide use schedule of hazelnut growers within the same production season; It was determined that 31.3% (120) used one drug, 29.8% (114) used two drugs, and 23% (88) used three drugs. It was observed that 11.7 (45) of them sprayed four times. It was observed that 61.1% of the farmers spray once or twice a year. Sevim et al. (2023), when looking at the pesticides and the total number of pesticides made by farmers on a product basis, determined that on average a farmer sprays 3.23 times for wheat, 4.16 times for cotton and 1.71 times for corn. Aydin (2015). While 50% of Konya bean farmers declared that they sprayed twice, 28.3% sprayed three times, and 11.7% sprayed once, 10% stated that the number of sprayings they applied varied depending on the disease.

The answers of sugar beet farmers to the question "When do you prefer to spray during the day?" are given in Table 1. According to Table 1, 41.67% of the farmers stated that they sprayed in the morning, 36.67% stated that they sprayed in the afternoon, and 18.33% stated that they sprayed in the afternoon and in the morning. Batur et al. (2023) determined that among hazelnut farmers, 50% apply pesticides in the morning, 18% in the morning or evening, and 10% in the afternoon or evening. Additionally, 10% of the farmers apply pesticides during the afternoon or evening. Yeşilayer et al. (2016) reported, in a study conducted in the Zile district of Tokat province, that sunflower farmers apply pesticides for pest control, disease management, and weed control. According to the findings, 87% of the farmers apply pesticides in the morning and afternoon, while 13% apply them at noon. Ediboğlu (2019) indicated, based on their study with tobacco farmers, that 57.7% prefer to perform pesticide applications in the morning, while 26.8% choose either the morning or the afternoon.

Table 1 provides the aspects that farmers consider when determining the dosage of pesticides. According to the table, 35% of the farmers determine the dosage based on the label, 50% determine it based on the dealer's recommendation, and 8.33% mentioned that they apply by determining the dosage both according to the label and the dealer's recommendation. Çevik (2019) found that 59% of pistachio farmers in the GAP Region determine pesticide dosage based on the recommendations of pesticide dealers, while 27% rely on experience or recommendations from other farmers. Similarly, Erdil (2019) reported that 63.8% of farmers in Manisa province determine the pesticide dosage based on the recommendations of pesticide dealers. Erdoğan et al. (2017) determined that almond farmers in Adıyaman province select pesticide dosage in chemical control as follows: 52.7% rely on pesticide dealers, 25.8% on the Agriculture Provincial Directorate, 17.2% on private consultants, 3.2% on their own experience, and 1.1% based on their neighbor's recommendation. Kalıpcı et al. (2011) reported that in Konya province, when determining the dosages of pesticides used by farmers, 8.3% adhere to the dosage written on the pesticide packaging label, 26.6% adjust the dosage based on trial and error and their own experiences, 11.6% adjust the dosage by adding a slightly higher amount than what other known farmers suggest, 33.3% follow the recommendations of pesticide dealers, 10.8% determine the application dosage by consulting the Agricultural Provincial and District Directorates, 3.3% consult Agricultural Chambers, and 5.8% consult Agricultural Engineers.

Table 1 presents the responses of farmers to the question 'Do you regularly spray pesticides at regular intervals for preventive purposes before encountering any disease or pest?' According to the results in Table

1, 46.67% of sugar beet farmers sometimes apply pesticides for preventive purposes, 43.33% do not spray pesticides for preventive purposes, and 10% indicated that they regularly spray pesticides for preventive purposes. According to another study conducted by Çalışkan (2022) in Konya province, carrot farmers have reported that 37.5% of them do not perform pesticide applications when diseases, pests, and weeds are not observed, 36.25% occasionally conduct pesticide applications, and 26.25% regularly engage in pesticide applications. According to Karaömerlioğlu (2019), 45% of farmers in the Gönen plain of Balıkesir province regularly spray pesticides at regular intervals without inspecting the plants, with the intention of avoiding encountering any diseases or pests. Additionally, 28% of the farmers sometimes engage in this practice, while 21% do not. 6% of the farmers did not provide a response to this question. Erdil (2019) reported that 64.3% of farmers in Manisa province do not engage in pesticide applications when diseases, pests, and weeds are not observed. Akar and Tiryaki (2017) stated that 54.5% of farmers in Antalya province do not perform pesticide applications when diseases, pests, and weeds are not observed.

Table 2. Pesticide Application and Post-Behavior of Sugar Beet Farmers in Konya Province (%)

Opinions on Residue Issue	**Altınekir**	**Çumra**	**Seydişehir**	**Average**
A	0	10	10	6,67
B	20	75	80	58,33
C	60	10	10	26,67
D	20	5	0	8,33
(A: What matters in spraying is eliminating the disease, B: Important, but the benefit of the pesticide is more important, C: Very important, more important than the benefit of the pesticide, D: I specifically consider the problems that residues can cause when spraying)				
Habit of Mixing Pesticides				
A	20	20	5	15
B	0	0	0	0
B-1	30	15	45	30
B-2	0	0	0	0
B-3	30	35	25	30
B-1+B-3	20	30	25	25
(A: No, B: Yes, B-1: To eliminate multiple diseases and pests in one spraying, B-2: To eliminate a single disease and pest by using multiple pesticides, B-3: To reduce the cost of spraying)				
Consciousness Level Regarding the Waiting Period for Pesticides				
A	20	60	60	46,67
B	50	5	0	18,33
C	15	30	15	20
D	15	5	25	15
E	0	0	0	0
(A: I harvest based on the maturity of the crop, B: I adhere to the necessary waiting period after spraying, C: I harvest based on market conditions, D: I don't pay attention to the waiting period, E: Other)				
Habit of Disposing of Excess Pesticide Waters				
A	70	30	20	40
B	15	35	65	38,34
C	0	0	0	0
D	0	10	0	3,33
E	15	10	15	13,33
A+B	0	15	0	5
(A: I pour it on one side of the garden, B: I spray it on vacant land, C: I discharge it into the irrigation channel or river, D: I pour it into the sewerage system, E: Other)				

Habit of Disposing of Empty Pesticide Containers				
A	30	65	75	56,67
B	0	5	0	1,67
C	0	25	15	13,33
D	70	5	10	28,33
E	0	0	0	0
(A: I throw it on the edge of the field, B: I throw it into the irrigation channel or river, C: I throw it into the general waste bin, D: I store it somewhere and then destroy it by burning, E: Other)				
Precautions Taken While Preparing Pesticides				
A	40	5	5	16,67
B	0	0	0	0
C	0	10	5	5
D	0	20	35	18,33
E	0	30	35	21,66
A+B	20	0	20	13,33
A+C	20	5	0	8,33
A+D	20	0	0	6,67
B+C	0	15	0	5
B+D	0	5	0	1,67
C+D	0	5	0	1,67
A+B+C+D	0	5	0	1,67
(A: I read the necessary information on the pesticide package, B: I use gloves and goggles when preparing pesticides, C: I pay attention to the thorough mixing of suspension and emulsion pesticides, D: I refrain from eating and drinking during pesticide preparation, E: I don't take any precautions.)				
Precautions Taken During Pesticide Spraying				
A	90	50	75	71,67
B	10	5	0	5
C	0	35	25	20
D	0	0	0	0
A+B	0	10	0	3,33
(A: I refrain from eating and drinking during pesticide spraying, B: I use protective clothing, C: I don't take any precautions, D: Other)				
Habits After Pesticide Application				
A	20	10	10	13,34
B	10	75	75	53,33
C	0	0	0	0
A+B	70	15	15	33,33
(A: I wash all my clothes after pesticide application, B: I wash thoroughly with water and soap, C: I do nothing.)				

The importance of residue issues due to chemical control was questioned to sugar beet farmers, and the results are provided in Table 2. According to this, 58.33% of the farmers stated that it is important, but the benefit of the pesticide is more significant. Meanwhile, 26.67% expressed that it is very important, with the residue being more significant than the benefit of the pesticide. Additionally, 6.67% emphasized the importance of eliminating the disease in pesticide application, while 8.33% mentioned that they particularly consider the problems that residues may cause when discarding the pesticide. Aydın and Boyraz (2015), in their study conducted in Konya, found that 45% of bean farmers consider the elimination of the disease more important than the residue issue in pesticide application. Meanwhile, 20% believe that the residue problem is significant, but the benefit of the pesticide is more crucial. Another 20% think that the importance of the residue problem surpasses the benefit of the pesticide, and 15% reported that they take into account the problems caused by residues when discarding the pesticide. In a study conducted by Kaplan and Ayaz (2023) in the Ömerli district of Mardin province, cherry farmers reported that 27% of them observed residues from

agricultural pesticides in their products. Another 13% stated that this rate is low, and a majority of 60% mentioned that they did not observe any residues at all. Kalıpcı et al. (2011) reported that 45.8% of farmers believe that pesticide residues will be lost through rain and/or washing of the products. Additionally, 18.3% expressed the belief that there would be no pesticide residue in the products, while 28.3% acknowledged that residues could be present in the products. Furthermore, 7.5% stated that they had no knowledge about pesticide residues.

Sugar beet farmers were asked if they mix agricultural pesticides, and the reasons for mixing pesticides were inquired. According to Table 2, 15% of the farmers stated that they do not mix pesticides, while 85% reported that they use pesticides by mixing. Among those who mix pesticides, 30% stated that they mix them to eliminate multiple diseases and pests in a single spraying, 30% mix pesticides to reduce the cost of spraying, and 25% mix pesticides to both eliminate multiple diseases and pests and reduce costs in spraying. İnan (2001) in a study conducted in the Konya region, reported that 71.5% of the farmers use multiple pesticides by mixing them in chemical control, while 28.5% use pesticides without mixing them. Ulusay (2018) stated that 23.3% of tomato farmers in Aydın province mostly and 47.6% sometimes mix multiple pesticides. Peker (2012) found that 56% of tomato farmers use pesticides in a mixed form, 24% apply pesticides without mixing, and 20% occasionally mix pesticides. On the other hand, Erdoğan et al. (2017) reported that 78.5% of almond farmers apply agricultural pesticides by mixing them, 19.4% occasionally mix pesticides, and 2.1% apply individual pesticides without any mixing.

Farmers were surveyed regarding their attention to the waiting period after applying pesticides until the harvest time, and the results are presented in Table 2. The results indicate that 18.33% of the farmers pay attention to the waiting period, while 81.67% do not consider the waiting period. Among the farmers who do not pay attention to the waiting period, 46.67% harvest based on the ripening of the crop, 20% harvest based on market conditions, and 15% stated that they never consider the waiting period before harvesting. Özşahin (2021) reported that 91.03% of fruit farmers in Lapseki (Çanakkale) district do not adhere to the waiting period when harvesting their crops. Emeli (2006) conducted a survey in 2005 in the Seyhan and Yüreğir Basins with the aim of identifying the problems encountered in the implementation of plant protection methods. The study involved 50 agricultural pesticide dealers, 112 farmers, and 48 technical personnel. The findings indicated that they harvest their crops without adhering to the necessary waiting period after pesticide application. Kaplan and Ayaz (2023) reported that among the pesticide-using farmers in Ömerli, Mardin, 53.58% stated that they adhere to the waiting period between pesticide application and harvest, 32.14% mentioned that they do not adhere to it, and 14.28% indicated that they sometimes adhere to it.

The sugar beet farmers were asked where they discharge the excess pesticide-laden water after spraying, and the results are provided in Table 2. Farmers stated that 40% of the excess pesticide-laden water is poured along the edge of the garden, 38.32% is sprayed onto vacant land, 3.33% is poured into the sewage system, 13.33% is sprayed onto the road by opening the machine, and 5% is poured along the edge of the garden and sprayed onto vacant land. Çalışkan (2022) reported that in their research conducted in Konya and Ankara, 60% of the farmers mentioned that they dispose of the excess agricultural chemicals after usage and the water containing pesticides generated during the cleaning of the spraying tank by pouring it to the edge of the field. Additionally, 38.75% stated that they spray it onto vacant land. Karaömerlioğlu (2019) stated that 33% of the farmers in the Gönen Plain of Balıkesir province dispose of the excess agricultural chemicals after usage, as well as the water containing pesticides generated during the cleaning of the spraying tank, onto vacant land. Furthermore, 31% pour it into the sewage system, and 26% discharge it along the edge of the garden. Akbaba (2010) indicated that 67.3% of citrus farmers in Adana province stated that they dispose of the more medicated water on the edge of their orchards or on vacant land, while 13% mentioned pouring them into water channels, rivers, or sewage systems.

The disposal methods of empty pesticide containers after spraying were inquired from the farmers, and their responses are provided in Table 2. According to Table 2, 56.67% of sugar beet farmers dispose of empty pesticide containers by throwing them on the edge of the field, 28.33% store them somewhere and later burn them for disposal, 13.33% throw them into general waste bins, and 1.67% reported discarding them into irrigation channels or rivers. Tücer et al. (2004) reported that 60.54% of grape growers in Manisa province randomly discard empty pesticide containers, 4.98% repurpose pesticide boxes for different purposes, 19% bury them in the soil, and 15.48% dispose of them by burning. Gözener et al. (2017) found that 59.72% of tomato farmers in Tokat province dispose of used pesticide containers by burning them, 29.17% bury them underground, 5.56% place them in garbage areas with household waste, and 5.56% randomly leave them in their surroundings. Zeren and Kumbur (1998) revealed in their study conducted in İçel province that 45.29% of farmers randomly discard empty pesticide containers, 38.48% burn them, and 6.23% bury them in the soil after spraying.

Farmers were asked about the precautions they take while preparing pesticides, and their responses are provided in Table 2. According to this, it has been determined that 78.34% of the farmers take measures to protect themselves during pesticide preparation, even through different methods. Farmers have indicated that 16.67% read the necessary information on medication packaging, 5% ensure proper mixing of suspension and emulsion drugs, 18.33% refrain from eating and drinking during pesticide preparation, 13.33% read the necessary information on medication packaging and use gloves and goggles during preparation, 8.33% read the necessary information on packaging and ensure the proper mixing of suspension and emulsion drugs, and 5% mentioned using gloves and goggles during medication preparation while also paying attention to the thorough mixing of suspension and emulsion drugs. 21.66% of the farmers have stated that they take no precautions during the preparation of medications. In the Altınekin district, 40% of farmers have been observed to read the information on packaging. In contrast, in other districts, this rate is observed to be 5%. Altınekin district shows a higher level of awareness among farmers regarding the precautions taken in the preparation of medications. Aydoğan and Baran (2023) determined that 69.0% of tobacco farmers in the research area do not read the labels of the agricultural chemicals they use. Çalışkan (2022) reported that 40% of farmers do not use gloves when preparing agricultural chemicals, 32.5% use gloves, and 27.5% use them occasionally. In the Beypazarı district, the majority of farmers (52.5%) stated that they do not use gloves while preparing chemicals. In the Meram district, 30% of farmers use gloves, while 42.5% use them occasionally. Denkçi (2019) conducted a study on sunflower farmers in Edirne, asking about their self-protection measures during the preparation of pesticides. Out of 166 participants, 155 stated that they protect themselves, while 11 reported not taking protective measures.

The precautions taken by farmers during pesticide application were inquired, and their responses are provided in Table 2. According to these results, 71.67% of the farmers stated that they did not engage in eating or drinking during pesticide application, 20% did not take any precautions, 5% used protective clothing, and 3.33% mentioned that they refrained from eating or drinking during pesticide application and used protective clothing. Akar (2017), Erdil (2019), and Uzun (2021) reported that 84.1% of farmers in Antalya province, 68.5% of farmers in Manisa province, and 87% of hazelnut farmers in Kocaeli province stated that they did not smoke during pesticide application. Akar (2017) and Erdil (2019) reported that 87.8% of farmers in Antalya province and 92.4% of farmers in Manisa province indicated that they did not eat or drink anything during pesticide application. Aydın (2015) reported that 46.7% of bean farmers in Konya pay attention to not eating and smoking while applying pesticides, 30% did not take any precautions during pesticide application, 16.7% used protective clothing during pesticide application and 6.6% used protective clothing during pesticide application while also refraining from eating anything.

The sugar beet farmers were asked about the precautions they took after applying the pesticide, and their responses are provided in Table 2. According to the responses of the farmers, 53.33% mentioned that they

carefully washed themselves with water and soap after pesticide application, 33.33% stated that they washed all their clothes, and 13.34% indicated that they washed themselves carefully with water and soap, also washing the clothes worn during pesticide application. According to the study conducted by Çalışkan (2022) with carrot farmers in Konya, 46.25% of the farmers stated that they changed their clothes after pesticide application, while 36.25% indicated that they occasionally changed their clothes. In the Meram district, 60% of farmers, and in the Beypazarı district, 32.5% of farmers reported changing their clothes after pesticide application. Regarding taking a bath after pesticide application, 48.75% of farmers mentioned doing so, and 37.5% indicated doing it occasionally. In response to this question, 62.5% of farmers in the Meram district answered 'yes,' 27.5% answered 'sometimes,' while in the Beypazarı district, 35% answered 'yes,' and 47.5% answered 'sometimes. According to the study conducted by Denkçi (2019) in Edirne province, when participants were questioned about their immediate actions after pesticide application, 102 out of 165 individuals (61.8%) reported performing handwashing, changing clothes, and taking a shower together.

Farmers were asked whether they received training on applying plant protection products, and 18.33% of the farmers reported receiving training on the application of plant protection products, while 81.67% stated that they did not receive training on the application of plant protection products. Batur et al. (2023) reported that, regarding the education levels on pesticides among farmers in Düzce province, the majority of farmers (71%) did not receive any training on pesticides, while 29% reported having received training. In the study conducted by Karaömerlioğlu (2019) with farmers in the Gönen Plain of Balıkesir province, it was observed that 18% had received training courses for the purpose of applying plant protection products, while 82% had not taken any training courses. Aydın and Sağlam (2019) determined that only 8.5% of chickpea farmers in the Elbistan district of Kahramanmaraş province received training on pesticide application.

4. Discussion

Sugar beet farmers, with 56.67%, primarily obtain their agricultural pesticides from dealers, and 50% of them determine the pesticide dosage by consulting with these dealers. In this case, individuals managing agricultural pesticide dealerships and those engaging with farmers must be specifically agricultural engineers. Additionally, 45% of farmers reported obtaining pesticides when they start growing the crop. It is essential for the agricultural engineer dealing with the farmer to have sufficient knowledge about potential diseases, pests, and weed damage in that region. This ensures that issues such as incorrect pesticide usage and excessive pesticide dosage are avoided.

It has been determined that a significant majority of sugar beet farmers, 85%, use agricultural pesticides by mixing them. Farmers argue that they mix pesticides to reduce costs and eliminate multiple diseases and pests. It has been observed that farmers choose this method to simplify their work and economically reduce expenses, but they may not be aware that the active substances of the mixed pesticides can interact, leading to serious problems for themselves and the development of resistance in pests or diseases. To prevent these issues, farmers should be carefully informed about the drawbacks of mixing pesticides. Much of this information dissemination responsibility falls on agricultural pesticide dealers because a significant portion of farmers source their pesticides from these dealers and direct their questions to the agricultural engineers working at these dealerships. Therefore, agricultural engineers working at pesticide dealerships should be trained by relevant departments of the Ministry of Agriculture and Forestry to provide information about which pesticides can be mixed and potential issues that may arise from mixing. This way, farmers can access this information more quickly and effectively.

A considerable portion of sugar beet farmers, 40%, stated that they spray the excess pesticide water on the edge of the garden, while 38.34% spray it on vacant land. It has been determined that a significant portion of farmers mix the excess pesticide water with the soil. Due to this behavior, the soil is heavily contaminated with pesticide residues. As a result, beneficial organisms in the soil are harmed, and ecological imbalances

occur. Additionally, pesticide residues reduce germination in seeds planted in the next season, causing growth retardation or death in plants. To prevent farmers from haphazardly disposing of excess pesticide water, special areas should be designated in the production areas to ensure that the pesticide water does not mix with the soil.

More than half of the sugar beet farmers, specifically 56.67%, have been found to dispose of empty pesticide containers on the edge of the field. This habit of farmers not only pollutes the environment but also harms animals. Empty pesticide containers should be washed, punctured, and taken to collection areas. To instill this habit in farmers, collection areas should be established near production fields. Additionally, a deposit system should be implemented for empty pesticide containers to encourage farmers to participate in this practice. This way, farmers will have an incentive to adopt the practice, and environmental pollution and harm to animals will be reduced.

A significant portion of sugar beet farmers, 43.33%, stated that they do not regularly apply pesticides, while 46.67% mentioned that they occasionally do. Looking at the results, a significant portion of farmers do not seem inclined towards regular pesticide application. It is crucial to provide information to farmers about the benefits of regular pesticide application, emphasizing its potential to prevent a considerable portion of future diseases and increase yield by reducing plant stress. When farmers are informed about these aspects, excessive pesticide use can be avoided, leading to a decrease in pesticide costs, and the issue of pesticide residues in the soil can be substantially mitigated.

It was found that a large majority of sugar beet farmers, 81.67%, do not adhere to the recommended waiting period after pesticide application. It is crucial to communicate the significance of adhering to the waiting period to the farmers. To achieve this, institutions capable of conveying this important information should be established at the provincial, district, and village levels. If such an approach is followed, potential threats to human and animal health will be eliminated, and the issue of pesticide residues in exports can be mitigated.

The majority of sugar beet farmers, 78.34%, stated that they take certain precautions when preparing agricultural pesticides, while 21.66% mentioned that they do not take any precautions during spraying. However, the precautions taken may not provide complete protection. It should be emphasized to farmers that using a mask, gloves, and protective clothing is essential when preparing chemicals, and similarly, wearing a mask, gloves, and protective clothing is mandatory during pesticide application. The responsibility for conveying this information lies with the Agricultural Provincial/District Directorates. Meetings and training sessions should be organized for farmers at the beginning of the production season, providing them with masks, gloves, and protective clothing to instill the habit of using these products.

More than half of the farmers, 58.33%, have argued that the residue problem is important, but the benefit of the pesticide is even more crucial. When considering these results, it is evident that farmers are aware of polluting the environment with pesticides. However, this awareness is not deemed significant by the farmers. Consequently, this leads to a substantial accumulation of residues in the soil, causing harm to the surrounding organisms. It is necessary to overcome the farmers' lack of concern for the residue problem despite their awareness. Therefore, providing education to farmers on residue issues and environmental pollution is essential. These educational programs should draw attention to the potential harms of unconscious pesticide use and promote sustainable farming practices. Farmers should be guided on proper pesticide use, paying attention to dosages, and evaluating alternative solutions, encouraging them to adopt environmentally friendly agricultural practices. This way, it is possible to prevent residue problems and enhance environmental sustainability.

5. Conclusions

In conclusion, significant deficiencies are observed in farmers' use of agricultural pesticides. To address and resolve these issues and cultivate informed farmers. It is crucial to ensure that university students are thoroughly trained. Moreover, a substantial responsibility lies with the Ministry of Agriculture and Forestry, along with its affiliated Agricultural Provincial/District Directorates, to fulfill tasks related to training and promoting awareness among farmers.

Author Contributions: Conceptualization, Z.D. and N.B.; methodology, N.B.; validation, Z.D.; formal analysis, Z.D.; investigation, Z.D.; data curation, Z.D.; writing—original draft preparation, Z.D.; writing—review and editing, N.B.; visualization, Z.D.; supervision, N.B.. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Acknowledgments: This article was summarized from Zülüye Duman's Master's Thesis.

Conflicts of Interest: The authors declare no conflict of interest.

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