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CHEMICAL FERTILISER AND PESTICIDE USAGE PREFERENCES IN AVOCADO PRODUCTION FARMS: A CASE OF ANTALYA PROVINCE, TÜRKİYE

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Abstract

Avocado cultivation holds substantial economic significance within tropical fruit production, prompting this research to investigate farmers' attitudes and behaviours concerning fertiliser and pesticide usage. Data were gathered through a survey conducted across 75 avocado farms in the Antalya districts of Alanya, Manavgat, Aksu, and Gazipaşa. The results highlighted that the primary challenge faced in chemical fertiliser use was predominantly due to high fertiliser prices (90.7%). Additionally, 76% of respondents expressed their intent to increase fertiliser application, given sufficient economic resources. However, only 25.3% of producers agreed that augmenting fertiliser usage would enhance yields. Regarding pesticide disposal methods, most growers disposed of pesticide packages through burning (60%), while nearly half of them identified collecting and reusing as the optimal approach for pesticide packaging disposal. The majority of producers acknowledge the detrimental environmental impact of excessive chemical usage. Nonetheless, their persistent use of these chemicals and improper disposal methods for leftover chemicals and packaging reveal inadequate awareness of environmental concerns. Similar to fertilisation, issues about agricultural pesticide supply were predominantly centred on the exorbitant rise in prices (94.7%), followed by inadequate spraying equipment (6.7%) and insufficient credit for pesticide procurement (5.3%). Consequently, providing financial support through incentive programmes, subsidies, or low-interest loan opportunities is imperative to mitigate costs associated with fertiliser and pesticide purchases. Simultaneously, developing environmentally conscious agricultural policies, reinforced by legal regulations, is crucial for monitoring and controlling the use of fertilisers and pesticides.

Key words**:** *avocado, fertiliser, pesticide, preference, production, Türkiye*

INTRODUCTION

Fruit farming is an essential branch of agricultural activity as it provides the necessary vitamins and minerals for healthy nutrition and adds value and export income to the country's economy. To obtain more products per unit area in agricultural production, an effective defence against diseases and pests with fertilisation is an inevitable necessity. Fruit farming should use as much fertiliser as necessary to maximise output; excessive use will raise costs and lower product quality. For this reason, it is imperative to fertilise at the proper moment and dose. In the same way, appropriate action should be taken if diseases and pests result in losses with a financial impact. Agricultural control (cultural, physical, biological, chemical, biotechnological, and integrated control) will greatly reduce yield losses using the proper techniques for pest and disease factors [8]. However, despite the increase in agricultural productivity and total production, the excessive use of intensive production techniques and chemical substances causes significant social, economic, environmental, and ecological problems such as soil erosion, pollution of underground and surface waters, and destruction of natural life. Additionally, intensive use of pesticides against pests causes pests to gain more resistance to these pesticides, thus increasing production costs due to more pesticides [4]. Uncontrolled input practices in agriculture have made farmers reliant on fertilisers and pesticides while also turning the industry that produces and trades these products into a significant problem sector [10]. It is crucial to think about how agricultural products that provide human

nutrition are produced and how sensitive the producers are to the environment and human health while producing them, given the adverse effects of intensive agriculture on the environment and human health. Obtaining, assimilating, and applying the correct agricultural information on the farm are all critical issues in the safe use of chemical fertilisers and pesticides.

The amount of input used in agriculture can be said to be low in Türkiye. When compared to developed countries, the use of fertilisers and pesticides per unit area is seen as insufficient. Pesticide use per area of cropland is 2.32 kg in Türkiye, 2.05 kg in Australia, 2.54 kg in the United States of America (USA), 3.44 kg in France, 4.05 kg in Germany, and 10.82 kg in the Netherlands. In terms of pesticide use per capita, Australia is 2.49 kg/cap, Canada is 2.09 kg/cap, Ecuador is 1.93 kg/cap, and Brazil is 1.77 kg/cap. Türkiye is slightly above the world average (0.37 kg/cap) with 0.64 kg/cap [11]. Regarding fertiliser use per area of cropland, it is 126.63 kg/ha in Türkiye, while in developed countries such as Germany, it is 160.51 kg/ha, France is 159.96 kg/ha, the USA is 124.04 kg/ha, and Australia is 83.33 kg/ha. The most fertiliser used in the world is in Kuwait at 641.89 kg/ha, Taiwan at 468.59 kg/ha, Bahrain at 433.61 kg/ha, and Ireland at 412.29 kg/ha. The highest fertiliser use per capita is in New Zealand (188.62 kg/cap), Ireland (140.57 kg/cap), Canada (134.1 kg/cap), Uruguay (118.35 kg/cap), and Lithuania (115.68 kg/cap). Türkiye uses 34.75 kg of fertiliser per capita, which is higher than the global average (25.72 kg/cap) [11]. However, despite Türkiye's low use of fertilisers and pesticides relative to its land area, intensive farming is practiced in some regions, such as the Mediterranean and Aegean, where there is a high use of fertilisers and pesticides. Therefore, the production activities in these areas need to be evaluated within this framework. Significant contributions could be made in terms of the economy and the ecosystem as a result of avoiding the potential overuse of inputs. In this regard, it is crucial to analyse how pesticides and fertilisers are used during farming.

Considering the detrimental effects of intensive agriculture on the environment and human health is crucial. Therefore, it is essential to pay attention to how agricultural products that contribute to human nutrition are produced and how environmentally friendly the production process is. Fruits play a pivotal role in human nutrition, and avocado stands out compared to other fruits due to its distinctive nutritional profile. It is rich in fat and protein while containing very little sugar. Avocado's fat-soluble components, including vitamins and unsaturated fatty acids present in the fruit matrix, make it unique [9]. Avocado offers several health benefits related to cardiovascular health, weight management, and healthy ageing, as well as protection against DNA damage and osteoarthritis, promoting eye and skin health, and even cancer prevention [6]. The popularity of avocados has risen among those who desire a healthy diet and lifestyle, resulting in a notable increase in demand, growth, and exports over the past two decades.

The avocado (*Persea Americana*) is a tropical fruit native to North, South, and Central America [13]. Avocado cultivation began commercially in 1911 with the contributions of the 'Fuerte' variety from Mexico to California in the USA. Since then, avocado production has witnessed a remarkable global surge, especially with the help of countries such as the USA, Chile, Spain, Indonesia, Israel, and Australia [7, 14]. According to the Food and Agriculture Organization of the United Nations (FAO) [11], production has tripled, rising from 2.7 million metric tonnes in 2000 to 8.7 million metric tonnes in 2021. Furthermore, the harvested area has expanded from 329 thousand ha to 858 thousand ha during the same period (Figure 1). Mexico stands as the largest producer of avocados, accounting for over 28% of global production, with a capacity of 2.4 million metric tonnes in 2021. Following Mexico, notable producers include Colombia (11.3%), Peru (8.9%), and Indonesia (7.7%) [11].

Türkiye began avocado cultivation in the 1970s with the introduction of varieties such

as "Fuerte, Hass, Bacon, and Zutano" by researchers. These varieties were later developed in provinces such as Antalya, Muğla, Mersin, and Adana, which have ideal growth conditions for avocados [3]. Avocado production is now concentrated along Türkiye's Mediterranean coast, particularly in Antalya, which is the leading city in avocado production (23,338 metric tonnes), accounting for 83.2% of the total capacity in 2022. Mersin (16,556 metric tonnes) comes in second with 14.7%, while Muğla (140 metric tonnes) is responsible for only 1.4% of the total avocado production. Production is conducted on 2,498 ha in Antalya and 669 ha in Mersin when it comes to the total orchard area. With 356 ha of orchards, the province of Adana comes in third. Regarding yield values, Mersin ranks first with 147 kg per number of fruit-bearing trees, followed by Antalya with 80 kg per number of fruit-bearing trees, and Hatay with 57 kg per number of fruit-bearing trees. It is evident that when considering yield data, Mersin surpasses Antalya, despite the latter having a larger planted area and greater production volume [15]. The most commonly cultivated varieties in Türkiye include Bacon, Hass, Zutano, Fuerte, Pinkerton, Ettinger, and Wurtz [3].

Türkiye's avocado production experienced modest growth until 2006 but has increased significantly since then. Annual production reached 492 metric tonnes in 2006 and has grown nearly eighty-twofold in the last fifteen years, reaching 40,181 metric tonnes in 2022. Furthermore, the total area of land dedicated to avocado orchards has increased from 73.6 ha in 2006 to 27,282 ha in 2022 [11].

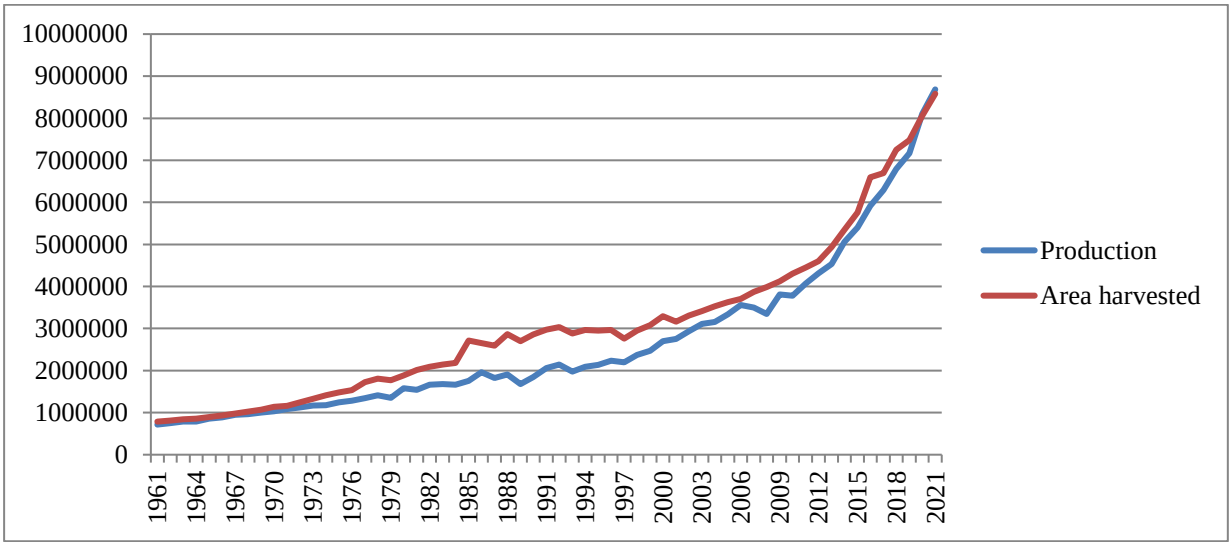

Fig. 1. Avocado production amount (tonnes) and harvested area (da) in the world (1961-2021)
Source: [11].

Regarding the avocado trade in the world, according to FAO [11], Mexico emerged as the top exporting country of avocados, with exports totalling 1.2 million metric tonnes. Peru followed closely with 542 thousand metric tonnes, while the Netherlands, Spain, and Chile exported 415, 141, and 98 thousand metric tonnes, respectively. As the largest importing country, the USA imported 1.2 million metric tonnes. Interestingly, the Netherlands imported 457 thousand metric tonnes in 2021. It is noteworthy that the Netherlands exported significantly despite its lack of avocado production. Türkiye, on the other hand, was a net importer, with export and import quantities of 505 and 6,368 metric tonnes, respectively. In Türkiye, the average yield of avocado cultivation stands at 3.3 tonnes per hectare, which is lower than that of prominent producer countries like Indonesia and Mexico. Notably, El Salvador boasts the highest yield at 34 tonnes per hectare, followed by Samoa (30 tonnes/ha) and Panama (27.7 tonnes/ha).

When examining global data, it becomes evident that Türkiye's yield value is

remarkably lower than that of leading countries. From a regional perspective, this trend is observed in Antalya when compared to other major cities. Therefore, it is expected to be highly beneficial for the avocado sector to determine the awareness and preferences of producers regarding fertilisers and pesticides. This information can help enhance the productivity of both Türkiye's and Antalya's avocado yields. This study aims to ascertain the fertiliser and pesticide preferences of avocado producers in Antalya province based on their environmental awareness and information sources. Avocado cultivation is an economically significant tropical fruit production, and this research also seeks to uncover the attitudes and behaviours of farmers towards the use of fertilisers and pesticides. The data was collected from farms where avocado cultivation was carried out intensively, and the findings will shed light on the farmers' practices. In this regard, the study aims to address knowledge gaps and offer valuable insights to avocado farmers and policymakers.

MATERIALS AND METHODS

The data used in this study are primary data gathered by the survey method from avocado farms in the Antalya districts of Alanya, Manavgat, Aksu, and Gazipaşa. The survey data spans the production years 2021–2022.

The first section of the questionnaire addressed the producers' socio-demographic characteristics, the fertilisers used and their usage patterns, the locations where the fertiliser is supplied, the fertiliser preference, the factors that are effective in deciding on fertilisation, and so on. Questions about pesticide use were included in the second section of the questionnaire.

In the research area, 3,119 avocado producers were found to be registered in the Farmer Registration System. The number of farms to be surveyed was determined using the Simple Random Sampling Method [5]. The formula for the method is:

$$N = \frac{n*\sigma^2}{(n-1)*D^2*\sigma^2} \quad (1)$$

In the formula,
N: Sample size
n: Number of farms in the population
σ^2: Population variance
D^2: $(d/t)^2$, where d denotes a certain deviation from the mean (10%) and t represents the t table value (1.96), which corresponds to the 90% confidence limit.

In light of this information, the number of farms to be surveyed was computed using the formula in equation (1) as 75, with a 90% confidence limit and a 10% margin of error. The data collected from farmers through surveys was analysed using MS Excel and SPSS 26.0 programmes, and tables were constructed and interpreted. Furthermore, the Food and Agriculture Organization of the United Nations [11], the Turkish Statistical Institute [15], and numerous scientific papers were employed in the study.

RESULTS AND DISCUSSIONS

Descriptive Statistics

In this section, the characteristics of the farmers, such as age, gender, education level, agricultural experience, and avocado farming experience, are discussed. According to the research results, it was determined that all of the producers participating in the study from the research area were male, ranging from 28 to 65, with an average of 42.5. When the distribution of the 75 participants was examined by age range, it was determined that 37.20% were fewer than 40. Additionally, 46.7% of them were between 40 and 49, while the remaining 16.10% were 50 and older. Regarding the educational status of the participants, it was found that 36.80% were primary school graduates, 41.90% had completed secondary school, 19.28% were high school graduates, and 2.02% held university degrees. Most participants had completed secondary school, indicating a concentration of education at this level.

It was determined that the producers had a minimum of one year and a maximum of 32 years of agricultural experience, with an average of 9.8 years of experience. In addition to avocados, these producers engage in various other farming activities, including the

cultivation of tomatoes, peppers, cucumbers, olives, kumquats, bananas, oranges, beekeeping, and small ruminant husbandry. Many of these ancillary activities are carried out on separate land plots distinct from their avocado orchards. It was observed that producers who grow kumquats and oranges alongside avocados often combine these products within the same orchards. This is due to the similar climate requirements of avocados and citrus fruits, leading many citrus producers to cultivate avocados alongside their citrus crops and vice versa. The producers were also asked about their total land holdings. The land availability among these producers ranged from a minimum of one decare (da) to a maximum of 600 da. The average total land holding of them was 18.9 da. In the Antalya region, land parcels are typically relatively small, with a maximum of 10 parcels and a minimum of one parcel per farmer. The average number of parcels owned by the farmers was 1.6. Furthermore, the most preferred avocado variety among the surveyed producers was Hass, chosen by 32.4% of respondents. The second most preferred variety was Fuerte, selected by 22.06% of respondents, and the third one was Zutano, with 16.18% of respondents indicating their preference. It is important to mention that the Hass variety is the most popular avocado globally, as per the literature. This preference is attributed to the Hass variety's high yield, high fruit oil content, exceptional taste, and aroma, making it the most popular and widely exported variety internationally [3].

When examining the production of avocado varieties per da, the Fuerte variety ranks first with an average of 1280.6 kg/da, followed by the Zutano variety in second place with 1074.6 kg/da, and the Bacon variety in third place with 900.5 kg/da. However, it is seen that Hass variety production was 673.8 kg. It can be inferred that the larger fruit size of the Fuerte variety compared to other varieties causes the average kg per da to be high.

Fertiliser Use

Information about the fertiliser use of the surveyed producers is given in Table 1. According to the survey, animal manure was the most frequently employed fertiliser by producers, with a rate of 89.3%. Conversely, zinc (Zn), calcium (Ca), and phosphorus (P) reducers were the least utilised, with a mere 1.3% usage rate. Rooting agents were employed by 60% of the farmers to enhance root development, while humic acid and amino acids were adopted by only 2.7% and 9.3% of producers, respectively. Nitrogen (N) emerged as the predominant choice for promoting plant growth, with a rate of 56% among the respondents surveyed.

The farmers were asked about the purposes for which they used fertilisers, and the following trends emerged: 61.9% of those employing N indicated its usage for plant growth; 62.1% of P users cited its application for enhancing flowering; 60.7% of K users and all Ca users stated their preference for quality and taste enhancement. All producers who utilised iron (Fe) and trace elements reported their use for plant nutrition. A significant 95.5% of those employing animal manure indicated efficiency as their motivation. The majority of humic acid and rooting agent users specified rooting as their intended purpose. While 42.9% of amino acid users preferred rooting as their purpose, 14.3% mentioned its use for improving yield, quality, and taste. All of the producers employing leonardite confirmed its role as a soil conditioner. According to a survey conducted, it was observed that a maximum of 2.6 kg/da of N and 2.5 kg/da of P and K were applied, depending on the frequency of chemical fertiliser usage. Furthermore, 795.6 kg of animal manure was utilised per da, while leonardite, an organic substance, was applied at a rate of 237.3 kg/da.

When the producers were questioned about their fertiliser application practices, they all reported that they administered all types of fertiliser through irrigation, except animal manure, leonardite, and trace elements. While all producers uniformly applied animal manure and leonardite to the soil band, they also administered trace elements via foliar application. It was determined that the producers did not differentiate the types or quantities of fertiliser used among the different varieties in the orchards.

Table 1. Information about the fertiliser use

Qualification	Number of Farmers Using	Number of Usage	Average Usage Amount (kg/da)
Nitrogen (N)	42	239	2.6
Phosphorus (P)	29	86	2.5
Potassium (K)	28	86	2.5
Iron (Fe)	6	11	2.1
Animal Manure	67	86	795.6
Humic Acid	2	10	2.0
Rooter	45	460	2.2
Trace Element	16	80	1.0
Amino acid	7	28	1.3
Leonardite	11	11	237.3
Balanced Fertiliser	11	51	2.4
Manganese (Mn)	2	2	2.0

Source: Author's calculation.

When queried about whether the producers had conducted a soil analysis, the majority (65.3%) responded affirmatively. Among them, 25.3% performed it every six months, 24% did it annually, and 14.7% conducted it biennially. When questioned about why they had not conducted a soil analysis, the majority responded that they refrained due to a lack of concern (42.3%) or because they perceived it as costly (38.5%). The remaining farmers cited reasons such as distrust in the accuracy of soil analysis results, disbelief in its advantages, the perception of it being time-consuming, and a lack of knowledge regarding the procedural aspects.

When asked whether they had leaf analysis done, 56% of the producers who participated in the survey said no. Among them, the majority (39.4%) conducted leaf analysis annually, while 33.3% did it semi-annually and 27.3% biennially. Most producers responded that they refrained due to a lack of concern (35.7%); 26.2% of them stated that they perceived it as costly. It was determined that 14.3% of the producers thought that leaf analysis took a long time, and 7.1% of them said that there were no laboratories performing soil and leaf analysis in their region. The remaining farmers stated reasons such as doubt in the accuracy of leaf analysis data, mistrust about its benefits, and a lack of knowledge about where to apply. For the necessary conditions for soil and leaf analysis, 42.7% of producers believe that analyses should be completed more rapidly, while 32% opine that machines used for measuring soil nutrients should be provided to farmers free of charge. On the other hand, in a study conducted by Yilmaz et al. [18] in the same province of Türkiye, 72% of the producers reported that they had not conducted soil and crop analyses. Reasons provided included the absence of a laboratory in their district (43%), absence of positive outcomes from previous requests (11%), unrealistic recommendations (11%), lack of significance attributed to the issue (11%), and impossibility (9%).

When surveyed about the alterations in fertiliser usage concerning rising fertiliser prices and adjustments based on economic sufficiency, 84% of participating producers reported a reduction in fertiliser usage due to price increases. Additionally, 76% indicated their intention to increase fertiliser application, provided they had sufficient economic resources. Furthermore, the participants were questioned regarding their receipt of training in fertilisation techniques and their willingness to partake in a fertilisation course if one were arranged. 61.3% of the producers reported not having received any training in fertilisation techniques. Among those queried about their potential attendance, 50.7% expressed their intention to attend such a course if organised. When queried about visits by extension agents, the majority (54.7%) of producers indicated that extension agents had not visited them, while 36% reported being unfamiliar with the extension agents. Also, 96% of the producers stated that they are not members of

a cooperative or non-governmental organisation.

Subsequently, they were asked about their methodology for determining the type of fertiliser they use. The findings revealed that 41.3% of the producers base their fertiliser choice on recommendations from agricultural engineers, 37.3% rely on suggestions from fertiliser dealers, and 34.7% make their decisions based on their knowledge and experience. Similarly, in a study carried out in the Thrace region [2], farmers primarily relied on the agricultural engineer (41.48%), followed by their own experience (37.79%) when deciding on fertiliser use. However, according to a study conducted in Isparta province, Türkiye, the most frequently used source for selecting the type of fertiliser (37.76%) was the producer's own knowledge and experience [17]. Moreover, Pandey and Diwan [12], in their study conducted within intensive agricultural regions in India, discovered that farmers predominantly rely on past experiences when applying fertilisers.

When the survey participants were asked about the challenges encountered in utilising chemical fertilisers, it was discovered that 90.7% of them faced issues attributable to high fertiliser prices. Besides, challenges such as insufficient credit for fertiliser procurement and inadequate regulatory oversight in the fertiliser sector were identified. Likewise, Yuzbasioglu [19], in a study conducted within the Tokat province of Türkiye, identified that the most prevalent issue faced by producers using chemical fertilisers was the escalation in fertiliser prices, accounting for 55.2%. This issue of price increases was followed by challenges such as low purchasing power, diminished product prices, and inadequate subsidies. Conversely, in the study conducted by Yilmaz et al. [18], producers highlighted various issues in order of priority during their interviews: expensive fertilisers used in drip irrigation (24%), bureaucratic hurdles in accessing fertiliser support (13%), insufficient information on fertiliser usage (11%), ineffective fertilisers (11%), lack of oversight in fertiliser sales and counterfeit products (10%), mistrust of dealers (6%), and reliance on foreign countries (1%).

All growers utilise drip irrigation systems, with an additional 2.7% employing mini-spring irrigation systems. Unlike in Mexico, the native region of avocados, furrow irrigation is seldom utilised by growers in the Antalya region. Growers favour drip irrigation systems due to avocados' vulnerability to fungal diseases and the inherent advantages that drip irrigation systems offer over other irrigation methods. The percentage of producers who express agreement (including both 'strongly agree' and 'agree') that increasing fertiliser usage would enhance yields stands at 25.3%. Meanwhile, 37.3% of growers indicated their indecision on the matter. When asked about the environmental impact of excessive fertiliser use, 60% of producers strongly agreed, with an additional 26.7% agreeing.

Pesticide Use

Today, as the adverse impacts of extensive and intensive chemical usage for pest control have become evident, research into the use of controlled pesticides has commenced. Nevertheless, it can be argued that the application of harmful chemicals persists at the producer level.

Since avocado is a relatively new crop in Türkiye, numerous pests do not yet recognise it, resulting in a lower pest population compared to other plants. Among the primary pests identified in the surveyed Antalya region are aphids, slugs, and grasshoppers. When questioned about the pesticides used to manage these pests, 96% of growers reported using copper (Cu) to control fungal diseases that may occur in avocado roots, 10.7% used pesticides for aphids, and 6.7% employed pesticides targeting snails. Surveyed producers were queried about their pesticide application methods, with all stating the utilisation of Cu through drip irrigation on plants and the application of aphids and slug pesticides using a backpack sprayer. When asked about the quantity of pesticides applied per da, it was found that producers applied a minimum of two kg and a maximum of three kg of Cu, averaging 2.3 kg per da. The average quantity used for aphids was determined to be 0.25 g, while for slugs, it was 1.25 kg.

The examination of the criteria employed by growers in determining their spraying practices revealed that 48% of growers applied spray treatments without prior observation of pests and diseases. Additionally, 30.7% of the growers reported reliance on recommendations provided by dealers, while 4% indicated adherence to suggestions offered by the technical staff of the Provincial/District Directorate of Agriculture. Contrarily, in Ates et al.'s [1] study on tomatoes in the Antalya province of Türkiye, the majority of growers (74.4%) applied pesticides upon observing disease symptoms.

When questioned about the sources they relied on for diagnosing diseases and pests, it was revealed that 37.3% of the producers conducted the diagnosis themselves. Another prevalent method employed by the producers for diagnosing diseases and pests was consulting pesticide dealers, which accounted for 40%. Moreover, a minority, 5.3% of the producers, sought a diagnosis from the technical staff of the Provincial/District Directorate of Agriculture. When queried about the sources they relied on for selecting pesticides, it was discovered that producers primarily chose pesticides based on recommendations from pesticide dealers (41.3%) and agricultural engineer consultants (41.3%). Additionally, 26.7% of the producers relied on their knowledge and experience for pesticide selection. A smaller percentage, 10.7%, based their pesticide choices on recommendations from Provincial/District Agriculture personnel, while 6.7% considered soil analysis results. Merely 1.3% of producers relied on information from written sources. According to the study conducted by Yilmaz et al. [17], the most frequently used sources for pesticide use were consulting an agricultural engineer (47.25%) and making decisions based on personal experience (29.97%).

The sources utilised by producers when adjusting pesticide doses are as follows: recommendations from agricultural engineer consultants (41.3%), suggestions from dealers (40%), reliance on their knowledge and experience (28.0%), recommendations from Provincial/District Agriculture personnel (10.7%), and consideration of soil analysis results (9.3%). However, upon analysing whether the recommended pesticide application doses were adhered to, it was found that 81.3% of the participating producers used pesticides below the recommended doses. When questioned about this during the survey, it was deduced that many producers generally applied pesticides slightly below the recommended doses due to escalating pesticide prices. In Ates et al.'s study [1], a substantial proportion of producers followed pesticide dosage instructions: 54.5% utilised the specified amounts on the package, and 25.6% exceeded the recommended doses, totalling 80.1%. Similarly, Yilmaz et al. [18] found that 59% of producers determined spraying doses based on pesticide label instructions, 58% relied on recommendations from pesticide dealers, and 17% used their own knowledge and experience. Moreover, 68% of producers applied the recommended dose precisely, while 32% disregarded the recommendations, with 12.5% increasing the dosage on average. Additionally, Wang and Liu [16] revealed that 61.9% of farmers interviewed in their study used pesticides at the recommended dose, while 21.9% exceeded the recommended dose. When asked, 'Will excessive use of pesticides in production damage the environment?' 94.7% of the producers responded affirmatively. Those who responded positively were further questioned about the perceived damages. It was revealed that 61.3% of them believed excessive pesticide use could lead to crop burning and reduced yields; 52% expressed concerns about harm to domestic and wild animals; and 33.3% anticipated the emergence of rust and stains on the products.

When surveyed about the disposal methods for unused pesticide packages, it was observed that the majority of responding growers disposed of pesticide packages through burning (60%), while 20% buried the packages in the ground post-spraying, and 12% irregularly discarded the packages into the environment. Despite these results, nearly half of the growers (49.3%) indicated that the

optimal method for disposing of pesticide packaging was collecting and reusing it. Approximately 32% of respondents suggested that pesticide packaging should be regularly stored in appropriate environmental locations, while an additional 14.7% recommended burying it in the ground. Almost all producers (93.3%) confirmed having leftover or unused pesticides. When questioned about their storage practices for these pesticides, it was revealed that 74.2% stored them in warehouses and storage facilities, 22.6% utilised other storage areas, and 3.2% stored them at home. Upon analysing the issues encountered by the surveyed producers concerning the supply of agricultural pesticides, it was determined that the most prominent problem is the steep and rapid escalation in prices (94.7%), trailed by inadequate spraying equipment (6.7%) and insufficient credit for pesticide procurement (5.3%). Likewise, in Yilmaz et al.'s study [18], farmers identified the most significant issue (96%) related to pesticide use as the sharp and sudden rise in pesticide prices.

CONCLUSIONS

This study aims to understand the fertiliser and pesticide preferences of avocado producers in Antalya province, Türkiye, based on their environmental awareness and information sources. Avocado cultivation is an economically significant tropical fruit production, and this research seeks to uncover the attitudes and behaviours of farmers towards the use of fertilisers and pesticides. The data collected from avocado farms by the survey method in the Antalya districts of Alanya, Manavgat, Aksu, and Gazipaşa will shed light on the farmers' practices and offer valuable insights to avocado farmers and policymakers. The number of farms to be surveyed was determined using the Simple Random Sampling Method, and it was computed as 75.

According to the results, the most preferred avocado variety among the surveyed producers was Hass, chosen by 32.4% of respondents, similar to the rest of the world. It was seen that animal manure was the most frequently employed fertiliser by producers, with a rate of 89.3% when the most used fertiliser was examined. When questioned about their fertiliser application practices, all producers reported that they administered all types of fertiliser through irrigation, except animal manure, leonardite, and trace elements. Furthermore, it was observed that the percentage of those who stated that the amount of fertiliser used decreased with the price increase was 84%. At the same time, 76% indicated their intention to increase fertiliser application, provided they had sufficient economic resources. The difficulties encountered in the use of chemical fertilisers were mostly (90.7%) due to fertiliser prices. Besides, challenges such as insufficient credit for fertiliser procurement and inadequate regulatory oversight in the fertiliser sector were identified. 61.3% of the producers reported not having received any training in fertilisation techniques, and almost all farmers (96%) stated that they are not members of a cooperative or non-governmental organisation.

The percentage of producers who agree that increasing fertiliser usage would enhance yields is only 25.3%. Regarding the environmental impact of excessive fertiliser use, the majority of producers stated that excessive fertiliser use will negatively affect the environment.

Regarding the pesticides used to manage the pests, 96% of growers reported using Cu to control fungal diseases that may occur in avocado roots, 10.7% used pesticides for aphids, and 6.7% employed pesticides targeting snails. Also, producers stated the utilisation of Cu through drip irrigation on plants and the application of aphids and slug pesticides using a backpack sprayer.

When the disposal methods for unused pesticide packages were questioned, the majority of responding growers disposed of pesticide packages through burning (60%), while 20% buried the packages in the ground post-spraying, and 12% irregularly discarded the packages into the environment. Despite these practices, nearly half of the growers indicated that the optimal method for disposing of pesticide packaging was

collecting and reusing it. Almost all producers (93.3%) confirmed having leftover or unused pesticides.

Finally, upon analysing the issues encountered by the surveyed producers concerning the supply of agricultural pesticides, it was determined that the most prominent problem is the steep escalation in prices (94.7%), followed by inadequate spraying equipment (6.7%) and insufficient credit for pesticide procurement (5.3%). Consequently, it is evident that the most critical issue is the high cost associated with purchasing fertilisers and pesticides. As a solution, providing financial support such as incentive programmes, subsidies, or low-interest loan opportunities to reduce costs in fertiliser and pesticide purchases may be useful in solving the rapidly increasing price problem that producers face most.

Most producers acknowledge the detrimental impact of excessive chemical usage on the environment. However, their continued use of these chemicals, coupled with inappropriate disposal methods for leftover chemicals and packaging, indicates an inadequate awareness of environmental concerns. This situation not only endangers their health but also poses risks to public health, environmental sustainability, and overall environmental well-being.

Furthermore, the research results underscore the significant role played by pesticide and fertiliser dealers within the agricultural information system in the region. Given that commercial organisations, such as pesticide dealers, primarily operate for profit, relying solely on these entities as the main source of information for producers is not advisable. Such reliance can render producers unable to safeguard their interests, forcing them into a passive role rather than an active one. To foster a more positive framework, this structure needs revision. Counselling services should provide producers with the necessary information while safeguarding their interests. Therefore, organising producers into cooperatives and empowering them to address issues through the employment of expert agricultural engineers is vital for effective and sustainable problem-solving. This approach not only resolves pesticide-related concerns within cooperatives but also tackles various other issues, particularly marketing challenges. Moreover, agricultural training programmes are instrumental in motivating producers to shoulder responsibility for environmental problems. Thus, increased producer awareness of the prudent use of fertilisers and pesticides leads to enhanced product yields with fewer inputs, ultimately reducing unit production costs. Training sessions for producers should continually emphasise the significance of soil and plant analyses in preventing excessive fertiliser use, as well as the necessity of integrated pest management practices during spraying.

Last but not least, the development of agricultural policies with an environmentally conscious approach, coupled with legal regulations, is essential to monitoring and controlling the use of fertilisers and pesticides. The knowledge gained could serve as a significant benchmark for future comparisons in Türkiye as well as assessments with other avocado-producing regions around the world.

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