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Pest and Disease Management Practices and Producers' Perceptions of Chemical Pesticide Use in Pistachio Production

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Abstract: Pistachio is an important agricultural product in Turkey. However, pests and diseases are still major problems for sustainable production. The objectives of this study were to determine the pest and disease management practices, sources of information, perception of pesticide use, and the factors influencing the concern of producers on chemical pesticides. The study was carried out on 100 pistachio producers in Şehitkamil district of Gaziantep Province. Data were collected via face-to-face surveys and analyzed using descriptive statistics and an ordered probit model. The results revealed that producers mainly rely on their own experience, agricultural input dealers and experienced family members as sources of information on pest and disease management. Most frequent biotic constraints were processionary caterpillar (Thaumetopoea solitaria), leaf spot disease caused by Pseudocercospora pistacina and bark beetle (Hylesinus vestitus). The producers most preferred the chemical control methods and the application of integrated control practices was still low. Results also showed that pesticide prices were generally high and producers varied in how concerned they were about chemical pesticide use. The ordered probit outputs reveal that producers' concern on chemical pesticide use has been significantly influenced by education level, pistachio orchard size and pesticide price perception. In particular, producers who thought pesticide prices were high were more likely to report higher levels of concern. The findings point to the importance of enhancing extension services, providing access to accurate technical information, and promoting integrated pest management strategies for the sustainable cultivation of pistachio.

Keywords: *Pistachio, Pesticide, Ordered Probit Model*

INTRODUCTION

Pistachio (*Pistacia vera L.*) is one of the most important nut crops grown in arid and semi-arid regions due to its high economic value, drought tolerance and adaptability to marginal lands [1];[7]. Türkiye is one of the top pistachio producing countries in the world [8] and pistachio cultivation is a major source of income for many rural households [10], especially in Southeastern Anatolia. In addition to its contribution to farm income and employment, pistachio production is also significant for regional development and agricultural exports [22].

According to the FAO (2024) figures, Türkiye ranks second in the world in pistachio production after the United States. However, in terms of yield per unit area the country still lags behind several major producing countries, despite its strong position in respect of total production. This indicates that there are important limitations in productivity and that producers are unable to reach the productive potential of pistachio orchards. Thus, identifying and managing factors that negatively affect yield and production efficiency have become increasingly important to enhance the competitiveness and sustainability of the pistachio sector [13].

Biotic factors are especially important among these restrictions. Pistachio production is impacted by many pests and diseases, reducing the yields and quality and increasing production costs [20]. To reduce these losses, producers often rely on chemical pesticides to protect orchards and maintain their productivity [15];[27]. However, the debate on the use of pesticides in agricultural production systems has been amplified with growing concerns on environmental sustainability, food safety, human health and increasing input costs [27]. Thus, it is important to understand the pest and disease management practices of producers and their perception regarding pesticide use to develop effective and sustainable pest management strategies [3].

Previous studies on pistachio production have been mainly focused on the occurrence and distribution of major pests and diseases affecting pistachio orchards [12];[4]; [9]. Many studies have been conducted on the biology, life cycle, seasonal abundance, population dynamics and natural enemies of economically important pistachio pests [16];[14];[1]. Moreover, many researchers have tested the efficacy of chemical pesticides and alternative control methods to control the major pests and diseases ([26]; [6]; [23]. Other researchers have dealt with the reduction of dependency on chemical pesticides and the enhancement of sustainability of pest management programs through biological control, cultural control, and integrated pest management (IPM) strategies [14];[6];[19]. Besides, the economic losses due to pests and diseases and the economic efficiency of different pest control methods have been assessed in several studies [2];[11];[20].

While these studies have provided useful technical and economic information, relatively little attention has been paid to perceptions, attitudes and concerns of producers about pesticide use. In particular, empirical evidence on the socio-economic and farm-level determinants of producers' concern about the use of chemical pesticides is still sparse.

This study differs from previous research in that it incorporates information on pest and disease occurrence, management practices, pesticide-related perceptions and producer characteristics into a common analytical framework. Furthermore, the study employs an ordered probit model to identify the factors influencing the concern of the producers on the use of chemical pesticide, moving beyond descriptive analyses. Thus, the study contributes to the literature by offering evidence on both behavioral and economic facets of pesticide application in pistachio cultivation.

The main purpose of this study was to investigate pest and disease control practices of pistachio producers, their attitudes towards the use of chemical pesticides and the factors influencing the level of their concern about pesticide use. The results are expected to provide useful insights for extension services, policymakers and researchers interested to promote more sustainable pest management practices in pistachio production.

MATERIAL AND METHOD

The main data of the study were acquired by face-to-face surveys with pistachio producers in Şehitkamil region of Gaziantep Province, Türkiye in 2025. The size of the sample was calculated by proportional sampling. [21];[1].

$$n = \frac{Np(1-p)}{(N-1)\sigma_{p_x}^2 + p(1-p)} \quad (1)$$

Where n is the sample size, N is the population size, p is the population proportion (assumed to be 0.5), and $\sigma_{p_x}^2$ is the variance of the proportion.

The data of the Şehitkamil District Directorate of Agriculture and Forestry indicate that around 7,000 producers are involved in pistachio production in the research region [24]. The required sample size was estimated based on the proportional sampling formula as 95 respondents with a level of confidence of 95% with margin of error of 10%. To strengthen reliability and representativeness of the study, the number of completed surveys was increased to 100. Data collected from the surveys was analyzed by descriptive statistics, percentage

distributions and ordered probit model. Descriptive statistics and percentage distributions were used to summarize producers' socio-economic characteristics, pest and disease management practices and perceptions regarding pesticide use, while the ordered probit model was used to identify the factors affecting producers' concern regarding chemical pesticide use.

The Ordered Probit Model is especially effective when the dependent variable is made up of ordered categories such as Likert-scale responses measuring attitudes, perceptions or levels of worry [18]. In this study, the dependent variable was measured on a five-point ordinal scale, ranging from "not concerned at all" to "very concerned". Hence, the correct analysis was the Ordered Probit Model. Unlike the multinomial logit or multinomial probit models which explicitly ignore the ordinal nature of the dependent variables, the Ordered Probit Model takes into account the ranking structure of the responses, which results in more efficient and consistent estimates when the dependent variable is ordered [5];[25]. The model was thus utilized to explore the influence of selected socio-economic and farm-related factors on producers' concern regarding chemical pesticide use.

RESULTS AND DISCUSSION

Socio-economic and farm characteristics of producers

Socio-economic and farm characteristics of pistachio farmers in the research area are presented in TABLE I. The results show that pistachio production is generally operated by experienced farmers and is an essential component of farming activities. The farm structures are characterized by small landholdings and scarce irrigated land, which is an indicator of the traditional production pattern of pistachio agriculture in the region. The results also show a significant variability in farm resources and economic capacity among growers. Moreover, it seems that producers' engagement in cooperatives and formal plant protection training programs is minimal, suggesting possible limits to access collective action, technical support and knowledge transfer methods. Results indicate the need for strengthening extension services and farmer groups to encourage the adoption of contemporary production practices and improve the sustainability of pistachio production.

TABLE I. SOCIO-ECONOMIC AND FARM CHARACTERISTICS OF PRODUCERS

Socio-economic characteristics	**Mean**	**Std. Dev.**
Age	46.69	11.66
Education (years)	8.99	4.19
Farming experience (years)	21.54	13.45
Pistachio income (annual, TRY)	615,500.00	1,450,633.00
Off-farm income (monthly, TRY)	27,940.83	20,027.05
Farm characteristics	**Mean**	**Std. Dev.**
Total land area (da)	41.97	107.65
Number of parcels	3.33	2.61
Irrigated land area (da)	6.16	24.45
Pistachio cultivation area (da)	30.78	72.53
Farm characteristics	**N**	**%**
Registered in *FRS	69	69.00
Cooperative membership	5	5.00
Plant protection training	10	10.00

*Farmer Registration System

Information sources and knowledge level regarding pest and disease management

TABLE II shows the sources of information on pest and disease management used by producers, based on experience and informal sources. Sources of information used are personal experience, agricultural input dealers and experienced family members, institutional and written sources play only a limited role. This result indicates that practical knowledge and local networks are still the main channels of information exchange between producers.

Results also show that, on the whole, producers feel their knowledge of pest and disease management is sufficient. Yet, the low utilization of formal information sources, such as extension personnel and technical experts, may be a concern in terms of the accuracy and timeliness of information used in management decisions. Therefore, improving access to reliable technical information, and strengthening extension service, could result in more effective and sustainable pest and disease management practices.

TABLE II. SOURCES OF INFORMATION ON PEST AND DISEASE MANAGEMENT AND PERCEIVED LEVEL OF KNOWLEDGE

Variable	Response	%
Information sources*	Own knowledge and experience	72
	Agricultural input dealers	68
	Experienced family members	59
	Internet	33
	Neighboring farmers	32
	Technical support engineers of companies	7
	Technical staff of the Ministry	5
	Printed materials	1
Perceived level of pest and disease management knowledge	Completely insufficient	14
	Slightly sufficient	14
	Moderately sufficient	26
	Quite sufficient	35
	Completely sufficient	11

*Multiple responses allowed

Major pests and diseases and their perceived economic impact

TABLE III shows that pistachio producers encounter a wide range of pest and disease problems. Processionary caterpillar (*Thaumetopoea solitaria*), leaf spot disease caused by Pseudocercospora pistacina and bark beetle (*Hylesinus vestitus*) were the most frequently reported biotic constraints in the study area. In terms of economic impact, producers identified flat-headed root borer (*Capnodis cariosa*), processionary caterpillar and leaf spot disease as the most damaging problems. The findings suggest that the prevalence of a pest or disease does not necessarily correspond to its perceived economic impact. Therefore, pest and disease control methods should account both the incidence of biotic agents and the extent of economic losses they generate.

TABLE III. OCCURRENCE OF MAJOR PESTS AND DISEASES AND PERCEIVED ECONOMIC DAMAGE

Pest/Disease	Occurrence* (%)	Most damaging pest* (%)
Processionary caterpillar (Thaumetopoea solitaria)	97	27
Leaf spot disease (Pseudocercospora pistacina)	96	22
Bark beetle (*Hylesinus vestitus*)	86	15
Flat-headed root borer (*Capnodis cariosa*)	84	28
Pistachio psyllid (*Agonoscena pistaciae*)	61	10
Pistachio scale insect (*Pistaciaspis pistaciae*)	60	2
Pistachio twig borer (*Kermania pistaciella*)	56	3
Pistachio seed wasp (Megastigmus pistaciae)	17	1
Pistachio fruit moth (Schneidereria pistaciicola)	14	1
Black seed wasp (*Eurytoma plotnikovi*)	14	0

*Percentage of respondents, Multiple responses allowed

Pest and disease management practices

As seen in TABLE IV, chemical control is the most common strategy employed against most

of the pest and disease encountered in pistachio production. The application of integrated control measures is still very restricted, however some growers are using a combination of chemical and cultural practices. The percentage of farmers that do not use any control measures is low, indicating that the awareness of pest and disease control is generally high. These results show the persistent reliance on chemical pesticides and point to the necessity for promoting more sustainable and integrated pest management solutions.

TABLE IV. CONTROL METHODS APPLIED AGAINST MAJOR PESTS AND DISEASES

Pest/Disease	Control Method		
	No control (%)	Chemical control (%)	Chemical and Cultural control (%)
Processionary caterpillar	-	75	22
Leaf spot disease	2	75	19
Bark beetle	2	61	23
Flat-headed root borer	3	53	28
Pistachio psyllid	3	55	3
Pistachio scale insect	2	45	13
Pistachio twig borer	-	39	17
Pistachio seed wasp	-	14	3
Pistachio fruit moth	-	10	4
Black seed wasp	1	11	2

Fertilization practices and information sources

Pistachio producers routinely use fertilizers, but the frequency of application varies from field to farm (TABLE V). The findings also indicate that the producers preferred chemical fertilizers to the organic fertilizers. As in the case of pest and disease management, fertilization decisions are mainly dependent on personal experience and on the knowledge of agricultural input merchants and family members, with professional advisory services and written sources being relatively less important. These findings indicate that informal knowledge networks still have a significant position in farm management decisions regarding nutrient management.

TABLE V. FERTILIZATION PRACTICES AND INFORMATION SOURCES USED BY PISTACHIO PRODUCERS

Variable	Response	%
Fertilization frequency	Twice a year or more	34
	Once a year	49
	Never	17
	Total	**100**
Type of fertilizer used	Chemical fertilizers only	25
	Mainly chemical fertilizers	31
	Organic fertilizers only	18
	Mainly organic fertilizers	11
	Total (Producers applying fertilizers)	**83**
Information sources on fertilization*	Own knowledge and experience	55
	Agricultural input dealers	49
	Experienced family members	48
	Internet	19
	Neighboring farmers	16
	Technical support engineers of companies	7
	Printed materials	6
	Technical staff of the Ministry	5

*Multiple responses allowed

Risk and economic perceptions regarding chemical pesticide use

TABLE VI reveals that producers range in the degree of concern they have about the usage of chemical pesticides. Many producers said they were not very concerned, but a large minority of producers reported being somewhat or highly concerned. This means that farmers do not have the same impression of risk of pesticide. From the table, it can also be seen that the prices of pesticides are generally considered to be excessive with most growers rating them as expensive or extremely expensive. This means that the usage of chemical pesticides is associated with risks and economic factors. Thus, producers' pest management decisions and readiness to adopt alternative or integrated control measures may be influenced by the high perceived cost of pesticides and different levels of worry about their use.

TABLE VI. PRODUCERS' PERCEPTIONS REGARDING CHEMICAL PESTICIDE USE AND PESTICIDE PRICES

Variable	Response	%
Concern level regarding the use of chemical pesticides	Not concerned at all	23
	Slightly concerned	25
	Moderately concerned	20
	Quite concerned	17
	Very concerned	15
	Total	**100**
Perceived expensiveness of pesticide prices	Cheap	1
	Slightly expensive	4
	Moderately expensive	8
	Quite expensive	28
	Very expensive	59
	Total	**100**

Factors affecting producers' concern regarding chemical pesticide use

TABLE VII presents the variables included in the ordered probit model. Producers' concern regarding the use of chemical pesticides was used as the dependent variable and was measured on a five-point ordinal scale ranging from "not concerned at all" to "very concerned". The explanatory variables included age, education level, pistachio orchard size and perceived expensiveness of pesticide prices. Dummy variables were created for age, education and pistachio area categories to examine potential differences among producer groups. In addition, the original five-point scale measuring pesticide price perception was recoded into three categories due to the limited number of observations in the lower response categories.

TABLE VII. DESCRIPTION OF VARIABLES USED IN THE ORDERED PROBIT MODEL

Variables	Description	Mean
Concern (dependent)	**Concern level regarding the use of chemical pesticides** 0=Not concerned at all 1=Slightly concerned 2=Moderately concerned 3=Quite concerned 4=Very concerned	2.75
Age 2	**Dummy variable** 41-50 years:1, otherwise:0	0.31
Age 3	**Dummy variable** 51 years and above:1, otherwise:0	0.37
Education 1	**Dummy variable** Primary school or below:1, otherwise:0	0.28
Education 2	**Dummy variable** Middle school and high school:1, otherwise:0	0.51

Pistachio Area 1	**Dummy variable** (0-9 da):1, otherwise:0	0.40
Pistachio Area 2	**Dummy variable** (10-29 da):1, otherwise:0	0.25
Pesticide Price Perception	**Perceived expensiveness of pesticide prices** Cheap, slightly and moderately expensive:0 Quite expensive:1 Very expensive:2	1.46

The ordered probit model was statistically significant (LR $\chi^2 = 29.44$, $p < 0.001$), indicating that the selected explanatory variables jointly contributed to explaining producers' concern regarding the use of chemical pesticides. The results revealed that producers with primary school education or lower were less likely to report higher levels of concern compared with the reference education group. Similarly, producers with smaller areas of pistachios (0–9 da) had fewer levels of worry about pesticide use. On the contrary, the perception of pesticide costs being expensive had a positive and significant effect on the level of worry, indicating that producers who regarded pesticide prices to be expensive were more likely to be more concerned about the use of chemical pesticides. Additionally, producers 51 years and older tended to express higher levels of concern, at 10% significance (TABLE VIII).

TABLE VIII. ORDERED PROBIT ESTIMATES FOR PRODUCERS' CONCERN REGARDING THE USE OF CHEMICAL PESTICIDES

Variables	Coefficient	Std. Error
Dummy Age 2	-0.107	0.337
Dummy Age 3	0.718*	0.379
Dummy Education 1	-0.982**	0.459
Dummy Education 2	-0.059	0.356
Dummy Pistachio Area 1	-0.662***	0.257
Dummy Pistachio Area 2	0.123	0.292
Pesticide Price Perception	0.471***	0.156

N = 100, LR $\chi^2 = 29.437$***, McFadden $R^2 = 0.090$

CONCLUSION

The objective of this study was to explore sources of information, pest and disease management strategies, views towards pesticide use, and factors affecting concern about chemical pesticides of pistachio producers. The findings indicated that producers largely base their pest and disease control decisions on their own experience, agricultural input dealers, and experienced family members, whereas formal extension agencies and printed sources play a somewhat limited role.

The results showed that pistachio plantations are affected by a wide range of pests and illnesses. The most common biotic limitations were processionary caterpillar (*Thaumetopoea solitaria*), leaf spot disease caused by *Pseudocercospora pistacina* and bark beetle (*Hylesinus vestitus*). Producers were mostly relying on chemical control methods and the combined use of chemical and cultural control methods was restricted. This result suggests that chemical pesticides continue to be used in pistachio farming.

The study also found that producers usually considered pricing of pesticides to be high and had various levels of concerns on the use of chemical pesticides. The ordered probit results indicated that the level of education, size of pistachio orchard, and perception of pesticide prices greatly influence producers' worry about chemical pesticide use. In particular, growers who thought pesticide prices were more expensive were more likely to indicate higher levels of anxiety.

Overall, the results imply that improved access to credible technical information and

development of extension services could contribute to more effective and sustainable pest management strategies. More training efforts on integrated pest management should be increased and alternative control methods should be advocated to reduce the dependence on chemical pesticides, while preserving the productivity and profitability in pistachio production.

Ethics Statement

Ethical approval for this study was obtained from the Ethics Committee of Kahramanmaraş Sütçü İmam University.

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