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Research Article

The Effect of Soil Analysis-Based Fertilization and Soil Analysis Subsidies on Sunflower Production and Cost in Tekirdağ Province

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Abstract

This study was carried out in sunflower production enterprises in Tekirdağ province, which had soil analysis and benefited from the subsidies, and enterprises that did not have soil analysis. Product cost and income changes caused by soil analysis and soil analysis subsidies were revealed. Three of the laboratories with the highest number of soil analyses in Tekirdağ province were included in the sampling, and a total of 100 producers were interviewed, including 60 people who applied to the laboratories in 2015 and benefited from soil analysis subsidies and 40 producers with similar characteristics who did not benefit. Operating expenses were determined by the budget analysis method, and production expenses were determined by the alternative cost method. It was determined that a total of 1.10 hours of the labor force and 0.82 hours of machinery were used in the enterprises that had the analysis done, while a total of the 1.25 hours of labor force and 0.93 hours of machinery were used in the enterprises that did not have. It was determined that sunflower producers who had soil analysis used 12.17% less nitrogen, and 5.26% more phosphorus than those who did. The enterprises with soil analysis used 13.24% less labor, 2.18% less seed, 6.31% less fertilizer, and 0.99% less pesticide than the enterprises that did not have soil analysis. The average sunflower yield was 238.12 kg da^{-1} in the enterprises that had the analysis and 224.25 kg da^{-1} in the enterprises that did not have the analysis, and the relative profit was calculated as 1.08 in the enterprises that had the analysis and 1.01 in the enterprises that did not have the analysis. It was determined that sunflower producers who had soil analysis obtained a 6.19% increase in yield and a 25.08% increase in gross profit compared to the producers who did not have soil analysis. Although sunflower cultivation was profitable in both production styles, sunflower cultivation was more profitable in the enterprises with soil analysis. The importance of having a soil analysis and applying the amount of fertilizer according to the soil analysis results was revealed in the higher profitability rate and yield value in the producer group that had soil analysis.

Keywords: Cost, fertilizing, soil analysis, soil analysis subsidy, sunflower

Tekirdağ İlinde Toprak Analizine Dayalı Gübrelemenin ve Toprak Analizi Desteklemelerinin Ayçiçeği Üretimi ve Maliyeti Üzerine Etkisi

Özet

Bu çalışmada, Tekirdağ ilinde ayçiçeği üretimi gerçekleştiren, toprak analizi yaptıran ve destekten yararlanan işletmeler ile toprak analizi yaptırmayan işletmelerde ayçiçeği yetiştiriciliğinde, toprak analizi ve toprak analizi desteklemelerinin ürün maliyetinde ve gelirde meydana getirdiği değişimler ortaya konmuştur. Tekirdağ ilinde toprak analiz sayısı en fazla olan laboratuvarlardan üç tanesi örnekleme dâhil edilmiş olup, 2015 yılında laboratuvarlara başvuran ve toprak analiz desteğinden yararlanan toplam 60 kişi ve benzer özelliklere sahip toprak analizi desteğinden yararlanmamış olan 40 üretici olmak üzere, toplam 100 üretici ile görüşülmüştür. İşletme giderleri bütçe analiz yöntemi ve üretim giderleri ise alternatif maliyet unsuru yöntemi ile belirlenmiştir. Analiz yaptıran işletmelerde toplam 1,10 saat iş gücü, 0,82 saat çeki gücü, analiz yaptırmayan işletmelerde toplam 1,25 saat işgücü, 0,93 saat çeki gücü kullanıldığı belirlenmiştir. Toprak analizi yaptıran ayçiçeği üreticilerinin toprak analizi yaptırmayan üreticilere göre %12,17 daha az azot, %5,26 daha fazla fosfor kullandıkları belirlenmiştir. Toprak analizi yaptıran işletmeler, yaptırmayan işletmelere göre iş gücü kullanımında %13.24, tohumda %2.18, gübrede %6.31, ilaçta %0.99 oranında daha az masraf yapmışlardır. Ortalama ayçiçeği verimi analiz yaptıran işletmelerde 238.12 kg/da, analiz yaptırmayan işletmelerde 224.25 kg/da, nispi kâr analiz yaptıran işletmelerde 1.08, analiz yaptırmayan işletmelerde 1.01 olarak hesaplanmıştır. Toprak analizi yaptıran ayçiçeği üreticilerinin toprak analizi yaptırmayan üreticilere göre verimde %6,19, brüt karda %25,08 artış elde ettikleri belirlenmiştir. Her iki üretim tarzında da ayçiçeği yetiştiriciliği kârlı olmakla birlikte, toprak analizi yaptıran işletmelerde ayçiçeği yetiştiriciliği daha kârlı görülmektedir. Toprak analizi yaptıran üretici grubunda karlılık oranının ve verim değerinin daha yüksek çıkmasında toprak analizi yaptırmanın ve gübre miktarını toprak analiz sonuçlarına göre uygulamanın önemi ortaya konulmuştur.

Anahtar Kelimeler: Ayçiçeği, gübreleme, maliyet, toprak analizi, toprak analiz desteği

1. Introduction

Soil is recognized, as the most important natural resource as it is at the center of all agricultural activities. Soil analysis is of great importance in soil protection. Soil analysis is also important in terms of preventing excessive fertilizer use and eliminating the use of deficient fertilizers. With soil analysis, it is possible to determine the deficiencies of nutrients that will ensure the growth and development of the plant in the soil to be produced and to determine how much, when and how to give which fertilizer according to the analysis result. Again, using fertilizer, according to the analysis result, is the most economical way for the farmer. Fertilizations that are not based on analysis may damage the soil and the environment, as well as the economy and the farmer's budget (Küçükkaya and Özçelik, 2014).

The Ministry of Agriculture and Forestry initiated soil analysis subsidies in 2005 in addition to direct income support to encourage correct and adequate fertilization soil analysis. In 2005, it was decided to provide soil analysis subsidy with the first article of the Council of Ministers Decision annexed to the decree dated 28 March 2005 and numbered 2005/8629. Based on this, it was determined how the soil analysis support would be received with article b of the 11th article of the Communiqué No. 2005/21 in the Official Gazette dated 30 April 2005, and since 2006, a soil analysis subsidy payment of 2.5 TL per decare was made. In the Communiqué No. 2006/27 published in 2006, additional soil analysis subsidy was provided to producers who had soil analysis done together with Direct Income Support payments. A maximum of 60 decares was paid for each soil analysis. In 2008, a separate communiqué was published in the Official Gazette dated 31 December 2008, and numbered 27097 regarding the payment of Soil Analysis Support Payment to the Farmers Included in the Farmer Registration System dated 2008/70 and 18 March 2010, and a subsidy payment of 2.5 TL per decare and up to 50 da for each soil analysis was made. In the communiqués numbered 2009/41 published in the Official Gazette dated 8 July 2009, and finally 2010/10 published in the Official Gazette dated 18 March 2010 and numbered 27525; soil analysis subsidy was added to the diesel and chemical fertilizer support and renewed as diesel, chemical fertilizer and soil analysis subsidy payment to farmers included in the farmer registration system. Soil Analysis subsidy was determined as 2.5 TL per decare, and soil analysis condition was introduced to benefit from chemical fertilizer subsidy on 50 decares or more lands. Soil analysis subsidy was determined as 2.5 TL per decare in the decision regarding agricultural supports in 2014, and the decision was published in the Official Gazette dated 12 April 2014.

According to the communiqué dated 03 June 2014 and numbered 29019 and the communiqué dated 27 May 2015 and numbered 29368, soil analysis subsidy payments were given to farmers with diesel and fertilizer subsidy. Regarding Decision No. 2016/8791 on Agricultural Supports to be made in 2016, soil analysis subsidy payments were abolished. The the communiqué numbered 30183, published in the Official Gazette dated 17 September 2017, stated that soil samples would be taken by the technical staff of authorized soil analysis laboratories using a coordinate determining device. As of 2017, soil analysis subsidy payments were made to laboratories, not producers.

Sunflower (*Helianthus annuus L.*) is one of the most important oilseed crops in the world and has the highest cultivation area and production in Turkey. Approximately 50% of the country's vegetable oil requirement is obtained from sunflower. Sunflower is an important oil plant for vegetative crude oil production due to its high oil content (22-50%) in its seed content. Sunflower oil is one of the oils with high nutritional value. Sunflower accounts for 9.52% of the world's vegetative crude oil production. In Turkey, 46% of vegetative crude oil production is supplied by sunflowers (Palabıyık, 2022). Sunflower, important in industrial plants, is cultivated as oil, and snack. Sunflower seeds can be consumed as snacks and the remaining part of the sunflower seed after the oil is extracted is used as an animal meal. Sunflower seeds contain 35-55% oil and 15-30% protein (Atakişi, 1999).

According to the Food and Agriculture Organization of the United Nations (FAO) data, 50,229,567 tons of sunflower production was performed on 27,874,284 hectares of land in the world in 2020. Sunflower production amount, 22,705,559 tons in 1990, increased more than double in the last 30 years. In Turkey, oil sunflower is mainly produced in the Thrace Region and Konya. Turkey's sunflower cultivation area was about 0.9 million hectares in 2021, accounting for 3.46% of the world's sunflower cultivation area. Total sunflower production was 2.42 million tons in the 2020/21 production season. In the 2020/21 production season, 399,531 tons of sunflowers were produced in Tekirdağ province. The share of sunflower production in Tekirdağ province in Turkey was 16.54%, and the share of cultivation area was 18.46% (Anonymous, 2021). Tekirdağ province ranks first in Turkey regarding oil sunflower cultivation area and production amount.

Some studies on soil analysis and soil analysis subsidies were conducted in Turkey and other countries in previous years (Sipahi and Kızılaslan, 2003; Akar, 2007; Sönmez et al., 2008; Kızılaslan and Gülaç, 2012; Nambiro and Okoth, 2013; Ataseven et al., 2014; Küçükkaya and Özçelik, 2014; Özçelik and Güldal, 2014; Mishra et al., 2015; Çönoğlu et al., 2016; Güldal and Özçelik, 2017; Kızıloğlu and Kızılaslan, 2017; Tanrıverdi, 2017; Haroll Kokoye et al., 2018; Micha et al., 2018; Polat, 2018; Güneş, 2019; Yüzbaşıoğlu, 2019; Harou et al., 2020; Sarılar, 2020; Kalabak and Aslan, 2021). In this study, enterprises producing sunflowers in Tekirdağ province had soil analysis and benefited from the subsidy, and enterprises that did not have soil analysis were compared in terms of socio-economic aspects. In addition, the changes in product cost and income caused by soil analysis and soil analysis subsidy in sunflower cultivation were revealed, and the differences between the amounts of fertilizer used were determined.

2. Material and Method

2. 1 Material

The material of the study consisted of data obtained from primary and secondary sources. The primary data of the research consisted of the data obtained from the surveys conducted with the producers who had soil analysis and received subsidies in 2015 in the laboratories that accepted the highest number of samples for soil analysis and gave fertilizer recommendations in Tekirdağ province. In addition, the producers who did not benefit from the soil analysis subsidy, which were 2/3 of the number of producers benefiting from soil analysis subsidy, were interviewed. Besides, previous studies on the subject and data from public and private organizations were also used.

2. 2 Method

Three of the laboratories with the highest number of soil analyzes were included in the sampling. According to purposeful sampling method, a total of 60 producers (20 from each of the producers who applied to the laboratories and benefited from soil analysis subsidy in 2015) and 40 producers with similar characteristics (land size, crop pattern, etc.) who did not benefit from soil analysis subsidy in the regions where the same laboratories were located were interviewed, in other words, the survey was conducted with a total of 100 producers.

Descriptive statistics and cross tables were used to analyze of the data obtained. In terms of the variables analyzed, whether there was a difference between the groups was determined by the chi-square test for discrete data, the t-test for variables with normal distribution when the number of groups was 2 for continuous data, and the Mann-Whitney U test for variables that did not show normal distribution.

Input use amounts and production costs for sunflower production were calculated separately for producer groups with and without analysis (receiving and not receiving subsidy). Operating costs were determined by the budget analysis method, and production costs were determined by the alternative cost method. Variable costs in the study consisted of fertilizer, pesticide, equipment rent, labor, seed costs, crop insurance, and revolving fund interest. Family labor wage and equipment expenses were priced based on the opportunity cost principle. The interest of the variable costs (revolving fund interest) represents the opportunity cost and refers to the interest income that could have been obtained in case the amount of production inputs had been used in another field. The agricultural credit interest of the Turkish Agricultural Bank is used by taking into account the time the capital remains in agricultural production (Kıral et al., 1999). The half of the credit interest rate (6%) determined by the Turkish Agricultural Bank for crop production in 2021 was used to calculate revolving fund interest. In the study, fixed costs comprised land rent and general administrative expenses, and 3% of production costs were taken as general administrative expenses. In the calculation of gross production value, the selling price of the product received by the farmer was taken into account. In 2021, the soil analysis subsidy determined for the calculation made on every 50 decares was 40 TL. Landowners with 50 decares and more parcels received 40 TL soil subsidies per sample.

The following formulas were used to calculate gross and absolute (net) profits (Açıl and Demirci, 1984; Kıral et al., 1999).

$$Gross\ profit\ = Gross\ production\ value - Variable\ costs \quad (1)$$

$$Absolute\ (net)\ profit\ = Gross\ production\ value - Production\ costs \quad (2)$$

$$Relative\ profit\ = Gross\ production\ value\ /\ Production\ costs \quad (3)$$

3. Results and Discussion

3.1 General Characteristics of the Producers and Enterprises

Some socio-economic characteristics of the producers are given in Table 1. The average age of the producers who had soil analysis was 51.73 years, while the average age of those who did not was 51.70 years. The average period of education of the producers who had the analysis was 9.50 years, while the average education period of the producers who did not was 8.05 years. The agricultural experience of the producers who had the analysis was 27.80 years, while that of the producers who did not was 29.70 years. The average number of family members of the producers who had the analysis was 4.13, which was determined as 3.85 in the group of producers who did not have the analysis. As a result of the statistical analysis, it was determined that the period of education of the producers varied at a 5% significance level (p=0.034) according to the producer groups. In the study conducted by Çönoğlu et al. (2016) in İzmir province, it was determined that the period of education and the number of individuals in the families of the producers who benefited from soil analysis support were higher than the producers who did not benefit from soil analysis support, and their agricultural experience was slightly lower, which were similar to the results of the study.

The total cultivated land size of the producers who had the analysis was 649.80 da, and the total cultivated land size of the producers who did not have the analysis was 319.43 da. It was determined that the total cultivated land size of the producers who had the analysis was considerably higher than those who did not. As a result of the statistical analysis, it was determined that the own land size (p=0.001) and total cultivated land size (p=0.002) of the producers varied according to the producer groups at 1% significance level, and the size of the land they cultivated through rent varied at 10% significance level (p=0.091). In the study conducted by Çönoğlu et al. (2016), it was determined that there was a statistically significant difference between the farming groups according to the benefit from soil analysis support in terms of own, rented and total cultivated land, which was similar to the research result.

The irrigated land in the group of producers with soil analysis was 48.37 da, while the irrigated land in the group of producers who did not have soil analysis was 18.33 da. While the parcel size of sunflower production of the producers with soil analysis was 58.45 da, this value was found as 21.50 da in the group of producers who did not have soil analysis. As a result of the statistical analysis, it was determined that the size of the land on which the producers produced sunflowers varied at 1% (p=0.000), and the size of irrigated land varied at 10% (p=0.098) significance level according to the producer groups.

Table 1. Socio economic characteristics of the producers

Socio economic characteristics	Soil analysis	No soil analysis	Average	P
Age	51.73	51.70	51.72	0.988
Education period (year)	9.50	8.05	8.92	0.034**
Agricultural experience (year)	27.80	29.70	28.56	0.437
Number of family members	4.13	3.85	4.02	0.231
Own land size (da)	430.72	199.78	338.34	0.001***
Rented land size (da)	217.42	117.90	177.61	0.091*
Total cultivated land size (da)	649.80	319.43	517.65	0.002***
Irrigated land size (da)	48.37	18.33	36.35	0.098*
Sunflower cultivation area (da)	58.45	21.50	43.67	0.000***

Significant at * %10 significance level, ** %5 significance level, *** %1 significance level

The rate of producers who stated that they had non-agricultural income was 48.33% in the group of producers who had soil analysis and 52.50% in the group of producers who did not (Table 2). It was seen that the rate of producers who stated that they had agricultural insurance in the group of producers who had soil analysis (66.67%) was slightly higher than the rate of producers who did not have soil analysis (62.50%). In the enterprises that had soil analysis done, the rate of producers (85%) who performed both plant and animal production was higher than the producers (72.50%) who did not have soil analysis done. 50% of the producers who had the analysis and 45% of the producers who did not have the analysis stated that they received training on fertilization.

While 8.33% of the producers who had soil analysis stated that they made contracted production, this rate was found to be 10% in the group of producers who did not have soil analysis. The rate of certified seed use was relatively high in both enterprise groups, and 98% of the producers stated that they used certified seeds. As a result of the chi-square test, it was determined that having a non-agricultural income, having agricultural insurance, receiving fertilization training, making contracted production, the types of activities they were engaged in, and the type of seed they used did not vary according to the producer groups.

Table 2. General information of the producers and the enterprises

General information		Soil analysis		No soil analysis		Total		P
		Number	%	Number	%	Number	%	
Non-agricultural income	Yes	29	48.33	21	52.50	50	50.00	0.683
	No	31	51.67	19	47.50	50	50.00	
Agricultural insurance	Yes	40	66.67	25	62.50	65	65.00	0.669
	No	20	33.33	15	37.50	35	35.00	
Activity type	Plant	9	15.00	11	27.50	20	20.00	0.129
	Plant and animal	51	85.00	29	72.50	80	80.00	
Receiving fertilization training	Yes	30	50.00	18	45.00	48	48.00	0.624
	No	30	50.00	22	55.00	52	52.00	
Contracted production	Yes	5	8.33	4	10.00	9	9.00	0.776
	No	55	91.67	36	90.00	91	91.00	
Seed type	Certified	59	98.33	39	97.50	98	98.00	0.773
	Conventional	1	1.67	1	2.50	2	2.00	

3.3 Input Use and Cost Analysis in Sunflower Production

In the research area, three ploughings were prepaed for soil preparation before sunflower planting in March-April. Plough was used during the first tillage, disc harrow was used during the second tillage, and harrow was used during the third tillage. Planting was done in April-May using a pneumatic seeder. Fertilization was done twice, the first fertilization was done with the seed during planting, and the other was done after planting in June-July. Although sunflower plants' need for phosphorus is not high, phosphorus fertilizer should be applied to create a specific yield. All phosphorus fertilizer was applied with planting. During planting, 20-20-0 or 15-15-15 fertilizer was used as bottom fertilizer; fertilization was done once after planting until harvest and urea or A.N. (26) fertilizers were generally used. After planting, intermediate plowing was done once in April-May with a hoeing machine. Weed spraying was done once in June-July. Harvesting was carried out in August-September.

The use of human labor and machinery according to production processes in sunflower production is given in Table 3. It was determined that a total of 1.10 hours of human labor and 0.82 hours of machinery were required in the enterprises with soil analysis. Of the total human labor, 15.45% was used in plowing, 8.18% in disc harrow, 7.27% in harrowing, 21.82% in planting-fertilization, 8.18% in intermediate plowing, 10.91% in fertilization, 9.09% in spraying, 7.27% in harvesting and 11.82% in transportation. Of the total machinery, 20.73% was used in plowing, 10.98% in disc harrow, 9.76% in harrowing, 14.63% in planting-fertilization, 10.98% in intermediate plowing, 7.32% in fertilization, 6.10% in spraying, 9.76% in harvesting and 9.76% in transportation.

A total of 1.25 hours of human labor and 0.93 hours of machinery were used in enterprises that did not have soil analysis. Of the total human labor, 14.40% was used in plowing, 8% in disc harrow, and 7.20% in harrowing, 19.20% in planting-fertilization, 8.80% in intermediate plowing, 12.80% in fertilization, 11.20% in spraying, 7.20% in harvesting and 11.20% in transportation. Of the total machinery, 19.35% was used in plowing, 10.75% in disc harrow, 9.68% in harrowing, 12.90% in planting-fertilization, 11.83% in intermediate plowing, 8.60% in fertilization, 7.53% in spraying, 9.68% in harvesting and 9.68% in transportation.

According to production activities, the highest human labor was used in planting-fertilization, followed by plowing, transportation, fertilization, spraying, intermediate plowing, and plowing with disc harrow, harvesting, and harrowing with a disc harrow. The highest use of machinery was in plowing, followed by planting-fertilization, intermediate plowing, plowing with a disc harrow, harrowing, harvesting, transportation, fertilization, and spraying, respectively.

Table 3. Use of labor and tractive power in sunflower production (h da^{-1})

Production processes	Soil analysis				No soil analysis			
	Human labor		Machinery		Human labor		Machinery	
	h	%	h	%	h	%	h	%
Plowing	0.17	15.45	0.17	20.73	0.18	14.40	0.18	19.35
Disc harrow	0.09	8.18	0.09	10.98	0.10	8.00	0.10	10.75
Harrowing	0.08	7.27	0.08	9.76	0.09	7.20	0.09	9.68
Planting-fertilization	0.24	21.82	0.12	14.63	0.24	19.20	0.12	12.90
Intermediate plowing	0.09	8.18	0.09	10.98	0.11	8.80	0.11	11.83
Fertilization	0.12	10.91	0.06	7.32	0.16	12.80	0.08	8.60

Spraying	0.10	9.09	0.05	6.10	0.14	11.20	0.07	7.53
Harvesting	0.08	7.27	0.08	9.76	0.09	7.20	0.09	9.68
Transportation	0.13	11.82	0.08	9.76	0.14	11.20	0.09	9.68
Total	1.10	100.00	0.82	100.00	1.25	100.00	0.93	100.00

In the enterprises with soil analysis, 0.35 kg of seed per decare, and 4.00 kg of nitrogen and 4.00 kg of phosphorus were used as bottom fertilizer. Fertilization was applied once after planting, and 2.00 kg nitrogen was applied. In the enterprises that did not have soil analysis, 0.36 kg of seed per decare was used, 3.80 kg of nitrogen and 3.80 kg of phosphorus were used as bottom fertilizer, and 2.93 kg of nitrogen was applied after planting. As pesticides, herbicide was applied once, and both groups used 0.15 kg of herbicide per decare.

As a result of the evaluations, it was determined that sunflower producers who had soil analysis used 12.17% less nitrogen and 5.26% more phosphorus than the producers who did not have soil analysis. In the study conducted by Akar (2007), it was determined that sunflower farms that had soil analysis used 14% less nitrogen and 23.3% more phosphorus than the farms that did not have soil analysis, which was similar to the study results.

Table 4. Input use in sunflower production (kg da^{-1})

Inputs	Soil analysis	No soil analysis
Seed	0.35	0.36
N (20-20-0)	4.00	3.80
P (20-20-0)	4.00	3.80
N (Urea/A.N. 26)	2.00	2.93
Herbicide	0.15	0.15

The agricultural processes carried out in sunflower production were determined, and the costs of human labor, machinery, and input costs were calculated separately (Table 5). In the enterprises that had soil analysis, 40 TL da^{-1} of machinery costs were done in plowing, 25 TL da^{-1} in plowing with a disc harrow, 20 TL da^{-1} in harrowing, 3.60 TL da^{-1} of labor, 30 TL da^{-1} of machinery, 40.83 TL da^{-1} of input costs in planting, and 30 TL da^{-1} of machinery costs in intermediate plowing. In fertilization, 1.80 TL da^{-1} labor, 20 TL da^{-1} machinery, 4 TL da^{-1} input costs, in spraying, 1.50 TL da^{-1} labor, 20 TL da^{-1} machinery, 21.92 TL da^{-1} spraying costs were done. In harvesting, 30 TL da^{-1} of machinery cost was done and 1.95 TL da^{-1} of labor, and 25 TL da^{-1} of machinery cost were done in transportation.

In the enterprises that did not have soil analysis, machinery costs were equal to those with soil analysis. Labor costs were found to be 3.60 TL da^{-1} for planting, 2.40 TL da^{-1} for fertilization, 2.10 TL da^{-1} for spraying, and 2.10 TL da^{-1} for transportation. Input costs were 40.76 TL da^{-1} for planting, 5.86 TL da^{-1} for fertilization and 22.14 TL da^{-1} for spraying.

Table 5. Agricultural processing costs in sunflower production (TL da^{-1})

Production processes	Soil analysis				No soil analysis			
	Human labor	Machinery	Input	Total	Human labor	Machinery	Input	Total
Plowing	0.00	40.00	0.00	40.00	0.00	40.00	0.00	40.00
Disc harrow	0.00	25.00	0.00	25.00	0.00	25.00	0.00	25.00
Harrowing	0.00	20.00	0.00	20.00	0.00	20.00	0.00	20.00
Planting-fertilization	3.60	30.00	40.83	74.43	3.60	30.00	40.76	74.36
Intermediate plowing	0.00	30.00	0.00	30.00	0.00	30.00	0.00	30.00
Fertilization	1.80	20.00	4.00	25.80	2.40	20.00	5.86	28.26
Spraying	1.50	20.00	21.92	43.42	2.10	20.00	22.14	44.24
Harvesting	0.00	30.00	0.00	30.00	0.00	30.00	0.00	30.00
Transportation	1.95	25.00	0.00	26.95	2.10	25.00	0.00	27.10

Expense items in sunflower production and their shares in production costs are given in Table 6. The total variable costs were calculated as 369.51 TL da^{-1}, the total fixed costs as 131.09 TL da^{-1} in the enterprises with soil analysis, and the total production costs were determined as 500.60 TL da^{-1}. The share of variable costs in total production costs was 73.81%, and the share of fixed costs was 26.19%. Sunflower cultivation is one of the best examples of mechanized agriculture. Therefore, the share of the machinery costs in the production costs is one of the cost elements that significantly affect the production costs and the share of the machinery costs in the production costs has the highest value. This was followed by the land rent value, which was included in fixed costs. The share of seed costs used in planting was 5.46%, the share of pesticide costs was 4.38%, and the share of fertilizer costs was 3.50%. The soil analysis fee was included as a variable cost item in the enterprises with soil analysis and constituted 7.34% of total production costs.

In the enterprises that did not have soil analysis, the total variable costs were calculated as 336.18 TL da^{-1}, the total fixed costs were calculated as 130.09 TL da^{-1}, and the total production costs were determined as 466.27 TL da^{-1}. The share of variable costs in total production costs was 72.10%, and the share of fixed costs was 27.90%. While the highest share in production costs was the machinery costs (51.47%), the land rent value, included in fixed costs, constituted 25.74% of production costs. The share of seed costs was 5.99%, the share of pesticide costs was 4.75%, and the share of fertilizer costs was 4.01%.

Crop insurance is also a variable cost element, and the share of insurance costs in production costs was found to be 1.28% in the enterprises that had soil analysis and 1.59% in the enterprises that did not have soil analysis. Small family enterprises generally cultivate sunflowers in the region due to the land structure suitable for mechanized agriculture and where family labor is used. In this context, the average general administrative expenses of family enterprises were 11.09 TL da^{-1} in the enterprises having soil analysis and 10.09 TL da^{-1} in those that did not.

The enterprises with soil analysis spent 13.24% less on labor, 2.18% less on seeds, 6.31% less on fertilizers, and 0.99% less on pesticides than the enterprises that did not have soil analysis. In the study conducted by Akar (2007) in the Thrace Region, it was determined that sunflower enterprises that had soil analysis made 2.8% less expenditure on fertilizer, and 12.2% less expenditure in labor use compared to the enterprises that did not have soil analysis, which was similar to the result of the research.

Table 6. Total production costs in sunflower production

Cost items	Soil analysis		No soil analysis	
	TL da^{-1}	%	TL da^{-1}	%
Human labor	8.85	1.77	10.20	2.19
Machinery	240.00	47.94	240.00	51.47
Seed	27.31	5.46	27.92	5.99
Fertilizer	17.52	3.50	18.70	4.01
Pesticide	21.92	4.38	22.14	4.75
Crop insurance	6.40	1.28	7.43	1.59
Soil analysis fee	36.75	7.34	0.00	0.00
Revolving interest	10.71	2.14	9.79	2.10
Variable costs	369.51	73.81	336.18	72.10
General administrative expenses	11.09	2.22	10.09	2.16
Land rent	120.00	23.97	120.00	25.74
Fixed costs	131.09	26.19	130.09	27.90
Total production costs	500.60	100.00	466.27	100.00

Economic analysis results are given in Table 7. The average sunflower yield was determined as 238.12 kg da^{-1} in the enterprises with soil analysis and 224.25 kg da^{-1} in the enterprises that did not have soil analysis. The cost of 1 kg of sunflower was calculated as 2.10 TL kg^{-1} in the enterprises with soil analysis and 2.08 TL kg^{-1} in the enterprises that did not have soil analysis. The sales price (2.10 TL kg^{-1}) was the same as the cost in the enterprises that had soil analysis and above the cost in those that did not have the analysis. However, when the analysis support given in the enterprises with soil analysis was included in the production value, the enterprises in this group made more profit.

Relative profit was calculated as 1.08 in the enterprises that had soil analysis and 1.01 in the enterprises that did not have soil analysis, and it was concluded that sunflower cultivation was more profitable in the enterprises that had soil analysis.

Table 7. Economic analysis results of sunflower production

Economic analysis	Soil analysis	No soil analysis
Yield (kg da^{-1})	238.12	224.25
Production cost (TL kg^{-1})	2.10	2.08
Selling price (TL kg^{-1})	2.10	2.10
Gross production value (TL da^{-1})	500.05	470.93
Gross production value + subsidy (TL da^{-1})	538.05	
Gross profit (TL da^{-1})	168.54	134.75
Production value per 100 TL of variable cost (TL da^{-1})	145.61	140.08
Net profit (TL da^{-1})	37.45	4.66
Relative profit (TL da^{-1})	1.08	1.01

As a result of the evaluations, it was determined that sunflower producers who had soil analysis achieved a 6.19% increase in yield and a 25.08% increase in gross profit compared to producers who did not have soil analysis. Although sunflower cultivation was profitable in both groups, it was more profitable in enterprises with soil analysis. In the study conducted by Akar (2007) in the Thrace Region, it was determined that sunflower farms that had soil analysis achieved a 10.5% increase in yield compared to those that did not. In the study conducted by Gülaç (2011), it was determined that the enterprises that had soil analysis obtained 11.39% more yield than the enterprises that did not, and in the study conducted by Özçelik and Güldal (2014), it was determined that the enterprises that had soil analysis obtained 1.62% more yield than the enterprises that did not. The results of the research were similar to the results of the studies conducted by Akar (2007), Gülaç (2011), and Özçelik and Güldal (2014).

4. Conclusion

It was determined that the size of the land cultivated by the producers who had soil analysis was higher than the producers who did not. The small land size of the producers who did not have soil analysis can be considered as one of the factors limiting the utilization of soil analysis subsidies. The fact that the lands were small and fragmented made it necessary for the producers to have a separate a soil analysis for each land, and it was possible to say that the producers did not have soil analysis done because this process increased the cost.

Gross profit was considered in the economic evaluation of the contribution of soil analysis. When the enterprises' gross profits were evaluated, it was calculated that sunflower producers who had soil analysis done had a gross profit of 25.08% more than those who did not. Although this difference in profitability was primarily due to the soil analysis support, it also indicated that the limited land capital was used more effectively in the enterprises that had the analysis done.

It was calculated that there was a positive yield difference of around 6.19% in sunflower farms with soil analysis. Producers who had soil analyses performed fertilizer applications, which had an important place among inputs, with a fertilization program prepared based on the analysis results under expert control. In this way, the negative effects of chemical fertilizers on the environment are reduced and economic and high yield potential is provided. According to the research results, the importance of having a soil analysis and applying the amount of fertilizer according to soil analysis results was revealed in the higher profitability rate, and yield value in the producer group that had soil analysis done.

It was observed that the cost of sunflower was lower in case the producers had soil analysis and that soil analysis positively affected enterprise income. It is possible to say that this situation will also be effective protecting the environment and natural resources. It is very important to provide practical training to producers on sampling, not to buy fertilizer without soil analysis results, to make subsidies conditional on soil analysis, and to remove the area limitation. In addition to these, it is foreseen that it would be beneficial to implement fertilizer sales according to the analysis reports of laboratories, to expand training, and extension activities and to explain the obligation to have analysis done to producers who make their subsistence from the field.

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