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ARAŞTIRMA MAKALESİ **RESEARCH ARTICLE**

Determination of Plant Nutrition Capacities of Agricultural Areas by Soil Analysis: Example of Süleymanpaşa District of Tekirdağ Province

Tarım Alanlarının Bitki Besleme Kapasitelerinin Toprak Analizleri ile Belirlenmesi: Tekirdağ İli Süleymanpaşa İlçesi Örneği

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Abstract

Soil is one of the most important components of agricultural production. Therefore, healthy soils are increasingly needed for food security, nutrition goals and combating climate change. Soil health is critical to both ecosystem balance and human life. Soil not only supports plant growth, it also performs many important functions, from storing water to sequestering carbon. In addition, soil health is a critical factor not only for agriculture and food production but also for general environmental health, combating climate change and sustainable development. In this study, it was aimed to determine the sustainable productivity capacities by evaluating the analysis results of 60 soil samples taken from the fields in Süleymanpaşa district of Tekirdağ province, which were exposed to intense agricultural activities with wheat-sunflower rotation. The average pH, total salt, organic matter and lime contents of the samples taken were determined as 7.28, % 0.40, % 1.29 and % 3.62 respectively. It was determined that the majority of the soils (47 units) were in the "loam" texture class. The total N contents of the soil samples were determined as the lowest % 0.02 and the highest % 0.15. The average P, K, Ca, Mg, Fe, Mn, Zn and Cu contents of the soil samples were determined as 14.94, 211.68, 5393.15, 408.86, 13.60, 12.71, 0.88 and 1.05 mg kg^{-1} respectively. When the average organic matter and total N contents in the samples were evaluated, it was determined that they had low levels of organic matter and total N contents. Considering the average values of the soil samples, it was determined that they were "high" in terms of Ca and Fe; "low" in terms of Mn and "sufficient" in terms of P, K, Mg, Zn and Cu. The biggest benefit of these studies is that, the correct use of fertilizer also has positive benefits in terms of economy and the environment. For this reason, organic fertilizers must be included in the fertilization programmes of soils with low organic matter.

Keywords: Soil analysis, Wheat, Sunflower, Organic Fertilizer, Soil productivity

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Öz

Toprak, tarımsal üretimin en önemli bileşenlerinden biridir. Bu nedenle gıda güvenliği, beslenme hedefleri ve iklim değişikliğiyle mücadele için sağlıklı topraklara giderek daha fazla ihtiyaç duyulmaktadır. Toprak sağlığı, hem ekosistem dengesi hem de insan yaşamı için kritik bir öneme sahiptir. Toprak, sadece bitkilerin büyümesini desteklemekle kalmaz, aynı zamanda suyun depolanmasından karbon tutmaya kadar birçok önemli işlevi yerine getirmektedir. Bunun yanı sıra toprak sağlığı sadece tarım ve gıda üretimi için değil genel çevre sağlığı, iklim değişikliğiyle mücadele ve sürdürülebilir kalkınma için de kritik bir faktördür. Bu çalışmada, Tekirdağ ili Süleymanpaşa ilçesinde bulunan ve buğday-ayçiçeği ekim nöbetiyle yoğun tarımsal faaliyetlere maruz kalan tarlalardan alınan toplam 60 adet toprak örneğinin analiz sonuçları değerlendirilerek sürdürülebilir verimlilik kapasitelerinin belirlenmesi amaçlanmıştır. Alınan örneklerin ortalama pH, toplam tuz, organik madde ve kireç içerikleri sırasıyla 7.28, % 0.40, % 1.29 ve % 3.62 olarak belirlenmiştir. Toprakların büyük bir çoğunluğunun (47 adet) "tın" tekstür sınıfında olduğu tespit edilmiştir. Toprak örneklerinin toplam N içerikleri en düşük % 0.02 ve en yüksek % 0.15 olarak belirlenmiştir. Toprak örneklerinin ortalama P, K, Ca, Mg, Fe, Mn, Zn ve Cu içeriklerinin sırasıyla 14.94, 211.68, 5393.15, 408.86, 13.60, 12.71, 0.88 ve 1.05 mg kg^{-1} olduğu tespit edilmiştir. Alınan örneklerdeki ortalama organik madde ve toplam N içerikleri değerlendirildiğinde düşük organik madde ve toplam N içeriklerine sahip olduğu saptanmıştır. Toprak örneklerine ait ortalama değerler dikkate alındığında Ca ve Fe bakımından "yüksek"; Mn bakımından "düşük"; P, K, Mg, Zn ve Cu bakımından "yeterli" düzeyde oldukları tespit edilmiştir. Bu çalışmaların en büyük faydası, doğru gübre kullanımının ekonomi ve çevre açısından da olumlu faydalarının bulunmasıdır. Özellikle bu çalışmadan da anlaşılan düşük organik madde içeren toprakların gübreleme programlarına mutlaka organik gübrelerin de dahil edilmesi gerçeğidir.

Anahtar Kelimeler: Toprak analizi, Buğday, Ayçiçeği, Organik Gübre, Toprak verimliliği

1. Introduction

In addition to the increasing population both in the world and in our country, we are faced with a major climate change. Climate change is among the causes of many natural events such as heavy and irregular rainfall, floods, inundations, extreme droughts, dust clouds, long-term frosts, storms, earthquakes, etc. For this reason, future plans should be made for agricultural production in line with these realities, and particular attention should be paid to preserving the productivity potential of soils (Bellitürk, 2019). It has been reported that there have been decreases in the organic matter, nutrient content and water holding capacity of soils, especially due to intensive use in recent years (Bellitürk, 2016; Aslam et al., 2020). One of the clearest examples of this is clearly seen in many regions of the Trakya Region, including the Süleymanpaşa district (Bellitürk and Sağlam, 2005; Bellitürk, 2011; Bellitürk, 2018; Büyükfiliz et al., 2022; Gürbüz and Bellitürk, 2021; Polat et al., 2019). It has been determined that the uncontrolled use of chemical fertilizers and agricultural pesticides to obtain the highest yield from a unit area has caused environmental pollution, contamination of underground water resources, and chemical residues in cultivated products have seriously threatened human and animal health (Kırımhan, 2005). Therefore, it is aimed to increase not only the productivity but also the cultivation of healthy products by protecting the soil with organic fertilizers obtained in completely natural ways that do not disturb the natural balance and are friendly to humans and the environment (Akan and Yanmaz, 2015; Demirkıran, 2021). One of the materials that will allow the soil to heal without disturbing its natural balance and away from chemical fertilizers is worm manure. With the spread of worm manure and the academic studies revealing its contributions to the soil and the environment, scientists have begun to call this situation the "organic green revolution" (Bellitürk, 2018). Organic earthworm, also known as vermicompost, is the product obtained as a result of the composting process of organic waste using earthworms. Vermicompost is a good organic fertilizer and an environmentally friendly production material with superior properties that can be easily used in organic agriculture (Bellitürk, 2016; Bellitürk and Çelik, 2021; Görres and Bellitürk, 2012).

According to *Table 1*, when the data for 2023 is taken into account, it is seen that the total chemical fertilizer used in our country is 7 million tons and the chemical fertilizer consumption of Tekirdağ province is 136 thousand tons. However, due to the low consumption of organic fertilizer, a clear figure can not be given. When we look at the long-term average of chemical fertilizer use in Tekirdağ province, it is seen that the highest consumption was recorded in 2016 as 210 thousand tons. It is stated in *Table 1* that the highest chemical fertilizer use in Türkiye was in 2020 with 7.1 million tons. It is thought that the fluctuations in the use of chemical fertilizers in our country in the last few years are due to reasons such as epidemics, economic recession, global energy crisis, etc. (Anonymous, 2024a).

Table 1. The amount of chemical fertilizer consumed in Turkey and the amount of chemical fertilizer consumed in Tekirdağ province

Year	Chemical fertilizer consumption in Tekirdağ province (ton)	Chemical fertilizer consumption in Türkiye (ton)
2013	180 713	5 813 612
2014	150 807	5 471 518
2015	159 501	5 507 779
2016	210 613	6 744 922
2017	187 159	6 332 872
2018	139 755	5 411 881
2019	186 414	6 087 714
2020	193 950	7 143 144
2021	151 329	6 480 101
2022	157 369	5 902 539
2023	136 471	7 030 779

The agricultural areas of Süleymanpaşa district for the last 5 years are given in *Table 2*, and population information is given in *Table 3* (Anonymous, 2024b). As can be seen, it is observed that there are increases in the population rates in both Tekirdağ province and Süleymanpaşa district in 2022 and 2023, but there are some decreases in agricultural areas.

Table 2. Agricultural areas of Tekirdağ province and Süleymanpaşa district

Year of production	Süleymanpaşa district agricultural area (da)	Tekirdağ province agricultural area (da)
2019	711 952	3 911 723
2020	715 731	3 927 950
2021	759 318	4 154 336
2022	759 446	4 153 674
2023	759 182	4 153 457

Table 3. Population amounts of Tekirdağ province and Süleymanpaşa district

Year	Population of Suleymanpasa district	Population of Tekirdağ province
2019	204 001	1 055 412
2020	203 617	1 081 065
2021	210 547	1 113 400
2022	215 558	1 142 451
2023	219 230	1 167 059

The planted area, yield and production amounts for wheat, sunflower and canola plants, which have been intensively planted in the last 5 years in Süleymanpaşa district, are shown in *Tables 4*,5 and *6*, respectively (Anonymous, 2024b). Especially when *Tables 4* and *5* are examined, it is seen that there are decreases in wheat and sunflower yields and production quantities in the last 2 years (2022 and 2023). It is understood that this decrease is due to reasons other than the decrease in cultivated areas. Many human-induced factors, especially the increase in greenhouse gases in the atmosphere, the destruction of forests and industrial activities, accelerate climate change and drought. In addition, these reasons include the decrease in the amount of chemical fertilizer use due to drought caused by climate change and the increasing prices of chemical fertilizers due to the energy crisis *(Table 1).* While chemical fertilizer consumption in Turkey was 7.1 million tons in 2020, it decreased to 6.4 million tons in 2021 and 5.9 million tons in 2022. A similar situation emerges when the data for Tekirdağ province is examined.

When *Table 4* is examined, it is seen that despite the increase in the wheat planting areas especially in Süleymanpaşa district in 2023, there is a serious decrease in wheat yield and production amount. One of the most important reasons for this decrease is thought to be the drought caused by climate change in recent years and the increase in chemical fertilizer prices as a result of increasing energy costs, as shown in *Table 1*.

Table 4. Wheat planting areas, yield and production amounts in Tekirdağ province Süleymanpaşa district

Year of production	Planting area (da)	Yield (kg/da)	Amount of production (ton)
2019	347 039	433	150 382
2020	355 366	375	133 409
2021	351 927	554	194 902
2022	357 588	438	156 461
2023	361 548	355	128 249

While the wheat and sunflower plants, which are intensively cultivated in the Süleymanpaşa district, are planted at one-year intervals, some producers also plant canola as an alternative to wheat. However, it is clearly understood from the data given in *Table 6* that canola planting areas have decreased significantly in recent years and that this decrease has caused a decrease of more than % 50 in production quantities. Therefore, it is likely that the effects of climate change on plants will affect agricultural activities in the future. Factors such as climate conditions, water and temperature can put pressure on product quality and thus affect production potential. In this respect, one of the basic elements of regional agricultural production suitability is climate (Holzkaemper et al., 2011).

One of the most important problems of the agricultural soils of the Trakya Region today is that they contain "low organic matter". In many previous studies on the agricultural soils of the Trakya Region, it was stated that the organic matter was insufficient and in some studies even % 80-85 of the soils had low organic matter content (Bellitürk, 2019). In this study, soil samples taken from 60 different points representatively from Süleymanpaşa district of Tekirdağ province were analyzed and the results were evaluated considering scientific data. In this regard, the objective of the research is to ascertain the present productivity capacity and agricultural sustainability of the Süleymanpaşa district.

Table 5. Sunflower planting areas, yield and production amounts in Tekirdağ province Süleymanpaşa district

Year of production	Planting area (da)	Yield (kg/da)	Amount of production (ton)
2019	256 417	230	58 989
2020	268 824	245	65 990
2021	313 101	250	78 251
2022	318 822	193	61 589
2023	327 199	112	36 779

Table 6. Canola planting areas, yield and production amounts in Süleymanpaşa district of Tekirdağ province

Year of production	Planting area (da)	Yield (kg/da)	Amount of production (ton)
2019	41 599	320	13 312
2020	21 100	320	6 752
2021	22 500	369	8 300
2022	10 000	315	3 150
2023	4 400	308	1 353

2. Materials and Methods

The soil samples used in this study were taken from 0-30 cm depth, when the final soil preparation was done before planting (before any fertilizer and pesticide application), from different villages and central locations of Süleymanpaşa district of Tekirdağ province and especially from areas where intensive agricultural production (wheat, sunflower, canola) was done *(Table 7)* using the zig-zag method. After being brought to the laboratory to be analyzed, it was air dried and then passed through a 2 mm sieve to make it ready for analysis (Jackson, 1958). The texture class of the soil samples was determined according to the percentage of saturation with water; the soil reaction was measured with a glass electrode pH meter at a ratio of 1:2.5 (soil:water) as recommended by the International Soil Science Association; the salt content was measured with an EC-meter and determined in percent (Lindsay and Norvell, 1978; Richards, 1954). Determination of lime amounts was done volumetrically with Scheibler calcimeter (Ülgen and Yurtsever, 1974). Organic matter in soils was determined by the Walkley-Black method (Sağlam, 2012). Available phosphorus was determined spectrophotometrically according to the Olsen method. Available Ca and Mg were determined by ICP-OES (DTPA), Fe, Mn, Cu and Zn contents were determined by the ICP-OES method (Lindsay and Norvell, 1978). Exchangeable K was determined in a flamephotometer (by extraction with ammonium acetate) (Jackson, 1958; Sağlam, 2012). In the evaluation of soil analyses, standard values specified in previous studies were used (FAO, 1990; Güneş et al., 1996; Güneş et al., 2010; Lindsay and Norwell, 1969; TOVEP, 1991). Information about the locations where soil samples were taken is shown in *Table 7*.

Located in the Thrace Region, Süleymanpaşa is the central district of Tekirdağ province. The districts of Muratlı and Hayrabolu are in the north, Çorlu in the east, Malkara in the west and Şarköy in the southwest. The Marmara Sea is in the south of the district *(Figure 1 and 2)*. There are 78 neighborhoods in the district and its surface area is 1111 km². Süleymanpaşa generally has a slightly rugged soil structure and it is possible to come across all shapes of the earth. The Mediterranean climate prevails on the Marmara coast of the district, while the continental climate prevails in the inner parts. The annual average temperature of Süleymanpaşa district is 13.9 °C and the annual average rainfall is 565 mm. Most of the precipitation occurs in the winter season (Anonymous, 2024c).

Figure 1. Tekirdağ province map (Anonymous, 2024d)

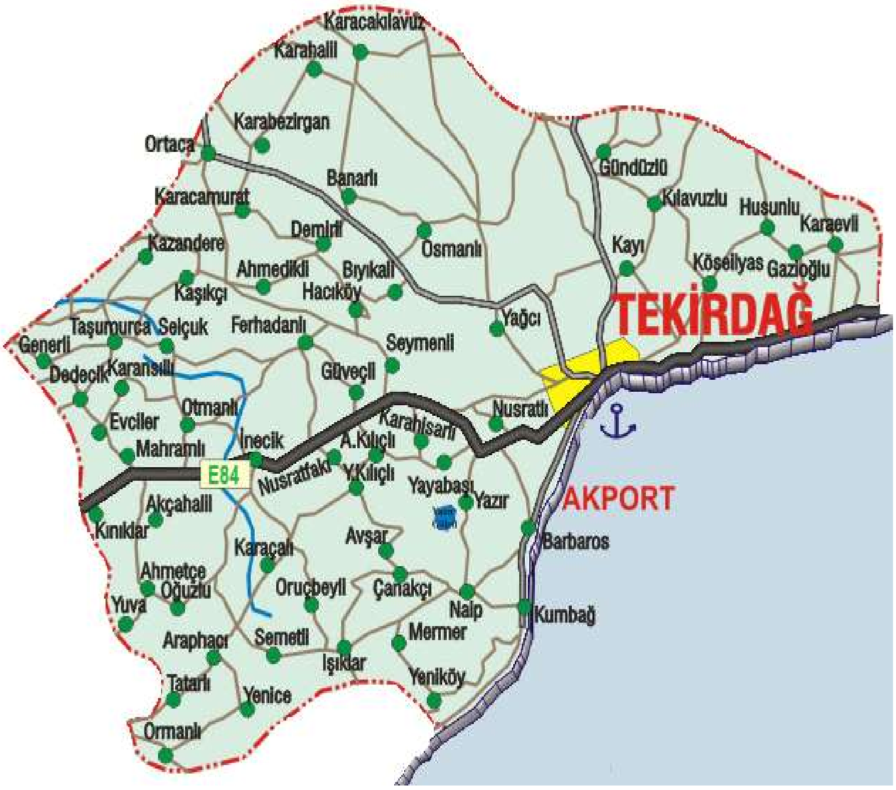

Figure 2. Süleymanpaşa district map (Anonymous, 2024e)

3. Results and Discussion

Some chemical and physical analysis results of the soil samples examined in the research region are given in *Table 7*.

Table 7. Some physical and chemical analysis results of soil samples

Sample no	Neighborhoods belonging to the sampled places	pH (1:2.5)	Total salt (%)	Org. matter (%)	$CaCO_3$ (%)	Saturation (%)	Texture class
1	Akçahalil	7.48	0.29	1.18	10.06	53.00	Clay Loam
2	Akçahalil	7.61	0.26	0.86	1.86	51.00	Clay Loam
3	Akçahalil	7.36	0.26	1.45	3.10	48.00	Loam
4	Akçahalil	7.60	0.22	1.02	15.94	49.00	Loam
5	Husunlu	7.33	0.30	1.90	2.91	46.00	Loam
6	Husunlu	6.87	0.22	1.44	2.30	46ç00	Loam
7	Husunlu	6.78	0.25	1.17	2.45	42.00	Loam
8	Husunlu	7.80	0.28	1.05	1.69	42.00	Loam
9	Husunlu	7.24	0.19	1.14	1.86	46.00	Loam
10	Husunlu	7.38	0.22	1.22	3.25	48.00	Loam
11	Husunlu	7.52	0.30	1.00	8.60	46.00	Loam
12	Husunlı	7.55	0.16	1.22	10.32	46.00	Loam
13	Husunlu	7.15	0.14	1.04	2.32	42.00	Loam
14	Husunlu	6.50	0.22	0.99	1.24	40.00	Loam
15	Karahisarlı	6.91	0.67	0.48	1.84	46.00	Loam
16	Karahisarlı	6.95	0.88	1.23	2.94	42.00	Loam
17	Karahisarlı	7.21	0.84	3.11	1.70	40.00	Loam
18	Karahisarlı	7.13	0.75	2.87	1.55	38.00	Loam
19	Karahisarlı	7.33	0.69	1.08	1.55	52.00	Clay Loam
20	Karahisarlı	7.13	0.84	2.22	1.55	35.00	Loam
21	Karahisarlı	7.21	0.81	0.94	1.24	43.00	Loam
22	Karaevli	7.64	0.16	0.66	6.13	51.00	Clay Loam
23	Karaevli	7.34	0.18	0.80	1.69	49.00	Loam
24	Karaevli	7.61	0.15	0.49	7.66	45.00	Loam
25	Karaevli	7.55	0.11	1.16	1.38	52.00	Clay Loam
26	Karaevli	7.57	0.15	0.80	4.90	51.00	Clay Loam
27	Karaevli	7.63	0.14	0.88	6.28	49.00	Loam
28	Karaevli	7.43	0.35	1.15	12.56	44.00	Loam
29	Karaevli	7.44	0.13	1.14	1.84	45.00	Loam
30	Karaevli	6.62	0.09	1.55	1.53	46.00	Loam
31	Karaevli	7.56	0.19	1.37	1.38	40.00	Loam
32	Karaevli	7.52	0.18	1.45	1.23	46.00	Loam
33	Karaevli	7.47	0.17	1.56	2.60	52.00	Clay Loam
34	Karaevli	7.14	0.16	1.78	0.93	54.00	Clay Loam
35	Karaevli	7.58	0.16	1.34	2.60	54.00	Clay Loam
36	Kayı	6.51	0.18	1.09	0.92	44.00	Loam
37	Kayı	7.44	0.16	1.24	2.45	35.00	Loam
38	Kayı	7.58	0.13	1.11	3.98	38.00	Loam
39	Kayı	7.62	0.20	1.15	1.69	44.00	Loam
40	Kayı	7.40	0.14	1.48	1.53	44.00	Loam
41	Kayı	7.52	0.34	0.91	7.97	40.00	Loam
42	Kayı	6.31	0.14	1.16	1.38	40.00	Loam
43	Yağcı	7.51	0.41	1.37	3.87	49.00	Loam
44	Yağcı	7.10	0.62	1.83	1.08	39.00	Loam
45	Yağcı	7.59	0.41	1.49	3.56	54.00	Clay Loam
46	Yağcı	7.67	0.21	1.70	4.02	51.00	Clay Loam
47	Yağcı	4.64	0.08	1.08	1.24	32.00	Loam

Table 7. Some physical and chemical analysis results of soil samples (continued)

Sample no	Neighborhoods belonging to the sampled places	pH (1:2.5)	Total salt (%)	Org. matter (%)	$CaCO_3$ (%)	Saturation	
						(%)	Texture class
48	Yağcı	7.59	0.24	1.31	1.70	48.00	Loam
49	Yağcı	7.61	0.22	1.20	3.41	48.00	Loam
50	Yağcı	7.52	0.38	1.07	2.63	46.00	Loam
51	Aşağıkılıçlı	7.05	0.78	1.68	1.08	40.00	Loam
52	Aşağıkılıçlı	7.31	2.15	1.12	4.64	40.00	Loam
53	Aşağıkılıçlı	7.55	0.63	1.35	10.06	42.00	Loam
54	Aşağıkılıçlı	6.98	0.69	2.57	2.32	38.00	Loam
55	Seymenli	7.53	0.43	1.33	9.44	46.00	Loam
56	Seymenli	7.25	0.87	0.88	1.70	42.00	Loam
57	Güveçli	7.24	1.98	1.31	5.11	39.00	Loam
58	Güveçli	7.13	0.94	0.83	1.55	47.00	Loam
59	Köseilyas	7.56	0.18	1.64	4.75	52.00	Clay Loam
60	Köseilyas	7.60	0.16	0.62	1.99	42.00	Loam
Min.	-	4.64	0.08	0.48	0.92	32.00	-
Mean	-	7.28	0.40	1.29	3.62	45.00	-
Max.	-	7.80	2.15	3.11	15.94	54.00	-

Some macro and micro plant nutrient element statuses of soil samples are given in *Table 8*.

Table 8. Some macro and micro plant nutrient element contents of soil samples

Sample no	N	P	K	Ca	Mg	Fe	Mn	Zn	Cu
	%	mg kg^{-1}							
1	0.06	5.17	221.00	7278.00	250.10	12.45	12.27	0.24	1.01
2	0.04	4.35	200.00	4435.00	691.00	19.42	12.55	0.26	1.76
3	0.07	3.54	215.90	5898.00	389.80	18.78	20.37	0.34	1.32
4	0.05	7.08	186.50	6301.00	89.72	9.95	10.02	0.25	0.85
5	0.09	10.55	218.70	3795.00	199.20	6.58	7.95	0.29	0.98
6	0.07	2.95	199.00	6146.00	413.90	26.14	14.31	0.71	0.72
7	0.06	16.53	215.80	6549.00	547.40	40.53	18.07	0.60	0.99
8	0.05	4.28	211.50	5571.00	539.70	50.64	19.76	0.60	1.09
9	0.06	8.86	98.85	2288.00	344.70	9.01	11.41	2.20	0.87
10	0.06	4.21	105.40	5236.00	371.20	7.38	7.82	2.52	0.90
11	0.05	1.92	60.67	5364.00	161.30	4.43	4.85	0.35	0.54
12	0.06	7.82	159.80	4249.00	148.60	4.39	6.42	0.58	1.12
13	0.05	8.49	76.55	1758.00	389.30	7.69	9.98	6.28	0.84
14	0.05	11.88	33.04	733.40	163.80	17.83	19.65	5.16	1.84
15	0.02	8.12	186.30	5735.00	527.20	15.60	17.71	0.18	1.58
16	0.06	15.28	182.10	5395.00	461.50	10.98	12.61	0.39	1.14
17	0.15	77.93	367.40	4604.00	545.10	14.20	13.19	3.54	1.56
18	0.14	93.95	395.40	4077.00	491.70	12.70	10.76	4.31	1.49
19	0.05	3.10	184.40	6238.00	568.20	14.82	13.06	0.28	1.53
20	0.11	81.11	394.30	4432.00	473.90	13.69	12.14	2.97	1.22
21	0.05	3.84	188.20	5380.00	566.10	13.41	13.10	0.21	1.48
22	0.03	5.98	208.30	7926.00	461.80	8.13	7.87	0.53	0.51
23	0.04	4.50	260.70	73.17	500.20	11.62	18.21	0.61	1.05
24	0.02	10.62	195.60	7994.00	403.00	8.42	7.16	0.40	0.52
25	0.06	9.44	167.00	7214.00	352.20	12.94	12.28	0.24	0.88
26	0.04	12.77	236.70	7948.00	242.20	10.26	9.01	0.29	0.72

Table 8. Some macro and micro plant nutrient element contents of soil samples (continued)

Sample no	N	P	K	Ca	Mg	Fe	Mn	Zn	Cu
	%				mg kg^{-1}				
27	0.04	3.69	201.20	8024.00	419.70	8.51	7.84	0.44	0.50
28	0.06	4.28	190.70	8099.00	234.30	9.12	10.20	0.27	0.67
29	0.06	13.80	110.60	4034.00	144.40	10.52	10.75	0.31	0.78
30	0.08	1.77	190.70	6528.00	567.20	16.88	23.58	0.47	1.09
31	0.07	6.86	225.70	5475.00	354.00	12.80	7.36	0.46	1.17
32	0.07	7.45	284.00	6473.00	399.70	18.48	8.52	0.50	1.25
33	0.08	12.69	279.10	8466.00	493.70	8.09	13.65	0.37	0.86
34	0.09	11.14	240.80	7140.00	425.30	13.42	16.82	0.47	0.93
35	0.07	12.32	241.70	8292.00	461.00	8.87	13.50	0.38	0.95
36	0.05	21.40	235.40	3517.00	549.20	14.46	19.74	0.09	1.26
37	0.06	15.42	259.50	4030.00	122.70	3.98	6.67	0.14	0.67
38	0.06	7.60	195.50	4639.00	158.40	3.78	4.11	0.03	0.61
39	0.06	7.31	165.70	5435.00	272.80	9.45	9.85	0.11	0.82
40	0.07	8.93	359.70	4462.00	211.90	6.29	10.77	0.15	0.99
41	0.05	13.95	234.30	4728.00	212.00	7.03	8.19	0.18	0.59
42	0.06	13.36	202.50	3464.00	574.60	16.69	29.85	0.13	1.20
43	0.07	9.82	181.00	6421.00	940.30	10.43	7.48	0.15	1.33
44	0.09	61.25	375.10	2718.00	331.20	8.65	9.14	2.87	0.83
45	0.08	11.07	169.20	6555.00	931.70	11.40	7.37	0.21	1.36
46	0.09	5.39	166.50	6583.00	889.70	15.41	9.24	0.18	1.31
47	0.05	12.69	129.30	972.40	210.70	68.48	67.65	0.32	1.06
48	0.07	1.85	152.70	3861.00	118.10	10.00	15.20	0.31	0.86
49	0.06	5.31	169.50	6625.00	937.30	14.05	7.29	0.23	1.37
50	0.05	10.11	164.30	6826.00	955.80	13.04	6.90	0.28	1.36
51	0.08	45.17	317.70	3425.00	389.10	10.97	9.77	2.71	1.04
52	0.06	5.09	138.40	5095.00	283.50	12.14	15.31	0.26	1.00
53	0.07	4.21	236.20	7672.00	207.10	9.11	6.64	0.32	1.26
54	0.13	101.40	405.90	4723.00	521.60	15.76	13.30	4.22	1.60
55	0.06	4.28	445.60	5392.00	148.90	6.65	4.99	0.25	0.78
56	0.04	8.19	193.00	6126.00	534.80	16.00	13.70	0.24	1.44
57	0.07	5.98	138.30	5321.00	294.80	14.57	17.79	0.35	1.10
58	0.04	11.37	188.30	5843,00	563.30	14.22	13.32	0.16	1.47
59	0.08	1.70	207.10	9301,00	220.20	9.45	8.28	0.40	0.64
60	0.03	5.02	136.20	4706.00	159.60	5.39	5.15	0.26	0.56
Min.	0.02	1.70	33.04	73.17	89.72	3.78	4.11	0.03	0.50
Mean	0.06	14.94	211.68	5393.15	408.86	13.60	12.71	0.88	1.05
Max.	0.15	101.40	445.60	9301.00	955.80	68.48	67.65	6.28	1.84

As seen in *Table 7*, the lowest pH value was 4.64 in sample 47 and the highest pH value was 7.80 in sample 8. The average pH value of the soils was 7.28 (neutral). When the total salt values of the soil samples were analysed, it was determined that the lowest salt content was % 0.08 (sample no. 47) and the highest salt content was % 2.15 (sample no. 52) and they were medium saline soils. In terms of organic matter content, the highest value was determined as % 3.11 (soil no. 17) and the lowest value was determined as % 0.48 (soil no. 15) and the average was determined as 1.29 (less). In terms of lime ($CaCO_3$) content, it was determined that the soils had an average of % 3.62 lime content and the textural classes were clay loam and loam soils. Similar results were obtained in Hayrabolu district of Tekirdağ province and the average pH, total salt, organic matter and lime contents of 26 soil samples were determined as 6.75, % 0.16, % 1.38 and % 1.98 respectively (Bellitürk and Çelik, 2023). In a study carried out to determine the nutrient status of agricultural soils in the Marmara Region of Turkey, where Tekirdağ province is located, it was reported that % 67.7 of the soils were very low and low in terms of organic matter coverage and very poor and poor in terms of nitrogen, whereas % 7.2 of only 1752 soils were good or very good (Taşova and Akın, 2013). In this case, it can be considered that factors such as destruction of surface cover, deforestation, erosion as a result of continuous cultivation of soils for agricultural purposes prevent the accumulation of organic matter in the soils of the region.

Organic matter content in Turkish soils is generally low, thus limiting productivity. In this respect, different combinations of applications such as compost and vermicompost improve the physico-chemical properties of the soil and positively affect soil health and productivity. As a result of the application of vermicompost prepared from different substrates (cow manure, paper waste and rice straw) together with N:P:K, which is recommended for fertilizing soils poor in organic matter, it was determined that cow manure vermicompost increased soil health and product yield, and at the same time, products rich in Zn and Fe in wheat (Aslam et al., 2019) and N, P, K in grapes (Açıkbaş and Bellitürk, 2016) were obtained. In the studies conducted by Tavalı et al., (2014) and Çıtak et al., (2011), it was emphasized that the application of vermicompost to the soil increases the organic matter content of the soil. In addition, in the study conducted by Barlas et al. (2018) examining the effects of increasing vermicompost doses applied to soil and peat on the growth and development of wheat (*Triticum vulgaris* L.) plants, it was determined that all vermicompost doses applied to the growing medium had a statistically significant effect on the nutritional status of the above-root organs of the plants.

When the soils were evaluated in terms of texture classes, it was determined that a total of 48 soils fell into the "loam (L)" texture class (FAO, 1990; Güneş et al., 1996; Güneş et al., 2010; Lindsay and Norwell, 1969; TOVEP, 1991). When the general physical and chemical properties of soils are examined, it is thought that there has been a gradual depletion of organic matter in the last 10 years, and this is due to conventional agriculture and planting with an emphasis on chemical fertilizers. Considering the parameters in *Table 8*, it was determined that the soils were in the "low" class and poor in terms of N with an average total N value of % 0.06. This may be due to N losses in the soil in gaseous form or through leaching. In most of the similar studies conducted on local soils, it was found that the soil samples were poor in terms of both organic matter and total N (Bellitürk, 2023; Bellitürk and Çelik, 2023; Büyükfiliz et al., 2022). The average P, K, Ca and Mg contents of the soil samples in terms of macro elements were determined to be 14.94 mg kg^{-1}, 211.68 mg kg^{-1}, 5393.15 mg kg^{-1} and 408.86 mg kg^{-1}, respectively. Accordingly, it was revealed that the soil samples were "sufficient" in terms of P, K and Mg and "excessive" in terms of Ca. According to the results of a similar study conducted by Gürbüz and Bellitürk (2021) in Ergene district, it was determined that % 69.57 of the 70 soils examined were in the 'low' class of total nitrogen % 55.07 were in the 'sufficient' class of available phosphorus, % 49.28 were in the 'sufficient' class of exchangeable potassium, % 42.03 were in the 'sufficient' class of exchangeable Ca, and % 57.97 were in the 'sufficient' class of exchangeable Mg. Considering the average micro element values, it was determined that Fe, Mn, Zn and Cu contents were in the 13.60 mg kg^{-1} (excess), 12.71 mg kg^{-1} (low), 0.88 mg kg^{-1} (sufficient) and 1.05 mg kg^{-1} (sufficient) classes, respectively. In similar studies conducted previously in the local soils, the emphasis on low organic matter comes to the fore (Bellitürk, 2011; Bellitürk, 2019; Büyükfiliz et al., 2022; Büyükfiliz et al., 2023; Gürbüz and Bellitürk, 2021; Polat et al., 2019).

Although it is one of the most important indicators of soil quality, the importance of soil organic matter is not sufficiently known in our country. This results in low fertilization efficiency and can lead to increased fertilizer input costs for producers and even pollution of the environment. In this respect, it is of great importance to pay attention to increasing the amount of organic matter in the soil, to use chemical fertilizers and organic fertilizers together, and to abandon agricultural systems that use only chemical fertilizers.

4. Conclusions

As a result of the study in which the analysis results of a total of 60 soil samples taken from fields exposed to intensive agricultural activities with wheat-sunflower crop rotation in Süleymanpaşa district of Tekirdağ province were evaluated, it was determined that the average pH value of the samples taken was 7.28 (neutral), total salt content was % 0.40 (salt-free), organic matter amount was % 1.29 (low), total N content was % 0.06 (low) and lime content was % 3.62 (low calcareous) and the texture class was clayey loam and loamy soils. The average P, K, Ca, Mg, Fe, Mn, Zn and Cu contents of the soil samples were determined to be 14.94, 211.68, 5393.15, 408.86, 13.60, 12.71, 0.88 and 1.05 mg kg^{-1}, respectively. Considering these values, it was determined that the soil samples were high in Ca and Fe; low in Mn; and sufficient in P, K, Mg, Zn and Cu.

Organic matter content is of great importance for the physical, chemical, biological properties and productivity potential of agricultural soils to be at the desired levels. In this respect, organic matter is widely accepted as a very important indicator of productivity in terms of sustainable soil management. Therefore, agricultural activities carried out on soils poor in organic matter must be taken into consideration and the use of organic fertilizers must be included in fertilization programs. Otherwise, soil fertility may decrease over time as a result of chemical fertilizer applications alone, and agricultural production may be at risk. Although it is known by everyone that excessive chemical fertilizer is used in the Süleymanpaşa district, agricultural production such as wheat and sunflower according to the correct fertilization programs will be very beneficial for the producers and the ecology. What is particularly understood from this study is that organic fertilizers must be included in the fertilization programs of soils with low organic matter content.

In countries like Turkey, where the population is increasing and agricultural lands are decreasing, it is very important to expand the use of organic fertilizers obtained by evaluating organic waste rather than those obtained from fossil fuels in the use of fertilizers among agricultural inputs. According to the results of this study, in which various findings were obtained on wheat, sunflower and partly canola farming in Süleymanpaşa district using intensive chemical fertilizers, it was revealed that fertilization programs should be made according to soil analysis results and that biological and/or organic fertilizers should definitely be included in the fertilization program in addition to chemical fertilizers. It is a known fact that in order to implement sustainable agriculture, the right type and amount of fertilizer must be used at the right time. It is of great importance that the inputs used in agricultural production are carried out in a controlled and planned manner in order to meet the needs of the increasing population, protect the environment and use natural resources without depletion. In this respect, this study, which revealed that the agricultural soils of Süleymanpaşa district are insufficient in terms of organic matter, should be carried out every year in a more comprehensive manner, including all villages, and the results should be shared with the producers, and the producers should be informed about the subject through agricultural publishing.

Ethical Statement

There is no need to obtain permission from the ethics committee for this study.

Conflicts of Interest

We declare that there is no conflict of interest between us as the article authors.

Authorship Contribution Statement

Concept: Buyukfiliz, F., Belliturk, K.; Design: Erkocak, A., Buyukfiliz, F., Data Collection or Processing: Buyukfiliz, F., Belliturk, K.; Literature Search: Buyukfiliz, F., Erkocak, A., Acikbas, B.; Writing, Review and Editing: Erkocak, A.; Buyukfiliz, F.

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