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Determination of Productivity Status of Agricultural Lands in Solhan District of Bingöl Province

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Abstract

The study focuses on Solhan's agricultural lands, situated within the boundaries of Bingöl Province. Bingöl is located in the Eastern Anatolia Region, spanning latitudes 41°20' to 39°54' north and longitudes 38°27' to 40°27' east. The province covers a total area of 8,253 km², with the central district occupying 1,790 km². Bingöl shares a border with Diyarbakır to the south, Muş to the east, Tunceli and Elazığ to the west, and Erzincan and Erzurum to the north. The precipitation pattern in Bingöl reflects a continental climate, but the region's overall climatic conditions exhibit a unique blend of Mediterranean and continental influences. This study aimed to assess the productivity levels of agricultural lands in Solhan. For this purpose, 130 soil samples were collected from 0-30 cm depth across 13 villages in the Solhan district where farming activities are prevalent. These samples were analyzed in terms of various parameters, including texture, pH, electrical conductivity (EC), calcium carbonate (%$CaCO_3$) content, organic matter content (% OM) and essential plant nutrients such as nitrogen (N), phosphorus (P), potassium (K), iron (Fe), zinc (Zn), manganese (Mn), and copper (Cu). The analysis revealed that the soils were non-saline, low in calcite content, and deficient in organic matter, with a near-neutral pH. Potassium levels were found to be high, while phosphorus levels were moderate in 60% of the samples. Zinc levels were sufficient in 65% of the samples, manganese levels were adequate, and there was no iron deficiency. Copper levels were also determined to be sufficient. The soil texture of the agricultural lands was predominantly clay-loam and loam.

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Bingöl İli Solhan İlçesi Tarım Arazilerinin Verimlilik Durumunun Belirlenmesi

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Öz

Çalışma, Bingöl ili sınırları içerisinde yer alan Solhan'ın tarım arazilerine odaklanmaktadır. Bingöl, 41°20' ila 39°54' kuzey enlemleri ve 38°27' ila 40°27' doğu boylamları arasında yer alan Doğu Anadolu Bölgesi'nde yer almaktadır. İlin toplam alanı 8.253 km² olup, merkez ilçe 1.790 km²'dir. Bingöl, güneyde Diyarbakır, doğuda Muş, batıda Tunceli ve Elazığ ve kuzeyde Erzincan ve Erzurum ile sınır komşusudur. Bingöl'deki yağış düzeni karasal bir iklimi yansıtır, ancak bölgenin genel iklim koşulları Akdeniz ve karasal etkilerin benzersiz bir karışımını sergiler. Bu çalışma, Solhan'daki tarım arazilerinin verimlilik seviyelerini değerlendirmeyi amaçlamaktadır. Bu amaçla, çiftçilik faaliyetlerinin yaygın olduğu Solhan ilçesindeki 13 köyden 0-30 cm'lik üst tabakadan 130 adet toprak örneği alınmıştır. Bu örneklerde doku, pH, elektriksel iletkenlik (EC), kalsiyum karbonat (%$CaCO_3$) içeriği ve azot (N), fosfor (P), potasyum (K), demir (Fe), çinko (Zn), manganez (Mn) ve bakır (Cu) gibi temel bitki besin maddeleri gibi çeşitli parametreler analiz edilmiştir. Analiz sonucunda toprakların tuzlu olmadığı, kireç içeriğinin düşük, organik madde bakımından yetersiz ve pH'ının neredeyse nötr olduğu ortaya çıkmıştır. Örneklerin %60'ında potasyum seviyeleri yüksek, fosfor seviyeleri ise orta düzeyde bulunmuştur. Örneklerin %65'inde çinko seviyeleri yeterli, manganez seviyeleri yeterli ve demir eksikliği görülmemiştir. Bakır seviyeleri de yeterli bulunmuştur. Tarım arazilerinin toprak bünyesi ağırlıklı olarak killi tın ve tınlıdır.

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Introduction

Soil is a structure that contains organic matter, various minerals, organisms, air and water. A good soil structure consists of an average of 25% water, 45% minerals, 5% organic matter and 25% air. In addition, there are micro soil organisms that directly contribute to the formation of humus during the decomposition of organic matter. Despite their many functions in the soil, the ratio of microorganisms in the soil to the entire soil is very small (Sağlam et al., 1993).

Soil is a natural structure that offers sustainability and renewal if used with good management. Therefore, the first goal of the soil use method is to protect the soil and provide continuous and maximum yield from it (Göl, 2002).

The loss of soil fertility is caused by situations such as incorrect soil processing methods, increased erosion due to land not being used according to its capabilities, soil pollution and non-agricultural uses. This situation necessitates more efficient use of natural resources, such as our existing agricultural resources. Research and development studies are important for ensuring sustainable agriculture and preserving the yield obtained from the soil. If sufficient attention is not given, soil fertility decreases over time and after a certain limit, irreversible failure to obtain yield may occur (Günal 2008).

Excessive or insufficient use of fertilizers is one of the primary factors leading to the degradation of soil chemical properties. Given that Turkey is one of the 19 countries with depleted soil reserves, need to utilize the remaining agricultural lands efficiently and sustainably becomes even more critical (Cangir, 1994).
One of the most important problems of agricultural lands in the world is the soil salinity and alkalinity affecting agricultural lands. The fact that 10 million hectares of land worldwide become unusable due to salinity problems every year clearly shows the importance of the problem (Kwiatowski 1998).

Conducting very intensive soil salinity measurements is quite costly and time-consuming. However, due to the techniques developed for the on-site measurement of electrical conductivity in recent years, it has become easier to evaluate soil salinity (Rhoades et al., 1999).

Fertilization is one of the most effective methods to enhance the productivity of agricultural lands. It involves the application of organic or inorganic materials containing essential plant nutrients to the soil or directly to plants, aiming to achieve desired quality and yield in crop production. The main goal of fertilization is to replenish soil nutrients and create an optimal growth environment for plants by improving the biological and physical properties of the soil. Effective fertilization requires a thorough understanding of soil and environmental conditions. Over the years, the importance of soil fertilization has gained recognition, leading to a steady increase in fertilizer usage. In Turkey, fertilization is necessary to address nutrient deficiencies in agricultural soils. High-yield crop varieties are cultivated continuously, which depletes soil nutrients over time. To ensure efficient fertilizer use, it is crucial to accurately determine the nutrient content of the soil. Soil analysis provides the necessary information to determine the appropriate timing, quantity, and type of fertilizer application (Sağlam, 2012).

The first thing to look at regarding the useful nutrients found in the soil sample is to conduct accurate studies with soil analysis. In addition, although the analyses performed indicate the level of the elements, they generally do not provide sufficient comprehensive information about the productivity and healthy use of the soil (Demirkıran et al., 2012).

Conducting soil analysis is crucial for addressing nutrient deficiencies in crops. Based on the results of these analyses, tailored fertilization programs can be developed to meet the specific needs of the planted crops. The primary objective of soil testing methods is to determine the availability of nutrients that plants can uptake. These methods involve extracting nutrients from the soil using various chemical solutions, simulating the process by which plant roots uptake nutrients from the soil (Erdal and Boydak, 2011).

The aim of this study was determined to be the determination of the fertility status of agricultural soils in Solhan district of Bingöl province, investigating their characteristics, doing agriculture consciously and increasing the fertility in the agricultural area accordingly. For this purpose, total 130 soil samples were taken from 0-30 cm depth from 13 different villages where crops are grown at an economic level in Solhan (Figure 1). Then, the samples were brought to the laboratory for analysis and subjected to some fertility analyses. The data obtained from these analyses are valuable as they serve as a reference for future scientific research in the field.

Material and Method

Basic characteristics of the research area

Bingöl is situated in the Eastern Anatolia Region, bordered by Diyarbakır Province to the south, Muş to the east, Tunceli and Elazığ to the west, and Erzurum and Erzincan provinces to the north.

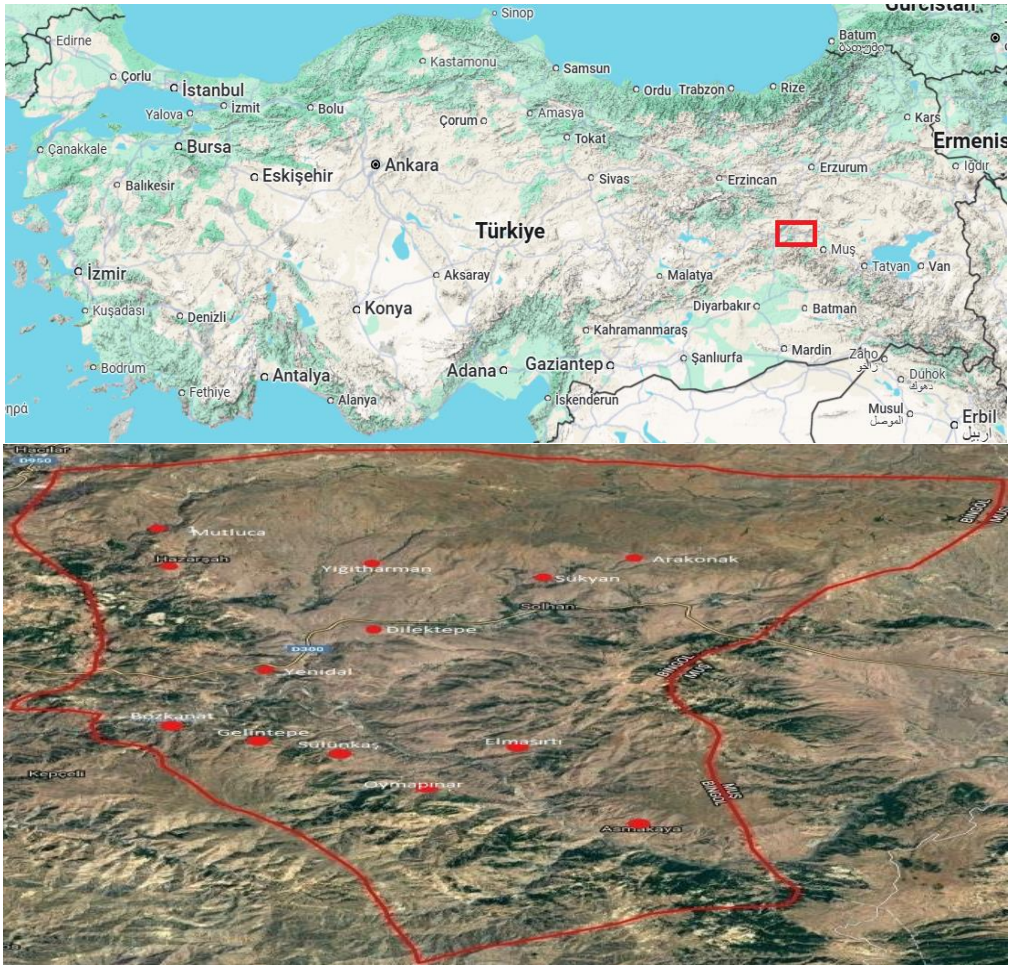

Figure 1. Soil sampling map of the agricultural lands studied

Geographically, it lies between 41°20' and 39°54' north latitudes and 38°27' and 40°27' east longitudes. Agricultural lands in Bingöl are quite high and rugged. The average altitude is above 1250 meters. Mountain ranges with an altitude exceeding 2000 meters and hilly lands with an altitude between 1500-2000 meters have been determined by scientific studies to have been formed by tectonic movements in the 3rd geological period (Meozoic).

The total land area of Bingöl is 812,537 hectares and the management status is as follows; 10.25% is afforestation area, 27.92% is forest, 7.28% is agricultural land, 51% is pasture, 2.2% is meadow and 1.3% is other areas. Bingöl reflects the continental precipitation regime. However, when the climatic conditions in the region are considered as a whole, it is determined that it has a unique feature between the continental regime and the Mediterranean (Soylu, 2010). The annual precipitation is 831.5 mm on average and the annual evaporation total is 1202.5 mm. The average temperature of Bingöl province is 12.5 ^{o}C and the temperature difference between summer and winter is 5 ^{o}C (Anonymous, 2019). The temperature regime is Mesic and the humidity regime is Xeric since the winters are dry and harsh and the summers are rainy.

Laboratory Studies

Soil samples taken from the study area were analyzed in the laboratory of the Department of Soil Science and Plant Nutrition, Faculty of Agriculture, Bingöl University. Soil texture analysis was done according to the hydrometer method reported by Bouyoucus (1951). Soil pH was analyzed according to the 1:2.5 soil-water mixture reported by Jackson (1967). Electrical conductivity (EC) was measured with EC meter by preparing soil saturation paste as reported by Richards (1954). Calcite content of the soil was determined using the Scheibler calcimeter according to Allison and Moodie (1965). Organic matter analysis was based on the Walkley-Black method modified by Jackson (1967). Phosphorus analysis as amount of plant-available P in the soil was calculated according to Olsen et al. (1954). Potassium available to plants has been analysed with the ammonium acetate extract and the potassium passing into the solution in the Atomic Absorption Spectrophotometer with the method determined by Carson (1980). Iron, copper, manganese, zinc analysis with the DTPA extraction method Iron, copper, manganese and zinc analysis was carried out in the soil with the DTPA extraction method determined by Lindsay and Norwell (1978).

Results and Discussion

Descriptive chemical and physical properties and their statistics of agricultural soils of Solhan district are presented in Table 1 and Table 2. Sand content of samples at 0-30 cm depth is 31.98%, silt content is 37.74% and clay content is 30.26% on average. Overall results of the texture analysis showed that the textural classes of the soils were clayey-loamy and loamy. EC is in the range of 0.006-0.081 dS/m and average EC value is 0.028 dS/m. Potassium content is in the range of 140-220 kg/da and average is 176 kg/da. Organic matter ratio is in the range of 0.40-1.37% and average is 0.72%. Calcite content is in the range of 2-5.1% and average is 3.61%. pH is in the range of 6.30-7.95 and average pH value is 7.30. Phosphorus content is in the range of 3.2-12.3 kg/da and average is 7.20 kg/da.

The pH values of the study area soils are seen to be between 6.3 and 7.95. According to Yurtsever and Ülgen (1995), neutral soils, which make up approximately half of the total soil area, constitute 60.76% of the total area. While slightly acidic soils constitute 3.07% of the total area, slightly alkaline soils constitute 36.15% of the area. The data obtained as a result of the analyses revealed that the study area soils are the most suitable areas for agriculture in terms of pH.

The salt value of the study area soils was determined to be between 0.006% and 0.081%, with an average of 0.028%. According to Richards (1954), the analysis revealed that all of the study area soils were salt-free. The salt-free nature of agricultural soils is an advantage for plant production, and this situation must be preserved.

Table 1. Descriptive statistics of chemical analyses of Solhan agricultural soils

Location	**K_2O**	**P_2O_5**	**Fe**	**Cu**	**Zn**	**Mn**	**O.M.**
Unit	kg/da	kg/da	mg/kg	mg/kg	mg/kg	mg/kg	%
Oymapınar	181,14	3,29	4,93	4,51	1,31	6,05	0,74
Dilektepe	174,14	3,67	4,90	4,28	1,27	6,89	0,66
Bozkanat	158,71	4,17	4,45	379	1,34	7,09	0,62
Yiğitharman	183,71	2,73	3,55	4,61	1,24	5,27	0,78
Asmakaya	163,57	2,52	4,75	3,65	1,03	6,72	0,79
Hazarşah	165,00	2,53	3,98	5,17	0,99	5,53	0,72
Arakonak	205,57	3,25	4,32	3,68	0,86	5,57	0,74
Sülünkaş	161,28	3,76	5,65	4,16	1,16	4,61	0,61
Sükyan	164,42	2,74	5,63	4,25	0,85	5,74	0,54
Yenidal	184,28	2,87	5,41	3,92	1,37	7,48	0,76
Mutluca	167,42	3,63	4,71	4,92	1,18	7,17	0,83
Murat	207,29	3,50	4,48	4,24	1,03	5,62	0,85
Elmasırtı	187,00	2,97	4,28	4,44	1,33	6,61	0,78
Mean	176	7,20	4,69	4,28	1,15	6,18	0,72
Standard Deviation	19,45	1,95	1,13	1,14	0,49	1,35	0,19
Minimum Value	140	3,2	2,46	2,04	0,49	3,18	0,40
Maximum Value	220	12,3	7,35	6,49	3,14	9,58	1,37

Table 2. Descriptive statistics of physical analysis of Solhan agricultural soils

Location	**Clay**	**Silt**	**Sand**	**pH**	**EC**	**$CaCO_3$**
Unit	%	%	%	1:2,5	dS/m	%
Oymapınar	34,24	33,03	32,72	7,25	0,052	3,67
Dilektepe	33,01	36,27	30,71	7,57	0,024	4,22
Bozkanat	31,77	39,72	28,50	7,55	0,028	3,00
Yiğitharman	31,53	38,33	30,13	7,43	0,028	4,12
Asmakaya	30,92	37,04	32,03	7,60	0,022	4,00
Hazarşah	30,73	35,42	33,83	7,53	0,013	4,34
Arakonak	30,52	39,61	29,86	7,49	0,019	4,47
Sülünkaş	30,16	38,34	31,49	7,13	0,032	3,21
Sükyan	29,40	36,00	34,59	7,58	0,058	2,97
Yenidal	28,60	37,86	33,53	7,45	0,052	3,32
Mutluca	28,40	40,07	31,52	6,84	0,026	4,42
Murat	27,60	39,75	32,63	7,70	0,060	4,18
Elmasırtı	26,58	39,19	34,21	7,55	0,018	3,94
Mean	30,26	37,74	31,98	7,30	0,028	3,61
Standard Dev.	6,14	5,50	7,36	0,36	0,014	0,70
Minimum Value	16,67	25,69	17,40	6,30	0,006	2
Maximum Value	39,88	49,80	48,80	7,95	0,081	5,1

The calcite content of the study area soils varied between 2% and 5.1%, and the soils were evaluated according to Ülgen and Yurtsever (1995). Accordingly, 98.47% of the soils are low-lime and 1.53% are medium-lime soils. Due to the calcite content of the study area soils, the plant may not be able to take enough plant nutrients such as iron, zinc, manganese, etc. For this reason, in order to regulate the calcite status of the soil, it is considered appropriate to mix plant wastes with agricultural machinery after harvest and to apply burnt barn manure.

The organic matter content of the soils in the study area varies between 0.40% and 1.37%. The inorganic matter values of the soils were evaluated according to Yurtsever and Ülgen (1995). In this regard, the amount of organic matter in 94.61% of the soils in the study area is very low, and in 5.38% it is low. In order to eliminate the lack of organic matter, burnt barnyard manure application, legume plant cultivation, and nitrogenous fertilizer application should be done.

The phosphorus content of the soils in the study area varies between 3.2 kg/da and 12.3 kg/da. The phosphorus values of the soils were assessed based on Ülgen and Yurtsever (1995). Accordingly, the analyses revealed that 0.76% of the soils in the study area have high phosphorus, 16.92% have good phosphorus, 57.69% have medium phosphorus, and 24.61% have low phosphorus. Since the movement of phosphorus fertilizer to be applied to the soil is limited in the soil, it should be applied to the root part of the plant in the spring period.

According to Ülgen and Yurtsever (1995), the potassium values of the agricultural soils of Solhan are between 140 kg/da and 220 kg/da, and the analysis revealed that 13.07% of these soils have high potassium levels and 86.92% have medium levels. Since there is no potassium deficiency in the soils of the study area, there is no need for K fertilization. In this case, it was determined that the land is suitable for plant cultivation that uses a lot of potassium.

The iron values of the study area soils were evaluated according to Lindsay and Norvel (1978). The iron content of the study area soils varies between 2.46 ppm and 7.35 ppm. The analyses revealed that 57.14% of the soils in the area had high iron content, 40.65% had medium, and 2.19% had low iron content. In the study area soils, leaves turn bronze when there is excess iron. This situation is observed in the study area plants.

Solhan agricultural soil copper values were evaluated according to Lindsay and Norvel (1978). The copper content of the study area soils varies between 2.04 ppm and 6.49 ppm. As a result of the analyses, it was revealed that the copper content was high in all of the soils of the villages where agriculture is practiced. The high copper content and the low N content in the study area soils support each other.

The manganese values of the agricultural soils in question were evaluated according to Lindsay and Norvel (1978). The manganese content of these 13 village soils varies between 9.58 ppm and 3.18 ppm. As a result of the analyses, it was revealed that the manganese content was high in all of the 13 village soils. Plants that are very sensitive to manganese excess, such as cereals, sugar beet, cabbage, tomato, lettuce and potato, should not be grown in the study area soils.

The zinc values of the agricultural soils in Solhan were evaluated according to Lindsay and Norvel (1978). The zinc content of the soils of 13 villages varies between 0.49 ppm and 3.14 ppm. The analyses revealed that 57.14% of the soils in the study area have high zinc content, 41.75% have sufficient zinc content, and 1.09% has low zinc content. Since the amount of zinc in the study area soil is sufficient and high, phosphorus and organic fertilizers should be used to prevent toxic effects.

Conclusions

This research was conducted to determine the fertility status of Solhan agricultural lands. In the research, 130 samples were taken from 0-30 cm of 10 soil samples from each village 13 different villages where agricultural production is carried out in Solhan district of Bingöl province. The soil samples were analyzed for texture, pH, EC, %CaCO3, and some macro and micro nutrients (N, P, K, Fe, Zn, Mn and Cu). According to the analysis results of the agricultural land soils studied, it was determined that the soils were salt-free, low in calcite, insufficient in organic matter, and had a pH around neutral. The potassium level was high and 60% of the phosphorus level was moderate. It was determined that 60-65% of the zinc level was good, 40% of the iron level was moderate, the manganese level was sufficient, and the copper level was sufficient. The soils in the study area have clayey-loamy and loamy texture.

In the villages located in the study area, mostly garden plants, forage crops and cool climate cereals are grown. As a result of this study conducted to determine the productivity of the agricultural soils in the study area; it was determined that the soils of the region without EC problems were low in N, low in phosphorus, high in available potassium and low in calcite. Most of the soils' pH values was determined to be slightly acidic and neutral. In order to increase N in agricultural lands, barnyard manure, plant nutrition, organic fertilizers are valuable in terms of soil productivity. In agricultural areas, water, plant and soil analyses should be emphasized and according to the analysis results, the amounts of especially N and P fertilizers and appropriate types of fertilization should be applied.

In the samples taken from the field, in Zn, clay-silt, clay, sand, silt analyses; these criteria were not found to be significant according to the results of the statistical analysis. Apart from this, in the organic matter, pH, EC, Cu, calcite, N, P, K analyses; the difference between the mentioned criteria of the soils was found to be significant according to the results of the analysis.

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