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ARAŞTIRMA MAKALESİ **RESEARCH ARTICLE**

Fertility Characteristics of Soils in Different Stream Beds under Transitional Climate Conditions

Geçiş İklimi Koşulları Altında Farklı Akarsu Yataklarında Yer Alan Toprakların Verimlilik Özellikleri

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Abstract

This study was conducted to identify and evaluate some of the fertility characteristics of soils in stream beds in Şebinkarahisar district of the Giresun province of Türkiye, which has a transitional climate between semi-arid and humid climate zones. To this end, a total of 48 soil samples, surface (0-30 cm) and subsurface (30-60/61/62/65 cm), were collected from 24 different sampling points on various stream beds. The textures of the surface and subsurface soils taken were determined as CL, SL, SCL, L, C, and LS. pH values of surface soils ranged from 5.84 to 7.98, and the pH values of subsurface soils ranged from 6.06 to 8.05. Lime contents of the soils without salinity problem ranged from 0.00% to 38.30% for surface soils, and from 0.00% to 37.90% for subsurface soils. Organic matter contents varied between 0.32% and 4.16% for surface soils, and between 0.14% and 2.16% for subsurface soils. While the soils were poor in total nitrogen, phosphorus, zinc and manganese, it was determined that the calcium and copper contents were at sufficient levels. Although deficiencies were detected in some soils for potassium, magnesium and iron, they were generally determined to be at sufficient levels. To deal with deficiencies of macro and micro plant nutrients, including deficiency of organic matter, a fertilization planning is recommended that includes barnyard manure, poultry manure, green manure, compost, vermicompost, and various organic fertilizers containing macro and micro elements. Within the scope of the research, climate classifications were also made according to Thornthwaite, De Martonne-Gottman and Erinç methods by had used 48 years (1965-2012) climate data of Şebinkarahisar district. Plant species and varieties to be grown in the study area should be selected from among those suitable to the transitional climate conditions prevailing in the region. It will also be useful to analyze the stream waters in the areas where soil sampling is done.

Keywords: Soil fertility, Stream bed, Transitional climate, Şebinkarahisar, Giresun

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Öz

Bu çalışma, Türkiye'nin Giresun ilinde, yarı kurak iklim ile nemli iklim arasında bir geçiş ikliminin görüldüğü Şebinkarahisar ilçesinde yer alan akarsu yataklarındaki toprakların bazı verimlilik özelliklerinin belirlenmesi ve değerlendirilmesi amacıyla yapılmıştır. Bu amaçla çeşitli akarsu yataklarının bulunduğu 24 farklı örnekleme noktasından yüzey (0-30 cm) ve yüzey altı (30-60/61/62/65 cm) olmak üzere toplamda 48 adet toprak örneği alınmıştır. Alınan yüzey ve yüzey altı toprakların bünyeleri CL, SL, SCL, L, C, ve LS olarak belirlenmiştir. Yüzey topraklarının pH değerleri 5.84 - 7.98 aralığında değişirken; yüzey altı topraklarının da pH değerleri 6.06 - 8.05 aralığında değişmektedir. Tuzluluk problemi bulunmayan toprakların kireç kapsamları yüzey topraklarında 0.00 ile %38.30 arasında; yüzey altı topraklarında ise 0.00 ile %37.90 arasında değişmektedir. Organik madde içerikleri yüzey topraklarında %0.32 - %4.16 arasında; yüzey altı topraklarında ise %0.14 - %2.16 arasında değişmektedir. Topraklar toplam azot, fosfor, çinko ve manganca fakir iken, kalsiyum ve bakır içeriklerinin yeterli düzeylerde olduğu belirlenmiştir. Potasyum, magnezyum ve demir için bazı topraklarda noksanlıklar saptanmasına rağmen, genellikle yeterli düzeylerde oldukları belirlenmiştir. Organik madde eksikliği de dâhil olacak şekilde belirlenen makro ve mikro besin elementleri eksiklikleri için ahır gübresi, kanatlı hayvan gübreleri, yeşil gübre, kompost, solucan gübresi ve çeşitli makro ve mikro elementli organik gübreleri içeren bir gübreleme planlaması yapılmasının verimlilik için gerekli olduğu düşünülmektedir. Araştırma kapsamında Şebinkarahisar ilçesinin 48 yıllık (1965-2012) iklim verilerinden faydalanılarak, Thornthwaite, De Martonne-Gottman ve Erinç yöntemlerine göre iklim sınıflandırmaları da yapılmıştır. Çalışma alanında yetiştirilebilecek bitki tür ve çeşitleri yörede etkili olan geçiş iklimi koşullarına uygun olanlar arasından seçilmelidir. Toprak örneklemesi yapılan alanlardaki akarsu sularının da analiz edilmesi faydalı olacaktır.

Anahtar Kelimeler: Toprak verimliliği, Akarsu yatağı, Geçiş iklimi, Şebinkarahisar, Giresun

1. Introduction

Soil and water resources are of great importance for living things to survive. These resources, which are among the most important factors of agricultural production, must be protected and their sustainability must be ensured. The success of agricultural activities to be carried out in different regions and under different climatic conditions depends on the availability of clean, healthy and suitable natural resources. Soils in stream beds are very valuable for agriculture. Determining and evaluating the some characteristics of these soils will make an important contribution to various agricultural applications.

Multiple climate conditions prevail in different parts of Türkiye because of differences in elevation and the presence of mountain ranges that act as barriers to rain bearing winds. With the exception of a few places, however, almost all regions of Türkiye suffer from drought and water scarcity in summer. Topography and climate characteristics, along with the presence of different sorts of natural vegetation in places with different climate conditions, means Türkiye has a wide variety of soils, which is also reflected in plant nutrients these soils have (Ülgen and Yurtsever, 1984).

Türkiye is rich in terms of the number of streams it has, with a majority of the streams originating in the country draining into the surrounding seas, and some draining into lakes (closed basins) (Başgelen, 2010). The diversity of drainage types in Türkiye is one of the main characteristics of its drainage network. This is a natural consequence of the fact that Türkiye consists of different parts with diverse characteristics in terms of structure, lithology, geological evolution, and tectonic slope. New tectonic movements, climate change, and karstification add to this diversity. One of the findings of studies on drainage types in Türkiye is that stream networks in large areas are usually young in terms of valley evolution (Erinç, 2012a).

Throughout history, civilizations have emerged and developed in river valleys. This was because rivers provided drinking and domestic water for settlement areas, irrigation water for agricultural areas, and later, energy and industrial water (Yanmaz and Usul, 2006). Stream is the general name given to bodies of water that flow within a bed and its banks. This flow can be constant or intermittent. A stream bed emerges when rainwater is collected along a specific line and then starts flowing (Erinç, 2012a). Initially, surface flow is a wide and thin body of water moving downslope, called sheet flow. This fluctuating and shallow surface flow eventually develops into rivulets of water, which in turn form small channels called brooklets. Brooklets combine to form brooks, and brooks combine to form creeks, streams and rivers. What separates streamflow from surface runoff is that streamflow takes places within a stream bed with defined boundaries (Lutgens et al., 2017).

Agricultural production plays an important role in the development of a society. To grow in a healthy environment, plants need more than a good quality soil. They also need the presence of a reliable source of water. Hydrological characteristics of a given locality depends on its climate, topography, and geology. Climate-related or hydro-meteorological factors are solar radiation, temperature, atmospheric pressure, humidity, and wind. These factors are important because they directly effect key components of the hydrological cycle such as precipitation, evaporation, and transpiration. In hydrology, the term precipitation refers to all sorts of water that comes backs to Earth from the atmosphere. Rain, snow, hail, fog, sleet, and dew are the main forms of precipitation. Precipitation is the source of all usable water on land, and is vital for the humankind. Streams are usually considered to be a reliable source in water supply projects (Yanmaz and Usul, 2006). The effect of precipitation that falls on any given area, in other words the degree of humidity or aridity, is not simply a function of the amount of monthly or annual precipitation. Many other factors including temperature, precipitation regime, evaporation conditions, and soil characteristics also play an important role (Erinç, 2012b).

Knowledge of climate characteristics allows identifying the boundaries between different climate zones, which is important for sustainable use of local resources and providing guidance for land use plans (Çolak and Memişoğlu, 2021). In addition to climate conditions, soil formation and characteristics depend on factors such as decomposition, landforms, particularly the slope of the land, vegetation, main material, and time. Air temperature and precipitation are the most important climate elements that affect soil formation. However, there are other factors beside temperature and precipitation that are required for soil formation. The distribution of air temperature and precipitation throughout the year is also very important (Atalay, 2014). Topography, which is related to climate conditions as well, has indirect effects on soil through temperature and precipitation (Sağlam et al., 1993). Leaving the time factor aside, climate has the most important direct and indirect effect on pedogenesis and soil character

(Erinç, 2012a). Local soils are mainly formed under the influence of climate and vegetation. Characteristics of the parent material are very important for plant attachment, rejuvenation, and development. There is a close relationship between the nutrient needs and root systems of plants on the one hand, and the parent material on the other (Saya and Güney, 2014). The climate factor, because it controls plant development, affects plant nutrition and contents. The factor of precipitation or water, in particular, dissolves the elements in soil, helping a plant make use these elements. Similarly, temperature affects development, and as a result, the nutrient content of the plant as well (Karaçal, 2008). In natural resource management, culture, pasture and forest plants that are resistant to drought and the region should be determined together with climate data and soil structure, and zoning plans should be associated with production planning (Cangir and Boyraz, 2008).

In semi-arid regions, streams have a bigger influence on landforming. However, this effect is also more prominent at specific times. In terms of climate and topography, it is difficult to draw strict boundaries between humid and semi-arid regions. In humid regions, streams are the main factor in landforming. In semi-arid regions, on the other hand, local water table levels play an important role, but the main factor is sea level. In this respect, semi-arid regions are similar to humid regions. Humid regions, on the other hand, are distinguished from semi-arid and arid regions in that they are covered, in areas where original vegetation is not destroyed, by forests or permanently green, uninterrupted grassland (Erinç, 2012b). Bahrami and Ghahraman (2019) argued that, because their study area was located in a semi-arid climate with limited soil and water resources, a proper understanding of geomorphological controls on soil development and fertility would help planners and managers with better management regarding irrigation, agriculture, and soil preservation. Chidozie et al. (2019) found that indiscriminate land use in tropical Nigeria, without sufficient attention paid to land and soil evaluation, caused serious ecologic problems and deterioration of land resources.

Today, in addition to the necessity of increasing soil fertility, ensuring and maintaining continuity in yield is also of great importance. This situation can only be achieved by determining the existing physical, chemical and biological properties of the soils and conscious fertilization studies to be carried out in line with these properties (Bellitürk, 2011).

This study aimed to examine the fertility of soils in stream beds and evaluate their agriculture potential in a locality with a transitional climate between semi-arid and humid climate zones. To this end, some of the fertility characteristics of the collected soil samples were analyzed, followed by an evaluation of data and recommendations. There were two main reasons for selecting the district of Şebinkarahisar as the study area: The district has a transitional climate between semi-arid and humid climate zones, and a variety of stream and soil resources.

2. Materials and Methods

2.1. Study area and soil sampling

Şebinkarahisar district of the province of Giresun is in the Eastern Black Sea part of the Black Sea region of Türkiye. The district center is located on the southern outskirts of Giresun Mountains and the northern slopes of Avutmuş Creek Valley (Yürüdür, 1998). Soil sampling sites on stream beds in the study area were identified using the relevant sections of the 1/25.000 scale standard topographical maps obtained from Anonymous (2019), and carrying out fields observations and investigations. Coordinates and altitudes of the sampling points were identified using a GPS device with a sensitivity of 1 to 3 meters (Magellan Explorist 610). A total of 48 surface (0-30 cm) and subsurface (30-60/61/62/65 cm) soil samples were collected from 24 sampling points on different stream beds. Soil samples were collected between September 28, 2019 and November 2, 2019. Samples were collected from uncultivated land, orchards, and cultivated land. The altitudes of the soil sampling points in the study area ranged from 848 meters to 1714 meters. Location and stream/soil sampling maps (*Figure 1* and *Figure 2*) were created in ArcGIS - ArcMap 10.3 software, using the World Geodetic System (WGS) 1984 Datum. For the stream/soil sampling map, a hydrology analysis was conducted using the Digital Elevation Model (DEM) data (SRTM 1 Arc-Second Global/~30 meters) obtained from USGS (2021). For accurate naming of the stream, the relevant sections of the 1/25.000 scale standard topographical map was used, along with the statements of land owners and Anonymous (2021). Information about soil sampling points and streams is presented in *Table 1*.

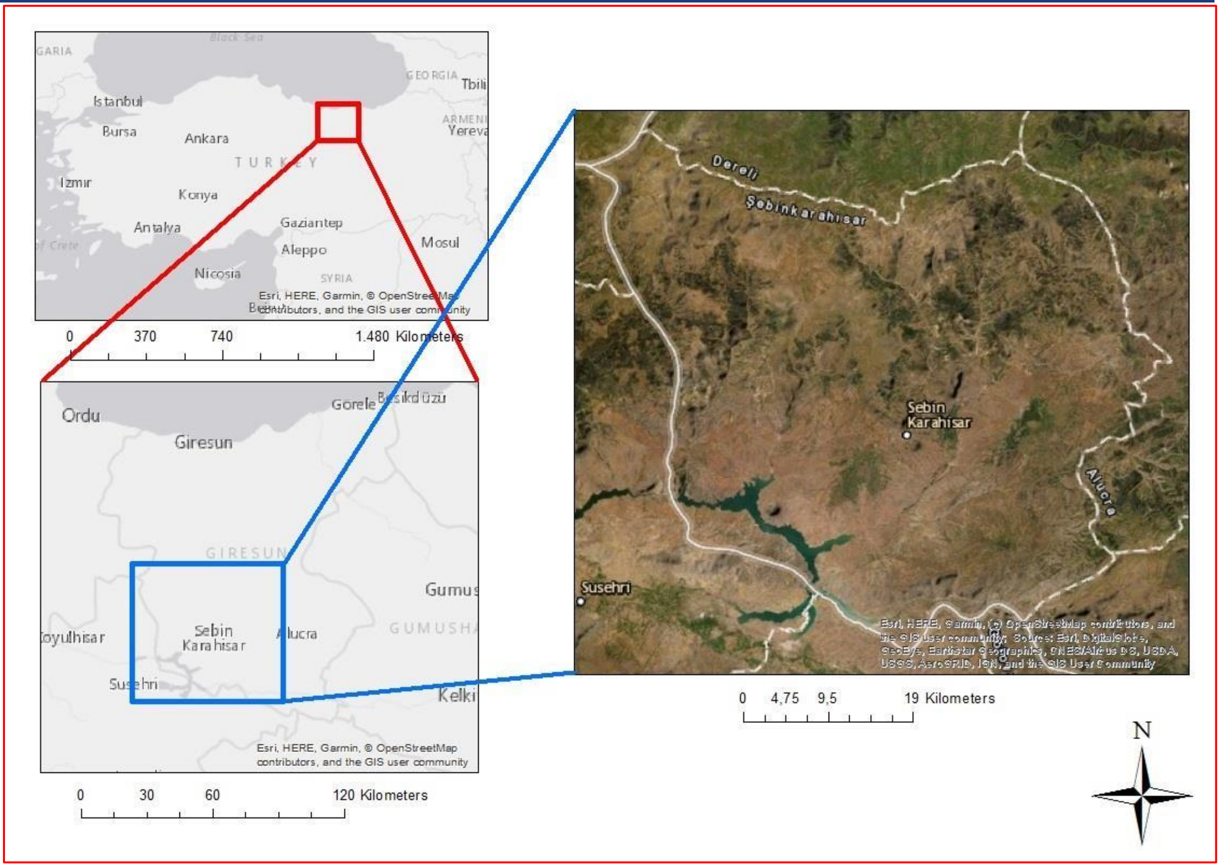

Figure 1. Location map of Şebinkarahisar district

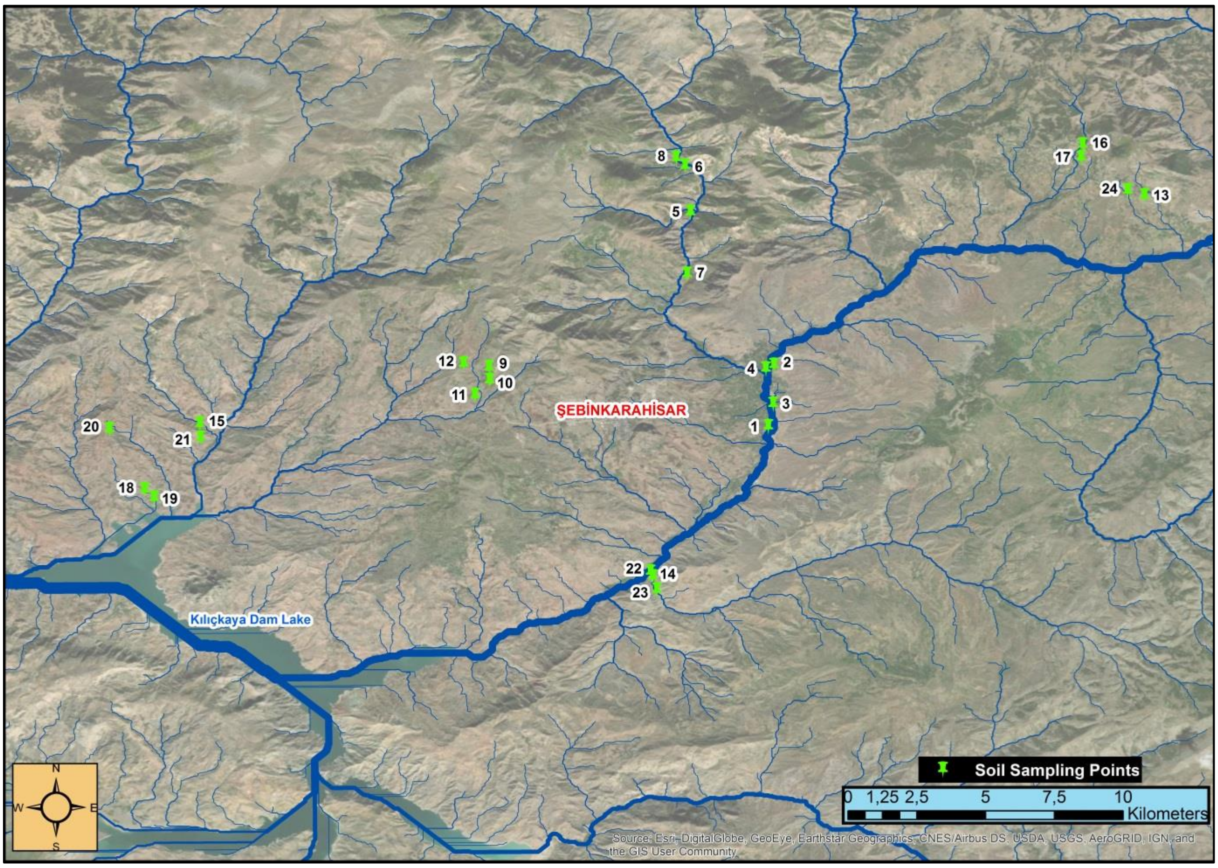

Figure 2. Stream/soil sampling map of the research area

Table 1. Information about the soil sampling points and streams in the study area

Soil sample	Coordinates	Stream name (Stream bed)	Stream
1	40°17'10"N 38°28'15"E	Avutmuş Creek	Active
2	40°18'22"N 38°28'22"E	Avutmuş Creek	Active
3	40°17'36"N 38°28'21"E	Avutmuş Creek	Active
4	40°18'18"N 38°28'12"E	Avutmuş Creek	Active
5	40°21'22"N 38°26'43"E	Asarcık Stream	Active
6	40°22'17"N 38°26'37"E	Asarcık Stream	Active
7	40°20'09"N 38°26'39"E	Asarcık Stream	Active
8	40°22'26"N 38°26'27"E	Asarcık Stream	Active
9	40°18'19"N 38°22'47"E	Bayhasan Stream	Active
10	40°18'04"N 38°22'47"E	Bayhasan Stream	Active
11	40°17'47"N 38°22'30"E	Bayhasan Stream	Active
12	40°18'24"N 38°22'16"E	Kepçeli Stream	Active
13	40°21'42"N 38°35'38"E	Derin Stream	Active
14	40°14'13"N 38°25'59"E	Soğulcuk Stream	Active
15	40°17'13"N 38°17'06"E	Acı Stream	Active
16	40°22'42"N 38°34'25"E	Püsküllü Stream	Active
17	40°22'26"N 38°34'23"E	Püsküllü Stream	Active
18	40°15'55"N 38°16'01"E	Çatalkaya Stream	Intermittent
19	40°15'46"N 38°16'12"E	Çatalkaya Stream	Intermittent
20	40°17'06"N 38°15'20"E	Derin Stream	Intermittent
21	40°16'56"N 38°17'07"E	Yedikardeş Stream	Active
22	40°14'19"N 38°25'56"E	Avutmuş Creek	Active
23	40°13'57"N 38°26'04"E	Soğulcuk Stream	Active
24	40°21'47"N 38°35'18"E	Derin Stream	Active

2.2. Geology and climate

Şebinkarahisar district is located in the southern zone of the eastern belt of Pontides tectonic unit (Ketin, 1966; Altan, 2010; Sarı, 2013). Geological descriptions of the soil sampling points in the study area were taken from the relevant sections of the 1/25.000 scale geological map obtained from the General Directorate of Mineral Research and Exploration, and shown in *Table 2* (Yılmaz, 1984; Akbaş, 1991; Sevin, 1991).

Şebinkarahisar has a transitional climate between semi-arid Central Anatolia climate and humid Black Sea climate (Yürüdür, 1998). Şebinkarahisar has an average temperature of 9.0ºC, a maximum temperature of 39.6ºC, and a minimum temperature of -23.5ºC, and much lower temperatures in winter months compared to Giresun (Kurdoğlu et al., 2017). The average annual precipitation in the district in 584.3 mm, and annual average temperature is 9.1ºC. Data from the Şebinkarahisar station were plugged in the de Martonne formula, and its humid temperate climate was found to display characteristics of a transitional zone between maritime and continental climates (Uzun et al., 2013).

Using the Thornthwaite (1948) method, researchers found the following about the climate of the Şebinkarahisar district: From 1989 to 2008, the climate index was C_2 B'_1 s_2 b'_3 (Subhumid), and it had the sub-climate type 1st degree Mesothermal with strong water deficit in summer, close to marine effects (Aydemir, 2010). From 1981 to 2010, the climate index was C_2 B'_1 s_2 b'_3 (Subhumid), and it had the sub-climate type 1st degree Mesothermal with strong water deficit in summer (Bölük, 2016a). Based on long term annual averages, the climate index of the Şebinkarahisar district was found to be C_2 B'_1 s_2 b'_3 (Çiçek, 1995). Using the De Martonne-Gottman (De Martonne, 1942) method, researchers found the following about the climate of the Şebinkarahisar district: For the period 1989-2008, the aridity index was 16.77 mm, and the climate type of the district approximated that of semi-arid areas (Aydemir, 2010). For the period 1981-2010, the aridity index was 17.13, and the climate type of the district was between semi-arid and humid (Bölük, 2016b). According to the Erinç method, precipitation effectiveness index for the period 1981-2010 was 38.99, and the climate was classified as semi-humid (Bölük, 2016c).

The present study presents average climate data for Şebinkarahisar for the 48 years from 1965 to 2012 (Anonymous, 2020) in *Table 3*, and climate classification of the district on the basis of Thornthwaite (1948), De Martonne-Gottman (De Martonne, 1942; Baltas, 2007) and Erinç (Erinç, 1965; Erinç, 1984) methods in *Table 4*. The average annual temperature in Şebinkarahisar is 9.0°C, the average annual precipitation is 583.5 mm, and the annual average relative humidity is 61.05%.

Table 2. Geological descriptions of soil sampling points

Geological descriptions	Soil sampling points
Oligocene-Lower Miocene, conglomerate-sandstone-mudstone, continental, sedimentary rock	7,9,10,11,12,14,15, 18,19,20,21,22,23
Upper Cretaceous-Paleocene, andesite, shelf, volcanic rock	13,16,17,24
Quaternary, alluvial, continental, sedimentary rock	1,2,3,4
Campanian-Maastrichtian, igneous-sedimentary rock, slope, sedimentary rock	6,8
Senonian-Paleocene, granitoid, deep rock	5

Table 3. Average climate data for Şebinkarahisar for the 48 years (1965 to 2012)

Parameter (Average)	Months												Annual
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
T	-2.4	-1.5	2.8	8.7	12.8	16.2	19.4	19.7	16.2	11.2	4.8	0.1	9.0
P	50.9	48.8	59.2	86.0	71.2	44.1	15.5	11.8	23.8	54.4	61.8	56.0	583.5
RH	68.8	66.9	63.1	59.1	59.5	57.4	54.8	54.0	54.5	59.9	65.4	69.2	61.05
T_{DMT}	1.6	2.9	7.8	14.2	19.0	23.0	27.1	27.8	23.9	17.3	9.6	3.9	14.84

T: Temperature (°C), P: Precipitation (mm), RH: Relative Humidity (%), T_{DMT}: Daily Maximum Temperature (°C)

Table 4. Climate classifications of Şebinkarahisar district

Şebinkarahisar (Latitude: 40.2872 Longitude: 38.4193 Elevation: 1364.0 m) Climate period (1965 - 2012 / 48 Years)		
Method and classification	**Climate indice**	**Climate feature**
Thornthwaite (1948)	C_2 B'_1 s_2 b'_3 (Moist subhumid)	First Mesothermal, large summer water deficiency, summer concentration 54.57%
De Martonne-Gottman (De Martonne, 1942; Baltas, 2007)	Aridity Index 17.74	Semi Arid - Humid
Erinç (Erinç, 1965; Erinç, 1984)	Precipitation Efficiency Index 39.32	Semi Humid

2.3. Methods

In this study, soil sampling points in Şebinkarahisar district, which has a transitional climate between semi-arid and humid climate zones, were determined by considering the geographical locations and topographic characteristics of the stream beds. Disturbed surface (0-30 cm) and subsurface (30-60/61/62/65 cm) soil samples were collected from the sampling points identified. Soil samples were taken using a spade shovel, a small shovel, a earth auger machine and a tape measure. The samples taken were placed in plastic bags and the characteristics of the sampling area were noted. Afterwards, soil samples brought to the laboratory were laid on newspapers and left to dry. Samples were dried out, and then, prepared for analysis using the necessary materials. The textures of the soils were determined using the hydrometer method (Bouyoucos, 1951). Texture triangle was used to name texture classes (Anonymous, 1993). Soil reaction (pH) was measured using a pH meter in the saturation mud prepared (Richards, 1954). Results of the pH analysis were classified on the basis of the values reported by Kellogg (1952). Total salt contents (%) of the soils were calculated on the basis of the values measured using an electrical conductivity meter in the saturation mud (Richards, 1954). Total salt contents were interpreted on the basis of the values reported by Korkut (1983). Lime contents (%) were measured volumetrically, using the calcimetric method (Kacar, 2016). Organic matter (%) was identified using the Walkley-Black method (Müftüoğlu et al., 2014). Lime contents were classified on the basis of Güçdemir (2008). Organic matter contents were classified according to Ülgen and Yurtsever (1984). Total nitrogen (%) was measured using the Kjeldahl method (Sağlam, 2008). Phosphorus content was measured using the Olsen method (Olsen et al., 1954) and a spectrophotometer; and potassium, calcium, and magnesium contents were measured using an ICP instrument (Müftüoğlu et al., 2014) after extraction with ammonium acetate (Jackson, 1958). Total nitrogen, phosphorus, potassium, calcium, and magnesium contents were interpreted on the basis of the values reported by Anonymous (1990). Fe, Cu, Zn and Mn were extracted with DTPA, and then measured using an ICP instrument (Lindsay and Norvell, 1978). Fe contents were evaluated according to Lindsay and Norvell (1978) Cu contents according to Follett (1969), and Zn and Mn contents according to Anonymous (1990). IBM SPSS Statistics 22 software was used to calculate some of the descriptive statistics and correlation coefficients for soil analysis results.

3. Results and Discussion

In the study, the investigated surface soils (0-30 cm) were classified as CL (nine soil samples), SL (seven soil samples), SCL (four soil samples), L (three soil samples), and C (one soil sample) in terms of texture. Textures of the subsurface soils (30-60/61/62/65 cm) were classified as CL (eight soil samples), as SL (five soil samples), as SCL (five soil samples), as L (three soil samples), as C (two soil samples), and as LS (one soil sample) (Anonymous, 1993). A great majority of the surface soil samples (0-30 cm) collected from orchards around the western parts of the Avutmuş Creek, which is in Şebinkarahisar district of the Giresun province of Türkiye, were classified as sandy clay loam and clay loam in terms of texture (Atmaca and Nalbant, 2018). Textures of surface and subsurface soil samples collected from a stream terrace in Kahta district of the Adıyaman Province of Türkiye were classified as clay loam (CL) and sandy clay loam (SCL) (Çelik and Akça, 2017). In the humid tropical southeastern part of Nigeria, textures of soil samples (0-20) were classified as SL, SCL, and S (Chidozie et al., 2019). Texture classes found in these studies are similar to the texture classes found in the present study. On the other hand, Sowiński et al. (2020) found SiL, SL, and Si texture classes in all horizons of the 20 soil samples they collected from the genetic horizons of 6 soil layers in the soil catena in a hilly valley of Lier River in Buskerud region of Southern Norway, and, Atmaca and Boyraz Erdem

(2016) found that many of the soils in stream beds in the Central district of the province of Tekirdağ were classified as clay, findings that are at variance with the findings of the present study.

Soil in high precipitation areas shows acid reaction, and soil in arid and semi-arid areas with little precipitation shows alkaline reactions (Atalay, 2014). Some of the chemical properties of the soils were analyzed, and the results are reported in *Table 5*. pH values of surface soils ranged from 5.84 to 7.98, and the pH values of subsurface soils ranged from 6.06 to 8.05. Surface and subsurface soils from sampling points 1, 2, 3, 4 (Avutmuş Creek bed), 7 (Asarcık Stream bed), 9, 10, 11 (Bayhasan Stream bed), 12 (Kepçeli Stream bed) and 21 (Yedikardeş Stream bed) were found to be slightly alkaline, and surface and subsurface soils from sampling points 5 (Asarcık Stream bed), 13 and 24 (Derin Stream active bed), 16 (Püsküllü Stream bed) were found to be neutral. Surface and subsurface soils from sampling point 17 (Püsküllü Stream bed) were found to be slightly acidic, and surface and subsurface soils from sampling points 18, 19 (Çatalkaya Stream bed), and 20 (Derin Stream intermittent bed) were found to be alkaline. On the other hand, surface soils from sampling points 14 and 23 (Soğulcuk Stream bed), and 22 (Avutmuş Creek bed) were found to be slightly alkaline, and subsurface soils from the same sampling points were found to be alkaline. Surface soils from the sampling points 6 (Asarcık Stream bed) and 15 (Acı Stream bed) were found to be moderately acidic and alkaline, respectively, and subsurface soils from the same sampling points were found to be slightly acidic and slightly alkaline. Surface soil from the sampling point 8 (Asarcık Stream bed) were neutral, and subsurface soil from the same sampling point were slightly acidic (Kellogg, 1952). Overall, soil reaction results show that soils in the study area, which has a transitional climate between semi-arid and humid climate zones, are similar to soils of semi-arid regions. Some of the soil samples showed acidic reaction, but they were few in number. Because the total salt contents (%) of all the samples from the study area were lower than the reference value of 0.15% reported by Korkut (1983), all of the soils were classified as non-saline. In similar studies, Atmaca and Nalbant (2018) classified as non-saline all of the surface soil samples they collected from around the western parts of the Avutmuş Creek, and reported that most of the soils had neutral soil reaction. Atmaca and Boyraz Erdem (2016) reported that surface soil samples collected from stream beds in the Central district of the province of Tekirdağ in Türkiye usually had neutral pH values, and did not have a salinity problem.

Lime contents of the surface soils from the study area ranged from 0.00% to 38.30%, and lime contents of subsurface soils ranged from 0.00% to 37.90%. Using the threshold values reported by Güçdemir (2008), surface and subsurface soils from sampling points 5, 6, 8 (Asarcık Stream bed), 13 (Derin Stream active bed), and, 16 and 17 (Püsküllü Stream) were classified as lime-free, along with the surface soil from sampling point 24 (Derin Stream active bed). Surface and subsurface soils from sampling points 1 (Avutmuş Creek bed) and 10 (Bayhasan Stream bed) were classified as moderately limey, those from sampling points 11 (Bayhasan Stream bed) and 18 (Çatalkaya Stream bed) were classified as limey, those from sampling points 2 (Avutmuş Creek bed), 15 (Acı Stream bed), 19 (Çatalkaya Stream bed) and 21 (Yedikardeş Stream bed) were classified as highly limey, and those from sampling points 14 and 23 (Soğulcuk Stream bed), and 20 (Derin Stream intermittent bed) were classified as extremely limey. In terms of the lime contents of their surface/subsurface soils, sampling point 4 (Avutmuş Creek bed) was classified as somewhat/slightly limey; sampling point 7 (Asarcık Stream bed) as moderately/highly limey; sampling point 3 (Avutmuş Creek bed) as limey/extremely limey; sampling point 9 (Bayhasan Stream bed) as highly limey/limey; sampling point 12 (Kepçeli Stream bed) as limey/highly limey; and sampling point 22 (Avutmuş Creek bed) as extremely/highly limey. Subsurface soil from the sampling point 24 (Derin Stream active bed) was also classified as slightly limey. One important factor behind the diversity in the lime contents of the soil samples, ranging from non-limey to extremely limey, is that Şebinkarahisar has a transitional climate.

Organic matter contents of the samples varied between 0.32% and 4.16% for surface soils, and between 0.14% and 2.16% for subsurface soils. According to threshold values reported by Ülgen and Yurtsever (1984); surface soils from sampling points 10, 17, and 22 (Bayhasan Stream bed; Püsküllü Stream bed; Avutmuş Creek bed) and subsurface soil from sampling point 6 (Asarcık Stream bed) were found to contain moderate amount organic matter. Surface soils from sampling points 5 and 6 (Asarcık Stream bed) had a high and good amounts of organic matter. The rest of the surface and subsurface soils on the all stream beds had very little or little amounts of organic matter. Ülgen and Yurtsever (1984) argue that soils in Türkiye are usually deficient in organic matter because of a failure to good practice crop rotation, and because the hot and dry climate makes it difficult or impossible for organic matter to accumulate. Atmaca and Boyraz Erdem (2016) found that soils in stream beds in Tekirdağ usually had low lime and organic matter contents. Atmaca and Nalbant (2018) found that organic matter contents varied between 0.76% and 3.87% around the western part of the Avutmuş Creek in Şebinkarahisar, and lime contents varied between 0.00% and 14.83%.

Bahrami and Ghahraman (2019) found that the soil reaction ranged from 7.66 to 8.81 in 36 soil samples collected from the surfaces (0-30 cm) of three alluvial fans of different ages (relict, old, and young) in Western Sabzevar in Northeast Iran. Chidozie et al. (2019) studied contrasting land use and similar lithology (coastal plain sands) in eight local government areas of Imo State in Nigeria, with an elevation of 91 m above sea level and covering 5530 km^2. They collected surface soil samples (0-20 cm) from all land use types. The authors reported that the hydrology of the study area was governed by Imo River and other rivers such as Nworie, Ogochie, Otamiri, Oramirukpa, and Mba rivers. They found that pH (1:2.5 H_2O) values of the soil samples varied between 4.58 and 6.46 (slightly acidic), and their organic matter contents varied between 0.69% and 2.65%. pH results of study in Northeast Iran and pH and organic matter results of study in Nigeria are different from the findings of the present study regarding pH and organic matter contents of surface soils. Çelik and Akça (2017) reported that elevation from sea level was 637-668 m in their study area in the Kahta district (of Adıyaman), the climate of the district was classified as Csa according to the Köppen-Geiger classification, average annual temperature was 16.6°C, and average annual precipitation was 584 mm. The 14 disturbed soil samples they collected from 7 points on a stream terrace in Research and Application Field of Vocational School of Kahta of Adıyaman University, from depths of 0-30 cm and 30-60 cm, had pH values between 7.60 and 7.89, organic matter contents ranging from 2.02% to 3.11%, and lime contents ranging from 0.08% to 7.47%. They reported that the soils did not have a salinity problem. Çelik and Akça's (2017) findings regarding pH values and lime and organic matter contents are different from those of the present study, but their finding regarding salinity is similar. Mehdi et al. (2002) found that in the surface horizons of Shahdara, Sultanpur and Lyallpur alluvial soil series in Pakistan, $CaCO_3$ levels varied between 1.1% and 13%, organic matter contents between 0.50% and 1.00%, pHs values between 7.8 and 8.1, and ECe between 0.74 and 0.86 dsm^{-1}. At various depths of subsurface horizons, on the other hand, $CaCO_3$ levels varied between 1.1% and 14.0%, organic matter contents between 0.16% and 0.60%, pHs values between 7.9 and 8.2, and ECe values between 0.34 and 9.50 dsm^{-1}. Climate characteristics were classified as semi-arid and semi-humid subtropical continental in the Shahdara series, and semi-arid subtropical continental in Sultanpur and Lyallpur series. Looking at the values reported by Mehdi et al. (2002), all of their findings regarding organic matter, pHs, $CaCO_3$ and ECe results of surface and subsurface soils are different from those of the present study, except for the finding that the surface ve some subsurface soils did not have a salinity problem.

Findings from an analysis of the macro element contents of the study soils are reported in *Table 6*. Total nitrogen, phosphorus, potassium, calcium, and magnesium contents of the soil samples were classified on the basis of the threshold values reported by Anonymous (1990). Total nitrogen contents varied between 0.02% and 0.21% for surface soils, and between 0.01% and 0.11% for subsurface soils. 37.5% of the surface soils were classified as having very little total nitrogen, 41.67% as having little total nitrogen, 12.5% as having sufficient total nitrogen, and 8.33% as having a large amount of total nitrogen. Of the subsurface soil samples, 19 had very little total nitrogen, 4 had little total nitrogen, and 1 had sufficient total nitrogen. Surface and subsurface soils from sampling point 6 on the bed of Asarcık Stream had a large amount and sufficient total nitrogen. Surface soils from sampling points 5 (Asarcık Stream bed), 10 (Bayhasan Stream bed), 17 (Püsküllü Stream bed), and 22 (Avutmuş Creek bed) had sufficient or a large amounts of total nitrogen. The rest of the soil samples on the stream beds had very little or little amounts of total nitrogen.

Phosphorus contents varied between 0.08 ppm and 80.80 ppm for surface soils, and between 0.01 ppm and 48.10 ppm for subsurface soils. Sampling points 9 (Bayhasan Stream bed), 12 (Kepçeli Stream bed), and 19 (Çatalkaya Stream bed) had very little phosphorus, sampling points 1 and 3 (Avutmuş Creek bed), 10 (Bayhasan Stream bed), and 16 (Püsküllü Stream bed) had little phosphorus, and sampling points 4 (Avutmuş Creek bed) and 8 (Asarcık Stream bed) had sufficient phosphorus in their surface and subsurface soils. Sampling points 2 (Avutmuş Creek bed), 13 and 24 (Derin Stream active bed), and 17 (Püsküllü Stream bed), on the other hand, had sufficient phosphorus in their surface soils, and little phosphorus in their subsurface soils. Sampling points 7 (Asarcık Stream bed), 11 (Bayhasan Stream bed), 15 (Acı Stream bed), 18 (Çatalkaya Stream bed), 20 (Derin Stream intermittent bed), 21 (Yedikardeş Stream bed), 14 and 23 (Soğulcuk Stream bed) had little phosphorus in their surface soils, and very little in their subsurface soils. Sampling point 5 (Asarcık Stream bed) had a very large amount phosphorus in its surface soil and a large amount in its subsurface soil; sampling point 6 (Asarcık Stream bed) had a large amount phosphorus in its surface soil and sufficient in its subsurface soil; and sampling point 22 (Avutmuş Creek bed) had sufficient phosphorus in its surface soil and very little in its subsurface soil.

Table 5. Some of the chemical properties of the research soils

Sample no.	Depth (cm)	pH	Total salt (%)	Lime (%)	OM* (%)	Sample no.	Depth (cm)	pH	Total salt (%)	Lime (%)	OM* (%)
1	0-30	7.53	0.03	4.75	1.10	13	0-30	6.77	0.03	0.00	1.60
	30-60	7.66	0.03	4.91	0.68		30-60	6.97	0.02	0.00	0.82
2	0-30	7.68	0.04	16.17	1.18	14	0-30	7.69	0.02	31.14	0.90
	30-61	7.75	0.04	18.34	0.46		30-60	7.92	0.01	37.90	0.32
3	0-30	7.70	0.01	12.15	0.59	15	0-30	7.89	0.02	24.38	0.40
	30-60	7.68	0.03	26.71	1.04		30-60	7.70	0.01	24.62	0.14
4	0-30	7.54	0.02	3.62	1.49	16	0-30	6.94	0.02	0.00	0.63
	30-60	7.40	0.01	0.16	0.76		30-60	6.98	0.02	0.00	0.46
5	0-30	6.62	0.02	0.00	4.16	17	0-30	6.19	0.01	0.00	2.02
	30-61	6.97	0.01	0.00	1.79		30-61	6.30	0.01	0.00	0.91
6	0-30	5.84	0.01	0.00	3.89	18	0-30	7.91	0.02	13.04	1.23
	30-61	6.06	0.01	0.00	2.16		30-60	7.97	0.02	12.95	0.88
7	0-30	7.36	0.03	5.79	0.34	19	0-30	7.88	0.02	16.74	0.63
	30-61	7.69	0.02	18.34	0.32		30-60	8.02	0.02	19.07	0.32
8	0-30	6.92	0.01	0.00	1.40	20	0-30	7.98	0.01	38.30	0.60
	30-62	6.17	0.01	0.00	0.37		30-61	7.99	0.02	32.02	0.14
9	0-30	7.46	0.05	17.06	0.59	21	0-30	7.78	0.02	23.42	0.83
	30-61	7.67	0.04	10.14	0.37		30-61	7.66	0.02	24.22	0.66
10	0-30	7.56	0.03	7.40	2.16	22	0-30	7.50	0.03	27.12	2.28
	30-62	7.68	0.03	5.71	0.54		30-65	7.87	0.02	21.16	0.32
11	0-30	7.54	0.05	11.18	0.93	23	0-30	7.78	0.03	31.14	1.17
	30-60	7.69	0.04	13.76	0.48		30-60	8.05	0.02	33.47	0.43
12	0-30	7.59	0.03	12.95	0.32	24	0-30	6.84	0.02	0.00	1.77
	30-60	7.69	0.02	16.82	0.34		30-61	7.17	0.02	0.48	0.91

* Organic Matter

Potassium contents of the soils varied between 67.47 ppm and 626.92 ppm for surface soils, and 57.61 ppm and 368.48 ppm for subsurface soils. Sampling points 1, 2, 3, 4 (Avutmuş Creek bed), 6, 7, 8 (Asarcık Stream bed), 9 (Bayhasan Stream bed), 12 (Kepçeli Stream bed), 13 and 24 (Derin Stream active bed), 18 (Çatalkaya Stream bed), 20 (Derin Stream intermittent bed), and 23 (Soğulcuk Stream bed) had sufficient potassium, and sampling point 5 (Asarcık Stream bed) had a large amount of potassium in their surface and subsurface soils. Sampling points 10 and 11 (Bayhasan Stream bed), 21 (Yedikardeş Stream bed), and 22 (Avutmuş Creek bed), on the other hand, had a large amount of potassium in their surface soils, and sufficient potassium in their subsurface soils. Sampling points 16 and 17 (Püsküllü Stream bed) were found to have little potassium in their surface and subsurface soils. Sampling points 14, 15, and 19 (Soğulcuk, Acı and Çatalkaya Stream beds) had sufficient potassium in their surface soils, but little potassium in their subsurface soils.

Bahrami and Ghahraman (2019) found that total nitrogen varied between 0.012% and 0.084%, available phosphorus varied between 0.1 and 19 ppm, and available potassium varied between 52 and 280 ppm in the surface soils they collected. Chidozie et al. (2019) reported that total nitrogen varied between 0.01% and 0.06%, and available phosphorus varied between 0.72 ppm and 6.77 ppm in the surface soil samples they collected in Nigeria. Findings reported by Bahrami and Ghahraman (2019) and Chidozie et al. (2019) regarding surface soils are different from the findings of the present study. In similar studies; Atmaca and Nalbant (2018) reported that surface soils around the western parts of the Avutmuş Creek usually had sufficient total nitrogen and potassium, but some of the soils were deficient in phosphorus. Atmaca and Boyraz Erdem (2016) reported that available phosphorus and exchangeable potassium contents of soil samples collected from stream beds in the Central district of the province of Tekirdağ were usually sufficient. Çelik and Akça (2017) found that, on average, the soil samples they collected from a stream terrace in Kahta, Adıyaman had low levels of total nitrogen and available phosphorus, and high levels of available potassium.

Calcium contents of surface and subsurface soils from all sampling points varied between 1587.79 ppm and 9648.03 ppm. Surface and subsurface soils from sampling points 6 and 8 (Asarcık Stream bed), and surface soil from sampling point 5 (Asarcık Stream bed) had sufficient calcium. The rest of the surface and subsurface soils from sampling points on the stream beds had a large amount of calcium.

Magnesium contents varied between 168.01 and 821.66 ppm for surface soils, and between 154.29 and 829.02 ppm for subsurface soils. 20 of the surface soils were classified as having sufficient magnesium, and 4 as having a large amount of magnesium. 16 of the subsurface soil samples were found to have sufficient magnesium, and 7 were found to have a large amount of magnesium. Subsurface soil from the sampling point 7 on the bed of Asarcık Stream, on the other hand, was found to contain little magnesium.

Sowiński et al. (2020) found that in the surface horizons of soil samples from the Buskerud region of Southern Norway, total Ca content varied between 3.08 and 7.14 g kg^{-1}, total Mg varied between 3.27 and 4.86 g kg^{-1} and total K varied between 2.85 - 5.12 g kg^{-1}; whereas in subsurface horizons, total Ca varied between 3.18 and 5.97 g kg^{-1}, total Mg varied between 3.66 and 5.46 g kg^{-1} and total K varied between 2.95 - 6.57 g kg^{-1}. Chidozie et al. (2019) reported that surface soil samples collected in Nigeria had Ca contents varying between 0.4 and 2.6 cmol kg^{-1}, Mg contents varying between 0.1 and 1.6 cmol kg^{-1} and K contents varying between 0.01 and 0.22 cmol kg^{-1}. Mehdi et al. (2002) reported that surface horizons of alluvial soil series in Pakistan had $Ca^{++}Mg^{++}$ values ranging from 3.0 to 7.0 me L^{-1}, K^{+} values ranging from 0.13 to 0.30 me L^{-1} and subsurface horizons had $Ca^{++}Mg^{++}$ values ranging from 1.5 to 44.1 me L^{-1}, K^{+} values ranging from 0.10 to 0.31 me L^{-1}. Atmaca and Nalbant (2018) reported that all soil samples collected from around the western parts of the Avutmuş Creek contained large amounts of calcium and sufficient magnesium.

Findings from an analysis of the micro element contents of the study soils are reported in *Table 7*. Iron contents varied between 1.01 ppm and 85.50 ppm for surface soils, and between 2.22 ppm and 69.76 ppm for subsurface soils. Using the values provided by Lindsay and Norvell (1978), surface and subsurface soils from the sampling points 14, 18, 19, and 23 (Soğulcuk and Çatalkaya Stream beds) were classified as containing a moderate amount of iron. Sampling point 12 (Kepçeli Stream bed) had a moderate amount of iron in its surface soil, and little iron in its subsurface soil. Sampling points 15 (Acı Stream bed) and 21 (Yedikardeş Stream bed) had little iron in their surface soils, and a moderate amount in their subsurface soils. Surface soil from the sampling point 20 (Derin Stream intermittent bed), and subsurface soil from the sampling point 22 (Avutmuş Creek bed) contained a moderate amount of iron. All surface and subsurface soils samples apart from these were found to contain a large amount of iron.

Copper contents varied between 1.33 ppm and 6.48 ppm for surface soils, and between 1.30 ppm and 8.41 ppm for subsurface soils. All soil samples in the study were classified as having sufficient copper because they contained more than the threshold value of 0.2 ppm reported by Follett (1969).

Zn and Mn contents were classified on the basis of the threshold values provided by Anonymous (1990). Zinc contents varied between 0.06 ppm and 7.29 ppm for surface soils, and between 0.04 ppm and 4.70 ppm for subsurface soils. 17 of the surface soils contained little or very little zinc, and the rest contained sufficient or a large amount of zinc. Of the subsurface soils, on the other hand, 17 contained very little zinc, 4 contained little zinc, 1 contained sufficient zinc, and 2 contained a large amount of zinc. Sampling points 5 and 6 (Asarcık Stream bed) were found to have a large amount of zinc in their surface and subsurface soils. Surface and subsurface soils from sampling point 4 on the bed of Avutmuş Creek had a large amount and sufficient zinc. Sampling points 7 and 8 (Asarcık Stream bed), and 13 and 24 (Derin Stream active bed) had sufficient or a large amount zinc in their surface soils. All surface and subsurface soils samples apart from these were found to contain very little and little of zinc.

Manganese contents varied between 2.74 ppm and 58.82 ppm for surface soils, and between 1.75 ppm and 41.32 ppm for subsurface soils. Sampling points 1, 2, 3 (Avutmuş Creek bed), 7 (Asarcık Stream bed), 11 (Bayhasan Stream bed), 18 and 19 (Çatalkaya Stream bed), 20 (Derin Stream intermittent bed), 21 (Yedikardeş

Stream bed), 22 (Avutmuş Creek bed) had little manganese, sampling point 15 (Acı Stream bed) had very little manganese, and sampling points 6 and 8 (Asarcık Stream bed), 16 and 17 (Püsküllü Stream bed), and 24 (Derin Stream active bed) had sufficient manganese in their surface and subsurface soils. Sampling points 9, 12, 14, and 23 (Bayhasan, Kepçeli and Soğulcuk Stream beds) on the other hand, had little manganese in their surface soils, and very little in their subsurface soils. Sampling points 4 (Avutmuş Creek bed) and 10 (Bayhasan Stream bed) had sufficient manganese in their surface soils, and little manganese in their subsurface soils. Sampling points 5 (Asarcık Stream bed) and 13 (Derin Stream active bed), on the other hand, had a large amount of manganese in their surface soils, and sufficient manganese in their subsurface soils.

Atmaca and Nalbant (2018) reported that soils around the western parts of the Avutmuş Creek contained sufficient copper. They found that a majority of the soils contained a large amount of iron, but some of the soils were deficient in zinc and manganese. Their findings regarding iron, copper, zinc, and manganese contents are consistent with those of the present study. Atmaca and Boyraz Erdem (2016) found that surface soils in stream beds in the Central district of Tekirdağ in Türkiye had sufficient iron, copper, and manganese. On the other hand, they found that some of the soils were deficient in zinc. Atmaca and Boyraz Erdem's (2016) findings regarding iron, copper and zinc are consistent with those of the present study. But their findings regarding manganese are different with those of the present study. Soils samples collected from a stream terrace in Kahta, Adıyaman were found to contain low and a moderate amount of available iron, sufficient copper and manganese, and low available zinc (Çelik and Akça, 2017). In surface horizons of soils samples from the Buskerud region of Southern Norway, total Fe was found to vary between 11.35 and 27.12 g kg^{-1} and total Mn was found to vary between 0.25 and 0.37 g kg^{-1}. In subsurface horizons, on the other hand, total Fe ranged from 12.36 to 25.13 g kg^{-1} and total Mn ranged from 0.22 to 0.37 g kg^{-1} (Sowiński et al., 2020).

Table 6. Contents of macro elements of the research

Sample no.	Depth (cm)	Total N (%)	ppm				Sample no.	Depth (cm)	Total N (%)	ppm			
			P	K	Ca	Mg				P	K	Ca	Mg
1	0-30	0.05	4.96	192.27	7616.83	383.58	13	0-30	0.08	10.06	230.03	5394.24	821.66
	30-60	0.03	3.88	200.64	7937.54	405.77		30-60	0.04	4.33	203.18	5510.11	730.58
2	0-30	0.06	8.01	270.36	8165.15	607.91	14	0-30	0.05	7.53	220.58	6408.90	253.23
	30-61	0.02	5.08	199.73	7917.88	630.00		30-60	0.02	0.59	98.09	6452.18	296.07
3	0-30	0.03	5.57	123.98	5812.61	313.51	15	0-30	0.02	2.90	143.23	7139.20	285.98
	30-60	0.05	5.23	146.69	7203.12	592.64		30-60	0.01	1.26	81.81	6438.30	341.44
4	0-30	0.07	18.89	199.20	6552.37	353.73	16	0-30	0.03	7.75	67.47	6241.91	646.65
	30-60	0.04	10.27	168.65	4681.85	334.15		30-60	0.02	6.94	60.01	6099.97	633.47
5	0-30	0.21	80.80	579.63	3137.76	332.94	17	0-30	0.10	10.50	85.87	4533.57	459.74
	30-61	0.09	48.10	368.48	4266.27	357.01		30-61	0.05	7.25	57.61	4569.44	563.80
6	0-30	0.19	27.08	152.62	1601.04	191.23	18	0-30	0.06	2.76	176.10	8060.13	223.83
	30-61	0.11	21.33	154.29	1695.91	226.63		30-60	0.04	0.91	168.52	7592.28	255.27
7	0-30	0.02	5.78	244.31	7865.14	200.55	19	0-30	0.03	0.08	136.43	7763.85	197.26
	30-61	0.02	1.31	113.33	6715.42	154.29		30-60	0.02	0.86	90.43	7608.33	260.29
8	0-30	0.07	22.53	219.37	2952.76	188.61	20	0-30	0.03	2.99	153.90	6628.55	168.01
	30-62	0.02	12.76	114.53	1587.79	188.80		30-61	0.01	1.47	177.50	6485.80	209.83
9	0-30	0.03	2.37	233.32	7561.52	411.34	21	0-30	0.04	5.50	350.31	6287.77	185.45
	30-61	0.02	0.82	164.09	8606.08	736.33		30-61	0.03	1.18	204.39	6250.37	219.15
10	0-30	0.11	4.83	306.87	8549.18	228.73	22	0-30	0.11	10.53	626.92	6387.76	386.66
	30-62	0.03	2.58	197.96	7894.05	247.13		30-65	0.02	0.39	156.77	6355.61	327.30
11	0-30	0.05	3.18	323.88	9648.03	636.86	23	0-30	0.06	5.06	276.20	6468.89	263.46
	30-60	0.02	0.10	251.09	8794.55	829.02		30-60	0.02	0.65	114.28	5898.07	289.02
12	0-30	0.02	1.22	194.49	8627.93	246.95	24	0-30	0.09	16.48	222.90	6258.51	468.36
	30-60	0.02	0.01	126.02	8689.45	286.26		30-61	0.05	3.42	131.79	6555.82	440.10

Table 7. Contents of micro elements of the research soils

Sample no.	Depth (cm)	ppm				Sample no.	Depth (cm)	ppm			
		Fe	Cu	Zn	Mn			Fe	Cu	Zn	Mn
1	0-30	7.61	4.45	0.49	12.67	13	0-30	30.32	3.84	0.73	51.75
	30-60	11.40	5.33	0.13	9.19		30-60	37.01	3.65	0.20	41.32
2	0-30	6.91	1.89	0.26	8.00	14	0-30	3.24	1.33	0.19	4.99
	30-61	7.98	2.19	0.13	6.43		30-60	3.57	1.30	0.06	2.94
3	0-30	11.88	2.26	0.25	5.31	15	0-30	1.01	1.91	0.45	2.74
	30-60	21.30	4.11	0.26	4.24		30-60	4.24	1.47	0.07	2.75
4	0-30	18.33	5.57	4.00	16.46	16	0-30	14.61	1.88	0.13	39.32
	30-60	14.16	4.09	0.92	13.35		30-60	13.49	1.38	0.12	32.62
5	0-30	54.48	6.48	7.29	58.82	17	0-30	33.25	3.45	0.45	47.66
	30-61	33.62	8.41	4.70	38.50		30-61	21.37	2.69	0.10	30.13
6	0-30	85.50	3.88	6.53	44.55	18	0-30	3.69	2.10	0.40	5.72
	30-61	69.76	5.40	3.69	37.17		30-60	4.30	2.56	0.11	6.22
7	0-30	10.72	4.52	1.23	12.26	19	0-30	2.85	1.48	0.07	7.60
	30-61	8.22	3.19	0.19	7.07		30-60	2.82	1.34	0.05	4.76
8	0-30	45.77	3.55	2.44	34.53	20	0-30	3.43	1.64	0.11	10.81
	30-62	24.34	3.12	0.43	28.79		30-61	4.55	1.35	0.10	6.12
9	0-30	16.10	3.98	0.27	12.26	21	0-30	1.41	1.60	0.62	4.63
	30-61	5.86	2.39	0.09	2.51		30-61	3.95	2.18	0.13	4.53
10	0-30	7.87	3.43	0.32	14.80	22	0-30	6.07	4.17	0.56	8.46
	30-62	7.40	3.97	0.08	10.87		30-65	3.07	1.94	0.07	4.67
11	0-30	6.17	2.65	0.11	9.25	23	0-30	3.29	1.58	0.18	6.48
	30-60	7.17	2.57	0.07	5.79		30-60	2.97	1.66	0.04	2.95
12	0-30	2.91	1.87	0.06	5.54	24	0-30	17.40	2.65	0.84	35.04
	30-60	2.22	1.93	0.04	1.75		30-61	10.75	2.05	0.23	25.71

Table 8 reports descriptive statistics for the soil parameters in the study, and *Table 9* reports correlation coefficients and results of the correlation analysis carried out for surface and subsurface soil samples. For all surface and subsurface soils: Results of the correlation analysis showed that here was a positive (+) relationship between pH-lime, pH-Ca, total salt-Ca, total salt-Mg, OM-total nitrogen, OM-P, OM-K, OM-Fe, OM-Cu, OM-Zn, OM-Mn, total nitrogen-P, total nitrogen-Fe, total nitrogen-Cu, total nitrogen-Zn, total nitrogen-Mn, P-K, P-Fe, P-Cu, P-Zn, P-Mn, K-Cu, Fe-Cu, Fe-Zn, Fe-Mn, Cu-Zn, Cu-Mn, and Zn-Mn. On the other hand, there was a negative (-) relationship between pH-OM, pH-total nitrogen, pH-P, pH-Fe, pH-Cu, pH-Zn, pH-Mn, lime-OM, lime-total nitrogen, lime-P, lime-Fe, lime-Cu, lime-Mn, OM-Ca, total nitrogen-Ca, P-Ca, Ca-Fe, Ca-Zn, and Ca-Mn. In addition, a positive (+) relationship was found between total nitrogen-K in surface soils, and between pH-total salt and K-Zn in subsurface soils. A negative (-) relationship was found between lime-Zn in surface soils, and between total salt-Mn in subsurface soils. In a similar study, Atmaca and Nalbant (2018) performed correlation analysis of the surface soil (0-30 cm) characteristics of the orchards around the western parts of the Avutmuş Creek in Şebinkarahisar district. They determined that there was a positive (+) relationship between salt-lime, OM-total N, OM-P, OM-Fe, OM-Cu, OM-Zn, total N-P, total N-Fe, total N-Cu, total N-Zn, P-K and Fe-Cu. On the other hand, they found that there was a negative (-) relationship between pH-OM, pH-total N, pH-Fe, pH-Cu, salt-Mn and lime-Mn.

Table 8. Descriptive statistics for the soil parameters in the study

Parameter	Surface Soils (0-30 cm) (N:24)			
	Minimum	**Maximum**	**Mean**	**Std. Deviation**
pH	5.84	7.98	7.35	0.57
Tot.Salt (%)	0.01	0.05	0.02	0.01
Lime (%)	0.00	38.30	12.35	11.78
OM (%)	0.32	4.16	1.34	1.00
Tot.N (%)	0.02	0.21	0.07	0.05
P (ppm)	0.08	80.80	11.14	16.33
K (ppm)	67.47	626.92	238.76	132.60
Ca (ppm)	1601.04	9648.03	6485.98	1908.15
Mg (ppm)	168.01	821.66	352.34	175.99
Fe (ppm)	1.01	85.50	16.45	20.41
Cu (ppm)	1.33	6.48	3.01	1.40
Zn (ppm)	0.06	7.29	1.17	1.98
Mn (ppm)	2.74	58.82	19.15	17.56
Parameter	**Subsurface Soils (30-60/61/62/65 cm) (N:24)**			
	Minimum	**Maximum**	**Mean**	**Std. Deviation**
pH	6.06	8.05	7.45	0.58
Tot.Salt (%)	0.01	0.04	0.02	0.01
Lime (%)	0.00	37.90	13.37	12.31
OM (%)	0.14	2.16	0.65	0.48
Tot.N (%)	0.01	0.11	0.03	0.02
P (ppm)	0.01	48.10	5.86	10.27
K (ppm)	57.61	368.48	156.25	67.30
Ca (ppm)	1587.79	8794.55	6325.26	1906.17
Mg (ppm)	154.29	829.02	398.10	197.60
Fe (ppm)	2.22	69.76	13.56	15.42
Cu (ppm)	1.30	8.41	2.93	1.68
Zn (ppm)	0.04	4.70	0.50	1.16
Mn (ppm)	1.75	41.32	13.77	13.49

Table 9. Correlation coefficients (r) and results of the correlation analysis for surface and subsurface soil samples

Surface Soils (0-30 cm) *p<0.05, **p<0.01												
	pH	**Tot.Salt**	**Lime**	**OM**	**Tot.N**	**P**	**K**	**Ca**	**Mg**	**Fe**	**Cu**	**Zn**
Tot.Salt	0.289											
Lime	0.720**	0.105										
OM	-0.698**	-0.230	-0.417*									
Tot.N	-0.696**	-0.217	-0.412*	0.999**								
P	-0.542**	-0.245	-0.412*	0.788**	0.798**							
K	0.027	0.334	0.145	0.472*	0.482*	0.497*						
Ca	0.747**	0.650**	0.353	-0.668**	-0.660**	-0.650**	-0.046					
Mg	-0.266	0.444*	-0.355	0.009	0.010	-0.015	0.013	0.122				
Fe	-0.882**	-0.365	-0.608**	0.781**	0.777**	0.679**	0.041	-0.860**	0.011			
Cu	-0.485*	0.073	-0.568**	0.602**	0.593**	0.652**	0.436*	-0.363	0.106	0.546**		
Zn	-0.605**	-0.313	-0.453*	0.802**	0.799**	0.865**	0.299	-0.712**	-0.176	0.831**	0.683**	
Mn	-0.899**	-0.308	-0.719**	0.679**	0.680**	0.673**	0.039	-0.723**	0.377	0.799**	0.522**	0.597**
Subsurface Soils (30-60/61/62/65 cm) *p<0.05, **p<0.01												
	pH	**Tot.Salt**	**Lime**	**OM**	**Tot.N**	**P**	**K**	**Ca**	**Mg**	**Fe**	**Cu**	**Zn**
Tot.Salt	0.445*											
Lime	0.736**	0.117										
OM	-0.586**	-0.266	-0.506*									
Tot.N	-0.607**	-0.330	-0.505*	0.992**								
P	-0.549**	-0.389	-0.478*	0.747**	0.752**							
K	0.058	0.278	-0.189	0.425*	0.379	0.553**						
Ca	0.798**	0.733**	0.392	-0.517**	-0.550**	-0.586**	0.066					
Mg	-0.082	0.572**	-0.243	0.011	-0.041	-0.079	0.144	0.325				
Fe	-0.798**	-0.336	-0.556**	0.838**	0.843**	0.647**	0.209	-0.723**	0.060			
Cu	-0.420*	-0.123	-0.530**	0.770**	0.755**	0.817**	0.681**	-0.369	-0.023	0.644**		
Zn	-0.497*	-0.381	-0.390	0.841**	0.853**	0.933**	0.541**	-0.571**	-0.163	0.736**	0.795**	
Mn	-0.860**	-0.422*	-0.771**	0.640**	0.649**	0.655**	0.153	-0.695**	0.167	0.786**	0.507*	0.576**

4. Conclusions

This study presents climate classification for Şebinkarahisar district for the 48 years (1965-2012), on the basis of Thornthwaite (1948), De Martonne-Gottman (De Martonne, 1942; Baltas, 2007), and Erinç (Erinç, 1965; Erinç, 1984) methods. Using the Thornthwaite (1948) method, the climate index was found to be C_2 B'_1 s_2 b'_3 (Moist subhumid), and its climate feature was found to be first mesothermal, large summer water deficiency, summer concentration 54.57%. Using the De Martonne-Gottman (De Martonne, 1942; Baltas, 2007) method, aridity index was found to be 17.74, and the climate type was classified as semi arid - humid. According to the Erinç (Erinç, 1965; Erinç, 1984) method, precipitation efficiency index was found to be 39.32, and the climate type was classified as semi humid.

Analysis results showed that soils in the study area had deficiencies in organic matter, total nitrogen, phosphorus, potassium, magnesium, iron, zinc, and manganese, and a fertilization planning that includes poultry manure, green manure, compost, vermicompost, and organic fertilizers containing various macro and micro elements, in addition to barnyard manure, is recommended for fertility. Moreover, analysis of the pH values and lime contents of the soils should also be taken into account for important agricultural work such as irrigation, growing plants, and tilling the land. Plant species and varieties to be grown in the study area should be selected from among those suitable for transitional climate conditions. Waters of the streams in the areas from which soil samples were collected should also be analyzed. For agricultural activities (tillage, irrigation, harvesting, fertilization, etc.), it will be useful to map the elevation, slope and aspect characteristics of the lands located in the stream beds in the study area.

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