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Basic Soil Properties and Soil Classification of Hazelnut Cultivation Area in the Eastern Black Sea Region, Case Study; Ünye-Tekkiraz District*

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ABSTRACT

The objective of this research was to investigate physical, chemical and morphological properties, classification and mapping of soils of hazelnut cultivation in Ünye-Tekkiraz district of The Eastern Black Sea Region. The study area is located between west of the Ordu and south of the Samsun provinces, at coordinates 4542495-4537485 N and 342549-347523 E and total area is approximately 31.5 km^2. Average annual precipitation and temperature are 1162.4 mm and 14.2 ^{o}C, respectively. Elevation varies from 200 m to 550 m above sea level. According to soil taxonomy, the soil temperature regime and moisture regime were classified as mesic and ustic, respectively. Most of the study areas have been commonly used for hazelnut cultivation, whereas southern part of the study area generally cover small forest and pasture lands. In the study area, distribution of geological pattern is palaeocene and eocene rocks consisting of sandstone, siltstone and marl including widely distributed and altered eocene aged volcano-clastics which are composed of basalt and andesite. After examination of topographic, land use, geologic and geomorphologic maps and land observation, 15 profile places were excavated in the study area. The soil samples were taken from each profile based on genetic horizons and their analyses were done in the laboratory. According to the results of laboratory analyses by taking into consideration of soil taxonomy, 11 different soil series were classified and described. Two them were classified as Entisol due to their young age and five are Inceptisol, three are Alfisol, and one is Vertisol. Whereas Hatipler seri has the largest area (14.7 %), Yenicuma Dere soil seri has the smallest area in the study area (3.2 %).

Key Words: Soil survey and mapping, soil characteristics soil taxonomy

INTRODUCTION

In order to produced food for increasing population soil and water resources have to be used more sustainable manner. In last decade, catastrophic events like land use change and land degradation have occurred due to mismanagement practices such as soil tillage, irrigation, overgrazing, illegal timbering etc. Therefore, detailed knowledge about land recources is imporant for any project planning to prevent the environmental conditions. In this case, soil resource inventory provides an insight into the potentialities and limitation of soil for its effective exploitation. Soil survey provides an accurate and scientific inventory of different soils, their kind and nature, and extent of distribution

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so that one can make prediction about their characters and potentialities (Manchanda et al., 2002). It also provides adequate information in terms of land form, terraces, vegetation as well as characteristics of soils (texture, depth, structure, stoniness, drainage, acidity, salinity and so on) which can be utilized for the planning and development. Consequently, soil survey and mapping are an integral part of an effective agricultural recearch and advisory for planers and decision makers to provide information about soil and they are inventory of the soil resource of the land. Particularly they give information needed for land use planning and soil management programs (Ramakrishnan, 2000).

Today advanced computer programs including decision support systems (Geographic Information System and Remote Sensing) contribute to the speed and efficiency of the overall planning process and allow access to large amounts of information quickly. Especially during the last decade, GIS and RS have received much attention in application related to resources at significantly large spatial scales (Green 1995; Hinton 1996).

Turkey is one of the few countries in the world with a favorable climate for hazelnut production. Hazelnut is an important nut species for Turkish economy. Turkey is responsible for about 70% of world hazelnut production and 75% of the world hazelnut trade. The production area is spread densely all along the Black Sea coast, where the hazelnut has been native for the last 2500 years. In addition, hazelnut farming has been the chief for livelihood in the region for centuries, and still is today. Ordu is one of the most important hazelnut production centers. It constitutes 28% of Turkish hazelnut production. Although hazelnut has the long history in this region, there has been still low level of production in hazelnut farming (Dengiz, 2008). Howevre, there is insufficiently soil survey and mapping studies for hazelnut farming areas. Therefore the objective of this research was to investigate physical, chemical and morphological properties, classification and mapping of soils of hazelnut cultivation in Ünye-Tekkiraz district of The Eastern Black Sea Region.

MATERIALS and METHODS

Field Description

The study area is located between west of the Ordu and south of the Samsun provinces, at coordinates 4542495-4537485 N and 342549-347523 E and total area is approximately 31.5 km^2 (Figure 1). Average annual precipitation and temperature are 1162.4 mm and 14.2 ^oC, respectively. Elevation varies from 200 m to 550 m above sea level.

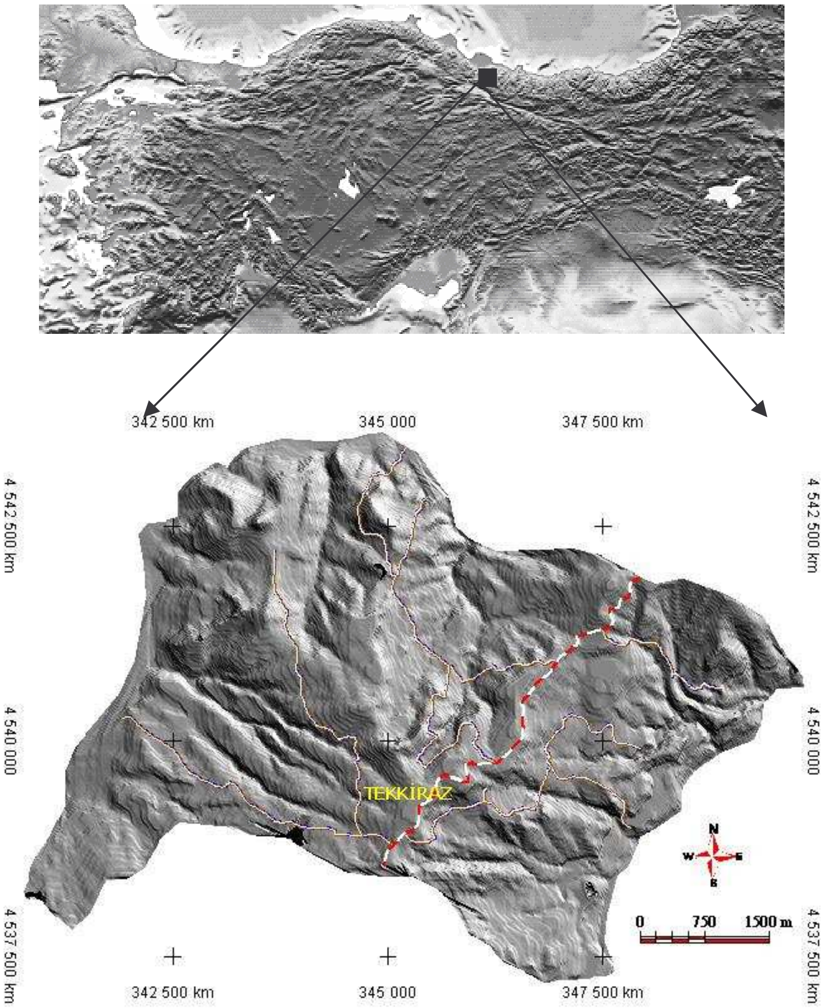

Figure 1. Location of the study area

Most of the study areas have been commonly used for hazelnut cultivation, whereas southern part of the study area generally cover small forest and pasture lands. In the study area, distribution of geological pattern is palaeocene and eocene rocks consisting of sandstone, siltstone and marl including widely distributed and altered eocene aged volcano-clastics which are composed of basalt and andesite.

METHODS

Soil surveyors consider the topographic, parent material, vegetation and climate variations as a base for depicting the soil variability. In addition, soil mapping needs identification of a number of elments. These elements which are of major importance for soil survey are land type, vegetation, landuse, aspect, drenage patern, geological material, slope, relief and so on. Soils are surveyed and mapped, following three tier approachs, comprising interpretation of all data, field survey (including laboratory analysis of soil samples) and cartography (Sehgal *et al.*1989, Soil Survey Staff, 1993). However, computer aided digital image processing and GIS techniques have also been used for mapping soil (Epema 1986; Korolyuk & Sheherbenko 1994; Kudrat et al. 1990, Dengiz et al., 2003) and advocated to be a potential tool (Kudrat et al. 1992; Lee et al. 1988, Manchanda et al., 2002).

Descriptions of soils in the stusy area were accomplished according to soil survey manual (1993). Soil samples collected from all horizons were analyzed for total soluble salts, CEC (Cation Exchange Capacity) and pH (Soil Survey Staff,1992), texture (Bouyoucos, 1951), organic matter (Nelson and Sommers, 1982), $CaCO_3$ (Soil Survey Staff,1993) and bulk density (Blacke and Hartge, 1986). Soil classification was accomplished using Soil Taxonomy (1999).

RESULTS and DISCUSSION

Topographic, land use-land cover, geological maps and meteorological data were used to detect different soil profile places, to prepare soil map and to form soil data-base of study region. First of all, Digital Elevation Model (DEM) was generated by digitizing from topographic sheets to determine elevation, slope percentage, aspect and physiographic variations (Figure 2). All these data were analysed using of TNT Mips 6.4v MicroImage GIS and RS programme.

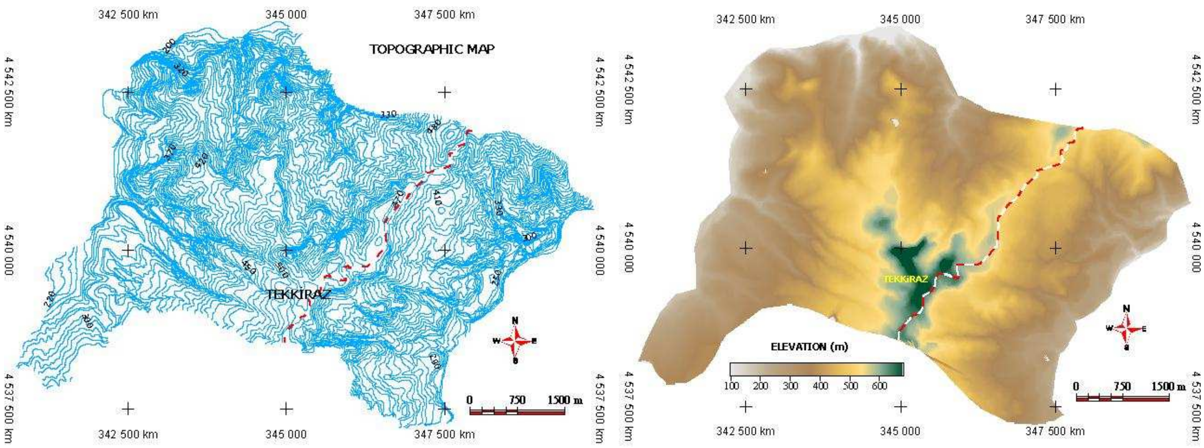

Figure 2. Topographic and dem maps of the study area

Soils on slope ofen vary in response to the way in which water and soil materials move through and over the land surface, this movement is in turn controlled by the geometry of the land surface (Huggett, 1975). This approach has rapidly gained popularity with the recent development of techniques for the direct calculation of terrain parameters from DEM. According to slope distributions derived from DEM are 30.4% of the study area has less than 20% slope and 69.6% has more than 15% slope varying from steep to very steep land

Physico-chemical Properties of Soil

Soil is the combined product of different parent material or rock type, topographic position, or land form, biosfer and climate. Thus, these soil forming factors determine soil properties by governing the type and intensity of the pedological processes (Dengiz et al., 2007). Soil is a three dimensional natural body and is characterised by surface and subsurface diagnostic horizon characteristics. 11 soil series were identified and their horizon orders of the profiles in the study area were defined to be A-B-C form except for especially Kırantepe, Yenicuma and Tekkiraz soil series'profiles which have A-C or

A-R horizons. This means these soils have no diagnostic subsurface horizons and low pedogenetic development. Therefore, these soils can be defined as young soils. There are significant differences in the values of pH 5.95-7.70 among soil series' solum. According to Benton (1984) soil reaction classification, these soils varied from acid to alkaline (Table1). In addition, generally they have very high base saturation except for Mehellü soil series. Salic horizon did not exist in soils of the study area, therefore there is problem about salt concentration. Soil CEC varied between 15.00 to 64.54 cmol.kg^{-1}. The soil with the highest CEC was Kireçlik soil series (Vertic Calciustept) with high clay content and organic mattre, while the lowest value was determined in Mollic Ustifluvent soil (Yenicuma soil series).

All soils have low to high $CaCO_3$ content, ranging from 1.36 to 54.56%. Particularly, in some soil series these ratios have been increasing with soil depth leading to $CaCO_3$ accumulation colled calcification thus, Tekkiraz, Hapan and Kireçlik have a calcic horizon. Soil organic matter content depends on the complex interaction of several factors including the quantity and quality of litter fall, climatic factor, soil properties (especially the amount and type of clay), and erosion (Dahlgren, 1997). The soils of the study area were determined commonly to be poor in soil organic matter for the first two horizons ranging from 15-77 cm in depth. For all soils, the organic mater is highest in the surface horizon and decreases sharply to its lowest level in the subsoil. In the study area, the reasons of the low level organic matter are attributable to rapid decomposition and mineralization of organic matter (especially, due to intensive agricultural activities), to overgrazing and to soil erosion. Soil organic matter ranged from 2.75 to 5.14% in upper horizons.

Among all the horizons, the maximum clay content (80.1%) throughout the soils of the study area was determined in Ayazlı soil seris (Chromic Haplustert), while the lowest content (12.2%) was determined in Yenicuma soil series classified as Mollic Ustifluvent. Furthermore, argilluviation was determined in Hacıoğlu, Hatipler and Eksikli soil series. That refers to the movement of clay in solum and also known as lessivage (Bockheim and Gennadiyev, 2000; Duchaufour, 1998). Therefore, these soil seris have argillic horizon and slickensides with high clay accumulation that leads to low hydraulic conductivity.

Soil Classification

Four soil orders, fife suborders, seven great groups and eleven subgroupswere identified in the study area. The soils were classified according to the criteria proposed by the Soil Taxonomy (1999) based on morphological, physical and chemical characteristics. According to the meteorological data, the study area has ustic soil moisture regime and mesic temperature regime. Soils of the study area were classified as Entisols (13.3%), Inceptisol (47.3%), Alfisol (31.3%) and Vertisols (8.0%), according to Soil Taxonomy (1999) (Table 2).

Table 2. Classifications of Soils of Salt Lake (Tuz Gölü) Specially Protected Area according to Soil Taxonomy (1999)

Soil Series	Orders	Suborders	Great Groups	Sub Groups	Area (ha)	Ratio (%)
Yenicuma Deresi	Entisol	Fluvent	Ustifluvent	Mollic Ustifluvent	100.6	3.2
Kıran Tepe		Orthent	Ustorthent	Lithic Ustorthent	319.5	10.1
Mehellü	Inceptisol	Ustept	Dystrustept	Humic Dystrustept	210.6	6.7
Tekkiraz		Ustept	Calciustept	Lithic Calciustept	404.6	1.9
Hapan		Ustept	Calciustept	Typic Calciustept	166.1	5.3
Kireçli		Ustept	Calciustept	Vertic Calciustept	302.2	9.6
Sırmaköy		Ustept	Haplusept	Typic Haplusept	403.3	12.8
Hacıoğlu	Alfisol	Ustalf	Halustalf	Vertic Halustalf	215.4	6.8
Hatipler		Ustalf	Halustalf	Typic Halustalf	462.9	14.7
Eksikli		Ustalf	Halustalf	Typic Halustalf	309.9	9.8
Ayazlı	Vertisol	Ustert	Haplustert	Chromic Haplustert	253.4	8.0
Total					3111.8	100.0

CONCLUSION

This research demostrated a clear diffrerence in the spatial distribution of individual soil properties, which is mainly determined by in suit pedogenesis processes. The major problem faced in conventional soil survey and soil cartography is the accurate delineation of boundary. Field observations based on conventional soil survey are tedious and time consuming. DEM, aspect, slope data in conjunction with other digital ancillary data using GIS provide the best alternative, with a better delineation of soil mapping units. However, there is a need to check with field obsevation for accurate soil boundary delineation. In addition, the manual soil map production process limits soil scientists' ability to update soil surveys rapidly and accurately. Therefore, soil map production process must be repeated for each future soil survey update. For this reason, a radical change is needed to move soil survey to a more acceptable update rate and to a product that can be continually updated efficiently and accurately. In this case, GIS techniques have very important role by consolidating the entire process and update soil data

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Table 1. Results of physical and chemical analyses of soils of the study area

Soil Seris	Horizon	Depth (cm)	pH	Total salt (%)	CEC (cmol kg^{-1})	$CaCO_3$ (%)	OM (%)	Hid.Codn. (cm h^{-1})	Texture (%)			
									Clay	Silt	Sand	Class
Yenicuma	*Mollic Ustifluvent*											
	A1	0–21	6.96	0.013	28.73	5.19	5.14	11.02	39.1	23.9	36.9	CL
	A2	21–43	7.42	0.012	24.76	4.92	3.91	13.91	39.7	14.2	45.9	SC
	C1	43–78	7.17	0.008	23.69	5.75	1.71	22.25	28.3	11.3	60.3	SCL
	C2	78–95	7.24	0.002	15.00	4.56	1.56	31.36	12.2	7.5	80.2	SL
	C3	95+	6.67	0.013	22.77	6.53	1.26	8.91	30.2	15.3	54.4	SCL
Kırantepe	*Lithic Ustorthent*											
	A	0–15	7.20	0.024	20.12	7.68	4.59	47.71	23.9	29.5	46.4	SCL
	R	15+	-	-	-	-	-	-	-	-	-	-
Mehellü	*Humic Dystrustept*											
	A	0–20	5.95	0.039	35.58	1.36	4.61	0.15	52.7	28.5	18.7	C
	Bw	20–45	6.45	0.028	33.82	2.22	3.34	0.92	34.7	22.7	42.4	CL
	C1	45–80	7.30	0.016	26.80	2.30	0.37	5.57	17.6	28.3	53.9	SL
	2C2k	80+	7.85	0.024	14.63	28.38	0.29	0.67	49.1	34.1	16.7	C
Tekkiraz	*Lithic Calciustept*											
	A1	0–10	7.15	0.085	38.13	12.09	5.2	3.15	57.6	18.3	23.9	C
	A2	10–32	7.55	0.048	39.81	17.65	4.0	0.52	67.2	18.6	14.1	C
	Ck	32+	7.65	0.017	19.32	54.56	2.2	5.96	39.9	25.0	34.9	SiC
Hapan	*Typic Calciustept*											
	A	0–17	7.40	0.046	39.26	10.20	4.1	0.70	50.8	24.2	24.8	C
	Bk1	17–43	7.70	0.041	29.39	16.46	3.1	0.43	53.3	24.3	22.3	C
	Bk2	43–89	7.65	0.040	30.73	12.27	3.1	0.77	55.8	23.8	20.3	C
	C	89+	7.85	0.023	25.86	4.61	3.4	0.14	60.9	21.1	17.9	C
Kireçlik	*Vertic Calciustept*											
	Ap	0–15	7.53	0.051	53.71	5.33	4.6	0.052	72.8	17.1	9.9	C
	Bw	15–77	7.49	0.055	64.54	3.80	3.9	0.153	70.8	16.2	12.8	C
	Bk	77–108	7.58	0.041	45.94	15.68	2.9	0.874	52.9	22.3	24.6	C
	2C	108+	7.81	0.053	46.06	6.89	2.8	0.148	57.6	22.3	19.9	C
Typic Haplusept												
Sırmaköy	Ap	0–15	7.29	0.054	30.86	6.91	2.9	0.57	73.9	20.1	5.9	SiCL
	2Bwb1	15–40	7.35	0.037	22.51	19.42	1.7	0.88	74.5	21.7	3.7	SiCL
	2Bkb2	40–68	7.90	0.029	24.63	29.16	1.6	1.69	66.4	26.2	7.2	SiCL
	2Crb	68+	-	-	-	-	-	-	-	-	-	-

Table 1 continue

Soil Seris	Horizon	Depth (cm)	pH	Total salt (%)	CEC (cmol kg^{-1})	$CaCO_3$ (%)	OM (%)	Hid.Codn. (cm h^{-1})	Texture (%)			
									Clay	Silt	Sand	Class
	Vertic Halustalf											
Hacıoğlu	Ap	0–15	7.50	0.062	38.13	7.76	4.3	0.65	68.1	18.0	13.8	C
	A2	15–40	7.30	0.057	35.73	13.82	3.1	0.06	47.7	22.4	29.8	C
	Bt1	40–79	7.10	0.039	33.09	7.65	3.0	0.13	53.3	22.6	24.0	C
	Bt2	79–131	7.55	0.083	37.84	5.30	2.6	0.44	55.9	22.1	22.0	C
	2Cr	131–150	8.05	0.033	26.89	26.73	1.2	0.27	38.4	23.9	37.7	CL
	R	150+	-	-	-	-	-					
Typic Halustalf												
Hatipler	Ap	0–21	7.20	0.037	38.73	4.96	4.5	0.14	39.1	34.4	26.5	C
	Bt1	21–50	6.86	0.024	31.27	3.84	3.1	1.15	48.3	31.4	20.2	C
	Bt2	50–85	6.69	0.024	28.19	3.79	2.4	0.03	57.9	23.87	18.3	C
	Cg	85+	7.01	0.051	27.23	13.03	1.7	-	70.9	17.7	11.4	C
	Typic Halustalf											
Eksikli	A	0–15	7.15	0.062	51.91	3.07	5.2	0.67	54.8	16.5	28.5	C
	Bt1	15–50	7.70	0.018	38.25	3.20	1.4	0.11	68.4	14.5	17.0	C
	Bt2	50–78	7.83	0.031	38.95	3.46	1.3	0.24	65.2	15.1	19.6	C
	C	78+	7.32	0.048	38.05	11.06	1.5	0.25	57.9	18.1	23.8	C
	Chromic Haplustert											
Ayazlı	Ap	0–16	7.56	0.063	46.95	4.58	2.75	0.657	76.6	17.5	5.8	SiCL
	Bss1	16–46	7.27	0.051	45.96	6.50	1.85	0.313	71.0	20.8	8.0	SiCL
	Bss2	46–72	7.28	0.032	52.14	8.40	1.64	0.078	80.1	15.7	4.1	SiCL
	C	72+	7.42	0.027	34.86	13.39	1.33	0.097	59.8	24.2	15.9	C

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