CHARACTERIZATION OF SOME IMPORTANT AGRICULTURAL SOILS UNDER OLIVE TREES

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ABSTRACT

Olive production is important and intensive agricultural activity in this region. Generally, olive trees occur coastal side of the region under brown forest soils. Ten olive tree plantations were selected in this research. The some important physical, chemical and morphological properties were investigated and classified according to USDA Soil Taxonomy as Typic Xerochrepts.

KEY WORDS: brown forest soils, classification, fertility, olive.

DETAILED ABSTRACT

The investigated soil profiles were formed on calcareous hard sandstone in north of the province elevated from 5 to 25 m. Soils have been studied to investigate their important physical, chemical and morphological properties in this research. These soils are deep and have Ap-Bw-C horizons. Texture of the soils varies from loam to clay loam. The soil pH is slightly alkaline in all the soil profiles. The obtained results indicated that soils were fertile to support the good quality of olive crops in this region.

INTRODUCTION

Olives are important traditional fruit trees for the majority of subtropical Mediterranean countries, especially in Turkey, Greece, Italy, Spain and Croatia. They also grow in other regions having a Mediterranean climate, such as California, Chile, South Africa and South Australia. Olives have been grown since ancient times and are commercially produced in northwest, west and southern parts of the country. Olive tree plantations situated in regions under Mediterranean climate of the Bursa province in Turkey. The brown forest soils are under olive tree plantations. This soils type is important agricultural soils for various crops in the province. The province has 1,104,301 ha and this soil type occupies approximately 248,685 ha area [1]. Brown forest soils are mostly under natural vegetation. Nevertheless, some of them are under olive tree plantations in the coastal side of the region due to suitable climate and soil properties for olives. This region is used for olive tree plantations for hundreds of years. These soils are mostly used for olives and other crops such as various vegetables under olive trees. However, the rapid urbanization was caused misuse of these soils during last three decades due to rapid increase of population in the province. The current population had a tendency to have summerhouse in this coastal side of region due to Mediterranean climate and sea for spending their summer vacation. This demand was affected the olive tree plantations negatively and resulted the decreasing of olive tree plantation areas due to use of these soils for urbanization. This research was carried out to characterize some important properties of the agricultural soils under olive tree plantations.

MATERIALS AND METHODS

The research area is located on coastal side of the Bursa province in Turkey. Ten olive tree plantations were examined in this research. The soil profiles lie between 40° 22′ - 40° 17′ N latitudes and 28° 50′ - 28° 57′ E longitudes, and altitudes range from 5 to 25 m above mean sea level. These soils are developed on calcareous hard sandstone parent material under olive trees. The mean annual precipitation and temperature are 713.1 mm and 14.4 °C in the province. The soil temperature and moisture regimes are thermic and xeric respectively.

METHODS

The soil samples were taken from the recognized horizons in each profile. Morphological properties of the profiles were described according to Soil Survey Manual [2]. The soil samples were analyzed for particle-size distribution [3], pH in a 1:2 soil:water ratio [4], organic carbon [5], total nitrogen [6], calcium carbonate [7], electrical conductivity [8], available phosphorus [9], CEC [10], exchangeable cations [11] and DTPA extractable Fe, Mn, Cu and Zn [12].

RESULTS AND DISCUSSION

The morphological properties of the profiles were presented in Table 1. All the soil profiles had color of 7.5 YR hue. The values and chromas of soils ranged from 3 to 5 and 3 to 6 respectively. The all soil profiles were situated on north aspect and formed on flat landforms under olive trees in the studied area. These soils are well drained and have clay enriched in the Bw horizons. The Bw horizons had stronger structure than Ap horizons due to the high clay content of the soils. The soil structures were granular and subangular blocky in the investigated profiles. The Ap horizons had granular structure due to intensive ploughing in the studied soils.

The some selected physical and chemical properties of the soils are presented in Tables of 2, 3 and 4. The clay content of soils varied from 20.5 to 44.8% and increased with depth from Ap to Bw horizons in all profiles. Then, it decreased in the C horizons. These soils had more silt than sand in the Ap and Bw horizons and then sand had highest values in the C horizon of all the studied profiles. The highest clay content occurred from profile 5 to 10.

pH values ranged from 7.2 to 7.8 and increased with depth. The organic carbon and total nitrogen values varied from 0.43 to 1.94% and 0.05 to 0.16% respectively. C/N values ranged from 8.6 to 13.8. These soils had low $CaCO_3$ content and values varied from 1.0 to 4.5%. Electrical conductivity values ranged from 0.38 to 0.80 dS m^{-1} and these low values were indicated that soils were not saline due to good drainage in all the studied profiles. Available phosphorus values varied from 8.24 to 25.48 mg kg^{-1} and increased gradually with depth. The highest values were occurred in the surface horizons and these values were in moderate to high levels to support the plant growth.

The cation exchange capacity values ranged from 16.8 to 31.0 cmol (+) kg^{-1} and increased with depth in the Bw horizon of the profiles. This feature is probably related with high clay content of the profiles in the Bw horizons. The exchangeable Ca and Mg values varied from 13.4 to 27.8 and 1.1 to 2.2 cmol (+) kg^{-1} respectively. The exchangeable K and Na values ranged from 0.7 to 2.0 and 1.0 to 2.5 cmol (+) kg^{-1}. The some differences occurred in soils due to location of the profiles and degree of soil formation process in the research area. The profiles from 1 to 5 had lower clay, organic carbon and $CaCO_3$ contents than other profiles. Nevertheless, the profiles of 1 to 5 had higher phosphorus values than other profiles. Farmers were fertilized all the soil sites with triple super phosphate and ammonium nitrate to obtain enough yields in the region.

Table 1: Morphological characteristics of the profiles

Horizon	Depth (cm)	Munsell Color, (moist)	Texture	Structure	Consistence (moist)	Roots	Boundary
Profile 1							
Ap	0-18	7.5 YR 4/3	CL	2f, gr	fi	c, c	g
Bw	18-35	7.5 YR 5/3	CL	2f, sbk	fi	c, c	w
C	35-55	7.5 YR 5/4	L	1f, sbk	fr	---	w
Profile 2							
Ap	0-22	7.5 YR 4/4	CL	1f, gr	fi	c, c	g
Bw	22-40	7.5 YR 5/4	CL	2f, sbk	fi	c, m	s
C	40-60	7.5 YR 5/4	L	1f, sbk	fr	---	s
Profile 3							
Ap	0-15	7.5 YR 4/4	CL	2f, gr	fi	c, c	s
Bw	15-35	7.5 YR 5/3	CL	2m, sbk	fi	c, m	g
C	35-50	7.5 YR 5/3	L	1f, sbk	fr	---	w
Profile 4							
Ap	0-20	7.5 YR 4/4	CL	2f, gr	fi	c, c	w
Bw	20-45	7.5 YR 5/4	CL	2m, sbk	fi	c, c	g
C	45-70	7.5 YR 5/4	L	1f, sbk	fr	---	g
Profile 5							
Ap	0-22	7.5 YR 4/6	CL	1f, gr	fi	c, c	g
Bw	22-50	7.5 YR 5/4	CL	2f, sbk	fi	c, m	s
C	50-75	7.5 YR 5/3	L	1f, sbk	fr	---	s
Profile 6							
Ap	0-25	7.5 YR 3/3	CL	2f, gr	fi	c, m	w
Bw	25-60	7.5 YR 4/3	C	2m, sbk	fi	c, m	g
C	60-80	7.5 YR 4/3	L	1f, sbk	fr	---	g
Profile 7							
Ap	0-20	7.5 YR 3/3	CL	2f, gr	fi	c, c	g
Bw	20-55	7.5 YR 4/4	C	2m, sbk	fi	c, m	w
C	55-70	7.5 YR 4/4	L	1f, sbk	fr	---	w
Profile 8							
Ap	0-18	7.5 YR 4/3	CL	2f, gr	fi	c, c	s
Bw	18-45	7.5 YR 5/3	C	2m, sbk	fi	c, m	w
C	45-60	7.5 YR 5/3	L	1f, sbk	fr	---	w
Profile 9							
Ap	0-20	7.5 YR 3/3	CL	2f, gr	fi	c, m	s
Bw	20-50	7.5 YR 4/3	C	2m, sbk	fi	c, m	g
C	50-70	7.5 YR 4/3	L	1f, sbk	fr	---	g
Profile 10							
Ap	0-25	7.5 YR 3/4	CL	2f, gr	fi	c, m	g
Bw	25-55	7.5 YR 4/4	C	2m, sbk	fi	c, m	s
C	55-80	7.5 YR 4/4	L	1f, sbk	fr	---	s

Structure: 1 = weak, 2 = moderate. Type: f = fine, m = medium. Class: gr = granular, sbk = subangular blocky.
Consistency: fi = firm, fr = friable. Roots: abundance: c = common; size: m = medium c = coarse.
Boundary: g = gradual, w = wavy, s = smooth. Topography = flat

Table 2: Physical properties of soils

Horizon	Depth (cm)	Sand (%)	Silt (%)	Clay (%)	Texture
Profile 1					
Ap	0-18	26.1	40.1	32.2	CL
Bw	18-35	20.2	42.3	36.5	CL
C	35-55	38.8	36.6	22.7	L
Profile 2					
Ap	0-22	31.3	38.2	28.4	CL
Bw	22-40	21.6	43.9	33.0	CL
C	40-60	46.3	31.2	20.5	L
Profile 3					
Ap	0-15	26.2	42.4	30.1	CL
Bw	15-35	17.7	45.7	35.8	CL
C	35-50	35.7	38.5	24.3	L
Profile 4					
Ap	0-20	24.5	39.0	34.3	CL
Bw	20-45	18.2	42.8	37.5	CL
C	45-70	39.7	33.1	25.4	L
Profile 5					
Ap	0-22	32.0	36.5	29.7	CL
Bw	22-50	24.6	40.3	34.1	CL
C	50-75	42.5	32.2	23.8	L
Profile 6					
Ap	0-25	27.9	33.5	37.1	CL
Bw	25-60	19.5	37.3	42.4	C
C	60-80	41.9	30.8	25.5	L
Profile 7					
Ap	0-20	30.1	32.4	35.5	CL
Bw	20-55	21.6	35.9	41.2	C
C	55-70	47.3	29.2	21.7	L
Profile 8					
Ap	0-18	28.6	30.3	39.0	CL
Bw	18-45	15.2	38.5	44.8	C
C	45-60	48.8	25.2	24.1	L
Profile 9					
Ap	0-20	25.1	35.3	37.9	CL
Bw	20-50	18.3	37.1	43.3	C
C	50-70	49.2	28.4	20.5	L
Profile 10					
Ap	0-25	29.1	32.7	36.8	CL
Bw	25-55	22.2	35.5	41.6	C
C	55-80	47.8	26.9	23.7	L

Table 3: The some chemical properties of soils

Horizon	Depth (cm)	pH soil:water (1:2)	Org. C (%)	Total N (%)	C/N	$CaCO_3$ (%)	EC dS m^{-1}	P_2 mg kg^{-1}	CEC cmol kg^{-1}	Exchangeable cations Ca	Mg	K	Na
Profile 1													
Ap	0-18	7.3	1.60	0.13	12.3	1.5	0.65	22.03	24.1	19.7	2.0	1.9	1.4
Bw	18-35	7.4	0.72	0.07	10.3	2.1	0.52	20.17	25.8	22.2	1.7	1.1	1.7
C	35-55	7.5	---	---	---	2.9	0.48	15.36	20.7	16.9	1.9	0.8	1.9
Profile 2													
Ap	0-22	7.4	1.43	0.13	11.0	1.7	0.72	25.48	22.3	18.2	2.1	1.7	1.0
Bw	22-40	7.5	0.52	0.06	8.7	2.5	0.60	23.05	25.1	21.7	1.5	1.5	1.3
C	40-60	7.6	---	---	---	3.1	0.53	17.63	18.4	14.5	1.7	1.0	1.8
Profile 3													
Ap	0-15	7.2	1.54	0.12	12.8	1.1	0.57	20.41	23.7	19.4	1.9	1.8	1.5
Bw	15-35	7.3	0.43	0.05	8.6	1.9	0.45	18.50	26.2	22.5	1.2	1.4	1.9
C	35-50	7.4	---	---	---	2.1	0.38	11.38	21.9	17.4	1.6	0.7	2.3
Profile 4													
Ap	0-20	7.3	1.22	0.11	11.1	1.9	0.62	24.71	24.3	19.8	2.1	2.0	1.1
Bw	20-45	7.4	0.67	0.07	9.6	2.2	0.50	21.62	26.9	23.3	1.3	1.5	1.9
C	45-70	7.5	---	---	---	2.8	0.46	13.09	22.4	18.0	1.5	1.0	2.5
Profile 5													
Ap	0-22	7.2	1.10	0.09	12.2	1.0	0.75	21.45	20.7	16.1	2.0	1.9	1.6
Bw	22-50	7.3	0.55	0.05	11.0	1.8	0.62	19.82	25.1	21.5	1.5	1.2	1.8
C	50-75	7.4	---	---	---	2.3	0.58	12.45	21.9	18.2	1.7	0.8	2.1
Profile 6													
Ap	0-25	7.4	1.85	0.14	13.2	2.1	0.80	17.87	28.8	24.3	2.2	1.7	1.4
Bw	25-60	7.5	0.82	0.07	11.7	2.9	0.76	15.62	30.5	26.9	1.4	1.4	1.7
C	60-80	7.6	---	---	---	3.6	0.70	10.11	23.0	19.1	1.6	0.9	2.4
Profile 7													
Ap	0-20	7.5	1.91	0.16	11.9	2.2	0.74	15.95	24.6	20.5	2.1	1.9	1.0
Bw	20-55	7.6	0.85	0.08	10.6	3.1	0.70	13.07	28.2	24.8	1.3	1.6	1.3
C	55-70	7.8	---	---	---	4.2	0.63	8.24	17.3	13.6	1.4	1.2	1.8
Profile 8													
Ap	0-18	7.5	1.74	0.13	13.4	2.0	0.57	16.83	28.4	24.1	2.0	2.0	1.1
Bw	18-45	7.6	0.92	0.08	11.5	2.7	0.55	14.55	31.0	27.8	1.2	1.4	1.6
C	45-60	7.7	---	---	---	3.8	0.48	10.27	18.7	14.2	1.7	1.2	1.9
Profile 9													
Ap	0-20	7.6	1.80	0.15	12.0	2.1	0.51	17.46	26.9	23.2	2.2	1.8	1.0
Bw	20-50	7.7	0.78	0.09	8.7	2.8	0.44	15.03	29.3	25.8	1.4	1.3	1.5
C	50-70	7.8	---	---	---	3.9	0.40	8.29	16.8	13.4	1.8	0.7	1.7
Profile 10													
Ap	0-25	7.6	1.94	0.14	13.8	2.0	0.59	18.80	27.5	23.6	2.0	1.6	1.2
Bw	25-55	7.7	0.74	0.07	10.6	3.2	0.50	16.51	28.4	25.0	1.1	1.4	1.8
C	55-80	7.8	---	---	---	4.5	0.43	11.43	20.7	17.1	1.4	0.9	2.2

Table 4: The DTPA extractable Fe, Mn, Cu and Zn concentrations of soils

Horizon	Depth (cm)	DTPA extractable Fe	Mn	Cu	Zn
		mg kg^{-1}			
Profile 1					
Ap	0-18	11.30	5.14	6.11	2.01
Bw	18-35	8.71	4.02	5.03	1.25
C	35-55	4.12	3.73	4.27	0.72
Profile 2					
Ap	0-22	12.07	6.82	5.90	1.84
Bw	22-40	9.35	5.56	5.07	1.05
C	40-60	6.42	4.19	3.68	0.81
Profile 3					
Ap	0-15	12.86	5.81	5.71	1.52
Bw	15-35	10.04	5.01	4.13	1.10
C	35-50	5.18	4.14	2.70	0.67
Profile 4					
Ap	0-20	11.59	5.94	7.05	1.14
Bw	20-45	7.43	4.27	4.51	0.70
C	45-70	4.62	3.08	2.19	0.65
Profile 5					
Ap	0-22	13.02	6.83	8.80	1.18
Bw	22-50	11.67	6.10	6.79	1.04
C	50-75	7.88	4.62	2.56	0.86
Profile 6					
Ap	0-25	12.10	6.75	8.91	1.27
Bw	25-60	8.75	5.06	7.07	1.09
C	60-80	5.02	3.14	4.52	0.71
Profile 7					
Ap	0-20	11.23	7.18	7.84	1.10
Bw	20-55	9.48	5.22	7.19	0.94
C	55-70	6.51	4.50	4.06	0.82
Profile 8					
Ap	0-18	10.72	7.83	7.29	1.08
Bw	18-45	8.34	6.01	5.17	0.77
C	45-60	6.10	3.25	3.40	0.65
Profile 9					
Ap	0-20	10.86	6.79	6.78	1.22
Bw	20-50	7.52	5.45	6.22	1.10
C	50-70	5.67	3.18	3.49	0.88
Profile 10					
Ap	0-25	12.90	5.80	5.80	1.14
Bw	25-55	10.11	5.01	4.03	1.09
C	55-80	7.26	2.34	2.17	0.75

The DTPA extractable Fe and Mn values ranged from 4.12 to 13.02 and 2.34 to 7.83 mg kg^{-1} respectively. The Cu and Zn values varied from 2.17 to 8.91 and 0.65 to 2.01 mg kg^{-1}. The DTPA extractable Fe, Mn, Cu and Zn values both gradually decreased from Ap to C horizon with depth. These results were indicated that micronutrient elements in sufficient levels for most of the crops under Mediterranean climate [13, 14]. These soils were classified according to USDA Soil Taxonomy [15] as Typic Xerochrepts. The differences in soil properties have occurred due to location of the profiles and degree of pedogenic process in the research area.

CONCLUSION

These soils were formed on xeric moisture and thermic temperature regimes under Mediterranean climate in the coastal side of the province. Soils are ploughed intensively under olive trees because of the easy of cultivating the soils due to flat topography and deep soil layer. The main limitation factors regarding soil fertility for olive trees are summer drought, low to moderate wind erosion risk and low organic matter content.

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