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An Investigation on the Relationship between Saline Soil and Halophytic Plants in Semi Arid Region (Acıçay Stream)

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ABSTRACT

The main objectives of this study were to compare soil properties and plants of both sides of the Acıçay River and evaluate relationships between salinity and landscape positions under the condition of semi-arid climate. Right side of the Acıçay River lands has been generally used for agriculture crops, while left side lands used for grassland. Soil properties and plant composition differentiate in the right and left sides of Acıçay River in Çankırı city which is chosen for a research area. The change on salinity and topography affect directly vegetation and variety of land use. With the aim of determining soil-plant interaction ,salinity has been determined in the plant-root area from two different depths (0-20cm-20-40cm) in the right and and left sides of Acıçay River and floristic composition is introduced in this region. Salt ratio in upper soil increases when you go near to the watershed. Salt and EC values of soils are measured high in left sides. Besides salt and EC values decline as you come up the slope through the stream. As a result of assessing plant samples which are collected at the time of land study, belonging 26 family 70 species and 110 taxon (including species and sub-species) have been ascertained.The richest families in the research area are *Asteraceae, Fabaceae, Lamiaceae, Poaceae* ve *Chenopodiaceae*. The ratio of the five of the richest family to the total species is 56.37. The ratio of the species dispersed in the rest 21 family is 43.63%.

Key Words: Salin Soil, Plants, Halophytic, Semi Arid, Çankırı

INTRODUCTION

The soils that are affected by salt are about 1 billion ha.in the world, although there is not any definite figure in Turkey, it is cited that it is about 2.5 million ha (Munsuz *et al*., 2001). The increase on the world population and consumption necessitate gaining new production areas. When it is said new production area, one must think about bringing in economic support by rehabilitating problematic areas. Rehabilitation and development of production of salty and alkaline soils are quite complicated and it changes according with the region's climate, soil and plant features.

It is appeared that salt, gypsium and erosion are the most important soil problems in Turkey's arid and semi-arid regions. Slope areas of this region are used as a meadow and base lands are used for agricultural purposes. Great plant diversity does not exist in the areas which have salty soil condition except halophytic. The most important effect of salt on plant is to decrease taking in water and nutrients. Plants can not get enough water because of high osmotic potential. Toxic effect which is caused by excessive

amounts of Na^+ and Cl^- poisons the plant (Flowers and Yeo, 1981). Na^+ that is accumulated in excessive amounts in the salt stressed plants causes a corruption of ion balance of plants by preventing K (Siegel *et al*., 1980), and Cl^- especially (NO_3^-) (Güneş *et al*., 1994) intake. In the salty and gypsium regions, existent plants should be analysed accurately in the rehabilitation and afforestation practices and plant species that have adapted should be preferred (Sönmez, 1990). The objectives of this study were to characterize the soil properties of the both sides of the Çankırı-Acıçay River and identifiy soil salinity and compare effects of soil properties on plant community of Acıçay River.

MATERIALS and METHODS

Description of the Study Field

The study was carried out transect along both sides of the Çankırı-Acıçay stream which is a prominent land form, parent material and vegetation. The study area is located approximately between 557 733 E-4 497 924 N, 557 751 E-4 4978 89 N and situated in vicinity of Çankırı province. It ranges in relief from 740 m to 800 m and four landscape positions (in river, flat-terrace, backslope, shoulder), representing changes in geomorphology, topographic gradients and soil characteristics, were selected. The underlying bedrocks within the study area consist of primarily that while right side soils of the Acıçay stream are formed on quaternary alluvial deposits that find on young and old terraces, left side soils are formed on quaternary alluvium, alluvial-collivial material spotted on and floodplain and old terrace oligomiocene gypsium and rock salt strata located on mid-slope and steep lands. According to meteorological data (Anonymous, 2008), the mean annual temperature and rainfall are 11.1 ºC and 417.7 mm, respectivly. According to the Thornthwaite water-balance model, the prevailing climate is arid-semiarid, mezo-thermal, arid-semi arid climate that has intensive water absence in summer and that was coded with D B'_1 d b'_3

Sampling and Analysis

Climate, topography and soil properties might be the main controlling factor in plant community. Soil and plant samples were collected from different topography and parent material at right and left sides of stream (Figure 1). Soils have been studied on along transect (crosswise from East to West direction) at 0-20 cm and 20-40 cm depths. Soil samples were taken to investigate for their chemical properties at the laboratory. The soil samples were then air-dried and passed through a 2 mm sieve to prepare for laboratory analysis. Soil pH and electrical conductivity (EC) were measured by a pH/conductivity meter (Rhoades, 1996). Carbonate ($CaCO_3$) was determined by pressure calcimeter method (Richard and Donald, 1996). Ca^{++}, Mg^{++}, Na^+, K^+ were determined with flame photometer (Helmke and Sparks, 1996)

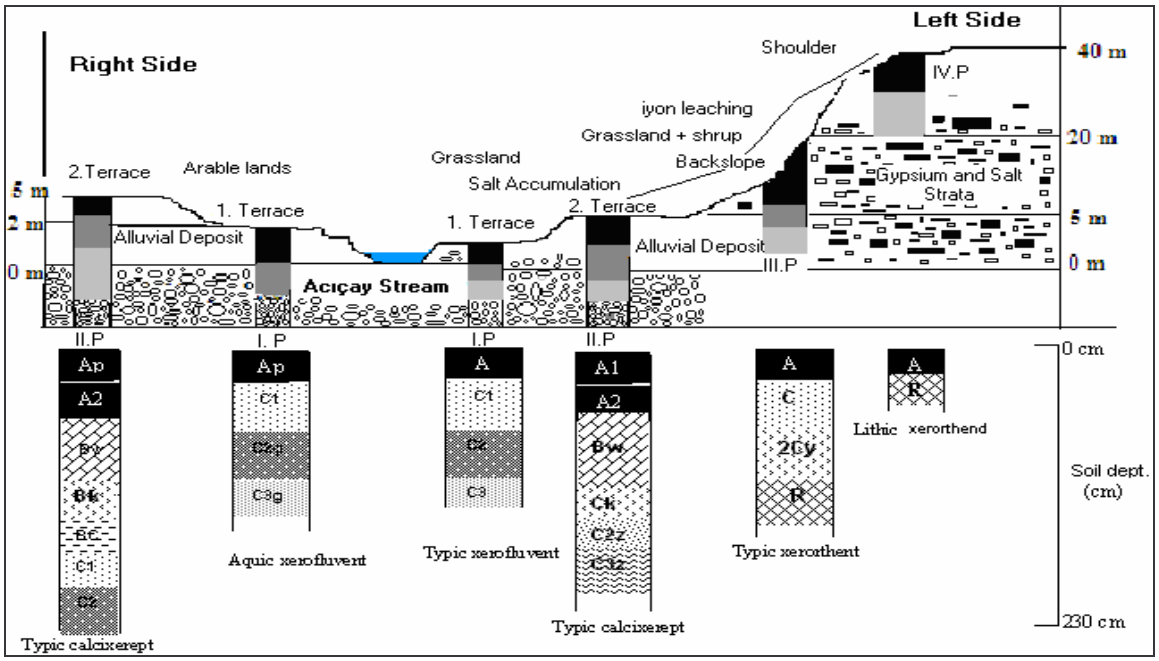

Figure 1. Different soil formations on various parent materials, slopes and land covers along the transect of both sides of the Acıçay stream (Dengiz *et al*., 2007)

The Acıçay stream is situated in the A4 square according to the Grid system of Davis (1965). The material of plant which forms the subject of the study was collected as a consequence of the estate studies during the term of the developing of vegetation in the years of 2007 and 2008. Plant samples have been studied on along transect (crosswise from East to West direction) like soil samples. The estate studies was conducted in various developing periods such as the aspect of Spring, Summer and Autumn of the vegetation. At least two pairs of sample were taken and these samples were put in the Herbarium of Forest Faculty, Çankırı Karatekin University after being defined. Boissier (1867-88), Harringion (1957), Polunin (1972) and particularly the work of "The Flora of Turkey and East Eagen Islands (Davis, 1965-85)" were used for recognition of the samples of the plants.

RESULTS and DISCUSSION

Soil chemical properties considered in this study are pH, salt, EC (Electrical Conductivity), exchangeable cations, total phosphorus and calcium carbonate. Right side soils of the Acıçay River are formed on quaternary alluvial deposits that are found on terrace and floodplain, alluvial-collivial deposits, left side soils formed from quaternary alluvium, alluvial-collivial material and oligomiocene gypsium and salt strata located on floodplain, terrace and steep lands respectively. In addition, right side lands have been generally used for agriculture crops, while left side lands have covered three major plant community types (herb, shrub-grass, and grass) and upper lands is generally barren due to overgrazing.

Soil chemical properties that have been taken into consideration in this study showed variability as a result of dynamic interactions among natural environmental factors such as climate, parent material, ground water, surface water, erosion and topography. Soil chemical properties on different slope position and parent material were significantly affected by ground water, river and leaching processing (Table 1-3)

In left side soils, salt percentage of surface soils in low slope sides is more than on higher slope except floodplain top soil that is almost salt recently alluvial deposits and the sand and gypsium content for slopes with high gradient is lower than for low slopes. The same properties are in right soils. This case is similar to the EC. While the lowest value (0.06 %) of salt is for slopes ranging from 30-40 %, the highest values of salt that are steadily increased with increasing slope gradient are 1-2 %. On the other hand, the salt ratios on the top soils increase as you come down area of the watershed. Accumulation of salt and gypsium which dissolve in the drainage area of the watershed increases as it gets down to the watershed. The highest salt is measured %0.26 from the 3 samples that are taken from the above of the watershed. But the highest salt is measured %4.09 in the 1.sample that are taken from the lower watershed. The ECs of top soils decrease as you go upward the watershed. Salt and EC amounts of soils are measured higher in the left sides of river. The reason of this is that left side's main material shows salty and gypsium properties. Besides salt and EC figures decrease as you go upward the slope through the stream.

Soils on shoulder position contain less exchangeable Na^{+}, K^{+}, and Mg^{++} due to stronger leaching. Soils can significantly accumulate these soluble ions such as Ca^{++}, Na^{+}, K^{+}, Mg^{++} from the upper slope and deposite on the floodplain and terrace soils where leaching is weaker. On the other hand exchangeable Na^{+}, K^{+}, and Mg^{++} which are carried from high slope to low slope, are moved away lower watershed by base water and stream flow. Therefore, the highest values (Na^{+}: 220 cmol kg^{-1}, K^{+}: 0.78 cmol kg^{-1} and Mg^{++}: 75.24 cmol kg^{-1}) are measured in the top soils in the lower watershed. The distribution of Ca^{++} among slope positions was the reverse of exchangeable Na^{+}, K^{+} and Mg^{++} In spite of the leaching process, upper slope soils contain higher Ca^{++} concentration than low slope soils due to their parent materials which are gypsiferous rocks. On the other hand, Ca^{++} amount of top soils is higher in the first transect that is taken from the lower awatershed. Ca movement that is occurred by groundwater and steram flows has continued. Soil pH is generally greater at soil surface than at the depth. This case positively correlated with accumulation of cation concentration such as Na^{+} and K^{+}. Cations that dissolve in subsoils by reason of arid and semi-arid climate are carried to the surface.

Soil chemical properties undergo great variations as you go upward from starting the first transect (Table 1-3). There is the effect of accumulation of soils that are carried by groundwater and surface flow in the lower watershed. The ratio of salinity, EC and cations decrease as you go upward the watershed.

70 genus belonging to 26 families and 110 taxons (including species and sub-species) have been determinede as a result of assessing plant samples being collected at the time of the land study (Table 4).

The richest families are *Asteraceae, Fabaceae, Lamiaceae, Poaceae* ve *Chenopodiaceae*. The ratio of the five of the richest family to the total speceis is 56.37%. The ratio of the species dispersed in the rest 21 species is 43.63%.

Research area is in Iran-Turan floristic region. According to this, regions' dominant vegetation constitute step formations in which trees and shrubs are found locally and sporadically. Regarding this, while step characteristic plants have been encountered in the third and fourth transect in the reserach area, salty characteristic (halophytic) plants have been especially encountered in the first and second transect and humid characteristic plants are in the stream.

Research area is quite close to setting areas in which antropojen effect is intense. In river and first terrace (flat-terrace) areas are used as a meadow land. Oleaster (*Elaeagnus angustifolia*), *Tamarix smyrnensis*, willow (S*alix alba, S. amplexicaulis*), poplar (P*opulus alba*) together with herbal species that are humid and salty characteristic spread in this regions. Over-grass has caused a destruction to the vegetation. 2-3and 4.terraces in right sides of river are used as a orchard and cültivated area throughout the research region. There is only an orchard in the second terrace of the first transect that is taken from the lowest point of the watershed. There is an orchard in the 2. and 3. terrace of third transect that is taken from the upward watershed (Figure 1). Being less salty as going upward the watershed provides production of fruit and vegetable.

CONCLUSION

Soil properties data of these both sides of Acıçay River soils indicated significant differences each other in terms of leaching processes which have been shaped by landscape position and parent material. In addition, the relationships between chemical properties of the soils and landscape positions determined by this research affect plant growth. Study of the variations in soil properties is important for soil management and selection that plant species. Therefore, in this study it is explained that parent material, salt, EC and pH and field slope factors affect plant variability through by how nutrients are retained. In

addition, Gerrard (1981) also indicated that the movement and distribution of salt on slopes and floodplain is one of the primary reasons for plant variability. While plant variability at lower slope positions is worse due to high salt and gypsium. Nutrient elements transported from upper slope by overland erosion and subsurface flow to floodplain.

As a result of the research, it is understood that surfacel water carries the salt that can be dissolved by melting them to the accumulation subwatershed. On the other hand soil water under the great temperature has vapoured and rised to the surface together with capilarity and while rising up, it has carried salts along with.

Choice of species becomes important in arid and semi arid region's agricultural areas and afforestation pratices. The amaount of pH, salinity and lime of the soil should be taken into account. The amount of salt is higher in the first terrace (alluvial deposits) of the both sides of the stream in the research area. Therefore species that are resistant to salt should be supported in these regions. Growth of crops that are resistant to salt in the agricultural activities will incerease the output. The first terraces are directly used as a meadow land. As from the second terraces arid-watery agriculture and orchards have come into being. Salt is transmitted into the depths by irrigating abundantly with the water from the stream. In this way the chance of lifetime of the plant is increased.Meadow lands have been destructed as a result of over and faulty pasturage .Meadow improvement measures should be taken and also supported in these regions. Species that are resistant to salt should be prefered in afforestation practices and young plants should be supported with additional soils.

Table 1. Selected chemical properties for 1st Transect Soil

		Right Side					Left Side			
	Terrace No	4	3	2	1	0	1	2	3	4
Soil Properties	Soil Depth (cm)	Shoulder (P. M.)	Backslope (C.M.)	Old River Terrace (A.-C. M)	New River Terrace (A.M.)	In River (N.S)	New River Terrace (A.M.)	Old River Terrace (A.-C. M)	Backslope (C.M.)	Shoulder (P.M.)
Tuz (%)	0-20	0.23	0.24	0.31	4.09	1.26	2.59	0.68	0.21	--
	20-40	0.20	0.19	0.47	1.67	0.17	0.96	1.48	0.19	--
EC ($dS\ m^{-1}$)	0-20	4.92	5.46	6.63	72.88	24.44	47.86	13.68	4.46	--
	20-40	4.22	4.37	9.78	31.90	3.70	19.04	28.50	4.07	--
pH (1/5 D. W.)	0-20	7.6	7.6	7.5	6.9	8.1	6.9	7.5	7.5	--
	20-40	7.5	7.7	7.4	7.3	8.0	7.6	6.6	7.6	--
Calcium Carbonate (%)	0-20	15.56	14.88	18.06	20.42	18.76	16.67	24.32	15.28	--
	20-40	15.98	15.41	15.70	15.84	15.70	15.84	19.59	20.01	--
P ($kg.da^{-1}$)	0-20	4.73	5.56	7.30	4.04	0.39	1.32	7.72	0.78	--
	20-40	0.16	1.13	2.33	0.39	0.08	0.23	1.24	0.31	--
Exchangeable cations ($cmol\ kg^{-1}$) Ca	0-20	30.35	31.16	40.74	59.75	28.35	31.92	51.03	22.68	--
	20-40	28.35	23.44	27.09	37.28	2.31	31.92	63.63	27.09	--
Mg	0-20	1.56	3.22	7.57	75.24	19.36	43.03	4.34	6.74	--
	20-40	0.38	4.98	9.18	20.57	9.42	20.86	40.14	4.22	--
Na	0-20	0.56	0.39	0.94	178.00	66.00	220.00	7.00	0.50	--
	20-40	0.42	0.51	6.00	78.00	13.00	94.00	120.00	0.76	--
K	0-20	0.36	0.41	0.36	0.78	0.68	4.00	0.63	0.28	--
	20-40	0.16	0.27	0.22	0.42	0.14	0.70	0.44	0.22	--

Note: P.M.; Parent materyal, C. M.; Collivial metaryal, A.-C. M.; Alluvial-collivial material, A. M.; Alluvial materia, N. S.; New sedimentation.

Table 2. Selected chemical properties for 2nd Transect Soil

		Right Side					Left Side			
	Terrace No	4	3	2	1	0	1	2	3	4
Soil Properties	Soil Depth (cm)	Shoulder (P. M.)	Backslope (C.M.)	Old River Terrace (A.-C. M)	New River Terrace (A.M.)	In River (N.S)	New River Terrace (A.M.)	Old River Terrace (A.-C. M)	Backslope (C.M.)	Shoulder (P.M.)
Tuz (%)	0-20	0,12	0,16	0.18	0.17	0.24	0.12	0.23	0.26	--
	20-40	0.16	0.15	0.19	0.15	--	0.73	0.23	0.23	--
EC ($dS.\ m^{-1}$)	0-20	2.74	2.84	3.83	3.62	5.12	3.71	5.03	5.45	--
	20-40	3.46	2.69	4.04	3.31	--	14.72	4.87	5.00	--
pH (1/5 D. W.)	0-20	8.2	7.7	7.7	7.8	8.4	8.1	7.7	7.7	--
	20-40	7.6	7.6	7.6	7.7	--	7.9	7.6	7.6	--
Calcium Carbonate (%)	0-20	10.16	12.92	13.09	14.69	11.78	17.45	14.69	19.05	--
	20-40	12.94	13.07	15.85	9.16	--	5.81	15.56	14.25	--
P ($kg.da^{-1}$)	0-20	0.85	5.15	6.21	7.84	0.62	4.58	1.55	2.41	--
	20-40	0.47	--	5.20	1.86	--	0.47	1.01	0.62	--
Exchangeable cations ($cmol.\ kg^{-1}$) Ca	0-20	22.05	23.60	27.09	28.04	11.76	25.83	32.76	29.72	--
	20-40	28.35	28.62	31.82	27.93	--	32.34	23.52	29.19	--
Mg	0-20	2.50	1.96	1.42	10.76	13.29	4.68	1.73	3.18	--
	20-40	3.16	3.71	4.36	5.17	--	45.49	12.07	6.00	--
Na	0-20	0.78	0.72	1.24	1.20	14.01	2.14	0.24	0.66	--
	20-40	0.90	--	0.94	0.88	--	64.00	0.50	0.46	--
K	0-20	0.16	0.28	0.36	0.42	0.20	0.22	0.70	0.52	--
	20-40	0.10	0.32	0.36	0.32	--	0.28	0.90	0.34	--

Table 3. Selected chemical properties for 3rd Transect Soil

		Right Side					Left Side			
	Terrace No	4	3	2	1	0	1	2	3	4
Soil Properties	Soil Depth (cm)	Shoulder (P. M.)	Backslope (C.M.)	Old River Terrace (A.-C. M)	New River Terrace (A.M.)	In River (N.S)	New River Terrace (A.M.)	Old River Terrace (A.-C. M)	Backslope (C.M.)	Shoulder (P.M.)
Tuz (%)	0-20	0.21	0.12	0.06	0.17	0.04	0.14	0.13	0.20	015
	20-40	0.26	0.17	0.04	0.21	0.05	0.16	0.04	0.25	0.15
EC ($dS.\ m^{-1}$)	0-20	4.49	2.60	1.48	3.78	1.12	3.18	2.95	4.32	3.30
	20-40	5.65	3.32	9.57	4.58	1.18	3.46	1.10	5.23	3.32
pH (1/5 D. W.)	0-20	8.0	7.9	8.4	7.7	8.5	8.3	8.5	7.7	7.7
	20-40	7.7	7.7	8.5	7.7	8.5	8.1	8.7	7.6	7.6
Calcium Carbonate (%)	0-20	31.11	14.25	11.05	1.63	10.18	13.09	11.63	12.36	8.43
	20-40	20.21	7.56	9.16	10.90	7.56	6.39	4.36	12.50	10.61
P ($kg.da^{-1}$)	0-20	1.32	2.79	1.32	0.93	0.85	0.70	0.70	1.24	0.39
	20-40	1.55	0.31	0.47	0.62	0.62	0.47	0.23	0.85	0.47
Exchangeable cations ($cmol.\ kg^{-1}$) Ca	0-20	26.99	5.25	8.61	24.47	3.15	11.03	13.44	27.51	26.67
	20-40	31.50	8.40	0.95	25.73	11.76	17.75	2.63	24.26	26.15
Mg	0-20	6.31	3.91	2.22	5.65	3.51	6.17	5.84	1.32	1.96
	20-40	3.49	2.78	1.73	6.58	5.83	8.30	4.13	9.24	2.18
Na	0-20	0.50	0.18	0.44	4.50	1.52	10.50	8.00	0.46	0.24
	20-40	0.18	0.44	0.64	3.00	6.00	6.00	1.52	0.66	0.34
K	0-20	1.02	0.30	0.16	0.26	0.10	0.18	0.18	0.50	0.22
	20-40	1.28	0.36	0.06	0.10	0.10	0.20	0.10	0.30	0.22

Table 4. Floristic list of various parent materials, slopes and terrace along the transect of both sides of the Acıçay stream

Plant Family	Genus	Rigt side					Left side			
		Terrace No								
		4	3	2	1	0	1	2	3	4
Apiaceae	*Heracleum platytaenium*								▲●	
	Bupleurum falcatum subsp. cernuum	●	●							
Asteraceae	*Achillea millefolium*				●▲					
	A. wilhelmsii		X	●	▲		X		X▲	X
	Anthemis tinctoria				●▲		X		▲	●
	A. sintenisii		X	X●		X				
	*Artemisia absinthium**								X	X
	A. santonicum	●							●▲	▲
	Carduus nutans	▲								
	Centaurea urvillei		▲							X●
	C. solstitialis		X						▲	▲
	C. virgata		X							▲
	C. depressa		X	X●	●▲	X			▲	
	C. drabifolia subsp. *detonsa*			X		X				
	C. carduiformis								▲	
	Cirsium vulgare	X								X●▲
	C. hypoleucum				▲					
	C. arvense								▲	▲
	C. elodes									▲
	Crepis macropus									X▲
	Crupina crupinastrum		X		●					X

	Echinops orientalis		X							
	*Inula aucherana**			●	●					
	*Koelpinia linearis**			X●	▲					
	Senecio vernalis	X▲								▲●
Boraginaceaea	*Alkanna orientalis*	▲		X	●	X●	X			
	Echium italicum				●					
	Onosma briquetii				●					
	Onosma tauricum subsp. *brevifolium*			X		X				
Brassicaceae	*Alyssum pateri*			X		X			▲	
	Brassica elongata				●					
	Cardaria draba			●		●				
	Crambe orientalis			●	▲					
	Lepidium campestre					●				
Caryophyllaceae	*Minuartia anatolica* var. *arachnoidea*				X▲		X		▲	
	Silene cappadocica				●					
	Spergularia rubra			●			X			
*Chenopodiaceae**	*Atriplex laevis*				▲●					
	A. lasiantha							●		
	A. rosea			X						
	Chenopodium botyrs							X	▲	
	C. foliosum						●▲			
Convolvulaceae	*Convolvulus arvensis*			X●		X				
Cyperaceae	*Bolboschoenus maritimus*					X●		X		
	Eleocharis palustris					X		X		▲
	Scirpoides holoschoenus					X		X		
Dipsaceae	*Scabiosa rotata*		X		▲				▲	X
	S. argentea			X		X				
Euphorbiaceae	*Euphorbia macroclada*						X			X
	E. orientalis		X							
	E. myrsinites	▲							▲	
Fabaceaea	*Astragalus plumosus*	▲							X	
	A. lineatus								X	
	A. macrocephalus			X		X			▲	
	A. elongatus									●
	A. lycius								▲	
	Dorycnium graecum	▲				●				●
	Genista sessilifolia								▲	
	Lotus corniculatus				●	X		X	X	
	Medicago falcata						X			
	Melilotus alba				●					
	M. officinalis		X		●					
	Onobrychis armena	▲								
	Vicia cracca	▲		●						
Frankeniaceae	*Frankenia hirsuta**				▲					▲
Geraniaceae	*Erodium hoefftianum*								▲	
Hypericaceae	*Hypericum lydium*		X●						●▲	
	H. linarioides									X
	H. perforatum	●	▲							

Table 4 continue

Juncaceae	*Juncus inflexus*					●▲				
	J. orticulatus					X				
Labiatae	*Ajuga chamaepitys*		X		●				▲	▲
	Marrubium parviflorum subsp. *parviflorum*						X			▲
	Mentha pulegium		X	●						
	Nepeta nuda						X			X
	Salvia cryptantha									●
	S. syriaca				●					
	S. forskahlei					●				
	Sideritis montana			X		X				
	Phlomis pungens		X						▲	
	Thymus leucostamus					●	X		X	X●
	T. praceox subsp. *jankae* var. *jankae*								▲	
	Ziziphora persica								▲	
Liliaceae	*Allium atroviolaceum*	▲			●		X		X	
	A. jubatum	▲								
	Ornithogalum narbonense									●
Papaveraceae	*Papaver dubium*			X		X				
Plantaginaceae	*Plantago maritima*					X		X		
	P. lanceolata		X		●					
Plumbaginaceae	*Limonium gmelinii*								▲	
Primulaceae	*Anagallis arvensis*			●						
Poaceae	*Aegilops triuncialis* subsp. *triuncialis*		X						X▲	
	Avena barbata		X			●			▲	▲
	Bothriochloa ischaemum	▲							X	
	Bromus tectorum						X			
	B. arvensis	▲			●					
	Calamagrostis epigejos					X●		X		
	Hordeum geniculatum				▲					
	H. bulbosum	▲								▲
	Stipa arabica	▲								
Ranunculaceae	*Adonis aestivalis*		X		●▲					
	A. flammae								▲	
	Consolida orientalis	▲	X		●▲					
	C. regalis	▲	X	●	▲					
Rubiaceae	*Galium aparine*		X						X	X
	G. verum			●						●
Scrophulariaceae	*Verbascum cheiranthifolium* var. *asperulum*				●					
Tamaricaceae	*Myricaria germanica*					X●▲		X		
	Tamarix smyrnensis					X●▲				

*Halophytic plant

▲: 1. transect, X: 2. transect, ●: 3. transect

Terrace no; 0: in river (water course), 1: flat-terrace (alluvial deposits), 2: flat-terrace (alluvial-collivial deposits), 3: backslope, 4: shoulder

REFERENCES

Anonim, 2008. Eldivan Meteoroloji İstasyonuna Ait Bazı İklim Verileri. TC. Çevre ve Orman Bakanlığı Meteoroloji Genel Müdürlüğü. Ankara

Boissier, E., 1867-88. Flora Orientalis. Basel & Genéve

Davis, P. H., 1965-85. Flora of Turkey and East Aegean Islands Vol. I-IX. University Press. Edingburgh.

Dengiz, O., Kızılkaya. R., Göl. C., Hepsen S. 2007. Effects of Different Topographic Positions on Soil Properties and Soil Enzymes Activities. Asian Journal of Chemistry Vol. 19. No. 3 (2007). 2295-2306

Flowers, T. J. and A. R. Yeo. 1981. Variability in the resistance of sodium chloride salinity within rice (*Oryza sativa* L.) varieties. New Phytol.. 88. 363-373..

Gerrard, A. J., 1981. Soils and Landforms, An Integration of Geomorphology and Pedology, Allen and Unwin.

Güneş, A., W. H. K. Post., E. A. Kirkby and M. Aktaş. 1994. Influence of partial replacement on nitrate by amino acid nitrogen or urea in the nutrient medium on nitrate accumulation in NFT grown winter lettuce. Journal of Plant Nutrition 17. 1929-1938. 1994.

Harringion, H. D. 1957. How To Identify Plants The Swallow Press ın Chicago.

Helmke, P.A. and Sparks. D. L. 1996. Methods of Soil Analysis. Part 3. Chemical Methods. Soil Science of America and American Society of Agronomy. *SSSA Book Series no.5.* Madison-USA.

Munsuz, N., Çaycı. G., Ok. S. 2001. Toprak Islahı ve Düzenleyiciler (Tuzlu ve Alkali Toprakların Islahı). Ankara Üniversitesi. Ziraat Fakültesi. Yayın No: 1518. Yardımcıu Ders Kitabı: 471. Ankara.

Polunin, O. 1972. The Concise Flowers of Europe. Oxford Üniversity Press.. Oxford. U. K. ISBN 0-19-217630-7

Rhoades, J.D. 1996. Methods of Soil Analysis. Part 3. Chemical Methods. Soil Science of America and American Society of Agronomy. *SSSA Book Series no.5.* Madison-USA.

Richard, H.L., Donald. L.S. 1996. Methods of Soil Analysis. Part 3. Chemical Methods. Soil Science of America and American Society of Agronomy. *SSSA Book Series no.5.* Madison-USA.

Siegel, S. M., Siegel. B. Z., Massey. J., Lahne P. and Chen. J. 1980. Growth of Corn in Saline Waters. Physiol. Plant 50: 71-73.

Sönmez, B. 1990. Tuzlu ve Sodyumlu Topraklar. Köy Hizmetleri Şanlıurfa Araştırma Enstitüsü Genel Yayın No: 62. Teknik Yayın No: 17. Şanlıurfa.