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Effects of Different Shrubby Rangeland Reclamation Practices on Some of Soil Characteristics

[1]Nuray Mücellâ MÜFTÜOĞLU*, [2]Ahmet GÖKKUŞ

[1]Çanakkale Onsekiz Mart University, Agricultural Faculty, Soil Science and Plant Nutrition Department, 17100-Çanakkale, Turkey
[2]Çanakkale Onsekiz Mart University, Agricultural Faculty, Field Crops Department, 17100-Çanakkale, Turkey

*Corresponding author: mucella@comu.edu.tr

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Abstract

The present research was conducted to determine possible changes in soil fertility characteristics during the reclamation practices over the prickly burnet (*Sarcopoterium spinosum* (L.) Spach) covered shrubby rangelands of Kaleköy village of Gökçeada (Çanakkale). During the initial year of the research (2010), soil samples were taken from the experimental plots before the implementation of reclamation processes. Then the reclamation processes (burning, grubbing, cutting and natural) were implemented to fight against prickly burnet shrubs. Following the implementation of these processes, second soil sampling was performed in 2011 and then half of all plots were seeded. The third sampling was performed in 2012 and then sheep grazing was performed over the half of the plots. Following the grazing, final soil samples were taken in 2013. Entire soil samples were subjected to soil reaction (pH), water soluble total salt, carbonate, texture, organic material, organic C (carbon), total N (nitrogen), available P (phosphorus), exchangeable Ca (calcium), Mg (magnesium), Na (sodium) and K (potassium) analyses and C/N ratio was calculated by using the analysis values. It was observed from the analyses that reclamation processes implemented over the shrubby rangelands for four years did not resulted in significant changes in soil pH, salinity, N, carbonate and Mg contents. However, significant changes were observed in organic C, organic matter, P, Na, Ca and K levels of shrubland soils with reclamation processes. Entire implementations increased soil reaction, salt and available phosphorus. The greatest changes in soil fertility characteristics were observed in burnt-seeded-preserved plots of the shrubby rangelands.

Key words: Gökçeada, reclamation, shrubland, soil characteristics

Meralarda Farklı Islah İşlemlerinin Bazı Toprak Özellikleri Üzerine Etkisi

Özet

Deneme, Gökçeada (Çanakkale)'da aptesbozan (*Sarcopoterium spinosum* (L.) Spach) çalısı ile kaplı Kaleköy köyü merasının ıslah çalışmaları sırasında toprak verimlilik özelliklerinde meydana gelebilecek değişimlerin tespiti amacı ile yapılmıştır. Denemenin ilk yılında (2010) merada ıslah uygulamalarına başlamadan önce parsellerden toprak örneklemesi yapılmıştır. Daha sonra aptesbozan çalısı ile mücadele amacıyla ana parsellerde ıslah işlemleri (yakma, sökme, biçme ve kontrol) gerçekleştirilmiştir. Bu işlemlerden sonra 2011'de 2. örnekleme yapılmış, sonrasında bütün parsellerin yarısı tohumlanmıştır. Üçüncü örnekleme 2012'de yapılmış ve deneme alanındaki parsellerin yarısında koyun otlatılmaya başlanmıştır. Otlatmadan sonra, deneme sonunda (2013) toprak örnekleri alınmış ve tüm örneklerde toprak reaksiyonu, suda eriyebilir toplam tuz, kireç, bünye, organik madde, organik C (karbon), toplam N (azot), alınabilir P (fosfor), değişebilir Ca (kalsiyum), Mg (magnezyum), Na (sodyum) ve K (potasyum) analizleri yapılmış ve C/N oranı hesapla bulunmuştur. Sonuç olarak dört yıllık sürede, yapılan uygulamalar toprakların pH, tuz, N, kireç, Mg içeriklerinde önemli değişime neden olmamış, organik C, organik madde, P, Na, Ca ve K önemli düzeyde değişmiştir. Tüm uygulamalar toprak reaksiyonu, tuz ve alınabilir fosforu artırmıştır. Toprak verimlilik özelliklerinde en fazla değişim yakılan, tohumlanan ve korunan alanda gerçekleşmiştir.

Anahtar kelimeler: Gökçeada, ıslah, mera, toprak özellikleri

Introduction

Rangelands of Gökçeada town in Çanakkale Province are covered with typical Mediterranean dwarf-shrubs (garig) and prickly burnet (*Sarcopoterium spinosum* (L.) Spach) shrubs (Cengiz et al 2009). Prickly burnet is a thorny shrub with relatively small leaves and it is the least grazed plant by the animals (Kababya et al 1998; Gökkuş et al 2009). Because of difficulties in grazing and favourable growth conditions, prickly burnet ratio in rangeland vegetation is continuously increasing (Atalay 1994; Sternberg & Shoshany 2001).

Widespread of thorny shrubs both hinders the animal grazing and exerts a pressure over the other easily-grazed herbaceous species. In order to overcome stated unfavourable conditions, shrubs are controlled through various methods. There are close and significant relationships between the shrubs and soil characteristics. For instance, total N, organic C, CEC, exchangeable K, P, Ca, Mg and Na contents of bare soils are always lower than the values of soils found under canopy cover. Therefore, shrubs can provide significant contributions to sustainability of soil fertility characteristics (Bochet et al 1999; Parlak et al 2012a). Reduction in rate of shrubs in rangeland vegetation may create significant changes in soil characteristics. Reclamation of shrubby rangelands through various methods (re-establish, chemical control, seeding and etc.) may also result in significant changes in vegetation and soil characteristics. Türkmen et al (2013) reported significant impacts of different rangeland reclamation methods on soil reaction, salinity, carbonate and available N content of soils.

Since seeding, burning, extrinsic plant control and similar reclamation practices disinter soil surfaces, they increase the risk of soil erosion and make the soil surface prone to erosion. Thus, burning and mechanical reclamations caused significant soil losses over the current research site (Parlak et al 2012b). Soil losses then evidently result in alterations in soil characteristics.

Grazing influences botanical composition, yield capacity and soil cover ratios of rangelands (Çomaklı et al 2012; Ruiz-Mirazo & Robles 2012). Changes are also observed in soil characteristics with grazing depending on soil texture and moisture content. Especially continuous heavy grazing over wet pastures results in soil compaction (Houlbrooke & Laurenson 2013), reduces root mass and soil organic matter (Yan et al 2013), decreases water holding capacities (Houlbrooke & Laurenson 2013), slows down microorganism activity (Devi et al 2014) and ultimately increases erosion (Yisehak et al 2013).

Prickly burnet cover seriously restricts the use of Gökçeada rangelands and urgent measures should be taken to control the botanical composition of the rangelands. However, post-reclamation changes in soil characteristics should also continuously be monitored for the sustainability of the rangeland ecosystems and grazing practices. The present research was conducted to investigate possible changes in soil fertility characteristics during the reclamation practices over the prickly burnet (*Sarcopoterium spinosum* (L.) Spach) covered shrubby rangelands of Kaleköy village of Gökçeada.

Materials and Methods

Soil samples taken at 4 different times (once in every year) between the years 2010-2013 from the prickly burnet-covered Kaleköy rangelands of Gökçeada town of Çanakkale province constituted the material of the present research. The research site has an average altitude of 53 m and 4 different soil texture groups as of loamy, sandy-loam, clay-loam and sandy-clay.

Experiments were carried out in split plots experimental design with shrubby rangeland reclamation processes (burning, grubbing, cutting and control) in main plots and seeding and grazing in sub-plots. Initial soil sampling was performed before the implementations of reclamation processes. Then reclamation processes of burning, grubbing and cutting were performed over the main plots to remove prickly burnet shrubs and a plot was left in its natural form. The second soil sampling was performed in October, 2011. Following this sampling, forage crops (alfalfa, sainfoin, garden burnet, orchard grass, perennial ryegrass and crested wheatgrass) were sown over the half of all plots. The third sampling was performed in October, 2012 and following this sampling Gökçeada sheep was started to be grazed over the half of the plots. Grazing intensity was arranged as 1.5 da per sheep. A year later following the start of grazing, forth sampling was performed. Coordinates of sampling locations were recorded with a GPS device so that the samples were taken from the same locations in each sampling. A total of 256 soil samples (4 years × 4 reclamations × 2 seeding × 4 replications) were taken.

Soil samples were taken from 0-20 cm depth as to represent the site (Jackson 1962). Air dried samples were sieved through 2 mm sieve and made ready for analysis.

Glass-electrode pH meter was used to measure the pH of soil samples from 1:2.5 diluted samples (Grewelling & Peech 1960). Electrical conductivity values of the 1:2.5 diluted soil samples were measured with an electrical conductivity meter. Scheibler calcimeter was used to measure carbonate contents of the samples in accordance with the procedure described by Allison & Moodie (1965). For organic C and total N content (%), soil samples were grinded in a porcelain mortar and sieved through 0.5 mm brass sieve. C/N/H analyses were performed in an elemental analysis device (Kirsten 1983). Organic matter (%) was determined in accordance with the principles defined by Smith & Weldon (1941). The method developed by Olsen et al (1954) including the extraction solution of 0.5 M sodium bicarbonate solution ($NaHCO_3$) with a pH of 8.5 was used to determine the available P of the samples. ICP device was used to measure the exchangeable Ca, Mg, Na and K from 1 N ammonium acetate extraction solution (Jackson 1962).

Data evaluation: The data was statistically evaluated by MINITAB 16.0. Data were subjected to variance analysis based on split plots experimental design and LSD test was used to compare means with significant differences.

Results and Discussion

The results obtained from the first three years (2010, 2011 and 2012) were already published in a paper (Gökkuş & Müftüoğlu 2013). The changes in soil fertility characteristics were evaluated in this study by using the soil analyses results of the first (2010) and the last (2013) year.

Significant differences were not observed between soil reaction values of the samples taken during the initial year of the experiments before the implementation of any reclamation processes. Effects of burning, grubbing, cutting and natural processes on soil reaction were not also significantly different. Seeding was significantly effective respectively on burnt, grabbed and cut plots (Gökkuş & Müftüoğlu 2013). However, with the initiation of grazing over the plots, such differences were not observed any more. Following the entire implementations, the greatest change was observed in natural-seeded-grazed plot (1.01); the least changes were observed in grabbed-seeded-grazed plot (0.09) (Table 1). Positive differences between the pH values of the processes implemented between the years 2010-2013 indicate that reclamation processes increased the pH of soil samples. Gökkuş & Müftüoğlu (2013) reported increasing soil reactions with burning during the initial 3 years of the experiments. Since the alkaline ions are released through burning (Altın et al 2005), similar findings were reported in studies carried out with burning treatments (Vallentine 1989; Mitros et al 2002; Okonkwo 2010).

Significant differences were not observed also between water soluble salt values of the samples taken during the initial year of the experiments before the implementation of any reclamation processes. Effects of burning, grubbing, cutting, natural, seeding and grazing on water soluble salt contents of the samples were not found to be significant. The greatest changes in water soluble salt contents with the processes implemented between the years 2010-2013 was observed in the natural-unseeded-grazed plot (123 ppm) and the cut-unseeded-grazed plot (-21 ppm). The least changes were observed in cut-unseeded-preserved plot (1 ppm) (Table 1). A positive change was observed in water soluble salt contents of soil samples with reclamation processes implemented between the years 2010-2013. Although not being significant, reclamation processes increased the salinities of soils. Such a case was because of the increases in Na contents.

Significant differences were not observed between the carbonate contents of soil samples taken at the beginning of the experiments before the implementation of reclamation. While burning, grubbing, cutting, and natural did not yield significant changes, seeding resulted in significant changes in carbonate contents (Gökkuş & Müftüoğlu 2013). However, such a change disappeared with grazing. The greatest changes in carbonate contents were observed in the burnt-seeded-preserved plot (3.09%) and the natural-unseeded-preserved plot (-1.17%). The least change was observed in cut-unseeded-grazed plot (0.03%) (Table 1).

The differences in organic C values of the soil samples taken at the beginning of the experiments before the implementation of reclamation processes were found to be significant. While burning, grubbing, cutting, natural and seeding treatments did not result in significant changes, grazing yielded significant changes in organic C contents of the samples (P=0.014). The greatest changes in organic C values of the samples were observed in the burnt-seeded-preserved plot (0.67%) and cut-seeded-grazed plot (-0.26%). The least change was observed in the burnt-unseeded-preserved plot (0.05%) (Table 2).

Table 1. Soil reaction, salt and carbonate values of soil samples

Process	Soil reaction			Water soluble salt (ppm)			Carbonate (%)		
	2010	2013	Difference	2010	2013	Difference	2010	2013	Difference
B+S+GZ	7.82	8.25	0.43	68	130	62	1.47	1.52	0.05
B+S+P	8.00	8.14	0.14	76	118	42	3.31	6.40	**3.09**
B+US+GZ	8.00	8.41	0.41	74	102	28	2.77	4.60	1.83
B+US+P	8.01	8.42	0.41	87	108	21	1.57	2.68	1.11
G+S+GZ	7.95	8.04	**0.09**	108	95	-13	1.77	1.91	0.14
G+S+P	8.03	8.72	0.69	96	107	11	3.05	5.42	2.37
G+US+GZ	7.88	8.18	0.30	75	112	37	1.01	2.26	1.25
G+US+P	8.13	8.40	0.27	90	115	25	1.79	2.22	0.43
C+S+GZ	8.22	8.52	0.30	109	131	22	5.09	4.35	-0.74
C+S+P	7.70	7.87	0.17	86	103	17	1.53	1.30	-0.23
C+US+GZ	7.87	8.17	0.30	130	109	**-21**	1.97	2.00	**0.03**
C+US+P	7.51	7.75	0.24	93	94	**1**	2.06	1.08	-0.98
N+S+GZ	7.69	8.70	**1.01**	108	118	10	1.28	2.41	1.13
N+S+P	8.09	8.39	0.30	90	109	19	2.93	1.95	-0.98
N+US+GZ	7.85	8.06	0.21	113	236	**123**	2.32	2.41	0.09
N+US+P	8.05	8.50	0.45	108	158	50	3.20	2.03	**-1.17**
	$P_{2013-2010}$= 0.349			$P_{2013-2010}$= 0.625			$P_{2013-2010}$= 0.129		

B: Burning; G: Grubbing; C: Cutting; N: Natural; S: Seeded; US: Unseeded; GZ: Grazing; P: Preserved

Table 2. Organic carbon, total nitrogen and C/N values of soil samples

Process	Organic carbon (%)			Nitrogen (%)			C/N		
	2010	2013	Difference	2010	2013	Difference	2010	2013	Difference
B+S+GZ	2.24	2.53	0.29 A-E	0.373	0.383	0.010	6.31	6.67	0.35
B+S+P	2.27	2.94	**0.67** A	0.343	0.372	0.029	7.33	8.07	0.75
B+US+GZ	2.71	2.51	-0.20 CDE	0.219	0.363	0.144	17.56	6.98	-10.59
B+US+P	2.55	2.60	**0.05** B-E	0.312	0.316	**0.004**	16.74	8.26	-8.48
G+S+GZ	2.38	2.52	0.14 A-E	0.584	0.341	**-0.231**	9.23	8.25	-0.81
G+S+P	3.09	2.85	-0.24 DE	0.331	0.282	-0.049	13.94	10.52	-3.41
G+US+GZ	2.08	2.58	0.50 AB	0.245	0.251	0.006	10.12	11.67	**1.55**
G+US+P	2.45	2.25	-0.20 CDE	0.424	0.263	-0.161	8.27	9.05	0.78
C+S+GZ	3.21	2.95	**-0.26** E	0.384	0.310	-0.074	11.89	12.01	**0.12**
C+S+P	2.66	2.97	0.31 A-D	0.227	0.384	0.157	12.09	8.05	-4.04
C+US+GZ	2.29	2.65	0.36 ABC	0.382	0.321	-0.061	7.66	8.73	1.07
C+US+P	2.83	2.60	-0.23 DE	0.293	0.258	-0.035	10.61	11.75	1.14
N+S+GZ	2.81	2.58	-0.23 DE	0.296	0.370	0.074	22.46	7.00	**-15.47**
N+S+P	2.56	2.63	0.07 B-E	0.304	0.335	0.031	11.66	7.98	-3.67
N+US+GZ	3.14	2.95	-0.19 CDE	0.217	0.387	**0.170**	15.94	7.64	-8.30
N+US+P	3.24	3.03	-0.21 CDE	0.442	0.359	-0.083	7.90	8.85	0.95
	$P_{2013-2010}$= 0.014			$P_{2013-2010}$= 0.848			$P_{2013-2010}$= 0.606		

B: Burning; G: Grubbing; C: Cutting; N: Natural; S: Seeded; US: Unseeded; GZ: Grazing; P: Preserved

Previous studies also reported decreasing organic C values for burnt sites (Kavdır et al 2005; Çetin et al 2009). However, in light fires where soil temperatures are not risen too much, changes expected in organic matter were not observed (DeBano 1990). On the other hand, soil organic carbon increased with seeding during the initial 3 years of the experiments (Gökkuş & Müftüoğlu 2013).

Significant differences were not observed between total nitrogen contents of soil samples. Burning, grubbing, cutting, natural, seeding and grazing did not yield significant changes in total N contents of the soils (P=0.848). Considering the initial and post-treatment total N values, the greatest changes were observed in natural-unseeded-grazed plot (0.170%) and grabbed-seeded-grazed plot (-0.231%). The least change was observed in burnt-unseeded-preserved plot (0.004%) (Table 2). Comparisons between the soil samples taken from burnt and non-burnt forest sites revealed decreased nitrogen values in burnt site (Kavdır et al 2005; Çetin et al 2009). Such a case can be explained volatilization of some of nitrogen with the impact of heat (DeBano 1990).

Table 3. Organic matter, phosphorus and potassium values of the soil samples

Process	Organic matter (%)			Phosphorus (ppm)			Potassium (ppm)		
	2010	2013	Difference	2010	2013	Difference	2010	2013	Difference
B+S+GZ	2.14	2.56	0.42 A-D	1.31	7.83	6.52 B-E	2396	2098	-298 B-E
B+S+P	1.67	3.40	**1.73** A	2.36	6.29	3.93 CDE	2212	2392	180 A-D
B+US+GZ	2.29	2.48	0.19 BCD	2.16	6.70	4.54 CDE	2140	1995	-145 B-E
B+US+P	3.05	3.08	**0.03** CD	1.65	8.14	6.49 B-E	2469	2479	**10** A-E
G+S+GZ	1.86	3.06	1.20 ABC	1.61	10.07	8.46 A-D	2289	2668	379 ABC
G+S+P	2.96	2.84	-0.12 CD	2.61	5.63	3.02 DE	3391	2769	-622 DEF
G+US+GZ	2.05	2.70	0.65 A-D	1.60	11.93	10.33 AB	2440	2339	-101 B-E
G+US+P	2.63	2.69	0.06 CD	1.82	10.41	8.59 A-D	2441	2094	-347 B-E
C+S+GZ	2.96	3.24	0.28 BCD	3.33	9.79	6.46 B-E	3333	2846	-487 C-F
C+S+P	3.50	3.99	0.49 A-D	1.75	8.87	7.12 A-D	3516	4373	**857** A
C+US+GZ	1.95	3.43	1.48 AB	2.20	11.77	9.57 ABC	2254	2771	517 AB
C+US+P	2.94	2.46	**-0.48** D	3.37	12.21	8.84 ABC	3752	2424	**-1328** F
N+S+GZ	2.97	2.71	-0.26 D	3.06	9.10	6.04 B-E	3509	2704	-805 EF
N+S+P	2.30	2.73	0.43 A-D	2.75	15.34	**12.59** A	2416	2634	218 A-D
N+US+GZ	3.93	3.90	**-0.03** CD	3.92	5.25	**1.33** E	3531	3219	-312 B-E
N+US+P	3.74	3.81	0.07 CD	3.15	11.78	8.63 A-D	3079	2742	-337 B-E
	$P_{2013-2010}$= 0.039			$P_{2013-2010}$= 0.022			$P_{2013-2010}$= 0.001		

B: Burning; G: Grubbing; C: Cutting; N: Natural; S: Seeded; US: Unseeded; GZ: Grazing; P: Preserved

Table 4. Exchangeable calcium, magnesium and sodium values of the soil samples

Process	Calcium (ppm)			Magnesium (ppm)			Sodium (ppm)		
	2010	2013	Difference	2010	2013	Difference	2010	2013	Difference
B+S+GZ	32261	32691	**430** BCD	3137	3143	**6**	438	890	452 ABC
B+S+P	37364	53744	**16380** A	3555	3567	12	714	750	36 BCD
B+US+GZ	39674	43481	3807 BC	2701	2074	**-627**	363	1009	646 AB
B+US+P	39239	44508	5269 ABC	3525	2923	-602	504	621	117 BCD
G+S+GZ	37807	35524	-2283 BCD	2961	2742	-219	466	476	**10** BCD
G+S+P	58523	62281	3758 BC	4017	3499	-518	899	887	-12 CD
G+US+GZ	28915	35254	6339 AB	2395	3036	**641**	334	741	407 ABC
G+US+P	37823	35961	-1862 BCD	3872	3551	-321	676	1040	364 ABC
C+S+GZ	55551	49353	-6198 CD	4787	4281	-506	775	679	-96 CD
C+S+P	47527	42488	-5039 BCD	9207	8603	-604	1434	1076	**-358** D
C+US+GZ	37492	42074	4582 BC	3132	3408	276	453	1294	**841** A
C+US+P	46979	36047	**-10932** D	6405	6397	-8	838	1257	419 ABC
N+S+GZ	42409	47063	4654 ABC	3912	3627	-285	563	700	137 BCD
N+S+P	37474	34824	-2650 BCD	4067	4450	383	918	1125	207 A-D
N+US+GZ	46766	42353	-4413 BCD	4913	4640	-273	616	777	161 BCD
N+US+P	46442	45838	-604 BCD	5812	5425	-387	812	1631	819 A
	$P_{2013-2010}$= 0.009			$P_{2013-2010}$= 0.996			$P_{2013-2010}$= 0.014		

B: Burning; G: Grubbing; C: Cutting; N: Natural; S: Seeded; US: Unseeded; GZ: Grazing; P: Preserved

The differences between C/N ratios of soil samples were not found to be significant. The changes in C/N ratios of burnt, grabbed, cut, seeded and grazed plots were not significant (P=0.606). The greatest changes were observed in the grabbed-unseeded-grazed plot (1.55) and natural-seeded-grazed plot (-15.47). The least change was observed in cut-seeded-grazed plot (0.12) (Table 2).

Significant differences were observed between organic matter contents of the soil samples taken before the implementation of reclamation. While burning, grubbing, cutting and natural did not result in significant changes, seeding and grazing yielded significant changes (P=0.039) in organic matter contents of the samples. With the reclamation processes implemented between the years 2010-2013, the greatest changes were observed in the burnt-seeded-preserved plot (1.73%) and cut-unseeded-preserved plot (-0.48%). The least change was observed in the burnt-unseeded-preserved plot

(0.03%) (Table 3). Increasing organic matter contents were observed during the initial 3 years of the experiments (Gökkuş & Müftüoğlu 2013).

Significant differences were observed between P values of the soil samples taken before the implementation of reclamation processes. While burning, grubbing, cutting, natural and seeding did not result in significant changes, grazing yielded significant changes (P=0.022) in P contents of the soil samples. With the reclamation processes implemented between the years 2010-2013, the greatest changes in available P were observed in the natural-seeded-preserved plot (12.59 ppm) and natural-unseeded-grazed plot (1.33 ppm). All reclamation processes and grazing increased the available P content of the soils (Table 3).

Significant differences were also observed between K values of the soil samples taken before the implementation of reclamation processes. While burning, grubbing, cutting, natural and seeding did not result in significant changes, grazing yielded significant changes (P=0.001) in K values of the samples (Table 3). With the reclamation processes implemented between the years 2010-2013, the greatest changes were observed in the cut-seeded-preserved plot (857 ppm) and cut-unseeded-preserved plot (-1328 ppm). The least change was observed in the burnt-unseeded-preserved plot (10 ppm).

Significant differences were observed between Ca contents of the soil samples taken before the implementation of reclamation processes. While burning, grubbing, cutting and natural did not result in significant changes, grazing (P=0.009) yielded significant changes in Ca values of the samples (Table 4). With the reclamation processes implemented between the years 2010-2013, the greatest changes were observed in the burnt-seeded-preserved plot (16380 ppm) and cut-unseeded-preserved plot (-10932 ppm). The least change was observed in the burnt-seeded-grazed plot (430 ppm).

Significant differences were observed between Mg contents of the soil samples taken before the implementation of reclamation processes. Burning, grubbing, cutting and natural and seeding resulted in significant changes in Mg contents of the soil samples, but such differences disappeared with grazing practices. With the reclamation processes implemented between the years 2010-2013, the greatest changes were observed in the grabbed-unseeded-grazed plot (641 ppm) and burnt-unseeded-grazed plot (-627 ppm). The least change was observed in the burnt-seeded-grazed plot (6 ppm) (Table 4).

Significant differences were also observed between Na contents of the soil samples taken before the implementation of reclamation. Burning, grubbing, cutting, natural and seeding did not result in significant changes, grazing yielded significant changes in Na contents of the soil samples (P=0.014) (Table 4). With the reclamation processes implemented between the years 2010-2013, the greatest changes were observed in the cut-unseeded-grazed plot (841 ppm) and cut-seeded-preserved plot (-358 ppm). The least change was observed in the grabbed-seeded-grazed plot (10 ppm).

Conclusions

Of the shrubby rangeland management and reclamation processes, burning, grubbing, cutting, natural, seeding and grazing did not significantly change the pH, salinity, N, carbonate and Mg contents of the soils. However, significant changes were observed between organic C, organic matter, P, Na, Ca and K contents of the soils. A similar study was performed over the rangelands of Sivas Province. In that study, effects of four different treatments (preservation × plant cover × fertilization, preservation × fertilization, only preservation and grazing) on physical and chemical soil characteristics were investigated for 5 years. Researchers observed that treatments did not yield distinctive changes in physical characteristics of the soil in the short-run and a distinctive improvement were not observed also in chemical characteristics of the soils (Oğuz et al 2010).

The greatest changes in carbonate, organic C, organic matter and Ca contents of the soils were observed in burnt-seeded-preserved plot. Again, the greatest changes in water soluble salt and total nitrogen contents were observed in natural-unseeded-grazed plot; the greatest changes in soil reaction were observed in natural-seeded-grazed plot; the greatest changes in available P were observed in natural-seeded-preserved plot. Sodium exhibited the greatest change in cut-unseeded-grazed plot; K in cut-unseeded-preserved plot and Mg in grabbed-unseeded-grazed plot.

The least changes in total N, K and organic C contents of the samples were observed in burnt-unseeded-preserved plot. Organic matter yielded the least change in burnt-unseeded-preserved plot and natural-unseeded-grazed plot; Ca and Mg in burnt-seeded-grazed plot; soil reaction and Na in grabbed-seeded-grazed plot; carbonate in cut-unseeded-grazed plot; water soluble salt in cut-unseeded-preserved plot; available P in natural-unseeded-grazed plot.

Entire treatments increased soil reaction, salt and available P contents of the soils. The greatest changes in soil fertility characteristics with the treatments were observed in burnt-seeded and preserved plot. Such a case was because of the impacts of heat on physical, chemical and biological characteristics of the soils (DeBano 1990). However, long-term monitoring is necessary to observe the distinctive changes in physical and chemical characteristics of rangeland soils.

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