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The Effects of Traditional Grazing Practices on Upland (Yayla) Rangeland Vegetation and Forage Quality

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Abstract: A seminomadic animal raising system, known as "yaylacılık" in Turkish, is one of the best ways of using upland rangelands, particularly in rough terrain regions. Three rangeland sites were selected to determine the spatial effect of summer grazing distribution on botanical composition, canopy coverage, soil aggregate stability, and forage nutrient content in these range sites. On average, grass covered 61.09% of the total land in site I, 67.04% and 57.40%, respectively, in sites II and III. Legume covered 11.61%, 13.67%, and 18.05%, respectively, of the total land in sites I, II, and III. Other families covered 27.30%, 19.29%, and 24.55% of each sites, respectively. Sheep fescue (*Festuca ovina*) was the dominate species in all sites. The canopy coverage was highest (38.63%) in site II, lowest (25.80%) in site III. The range condition score was 39.5, 45.8, and 41.7, respectively in sites I, II and III. The range condition and health class was at risk in site I and II, and unhealthy in site III. Compared to the other sites, soil aggregate stability was higher in site II. Crude protein content was 12.11%, 13.34%, and 12.81%; available K content was 2.47%, 2.69%, and 2.12%; Ca content was 0.74%, 0.86%, and 0.76%; Mg content was 2515, 2825 and 2720 ppm; available P content was 1155, 1392, and 1203 ppm, respectively, in sites I, II, and III. Current grazing management practices leads to overgrazing pressure around water resources; therefore, developing new water resources and a suitable grazing management plan are necessary to provide sustainable use of upland rangelands.

Key Words: Upland rangelands, botanical composition, canopy coverage

Geleneksel Otlatma Uygulamalarının Yayla Mera Vejetasyonu ve Yem Kalitesi Üzerine Etkileri

Özet: Türkçede yaylacılık olarak adlandırılan yarı göçer hayvan yetiştirme sistemi, özellikle engebeli bölgelerdeki yüksek rakımlı meraları kullanmanın en iyi yollarından biridir. Yarı göçer otlatma uygulamasının yayla bitki örtüsünün botanik kompozisyonu, toprağı kaplama oranı, toprak agregat stabilitesi ve yemin kimyasal içeriğı üzerine etkilerini belirlemek amacıyla üç mera kesimi seçilmiştir. Ortalama buğdaygil oranı I. kesimde %61,09; II. ve III. kesimlerde sırasıyla %67,04 ve %57,40 olarak belirlenmiştir. Baklagillerin oranı I., II. ve III. mera kesiminde sırasıyla %11,61, %13,67 ve %18,05 olarak, diğer familyaların oranı ise sırasıyla %27,30, %19,29 ve %24,55 olarak belirlenmiştir. Koyun yumağı (*Festuca ovina*) tüm kesimlerde dominant bitki türü olmuştur. Toprağı kaplama oranı II. kesimde en yüksek (%38,63), III. kesimde en düşük (%25,80) olarak belirlenmiştir. Mera kalite derecesi I., II. ve III. mera kesimlerinde sırasıyla 39,5, 45,8 ve 41,7 olarak belirlenmiş; buna göre mera durum ve sağlık sınıfı I. ve II. kesimde riskli, III. kesimde sağlıklı olarak belirlenmiştir. Toprak agregat stabilitesi II. kesimde diğer kesimlerden daha yüksek olarak belirlenmiştir. Mera kesimlerinde otun ham protein oranı sırasıyla %12,11, %13,34 ve %12,81; faydalanılabilir potasyum içeriğı %2,47, %2,69 ve %2,12; kalsiyum içeriğı %0,74, %0,86 ve %0,76; magnezyum içeriğı; 2515, 2825 ve 2720 ppm; faydalanılabilir fosfor içeriğı 1155, 1392 ve 1203 ppm olarak tespit edilmiştir. Mevcut otlatma yönetimi uygulamaları su kaynağının etrafında ağır otlatma baskısına sebep olmaktadır. Bu yüzden yayla meralarının sürdürülebilir kullanımını sağlamak için yeni su kaynakları geliştirmek ve uygun otlatma yönetimi planlaması gerekmektedir.

Anahtar Sözcükler: Yayla meraları, botanik kompozisyon, toprağı kaplama oranı

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Introduction

A seminomadic animal raising system, known as "yaylacılık" in Turkish, is a traditional animal production method. This system is similarly practiced in other regions of the world, such as China, India, Canada, and Greece (Chang and Tourtellotte, 1993; Smith, 1995; Miller, 1999; Nautiyal et al., 2003). In this system, domestic animals, such as sheep, goats, cattle, and horse are grazed on a rangeland around permanent settlements approximately until summer, and thereafter the herds are moved to upland pastoral areas until autumn. The objective is to keep the animals in suitable conditions during hot summer periods and provide better quality forage for animals.

Once animal breeders arrive at the uplands, they start to graze their animals around temporary settlements that they establish by themselves for the season. Thereafter, animals in the settlement are combined and grazing is conducted regularly, which modifies the spatial effects of grazing on rangeland vegetation in uplands.

Heavy grazing and grazing during wrong seasons are the most important rangeland degradation factors (Çomaklı and Menteşe, 1999; Holechek et al., 2004). The rangelands around the permanent settlements are heavily overgrazed and damaged by the impacts of grazing practices (Willms et al., 1993; Tosun, 1996; Taylor et al., 1997) but the condition of many nomadic or seminomadic pastoral areas is generally not so bad, and many rangelands can even be considered to be in good condition (Miller, 1999; Erkovan et al., 2003; Kadioğlu, 2003).

Upland range species are more vulnerable to biotic and abiotic stress factors than lowlands range plants (Thilenius, 1979; Gökkuş and Koç, 1991), and accordingly may need more careful management. Mismanagement can reduce rangeland productivity (Holechek et al., 2004), changes botanical composition toward poorer quality species (Öztaş et al., 2003), and reduces plant canopy coverage (Herbel and Pieper, 1991; Koç and Gökkuş, 1996). Canopy coverage is as important as botanical composition because erosion increases as canopy coverage decreases in arid and semiarid rangelands (Marshall, 1973). Changes in botanical composition due to stress factors can also cause changes in chemical content of the produced hay in rangelands (Noller and Rhykerd, 1974; Koç et al., 2000).

The differences in the use of rangelands can cause changes in rangeland soil properties. Overgrazing and its attendant effects reduce plant cover and trampling of soil contributes to degradation of rangeland soils (Branson et al., 1981). In general, soil aggregate stability decreases as grazing pressure increase in a rangeland (Koç, 1995).

The aim of this study was to estimate the changes in botanical composition, canopy coverage, soil properties, and nutrient content of forage in upland rangelands due to spatial distribution of grazing.

Materials and Methods

Seminomadic animal raising system was commonly employed in the highlands of Turkish lands since the beginning of its early history. Animal breeders graze their animals freely around permanent lower altitude settlements for approximately 1 month, from mid-April to mid-May. Thereafter, the settlement's animals are combined into herds and grazing is conducted regularly on the rangelands close to permanent settlements for 1 month from approximately May to June. In June, when the forage dries out on these rangelands due to dry summer conditions, animals are driven to a temporary settlement located on uplands (yayla) and animal owners move and live with their families there until September. Each family let their animals graze freely around temporary individual settlements until all the animals arrive at the upland, which takes about 2-3 weeks. Then, the settlement's animals are combined in herds and systematic grazing starts and continue until autumn (by the end of September). In this system, the rangelands around temporary settlements and water resources are exposed to more grazing pressure than the other sites. The duration of the grazing season in uplands is about 105 days, of which about 15 days is free at the beginning of the season and regular grazing under herds is 90 days.

This study was conducted on the rangelands of Narman district of Erzurum province of Turkey in 2001 and 2002. Three rangeland sites were selected: Site I was close to a temporary settlement; it was 250 m away from a temporary settlement (40°393'E, 41°962'N). Site II, located between a temporary settlement and a watering point, was 1 km away from a temporary settlement (40°394'E, 41°956'N). Site III was close to a watering source; 100 m away from a watering point and 3 km from a temporary settlement (40°389'E, 41°972'N).

The study site was located at the average altitude of 2300 m, and divided by valleys. Average slope was 10%-15% in site I and II, 5%-10% in site III. There are wide plains in upland (yayla) areas. Annual average temperature was 6 °C, and total annual precipitation was 450 mm. Precipitation data throughout the experimental years were compared with long term average monthly precipitation as shown in the Figure.

The experimental site soils are originated from residual volcanic (basaltic) parent material in aridisol order (Köy Hizmetleri il Raporu, 2000). Four composite soil samples were collected from the surface layer of each site and analyzed for physical and chemical properties. The soil texture was determined by a Bouyoucos hydrometer (Gee and Bauder, 1986) as sandy clay loam in site I, clay loam in site II, and sandy clay loam in site III. The soil pH, determined by a pH meter (McLean, 1982) with glass electrode (1:2.5 soil-water suspension), for site I, II and III was 7.29, 6.43, and 6.75, respectively. Soil organic matter content was determined by Smith-Weldon method (Nelson and Sommers, 1982) as 1.89%, 4.58%, and 2.80%; available K was determined by a flame photometry (Thomas, 1982) as 1.3, 1.4, and 0.9 t ha⁻¹; and Olsen P content was determined by molybdophosphoric blue color method (Olsen and Sommers, 1982) as 17.0, 13.3, and 19.3 kg ha⁻¹ in site I, II and III, respectively. CaCO₃ content was determined by a Scheibler calcimeter (Nelson, 1982) as 0.44 in site I and II, and 0.55 in site III. Soil aggregate stability was measured according to Kemper and Rosenau (1986).

Botanical composition of the range sites was determined by the line intercept method developed by Canfield (1941) in July in 2001 and 2002. Measurements were performed using 8-line intercept transects (for 10 m interval over a fixed 80 m long

transect) based on the basal area. The range condition score, and condition and health classification were determined for each range site using the 2-year average botanical composition values according to the criteria suggested by Koç et al. (2003), consisting of a combination of range condition classification (Dyksterhius, 1949) and rangeland health methods of the Committee on Rangeland Classification (National Research Council, 1994).

Forage samples for some chemical analysis were collected by hand-clippings at grazing height in each site when dominant species began to flower each year in July. Samples were oven-dried at 78 °C for 24 h, ground to pass a 2 mm sieve, and divided into 4 sub-samples. Total N was determined by the Kjeldahl method and multiplied by 6.25 to determine the crude protein content (Jones, 2001). The mineral (Ca, Mg, and K) content was determined by atomic absorption spectrophotometry after digestion (Grunder and Boettner, 1967) and P was determined by vanadomolybdophosphoric yellow color method (AOAC, 1990).

An arc-sine transformation of data was used before ANOVA for species composition and canopy coverage. All data were subjected to analysis of variance based on general linear models for repeated measurements using the SPSS (SPSS for Windows). Means were separated using the least significant difference (LSD) test.

Results

A total of 81 plant species was recorded (18 grasses, 13 legumes, and 50 other species). Grasses were the most common ($P < 0.01$) and legumes were the least common species recorded (Table 1). Grasses were most common in site II and least common in site III. Sheep fescue (*F. ovina*) was the dominant grass in all sites. Sheep fescue cover was most common in site III. Mat-grass (*N. stricta*) was most common in site I and mountain bluegrass (*P. longifolia*) was most common in site II. There was no significant difference in terms of other grass cover percentage between the sites. Total legume cover was most common in site III, and the least common in site I. Mountain clover (*T. montanum*) was more common in site I as compared to the other sites. However, thorny milk-vetch species (*Astragalus* sp.) was abundant in site III. Site I and III had higher percentage of herb species than site II. The most common species

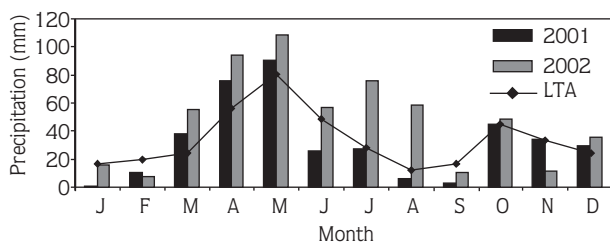


Figure. Monthly precipitation during the experiment (2001-2002) and long term average (1929-2002) (LTA).

Table 1. Percentage species composition in the study sites.

	SITES								
	I			II			III		
Families	2001	2002	Average	2001	2002	Average	2001	2002	Average
Grasses ¹	61.8	60.4	61.09 B	66.4	67.7	67.04 A	58.2	56.59	57.40 C
Legumes ²	12.01	11.20	11.61 C	13.20	14.10	13.67 B	18.73	17.37	18.05 A
Other families ³	26.19	28.40	27.30 A	20.40	18.20	19.29 B	23.07	26.04	24.55 A

Values with different letters differ significantly (P < 0.01).

among the herb families was thyme (*Thymus parviflorus*), which was found in site II. There was no statistically significant difference recorded between the years with respect to all botanical composition values presented in this study.

The highest canopy coverage percentage was recorded in site II with the lowest percentage in site III. The range condition score was highest in site II and the lowest score was in site I (Table 2). Range condition class and health class were fair-at risk in sites I and II, but fair-unhealthy in site III according to Koç et al. (2003).

Soil aggregate stability was highest in site II (Table 2), which was expected because soils in site II were richer in both clay and organic matter; consequently, fractions encourage soil aggregation compared to the other sites.

There were no significant differences recorded

between the sites and years with regard to crude protein content of the forage (Table 3). The crude protein content varied between 11.3% and 13.8%. The details of mineral (K, Ca, Mg, and P) content are given in Table 4. Site II had the highest mineral contents amongst all 3 sites.

Discussion

Rangelands generally occur in semi-arid areas, where the main precipitation type during the vegetation period is frequent light rains. This precipitation moistens only the upper layer of the soil and is used more efficiently by fibrous rooted grasses (Holeczek et al., 2004). Sheep fescue (*F. ovina*), a short grass, moderately preferred by stock, was the dominant species of the botanical composition in all sites. High sheep fescue percentages in

Table 2. Canopy coverage proportions, condition score, range condition and health class and soil aggregate stability values.

	SITES			
	Years	I	II	III
Canopy Coverage Proportions (%)	1	35.4	38.6	25.8
	2	36.9	38.7	25.7
	Average	36.1 c	38.6 a	25.8 b
Range Condition Score	1	38.5	44.5	41.1
	2	40.4	47.1	42.3
	Average	39.5 c	45.8 a	41.7 b
Range Cond. and Health Class		At risk	At risk	Unhealthy
Soil Aggregate Stability		64.38 b	89.78 a	67.38 b

Values with different letters differ significantly (P < 0.01).

Table 3. Crude protein content of the forage grown in the study sites (%).

	SITES			
	Years	I	II	III
Crude Protein	2001	11.3	12.9	13.1
Content (%)	2002	12.9	13.8	12.5
	Average	12.1	13.3	12.8

the botanical composition might relate to unsuitable grazing management since short grasses are resistant to grazing and their abundances increase under heavy grazing pressure (Koç, 2001; Vermeire and Bidwell, 2002). In this study the sheep fescue percentage was lower at the more heavily grazed sites. The higher mat-grass proportions in site I might be related to the starting time of the grazing. When animals arrive to the upland in the middle of spring, wet conditions still continue and animals initially graze on this site. Mat-grass is both resistant to grazing and is capable of reproducing by clinging to the hooves of animal during wet conditions (Prather et al., 2003). Therefore, heavy grazing at the beginning of the season in site I might be the main reason for higher mat-grass occurrence in this site.

Except for mountain clover (*T. montanum*) almost all types of forbs might be accepted as unpalatable species (legumes + the other family species) in the sites since they are usually less resistant to grazing than the grasses (Vermeire and Bidwell, 2002). Higher mountain clover in site I might be related to ecological conditions. In site I, grazing pressure decreases during warm summer days

because herds are driven to other sites after stock are combined under regular herds in beginning of the 'yayla' period. Thereafter, increased temperature causes slow growth in grasses and provides favorable growing conditions for forbs. These conditions might increase the abundance of mountain clover in the botanical composition of site I. In general, overabundance of forbs implies that there may be poor range management practices over a long period of time. The small differences in range condition scores between the sites stemmed from the differences of botanical composition between sites. The highest range condition score was recorded in site II. It is believed that this site suffers from neither early grazing as in site I, nor heavy grazing as in site III. These traditional range management practices cause different grazing pressure among the sites.

These results of canopy coverage imply that site III soils were more prone to erosion than the other sites. Because of higher aggregate stability, as an indicator of soil resistance erosion (Lal, 1990; Öztaş et al., 2003), lower canopy coverage also caused an unhealthy range health category in site III. During the dry summer period, all herds congregate around a pond near midday in site III. Water is available at other times at fountains around the temporary settlement areas during evenings and mornings. The herds spent more time grazing around water resources during the dry season (Holechek et al., 2004). Hence, canopy coverage was less in this site compared to other sites. Therefore, traditional grazing practices must be organized properly by introducing a suitable grazing plan primarily in site III and other sites because other sites are in risk with respect to rangeland health. Otherwise, degradation in range vegetation will continue in the sites. Hence, there are not many

Table 4. Mineral content of the forage grown in the study sites.

Sites	K (%)			Ca (%)			Mg (ppm)			P (ppm)		
	2001	2002	Aver.	2001	2002	Aver.	2001	2002	Aver.	2001	2002	Aver.
I	2.8	2.2	2.5 b	0.8	0.7	0.7 b	2650	2380	2515 c	1135	1175	1155 b
II	3.1	2.3	2.7 a	0.8	0.9	0.9 a	2750	2900	2825 a	1400	1384	1392 a
III	2.1	2.1	2.1 c	0.7	0.8	0.8 b	2680	2760	2720 b	1200	1206	1203 b
Average	2.7	2.2	2.4	0.8	0.9	0.8	2693	2680	2687	1245	1255	1250

Values with different letters differ significantly ($P < 0.01$).

rangelands around the world preserving their quality because of the heavy grazing pressure (Holechek et al., 2004).

Although there were differences between botanical compositions of the sites, there were no differences in herbage quality between the sites in terms of their protein or mineral contents. The differences of forage samples with respect to mineral contents might have originated from different mineral uptake and translocation performance of the plants among the sites (Whitehead, 2000).

There is often a linear relationship between the range condition score and production potential of the rangelands (Danckwerds and Aucamp, 1986). Botanical composition and range condition scores (upland rangelands in the present study) indicate a loss of production potential. The main problem with present grazing practices is uneven spatial distribution of grazing pressure and excessive grazing during the grazing season. Current grazing management causes overgrazing around the midday watering points. Therefore, developing new watering points and suitable grazing management plans are necessary to ensure more even distribution of grazing pressure.

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