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RESEARCH ARTICLE

A Research Based Evaluation of the Natural Grasslands within the Aspect of Sustainable Livestock Production Systems in Highlands of the Eastern Turkey [1] [2]

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Summary

In this study, two different grazing management systems were evaluated for not only sustainable agricultural systems but also for better monitoring the environment and conserving natural resources in the highlands of the eastern Turkey in Kars province. For this purpose an experiment was conducted to compare two grazing areas; one with naturally growing (NG) and the other one with artificial fertilizer applied (FG). Two grassland areas were chosen next to each other and fertilised with CAN fertilizer (calcium ammonium nitrate) and TSP (triple super phosphate) at the rate of 180 and 190 kg/ha respectively, the other area was set without fertiliser application. The results showed that there were no statistical differences (P>0.05) in botanical composition between NG and FG areas. Mean biomass dry matter per quadrat (1 m x 1 m) and sward height in NG and FG was statistically significant (P<0.05), 179 g and 382 g and 15 and 29 cm respectively. However, there were no statistical significant differences (P>0.05) in organic matter and mineral content of the soil between NG and FG during the experimental period, except K, Na, Fe, Zn and N contents. Therefore, it was concluded that there was no use in applying chemical fertiliser by considering the long-term adverse effects in the highlands of the eastern part of Turkey in order to sustain and preserve the quality of natural grasslands, animal production systems and environment as a whole.

Keywords: *Grazing, Beef cattle, Grasslands, Sustainable agriculture, Environment*

Türkiyenin Doğusunda Yer Alan Doğal Meraların Sürdürülebilir Hayvansal Üretim Sistemleri Yönünden Değerlendirilmesi Üzerine Bir Araştırma

Özet

Bu çalışmada Türkiye'nin doğusunda bulunan Kars ili doğal meraları, hem sürdürülebilir hayvansal üretim sistemleri hem de çevre ve doğal kaynakların daha iyi izlenmesi ve korunması açısından değerlendirilmiştir. Bu amaçla birbirine yakın 2 mera alanı seçilmiş ve bu alanlardan birine CAN (kalsiyum amonyum nitrat) ve TSP (triple super fosfat) gübreleri sırasıyla 180 ve 190 kg/ha oranlarında uygulanmış (FG) diğerine ise herhangi bir gübre uygulaması yapılmamıştır (NG). Araştırma sonucunda, NG ve FG mera alanları arasında botanik kompozisyon bakımından istatistiksel fark (P>0.05) önemli bulunmamış, buna karşın ortalama biomas kuru madde içerikleri (NG:179 g/m^2, FG: 382 g/m^2) ve ot yükseklikleri (NG: 15 cm, FG: 29 cm) istatiksel olarak önemli bulunmuştur (P<0.05). Deneme alanlarının toprakları arasında ise K, Na, Fe, Zn and N içerikleri arasında istatistiksel fark önemli bulunurken (P<0.05), organik madde ve diğer mineral içerikleri bakımından istatiksel bir farklılık bulunmamıştır (P>0.05). Türkiye'nin doğusunda bulunan doğal meralara kimyasal gübre uygulamasının, sürdürülebilir hayvansal üretim sistemleri, doğal kaynakların korunması ve mera-çevre kalitesi göz önüne alındığında uzun dönemde olumsuz etkilerinin ortaya çıkabileceği sonucuna varılmıştır.

Anahtar sözcükler: *Otlatma, Besi sığırları, Çayır-mera, Sürdürülebilir tarım, Çevre*

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INTRODUCTION

It was estimated that 17% of Turkey is covered by pastures and grasslands [1]. The variety in grasslands is very high, from steppe grasslands till upland grasslands. The total coverage of grasslands was estimated at 12.5 million ha [2,3]. In the thirties, the total coverage was about 44 million ha [4]. It means that the total surface was decreased with 70% over 70 years.

Degradation of existing grassland is the number one problem facing agricultural production, rural development and environmental improvement in Turkey. Degraded grassland produces much less and poorer quality herbage biomass. Consequently, it causes serious problems with livestock production and environmental protection [5].

East Anatolia region is very rich in forage and pasture plants and a gene centre for a number of them such as lucerne *(Medicago)*, clover *(Trifolium)*, vetch *(Vicia)*, sainfoin (*Onobrychis)*, and chickling vetch (*Lathyrus)*. The area is generally at high altitude and the pastures are severely degraded by heavy grazing. The most persistent grass species of the pastures are fescue (*Festuca*) and wheat grass (*Agropyron*). Although this is the coldest part of the country and heavy grazing has been going on for many decades causing serious genetic erosion, it is still possible to find very valuable plants in the pastures. This is because the native pasture plants are highly persistent and very well adapted to the conditions of the area [5].

In present conditions, about 37% of the pastures of Turkey are in this region. There are fewer livestock in this area so pasture condition is better than in the rest of the country. The climate is also very well suited to pasture growth. The flora is very rich in most of the desired pasture plant species: *Agropyron* spp., *Festuca ovina, Koelaria cristata, Bromus* spp.*, Poa bulbosa, Medicago* spp.*, Onobrychis* spp.*, Trifolium* spp.*, Sanguisorba* spp., *Artemisia fragrans, Thymus squarrosus,* and *Teuchrium* spp. are the major plant species. Because of the harsh topographic and climatic conditions in most of the region, Eastern Anatolia is essentially an animal husbandry region [6].

Several fertilizer experiments were carried out on natural meadow and pastures, mainly in the central and eastern parts of Turkey [2,7,8]. However, it is not studied to evaluate whether the use of fertilizer on natural grasslands is worthwhile in utilising for animal production in terms of environmental concern. Therefore, this study was aimed to evaluate the use of fertilizer application on natural grasslands within the aspects of sustainable animal production systems.

MATERIAL and METHODS

Experimental Location and Climate

This research was conducted in a village community owned pastures in Kars Province in the Eastern part of Turkey. Experimental area is located between 40°-33' North and 43°-21' East with 2090 latitude. In the east of Turkey, climate in the area is very harsh and rainfall occurs in spring; winter temperatures are much lower then the rest of the country, particularly in the highlands of this region nearly the whole area is under snow from November to March or April. During the experimental period, the average monthly rainfall for May through August was 97.8, 94, 70 and 76.4 mm respectively. The average monthly temperature and the relative humidity for the same period were 10.4, 13, 18.6 and 18.4 °C; and 69.6, 72.5, 66.4 and 68% respectively [22].

Experimental Design and Sample Collection

The experiment lasted from mid-May to mid-August in 2005. Two grassland areas were chosen next to each other and an area of 6 ha was fenced with wires and fertilised with CAN fertilizer (Calcium Ammonium Nitrate) and TSP (Triple Super Phosphate in granular form) at the rate of 180, (90 kg/ha of N fertiliser was applied in late Autumn in 2004 and the rest in early Spring in 2005) and 190 kg/ha respectively, in late Autumn in 2004 [9]. The other area was set without fertiliser application. In order to monitor chemical composition of grass 3 sub-plots (16 m^2) were fenced with wires within both areas to collect the soil and grass samples from non-grazed areas every two weeks in order for monitoring vegetation cover. Herbage biomass was measured by hand clipping herbage at ground level within quadrats (1 m × 1 m) then biomass per m^2 was calculated on fresh and dry matter basis [9]. Sward height was measured as the height of the top surface of the leaf canopy using wooden sward stick calibrated at 1 cm intervals. Soil samples (250 g) were collected at a depth between 15 and 20 cm, using stainless steel soil sampling tube as described by Bahia [10] at the same time and site as grass samples were taken. Botanical composition was determined by transect method with 10 points grids. Vegetation was cut to ground level, sorted into grasses, legumes and others for botanical composition [9].

Chemical Analysis

Hand-clipped grass samples taken from each quadrats were weighed on fresh basis, sub-sampled and dried at 60°C for 48 hours and then ground to pass through 1 mm screen. Forage samples were analysed using the proximate analysis as outlined by AOAC [11] for DM, CF

and Ash while NDF concentrations were determined using the detergent system as described by Georing and Van Soest [12]. Nitrogen was determined by the Kjeldahl method CP equalled N×6.25. Both forage and soil samples were analysed for Ca, P, Mg, Na, Mn, Fe, Cu, K, Al, Zn, pH, and OM (organic matter) using atomic absorption spectrophotometry according to procedure described by AOAC [11].

Statistical Analysis

Data were subjected to normality test by Ryan Joiner and analysed by Student's *t* test using statistical package Minitab [13]. Statistical significance of probability level was taken as 5% [14].

RESULTS

There was no significant (P>0.05) variation in botanical composition between both pastures since they were at the same location. However, the Graminea was the most predominant plant type in NG (40% Graminea, 30% Leguminosea and 30% other families) while Leguminosea was the most predominant in FG pasture (35% Leguminosea, 30% Graminea and 35% other families). Herbage mass (HM) and sward height (SH) were significantly (P<0.05) different between both pastures. Herbage mass, mean sward height and nutrient composition change of pastures during vegetation period are shown in *Table 1*.

Herbage mass was measured on fresh and dry basis as per square meter and there was a significant differences in HM fresh, HM dried and in sward height between NG and FG pastures as it was expected since fertilizer application resulted in higher herbage mass productivity and sward heights. The results showed that fertiliser application gave almost 2 times higher herbage yield than that of naturally grown pastures. However, DM% of NG pastures was significantly (P<0.05) higher than those of FG pastures and DM content of both pasture increased until the third harvesting time as vegetation reached at its peak point then declined after following harvesting times.

There were also no significant differences (P>0.05) in CP, CF, NDF and ash content of both pastures. This was also expected due to the increase in herbage mass. Soil macro-mineral and pH concentrations together with EC (Electrical Conductivity) and organic matter change of NG and FG pastures during experimental period are shown in *Table 2*.

Table 1. *Herbage mass, sward height and nutrient composition change of pastures during grazing period*
Tablo 1. *Otlatma döneminde meralarda ot miktarı, ot yüksekliği ve besin madde kompozisyonu değişimi*

Harvest Dates	Pastures	HM Fresh (g)	HM Dried (g)	SH cm	DM %	CP %	CF %	NDF %	Ash %
16.06.05	NG	364	130	10.5	35.7	15.10	20.85	51.23	9.84
	FG	1322	330	24.8	25.2	11.53	18.9	50.85	9.78
02.07.05	NG	696	241	21	34.6	10.90	22.08	52.46	9.47
	FG	1956	523	28	26.7	13.32	24.1	53.1	9.62
16.07.05	NG	506	215	21	42.5	12.44	26.0	53.4	8.92
	FG	1107	412	44	37	12.53	26.3	58.53	9.34
02.08.05	NG	349	128	9	36.6	12.31	31.85	59.44	8.97
	FG	664	261	20	39.3	12.38	33.86	61.36	9.12
Means	NG	478.8^{a}	178.5^{a}	15.4^{a}	37.3^{a}	12.68	25.2	54.13	9.3
	FG	1262.3^{b}	381.5^{b}	29.2^{b}	32.1^{b}	12.44	25.8	55.96	9.4

CP, CF, NDF and Ash is expressed as % of DM, Only statistical significant differences are shown with superscript letters

Table 2. *Soil mineral content change of pastures during grazing period*[ǂ]
Tablo 2. *Otlatma döneminde meraların toprak mineral içeriği değişimi*

	OM	$CaCO_3$%	pH	EC	Mn	Fe	Cu	Na	K	Mg
NG	8.77	0.81	6.4	76	13.6	18.4^{a}	0.14	25.4^{a}	211.9^{a}	10.9
FG	9.53	0.74	6.9	63.5	13.0	12.3^{b}	0.17	36.3^{b}	630.8^{b}	12.8
	Al	**Zn**	**N%**	**P%**	**Clay%**	**Silt%**	**Sand%**	**Texture**		
NG	6.8	1.66^{a}	0.49^{a}	0.12	28.86^{a}	45.03^{a}	26.12	CL		
FG	5.9	2.37^{b}	0.31^{b}	0.18	38.27^{b}	34.61^{b}	27.12	CL		

ǂ *OM is organic matter %, EC_e is the electrical conductivity and the units of other minerals are expressed as ppm. CL is Clay Loam. Only statistical significant differences are shown with superscript letters*

There were no significant differences (P >0.05) in OM, $CaCO_3$, pH, Mn, Cu, Mg, Al and P concentrations of soil samples between NG and FG pastures while the contents of K, Na, Fe, Zn, % of nitrogen, clay and silt were statistically significant. It was observed that K and N concentrations of FG pasture were increased by fertilizer application which was significantly higher (P<0.05) than those of NG pasture. Although fertilizer application did not increased P contents of the soil significantly (P >0.05), there was a tendency for P content of the soil in FG pastures to be higher than that of soil in NG pastures *(Table 2)*.

DISCUSSION

The results related to the botanical composition in this study were in line with the study carried out by Kaya et al.[15] who also not found any significant variation in botanical composition of pastures in locations with elevations ranging from 1500 to 2000 m in Kars province. In respect to chemical composition of pastures, as expected in this study CP concentration declined while NDF and DM increased as the stage of maturity advanced during the vegetation period as reported by Kaya et al.[15]. Increases in dry matter yield, as found in this study, have been reported by many studies of nitrogen and phosphorus fertilization on rangelands [2,7-9,15,16].

The effect of fertilizers on the yield of natural pasture and meadows was examined in Central Anatolia by Alinoglu and Mulayim [17], who reported that encouraging results were obtained in meadow areas. Green forage yield increase was up to 8 t/ha with N100, P60 and K20. As it was also observed in this study, they also reported that in addition to yield increase, fertilizer had a positive effect on the quality of hay. While hay yield increased with fertilizer application on natural pasture, the response to fertilizers was not economically feasible. In another experiment carried out by Buyukburc [18], fertilizing natural pasture in the same region gave similar results to those found in this study. It was concluded by Buyukburc [18] that hay yield of the pasture was 3-4 times greater than the control plots with N100, P100 application together with a complete rest treatment in spring and Eastern Anatolian pastures responded more strongly to fertilizers. However, in this study fertiliser application increased herbage yield almost 2 times as much as naturally grown pastures *(Table 1)*. In another experiment, application of P50 in autumn together with N75 in spring resulted in over six-fold increase in productivity [6]. Gokkus and Altin [19] stated that harrowing the pasture before fertilizer application results in better uptake of nutrients by the plants. In other experiments, depending on the quality of the pastures, Altin [20] recommended N50-100 and P40-80, whereas Manga et al.[21] suggested N60, P30-60 for the recovery of Eastern Anatolian pastures. It is also recommended that fertilizer is only effective on pastures in reasonable condition under suitable management practices. Efficient fertilizer use depends on the quality of the pastures. In order to get an adequate response, the pasture should be in good condition and grazing pressure should be at the correct level.

The results of the previous studies and this study indicated clearly that fertilizer application is quite an effective way of improving the productivity of the pastures and meadows. However, it is still not widely accepted in the country yet. The government fertilizes pastures on a limited scale for extension but these results brought about some disputes and controversial issues whether the use of fertilizer should be re-commended or not, considering the long term adverse affects of artificial fertilizer on environment, and taking into account the potentiality of organic animal production of the region as well. Therefore, it was concluded that there was no use in applying fertiliser in the highlands of the eastern part of Turkey in order to sustain and preserve the quality of natural grasslands, animal production systems and environment as a whole.

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