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SEASONAL TRENDS IN CHEMICAL COMPOSITION OF DIFFERENT ARTIFICIAL PASTURES

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ABSTRACT

This research was conducted to determine the chemical composition of different artificial pastures from the years 2010 to 2012. For this purpose, two different artificial pastures were established, each covering 1.5 ha area during the first year of the research. The mixtures of the pastures used were as follows: Pasture 1 (P1): *Medicago sativa* L. (20%) + *Bromus inermis* L. (40%) + *Agropyron cristatum* L. (30%) + *Poterium sanguisorba* (10%);Pasture 2 (P2): *Medicago sativa* L. (15%) + *Onobrychis sativa* Lam. (15%) + *Agropyron cristatum* L. (35%) + *Bromus inermis* L. (35%). Forage samples were collected from grazing and non-grazing areas once every 15 days during the grazing seasons. The nitrogen (N), phosphorus (P), potassium (K), calcium (Ca), magnesium (Mg), crude ash and tetany ratio were determined on the forage samples.
The results showed thatcontents of N, P, K, Mg, crude ash and tetany ratios decreased with advancing growth while Ca contents increased in grazing and non-grazing areas of two pastures. The highest values in terms of N, K and Mg contents were obtained from P2 compared to P1, while the highest crude ash ratio was determined from P1.The P, K, Ca, Mg, crude ash and tetany ratios in non-grazed areas were higher than grazed areas, while N content of grazed areas was higher than non-grazed areas.

Keywords: forage quality, grazing season, nitrogen, phosphorus, tetany ratio.

INTRODUCTION

Therangelands have substantial importance for animal production, especially during crop growing season because there are no artificial pastures or feed resources for expensive animal husbandry during this period.

In order to establish artificial pasture to produce sufficient and good quality feed in completely damaged vegetation is a suitable choice (Vallentine, 1989; Altin et al., 2011). In most situations, dryland pastures best comprised a simple mixture containing two and three species having similar palatability, season of growth, grazing tolerance, drought tolerance and rare cases of regrowth (Holzworth et al., 2003). Alfalfa, sainfoin, or other legumes planted in mixtures with grasses, provide nitrogen to increase yield and nutritive values of the entire mixture. However, it is sometimes difficult to keep legumes in the mixture because of their high palatability (Holzworth and Weisher, 2010). Alfalfa, crested wheatgrass and smooth brome cultivar would be suited for use in binary grass-alfalfa mixtures for dryland hay production (Berdahl et al., 2001).

Forage quality can be defined as the relative performance of animals (Buxton et al., 1996). In general, higher levels of cell-soluble, crude protein and minerals are considered as criteria for higher nutritive quality. These components of forage decline substantially with the advanced plant growth and reach the lowest level when plants become quality (Koc and Gokkus, 1994) as in all steppe vegetation. The changing trend of nutritive component of forage shows great differences among range types because the timing and length of growing season differ among themdue to climate (Holechek et al., 2004). Most plants show a similarity in declining nutrient composition with advancing development towards maturation (Rama et al., 1973; Stubbendieck and Foster, 1978; Rebole et al., 2004).

A mineral deficiency or excess in diet may affect the health of animals adversely. Grass tetany, an important disease of livestock, is caused by mineral imbalance in feeds. The risk of grass tetany is increased at a K:Ca+Mg ratio of 2.2 or higher (Elkins et al., 1977; Crawford et al., 1998).

The objective of this research was to determine chemical composition of the different artificial pastures established under the Mediterranean climate conditions in the Mediterranean Region of Turkey.

MATERIAL AND METHODS

Experimental Location

This study was carried out in Isparta Province (37°45′N, 30°33′E, elevation 1035 m) located in the Mediterranean region of Turkey on three consecutive years of 2010 and 2012. The total precipitation and average temperature data for the experimental area are given in Figures 1and 2. The major soil characteristics of the research area, determined based on the method described by Rowell (1996), were as follows. The soil texture was clay loam, the organic matter was 1.3% as determined using the Walkley–Black method, the lime was 7.1% as determined using a Scheibler calcimeter, the total salt was 0.29%, the exchangeable K was 122 mg kg–1 by 1 N NH4OAc, the extractable P was 3.3 mg kg–1 by 0.4 N NaHCO3 extraction, and the pH of a soil-saturated extract was 7.7. The soil type was calcareous fluvisol (Akgül and Başayiğit, 2005).

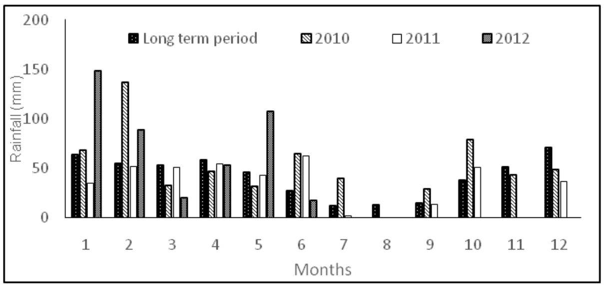

Figure 1. Rainfall values for individual experimental years and over the long term.

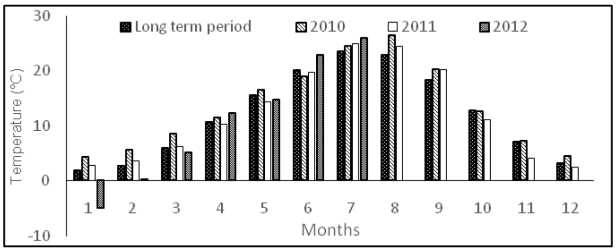

Figure 2. Temperature values for individual experimental years and over the long term.

Pasture Management

For the establishment of artificial grazing land, 3 ha pasture land was chosen adjacent to the university farm and cultivated in March 2010 with two different botanical compositions. Pasture 1 (P1) was composed of *Medicago sativa* L. (20%) + *Bromus inermis* L. (40%) + *Agropyron cristatum* L. (30%) + *Poterium sanguisorba* (10%); and Pasture 2 (P2) had mixtures of *Medicago sativa* L. (15%) + *Onobrychis sativa* Lam. (15%) + *Agropyron cristatum* L. (35%) + *Bromus inermis* L. (35%), respectively. In first year, cutting and maintenance applications were made carried out only. The pastures were harvested twice at the end of June and beginning of October in 2010.Animal grazing applications were performed in the second and the third year of the study since the first year covered only the establishment of the artificial pastures.

In order to monitor chemical composition changes in pastures, 4 non-grazed areas within each pasture were established and fenced with wires by 4×3m size and grass samples were collected by using 0.5m^2(0.5x1 m) quadrates fortnightly from May to August each year. The nitrogen (N), phosphorus (P), potassium (K), calcium (Ca), magnesium (Mg), crude ash and tetany ratio were determined on the forage samples.

After the harvest, the collected samples were dried first at 70 °C for 48 h, and then weighed. The dried samples were reassembled and ground to pass through a 1-mm screen.

Nitrogen content was calculated by Kjeldahl method (Kacar, 1972); K, Ca and Mg contents of samples was determined using an atomic spectrophotometer after digesting the samples with $HClO_4$:HNO_3 (1:4); P content was determined by vanadomolybdophosphoric yellow colour method (Kacar and Kovancı, 1982). Tetany ratios (K: (Ca + Mg)) were calculated on a milliequivalent basis (Cherney and Marten, 1982).

The data from 2010-2011 and 2011-2012 were analysed together using the Proc GLM (MINITAB 2010). Means were separated by Duncan at the 5 % level of significance.

RESULTS

The results showed that the effects of mixtures of pastures × grazing interactions on all investigated traits were statistically significant, except N content. Statistically significant interactions between mixtures of pastures × sampling times were found for N, K, Ca and crude ash contents. The grazing × sampling times interactions had significant effects on N, K, Ca, Mg and crude ash contents. These interactions indicated that harvesting stage affected N contents substantially according to the different pastures and grazing applications.

There were significant differences ($P <0.05$) in N, K, Mg, crude ash and tetany ratios between two pastures. The N, K and Mg ratios of P2 was higher than that of P1. However, the crude ash content of P1 was higher than that of P2 in the present study.The effects of the grazing and sampling times on all investigated traits were significant (Table 1).The P, K, Ca, Mg, crude ash and tetany ratios of the non-grazed areas were higher than that of the grazed areas in the present study.The highest N, P, K, Mg and tetany ratios in the grazed and non-grazed areas in both pastures were determined in May the 1st, while the lowest ratios were obtained from July the 30th (Figure 3).The N, P, K, Mg and tetany ratios were decreased linearly throughout the grazing season in both pastures, whereas Ca ratio was increased throughout the grazing season.The lowest Ca ratios were determined in May 1, while the highest values were determined in July the 30th.

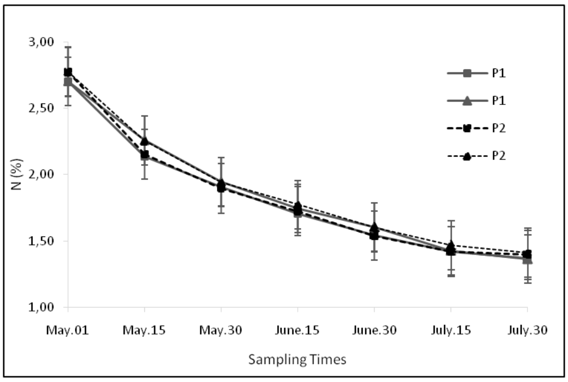

Figure 3. Seasonal variation of N contents of two different artificial pastures.

DISCUSSION

The N contents were decreased linearly throughout the grazing season in the grazed and non-grazed areas of P1 and P2 (Figure 3). Maturity stage at harvest is the most important factor determining forage quality. Besides N, and hence protein, most minerals, decline with advancing plant development. Other reports also support that the N contents decreases by advancing stage of maturity (Koç et al., 2000;Rebole et al., 2004), suggesting that animals should be supplemented with protein sources, especially towards the end of the grazing season. As a result of this process, forage quality lessens substantially towards the end of growing season.

The P, K and Mg contents weredecreased linearly during the grazing seasonin both pastures, while Ca contents increased in the present study (Figures 4, 5, 6, 7).

The changing trend of nutritive component of forage shows great differences among range types because the timing and length of growing season differ among them due to climate (Holechek et al. 2004). Most plants show a similarity in declining nutrient composition with advancing development towards maturation (Rama et al. 1973; Stubbendieck and Foster 1978; Rebole et al. 2004).

Table 1. Results of analysis of variance and mean squares of the traits determined.

Sources of variations	df	N	P	K	Ca	Mg	Ash	Tetany
Block (year)	6	0.0015	0.0002	0.00303*	0.00120	0.00011	0.0471**	0.0003
Year	1	0.7114**	0.0021	0.42905**	0.66138**	0.04398**	0.3061**	0.1429
Mix. of Pastures (MP)	1	0.0324**	0.0016	0.33907**	0.00644	0.05132**	0.3798**	1.1337**
Grazing (G)	1	0.8414**	0.0078**	0.49512**	0.16935**	0.17473**	1.6622**	1.2212**
Sampling Times (ST)	6	1.8114**	0.0598**	1.93148**	4.66778**	0.13861**	33.2809**	1.5493**
MP x G intr.	1	0.0417	0.0009**	0.06723**	0.17406**	0.00409**	1.8053**	0.0572**
MP x ST intr.	6	0.0227**	0.0001	0.00495**	0.01511**	0.00011	0.0486**	0.04049**
G x ST intr	6	0.0304**	0.0003	0.01429**	0.00636**	0.01615**	0.3354**	0.01429**
MP x Year	1	0.0817**	0.0003	0.17284**	0.00103	0.00043	0.0071	0.10084
G x Year	1	0.1334**	0.00002	0.00931**	0.02746**	0.00333**	0.0000	0.00701
ST x Year	6	0.0622**	0.00001	0.00186	0.00531**	0.00038*	0.0978**	0.0010
MP x G x ST intr.	6	0.0011	0.00003	0.00193	0.00559	0.00029	0.0583	0.0011
MP x G x Year intr.	1	0.0054	0.00000	0.00191	0.00060	0.00031	0.0006	0.0011
MP x ST x Year intr.	6	0.0122	0.00000	0.00059	0.00003	0.00001	0.0044	0.0009
G x ST x Year intr.	6	0.0163	0.00000	0.00027	0.00097	0.00009	0.0003	0.0008
MP x G x ST x Year int.	6	0.0012	0.00000	0.00006	0.00002	0.00001	0.0002	0.0004
Error	162	0.0071	0.00009	0.00109	0.00074	0.00016	0.0099	0.0011

df: degrees of freedom, ns: not significant, *P<0.05 and **P<0.01

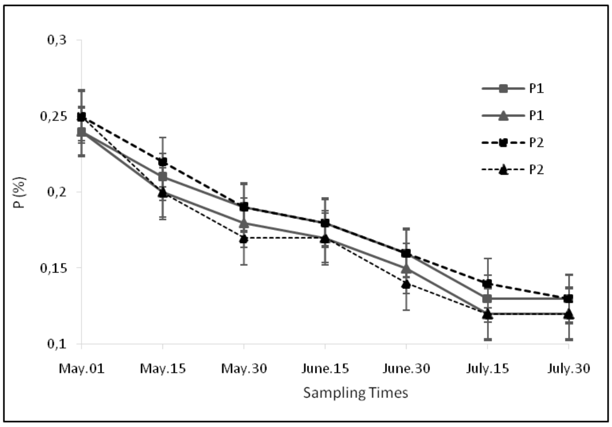

Figure 4. Seasonal variation of P contents of two different artificial pastures.

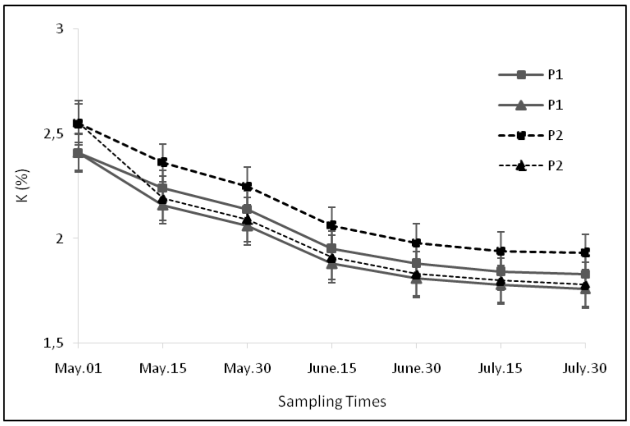

Figure 5. Seasonal variation of K contents of two different artificial pastures.

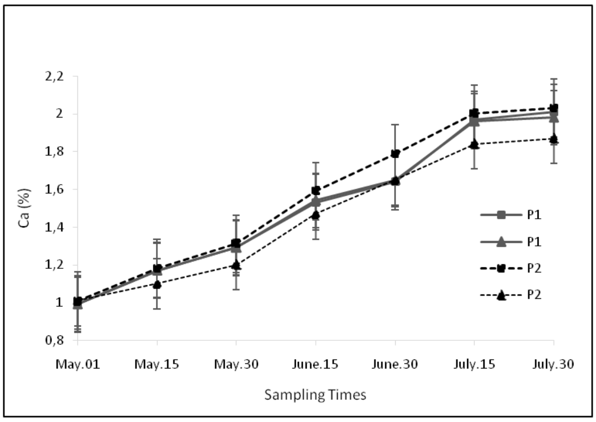

Figure 6. Seasonal variation of Ca contents of two different artificial pastures.

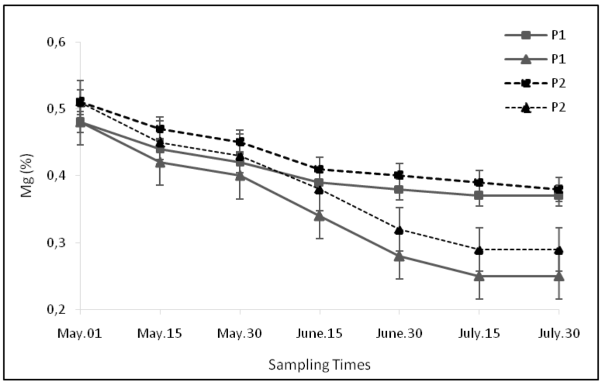

Figure 7. Seasonal variation of Mg contents of two different artificial pastures.

Maturity stage at harvest is the most important factor determining forage quality. Because P, Ca, Mg and K contents of forage decreased with delayed cutting, forage quality declines with advancing maturity (Blaser et al., 1986; Tan and Serin, 1996; Turk et al., 2007). Tan et al. (2003) reported that the contents of K, Mg, Ca and P decreased as plant growth advanced. These results are in agreement with our results, except for Ca content. There is a rapid uptake of minerals during early growth and a gradual dilution as the plant matures (Lanyasunya et al., 2007). The changes in element content with maturity are related to the increasing stem to leaf ratio. Leaves are richer in mineral nutrients than stems (Tan et al., 1997), and the proportion of leaves declines as plant growth advances because of senescence of the lower leaves or damage by diseases (Albrecht and Marvin, 1995). Changes in P content normally parallel those of protein in regard to seasonal changes. Phosphorus and Mg contents both decreased significantly with advancing season (Oelberg, 1956). In contrast, Ca content generally increases as the season advances (Savage and Heller, 1947). The increase with maturity was explained on the basis of the increased amount of cellular material which is composed principally of this element.

The American National Research Council (NRC, 1996) recommends that forage crops should contain 3.1 g kg^{-1} Ca, 6.5 g kg^{-1} K concentration for beef cattle. Tajeda et al. (1985) reported that forage crops should contain at least 0.3% of Ca, 0.2% of Mg, 0.8% of K for ruminants. The chemical properties found in this research indicate that the nutritional quality values of artificial pastures were higher than all the recommended standard values for ruminants.

The crude ash content increased until the May 15 and then decreased until end of the grazing season in both pastures. Results confirm those of Akgün et al., 1999, Ozyigit and Bilgen (2006).

The tetany ratio was decreased linearly throughout the grazing season in grazed and non-grazed areas of P1 and P2 (Figure 9).Grass tetany is associated with Mg deficiency in the blood of animals. The risk of grass tetany is increased at a K:Ca + Mg ratio of 2.2 or higher (Crawford et al., 1998). Grass tetany values, which changed from 1.69 to 0.77, in this research were less than the critical level. This could be explained by the decrease in content of K and increase of the contents of Ca with advancing plant maturity. Similar results were reported by Turk et.al.(2009, and 2011).

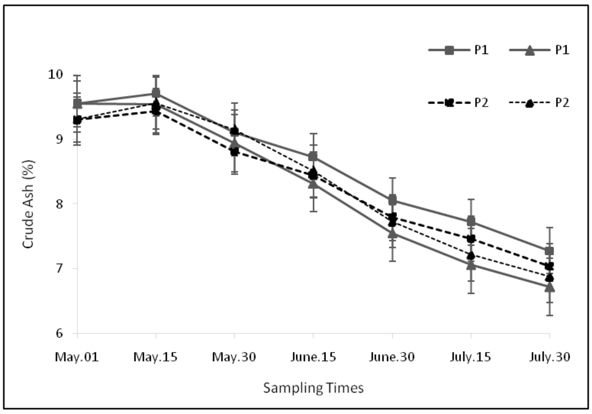

Figure 8. Seasonal variation of crude ash contents of two different artificial pastures.

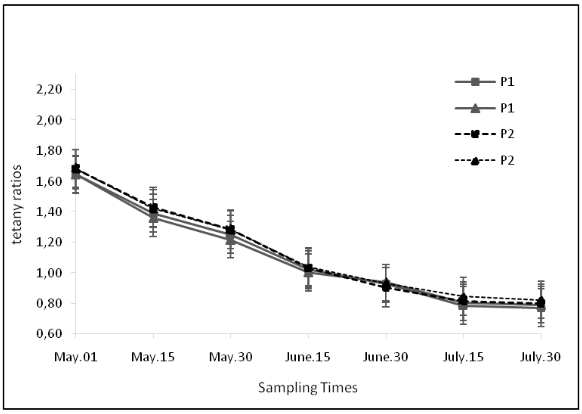

Figure 9. Seasonal variation of tetany ratios of two different artificial pastures.

The P, K, Ca, Mg, crude ash and tetany ratios of the non-grazed areas were higher than that of grazed areas in the present study. The N ratios of the grazed areas were also higher than that of non-grazed areas. This could be associated with the continued re-growth of the plants in grazed areas because young plant tissues are more nutritious than dead or mature plants (Lyons et al., 1996).

The N, K and Mg ratios of P2 were higher than that of P1. The reason for this was that legume rates of pastures were different. Legumes are rich in terms of N concentration (Altin et al., 2011). Pasture 1 have 20% legume ratio while Pasture 2 have 30% legume ratio in the present study. The crude ash content of P1 was also higher than that of P2 in this study.

CONCLUSION

It can be concluded thatthe harvesting at the late stages caused a reduction in forage quality. The N, P, K, Mg, crude ash and tetany ratios decreased throughout the grazing season, while Ca content increased in grazing and non-grazing areas in both pastures.The P, K, Ca, Mg, crude ash and tetany ratios in non-grazed areas were higher than the grazed areas, while N content of grazed areas was higher than non-grazed areas. The highest values in terms of N, K and Mg contents were obtained from P2 compared to P1, while the highest crude ash ratio was determined from P1.

At the end of a three-year research conducted in Mediterranean conditions of Turkey, pasture 2 (*Medicago sativa* L. (15%) + *Onobrychis sativa* Lam. (15%) + *Agropyron cristatum* L. (35%) + *Bromus inermis* L. (35%)) can be recommended for high quality for the region.

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