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EFFECTS OF NITROGEN FERTILIZATION ON MINERAL CONTENT OF SMOOTH BROMEGRASS (*Bromus inermis* Leyss.)

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Abstract

This study aimed to determine the effects of five nitrogen doses (0, 40, 80, 120 and 160 kg.ha^{-1}) on mineral content of smooth bromegrass (Bromus inermis Leyss.). Nitrogen, phosphorus, potassium, calcium, magnesium and tetany ratio were determined in this research. Nitrogen rates significantly affected all components determined in smooth bromegrass. Nitrogen applications increased N, P, K and tetany ratio but decreased Ca and Mg concentrations. The highest N, P, K concentrations and tetany ratio were obtained from 160 kg ha^{-1} N treatment, while the lowest values were obtained from control treatment.

Key words*: calcium, nitrogen, smooth bromegrass, tetany ratio.*

INTRODUCTION

Smooth bromegrass (*Bromus inermis* Leyss.) is a high-yielding grass but requires longer recovery periods than other grasses. It is best adapted to well drained soils and is an excellent choice for drought prone areas (Undersander et al., 1996). Because of its highly developed root system, smooth bromegrass is resistant to temperature extremes and drought. It grows best on deep, well-drained silt or clay loam but may also establish itself in sandier soils.

Grasses need nitrogen more than many plant groups need it. Organic matter and nitrogen deficiency could be removed by fertilization in agricultural areas including dry farming in Turkey (Serin et al., 1999; Koc et al., 2004). The nutrient contents of the forage have an important role in animal feeding. The factors influencing the nutritive value of forage are many, and the degree to which they are interrelated may vary considerably from one area to another. These factors may include, alone or in combination, plant type, climate, season, weather, soil type and fertility, soil moisture, leaf to stem ratio, and physiological and morphological characteristics, and may change depending on whether the plants are annuals, perennials, grasses or legumes (Turk et al., 2009).

The most important disease for livestock is grass tetany caused by mineral matter imbalance in feeds. N and K fertilizing used to enhance rangeland yield has increased the risk for tetany by increasing K/Ca+Mg ratio up to 2.2 (Elkins et al., 1977). Because, there is an antagonistic relationship between K and Mg. The yield decrease or mortality in livestock fed by feeds which are rich in K can be observed due to the fact that Mg is blocked. The concentrations of Ca, Mg and K are important for ruminants and must be higher than 3.1, 1 and 6.5 g kg^{-1} for beef cattle, respectively (NRC, 1984).

The objective of this research was to determine the effects of nitrogen doses on mineral content of smooth bromegrass.

MATERIALS AND METHODS

The research was conducted at Isparta (37°45′N, 30° 33′E, altitude 1035 m) located in the Mediterranean region of Turkey, between 2014 and 2016 years. The major soil characteristics, based on the method described by Rowell (1996) were as follows: the soil texture was clay-loam (clay: 31.2%, silt: 45.1%, sand:23.7%); organic matter was 1.1% by the Walkley-Black method; total salt was 0.3%; lime was 7%;sulphur was 12 mg kg^{-1}; extractable P by 0.5N $NaHCO_3$ extraction was 3.3 mg kg^{-1}; exchangeable K by 1N NH_4OAc was 119 mg kg^{-1}; pH was 7.1 in soil saturation extract. Soil type was a calcareous fulvisol. Total precipitation was 177 mm in 2015 (March–June) and 210 mm in 2016. The long-

term average is 208 mm. Average temperature was 13.9°C in 2015 and 12.7°C in 2016. The long- term average is 12.8°C.

The experiments were evaluated in a randomized complete block design with three replications. Sowing was done by hand on 15 March in 2014. Seeding rates were 25 kg ha^{-1}. Plot sizes were 2.1x 5 m = 10.5 m^2. Smooth bromegrass fertilized at the rates of 0, 40, 80, 120 and 160 kg N ha^{-1}. Calcium ammonium nitrate 26% was used as fertilizer. Herbage was not harvested during the growing season of 2014 due to the establishment year. All plots had been harvested only once every year (50% flowering stage of smooth bromegrass). Samples taken from each plot were dried at room temperature then dried in an oven at 65°C till they reached constant weight.

After cooling and weighing, the samples were ground for mineral contents analyses. Nitrogen content was calculated by the Kjeldahl method (Kacar and İnal, 2008); K, Ca and Mg contents of samples were 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 İnal 2008). Tetany ratios (K: (Ca + Mg)) were calculated on a milliequivalent basis (Cherney and Marten 1982).

The data were analyzed together using the Proc GLM (SAS 1998). Means were separated by LSD at the 5 % level of significance.

RESULTS AND DISCUSSIONS

The results of variance analysis showed that N, P, K, Ca, Mg and tetany ratios in smooth bromegrass were influenced significantly by nitrogen treatments (Table 1).

Table 1. Results of Analysis of Variance Traits Determined

	df	Nitrogen	Phosphorus	Potassium	Calcium	Magnesium	Tetany ratio
Years	1	*	ns	ns	ns	ns	ns
Block	2	*	ns	*	ns	ns	ns
Nitrogen	4	**	**	**	*	**	**
N x Year intr.	4	ns	ns	ns	ns	ns	Ns

df: degrees of freedom, *P<0.05 and **P<0.01.

Increasing N fertilization rates resulted in an increase in N concentration of smooth bromegrass (Table 2). 160 kg ha^{-1} nitrogen treatments had the highest N concentration (19.23 g kg^{-1}) followed by the 120 kg ha^{-1} nitrogen dose (17.78 g kg^{-1}). The lowest N concentration (14.32 g kg^{-1}) was obtained from control treatment. Nitrogen content of forage is one of the most important criteria for forage quality evaluation (Holechek et al., 1989; Vogel et al., 1993). These results are in agreement with those reported by Jacobsen et al. (1996) and McCaughey and Simons (1998).

Table 2. The N, P, K, Ca, Mg concentrations and tetany ratios of smooth bromegrass at different nitrogen doses

Nitrogen fertilization	N (g kg^{-1})	P (g kg^{-1})	K (g kg^{-1})	Ca (g kg^{-1})	Mg (g kg^{-1})	Tetany ratio
0	14.32 e	3.18 d	13.12 e	5.45 a	4.55 a	1.31 e
40	15.81 d	3.37 c	14.89 d	4.69 b	4.22 b	1.67 d
80	16.53 c	3.62 b	16.11 c	4.62 b	4.08 c	1.85 c
120	17.78 b	3.79 a	17.34 b	4.63 b	3.85 d	2.04 b
160	19.23 a	3.82 a	18.41 a	4.49 c	3.62 e	2.27 a

Application of N fertilization increased phosphorus concentration from 3.18 g kg^{-1} to 3.82 g kg^{-1} in present study. Similar results were reported by Albayrak and Türk (2011).

Nitrogen treatments significantly increased K concentration of smooth bromegrass (Table 2). K concentration in control plots was 13.12 g kg^{-1}, while it increased up 18.41 g kg^{-1} in 160 kg ha^{-1} N treatments. All treatments had higher K concentration than recommended daily requirement (6.5 g kg^{-1}) for beef cattle (NRC, 1984).

The highest Ca concentration (5.45 g kg^{-1}) was obtained from control treatments, while the

lowest Ca concentration (4.49 g kg^{-1}) was obtained from 160 kg ha^{-1} N treatments. All fertilizer treatments exceeded the Ca concentration of 3.1 g.kg^{-1} recommended for beef cattle (NRC, 1984). Similar results were reported by Albayrak and Türk (2011).

The highest Mg concentration (4.55 g kg^{-1}) was obtained from control treatments, while the lowest Mg concentration (3.62 g kg^{-1}) was obtained from 160 kg ha^{-1} N treatments. A linear decrease in Mg concentration was seen with N fertilization rates, as has been reported in other studies (Smith, 1975; Rominger et al., 1976; James et al., 1995; Ball et al., 2001). The determined Mg level in this study was higher than the recommended daily requirements of 1 g kg^{-1} for beef cattle (NRC, 1984).

Tetany values, changed from 1.31 to 2.27 with increasing N rates. Forage and animal scientists are aware of the importance of the concentrations of Ca, Mg, K and K/(Ca+Mg) ratio in diets for ruminants. A ratio between K and Ca+Mg of more than 2.2, expressed on an equivalent basis, has been considered to be an indicator of potential grass tetany (Kemp and t'Hart, 1957; Ward, 1966; Elkins et al., 1977; Mayland and Grunes, 1979). Kidambi et al. (1989) reported that both Ca and Mg had negative association with K in grasses. Tetany (K/Ca+Mg) is associated with Mg deficiency in the blood. There is an antagonistic relationship between K and Mg. In present study, means of K/(Ca+Mg) ratio exceeded the critical 2.2 level in 160 kg ha^{-1} N treatments. The ratios in other nitrogen treatments were less than the critical level. Mayland and Hankins (2001) reported that high N and K doses increases the risk of contracting grass tetany in early spring. Grass tetany causes yield decrease or mortality in livestock. The application of Mg fertilizer can decrease risk of grass tetany (Rayburn, 2005).

CONCLUSIONS

Smooth bromegrass has adequate mineral content for ruminant animal requirements for production in the Mediterranean region of Turkey. Nitrogen applications increased N, P, K and tetany ratio but decreased Ca and Mg concentrations. The highest N, P, K concentrations and tetany ratio were obtained from 160 kg ha^{-1} N treatment, while the lowest values were obtained from control treatment. The highest Ca and Mg concentrations were obtained from control treatment, while the lowest values were obtained from 160 kg ha^{-1} N treatment.

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