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Macro Element Content of Herbage under Different Nitrogen and Phosphorus Fertilization in Savucak Rangeland

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A B S T R A C T

The study was carried out in the rangeland of the Savucak village of Karakoçan district in Elazığ province in 2021 and 2022. The study aims to determine the macro element content of the herbage where five different nitrogen doses (0, 5, 10, 15, 20 kg da^{-1}) and phosphorus (0, 4, 8, 12, 16 kg da^{-1}) were applied. Macro element contents such as calcium (Ca), magnesium (Mg), potassium (K) and phosphorus (P) of dried and ground plants were determined. The research was carried out in randomized blocks with three replications following two-factor factorial experiment design. It was determined that the effect of increasing nitrogen doses on the macro element contents of the herbages was statistically significant, while the effect of the increasing phosphorus doses on the macro element contents of the herbages except phosphorus was statistically significant. It was observed that Ca, Mg, K, and P contents of herbage decreased with the increasing phosphorus, but they increased with the increase of nitrogen doses. It was determined that the Ca, Mg, K and P contents increased with the increase of the nitrogen dose, but the increase in the phosphorus ratio did not have any effect on the Ca, Mg, K and P contents of the pasture herbage. According to the results, it was concluded that 10 kg da^{-1} nitrogen and 4 kg da^{-1} phosphorus fertilization is appropriate in Elazig and rangeland with similar ecologies.

1. Introduction

In countries where animal husbandry is developed, mineral nutrients lost from the system due to herbage cut from meadow-pasture areas or grazing and this should be added to the system as input. Fertilization studies begun in the 19th century in order to increase the efficiency of meadows and pastures. Turkey's rangeland areas have been the main source of roughage for Anatolian livestock for centuries and it still maintains this feature. Rangelands of Turkey, for which no fertilization and improvement studies have been carried out for centuries, have been largely destroyed and lost their yield potential. Animals need food to survive. In our country, the roughage needs of livestock are met from meadows and pastures, forage crops grown in field agriculture and residues of agricultural products (Küçük et al. 2016).

One of the improvement methods applied to increase the productivity of rangelands is fertilization. Fertilization ensures that the mineral content of the plants in the meadow-pasture

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vegetation, which has sufficient quality forage plants in the vegetation, is balanced. Besides obtaining high-quality roughage for more animals from meadows and pastures, it is also possible to protect the soil with fertilization. However, in order to provide the expected benefits in fertilization in rangelands; It is necessary to determine the appropriate fertilizer type and dose, taking into account the botanical composition of the vegetation, the use of vegetation, the nutrient content of the pasture soil, the climatic conditions of the region where the pasture is located, and the economy of fertilization (Altın et al. 2005).

It is necessary to create better vegetation by improving the rangeland of Turkey and to feed the underground water resources by keeping the precipitation waters more (Altın et al. 2010). One of the most applied methods in rangeland improvement is fertilization. Considering the species composition of the vegetation and the precipitation, it is possible to increase the yield of the rangeland 2-3 times with an appropriate fertilization (Gökkuş and Altın 1986; Tükel et al. 1996; Altın et al. 2007). Nitrogen and phosphorus are the nutrients that are most deficient in the soil of our country and therefore affect the yield the most. The effectiveness of fertilizers varies according to the application time and amount of rain fertilizer (Çomaklı et al. 2005).

In addition to the botanical compositions of the pastures, the chemical content of the existing plants in the pasture or the herbage obtained from these plants should also be known. Quality roughage is of great importance in animal nutrition, and the quality of the feed varies according to the content of sufficient nutrients and mineral elements and their ratio in the feed. The feed value of pasture plants, in other words their nutrient and mineral element contents, varies according to the botanical composition of the grass (legumes, grasses and other families), soil and climate characteristics and utilization (grazing) factors. Quality herbage is consumed and digested more by animals, and even quality herbage is digested more in the digestive system of animals than low quality herbages (Ensminger et al. 1990).

In this study, it was aimed to determine the effect of five different nitrogen (0, 5, 10, 15 and 20 kg da^{-1}) and phosphorus doses (0, 4, 8, 12 and 16 kg da^{-1}) combined on the macro element content of the grasses of a natural pasture in the Savucak village of Karakoçan district in Elazig.

2. Material and Methods

The research was established in the rangeland of Savucak village, Karakoçan District of Elazığ Province, in the vegetation period of 2021-2022 and 2022-2023. In the study, the effects of five different nitrogen (0, 5, 10, 15 and 20 kg da^{-1}) and five different phosphorus doses (0, 4, 8, 12 and 16 kg da^{-1}) and the combinations of these doses on the macro element contents of the pasture herbages were investigated in both vegetation periods. Urea (46% N) was used as nitrogen fertilizer and TSP (44% triple super phosphate) fertilizer was used as phosphorus fertilizer. Nitrogen fertilization was done in spring and phosphorus fertilization was done in autumn in both years. The research was established in randomized blocks according to the two-factor factorial design with three replications. The research area consisted of 10 x 10 m = 100 m^2 and a total of 25 plots, one plot for each combination. For each application and combination, the plot size was 2 x 2 = 4 m^2.

The analysis of the soil sample taken from 0-30 cm depth of the land subject to the research was carried out in the laboratories of the Department of Soil Science and Plant Nutrition, Faculty of Agriculture, Bingöl University. According to the results of the analysis, it was determined that the research area has a clay-loam soil structure, there is no salinity problem and the soil pH is neutral. It was determined that the organic matter and nitrogen content were moderate, the lime and phosphorus content was low and the potassium content was sufficient. According to the data received from the Elazığ Meteorology Directorate; It was determined that the Karakoçan district of Elazığ province was warmer, less rainy and less humid in the years when the research was conducted.

At the end of May, which coincides with the beginning of the head of the dominant plant groups in the rangeland area in 2021 and 2022, three randomly determined areas in each plot were harvested in three replications with the help of a 33 x 33 cm quadrat frame (Çaçan and Başbağ 2019). After the cut herbage samples were dried in an oven at 78°C for 24 hours, they were ground and made ready for analysis (Cinar et al. 2020). In the study, ICP-MS device (Inductively Coupled Plasma-Mass Spectroscopy) was used to determine the calcium (Ca), magnesium (Mg), potassium (K) and phosphorus (P) contents of pasture herbages (Başaran et al. 2021).

Analysis of variance was applied to the combined data of the two years obtained from the study, using the JMP statistical package program in accordance with the two-factor factorial experiment design in randomized blocks with three replications. The differences of the groups were compared according to LSD test and P≤0.05 significance level (JMP, 2018).

3. Results and Discussion

The effect of nitrogen fertilization on all the macro element contents, phosphorus doses on the Ca, Mg and K contents, and the nitrogen × phosphorus interaction on the Ca, K and P contents of the herbage are statistically significant.

The effect of different nitrogen doses on the Ca, Mg, K and P contents of the pasture herbage is significant and the lowest values were obtained from the control group and the plots that fertilized by 5 kg da^{-1} nitrogen. The highest Ca, Mg, K and P contents were obtained from the plots fertilized 10, 15 and 20 kg da^{-1} nitrogen. It is seen that the highest P rates in terms of Ca, Mg, K and P were obtained from the control group and the plots fertilized 4 kg da^{-1} phosphorus. However, P, unlike N, gave its lowest values in all the remaining applications. It has been determined that the interaction of different nitrogen and phosphorus doses is important for all four macro element contents of pasture herbages. It is seen that the macro element contents decrease systematically with the increase of the nitrogen and phosphorus doses in the combination (Table 1).

Table 1. Macro element contents of pasture herbages of different nitrogen and phosphorus applications (%)

Calcium (Ca)						
Nitrogen/ Phosphorus	**P0**	**P4**	**P8**	**P12**	**P16**	**Average**
N0	1.30 ab	0.97 c	1.00 ab	1.00 ab	1.07 ab	**1.06 B**
N5	1.05 ab	1.29 ab	1.01 ab	1.04 ab	0.97 c	**1.07 B**
N10	1.30 ab	1.39 a	1.06 ab	1.03 ab	1.00 ab	**1.16 AB**
N15	1.12 ab	1.25 ab	1.36 ab	1.20 ab	1.08 ab	**1.20 A**
N20	1.21 ab	1.25 ab	1.16 ab	1.14 ab	1.19 ab	**1.19 AB**
Average	**1.20 AB**	**1.23 A**	**1.12 B**	**1.08 BC**	**1.06 C**	
Magnesium (Mg)						
Nitrogen/ Phosphorus	**P0**	**P4**	**P8**	**P12**	**P16**	**Average**
N0	0.28	0.28	0.27	0.25	0.24	**0.26 C**
N5	0.30	0.26	0.31	0.26	0.26	**0.28 B**
N10	0.29	0.35	0.30	0.27	0.26	**0.29 AB**
N15	0.35	0.34	0.32	0.32	0.30	**0.33 A**
N20	0.30	0.34	0.35	0.33	0.32	**0.33 A**
Average	**0.30 A-C**	**0.32 A**	**0.31 B**	**0.29 BC**	**0.28 C**	
Potassium (K)						
Nitrogen/ Phosphorus	**P0**	**P4**	**P8**	**P12**	**P16**	**Average**
N0	2.62 a-e	2.18 e	2.28 de	2.66 a-e	2.49 c-e	**2.44 C**
N5	3.01 a-c	2.76 a-e	2.76 a-e	2.75 a-e	2.49 c-e	**2.76 B**
N10	3.19 a	3.16 a	2.87 a-d	2.66 a-e	2.65 a-e	**2.91 AB**
N15	2.98 a-c	2.53 b-e	3.11 ab	2.67 a-e	2.75 a-e	**2.81 AB**
N20	3.03 a-c	3.09 ab	3.10 ab	2.96 a-c	2.84 a-d	**3.00 A**
Average	**2.97 A**	**2.83 AB**	**2.74 B**	**2.74 B**	**2.64 B**	
Phosphorus (P)						
Nitrogen/ Phosphorus	**P0**	**P4**	**P8**	**P12**	**P16**	**Average**
N0	0.36 ab	0.36 ab	0.30 b	0.30 b	0.36 ab	**0.34 B**
N5	0.38 a	0.34 ab	0.36 ab	0.34 ab	0.34 ab	**0.35 B**
N10	0.41 a	0.38 ab	0.35 ab	0.39 a	0.37 ab	**0.38 A**
N15	0.38 a	0.39 a	0.41 a	0.39 a	0.37 ab	**0.39 A**
N20	0.36 ab	0.41 a	0.38 ab	0.38 a	0.37 ab	**0.38 A**
Average	**0.38**	**0.38**	**0.36**	**0.36**	**0.36**	

Means shown with the same letter are statistically indistinguishable from each other within the error limits of P≤ 0.05 according to Duncan test.

In studies conducted to determine the chemical content of grasses obtained from pastures, it is reported that the chemical compositions of the pasture feed generally vary according to the type of plant they contain, the botanical composition of the vegetation, climate and soil characteristics, and the time of sampling (Kaya et al. 2003; Bayraktar 2012; Çetiner et al. 2012; Gökkuş et al. 2013; Polat and Bayraklı 2019).

The results obtained regarding the calcium contents of pasture herbages are among the limit values reported by Kacar (1984) as 0.10-10.0% for plants. While Bayraktar (2012) determined the calcium content of herbages in the grasslands at different elevations to be 0.36-0.65% and 0.27-0.74% in the herbages in the forest pastures, Aydın and Başbağ (2017) determined the calcium content of the herbages at different elevations as 1.09%.

In previous studies, it has been reported that the magnesium content of plants varies between 0.02% and 2.50%, and this value is between 0.059% and 0.316 in meadow plants (Kacar 1984). Considering that the magnesium ratio that some quality forage crops should contain should be in the range of 0.04-0.08% (Okuyan et al. 1986), it can be said that the results obtained in terms of magnesium content in the pasture herbages examined as a result of the research are more than sufficient.

It is known that the potassium content of plants varies between 0.2% and 11% in dry matter (Kacar 1984). It is seen that the pasture herbage in which the research was conducted is within the general limits specified in terms of potassium content. In the study carried out to determine the herbages quality of the pastures located at different elevations of Diyarbakır/Karacadağ, the potassium ratio of the pasture herbage was determined as 2.42% (Aydın and Başbağ 2017).

It is seen that the average 0.34-0.39% phosphorus ratios obtained for the P content of pasture herbages are within the limit values determined as 0.16-0.38% for sheep (NRC 2007) and 0.17-0.59% for cattle (NRC 2000). In the study carried out by Aydın and Başbağ (2017) to determine the herbage quality of the pastures at different elevations, the phosphorus rate of the pasture grass was determined as 0.34%.

In the study conducted to determine the macro element contents of some plants in the pastures, it was reported that the Ca, Mg and K contents of the pasture plants were determined as 1.00%, 2391 ppm and 3.85%, respectively (Bakoğlu et al. 1999). In the study conducted to determine the nutritional value of herbage in a pasture where fertilizer was applied, the Mg and K contents were determined as 2.46 g kg^{-1} and 21.44 g kg^{-1}, respectively, in 2007, and 2.57 g kg^{-1} and 24.10 g kg^{-1}, respectively, in 2008 (Ayan et al. 2010). On the other hand, in the study conducted to determine the nutritional values of the herbages of the highland pastures with traditional grazing, it was reported that the K and Mg contents of the pasture herbages were determined as 2.4% and 2687 ppm, respectively (Çomaklı et al. 2008).

In the study, it is seen that the opposite is the case with the increase in nitrogen doses, where the Ca, Mg, K and P contents of pasture herbage decrease with the increase in phosphorus doses. In some previous studies, it was reported that the Ca and Mg contents of pasture herbage decreased with the increase of nitrogen doses, but the K content did not change (Algan and Aydın 2015; Algan et al. 2016). On the other hand, it was reported that N and P fertilization increased the K content in some studies (Algan and Aydın 2017; Kacorzyk and Głąb 2017). Turk et al. (2007) reported that with increasing nitrogen doses, the K content of the herbages increased and the Mg content decreased. Aydın and Uzun (2008) reported that N, K and Mg fertilization and their combinations in pastures increased Ca and Mg contents and decreased K content of pasture herbage. Çaçan and Kökten (2023), reported that the Ca, Mg, K, and P contents of pasture herbage decreased systematically with the increase of nitrogen and phosphorus doses.

4. Conclusion

According to the research results, it was determined that the effect of fertilization with different nitrogen and phosphorus doses on the macro element contents of pasture herbage was statistically significant. In the study, it was determined that the macro element contents of the herbages, except P, decreased with the increase of the phosphorus doses, and the macro element contents increased with the increase of the nitrogen doses. Therefore, considering the ecological conditions of the region where the research was conducted, it is seen that 10 kg da^{-1} nitrogen and 4 kg da^{-1} phosphorus fertilization is appropriate in terms of meeting the roughage needs of animals and making fertilization economical.

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