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PHOSPHORUS, SULPHUR AND MICRONUTRIENTS ON GRASSLAND IMPROVEMENT WITH WHITE CLOVER (*Trifolium repens* L.) ON BASALTIC SOILS IN URUGUAY

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Abstract

Grasslands improvement with legumes is a promising technology for increasing forage quality and productivity on basaltic soils, but requires the correction of nutrient deficiencies. Phosphorus is a key element, but usual techniques of soil analysis are not good predictors. An experimental work was conducted in the northern region of the country. Evaluating the response of an improvement with white clover to P. Citric Acid showed a good association between soil P status and legume behavior. In addition there was a positive trend in forage production, in relation to S application, even though this effect was only significant in legume yield during the second year. Neither Mo nor B resulted in significant effects on forage yield. Results should be considered as preliminary, due to climatic problems that limited the experimental work.

Keywords: White clover, phosphorus, sulphur, micronutrients, grassland improvement

Introduction

Basaltic soils represent 21% of the country. Dominant soil is shallow associated with deeper ones. Cattle and sheep production on basaltic soils is mainly based on native vegetation. Its forage yield and quality is medium to low, showing a seasonal distribution with clear summer and winter deficits. Soils are variable but all are nitrogen (N) and phosphorus (P) deficient, presenting acidic pH and medium to high organic matter levels.

Experimental results have demonstrated the importance of increasing P levels in order to have good legume establishment and increased productivity. However, available soil P tests to support recommendation of P fertilizers are not consistent. In addition, there is no enough conclusive experimental information on the effect of other nutrients as sulphur (S), molybdenum (Mo) and boron (B) on legume behavior on these soils.

The objectives of this work were: 1) To study the magnitude of possible S, Mo and B deficiencies for white clover on basaltic soils. 2) To select a soil test to assess P availability for these soils with reasonable accuracy.

Material and Methods

In 1998 one experimental site at INIA Glencoe Experimental Station was selected. Site was under natural grassland on a moderately deep basaltic soil. Prior to the experiment, the vegetation was cut and paraquat (2 l/ha) was applied to improve white clover establishment. Sowing was accomplished by the end of May. White clover (cv e. zapicán) was inoculated with specific rhizobium and overseeded at a rate of 3 kg/ha.

Experimental design was an incomplete factorial with 4 replications, treatments applied at seeding and in the second year were:

1) Check
2) 40 kg/ha of P_2O_5

3) 80 kg/ha of P_2O_5

4) 160 kg/ha of P_2O_5

5) 80 kg/ha of P_2O_5 + Gypsum (25 kg/ha of S)

6) 80 kg/ha of P_2O_5 + Gypsum (50 kg/ha of S)

7) 80 kg/ha of P_2O_5 + Elemental S (25 kg/ha)

8) 80 kg/ha of P_2O_5 + Elemental S (50 kg/ha)

9) 80 kg/ha of P_2O_5 + Mo (250 g/ha of MoNH4)

10) 80 kg/ha of P_2O_5 + Mo (250 g/ha of MoNH4) + Gypsum (25 kg/ha of S)

11) 80 kg/ha of P_2O_5 + B (1 kg/ha of B as borax)

12) 80 kg/ha of P_2O_5 + B (1 kg/ha of B) + Mo (250 g/ha of MoNH4) + Gypsum (25 kg/ha of S)

P fertilizer used was triple superphosphate (TSP). Plot size was 4 x 2 m. Forage production was evaluated by cutting twice the first year and three times in the second one. The botanical composition was determined by visual estimation. Previous to the second fertilizer application a soil sampling at 0-7.5 cm of depth was performed. Bray (HCl 0.025 N+ FNH4 0.03 N), Citric Acid (5g/ L) and resins cationic (Dowex 50W - I 8880) were the soil P analysis used. In all cases the colorimetric tests were performed with the method of Ascorbic Acid and at 882 nm wave length.

Statistical treatment of data consisted of variance analysis and contrasts to determine the effect of S, Mo and B on total production (white clover + native grasses) and on pure white clover yield, for the first and second years (SAS Institute, 1988).

Results and Discussion

Forage yields were low in both years (Table 1). During the second spring occurred adverse climate for pasture growth (low temperature and water stress) resulting in poor annual yields. Observed coefficients of variation (CV) were medium to high, in agreement with previous information with respect to oversown improved grasslands. With high CV, strong treatment effects are needed to detect statistical differences. However, a strong and significant effect of P fertilizer was detected at the establishment (data not shown) as well as in forage yield (Table 1).

Most soil tests used in Uruguay (Bray, Resins) show low sensibility for detecting P fertilizer effect (Figure1). Citric Acid shows promise as an extractant of available soil P in agreement with white clover performance. Citric Acid acts by forming chelates with elements like iron, aluminum and calcium. It is a component of root exudates, having an important role in increasing P absorption under P stress conditions (Jones, 1998; Neuman & Römheld, 1999).

In general, white clover showed positive response to S fertilizer. However, a statistically significant response was detected only for the legume yield during the second year (Table 1). No significant differences were observed between S sources. Still, a higher S-SO_4 residual was registered in treatments that used elemental S (data not shown). Probably, with higher yields and lower CV, statistical significance might have been detected for all S effects. It is necessary to mention that Couto (1973, unpublished) also detected some variable S effects in different experimental works with Basaltic soils. Neither Mo nor B resulted in significant effects in forage yields, for any of the evaluations performed. Considering the limitations previously mentioned these results should be taken as preliminary. Consequently, two aspects must be studied in following works: S effects and calibration of the P soil availability test.

References

Couto, W. (1973). Deficiencias de potasio, azufre y molibdeno en suelos superficiales de basalto. Informe Centro de Investigaciones Agrícolas "Alberto Boerger" (CIAAB). Uruguay. Not published report. 33p.

Jones, D.L. (1998). Organic acids in the rizosphera-a critical review. Plant & Soil, **205**: 25-44.

Neumann, G. and Römheld V. (1999). Root excretion acids and protons in phosphorus-deficient plants. Plant & Soil, **211**: 121-130.

SAS Institute (1988). SAS / STAT User's Guide 6.03. Cary, NC: SAS Institute.

Table 1 - Average yields (kg dry matter /ha) and statistical analysis

Treatment	1-(WC+G)*	1-(WC)	2-(WC+G)	2-(WC)
1) Check	657	55	956	32
2) P1	1375	526	1596	353
3) P2	1300	644	1803	782
4) P3	1849	1176	2669	1813
5) P2+gypsum	1480	839	2184	1445
6) P2+gypsum	1690	1052	2266	1447
7) P2+S1	1311	521	2162	1189
8) P2+S2	1861	983	2237	1999
9) P2+Mo	1556	791	1847	713
10) P2+Y1+Mo	1722	1095	2656	1909
11) P2+B	1058	445	1885	791
12) P2+Y1+Mo+B	1765	1226	2233	1514
Statistical Analysis				
Average	1469	779	2041	1165
CV	26.3	58.2	26.8	58.2
F	3.42	2.4	2.95	3.47
Probability	0.003	0.026	0.008	0.003
LSD 10%	461	542	654	811
F(contrast S)	1.75	0.65	1.79	3.79
Probability	0.2	0.43	0.19	0.06
F (contrast Mo)	1.67	0.79	0.89	0.34
Probability	0.21	0.38	0.35	0.57
F(contrast B)	0.27	0.02	0.39	0.32
Probability	0.61	0.88	0.54	0.57

* 1-(WC+G) = year 1, white clover + native grasses

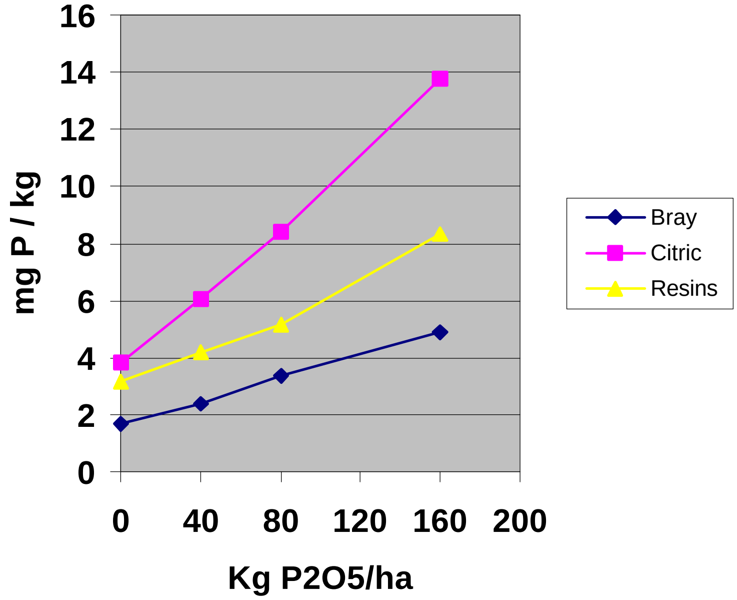

Figure 1 – Relationship between P fertilizer and available soil P in the second year to a depth of 0-7.5 cm.