Alfalfa Response to Phosphorus Sources Associated with the Application of Liming and Gypsum-Shoot Numbers

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ALFALFA RESPONSE TO PHOSPHORUS SOURCES ASSOCIATED WITH THE APPLICATION OF LIMING AND GYPSUM – SHOOT NUMBERS[1]

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Abstract

Alfalfa (*Medicago sativa* L.) was grown in a Typic Mapluolox soil with triple superphosphate (TS), Gafsa phosphate (GP) and GP with gypsum (GP + G). Three rates of phosphorus application were used 50, 100 and 200 mg P dm^{-3}, before and after liming. Alfalfa was harvested three times. Basal and axillary shoot numbers in alfalfa increased with increasing phosphorus rates. Shoots were produced in higher number with GP in comparison with TS. GP + G resulted in higher basal shoot number than GP. However, there was no gypsum effect on axillary shoot numbers. Liming before or after TS, GP and GP + G application had similar responses on shoot numbers.

Keywords: Gafsa phosphate, *Medicago Sativa* L., shoot, triple superphosphate

Introduction

Shoot number in alfalfa is highly dependent on soil phosphorus availability (Sanderson and Jones, 1993). Shoot number in alfalfa is an important component to forage production (Fick et al., 1988) and it is used as an indicator of the vigor and pasture persistence (Da Silva and Pedreira, 1997). Several phosphorus sources are available in the market and Gafsa phosphate (GP) is considered as efficient to plant production as soluble phosphates. This could indicate a more economical phosphorus source for alfalfa production. GP needs soil acidity to become more soluble, therefore this phosphorus source needs to be applied before liming followed by an incubation period. The use of GP associated to gypsum may be an alternative to correct soil aluminum in depth and to reduce soil phosphorus fixation. The study aimed to evaluate the effects of triple superphosphate (TS), GP and GP associated or not with gypsum, applied before or after liming, on alfalfa basal and axillary shoot numbers.

Material and Methods

The study was conducted in a glasshouse located at Centro de Biotecnologia Agrícola at ESALQ/USP. Plants were grown in pots containing six kg of a Typic Mapluolox soil collected in Nova Odessa, State of São Paulo. The experimental design was a complete randomized block with three replications. Treatments were: a) TS before and after liming (TSBL; TSAL); b) GP before and after liming (GPBL; GPAL); c) GP before and after liming combined with gypsum (GPBLG; GPALG). Phosphorus was used at rates of 50; 100 and 200 mg P dm^{-3}. Alfalfa (cv. XAI 32) was harvested three times: 90 days of growth after seeding (07/10/98) and 30 days of regrowth (08/09 and 09/08/98). Seeds were inoculated with *Rhizobium meliloti* SEMIA 116. Potassium and micronutrients were applied and lime used to increase soil base saturation to 85%. When gypsum (1/3 of Ca applied as lime) was associated with GP the rate of lime was 2/3 of that applied in the treatment without gypsum. Elementary

sulfur was applied in treatments without gypsum to maintain sulfur supply. Basal and axillary shoots were evaluated through the use of colored wires fitted every other day, during the three periods of growth. Responses evaluated were basal and axillary shoot numbers in alfalfa. The statistical procedures used were the SANEST/USP (Sarriés, 1993).

Results and Discussion

Basal and axillary shoot numbers increased ($P<0.05$) with phosphorus rates from 50 to 200 mg dm^{-3} (Table 1) as observed by Sanderson and Jones (1993).

Axillary shoot numbers were produced in higher ($P<0.05$) number with GP in comparation to TS at therate of 100 mg P dm^{-3} in the second and third harvests, and at 50 mg P dm^{-3} in the third harvest (Tables 1 and 2). Basal shoots were produced in higher number with GP ($P<0.05$) than TS, with 50 and 100 mg P dm^{-3} (Tables 1 and 2). These results may be due to phosphorus fixation from the soluble source and to the increase of the rock phosphate solubility, as seeding was made five months after the phosphorus sources were mixed to the soil.

There was no gypsum effect ($P>0.05$) on axillary shoot number (Tables 1 and 2) when mixed with GP. However a higher ($P<0.05$) basal shoot number was obtained with GP + G than with GP, at the levels of 50 and 200 mg P dm^{-3} (Tables 1 and 2). This may be due to the increase in soil pH in 0.18 units with applied gypsum, in comparison to GP without gypsum. Soil phosphorus concentrations with GP + G and GP were similar (15.33 mg P dm^{-3}), before seeding. Rando (1992) observed a increase in shoot numbers from 11.3 to 20.8, when soil pH (H_2O) increased from 5.8 to 6.8.

Lime application time had no effect ($P<0.05$) on basal and axillary shoot numbers when TS was used before or after liming (Tables 1 and 2) except for basal shoot numbers at the level of 100 mg P dm^{-3} (Tables 1 and 2).

There was no difference (P>0.05) in alfalfa basal and axillary shoot numbers when GP, with or without gypsum, was applied before or after liming, at the levels of 50, 100 and 200 mg P dm^{-3} (Tables 1 and 2) except for the use of gypsum at the level of 50 mg P dm^{-3} (Tables 1 and 2).

It was concluded that phosphorus increases alfalfa basal and axillary shoot numbers. Basal and axillary shoot numbers were higher with GP than with TS when seeding was made five months after the phosphates were mixed to the soil. Gypsum combined with GP increased basal shoot numbers due to soil pH increase. There was no effect on axillary shoot numbers from gypsum application. Liming before or after TS, GP or GP + G application had no effect on alfalfa basal and axillary shoot numbers.

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Table 1 – Effect of phosphorus sources and rates on shoot numbers per plant.

P (mg dm^{-3})	TSBL	TSAL	GPBL	GPAL	GPBLG	GPALG
Basal shoot numbers/plant						
50	0.87	0.87	0.97	1.47	1.63	3.23
100	2.43	4.03	5.33	6.73	5.97	6.77
200	8.20	7.90	6.53	6.73	10.33	8.27
Axillary shoot numbers/plant			Cut 1			
50	0.00	0.00	0.00	0.00	0.00	0.00
100	0.00	0.07	0.20	0.40	0.40	1.27
200	1.67	2.00	1.80	2.68	2.47	2.53
			Cut 2			
50	0.00	0.00	0.00	0.53	0.13	0.73
100	0.20	0.73	2.47	1.93	3.13	4.27
200	5.13	5.53	5.60	7.65	6.93	7.27
			Cut 3			
50	0.13	0.00	0.60	2.00	0.53	4.07
100	1.73	3.40	8.13	7.33	8.20	8.60
200	9.07	11.40	12.40	11.85	11.80	15.67

(TSBL, TSAL: Triple superphosphate before and after liming; GPBL, GPAL: Gafsa phosphate before and after liming; GPBLG, GPALG: Gafsa phosphate before and after liming combined with gypsum).

Table 2 – Orthogonal contrasts and contrast value for comparison of shoot numbers in alfalfa.

Nº	Contrasts	P (mg dm^{-3})		
Basal shoot numbers/plant		50	100	200
1	2TSBL + 2 TSAL – GPBL – GPAL – GPBLG – GPALG	-1.50*	-2.93*	0.13
2	TSBL – TSAL	0.03	-0.43*	0.05
3	GPBL + GPAL – GPBLG – GPALG	-0.94*	-0.15	-0.96*
4	GPBL – GPAL	-0.27	-0.29	-0.03
5	GPBLG – GPALG	-0.52*	-0.16	0.32
Axillary shoot numbers/plant	Cut 1			
6	2TSBL + 2 TSAL – GPBL – GPAL – GPBLG – GPALG	0.00	-2.10	-1.39
7	TSBL – TSAL	0.00	-0.15	-0.28
8	GPBL + GPAL – GPBLG – GPALG	0.00	-0.41	-0.14
9	GPBL – GPAL	0.00	-0.27	-0.31
10	GPBLG – GPALG	0.00	-0.44	-0.01
	Cut 2			
11	2TSBL + 2TSAL – GPBL – GPAL – GPBLG – GPALG	-1.60	-4.79*	-1.49
12	TSBL – TSAL	0.00	-0.44	-0.09
13	GPBL + GPAL – GPBLG – GPALG	-0.19	-0.90	-0.18
14	GPBL – GPAL	-0.71	0.15	-0.42
15	GPBLG – GPALG	-0.47	-0.29	-0.09
	Cut 3			
16	2TSBL + 2TSAL – GPBL – GPAL – GPBLG – GPALG	-4.22*	-5.11*	-1.71
17	TSBL – TSAL	0.21	-0.58	-0.40
18	GPBL + GPAL – GPBLG – GPALG	-0.78	-0.28	-0.45
19	GPBL – GPAL	-0.72	0.16	0.08
20	GPBLG – GPALG	-1.25*	-0.08	-0.54

(TSBL, TSAL: Triple superphosphate before and after liming; GPBL, GPAL: Gafsa phosphate before and after liming; GPBLG, GPALG: Gafsa phosphate before and after liming with gypsum).

*significant ($P<0.05$).