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The XXI International Grassland Congress / VIII International Rangeland Congress took place in Hohhot, China from June 29 through July 5, 2008.

Proceedings edited by Organizing Committee of 2008 IGC/IRC Conference

Published by Guangdong People's Publishing House

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Growth response of alfalfa cultivars and change in soil nutrient availability by lime application in acid soils

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Key words acidic tolerance, *Medicago sativa*, nutrients availability, purplish soil

Introduction Alfalfa (*Medicago sativa*) is suited edaphically to the northern China with soil pH levels from 6.5 to 7.5. Its potential distribution may be limited in the southern China, partly because of the preponderance of acid soils (Meng et al., 2004). Selecting tolerant alfalfa cultivars and lime application are the two main strategies in planting alfalfa in acid soils (Brauer et al., 2002). The objective of this study was to assess the variation in acidity tolerance of alfalfa cultivars and their relationships with soil available P, exchangeable Al and pH level.

Materials and methods The soil used in the pot experiment was acid purplish soil (pH 5.45) and was sterilized at 120°C for 20 minutes. The soil pH level was adjusted to 6.54 by lime application. The five cultivars tested were Gannong 1 (Gan No. 1), Gannong 3 (Gan No. 3), Sanditi, Eureka and Defi. *Sinorhizobium meliloti* inoculum used in the study was *S. meliloti* strains 1.163. Two kilograms of limed and unlimed soils was placed in each pot. After four months growth, three of the six replications were used to determine root weight and nodule development. Soils of the other three replications were collected individually and subjected to analyze exchangeable Al, pH level and available P.

Results and discussion Lime application increased soil pH level and decreased exchangeable Al concentration, which resulted in a significant increase of nodule number on alfalfa root (Table 1). However, lime limited nodule development; nodule weight per plant was significantly reduced. Alfalfa cultivars differ in their response to lime application. Under the conditions of non inoculation, shoot weight of Gan No. 1, Gan No. 2, and Eureka were significantly increased, Sanditi and Defi changed a little; lime had no significant effect on root weight except for a significant decrease in Defi. Because of the significant interaction between inoculation and lime, shoot and root weight had no significant response to lime application except for a significant increase of root weight in Gan No. 2. Alfalfa cultivars differ in their capacity to produce acids and acid-tolerant plant species contain and exude more organic acid that form stable chelates with Al and thereby reduce its chemical activity and toxicity (Foy and Lee, 1987). The results of the experiment showed that Sanditi might exude more acids than other cultivars, which resulted in lowest pH level. However, exchangeable Al concentration in soils of Sanditi was the highest among cultivars. Concentration of available P, which might be affected by lower pH level or higher exchangeable Al concentration, was not changed significantly either, and there was no significant difference among cultivars. Correlation analysis showed that concentration of available P was significantly correlated with shoot and root weight, soil pH level was negatively correlated with nodule number and concentration of exchangeable Al. Positively significant positive correlation was also found between exchangeable Al concentration and root weight of alfalfa.

Table 1 Effect of lime application on weight, nodulation, pH, available P and exchangeable Al in soil of alfalfa.

| Alfalfa Cultivar | Lime ^a | Nodule | | Weight (g/pot) | | | | pH | | Available P | | Exchangeable Al | |
|---------------------|-------------------|--------|---------|-----------------|------|------|------|------|------|-------------|-------|-----------------|-------|
| | | mg/pot | No./pot | Shoot | | Root | | -S | +S | mg/Kg | | mg/Kg | |
| | | | | -S ^b | +S | -S | +S | -S | +S | -S | +S | -S | +S |
| Gan No. 1 | - | 2.98 | 17.25 | 2.24 | 3.08 | 1.51 | 2.36 | 5.47 | 5.46 | 30.27 | 49.48 | 0.344 | 0.491 |
| | + | 1.64 | 20.67 | 2.58 | 2.97 | 1.55 | 2.22 | 6.31 | 6.44 | 30.78 | 47.92 | 0.086 | 0.172 |
| Gan No. 3 | - | 5.42 | 23.83 | 2.22 | 2.78 | 1.50 | 2.47 | 5.51 | 5.47 | 33.36 | 54.17 | 0.466 | 0.687 |
| | + | 3.71 | 34.67 | 2.60 | 2.98 | 1.91 | 3.06 | 6.27 | 6.41 | 31.81 | 36.98 | 0.098 | 0.344 |
| Sanditi | - | 4.15 | 29.42 | 2.94 | 2.90 | 1.70 | 2.66 | 5.43 | 5.56 | 33.36 | 36.46 | 0.973 | 1.154 |
| | + | 2.30 | 38.00 | 3.03 | 2.83 | 1.57 | 2.82 | 6.15 | 6.29 | 33.36 | 41.15 | 0.223 | 0.466 |
| Eureka | - | 2.75 | 27.58 | 2.37 | 2.52 | 1.55 | 2.54 | 5.49 | 5.57 | 32.33 | 48.44 | 0.307 | 0.736 |
| | + | 1.69 | 29.08 | 2.67 | 2.69 | 1.57 | 2.71 | 6.21 | 6.38 | 28.21 | 48.96 | 0.135 | 0.331 |
| Defi | - | 3.62 | 34.92 | 2.58 | 2.86 | 1.56 | 2.57 | 5.51 | 5.58 | 31.30 | 59.90 | 0.601 | 0.982 |
| | + | 0.40 | 7.75 | 2.65 | 2.64 | 0.75 | 2.28 | 6.19 | 6.42 | 29.75 | 50.52 | 0.025 | 0.700 |
| LSD _{0.05} | | 1.29 | 6.90 | 0.28 | 0.42 | 0.59 | 0.55 | 0.03 | 0.09 | 4.25 | 7.69 | 0.11 | 0.17 |
| Lime × cultivar | | | | | | | | | | | | | |

Note: ^a "+" and "-" refer to with and without lime application; ^b "-S" and "+S" refer to with and without inoculation.

(It is recommended that Table 1 be simplified a bit and to contain only the significant results. Conclusion part is missing. This paper should be in other sessions and not in rangelands and policy.)

Reference

Brauer, D.K., Ritchey, K.D., Belesky, D.P. 2002. Effects of lime and Ca on root growth and nodulation of clovers. *Journal of Plant Nutrition* 5, 1640-1646.