Effects of Molybdenum on Nitrogen Metabolism of Sugarcane

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ABSTRACT

Two nitrogen fixing sugarcane varieties of Brazil RB72/454 and RB86/7575 were employed as the plant materials. They were cultured in nutrient solution containing different levels of Mo i.e. 0mg/L, 0.01mg/L, 0.02mg/L and 0.04mg/L, respectively, in pot trial with sand in greenhouse. The activities of nitrate reductase (NR) and glutamine synthetase (GS), and the contents of NO3--N and NH4+-N were measured at different stages. The results showed that under nitrogenous conditions in the greenhouse, all the Mo treatments increased the activity of NR and decreased the NO3--N content compared with the control for both the test varieties. As a result, the treatment with 0.01mg/L Mo increased the activity of GS in RB72/454 after initial elongation stages and that in RB86/7575 at young seedling stage, and it also decreased the NH4+-N content to improve the nitrogen metabolism. Under non-nitrogenous conditions, after initial elongation stage, the activity of NR was increased and the NO3--N content was decreased in both sugarcane varieties treated with different levels of Mo. Furthermore, the activity of GS was lower than the control of RB72/454 and the NH4+-N content was lower in leaves of RB86/7575 at tillering stage. The effect of different Mo treatment on the process of nitrogen metabolism and ammonia assimilation at different stages of growth was different under nitrogenous or non-nitrogenous condition. The lower concentration of Mo could increase the activities of NR and GS absolutely, decrease the contents of NO3--N and NH4+-N in leaf of the two sugarcane varieties as well as improve the nitrogen metabolism and ammonia assimilation.

Keywords: sugarcane, molybdenum, nitrogen metabolism

INTRODUCTION

Molybdenum is an essential microelement for higher plants (Bortels, 1930). Arnon et al. (1958) found that the process of nitrogen fixation and nitrate reduction in plant need the participation of molybdenum and vanadium and other elements cannot substitute for molybdenum in nitrate reduction. Molybdenum is the compositional part of nitrogenase and nitrate reductase and having a core role in the nitrogen metabolism of plant. Although molybdenum does not take part in the nitrogen metabolism directly, some researches showed that it still plays an important stimulation role in the process of nitrogen metabolism. The activity of nitrate reductase decreased with absence of molybdenum in plant, the reduction of nitrate was inhibited, and the nitrogen assimilation was decreased. Molybdenum is also the activator of nitrate reductase. At present, the effects of molybdenum on the nitrogen fixation and nitrogen metabolism were mainly studied in peanut, soybean, wheat and cotton, etc., but less in sugarcane (Chao, 1997; Wu and Xiao, 1994; Wu and Lou, 1996; Du et al., 1994, 2001, 2002; Wei et al., 1996; Sun et al., 2002; Liu and Yang, 1999, 2000), and mostly on the nitrogen fixation, yield and quality. The demand of molybdenum for sugarcane is very low and the molybdenum content in sugarcane is lower (only 0.01-0.10ppm). As one of the co-factors of nitrogenase and nitrate reductase, the activities of all enzymes regulated by molybdenum in the process of nitrogen metabolism in sugarcane shall be comprehensively clarified for investigation of the physiological and biochemical mechanism of nitrogen fixation in sugarcane and provide reference to further research.

MATERIALS AND METHODS

Two nitrogen fixing sugarcane varieties viz., RB72/454 and RB86/7575 introduced from Brazil were employed as the experimental materials. All chemicals were analytical grade including HMoO4*H2O (85%).

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The experiments were performed in intelligent greenhouse of sugarcane in Agricultural College, Guangxi University. Sugarcane set of RB72/454 (A) and RB86/7575 (B) were planted in black pots with non-nutrition sand on March 2, 2004, and per treatment was 25 pails which one pail was four seed canes. Beginning from April 4, every pail with different treatment was added 0.5L Hongland nutrition solution that contained different levels of Mo, i.e. 0mg/L (1), 0.01mg/L (2), 0.02mg/L (3) and 0.04mg/L (4), respectively, every time interval 5-7 days with watering normally. Half of sugarcane plants with different treatments were separated and cultured with non-nitrogenous nutrition solution on May 25, 2004, the managements was like as that for nitrogenous nutrition solution.

The first fully expanded leaf (Leaf +1) of sugarcane was sampled for analysis of nitrate reductase and glutamine synthetase at 11:00 a.m. on May 24, Jun 13, July 3 and July 24, respectively; and the third fully expanded leaf (Leaf +3) was sampled for analyses of contents of NO₃⁻-N and NH₄⁺-N in next day.

The nitrate reductase (NR) was measured in vivo (Plant Physiological Teaching and Research Section, Biology Department of East China Normal University, 1980; Zhou and Zheng, 1985). The glutamine synthetase (GS) activity was measured with the method followed by Zou (1999) and the content of NO₃⁻-N was measured with the reference of Li et al. (2000). The content of NH₄⁺-N was measured with the reference of followed by (1981).

![Fig.1. The activity of NR in sugarcane leaves treated with different levels of Mo under nitrogenous condition](image)

**RESULTS AND DISCUSSION**

**Effects of Mo on the activity of NR in leaf of sugarcane**

Nitrate reductase is the key enzyme for nitrate assimilation in plant and plays an important role on nitrogen metabolism. The nitrate reductase activity might control the rate of assimilating NO₃⁻-N to organonitrogen compounds. Under the nitrogenous condition, the effects of three Mo treatments on the activity of nitrate reductase in the leaves of the two sugarcane varieties were different at different stages (Fig.1). Three Mo treatments obviously increased the NR activity in the leaf of RB72/454 at young seedling stage, especially the treatment 0.01mg/L Mo; the activity of NR was decreased by the three Mo treatments at first and then increased at tillering stage, and it had no more difference with the control at boom stage of sugarcane. For RB86/7575, it was different with RB72/454. The activity of nitrogen reductase in the leaf of RB86/7575 was increased with the three Mo treatments especially 0.01mg/L Mo from young stage to tillering stage of sugarcane, but obviously decreased at elongation stage and increased at boom stage. It showed that the treatment 0.01mg/