한국환경과학회 봄학술발표회 발표논문집 제12권(제1호), 261 - 262, 2003
Proceedings of the Korean Environmental Sciences Society Conference, May. 16~17, 2003

PH3

Adventitious root growth inhibition in boron-deficient or aluminum-stressed sunflower seedlings

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1. Introduction

Although boron is essential for growth and development of higher plants, its function is not fully understood. Boron plays a role in the cell wall organization that could be critical for proper cellular expansion. It has been also proposed that boron is involved in different processes such as vegetative growth, tissue differentiation, metabolic control through regulation of enzymatic reactions, membrane integrity and function, sugar translocation and nucleic acid synthesis among others. Nonetheless, although the symptoms due to boron deficiency are rapid and clear, the primary physiological effect of boron remains unknown. Hence, the requirement of boron in the physiology of higher plants is a topic open to research and discussion, because boron is probably the least understood of all the essential nutrients in higher plants. Aluminum is one of the major factors limiting crop production and aluminum toxicity is a growth-limiting factor for plants grown on acid soils. Aluminum inhibit root growth by inducing boron deficiency and supraoptimal concentrations of boron in aluminum-toxic medium greatly reduced root growth inhibition.

The objective of the present study was to investigate the effects of boron on the formation of adventitions roots and to examine the link between boron and ascorbate metabolism and the subsequent impact on growth of adventitious roots in sunflower seedlings grown under aluminum-toxic conditions.

2. Materials and methods

Seeds of sunflower(*Helianthus annuus* L.) were germinated in the dark for 3 days. Cuttings were made from 3-d-old seedlings and placed in Petri dishes containing nutrient solution medium in the presence or absence of boron. The cuttings were supplemented with 100 μM ascrobate. For aluminum treatment, the nutrient solutions were supplemented with various concentrations of aluminum and boric acid. The length and number of adventitious roots and root hairs were masured every 24h. Proline contents were determined by the methods of Bates et al.

3. Results and Discussion

In the presence of boron numerous adventitious roots occurred. However, at higher concentrations above 100 μM boric acid inhibited adventitious root development. Exogenous ascorbate promoted root elongation in the absence of boron and under low-boron conditions, suggesting that ascorbate can compensate for boron in root elongation. Without boron, total cessation of growth in adventitious roots were observed with and without aluminum. In the presence of boron, increasing concentrations of aluminum in the medium resulted in a progressive inhibition of root elongation. The effect of aluminum toxicity in the adventitious roots was emeliorated by exogenous ascorbate. High concentration of aluminum induced a significant increase of proline levels, especially in the absence of boron. The results suggest a connection between boron nutrition and ascorbate concentration in the roots and provide additional evidence linking ascorbate with adventitions root formation.

4. Abstract

Sunflower(*Helianthus annuus* L.) seedings were de-rooted and grown in nutrient solutions providing either deficient or sufficient boron supply and supplemented with aluminum. Increasing concentrations of aluminum in the nutrient medium caused progressive inhibition of root growth and a parallel increase in proline level of roots. Elevated boron levels improved root growth under toxic aluminum conditions and produced higher proline contents. Exogenous ascorbate improved adventitions root growth in plants supplied with insufficient boron and aluminum. These findings suggest that root growth inhibition resulting from either boron deficiency or aluminum toxicity may be a result of impaired ascorbate metabolism.

References

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