Proceedings of The 5th International Conference on Silicon in Agriculture

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Beijing, China

Welcoming address

Dear Guests, Friends, Ladies and Gentlemen:

On behalf of The International and Local Organizing Committees, I am pleased and honored to welcome all of the delegates throughout the world to participate in the 5th International Conference on Silicon in Agriculture at The Friendship Hotel in Beijing, China from September 13-18, 2011.

The international silicon community has gone through a glorious history of more than one decade. The first conference was successfully held in Florida, The United States (1999), followed by the second in Tsuruoka, Japan (2002), the third in Uberlandia, Brazil (2005), and the fourth in KwaZulu-Natal, South Africa (2008).

The theme of the 5th International Conference on Silicon in Agriculture is “Silicon and Sustainable Agricultural Development”. As we know, rapid progress and great breakthrough have been achieved in research on the roles of silicon in plant molecular biology and agriculture over the last decade. This conference will provide a forum for the distinguished scientists, colleagues, students, fertilizer producers and consumers to present their most recent findings and achievements, and to exchange their valuable experiences with their international partners.

Although silicon (Si) is not recognized an essential element for the growth of higher plants, it has been proved that Si is beneficial or quasi-essential to plants, especially gramineous plants such as rice, wheat, barley, maize, sorghum and sugarcane etc.. The beneficial effects are particularly distinct on plants exposed to various forms of biotic (e.g. plant disease and pest damage) and abiotic stress (e.g. alumiunum and heavy metals toxicity, salinity stress, drought and high temperature stress, chilling stress, mineral nutrient deficiency stress and UV radition etc.). Currently, slag-based calcium silicate fertilizers are extensively applied to rice and sugarcane in many countries, especially in Asian, African, North and South American countries. Silicon is now playing ever-increasingly important roles in the sustainability of agriculture. In the last two decades, the roles of silicon in plants and agriculture have been widely recognized by scientists, government officials and farmers throughout the world due to the great advancements in both basic and applied research on silicon. The Si community has also grown up, with more than 150 participants from 28 countries presenting 112 papers (abstracts) in this conference

China is one of the origins of rice, a typical silicon-accumulating plant species. According to statistics in 2006, there were about 29.3 million hectares of paddy rice fields in China, accounting for 30% of its total arable land. Surprisingly, approximately 50% of the paddy rice soils in China are Si-deficient. Silicon deficiency is a yield- and quality-limiting factor, especially in tropical and subtropical regions of China. It is estimated that about 35 million tons of silicon fertilizer per year are potentially required for rice production.

Confucius once said, "How happy we are to meet friends from afar!" The organizing committee wishes to extend its cordial invitation to all the attendees to participate in the 5th International Conference on Silicon in Agriculture. I believe deeply that your participation will contribute undoubtedly to the success of the conference.

I would like to thank The Chinese Academy of Agricultural Sciences (CAAS), International Co-operation Bureau of CAAS, Institute of Agricultural Resources and Regional Planning (IARRP), CAAS, Chinese Society of Plant Nutrition and Fertilizer Sciences and Leading Bio-agricultural Co. Ltd., for their joint organization of this conference. I am particularly grateful to all my colleagues and friends from both inside and outside China for their encouragement and support. Special thanks are also given to National Natural Science Foundation of China (NSFC), Leading Bio-agricultural Co. Ltd., Tisco Harsco Technology Co. Ltd., Agripower Australia Limited and LF Green for their generous sponsorship.

Finally, I wish that all the participants would benefit from this conference and enjoy staying in Beijing.

Yongchao Liang

Chair

The Organizing Committee of the 5th Silicon in Agriculture Conference

Contents

Silicon ameliorates iron deficiency chlorosis in strategy I plants: first evidence and possible mechanism (s)

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Abstract

Silicon (Si) and iron (Fe) are respectively the second and the forth most abundant minerals in the earth's crust. While the essentiality of Fe is discovered at the middle of the 19th century, Si is still not fully accepted as an essential element for higher plants. However, Si is the only known element that alleviates multiple stresses in plants (e.g. metal excess, drought, salt, lodging, diseases and pests). Fe deficiency chlorosis is a wide-spread nutritional disorder of many crops grown in calcareous and alkaline soils. The various adaptation mechanisms are involved in Fe acquisition from rhizosphere by roots of the so-called strategy 1 plants (all dicots and monocot species, with exception of grasses which belong to strategy 2), i.e. morphological changes (e.g. lateral roots and enhanced root hair formation in the apical zones) and physiological changes such as enhanced proton excretion, Fe^{III} reduction by a plasma membrane reductase and Fe uptake via an inducible Fe^{II} transporter (IRT1). These root responses have been studied and characterized mainly in the nutrient solutions without Si supply. Therefore, unambiguous information on an interaction between these two mineral elements is still lacking. We demonstrated for the first time that the application of Si in nutrient solution experiments also ameliorates Fe deficiency chlorosis in cucumber, a Si accumulating dicot, which is also commonly used as a model plant of strategy 1. I will present recent work from our lab in the context of the effect of Si on both physiological (e.g. Fe^{III} reducing capacity, release of phenolics and organic acids) and molecular (e.g. expression of *FRO2*, *HA1* and *IRT1*, the genes coding Fe^{III} chelate reductase, H^+-ATPase and IRT1, respectively) aspects of root responses to Fe deficiency. In particular, I will focus on the storage and utilization of

root apoplastic Fe, root-to-shoot Fe transport and utilization of Fe from the leaf apoplast. Based on these investigations we propose the possible role of Si in Fe deficiency stress as 1) increasing apoplastic Fe pool in roots and 2) improving internal Fe status and thus delaying Fe chlorosis, rather than a direct regulatory/signaling effect of Si on the key Fe deficiency inducible root responses.

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