Improving growth in Zn deficient soils: Role of leaf trichomes in foliar-uptake of Zn fertiliser

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Zinc (Zn) deficiency is by far the most widespread micronutrient deficiency limiting crop production in the world. Australia is heavily affected by Zn deficiency: Western Australia contains the world's largest contiguous area of Zn-deficient soils (8 Mha), whilst in South Australia 70–80 % of the cropping soils are potentially subject to Zn deficiency. It has estimated that 49 % of the world's important agricultural soils and one third of the world's population suffer from Zn deficiency. Foliar fertilisation shows promise as a biofortification strategy to overcome Zn deficiency, especially when the soil-application of Zn fertilisers is ineffective due to edaphic factors such as high pH, high carbonate content, and organic matter content or when plants are at the stage where Zn is in high demand. However, the process of foliar nutrient absorption is poorly understood. The present study aimed to investigate the role of trichomes in foliar absorption of Zn. We conducted experiments using soybean (Glycine max) mutants that differed in trichome density (including glabrous, low density, and high density), together with three forms of Zn (aqueous ZnSO4, ZnO nanoparticles, and bulk ZnO particles) in order to investigate the role of trichomes in the foliar absorption of Zn. Firstly, we quantified the absorption of Zn across the leaf surface for these different mutants – this providing information on the importance of trichomes. Next, we obtained laterally-resolved elemental maps showing the movement of Zn into the leaf tissues using synchrotron-based X-ray fluorescence microscopy (μ-XRF). The results assist in improving the understanding of foliar Zn absorption, thereby promoting the design of physiologically-based Zn foliar fertilisers and simultaneously minimising the threat to food security and human health.