The impact of selected factors on increasing the uptake of foliar-applied zinc

Wpływ wybranych czynników na zwiększenie pobrania dolistnie aplikowanego cynku

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Zinc (Zn) deficiency is a well-documented global micronutrient deficiency problem and affects both crop production and human health. Zinc deficiency is widespread in those regions of the world where soils are characterized by a very low amount of plant-available Zn. Today majority of cereals is cultivated on soils which have poor availability of Zn. Published data indicate that foliar spraying of Zn is a very effective method of increasing the Zn concentration in grain.

Many factors influence leaf absorption for example those related to the fertiliser (form, rate, application time), to the quality of water used for the preparation of spray solutions, factors related to weather (like air humidity) as well as anatomical and structural features of leaves such as cuticular permeability.

In this study, different zinc sources have been used to study leaf absorption and grain accumulation of Zn both under greenhouse and field conditions. The effectiveness of ZnIDHA 2.0 in increasing grain Zn concentration was also compared with the effects of ZnEDTA an $ZnSO_4$ $7H_2O$. In short term experiments in nutrient solution, absorption and localization of Zn were monitored using a Zn fluorescent probe "ZinPyr-1".

Experiments were established on wheat (*Triticum aestivum,* cv. Adana 99) grown both in nutrient solution and soil culture in the greenhouse and also under field conditions. Following factors were evaluated for their effects on foliar Zn absorption: i) solution pH (e.g., 5.5, 7.0 and 8.0), ii) use of tenside and iii) air humidity (e.g., DEW point).

In additional experiments, ZinPyr-1 has been used to monitor leaf absorption and localization of Zn in young wheat plants. Plants were first grown with low ($5x10^{-9}$ M) Zn supply in a greenhouse for 18 days. Low-Zn plants were then foliarly-treated with Zn solutions at a rate of 0.07% Zn. Control plants received H_2O only. Transverse leaf sections of ~0.1 mm were cut by scalpel and incubated in 10 mM EDTA for 1 min. After that the leaf sections were transferred into 10 μM Zinpyr solution prepared in 0.9% NaCl from a 2 mM Zinpyr stock solution. Images were taken by using a fluorescent microscope.

Foliar application of Zn was effective in improving grain Zn concentration under both greenhouse and field conditions. More than 2-fold increase in grain Zn was observed in experiments, with the use of certain tensides which reduce the surface tension between the solution droplet and leaf surface. Solution pH had little effect on agronomic effectiveness of ZnIDHA 2.0 and ZnEDTA in increasing grain Zn. There were significant increases in leaf absorption and accumulation of Zn from ZnIDHA 2.0 when the experiment was conducted under the dew point (DEW) at which water droplets occur on the leaf surface. By using a Zn fluorescent probe "Zinpyr-1", leaf absorption and localization of Zn were demonstrated in the transversal leaf sections. Zinc was mainly localized in and around vascular tissues of the leaves.

ZnIDHA 2.0 was an effective foliar Zn fertilizer for biofortifying wheat grain with Zn under greenhouse and field conditions. Zinpyr-1 can be used in studies dealing with leaf absorption and tissue localization of Zn from foliarly-sprayed zinc of different sources.