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Sugarcane Plantations Multi-Row Harvesting Quality

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Description

Hydrogen sulphide (H_2S) is emerging as an important gaseous molecule involved in various plant developmental processes and plant stress responses. In this study, exogenous H_2S donor (sodium hydrosulfide, NaHS) treated wheat plants were used to investigate the role of H_2S in response to iron-deficiency.

Iron (Fe) is an essential nutrient for all organisms, due to its important role in various cellular metabolic processes. Although the abundance of iron in soils is high, iron availability in a form that can be absorbed and used by plants is limited. It has been estimated that up to 40% of the world's arable land may be iron-deficient and the problem is particularly serious in alkaline soils, as iron availability decreases with increasing soil pH. Iron-deficiency in plants has become a worldwide concern. It usually causes a decrease in chloroplast particles and thylakoid lamellae, disorders in the basal thymoid and matrix thylakoid arrangement and even leads to chloroplast dissociation. Iron is an important participant in the redox reaction and electron transport in plants; therefore, iron-deficiency usually weakens photosynthesis and respiration, thus affecting plant yield and quality. Iron has been shown to be a limiting factor for biomass in important crop plants, such as tomato, spinach and rice.

Lateral Root

Apart from NO and CO, H_2S is also an important gas signalling molecule, and its physiological function in plants has been extensively studied in recent years. H_2S regulates the physiological processes of plant stomatal closure, seed germination, root development and senescence and it also induces responses to various abiotic stresses. Moreover, H_2S is also involved in NO, auxin and ethylene signal pathways. For instance, NO enhances the resistance of Cynodon dactylon to Cadmium (Cd) stress by inducing H_2S production; Auxin regulates lateral root development in tomato and *Arabidopsis thaliana* by inducing H_2S. Finally, H_2S also mediates the ethylene-regulated stomatal closure in *Arabidopsis thaliana*. Iron-deficiency leads to plant chlorosis, chlorophyll reduction and photosynthesis inhibition. Studies have shown that H_2S can enhance rice and spinach photosynthesis under normal conditions, as well as improve chlorophyll fluorescence of strawberry and wheat when exposed to drought stress. Despite the documented involvement of H_2S in NO, auxin and ethylene signaling pathways, all of which induce responses to iron-deficiency, it is unclear whether H_2S participates in the regulation of plant iron nutrition. However, H_2S has been showed to promote iron uptake in rice roots and leaves under both normal conditions and Cd stress. On the basis of these results, the effects of H_2S on wheat growth, chlorophyll content, photosynthesis, PSs release and Fe content in wheat under Fe-deficient and sufficient conditions were investigated. Wheat was considered to be research object because it is an important crop and a Strategy II plant, which releases PSs under Fe shortage.

The seeds of common cultivated wheat varieties Aikang 58 were surface-sterilized and germinated on water soaked filter papers for 48 h and then grown in 1/2 strength Hoagland nutrient solution. Three days later, the seedlings were transferred to Fe-sufficient (50 mM) and deficient (0 or 1 mM) nutrient solution with or without 0.4 mM NaHS and the nutrient solution was changed every two days. After two weeks, the third leaves were used for detecting chlorophyll content and Photosynthesis (Pn) and all the leaves were used for H_2S and Fe content assays. PSs release from seedling roots was analysed by determining PSs content in root washing. After treatment, the roots of wheat seedlings were washed twice with deionized water, and then root systems were transferred to 200 ml deionized water for 6 h.

Morphological Changes

Harvested seedlings were washed twice in 5 mM C_aSO_4 and 10 mM EDTA solution and then dried at 70°C. The samples with a weight of at least 0.2 g were digested completely in 70% HNO_3 at 120°C. Finally, the solution was diluted to a certain volume with distilled deionized water. Iron was quantified with inductively coupled plasma spectrometry. All data were collected from at least three independent experiments. For photosynthesis measurement, at least six leaves were used. For other analyses, the results were the mean of three replicated treatments. Differences of the means among treatments were compared using Duncan's multiple range tests at 0.05 probability level.

H_2S concentration was determined in both shoots and roots of wheat plants grown in Fe-sufficient and limited culture solutions. The H_2S content increased in leaves (145%) and decreased in roots (50%) under Fe-limited conditions compared to the Fe-sufficient group. In comparison with the no-NaHS treatment group, exogenously applied NaHS increased H_2S content in leaves and roots under both Fe-limited and sufficient conditions. The increase was of 21.2% in leaves and 253.6% in roots under Fe-sufficiency and of 41.9% and 307.1% respectively, in Fe-limited conditions.

Plants induce a variety of morphological and physiological changes to adapt to Fe-limited conditions. One of those changes is the increase of Lateral Root (LR) development, which has been demonstrated in Arabidopsis and tomato. Another study showed that NO acts downstream of auxin in regulating Fe-deficiency-induced root branching that enhances Fe-deficiency tolerance in tomato. Recently, the role of H_2S in lateral root development has also been investigated. NaHS treatment induced pepper lateral root formation, while hypotaurine (H_2S scavenger) showed an adverse effect. H_2S inhibits primary root, LR and root hair elongation but promotes LR initiation in Arabidopsis thaliana seedlings. Further, auxin depletion-induced inhibition of lateral root formation is rescued by NaHS. In this study, NaHS treatment significantly increased lateral root number, density and length under both Fe-deficiency and sufficiency conditions. These results, combined with previous findings, lead to the conclusion that the function of H_2S on improving wheat Fe-deficiency was related to the regulation of lateral root development. The findings of this study showed that H_2S plays an important role in the response of wheat plants to Fe-deficiency. In particular, H_2S can improve PSs secretion and iron uptake, consequently increasing chlorophyll biosynthesis and photosynthesis. Although this study provides important insights into the role of H_2S in plants' response to Fe-deficiency, further studies are needed to understand the regulatory mechanism of H_2S on PSs secretion and iron uptake.