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The effect of sulfur deficiency and drought stress on general performance and symbiotic nitrogen fixation in pea (*Pisum sativum L.*)

Master thesis (45 ECTS)

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Abstract

Livestock production significantly contributes to greenhouse gas emissions, underscoring the importance of adopting plant-based diets. Legumes, including peas, are a viable protein source for human consumption and can reduce nitrogen fertilization due to their symbiotic nitrogen fixation. The symbiotic nitrogen fixation of peas is drought sensitive, which makes it crucial to optimize fertilization related to symbiotic nitrogen fixation and drought tolerance. Sulfur affects crosstalk between drought tolerance and symbiotic nitrogen fixation in peas, but further research is needed to elucidate the topic.

This study aims to improve the understanding of pea responses to individual and combined sulfur deficiency and drought stress. To examine this, peas were grown in a greenhouse and exposed to various combinations of drought stress and sulfur availability. The impact of the stressors was evaluated based on plant height, leaf size, shoot fresh weight, shoot dry weight, shoot water content, pod number, pod dry weight, pod water content, root dry weight, root-to-shoot ratio, nodule number, nodule dry weight, total sulfur, carbon, and nitrogen content, and stable isotope ratios of carbon and nitrogen.

The results showed that drought stress and sulfur deficiency reduced plant height, shoot biomass, number of pods, and pod dry weight. Sulfur deficiency decreased root dry weight and increased the root-to-shoot ratio. Drought did not affect the root parameters, suggesting that most root growth was before the drought period. The total carbon content decreased at sulfur deficiency and drought, suggesting a lowered carbon assimilation. A decreased stable isotope ratio of carbon under sulfur deficiency suggests sulfur is involved in stomata regulation. However, sulfur deficiency or drought did not affect stomata distribution. Leaf wilting and reduced water content in shoots and nodules suggest that the water contents of nodules and leaves are correlated. Negative stable isotope ratios of nitrogen in all treatments indicated that all plants depended on symbiotic nitrogen fixation. A decreased total nitrogen content at sulfur deficiency but not at drought suggests that sulfur improves symbiotic nitrogen fixation. This was supported by reduced nodule number and dry weight under sulfur deficiency. However, due to the inability to induce drought stress in the lowest sulfur treatments, it was impossible to conclude the combined effect of the stressors on any of the measured parameters. The study underscores the need for investigating combined stress responses in crops to understand the underlying interrelationships between plant nutrition and abiotic stress tolerance.