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CÂMPUS DE JABOTICABAL

Effect of magnesium foliar application at different phenological stages in soybean and maize plants

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Supervisor: Prof. Dr. André Rodrigues dos Reis

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DADOS CURRICULARES DO AUTOR

JULIO GUILHERME TACCA - Nascido na cidade de Xanxerê no dia 25 de novembro de 1997. Em 2019, obteve o título de engenheiro agrônomo pela Universidade Federal do Mato Grosso-UFMT, campus Sinop. Durante a graduação foi monitor por dois semestre da disciplina de Fisiologia Vegetal e um semestre de Tecnologia da produção de sementes. Como resultado de seu trabalho, teve a oportunidade de apresentar trabalhos científicos em congressos nacionais e trabalhar com estes assuntos. Em janeiro de 2021 ingressou no Mestrado do Programa de Pós-Graduação em Agronomia (Produção Vegetal), da Universidade Estadual Paulista, Câmpus Jaboticabal, sob a orientação do Prof. Dr. André Rodrigues dos Reis desenvolvendo o trabalho “Aplicação de rates e fontes de magnésio em diferentes estádios fenológicos visando a maximização do enchimento de grãos na soja” sendo bolsista FAPESP (Processo n° 2020/16385-2).

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1. CAPTER 1 – General considerations

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ABSTRACT

Magnesium is an overlooked nutrient due to the paucity of research on it. In addition, it is found in low amounts in the soil, possibly due to anthropogenic activities, such as excessive potassium fertilization. The consequence of this is an antagonism of magnesium absorption, resulting in limited productivity. Since nitrogen fertilization in the soybean crop is unnecessary due to symbiosis with bacteria of the genus Rhizobium, magnesium plays a fundamental role in biological nitrogen fixation. In addition, it activates more than 300 enzymes and when it is deficient in plants, it causes a reduction in productivity. This study will provide relevant information regarding the role of magnesium in photosynthesis, biological nitrogen fixation and protein synthesis.

Keywords: photosynthesis, antagonism, magnesium, potassium.

1. INTRODUCTION

Magnesium (Mg) has essential functions in plants, as it is a structural component of the chlorophyll molecule and acts in the fixation of carbon dioxide (CO_2) during the process of photosynthesis (Farhat et al., 2016). Many physiological and biochemical processes in plants are negatively affected by Mg deficiency, leading to restrictions on plant growth and crop yields (Cakmak, 2013). Mg deficiency constitutes an important limiting factor for the development of high-productivity agriculture, in addition to compromising animal and human health (Cakmak, 2015).

Mg deficiency can occur due to several factors. The inadequate supply of potassium fertilizers in the soil stands out, causing an antagonism of the absorption of Mg, since the high content of potassium (K) in the soil interferes with the absorption of Mg by the roots (Meurer, 2006). Mg transporters are non-specific, whereas K transporters are very specific, and this gives them an advantage in absorbing both high and low concentrations in the soil, which can cause Mg deficiency, directly limiting crop productivity (Senbayram et al., 2015).

Mg participates in several physiological processes during plant growth and development, with a role that goes far beyond its function as the central atom of chlorophyll (Jezek et al., 2014). It also plays a fundamental role, since no nutrient activates more enzymes than magnesium in plant metabolism (Epstein and Bloom, 2005).

It should be noted that chlorophylls, which are formed by a Mg atom incorporated into a porphyrin ring, are the green pigments that allow plants to carry out photosynthesis, using light energy to produce organic material (Moynier and Fujii, 2017). In photosynthesis, rubisco (Ribulose-1,5-bisphosphate carboxylase/oxygenase) is the main enzyme responsible for the assimilation of photosynthetic carbon (Parry et al., 2003), in order to function, it must undergo an activation process that involves the binding of a Mg^{2+} ion (Bhat et al., 2017), emphasizing that Mg deficiency negatively affects the Rubisco involved in CO_2 fixation (Andersson, 2008).

Mg deficiency promotes damage in the formation of chlorophyll and in the fixation of photosynthetic carbon, causing alterations in several physiological processes, and the deterioration of the photosynthetic fixation of CO_2 leads to the accumulation of unused electrons in the chloroplast, resulting in the formation of reactive oxygen species (ROS) such as singlet oxygen, hydrogen peroxide and hydroxyl radical. ROS accumulation in plant cells causes photo-oxidative damage to chlorophyll and chloroplast membrane lipids (Guo et al., 2016), forming symptoms of chlorosis in leaves, which can be aggravated by high light intensity (Farhat et al., 2016).

Mg deficiency exerts a major influence on carbohydrate partitioning between shoots and roots, as it plays a key role in phloem loading of sucrose. In a situation of Mg deficiency, the export of sucrose in the phloem is severely impaired, an effect that occurs before any visible changes in chlorophyll concentration or photosynthetic activity (Tanoi and Kobayashi, 2015). One of the biochemical reactions in plants in response to Mg deficiency is associated with the massive accumulation of carbohydrates in the original leaves, especially sucrose and starch, constituting an indication of a serious insufficiency in the export of photoassimilates by the source, via the phloem (Cakmak and Kirby, 2008).

With adequate amounts of Mg, plants can carry out photosynthesis, producing carbohydrates and transporting photoassimilates from sources to drains via phloem, ensuring the performance of various physiological processes of interest to the plant (Verbruggen and Hermans, 2013). The biological fixation of atmospheric nitrogen is an important process that some plant species, mainly the Fabaceae (legume) carry out to obtain the necessary amounts of nitrogen for their metabolism.

In the soybean crop (*Glycine max* L. Merril), symbiosis with bacteria of the genus Bradyrhizobium is used to fix atmospheric nitrogen, resulting in the formation of nodules in the roots of the plants (Hungria et al., 2015). It should be noted that the entire functionality of the nodule and the respective biological fixation of atmospheric nitrogen depend on the adequate supply of carbohydrates elaborated by the leaves, since the nodule does not have ample storage capacity for these products.

The hypothesis of this work is that the application of rates and sources of Mg through the leaves increases soybean productivity and the translocation of photoassimilates to the grains. The objective of this study is to verify whether the application of Mg via foliar is capable of increasing soybean productivity and to understand how the sources and rates of magnesium applied via foliar effect on soybean metabolism.

and Weinstein, 1991).

5. CONCLUSION

Foliar fertilization with Mg regardless of source and rate reduces the concentration of amino acids in leaves and does not affect growth parameters, Mg content in leaves and mayze yield. However, Mg significantly increased the concentration of total sugars at lower rates in the Mg nitrate source and at higher rates in the Mg oxide and sulfate sources.

The concentration of reserve proteins in the grains is significantly influenced by the presence of Mg, where the best results are obtained in the source of Mg sulfate and in the highest applied rate. Our results also showed that as the levels of fertilization of the mother plants with Mg in the sources of sulfate and oxide increase, there is a greater initial development of the mayze seedlings.

This study shows that foliar application of different sources and rates of Mg act as a stimulus and not as nutrition in maize plants under field conditions.

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