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VITOR ALVES RODRIGUES

NITROGEN AND MAGNESIUM FOLIAR FERTILIZATION IN SOYBEAN AND MAIZE

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VITOR ALVES RODRIGUES

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Advisor: Carlos Alexandre Costa Crusciol

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TÍTULO DA DISSERTAÇÃO: NITROGEN AND MAGNESIUM FOLIAR FERTILIZATION IN SOYBEAN AND MAIZE

AUTOR: VITOR ALVES RODRIGUES
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Aprovado como parte das exigências para obtenção do Título de Mestre em AGRONOMIA (AGRICULTURA), pela Comissão Examinadora:

Prof. Dr. CARLOS ALEXANDRE COSTA CRUSCIOL (Participaçao Virtual)
Produção Vegetal / Faculdade de Ciências Agronômicas de Botucatu - UNESP

Prof. Dr. JULIANO CARLOS CALONEGO (Participaçao Virtual)
Produção Vegetal / Faculdade de Ciências Agronômicas de Botucatu - UNESP

Pesquisador Dr. ADÔNIS MOREIRA (Participaçao Virtual)
Pesquisa e Desenvolvimento / Embrapa Soja

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To my parents, Tânia and Dorival, and my brother Vinicius

I dedicate

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ABSTRACT

Soybean [*Glycine max* L. (merr.)] and maize (*Zea mays* L.) are the most important crops grown in cultivated area in Brazil. With the increasing demand for food, without increasing the area destined for agriculture, it is necessary to adopt technologies to increase yield and one of these technologies is foliar fertilization, which promote a stimulant effect, it is a tool that can contribute to minimize adverse environmental effects, such as water stress, high temperatures and solar radiation. Thus, the objective of this work was evaluate the physiological effects of foliar application of nitrogen and magnesium in soybean and corn in two growing seasons, splitting in two chapters. In the first chapter a study was carried out with foliar nitrogen in soybean in 2018/2019 and 2019/2020 growing seasons, and in corn 2019 and 2020 growing seasons. Second chapter refers to the study with magnesium in the same crops and growing season as in chapter 1. The experiments were carried out in the field at Lageado Experimental Farm belonging to the College of Agricultural Sciences of the São Paulo State University. Applications occurred in R3 and V10 physiological stages for soybean and corn, respectively. The evaluations carried out in both experiments were the nutritional plants status, gas exchange paramters, photosynthetic enzymes (Rubisco for soybean and Rubisco and PEPcase for corn), total soluble sugar concentration, oxidative stress and oxidative enzymes (hydrogen peroxide, malondialdehyde, superoxide dismutase, catalase, ascorbate peroxidase and proline content), estimation of number of grains per plant, 100-grain weight and grain yield. Foliar N provided increased net photosynthesis, stomatal conductance, water use efficiency and carboxylation. The application foliar Mg contributed to increase antioxidative enzymes, reduce oxidative stress and improve the of the accumulated energy of photosynthesis. The results obtained in this research represent a good strategy to decrease the stress caused by abiotic factors and increase the crop yield.

Keywords: *Glycine max* L. (Merr.). *Zea mays* L.. Foliar fertilization. Photosynthesis. Oxidative stress.

RESUMO

A soja [*Glycine max* L. (Merr.)] e o milho (*Zea mays* L.) são as culturas de maior importância em área cultivada no Brasil. Com a demanda cada vez maior por alimentos, sem aumentar a área destinada a agricultura torna-se necessário a adoção de tecnologias para aumento de produtividade e uma delas é a adubação foliar, promovendo efeito estimulante, uma ferramenta que pode contribuir para minimizar efeitos ambientais adversos como estresse hídrico, temperaturas elevadas e radiação solar. Dessa forma, o objetivo deste trabalho foi avaliar os efeitos fisiológicos da aplicação foliar de nitrogênio e magnésio nas culturas da soja e milho em dois anos agrícolas, dividindo-se em dois capítulos. O primeiro capitulo foi realizado um estudo com nitrogênio foliar em soja nas safras 2018/2019 e 2019/2020, e em milho nas safras 2019 e 2020. O segundo capitulo refere-se ao estudo com magnésio nas mesmas culturas e anos agrícolas do estudo 1. Os experimentos foram realizados em campo na Fazenda Experimental Lageado pertencente a Faculdade de Ciências Agronômicas da Universidade Estadual Paulista “Júlio de Mesquita Filho”. As aplicações ocorreram nos estádios fisiológicos R3 e V10 para soja e milho, respectivamente. As avalições realizadas em ambos os experimentos foram o status nutricional das plantas, trocas gasosas, enzimas fotossintéticas (Rubisco para soja e Rubisco e PEPcase para o milho), concentração de açúcares solúveis totais, estresse oxidativo e enzimas antioxidantes (peróxido de hidrogênio, malondialdeído, superóxido dismutase, catalase, ascorbato peroxidase e prolina), estimativa de grãos por planta, peso de 100 grãos e produtividade. O N foliar proporcionou aumento da fotossíntese liquida, condutância estomática, eficiência do uso da água e carboxilação. A aplicação de Mg foliar contribuiu para aumentar as enzimas antioxidativas, reduzir o estresse oxidativo e melhorar o uso da energia acumulada da fotossíntese. Os resultados obtidos nesta pesquisa representam uma boa estratégia para diminuir o estresse causado por fatores abióticos e aumentar a produtividade das culturas.

Palavras-chave: *Glycine max* L. (Merr.). *Zea mays* L.. Adubação foliar. Fotossíntese. Estresse oxidativo.

SUMMARY

GENERAL INTRODUCTION

Soybean [*Glycine max* L. (Merr.)] and corn (*Zea mays* L.) are among the most important crops grown in Brazil and world. In the last 10 years, soybean and corn production increased 81,7% and 242,1% respectively, while the area increased 57,4% and 161% in Brazil (CONAB, 2021). This data prove that the increase in production is not related with area increase but due to the implementation of new technologies that increase the yield of the areas already cultivated. Several factors can be managed to increase yield, among them we can mention foliar fertilization.

In the last few years, researches focusing in foliar fertilization have been increasing, because it is a located application, with the possibility to be realized at the correct time, into the target tissue, with limited volume, and consequently with less environment impact (FERNÁNDEZ; EICHERT, 2009). Others benefits can be highlighted such as lower application rates, have an immediate effect in the crop, higher uniformity application and due to the lower applications rates, do not accumulate into toxic levels (SEKHON, 2003).

For long time the effectiveness of foliar fertilization was under discussion and questioned, due to the incorrect use of the nutritional compounds as well as the low quality of products available until then (ROSOLÉM, 2002). However, new technologies were developed, such as adjuvants, surfactants, humectants, chelators and others, with the goal of improve the effectiveness of foliar fertilization (FERNÁNDEZ; SOTIROPOULOS; BROWN, 2015).

Nitrogen is the most required nutrient to soybean as well to corn (PINHO et al., 2009; GITTI; ROSCOE; RIZZATO, 2019). Nitrogen is part of several vital plant process, such as proteins, nucleic acids, chlorophylls, synthesis and transport of cytokinins, and tryptophan constituent (BORKERT et al., 1994; FAGAN et al., 2015). Magnesium is and activator of several enzymes that are essential for plant metabolism, such as phosphorylative enzymes, which are essential for photosynthesis, respiration and reactions of organic compounds synthesis (MALAVOLTA, 2006).

Considering how important nutrients are for all growing crops stages, stand out the importance of supplying them at all growing crops stages. Foliar application is a great alternative, with immediate effect and low cost.

GENERAL CONSIDERATIONS

In tropical weather conditions like in Brazil, where it is possible to have two crop cycles during a year and in some periods the precipitation is not enough to supply all the crops necessity, causing drought stress. In this scenario, the supplementary application of nitrogen and magnesium in well fertilized crops can be a good alternative to mitigate the effects caused by environmental conditions.

Foliar N and Mg can improve photosynthetic parameters and activation of the antioxidant system for maize and soybean, and these two parameters combined improved grain yield parameters which leaded to a significant increase in yield for both crops. Also, magnesium and nitrogen are mobile nutrients in the plants, this facilitates their translocation to photosynthetically active sites where photoassimilates will be produced and redistributed to the drain organs such as grains. In this context, foliar application with nitrogen and magnesium can be a good alternative to improve some parameters that will lead to a higher production.

The world population has increased as well as the food demand, therefore some practices have been adopted in order to increase yield in a sustainable way. Thus, the foliar fertilization has increased and can contribute to increase the yield without increasing the cultivated area. Considering this, new technologies have been developed with better characteristics that can improve leaf absorption and optimize its use.

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