https://dx.doi.org/10.22161/ijaers.6775 ISSN: 2349-6495(P) | 2456-1908(O)

Germination of Soybean Seeds treated with Sources and doses of Lithium for Agronomic Biofortification

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***Abstract*—*Lithium is a chemical element, symbol Li, this element can be new strand of world agriculture. The agronomic Biofortification of soybeans can be beneficial to the entire production chain that involves, because this practice can lead to an increase in the average productivity of culture in soils naturally poor, reversing the current picture of stagnation in productivity the last 10 years. Additionally, the producer of grains will benefit from adding value to the final product and the consumer will benefit by purchasing a product with higher Li content. Treatments were arranged in a completely randomized design (DIC), with three repetitions. The twelve treatments were arranged in a factorial scheme 2 x 6. The first factor is regarding the two lithium sources (Li_2SO_4 e LiOH) and the second factor refers to five doses of lithium in their fonts used (0; 20; 40; 60; 80 and 100 mg dm^{-3}). Soybeans have had a positive effect on germination with the use of doses and sources of lithium compared with the witness, but the germination percentage was less than 65% well below the expected, which shows that the lithium in large doses can be harmful for the germination of seeds.*

***Keywords*—Glycine max, trace element, food security**

I. INTRODUCTION

Lithium (Li), is a metal found in magmatic rocks. Like the other alkali metals of your group, the lithium is chemically very active and never occurs as a pure element in nature. Of 131 minerals known from lithium, the larger quantities of this element in your composition are found in the minerals: spodumene (Li_2O - 6 to 9%), petalite (Li_2O - 4.73%), lepidolite (Li_2O - 4.19%), Zinwa- limited (Li_2O - 2 to 5%), amblygonite (Li_2O - 7.4%), among these mineral spodumene is the principal mineral source of lithium due to your high content and deposits in the Earth's crust (LOSEY; JOHN, 2004; BRAGA; SAMPAIO, 2008; MINERALOGY DATABASE, 2012; CHOUBEY et al., 2016). [1–4]

In Brazil, the extraction of lithium is made from pegmatites (species of rocks) located in the Southeast and northeast regions, the most important being the ore spodumene (Li_2O - 6 a 9%) (BRAGA, 2008) [4]

In the midst of the lithium industry dispute is increasing the interest of medicine for this mineral, especially for your effectiveness in treating mental disorders, especially bipolar disorder, as well as in the treatment of cancer, high blood pressure, balance hormonal, leukemia, diabetes and immune functions. Recent studies show that this element can also be used in lower levels in some blood diseases, in the prevention of Alzheimer's disease, amyotrophic lateral sclerosis, and Parkinson's disease. (YOUNG, 2011; FORLENZA et al., 2014). [5, 6]

In addition to the use of lithium as a raw material in pharmaceuticals, this can be used in preventive actions like your addition to drinking water and food through your release for fertilization. These measures are being adopted, with success, to control the expression of behavioral diseases on population, in which modified behavior, showing signs of improvement, decreasing the aggression, increasing the level of socialization and regularization of sleep (SCHRAUZER, 2002). [7]

This element can be a new strand of world agriculture, and therefore should be treated as a key issue, to have food security (GUILHERME et al., 2013), [8] and in the not too distant future, the food will have as much importance as remedies, however, unlike these, acting preventively (GUÉRIN et al., 2011). [9]

One of the various crops, soybeans (Glycine Max L.) is one of the world's largest food consumption, animal and human, for being one of the most important sources of vegetable protein, in addition to the fat used for biofuel production. This culture also presents photochemical characteristics beneficial for all these features taken as the reference culture in the development of this work (MARTINEZ, 2013) [10]. Thus, the use of the technique of agronomic Biofortification becomes of great importance to introduce lithium levels in grain in sufficient quantities to prevent various diseases caused by a deficiency of this element.

The Biofortification is the enrichment of foods with nutrients, vitamins, and protein and can be accomplished through genetic improvement or an agronomist. The agronomic practice consists in addition, before and during cultivation, of one or more elements, with the goal of obtaining a food enriched with essential nutrients to the man (WHITE; BROADLEY, 2009). [11]

The introduction of these nutrients, micronutrients or trace element, and/or vitamins in basic crops seeds and one of the aspects of Biofortification. The Biofortification process begins with a seed that is seen through a multidisciplinary lens. This technique aims to make the Biofortification in seeds that will lead to a fully developed plant whose seeds have high concentrations of nutrients and that will later be consumed by the population in the world (HarvestPlus, 2017). [12]

On the above, the objective of this work is to evaluate the effects of the application of doses and sources of lithium on the seed germination of soybean cultivar M8808 IPRO to agronomic Biofortification.

II. MATERIALS AND METHODS

The experiment was conducted in the laboratory of Analysis of seed plant science and plant health department, Federal University of Tocantins, Gurupi, TO. The University is located in the southern region of Tocantins, the 280 m of altitude and coordinates 11° 43 ' 45 " south latitude and 49° 04 ' 07" west longitude. Treatments were arranged in completely randomized design s (DIC), with three replications of 50 seeds, totaling 150 seeds so for treatment. The twelve treatments were arranged in a factorial scheme 2 x 6. The first factor is regarding the two sources of lithium (Li_2SO_4 and LiOH) and the second factor refers to five doses of lithium in their fonts used (0; 20; 40; 60; 80 e 100 mg dm^{-3}).

For the test of germination from seeds were used to cultivate M8808 IPRO. The 50 seeds of each repetition were placed in plastic bags identified and separated is added 1.5 ml of the solution prepared earlier by bags of seeds after constant stirring to homogeneity, were left for 40 minutes on the solution and then dried in the Sun. The witness received no treatment of solutions containing lithiumFigure 1.

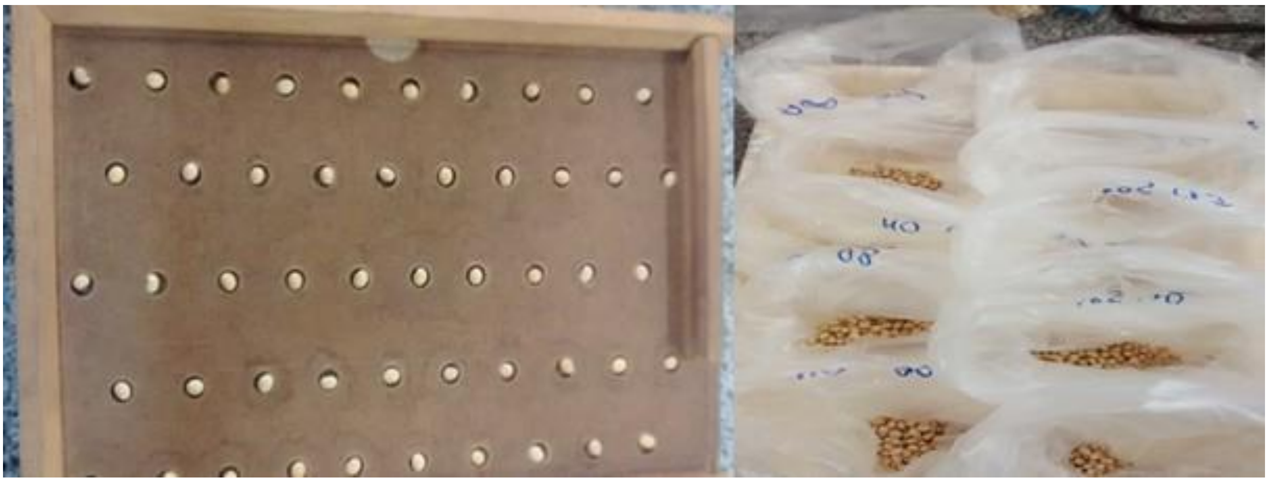

Fig. 1: Separateness for the application of doses and sources of lithium. Gurupi-TO, 2017.

Soon after the seeds were placed in blotting paper moistened with distilled water and subjected to the germination test being later taken to germination Chamber type BOD with constant temperature adjusted to 25 ºC as methodology advocated byFigure 2 [13].

Fig. 2: Seeds separated into blotting paper in 3 repetitions per treatment, taken the germination Chamber type BOD. Gurupi-TO, 2017.

III. RESULTS AND DISCUSSION

The results showed that the application via lithium seed showed a significant difference in seed germination of soybeans. Among the sources observed that the maximum dose of lithium sulfate reduction in the germination of normal seedlings and consequently increase in the germination of abnormal plants. The source Lithium hydroxide presented opposite effect on germination of normal and abnormal plants.

The normal seedlings showed quadratic response as a function of increasing doses applied via lithium sulfate and Lithium hydroxide Figure 3. The maximum estimated germination percentage will occur in use above 100 mg dm-3 Lithium hydroxide, which represents a gain of 9.4 percent compared to treatment witness. For the lithium sulfate source, maximum germination occurred with 40 mg dm-3 representing a gain of 12.4% compared to treatment without application of lithium, however as increasing the dosages noted a decrease in the percentage of germination.

According to Nascimento (2014) [14] Lithium when at doses above 71 mg dm^{-3} affected the development of lettuce plants, thereby reducing the total absorbed and accumulated by the plants. As observed in larger doses of LiSO4 treatments (Figure 4), where the highest doses were also had a smaller percentage of normal plants. This result that differed from finding by [15] in the study of Li absorption by plants of lettuce, cotton, and sunflower, in Poland, using doses of Li-like 0; 2,5; 20; 50 e 100 mg dm^{-3}, in hydroponic cultivation. These authors observed that high amounts of Li provided decreased dry mass of root, shoot and leaf area and presented signs of toxicity as necrosis in older leaves. However, in smaller doses, it was observed that there was positive development of these cultures, as well as accumulation of this element in the parts considered to be agricultural importance.

Already about the abnormal seedlings, quadratic response noted in light of increasing doses applied via lithium and Lithium hydroxide sulfate (Figure 5). The highest percentage of germination of abnormal plants was observed in the use of 60 mg dm-3 using lithium as a source of Lithium hydroxide, which represents an increase of 8% over the witness.

For lithium sulfate, the highest germination of abnormal plants happened on the application of 100 mg dm-3 lithium representing an increase of more than 8% in relation to the treatment without application of lithium.

Significant interference sources and doses of lithium in seed germination, agree with the results reported by Kalinowska et al. (2013) [16] in your work evaluating the influence chloride and Lithium hydroxide on growth, l-Ascorbic acid content and Lithium accumulation in lettuce plants in nutrient solution, lithium deposits found in plant tissues, reducing the development of plants, as well as typical symptoms of toxicity, the use of doses ranging from 20 to 100 mg dm-3 independent of source Used lithium, which demonstrates a negative effect and a loss in productivity of plants.

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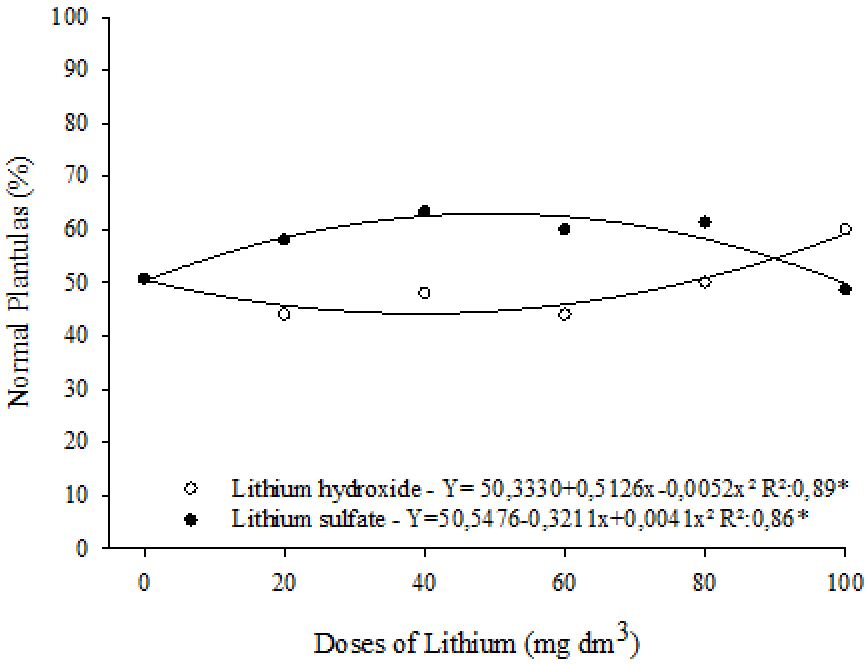

Fig. 3: Normal Seedlings (%) of soybean seeds (Glycine max) on the basis of different sources (sulfate and hydroxide) and doses (0; 20; 40; 60; 80 e 100 mg dm^{-3}) de Lítio. Gurupi-TO, 2017

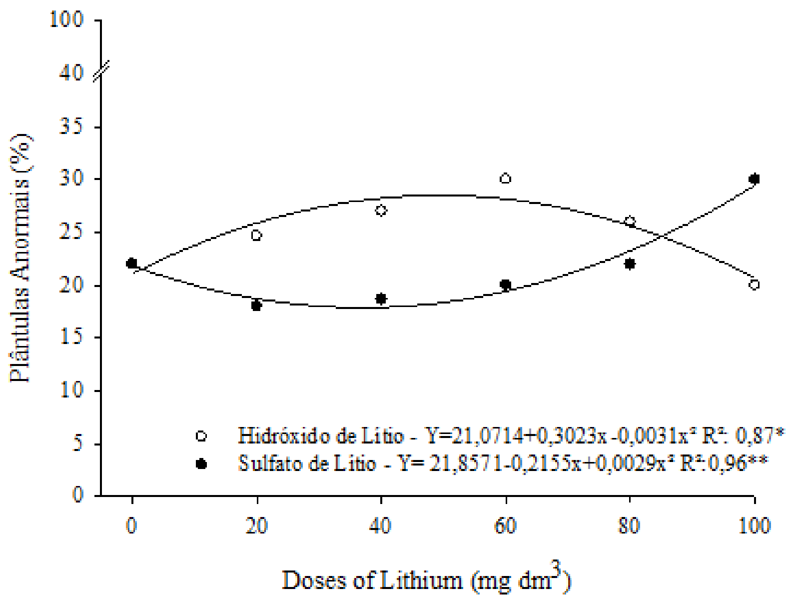

Fig. 4: Abnormal Seedlings (%) of soybean seeds (Glycine max) on the basis of different sources (sulfate and hydroxide) and shots (0; 20; 40; 60; 80 and 100 mg dm^{-3}). Gurupi-TO, 2017.

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One of the evaluations carried out, can be observed during the count of the source Lithium hydroxide has restricted growth of seedlings, in the shoot and root, as well as in the formation of secondary roots, considered of great importance for the establishment of a normal plant to be a limitation to the use of this source in agronomic Biofortification. Already the seedlings subjected to lithium sulfate source appeared larger in length of shoots and roots showing as much by roots in relation to Lithium hydroxide source (Figure 5).

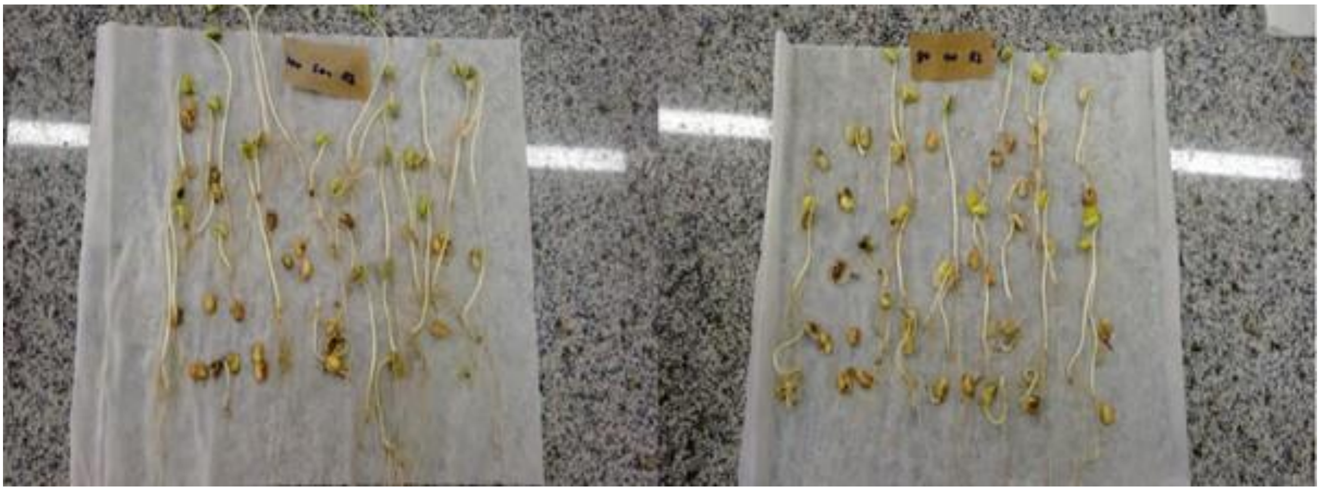

Fig. 5: Seedlings of soybean seeds (Glycine max) with high doses of lithium. Gurupi-TO, 2017

IV. CONCLUSION

1- sources and lithium doses provided a significant effect on seed germination of soybeans.

2-the lithium Sulfate source obtained the highest percentage of germination of normal plants in comparison with Lithium hydroxide.

3 – the number of abnormal plants increased when used as a source of Lithium hydroxide.

4 – For Biofortification of soybean seeds using lithium, it is recommended the use of sulfates source, with a view to your highest percentage of germination of normal plants, without any damage harmful to the development of culture.

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