OPTIMIZATION OF COTTON SEED DEVELOPMENT WITH COMMERCIAL INOCULANT

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Danielly Lima Vizotto[1], Monallysa Soares de Sá[2], Nicolas Oliveira de Araújo[3], Carlos Cicinato Vieira Melo[4], Ana Izabella Freire[5] and Filipe Bittencourt Machado de Souza[6]

ABSTRACT

Cotton is a crop of great economic importance. Improving germination and initial vigor of seedlings can result in higher productivity and quality of the cotton produced. To achieve high productivity in most crops, mineral fertilizers are used, thus increasing production costs and environmental impacts. The use of Azospirillum brasilense can potentially increase resource use efficiency, leading to more robust and healthier crops. The objective of this study was to evaluate the ideal dose of the bacterium Azospirillum brasilense in the germination of cotton seeds of the cultivar TMG22 GLTP. The experiment was carried out in a completely randomized design (DIC), and the cotton cultivar used will be TMG22 GLTP. Sowing took place in Styrofoam trays with 2 seeds per cell. The substrate used consisted of coarse sand and Topstrato in a 1:1 ratio. The evaluations took place up to 7 days after the emergency. The variables analyzed were: seedling length and germination percentage.

Keywords: *Gossypium hirsutum*. Production. Emergency. Germination.

[1] Undergraduate student in Agronomy
UNITPAC
[2] Undergraduate student in Agronomy
UNITPAC
[3] Professor UNITPAC
UNITPAC
[4] Dr. Professor
UNITPAC
[5] Postdoctoral Fellow
UNIFEI
[6] Dr. Professor
Unb

INTRODUCTION

Cotton (*Gossypium hirsutum*) is one of the main crops in Brazil, being cultivated in more than fifteen states. This crop is of great importance due to its complexity in the production and industrialization process, in addition to demanding a high amount of labor (FACUAL, 2005).

In recent years, cotton production in Brazil has increased significantly, while domestic consumption has not kept up with this growth. As a consequence, domestic surpluses increased, allowing for strong export growth. This increase was facilitated by the high quality of Brazilian cotton, which expanded its presence in the international market. (BRAZIL, 2020).

Cotton is a highly demanding crop in terms of soil quality, so areas that are markedly acidic or nutritionally poor, excessively humid or subject to waterlogging, and shallow or compacted soils do not favor the cultivation of this crop (CARVALHO, 1996).

To achieve high productivity in most crops, mineral fertilizers are used, thus increasing the production costs and environmental impacts (HUNGARY *et al*., 2005). After the discovery of the biological nitrogen fixation process (BNF), some crops in Brazil started to use less mineral fertilization (DÖBEREINER, 1997). This process can supply the plant's entire nitrogen need, dispensing with mineral fertilization (TAIZ *et al*., 2013). In this way, new ways to improve the efficiency of nitrogen use by crops are sought.

The constant search for alternatives that allow the maximization of production in a sustainable way is one of the topics most addressed by researchers around the world. When it comes to production, numerous researches are underway for the development of products that stimulate and enhance plant growth, providing favorable conditions for them to fully express their potential (TEJO et al., 2019).

The rhizosphere is an ecosystem composed of a variety of microorganisms that evolved in tandem with plants in the terrestrial environment. They establish relationships in various ways and, in doing so, mutually benefit each other to face the adversities found in different habitats.

Among these beneficial microorganisms, plant growth-promoting bacteria are widely researched and promising groups to be used as biological inputs in sustainable agricultural practices.

The definition of plant growth-promoting bacteria covers a variety of microorganisms that can be free-living or epiphytic and have the ability to establish symbiotic relationships, associative or not, with plants (GLICK, 2012).

The root system of plants must present good development in volume and good architecture to optimize the use of available resources (TAIZ et sl., 2004). Nitrogen-fixing bacteria are essential to help plant root establishment and development (BENEDUZI et al., 2012).

JUSTIFICATION

Improved Agricultural Productivity:

Cotton is a crop of great economic importance. Improving germination and initial vigor of seedlings can result in higher productivity and quality of the cotton produced.

The use of Azospirillum brasilense can potentially increase resource use efficiency, leading to more robust and healthier crops.

Reduction of the use of Chemical Fertilizers:

It is known for its ability to fix nitrogen, which can reduce the need for synthetic nitrogen fertilizers.

Decreasing dependence on these fertilizers can reduce production costs and minimize the environmental impacts associated with the overuse of these inputs.

Sustainability and Eco-Friendly Farming Practices:

The use of beneficial microorganisms such as Azospirillum brasilense is in line with more sustainable and environmentally friendly agricultural practices.

Promoting the use of bioinoculants can contribute to sustainable agriculture by improving soil health and microbial biodiversity.

Contribution to Scientific Knowledge:

Although the benefits of Azospirillum brasilense are known, the ideal dose for germination of cotton seeds of the TMG22 GLTP cultivar may not be well established.

This study may provide new data and insights into the dose-response relationship between Azospirillum brasilense and cotton seed germination, contributing to the existing body of knowledge.

Support for Small and Medium Producers:

Identifying the optimal dose can help small and medium-sized producers optimize their yields with reduced costs, increasing their competitiveness in the market.

Providing recommendations based on scientific evidence can facilitate the adoption of advanced agricultural technologies by these producers.

Economic Efficiency:

The determination of the ideal dose can avoid the excessive or insufficient use of Azospirillum brasilense, ensuring a more efficient and economical use of the bioinoculant.

This can result in a better return on investment for farmers by encouraging the adoption of biotech practices.

OBJECTIVES

General Objective

The objective of this study was to evaluate the ideal dose of the bacterium Azospirillum brasilense in the germination of cotton seeds of the cultivar TMG22 GLTP.

THEORETICAL FRAMEWORK

The world's leading cotton producers are India, China, the United States, Brazil, and Pakistan, which together account for about 74% of global fiber production (COÊLHO, 2021). In Brazil, the largest producers are the states of Mato Grosso, Bahia, Minas Gerais, Goiás, and Mato Grosso do Sul, with Mato Grosso maintaining the leadership since 2020 (IBGE, 2021).

Brazil, on the other hand, is the world's fourth largest producer of cotton. Despite the pandemic, Brazilian cotton lint production reached a record of 3 million tons in the 2019/2020 harvest (COÊLHO, 2021). In the foreign market, Brazil is the world's second largest exporter of cotton, maintaining high stocks since the 2018/2019 harvest (USDA, 2021).

Cotton production requires a large amount of agricultural inputs and fertilizers. In this context, several studies have shown that the use of plant growth-promoting microorganisms can be an effective alternative to improve the efficiency of nutrient uptake by plants (OLIVEIRA et al., 2022), as well as to mitigate abiotic stresses (PORTO, 2022) and biotic stresses, such as resistance to phytopathogens (THULER et al., 2006). The use of microorganisms in cultivation has a great impact, as it reduces production costs and environmental impacts resulting from the indiscriminate use of fertilizers in agriculture

Biological fixation is the process by which atmospheric nitrogen (N2) is converted into forms that can be used by plants. This conversion is carried out by the enzyme Nitrogenase, present in all fixing bacteria. In agriculture, the symbiosis between nitrogen-fixing bacteria and the seed is particularly important (EMBRAPA, 2020). For this biological fixation to occur, it is necessary to carry out Inoculation, which is the process through which nitrogen-fixing bacteria are added to plant seeds before sowing (EMBRAPA, 2020).

Studies by MORETTI et al. (2018) highlighted the importance of biological nitrogen fixation for development and productivity. In this context, the adoption of new technologies that aim to increase biological nitrogen fixation, with an impact on development and yield,

becomes essential for competitive and sustainable agriculture. Therefore, practices that reduce and/or optimize the use of inputs should be implemented in agricultural systems, according to previous studies (GALINDO et al., 2016).

In recent years, there has been a significant increase in the study of interactions between plants and microorganisms, aiming to understand the various factors that play a role in the selection of effective bacterial strains to stimulate the growth of large-scale crops (FERREIRA et al., 2014).

Among some microorganisms, the bacteria that stimulate plant growth stand out as highly promising biological inputs to promote sustainability in agricultural systems. They offer a range of benefits ranging from stimulating the growth of plant shoots and roots to enhancing enzyme protection against biotic and abiotic stress conditions (MAMÉDIO et al., 2020). They act through mechanisms that foster plant growth, including biological nitrogen fixation, synthesis of amino acids and phytohormones, and enhancement of the availability of nutrients, such as phosphorus, through phosphate solubilization processes (FRACASSO et al., 2020).

According to Santoyo et al. (2021), in recent years, plant growth-promoting bacteria have been investigated through the use of biological inputs. These microorganisms, initially found in the soil, when associated with plants, have the potential to contribute, both directly and indirectly, to the enhancement of crop growth.

MATERIALS AND METHODS

The experiment was carried out in a greenhouse located on the campus of the UNITPAC university, in the municipality of Araguaína - TO, with an altitude of 277m, Latitude: 7° 11' 31" South, Longitude: 48° 12' 28" West and average temperature of 26.4 °C.

Table 1. Seedling length (CP) evaluated at different doses of the bacterium Azospirillum brasilense in cotton seeds of the cultivar TMG22 GLTP.

Treatment	Average
T0	13.1897a
T2	12.9295a
T8	12.4372a
T5	12.4372a
T3	10.5013b
T1	6.6744b
T10	5.7378c

*Averages followed by the same letter in the column do not differ from each other by 5% of the probability by the Scott Knott test. T0 = Witness; T1 = 1 ml; T2 = 2 ml; T3 = 3 ml; T5 = 5 ml; T8 = 8ml; T10 = 10ml bacterium Azospirillum brasilense.

For the seedling length variable, there were significant differences. For seed germination (SG) there were no significant differences.

The treatments T0, T2, T8 and T5 had the highest averages but did not differ between them. T10 presented the worst average for seedling length. The use of nitrogen-fixing bacteria is more widespread in legumes, and the main example is soybeans. Bacteria have been used in soybeans since the 80s, today 100% of soybean crops in Brazil use the inoculation of these bacteria to help make N available to the plants. This symbiosis is so efficient that savings of approximately 7 billion dollars are observed per year (EMBRAPA, 2024).

When inoculating Azospirillum is used, significant improvements are found in relation to the agronomic characteristics of some plants (DARTORA, 2013).

The use of Azospirillum has been bringing many benefits to the producer. This association between the bacterium and the crop is very advantageous, in view of the fixation of nitrogen and also the production of phytohormones that stimulate plant growth (HUNGARY, 2011).

Because it is a cheap method in relation to mineral fertilization and brings benefits to the growth of the crop, in addition to the fixation of N to the soil, the use of Azospirillum has been increasingly increased in crops throughout Brazil. (EMBRAPA, 2015).

As shown by Rocha et al. (2020), the inoculation of the bacterium A. brasilense together with mineral fertilization brought increases in corn crop productivity. This shows that the association of mineral fertilization with the inoculation of the bacterium brings positive benefits to crop performance.

Among these bacteria, Azospirillum brasilense stands out for its ability to promote plant growth and development. In addition to biologically fixing atmospheric nitrogen, this bacterium also produces several plant hormones that stimulate root growth. As a result,

there is a greater absorption of water and nutrients, contributing to a more robust development of the crop (Baldani & Baldani, 2005).

For Taiz and Zeiger (2010), small concentrations of growth-promoting substances can alter the hormonal balance providing morphological responses in plants. This can be explained by the fact that T2 (2 ml) presented a high root growth value. However, very high doses of T10 (10ml) are already harmful to the morphological development of some parts of the plants and probably to the germination of seeds. The control T0 (0ml) did not show different behavior compared to root growth, this may have happened due to the cultivar used.

CONCLUSION

Increasing the dose of Azospirillum brasilense bacteria can positively affect seedling growth. But the 10 ml dose does not favor this development.

REFERENCES

1. Baldani, J. I., & Baldani, V. L. D. (2005). History on the biological nitrogen fixation research in graminaceous plants: Special emphasis on the Brazilian experience. *Anais da Academia Brasileira de Ciências, 77*, 549–579.

2. Beneduzzi, A., Ambrosini, A., & Passaglia, L. M. P. (2012). Plant growth-promoting rhizobacteria (PGPR): Their potential as antagonists and biocontrol agents. *Genetics and Molecular Biology, 35*, 1044–1051.

3. Brasil. Ministério da Indústria, Comércio Exterior e Serviços – MDIC. (2020). *Comex Stat*. Recuperado em 20 de agosto de 2020, de http://comexstat.mdic.gov.br/pt/home.

4. Carvalho, P. P. (1996). *Manual do algodoeiro*. Lisboa: Ministério da Ciência e da Tecnologia, Instituto de Investigação Científica Tropical.

5. Coêlho, J. D. (2021). *Algodão: Produção e mercados*. Caderno Setorial, Banco do Nordeste. Disponível em https://www.bnb.gov.br/s482dspace/bitstream/123456789/808/1/2021_CDS_166.pdf. Acesso em 24 de maio de 2024.

6. Dartora, J., et al. (2013). Adubação nitrogenada associada à inoculação com *Azospirillum brasilense* e *Herbaspirillum seropedicae* na cultura do milho. *Revista Brasileira de Engenharia Agrícola e Ambiental, 17*(10), 1023–1029. Acesso em 5 de setembro de 2024.

7. Embrapa Soja. (2019). *Soja em números (safra 2018/19)*. Londrina: EMBRAPA. Disponível em https://www.embrapa.br/en/soja/cultivos/soja1/dados-economicos. Acesso em 13 de maio de 2023.

8. Empresa Brasileira de Pesquisa Agropecuária (EMBRAPA). (2013). *Anos 80: Fixação Biológica de Nitrogênio (FBN)*. Disponível em https://sistemas.sede.embrapa.br/40anos/index.php/linha_do_tempo/historia/9. Acesso em 19 de setembro de 2024.

9. Empresa Brasileira de Pesquisa Agropecuária (EMBRAPA). (2015). *Bactérias aumentam produtividade do milho e reduzem adubos químicos*. Disponível em www.embrapa.br/busca-de-noticias//noticia/2467608/bacterias-aumentam-produtividade-do-milho-e-reduzem-adubos-quimicos. Acesso em 3 de outubro de 2024.

10. FACUAL - Fundo de Apoio à Cultura do Algodão no Estado do Mato Grosso. (2005). Notícias: Bahia implanta programa de combate ao bicudo. Disponível em http://www.facual.org.br/modules/news/article.php?storyid=70. Acesso em 7 de outubro de 2005.

11. Fracasso, A., Telò, L., Lanfranco, L., Bonfante, P., & Amaducci, S. (2020). Physiological beneficial effect of *Rhizophagus intraradices* inoculation on tomato plant yield under water deficit conditions. *Agronomy, 10*, 71.

12. Ferreira, E. P. B., Knupp, A. M., & Martin-Didonet, C. C. G. (2014). Crescimento de cultivares de arroz (*Oryza sativa* L.) influenciado pela inoculação com bactérias promotoras de crescimento de plantas. *Bioscience Journal, 30*(3), 655–665.

13. Galindo, F. S., Teixeira Filho, M. C. M., Buzetti, S., Santini, J. M. K., Alves, C. J., Nogueira, L. M., Ludkiewicz, M. G. Z., Andreotti, M., & Bellote, J. L. M. (2016). Corn yield and foliar diagnosis affected by nitrogen fertilization and inoculation with *Azospirillum brasilense*. *Revista Brasileira de Ciência do Solo, 40*, e015036.

14. Glick, B. R. (2012). Plant Growth-Promoting Bacteria: Mechanisms and Applications. *Scientifica, 2012*, 1–15.

15. Hungria, M., Campo, R. J., & Mendes, I. C. (2007). *A importância do processo de fixação biológica do nitrogênio para a cultura da soja: Componente essencial para a competitividade do produto brasileiro*. Londrina: Embrapa Soja; Embrapa Cerrados. (Documentos/Embrapa Soja, n. 283).

16. Hungria, M. (2011). *Inoculação com Azospirillum brasilense: Inovação em rendimento a baixo custo*. Londrina: Embrapa Soja. (Embrapa Soja. Documentos, 325). Acesso em 24 de agosto de 2024.

17. IBGE – Instituto Brasileiro de Geografia e Estatística. (2021). *Produção de algodão herbáceo*. Disponível em https://www.ibge.gov.br/explica/producaoagropecuaria/algodao-herbaceo/br. Acesso em 24 de maio de 2024.

18. Mamédio, D., Cecato, U., Sanches, R., Da Silva, S. M. D. S., Da Silva, D. R., & Rodrigues, V. O. (2020). Bactérias promotoras do crescimento de plantas contribuem para a maior persistência das pastagens tropicais em déficit hídrico? Uma revisão. *Research, Society and Development, 9*(8), 1–30.

19. Moretti, L. G., Lazarini, E., Bossolani, J. W., Parente, T. L., Caioni, S., Araujo, R. S., & Hungria, M. (2018). Can additional inoculations increase soybean nodulation and grain yield? *Agronomy Journal, 110*(2), 1–7.

20. Oliveira, A. A. de, Torres, F. E., Santos, É. F. dos, Rodrigues, A. M., Silva, R. A. da, Silva, G. N., Garcia, F. P., & Magri, T. A. (2022). Nitrogen and forms of application of *Azospirillum brasilense* in corn cultivated in sandy soil. *Research, Society and Development, 11*(13), e56411335819.

21. Porto, E. M. V., et al. (2022). Microrganismos promotores de crescimento de plantas como mitigadores do estresse hídrico em pastagens: Uma revisão narrativa. *Research, Society and Development, 11*(11), e514111134029.

22. Rocha, R. A. D. S., Coltro, G. L., & Lizzoni, G. C. (2020). Adubação nitrogenada associada à inoculação de *Azospirillum brasilense* na cultura do milho. *Biodiversidade, 19*(4). Acesso em 05 de julho de 2022.

23. Taiz, L., & Zieger, E. (2013). *Fisiologia vegetal*. Sunderland, MA: Sinauer Associates.

24. Taiz, L., & Zeiger, E. (2004). *Fisiologia vegetal* (719 p.). Porto Alegre: Artmed.

25. Tejo, D. P., Fernandes, C. H. D. S., & Buratto, J. S. (2019). Soja: Fenologia, morfologia e fatores que interferem na produtividade. *Revista Científica Eletrônica FAEF, 35*(1), 1–9.

26. Thuler, R. T., Bortoli, S. A., Guidelli Thuler, A., & Lemos, M. (2006). Tratamento de sementes de repolho com bactérias promotoras do crescimento de plantas (BPCP) para resistência contra *Plutella xylostella*. *Horticultura Brasileira, 25*.

27. USDA – United States Department of Agriculture. (2021). Cotton: World Markets and Trade. Disponível em: https://apps.fas.usda.gov/psdonline/app/index.html#/app/downloads. Acesso em 24 de maio de 2024.