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Effect of plant growth-promoting rhizobacteria in the hydroponic cultivation of basil (*Ocimum basilicum* L.)

Abstract

The aim of this study was to evaluate the effect of the plant growth-promoting rhizobacterium, *Azospirillum brasilense,* on the hydroponic cultivation of basil (*Ocimum basilicum* L.). The trial was carried out in the Agricultural Microbiology laboratory of the Faculty of Agricultural Sciences of the National University of Catamarca located in the city of San Fernando del Valle de Catamarca (Argentina) and basil plants were grown in the hydroponic system of "Floating Root" where 3 treatments were established (T. 1: Inoculated with *Azospirillum brasilense* and commercial solution for hydroponics; T. 2: Control (commercial solution for hydroponics) and T. 3 = HAKAFOS (Commercial fertilizer solution). Plant height, root length and fresh weight of the aerial part at the time of harvest were recorded. The design was completely randomized with 3 replications; the data were subjected to analysis of variance and LSD test ($p \leq 0.05$). The plants inoculated with the bacterium *Azospirillum brasilense* (Pi 8 strain) produced plants with greater growth than the controls and with the use of commercial fertilizer. Implementing a hydroponic system for the production of basil using the bacterial inoculant of *Azospirillum brasilense* (Pi 8 strain) in the nutrient solution is very efficient and achieves rapid plant growth and produces a safe food.

Keywords: *Azospirillum brasilense,* hydroponics, floating root

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Introduction

In recent years, production in urban gardens has increased significantly, especially through the development of new cultivation systems such as hydroponics, which offers an alternative to produce food in the domestic environment, and to produce in areas with problems of soil contamination and lack of water.

Hydroponics is a growing technique in which no soil is used, and the nutrients that the plant needs to grow are provided through water. The term hydroponics is derived from the Greek hydro = water and ponos = work or activity, i.e. 'water work' or 'water activity'. It is also known as soilless cultivation, nutriculture, chemoculture, artificial cultivation or soilless agriculture.[1,2] Currently the concept of hydroponics is known worldwide. This is how in the USA, Europe and Japan there are large establishments dedicated to the production of this type of crops. The Republics that made up the former Soviet Union also encouraged the expansion of hydroponic crops.[3]

The most important characteristic of hydroponic cultivation is that the soil is not required as a support or source of nutrients, since the plant takes nutrients directly from the water, where they are dissolved. The main advantage of the system is that it can be adapted to any space, climatic condition and economy.[1]

Compared to traditional agriculture, hydroponic cultivation systems have the advantage that they do not depend on weather phenomena and allow the same species to be grown cycle after cycle and yield several harvests per year. In this cultivation system, the balance between air, water and nutrients is maintained, and allows the control of pH, humidity and allows the correction of deficiencies and excesses of fertilizer. On the other hand, higher quality products are achieved, higher yields per unit of area and the time for harvest is shortened. In addition, environmental pollution and erosion risks are reduced.[1]

In general, there are 16 mineral nutrients essential for the normal development of plants. But with the exception of carbon (C), hydrogen (H) and oxygen (O), nutrients must be dissolved in water in order to be absorbed by the roots, constituting the so-called "nutrient solution".[4]

It is known that the bacterium *Azospirillum brasilense* has the ability to fix atmospheric nitrogen and to produce a wide range of active metabolites such as phytohormones and other plant growth regulators, such as indole acetic acid, cytokinins, gibberellins and siderophores,[5,6] which positively influence healthy plant growth and development.[7]

Basil (*Ocimum basilicum* L.) is an aromatic and medicinal plant. It belongs to the botanical family Lamiaceae. It is herbaceous, annual, up to 50 cm tall and leaves of intense green. Due to its intense aroma and flavor, this plant has uses as a culinary condiment in Mediterranean, European, and Asian cuisines, and is mainly consumed fresh.[8] It is one of the main herbaceous crops in the world that has shown components that can be beneficial for the treatment of cardiovascular diseases, inflammatory disorders, and decreased cancer risk.[9]

Therefore, the objective of this work was to evaluate the effect of the plant growth-promoting rhizobacterium, *Azospirillum brasilense,* on the hydroponic cultivation of basil (*Ocimum basilicum* L.).

Material and method

The trial was carried out in the laboratory of Agricultural Microbiology of the Faculty of Agricultural Sciences of the National University of Catamarca located in the city of San Fernando del Valle de Catamarca (Argentina), in this experience the cultivation of basil (*Ocimum basilicum* L.) was carried out in the hydroponic system of "Floating root" where the plants were supported by perforated telgopor plates on the nutrient solution with their roots immersed in it.

The sowing was carried out in phenolic foam and after 15 days the basil seedlings were transferred to the telgopor plates inside plastic containers. 3 treatments were established with three replications and with 15 experimental units per repetition.

T. 1= Inoculated with *Azospirillum brasilense* and commercial solution for hydroponics.

T. 2 = Control (commercial solution for hydroponics).

T. 3 = HAKAFOS (Commercial Fertilizer Solution)

It was used by the native Pi 8 strain of *Azospirillum brasilense*, anisland in the endorizosphere of paprika pepper (*Capsicum annum var. elephant trunk*) grown in the Province of Catamarca, whose identification was carried out biochemically and molecularly.[5,10,11] The concentration of *A. brasilense* used for inoculations was $1.3x10^7$ azospyrills. $^{mL-1}$ quantified in the Neubauer chamber.[12]

Plant height, root length and fresh weight of the aerial part were evaluated. The harvest of the aerial part was carried out 70 days after planting, and based on the total fresh mass per plant, the yield of each treatment was estimated.

The data were subjected to analysis of variance and LSD test ($p \leq 0.05$) with the Infostat statistical program (Figure 1).[13]

Figure 1 Hydroponic cultivation trial of basil (*Ocimum basilicum* L.).

Results and discussion

The results obtained in the hydroponic cultivation of basil determined that the highest growths, expressed in plant height and root length, were achieved with the inoculation of *A. brasilense,* registering statistically significant differences (Figure 2) (Figure 3). For the variable fresh weight of the aerial part, the greatest results were observed in treatment 1, with the inoculation of *A. brasilense,* however, no statistically significant differences were established (Figure 4).

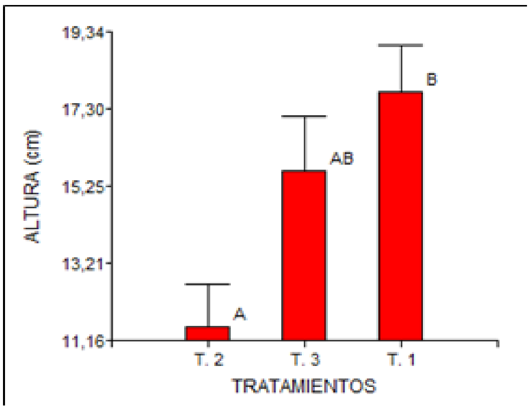

Figure 2 Average height of basil (*Ocimum basilicum* L.) plants at 70 days after planting.

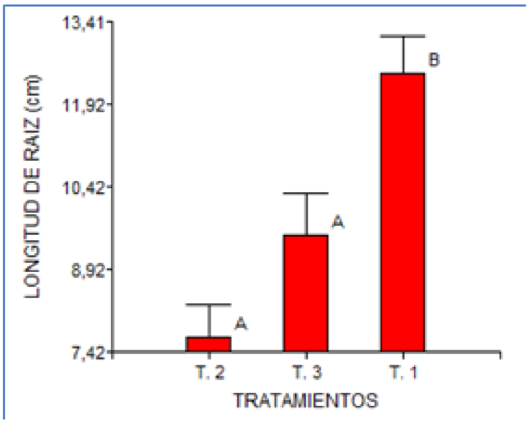

Figure 3 Average root length of basil (*Ocimum basilicum* L.) plants at 70 days after planting.

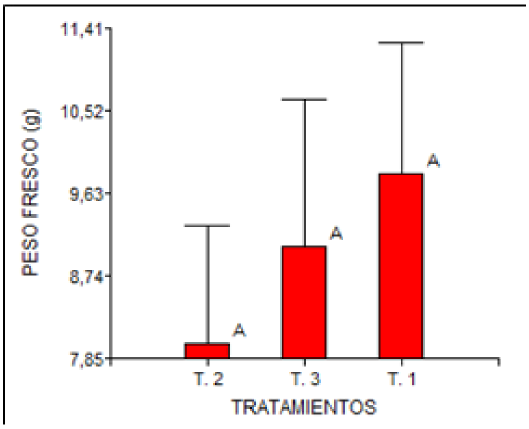

Figure 4 Average fresh weight of the aerial part of basil plants (*Ocimum basilicum* L.) at 70 days after planting.

It is estimated that the best results obtained were mainly due to the fact that the bacterial strain Pi 8 of *Azospirillum brasilense* increased the nitrogen content in the hydroponic cultivation system. Since nitrogen (N) is an essential element in plant nutrition, as it is the main nutrient that makes up proteins, amino acids, nucleic acids, and chlorophyll. For this reason, the basil plants of the inoculated treatment (T1) presented a more intense green color and greater growth (Figure 1).

The highest average yield was obtained with the application of the bacterium *Azospirillum brasilense* which was 443.25g. For the Control treatment (T2) of 360.45 g and 407.25g in T3 (Figure 5).

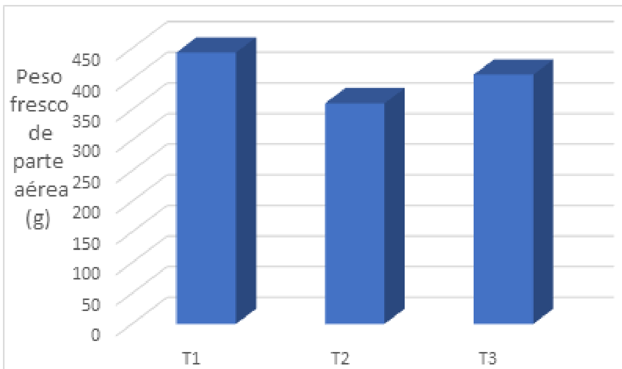

Figure 5 Average yield of aerial part of basil plants (*Ocimum basilicum* L.) at 70 days after planting.

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Conclusion

This work provides information on the hydroponic production of basil plants (O*cimum basilicum* L.) with the use of PGPR (Rhizobacteria Promoting Plant Growth) microorganisms, such as the bacterium *Azospirillum brasilense*, which will allow this culture system to be more efficient by improving yield, health and safety, fundamental characteristics to achieve the success of the crop. In addition, it shows the potential of the bacterial strain tested as a biofertilizer and reduce the costs of the nutrient solution. Implementing a hydroponic system for the production of basil using the bacterial inoculant of *Azospillum brasilense* (Pi 8 strain) in the nutrient solution is very efficient and achieves rapid plant growth and fundamentally produces a safe food.

Hydroponic basil cultivation is an agricultural technique that allows it to be developed from the simplest and most economical way in small spaces, such as the courtyard of a rural house, the roof of an urban/peri-urban house and in schools, to the most complex and expensive investment, such as greenhouses with the most sophisticated technology.

Acknowledgments

None.

Conflicts of interest

Authors declare that there is no conflict of interest.

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