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**ARAŞTIRMA MAKALESİ** **RESEARCH ARTICLE**

# Effect of soil biostimulant application for the growth and quality of beet seedlings

Pancar fidelerinin büyümesi ve kalitesine toprak biyostimulant uygulamasının etkisi

**Marcelle Michelotti BETTONI[1], Duelen Carolay Castro CABRAL[1], Tefide KIZILDENIZ[2]**

[1]*Universidade Tuiuti do Paraná, Curitiba-PR, Brasil.*

[2]*Niğde Ömer Halisdemir University, Faculty of Agricultural Sciences and Technologies, Biosystem Engineering Department, 51240, Niğde, Turkey.*

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Corresponding author: M.M BETTONI
✉: marcelle.bettoni@utp.br

Ö Z E T / A B S T R A C T

***Aims***: The goal of this investigation was to examine how different dosages of Viva BR® biostimulant affected the yield and quality of beet seedlings of Early Wonder Tall Top variety.
***Methods and Results***: The experiment was carried out at intervals of 7 days, the first being at 7 days after sowing (DAS) until 28 DAS, totaling 5 applications (0 (control), 7, 14, 21 and 28 DAS) in the greenhouse of the Universidade Tuiuti do Paraná/Brazil, in a completely randomized design.
***Conclusions***: It is concluded that the application via soil of the Viva BR® biostimulant had a positive impact on the growth of beet seedlings.
***Significance and Impact of the Study***: In warm climates, *Beta vulgaris* L. (beet) of the Chenopodiaceae family predominates and its cultivated intensively in Brazil's Southeast and South regions. The seedling cultivation phase identifies the crops early establishment in the field in order to ensure stand consistency and appropriate ultimate productivity. Among the diverse techniques treated to achieve increases in this stage is the application of substances with biostimulating impacts, which result from the combination of two or more bioregulators with other compounds that might boost plant growth and development. As a result, substances having a biostimulating impact emerge as a reasonable solution for improving seedling growth. The maximum efficiency for the biometric variables at the dose of 6.2 mL $L^{-1}$ while for the qualitative variables it was 5.0 mL $L^{-1}$.

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## INTRODUCTION

The beet, *Beta vulgaris* L., which belongs to the Chenopodiaceae family, has a tuberous root with a globular shape that develops almost superficially in the soil, with a purple color coming from the natural pigment anthocyanin (De Resende and Cordeiro, 2007; Sutor-Świeży, et al., 2022). It is a predominant vegetable from temperate climates, developing better in mild or cold temperatures, around 10 to 20 °C (Souza and Resende, 2006; Lombardi et al., 2022). Considered an important vegetable grown in Brazil, it has several biotypes, such as sugar, forage and horticultural. Practically all table beet cultivars planted in Brazil are of North American or European origin, and constitute the group called Wonder (Tivelli et al., 2011). However, today, the market brings great diversity of genetic materials such as cultivars Itapuã (Isla), Rubius F1 (Agristar), Cabernet (Horticeres) among others. The density of beet production takes place in the Southeast and South regions of Brazil. In Paraná, in the 2017/2018 harvest, the state produced about 96,798 tons in an area of 3,494 ha, that is, 3.10% of the total in Paraná (Departamento De Economia Rural-Deral, 2019). This step recommends obtaining

seedlings with maximum vigor and health (Nunes and Santos, 2007), with adequate development and good formation of the root system, in addition to better adaptability to the new location after transplanting. The implantation of the culture can take place by direct seeding in the field or by transplanting seedlings, which can be produced in seedbeds or trays. In the case of sowing, sowing takes place in the soil, close to the transplant area, in an open field, while production in trays takes place in a greenhouse, with a more controlled environment (Bettoni et al., 2014). It is known that most small producers use the method of obtaining seedlings in trays because they are efficient in several aspects such as obtaining high quality seedlings and minimizing labor.
The biostimulant originates by mixing two or more bioregulators with other substances (amino acids, nutrients, vitamins), and can depend on its composition, concentration and proportion of substances, rise plant growth and development, stimulating cell division, it can also rise the absorption of water and nutrients by plants (Vieira and Castro, 2001). This is due to the stimulus caused by plant regulators, such as an increase in plant metabolic activity (Khan et al., 2016; Taiz and Zeiger, 2013, Dinler et al., 2021).
The utilization of growth regulators in the early stages of seedling development, as well as their application in seed treatment, can boost root growth, acting in the faster improvement of seedlings under deprecating conditions, like water scarcity (Lana et al., 2009). The application of biostimulants in agriculture has shown, through research, potential for increasing the productivity of crops such as beans (Abrantes et al., 2011), pepper (Palangana et al., 2012) and lettuce (Guimarães et al., 2006). Therefore, products with biostimulant effect appear as an alternative for use in the production of seedlings, resulting in well-developed seedlings, with adequate nutritional balance, well-developed root system, increases in area and number of leaves, which give it greater photosynthetic capacity, allowing that after transplanting, they develop correctly, resulting in good production.
Based on the above mentioned framework, the aim of this investigation was to evaluate the application of different doses of biostimulant in the production and quality of beet seedlings.

**MATERIALS and METHODS**

The experiment was carried out in the greenhouse of the Universidade Tuiuti do Paraná, Curitiba-PR, Brazil. The sowing of beet, cultivar Early Wonder Tall Top, was carried out in April, in expanded polystyrene trays, containing 288 cells. The cells were completed with the commercial substrate Tropstrato HT® (composed of pine bark, included vermiculite enriched with macro and micronutrients and peat) and the trays were kept in a seedling nursery with timed micro-spray irrigation at fifteen-minute intervals.
The experimental design was completely randomized, with five doses (0 (control), 2.5; 5.0 and 7.5 and 10 mL $L^{-1}$) of the biostimulant Viva BR® (MAPA No. SP- 09055 10042-6) plus the control with application of water and three replications, each plot consisting of 48 cells. The product supplied by the Valagro® company is composed of 8.0% Total Organic Carbon; 3.0% Nitrogen (N) soluble in water; 8.0% Potassium oxide ($K_2O$) soluble in water, with a density of 1.24g $mL^{-1}$.
When the seedlings have 4 definite full expanded leaves (approximately 25 days after planting), the plants were transplanted in to 5 L plastic pots containing a commercial substrate of Tropstrato HT Hortaliças including pine bark, vermiculite, PG mix 14.16.18, potassium nitrate, simple superphosphate and peat (Vida Verde Indústria e Comércio de Insumos Orgânicos Eireli) and irrigated at field capacity, without sticking to the leaves. The application was carried out at intervals of 7 days, the first being at 7 days after sowing (DAS) until 28 DAS, totaling 4 applications (7, 14, 21 and 28 DAS). The doses were administered directly on the substrate, with 2 mL of the solution being applied to each cell.
At 35 DAS, 10 central plants of each repetition were selected, and the following biometric variables were evaluated as number of leaves (NL), root length (RL), height of the aerial part (HTAP), fresh mass of aerial part (FMAP) and root (FMR), dry mass of aerial part (DMAP) and root (DMR). The biochemical variables analyzed were as chlorophyll a (Chl *a*), chlorophyll (Chl *b*) content, chlorophyll a+b (Chl *a+b*) and Carotenoids.
To determine the RL and HTAP, a graduated ruler was used, the RL being obtained from the average of the 3 largest roots per plant, while the HTAP was measured from the stem to the apex of the plant with the aid of a ruler. For fresh mass (FM) and dry mass (DM), samples were washed and weighed on a 0.1 precision analytical balance. For the determination of dry matter production, the parts of the plant were separated and placed in paper bags, later placed in greenhouses with forced air circulation at 65°C ± 5°C, until reaching constant mass.
For the biochemical variables, 0.5 to 1.0 g of the leaves were weighed on a precision balance, and immediately frozen at -20ºC. Later 1$cm^2$ leaf discs were collected, measured for obtaining FW of each discs and extracted in 5 mL of ethanol 95% in 80 °C hot bath. The absorbance

from the extraction was obtained at 665, 649 and 470 nm for content of Chl *a*, Chl *b*, Chl *a+b* and Carotenoids, according to the methodology of Lichtenthaler (1987): Chl *a* = $(13.7 \times \Delta_{665}) - (5.76 \times \Delta_{649})$; Chl *b* = $(25.8 \times \Delta_{649}) - (7.6 \times \Delta_{665})$; Chl *a+b* = $(6.1 \times \Delta_{665}) - (20.04 \times \Delta_{649})$; Carotenoids = $[(1000 \times \Delta_{470}) - (2.13 \times \text{Chl } a) - (97.64 \times \text{Chl } b)]$.

The data obtained were evaluated for homogeneity of variances by the Bartlett's test and subsequently submitted to regression analysis. The concentrations associated with the maximum efficiency (ME) of the examined variables were calculated using the first derivative of the regression equations, which was set to zero.

## RESULTS and DISCUSSION

Regression analysis (Figure 1) for biometric variables are as NL, RL, HTAP, as well as FMAP and FMR and their dry mass (DMPA and DMR) of the plants, as a function of the applied doses, indicated a quadratic behavior.

The ME for NL (Figure 1A) and RL (Figure 1B) were, respectively, 6.5 mL $L^{-1}$ and 6.0 mL $L^{-1}$, both corresponding to an increase of 25% when compared to the control. Similar results were observed by the action of Vendruscolo et al. (2016) who, when treating lettuce with the biostimulant Stimulate®, obtained higher NL.

One of the factors responsible for the increase in RL can be explained by the presence of organic carbon in the composition of the product and, consequently, the presence of humic substances. De Dorlodot et al. (2007) explain that the increase in root growth is one of the main physiological effects of humic substances, which may be greater or lesser due to the species, age of the plant, source and concentration used.

For the HTAP (Figure 1B), with ME of 6.6 mL $L^{-1}$, the increment was 65% higher than the control, corroborating the results found by Vieira et al. (2018) using biostimulant (Siapton) in seedlings. lettuce, obtaining greater plant height at the dose of 3.0 ml $L^{-1}$. This increase, according to Bezerra et al. (2007), may be the result of the ability of biostimulants to increase the aerial growth of a plant and stimulate the induction of cell division, thus providing conditions for better use of nutrient absorption.

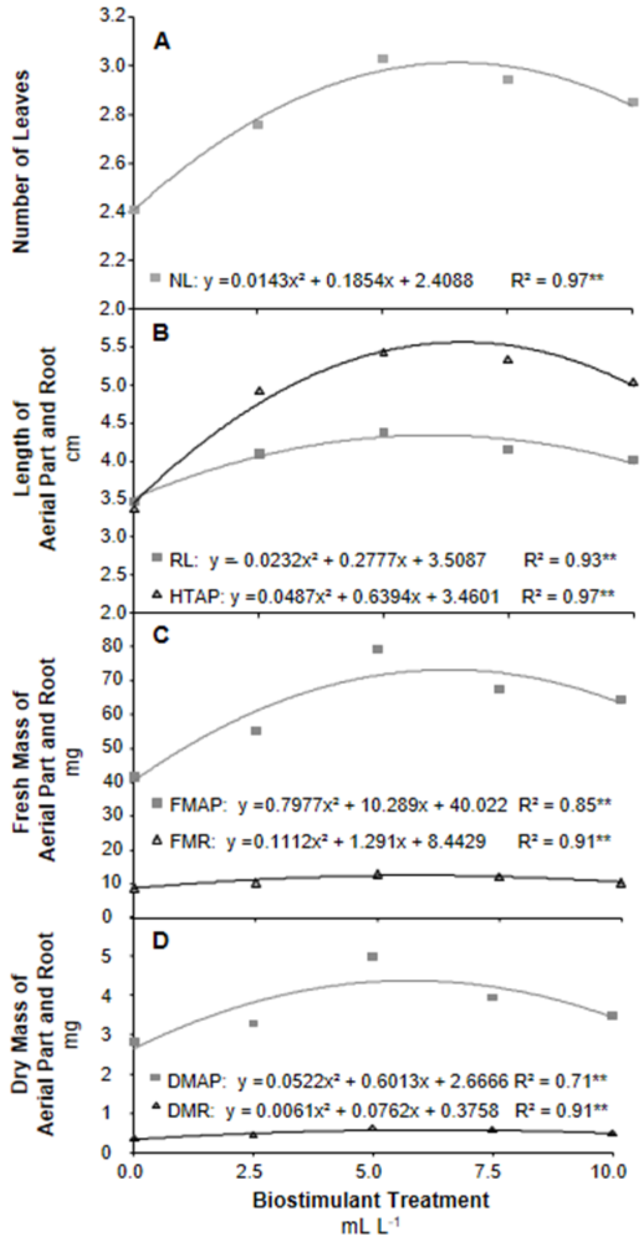


Figure 1. Number of leaves (A), length of aerial part and root (B), fresh mass of aerial part and root (C), and dry mass of aerial part and root (D) in beet cultivar of Early Wonder Tall Top treated with biostimulant Viva BR® evaluated 35 DAS

The quadratic result observed in the FMAP indicated the ME with 6.4 mL $L^{-1}$, equivalent to an increase of 77% compared to the control. The FMR (Figure 1C) and DMAP (Figure 1D) had the ME with 5.8 mL $L^{-1}$, with increases of 40% and 55%, respectively. The DMR (Figure 1D), with an increase of 57%, presented ME at the dose of 6.2 mL $L^{-1}$. Similar results were obtained by Borcioni et al. (2016) when testing fulvic acid in iceberg lettuce, noting that the concentration of 6.0 mL $L^{-1}$ increased the fresh and dry mass of leaves. Santos (2014) also found increases of up to 85% in plant dry mass when evaluating the foliar application of humic substances in sweet pepper.

The biochemical variables (Figure 2); Chl *a*, Chl *b*, Chl *a+b* and Carotenoids content also showed quadratic functions as a function of the applied doses.

There were 23% and 22% increments in relation to the control for the variables Chl *a* and Chl *a+b* (Figure 2A), respectively, with 4.9 mL $L^{-1}$ being the ME dose for both. As for Chl *b* (Figure 2A) and Carotenoids (Figure 2B), ME was found at a dose of 5.1 mL $L^{-1}$.

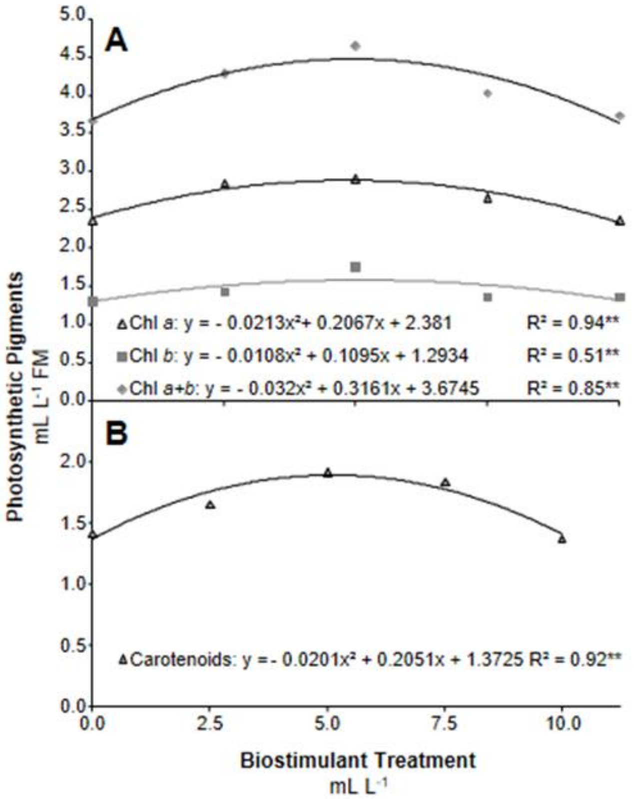


Figure 2. Photosynthetic pigments concentration of Chl *a*, Chl *b* and Chl *a+b* (A), Carotenoids (B) in beet cultivar of Early Wonder Tall Top treated with biostimulant Viva BR® evaluated 35 DAS

Busato et al. (2016), studying the effects of water-soluble humic substances and biofertilizer in Guanandi seedlings, observed increases in chlorophyll contents in plants compared to the control under the application of water-soluble humic substances and biofertilizer of 17.2 and 20.8%, respectively. Baldotto et al. (2009) observed that treatments with humic acids, in pineapple 'Vitoria', provided higher levels of photosynthetic pigments when compared to the control.According to Pelissari et al. (2012), the increase in chlorophyll contents result in higher photosynthetic rates, being directly related to plant growth.

Humic substances (HS) have a recognized to stimulate plant growth, modifying the metabolism and absorption of nutrients (Nardi et al., 2009). Such effect was verified by the increase in the synthesis and activity of membrane proton pumps stimulated by HS, which, consequently, stimulate the absorption of $NO^{3-}$ (Canellas et al., 2006). The greater efficiency of N metabolism, verified by the increased activity of nitrate reductase (NR), an enzyme that catalyzes the reduction of nitrate ($NO^{3-}$) to ammonium ($NH^{4+}$) (Campbell, 1999), was also observed in corn leaves (Vaccaro et al., 2015) and lettuce (Lima et al., 2008) treated with HS.

Consequently, It is concluded that the application via soil of the Viva BR® biostimulant had a positive effect on the development of beet seedlings. All the variables evaluated presented a quadratic behavior, being found the maximum efficiency for the biometric variables at the dose of 6.2 mL $L^{-1}$ while for the qualitative variables it was 5.0 mL $L^{-1}$. As a result, it can be said that substances having a biostimulating impact emerge as a reasonable solution for improving seedling growth.

## ÖZET

***Amaç***: Bu çalışmanın amacı, Viva BR® biyostimülanının farklı dozajlarının Early Wonder Tall Top çeşitlerinin pancar fidelerinin verim ve kalitesini nasıl etkilediğini incelemektir.

***Yöntem ve Bulgular***: Deneme, ilki ekimden 7 gün sonra (ekimden sonraki gün sayısı; DAS), 28 DAS'a kadar olmak üzere 7 günlük aralıklarla, Universidade Tuiuti do Paraná/Brezilya serasında, toplam 5 uygulama (0 (kontrol), 7, 14, 21 ve 28 DAS) olarak, tamamen rastgele bir tasarımda gerçekleştirilmiştir. Maksimum verim biyometrik değişkenler için 6,2 mL $L^{-1}$ dozunda, kalitatif değişkenler için 5,0 mL $L^{-1}$ ise dozunda gözlemlenmiştir.

***Genel Yorum***: Viva BR® biyostimülanının topraktan uygulanmasının pancar fidelerinin gelişimine olumlu etkisi olduğu sonucuna varılmıştır.

***Çalışmanın Önemi ve Etkisi***: Sıcak iklimlerde, Chenopodiaceae familyasından *Beta vulgaris* L. (pancar) baskın türdür ve Brezilya'nın Güneydoğu ve Güney bölgelerinde yoğun olarak yetiştirilmektedir. Fide yetiştirme aşaması, homojenizeyi ve uygun nihai üretkenliği sağlamak için fidelerin tarlaya erken dikilmesini belirler. Bu aşamada verimde artış elde etmek için uygulanan çeşitli teknikler arasında, iki veya daha fazla biyo-düzenleyicinin bitki büyümesini ve gelişimini artırabilecek diğer bileşiklerle kombinasyonundan kaynaklanan biyo-uyarıcı etkileri olan maddelerin uygulanması yer alır. Sonuç olarak, biyo-uyarıcı etkiye sahip maddeler, fide büyümesini

iyileştirmek için makul bir çözüm olarak ortaya çıkmaktadır.

***Anahtar Kelimeler***: *Beta vulgaris* L., pancar, humik maddeler, biyostimulant, Early Wonder Tall Top, Viva BR® Biyostimulant.

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**STATEMENT OF CONFLICT OF INTEREST**
Authors have declared no conflict of interest.

**AUTHOR'S CONTRIBUTIONS**
Marcelle Michelotti BETTONI designed the experiment and analysis of the field data, and reviewed the manuscript. Duelen Carolay Castro CABRAL performed the experiment and the analysis, and draft the manuscript. Tefide KIZILDENIZ contributed to the interpretation of the results, reviewed and elaboration of the final manuscript.

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