# Evaluation of the use biological inoculantes based on *Ascophyllum nodosum* as rooters in maize seeds *cultivar* MG545PWU (Power Core Ultra)

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**Abstract**

The objective of this study was to evaluate the use of rooters in corn using hybrid cultivar MG545PWU (Power Core Ultra). The experiment was installed on a Farm “Chácara Santa Luzia” in the municipality of Rio Verde, Goiás, Brasil, between April and June 2022. The experiment was carried out in pots with a 2:1:1 ratio, with a mixture containing 2 kg of substrate, 1kg of local soil and 1kg of medium-textured sand. The experiment was carried out in a randomized block design with five replications and four treatments. The Treatment was called a control, without adding rooters; Treatment 2 rooting A with addition of 4 mL; Treatment 3 rooting B with addition of 4 mL and Treatment 4 rooting C with addition of 2 mL. Three seeds of corn cultivar MG545PWU were sown in a three-cm depth pot. During the conduct of the experiment, the treatments were irrigated every 3 days after implantation. After 15 days of emergence, thinning was performed, leaving only one germinated plant with greater vigor in each pot. After 30 days with plants in V8, the stem diameter, root length (cm), plant height and fresh and dry mass of the aerial part (g) were measured. As a positive effect, it was observed that rooter B exhibited good results for the variables analyzed in the hybrid cultivar MG545PWU (Power Core Ultra) when compared to rooters A and C and control.

**Keywords:** Genus *Ascophyllum*, Growth promoters, Organic products, Corn cultivars, Inoculates.

**Resumo**

O objetivo desse estudo foi avaliar o uso de enraizadores na cultura do milho utilizando cultivar híbrido MG545PWU (Power Core Ultra). O experimento foi instalado em uma Fazenda “Chácara Santa Luzia” no município de Rio Verde, Goiás, Brasil, entre Abril a Junho de 2022. O experimento foi realizado em vasos com proporção 2:1:1, com mistura contendo 2 kg de substrato, 1kg solo local e 1kg de areia com textura média. O experimento foi conduzido em delineamento de blocos casualizados com cinco repetições e quatro tratamentos. O Tratamento foi chamado de controle, sem adição de enraizadores; Tratamento 2 enraizador A com adição de 4 mL; Tratamento 3 enraizador B com adição de 4 mL e o Tratamento 4 enraizador C com adição de 2 mL. Foram semeadas três sementes de milho cultivar MG545PWU por vazo em profundidade de três cm. Durante a condução do experiment, os tratamentos foram irrigados a cada 3 dias após a implantação. Com 15 dias de emergência, foi realizado desbaste deixando somente uma planta germinada e com maior vigor em cada vazo. Após 30 dias com plantas em V8, foi realizada a medição do diâmetro de colmo, comprimento de raiz (cm), altura de planta e massa fresca e seca da parte aérea (g). Como efeito positive, foi observado que o enraizador B exibiu bons resultados para as variáveis analisadas no cultivar híbrido MG545PWU (PowerCore Ultra) quando comparado aos enraizadores A e C e controle.

**Palavras-chave:** Gênero *Ascophyllum*, Promotores de crescimento, Produtos biológicos, Cultivar de milho, Inoculantes

**Resumen**

El objetivo de este estudio fue evaluar el uso de enraizadores en maíz utilizando el cultivar híbrido MG545PWU (Power Core Ultra). El experimento se instaló en una Granja “Chácara Santa Luzia” en el municipio de Rio Verde, Goiás, Brasil, entre Abril y Junio de 2022. El experimento se realizó en macetas con relación 2:1:1, con una mezcla que contenía 2 kg de sustrato, 1kg de tierra local y 1kg de arena de textura media. El experimento se llevó a cabo en un diseño de bloques al azar con cinco repeticiones y cuatro tratamientos. El Tratamiento se denominó testigo, sin agregar enraizadores; Tratamiento 2 enraizamiento A con adición de 4 mL; Tratamiento 3 enraizamiento B con adición de 4 mL y Tratamiento 4 enraizamiento C con adición de 2 mL. Se sembraron tres semillas del cultivar de maíz MG545PWU en una maceta de tres cm de profundidad. Durante la realización del experimento, los tratamientos se irrigaron cada 3 días después de la implantación. A los 15 días de emergencia se realizó un raleo, dejando solo una planta germinada con mayor vigor en cada maceta. Después de 30 días con plantas en V8, se midió el diámetro del tallo, la longitud de la raíz (cm), la altura de la planta y la masa fresca y seca de la parte aérea (g). Como efecto positivo se observó que el enraizador B presentó buenos resultados para las variables analizadas en el cultivar híbrido MG545PWU (PowerCore Ultra) al compararlo con los enraizadores A y C, y el testigo.

**Palabras clave:** Género *Ascophyllum*, Promotores de crecimiento, Productos orgánicos, Cultivares de maíz, Inoculados

## 1. Introduction

Corn (*Zea Mays* L.) belongs to the Gramineae Poaceae family, with origins in Central America for over 8,000 years, being cultivated in several parts of the world due to its ease of adapting to different environments. Corn seeds are called caryopsis, and under pleasant and favorable climate conditions, they can germinate in 5-6 days, with an ideal temperature for germination around 15 °C (Barros; Calado, 2014). It is from the corn grain that the starch used in various food products is extracted. In addition, this grain is an important source of carbohydrates in the human and animal diet (Tandzi; Mutengwa, 2019).

The Companhia Nacional de Abastecimento (CONAB) estimates for corn in the 2021/22 harvest, from a total area of 21,238.9 thousand hectares, an average productivity of 5,443 kg $ha^{-1}$ for this harvest period. This estimate is 24.6% higher in relation to the previous harvest. The total production forecast is 115,602.1 million tons of corn, an expected increase of 32.7% compared to the previous crop. For exports, the external demand for Brazilian corn produced in the 2021/22 harvest, it is estimated that 37 million tons will leave the country via ports. It is believed that the increase in Brazilian production and the heated international demand should promote a 77.8% increase in grain exports in 2022.

As it is a large crop, with high water requirements and susceptibility to lodging, this plant demands a large amount of roots, with deep and protected rootlets (Embrapa, 2010). For a good plant development and adequate nutrition, it is important that this plant has a well-disposed and developed root system in the soil, since all the absorption of nutrients and water takes place through the root system (Kluthcouski; Stone, 2003).

Through the use of some technologies, the rooting of corn plants can be optimized, among which the use of biological rooters containing micro and macronutrients stands out. For corn, Molybdenum (Mo) and Zinc (Zn) are more relevant, as they act as catalysts for some enzymes in the plant's metabolic processes (Lopes, 1989; Silva et al., 2018). Rooters have several sources of activation, in which they are applied in the treatment of seeds, in order to help the development of rootlets in plants from their initial stage (Lana et al., 2009; Silva; Hussain et al., 2020; Oliveira, 2021). With a well-developed root in length and strength, the corn plant will have greater sustenance, thus reducing the possibilities of plants falling, in addition to favoring the search for nutrients and water, providing physiologically better development for the plants (Simeoni et al., 2018; Silva et al., 2021).

The seaweed extract (*Ascophyllum nodosum*) has been widely used in several cultures, as it exhibits positive results with biostimulant action (Backes et al., 2017). Among the rooters, products of natural origin have been gaining space between products of synthetic and semi-synthetic origin (Vogel; Fey, 2019). Natural products present good results or even superior to commercial products from different origins. In particular, when applied, algae extracts provide special resistance mainly to water stress or to phytopathogens due to the presence of betaine in their content (Rossetti; Centurion, 2020; Pereira et al., 2021).

Rooters are generally used as root strengtheners, thus stimulating growth, providing water control in climatic variations, improving germination vigor and providing a better effect against phytopathogen attacks (Vanazzi et al., 2019). In general, the sources of rooters are composed of micronutrients, amino acids, stimulants, ascorbic acids, vitamins and proteins (Libera, 2010; Oliveira et al., 2018).

The rooters have the main function to improve the root system of the corn plant, making these roots explore a larger area of soil and thus have the possibility of absorbing a greater quantity of nutrients and, as a consequence, the plant can emerge with superior vigor and present development, with higher quality in their reproductive cycle (Neves; Mendes Júnior, 2018). Rooters also act as plant growth regulators, as previously treated plants have greater tolerance to stress factors (Aragão et al., 2003; Silva Neto et al., 2021).

The greater distribution of roots helps in greater absorption of water and nutrients, due to greater adherence and exploration of the soil, in addition to providing the plant with greater stability and increase in root architecture, helping the plant to be more resistant to water deficit. Therefore, the use of rooters in corn can be a viable alternative to increase the resistance of the crop (Berticelli; Nunes, 2009; Wang et al., 2019).

According to Lana et al. (2009), with faster rooting, the plant achieves greater resistance to diseases and pests, associated with a greater absorption of nutrients, due to the development of the rhizosphere, thus providing a faster, more resistant local establishment and consequently will be reflected in the final production. According to Berticelli & Nunes (2009), the use of rooters in corn increased the production of green mass in the flowering phase, and the final grain yield was statistically positive for the use of rooters, due to the fact that the increase in the number of rows and grains per ear, which justify such an increase in productivity.

Therefore, the objective of this work is to evaluate the use of rooters based on the extract of *Ascophyllum nodosum* algae on corn seeds using the hybrid cultivar MG545PWU (Power Core Ultra) in an environment without natural control.

## 2. Materials and Methods

The experiment was installed on a Farm "Chácara Santa Luzia" located in the municipality of Rio Verde, Goiás State, Brasil, coordinates (17.84853ºS and 51.15791ºW), between April 2022 and June 2022. The experiment was carried out in 10 L pots with the proportion 2:1:1, being mixed 2 kg of Solo Forte Premium substrate, with the composition (pine bark, ash, peat, third-party agro-industrial organic residue and limestone), 1 kg of soil was also added. The experimental system was maintained in an environment without control of irradiance, temperature and humidity. The soil used was collected in an area of the farm, which the physical-chemical analysis of this sample revealed the following characteristics as observed in Tables (1 and 2) and finally 1kg of medium textured sand.

**Table 1.** Physicochemical characteristics of the soil sample.

| **pH** | | **Ca** | **Mg** | **H+Al** | **K** | **P (mel)** | **S** | **B** | **OM** | **CO** |
|---|---|---|---|---|---|---|---|---|---|---|
| SMP | $CaCl_2$ | | $cmol_c\ dm^{-3}$ | | | $mg\ dm^{-3}$ | | | $g\ dm^{-3}$ | |
| 6.4 | 5.1 | 1.6 | 0.66 | 3.5 | 69 | 44 | 17.1 | 0.2 | 17.4 | 10.1 |

| **Cu** | **Fe** | **Mn** | **Zn** | **Na** | **T** | **t** | **Clay** | **Silt** | **Sand** |
|---|---|---|---|---|---|---|---|---|---|
| | | $mg\ dm^{-1}$ | | | $cmol_C\ dm^{-3}$ | | | % | |
| 2.1 | 72 | 35 | 1.9 | 2.6 | 5.9 | 2.5 | 34.5 | 7.5 | 58.0 |

Source: Authors, 2022.

The treatment of 1 kg of seeds of the corn hybrid MG545PWU (Power Core Ultra) from Morgan was carried out (for the treatment of the seeds, the product MAX ADV was used in the IST (industrial seed treatment)). The experiment was carried out in a randomized block design with five replications, using four treatments.

In treatment A (control) without addition of rooters; treatment 2 with addition of 4 mL of (Rooter B) (based on plant extracts: Gibberellin, Auxin and Cytokinin. Assurance levels: Nitrogen 18 g $L^{-1}$, Potassium oxide 60 g $L^{-1}$, Boron 0.96 g $L^{-1}$; Iron 4.8 g $L^{-1}$; Manganese 12 g $L^{-1}$; Sulfur 12 g $L^{-1}$; Zinc 24 g $L^{-1}$ and Total Organic Carbon 42 g $L^{-1}$); treatment 3 addition of 4 mL of (Rooter C) (*Ascophyllum nodosum* algae extract), Cobalt, Molybdenum and Gibberellin. Assurance levels: Co 12.8 g $L^{-1}$; Mo 89.6 g $L^{-1}$; Density 1.28 g $mL^{-1}$; EC 51.53 mS $cm^{-1}$; Saline content 19.56% and pH 5.5) and treatment 4 addition of 2 mL of (Rooter D) (*Ascophyllum nodosum* algae extract). Levels of assurance: K 61.48 g $L^{-1}$; Total Organic Carbon 69.60 g $L^{-1}$; pH 8.0; Density 1.16 g $mL^{-1}$; Salt content 18% and 0.5% citric acid complexing agents.

Taking into account that 1 bag of hybrid corn seed has the recommendation of planting 60,000 seeds with a weight of 19.7 kg, the recommended products are Rooters A 4 mL $kg^{-1}$, B 4 mL $kg^{-1}$ and C 2 ml/ kg of seed. Three corn seeds were sown per pot at a depth of three cm each, during the experiment they were irrigated every 3 days after implantation. After 15 days of emergence, thinning was performed, leaving only one germinated plant with greater vigor per pot. After 30 days, the final procedure was performed when the treatments were in V8, and the stem diameter, root length, root weight, plant height and fresh and dry mass were measured. The dry mass was determined in an oven with air circulation at 36 °C for 48 h and then the mass was determined on a digital analytical balance.

The results obtained were submitted to statistical analysis using the SISVAR 5.6 program (Ferreira, 2014) where the $F$ test was applied with $p < 0.05$ of significance.

## 3. Results and Discussion

According to Table 2, there is a significant difference between the treatments on the parameters plant height and stem diameter, in which the B and C rooters presented higher values compared to the A and control rooters. For root length, rooters A, B and C showed good results compared to the control treatment. For shoot fresh mass the rooter B, showed the highest value compared to the other rooters and control. As for shoot dry mass, rooters B and C showed higher values compared to rooter A and control. No significant effects were observed for root fresh mass (CV = 9.85%) and root dry mass (CV = 9.97%).

The positive effects of the application of algae extracts in crops show good results on the increase of the root system, higher seed germination rate, seedling establishment, mobilization, absorption, distribution of nutrients, rooting, growth, flowering of plants, increase in productivity, high leaf chlorophyll content, among others, in addition to providing tolerance to biotic and abiotic stresses, according to Sharma et al. (2014). The mechanisms that explain the stimulation of algae extract in plant development consist of the modulation of phytohormones, increase in photosynthetic efficiency, better stomatal conductance and regulation of biosynthesis (Popescu, 2014).

Among the phytohormones, the extract of *A. nodosum* in plants has shown effects similar to the group of cytokinins, known for their stimulation of protein synthesis, influence on cell division and differentiation and their interaction with other plant hormones, most notably in Auxins. In terms of crop responses, cytokinins are implicated in all stages of plant growth, as well as the formation of roots, shoots, stems and leaves. The fact that the production of these natural substances can be induced by the extract of *Ascophyllum nodosum* provides a nutritional contribution, which can complement conventional fertilizer programs. Examples of specific benefits that affect yield and quality may include better fruit, vigorous root development, and improved stress tolerance (Norrie, 2016).

Simeoni et al. (2018) used the corn cultivar 2B810 (Dow) and observed that the average length of roots and shoots of seedlings were not significant by the *Tukey* test with 5% significance when different rooters and the control were evaluated. The same occurred for the dry mass of the roots. Although still in this study, the researchers observed significance on the dry matter of seedlings with rooters. In the study conducted by Berticelli & Nunes (2009) the researchers evaluated the efficiency when using the rooter in the corn crop, focusing on the analysis of plant height, stem diameter, 1000-grain mass, fresh mass, insertion of the 1st ear, number of grains, rows per ear and final yield, in which the results of plant height, stem diameter and weight of one thousand grains did not show significant difference, while the other evaluations showed to be superior when compared to the treatment.

**Table 2.** Parameters on plant height (cm), stem diameter (mm), root length (cm), fresh and dry mass of the aerial part of corn crop hybrid MG545PWU (Power Core Ultra).

| Parameters | Height (cm) | Diameter (mm) | Root length (cm) | Aerial fresh mass (g) | Aerial dry mass (g) |
|---|---|---|---|---|---|
| Witness | 54.42 b | 11.68 c | 49.00 b | 22.50 b | 3.35 c |
| A | 58.47 ab | 12.75 bc | 63.47 a | 25.75 ab | 3.73 bc |
| B | 62.82 a | 14.57 a | 63.30 a | 30.75 a | 5.04 a |
| C | 63.37 a | 13.72 ab | 61.75 a | 26.75 ab | 4.51 ab |
| **CV (%)** | 5.96 | 3.72 | 5.82 | 12.80 | 11.21 |

**Note:** A, B and C: Commercial rooters. CV%: Coefficient of variation. Different letters in the same column differ statistically according to the *F* test with $p < 0.05$ of significance. Source: Authors, 2022.

## 4. Conclusions

In this study, it can be observed that the rooter B exhibited the best results for the variables analyzed in the hybrid cultivar MG545PWU (Power Core Ultra) from Morgan according to the F test.

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