

**Performance of the dekalb 230 corn hybrid using biostimulants: phenological and productive characteristics****Desempenho do híbrido de milho dekalb 230 utilizando bioestimulantes: características fenológicas e produtivas**

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## ABSTRACT

Corn is among the main grain crops grown in Brazil, standing out for its high yield potential. The increase in productivity achieved by the crop is due to genetic improvement, correct management practices and adhesion of new technologies available in the market, among them is the use of products with biostimulant action. The objective of this study was to evaluate the effect of seed and leaf applied biostimulant packages in order to analyze the vegetative and reproductive development variables of the DKB 230 (Dekalb) corn hybrid. The experiment was conducted in the agricultural year of 2018/2019 in the experimental area of the Federal University of Santa Maria campus of Frederico Westphalen / RS. The experimental design was randomized blocks, with five biostimulant treatments, namely, Vigor S®, Potassium with algae® and Grains +®; Vigor G®, Potássio com algas® and Grãos +®; Vigor SS®, Potássio com algas® and Grãos +®; Stimulate®, Start® and Mover®; and control (without any biostimulant), with four repetitions. Plant height, stem diameter, average number of rows of grain per ear, weight of one thousand seeds and grain yield were evaluated. According to the results obtained, the biostimulant packages did not influence the evaluated variables, under the conditions of the experiment.

**Palavras chave:** *Zea mays* L.; Development; Productivity.

## RESUMO

O milho está entre as principais culturas de grãos cultivadas no Brasil, destacando-se por seu alto potencial de produtividade. O aumento de produtividade alcançado pela safra deve-se ao aprimoramento genético, práticas corretas de manejo e adesão de novas tecnologias disponíveis no mercado, dentre elas o uso de produtos com ação bioestimulante. O objetivo deste estudo foi avaliar o efeito de embalagens bioestimulantes aplicadas em sementes e folhas para analisar as variáveis de desenvolvimento vegetativo e reprodutivo do híbrido de milho DKB 230 (Dekalb). O experimento foi conduzido no ano agrícola de 2018/2019 na área experimental do campus da Universidade Federal de Santa Maria de Frederico Westphalen / RS. O delineamento experimental foi em blocos casualizados, com cinco tratamentos bioestimulantes, Vigor S®, Potássio com Algas® e Grãos +®; Vigor G®, Potássio com algas® e Grãos +®; Vigor SS®, Potássio com algas® e Grãos +®; Stimulate®, Start® e Mover®; e controle (sem nenhum bioestimulante), com quatro repetições. Foram avaliados a altura da planta, diâmetro do caule, número médio de linhas de grãos por espiga, peso de mil sementes e produtividade de grãos. De acordo com os resultados obtidos, as embalagens bioestimulantes não influenciaram as variáveis avaliadas, nas condições do experimento.

**Palavras-chave:** *Zea mays* L.; Desenvolvimento; Produtividade.

## 1 INTRODUCTION

Corn crops are important for the Brazilian agricultural sector, due to their high productive potential and their various uses. They stand out for being among the main grain crops, which, at the same time, have been reaching a new level of productivity and reaching record yields. In this sense, the 2018/2019 corn crop is being considered the largest crop in the history of Brazil, with a production of 99.31 million tons of grain. Similarly, in the state of Rio Grande do Sul (RS) yield was significantly higher than the 2017/2018 crop, with an expected increase of 15.4% [1].

The increase in yield obtained from maize crop stems from genetic improvement, correct management practices and soil fertility, due to maize crop being extremely sensitive to soil-imposed nutritional conditions [2]. Among the innovations that seek to minimize stress generated by fertility,

the use of products with biostimulant action can contribute to increased productivity and offer several benefits, including greater tolerance to abiotic and biotic stresses [3].

Biostimulants are capable of causing changes in the vital and structural processes of the plant, since they are intended to promote hormonal balance, stimulate cell division and elongation (increase in root growth), supply the need for some essential nutrients, and increase soluble sugar levels and amino acid content [4].

According to [5] the use of biostimulant in corn provided an increase in stem diameter, number of grains per row and number of grains per ear. Although in this study, the authors point to gains with the application of biostimulants, there are still doubts of their response, especially for corn crops in other soil situations and climatic conditions.

From this perspective, we emphasize the need to seek more information about the effect of these products on plant development, assuming that biostimulants will positively influence the development and yield of corn crop. Thus, the objective of this work was to evaluate the effect of seed and leaf applied biostimulants on the development and yield of the DKB 230 corn hybrid.

## 2 MATERIAL AND METHODS

The experiment was conducted in the agricultural year of 2018/2019, in the experimental area of the research group Environmental Management and Water Resources Management at the Federal University of Santa Maria campus of Frederico Westphalen / RS, located at a latitude of 27°39'26" S and longitude 53°42'94" W, with an average altitude of 490 meters and humid subtropical climate, type Cfa, with average annual precipitation of 1,881 mm and average temperature of 19.1°C according to the Köppen classification [6].

The soil of the experimental area is classified as typical dystrophic Red Latosol, with clay texture and deep profile. Soil chemical analysis was performed before the winter crop was implanted, from soil sampling in the 0-20 cm layer and presented the following results: clay 60%; pH (H<sub>2</sub>O): 6.0; P: "3.8 mg dm<sup>-3</sup> (Mehlich<sup>-1</sup>)"; K: "128.0 mg dm<sup>-3</sup>"; Ca<sup>2+</sup>: "11,8 cmole<sub>c</sub> dm<sup>-3</sup>"; Mg<sup>2+</sup>: "3,8 cmole<sub>c</sub> dm<sup>-3</sup>" and 2.4% of organic matter.

The winter cultivation prior to the implementation of the experiment was barley (*Hordeum vulgare*), which was previously desiccated thirty days before corn sowing, with manual application of the herbicide Glyphosate.

The experiment was conducted in partnership with the company Agroimport, which provided the inputs used. The experimental design used was randomized blocks, with five treatments (table 1), one variety and four replications. The plots of the experiment measured 2.5 meters wide and 4 meters long, thus totaling an area of 10.00 m<sup>2</sup>.

Table 1. Treatments used in the Dekalb corn hybrid 230, 2018/2019.

| Treatment | Product             | Application Form | Dosage                  |
|-----------|---------------------|------------------|-------------------------|
| 1         | Control             | -                | -                       |
| 2         | Vigor S®            | Seed             | 15 mL kg <sup>-1</sup>  |
|           | Grãos +®            | Leaf             | 600 ml ha <sup>-1</sup> |
|           | Potássio com algas® | Leaf             | 500 ml ha <sup>-1</sup> |
| 3         | Vigor G®            | Seed             | 15 mL kg <sup>-1</sup>  |
|           | Grãos +®            | Leaf             | 600 ml ha <sup>-1</sup> |
|           | Potássio com algas® | Leaf             | 500 ml ha <sup>-1</sup> |
| 4         | Vigor SS®           | Seed             | 15 mL kg <sup>-1</sup>  |
|           | Grãos +®            | Leaf             | 600 ml ha <sup>-1</sup> |
|           | Potássio com algas® | Leaf             | 500 ml ha <sup>-1</sup> |
| 5         | Stimulate®          | Seed             | 5 mL kg <sup>-1</sup>   |
|           | Start®              | Leaf             | 600 ml ha <sup>-1</sup> |
|           | Mover®              | Leaf             | 600 ml ha <sup>-1</sup> |

\*Applied to seed: phenological stage V4 e V8.

\*Products Vigor S®, Vigor SS®, Vigor G®, Grãos +® & Potássio com algas® are classified as biofertilizers, Stimulate® is a plant growth regulator and Star® & Mover® are leaf fertilizers.

Treatments 2, 3 and 4 in the experiment are packages of biostimulants from Agroimport. VIGOR products (VIGOR S®, VIGOR SS® & VIGOR G®) are bioactivators developed from seaweed (*Ascophyllum nodosum*), which have in their composition auxins, cytokinines, betaines and polysaccharides such as alginic acid and mannitol.

Vigor S® contains in its composition 10% organic carbon, 5% molybdenum and 1% cobalt. Vigor SS® contains 1% cobalt, 10% molybdenum and 8% organic carbon. Vigor G® is composed of 8% organic carbon, 5% molybdenum, 1% cobalt, 3% zinc, 0.2% nitrogen and 2% sulfur.

Grains +® and Potássio com algas® products make up the VIGOR line biostimulant packages. The product Grains +® has in its composition organic carbon 16.5%, P<sub>2</sub>O<sub>5</sub> 5%, K<sub>2</sub>O 6,5%, algae extract and polysaccharides and Potássio com algas® contains 10% organic carbon, 25% potassium, hydrolyzed proteins, algae extract and polysaccharides.

The other treatment consists exclusively of products produced by the company Stoller. Stimulate® is composed of 90 mg L<sup>-1</sup> kinetin (cytokinine), 50 mg L<sup>-1</sup> gibberellic acid (gibberellin), 50 mg L<sup>-1</sup> indolbutyric acid (auxin) and 99.98% inert ingredients. For leaf applications, Start® leaf fertilizer was used, which provides nitrogen 10-30%, calcium 10-30%, boron 10-30%, amines and amino compounds 05-10% and the leaf fertilizer Mover®, which is a nutrients complex containing nitrogen, boron, copper, molybdenum and zinc.

The basic fertilization occurred mechanically, and was based on soil analysis following the recommendations of the Manual de Calagem e Adubação para os Estados do Rio Grande do Sul e Santa Catarina (2016) (liming and fertilization manual for the states of Rio Grande do Sul and Santa

Catarina). In the same operation, the lines for sowing were drawn (resulting in five rows per plot), which were sown with the corn crop manually on October 23, 2018. For the best establishment of the plants in the experiment, in order to avoid germination failures, two seeds were sown together, and after seedling establishment, thinning was performed, totaling four corn plants per linear meter.

The corn hybrid used was the DKB 230 PRO3 (Dekalb) variety with a hyper early cycle. Corn seeds received only biostimulants, as they already contained the industrial seed treatment (TSI).

The application of biostimulant via seed was performed manually, using plastic bags, identified with each type of treatment and agitated in circular movements. After that, the seeds were shadow dried for 1 hour, following the methodology proposed by [7]. For the foliar application of biostimulants, a hand-held sprayer was used, in the predefined stages by the biostimulant manufacturing companies, as presented in the footer of table 1.

For nitrogen cover crop fertilization, urea was applied manually at the phenological stage V4 of the crop, where the remaining 60% was applied. During the experiment, all necessary phytosanitary treatments were carried out, both for weed management and for pests and diseases.

The first phenological evaluation in corn crop occurred at 40 days after emergence (DAE) in 10 random plants of each plot, which were contemplated in the three central lines of the plot, discarding the two peripheral border lines. Plant height (PH) evaluations were performed using a graduated ruler, measuring from the base of the plant to the last fully expanded leaf and stem diameter (SD) measured at the smallest neck circumference of the first internode of the plant, with the aid of a digital caliper.

At the end of the corn cycle, on February 23, 2019, the crop was manually harvested and subsequently the evaluation of 10 random plants of each plot was made, respecting the border lines again. In the laboratory, the following variables were analyzed: Average number of grain rows per ear (NRE) with manual counting of grain rows of 10 ears of each repetition. Weight of one thousand seeds (WTS) counted by means of a seed counter and weighed on a digital scale and the grain yield (GY), quantified by the total weighing of the manually threshed ears of each parcel, after weighing, the data obtained were extrapolated in  $\text{kg ha}^{-1}$ .

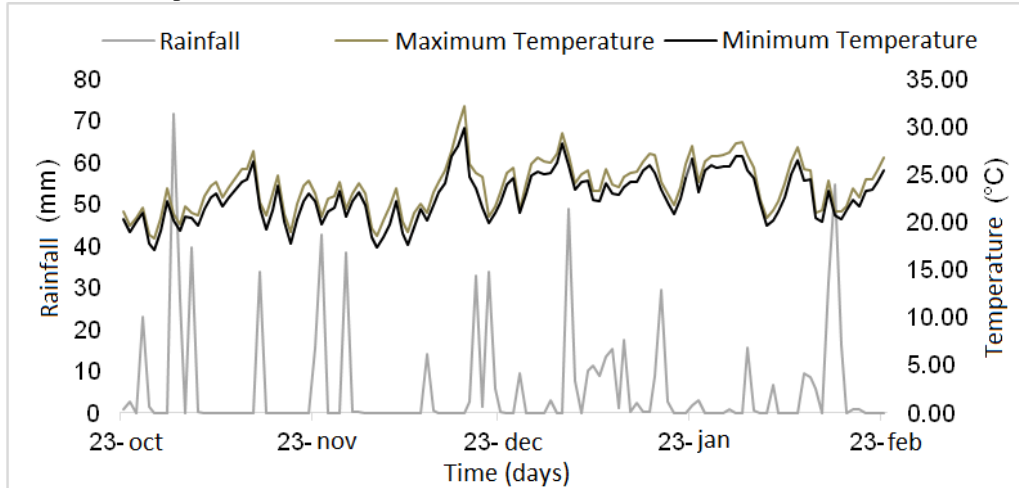
The data were submitted to variance analysis (ANOVA), and the averages were compared by the Tukey test at 5% error probability, using the statistical program SISVAR.

### **3 RESULTS AND DISCUSSION**

Figure 1 corresponds to rainfall data, maximum temperature and minimum temperature during the experiment. The data obtained are from an automatic weather station, linked to the National

Institute of Meteorology (INMET), installed at the Federal University of Santa Maria campus in Frederico Westphalen-RS.

**Figure 1** Distribution of precipitation, maximum temperature and minimum temperature while conducting the experiment. Frederico Westphalen- RS, 2018/2019.



As shown in figure 1, the temperature during the crop cycle oscillated between 20 and 30°C, a value close to that mentioned by [8] for a good crop development. Rainfall during the experiment was responsible for accumulating 738.9 mm, volume considered ideal for corn development [9].

In the results analyzed for the variables plant height and stem diameter, it was noted that treatment 5 presented superiority regarding plant height, with 66.7 cm in height, and also regarding stem diameter, with a diameter of 13.5 cm, however, even though the treatment stood out from the others, there was no statistically significant difference between treatments. This result, although not significant, may be related to the composition of plant regulators, which stimulate elongation and cell division. On the other hand, treatment 3 presented the smallest plant height (56.67 cm) and the smallest stem diameter (11.92 mm) when compared to the other treatments.

Table 2. Average plant height (PH) and stem diameter (SD) values of Dekalb 230 corn hybrid, submitted to different biostimulant packages, Frederico Westphalen, 2019.

| Treatment   | PH (cm)             | SD (mm)             |
|-------------|---------------------|---------------------|
| 1           | 58.2 a              | 12.3 a              |
| 2           | 64.3 a              | 12.6 a              |
| 3           | 56.7 a              | 11.9 a              |
| 4           | 60.6 a              | 12.4 a              |
| 5           | 66.7 a              | 13.5 a              |
| Values of F | 1.839 <sup>ns</sup> | 0.774 <sup>ns</sup> |
| CV(%)       | 10.02               | 10.69               |

\*Averages followed by the same letter in the column do not differ from each other by the 5% Tukey test. <sup>ns</sup>: not significant at 5% by Tukey test.

Like the present study, [10] found that the treatment of corn seeds with doses of Fertiactyl® SD biostimulant did not result in significant differences for the plant height and stem diameter variables, thus highlighting the lack of influence that biostimulants have on the initial development of plants.

[11] Also did not obtain significant results with Stimulate® seed application for the variable height of passion fruit seedlings, evaluated at 60 DAE. Period which the author believes was not sufficient for a satisfactory response of the biostimulant.

Regarding the variable stem diameter, no significant differences were found regarding the treatments used, as well as the results presented in table 3, a result that strengthens that found by [12], where the author also found that under conditions without extreme stress (salinity), the use of biostimulants did not present significant difference regarding the stem diameter variable on the control (plants that did not receive seed treatment with biostimulant).

[13] Testing different biostimulants and different times of application of the same, also did not find significant differences in the item SD, thus affirming the inexistence of improvements for the corn crop from the biostimulants regarding stem diameter.

Analyzing Table 3, it is noted that no statistically significant differences were observed for either of the variables analyzed after harvest, due to the application of biostimulant packages.

Table 3. Average values of grain rows per ear (NRE), weight of one thousand seeds (WTS) and grain yield (GY) of Dekalb 230 corn hybrid, submitted to different biostimulant packages, Frederico Westphalen, 2019.

| <b>Treatment</b> | <b>NRE (units)</b>  | <b>WTS (Kg)</b>     | <b>GY (Kg ha<sup>-1</sup>)</b> |
|------------------|---------------------|---------------------|--------------------------------|
| 1                | 14.0 a              | 0.344 a             | 10,084.0 a                     |
| 2                | 14.5 a              | 0.355 a             | 11,062.5 a                     |
| 3                | 14.0 a              | 0.322 a             | 10,539.0 a                     |
| 4                | 15.0 a              | 0.343 a             | 11,022.5 a                     |
| 5                | 15.0 a              | 0.358 a             | 10,779.0 a                     |
| Values of F      | 0.714 <sup>ns</sup> | 1.698 <sup>ns</sup> | 0.291 <sup>ns</sup>            |
| CV (%)           | 8.16                | 6.21                | 13.94                          |

\*Averages followed by the same letter in the column do not differ from each other by the 5% Tukey test.

<sup>ns</sup>: not significant at 5% by Tukey test.

However, there was a tendency of positive response in treatments 4 and 5 which presented the best results for the variable number of grain rows per ear, reaching an average of 15 rows. Treatment 5 also obtained the highest weight of one thousand seeds 0.358 Kg, very close to that found in treatment 2 (0.355 Kg), which reached the highest yield with 11,062.50 Kg ha<sup>-1</sup>.

The treatments that stood out had in their composition plant regulators, such as gibberellins that have a great influence on pollination and fruit formation, in addition, the higher productivity may be linked to the nutrients constituting biostimulants.

In their study, [14] also reported that the use of Stimulate® biostimulant via seeds and via leaf in soybean crop increases grain yield in both types of application. Attesting that the application of biostimulant in the reproductive phase of the crop is more effective in increasing productivity.

Further emphasizing the results analyzed in the present study, [15] also did not observe a significant effect of biostimulant application on any of the analyzed variables (plant height, number of ears per m<sup>2</sup>, number of grains per ear, grain yield, hectoliter weight and mass of 1,000 wheat grains) when applied at different times in the wheat crop. Thus validating the authors' hypothesis that the wheat crop does not respond positively to the application of biostimulant, be it applied at any time.

Similarly, analyzing all the results found in the present work, it was found that there were no significant effects with the application of biostimulant packages in the DKB 230 corn hybrid, for local conditions. This result confirms that found by [16], where the authors tested different seed treatments with biostimulants in different corn genotypes, and concluded that the biostimulants used did not interfere in the productive factors or in the productivity in relation to the control, attributed to the good conditions, generally speaking, in which the soil was.

In hypothesis, the good soil conditions of the experimental area, guaranteed the plants an adequate nutritional balance, supplying all the needs for the crop development, a fact proven by the inexistence of statistical difference between the control and the other treatments. Temperature and rainfall are also determining factors for their vegetative and reproductive development and these must be in accordance with the need of the plants, conditions observed during the conduction of the experiment, as shown in figure 1.

In addition, plants subjected to stress may limit the production of plant hormones, so applying a product may increase plant hormone levels and, consequently, stimulation. Thus, it is possible that the studied biostimulants did not show significant effects because they were used in a favorable environment for corn development and productivity. The DKB 230 corn hybrid may also not be responsive to biostimulant application or even the doses used may not have been effective even if applied as recommended.

#### **4 CONCLUSION**

The use of biostimulant packages (Vigor S®, Potássio com algas® and Grãos +®; Vigor G®, Potássio com algas® and Grãos +®; Vigor SS®, Potássio com algas® and Grãos +®; and Stimulate®, Start® and Mover®) did not significantly affect the analyzed vegetative and reproductive variables of the DKB 230 corn hybrid.

The DKB 230 corn hybrid did not respond significantly to seed and leaf biostimulant application, due to adequate soil conditions and climate of the experimental area.



For future work, it is suggested that the use of biostimulant should be tested in different application forms and under adverse environmental conditions, in order to really verify its economic viability, obtained by the significant increase of corn productivity.

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