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Performance of Corn Hybrids as a Function of Nitrogen Doses and *Trichoderma Harzianum*

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Abstract

This study aimed to assess the performance of commercial corn hybrids with the application of *Trichoderma harzianum* under varying nitrogen levels. The experiment was conducted at the State University of Goiás, Campus Sul, during the 2022/23 harvest. The experimental design employed a factorial scheme 9 x 3, involving nine commercial hybrids and three nitrogen doses, randomized in blocks with three replications. Three nitrogen doses were applied: control (160 kg ha^{-1} of nitrogen), low nitrogen (80 kg ha^{-1} of nitrogen), and low nitrogen (80 kg ha^{-1} + *Trichoderma harzianum*). The evaluation encompassed ear height, plant height, relative chlorophyll index, stem diameter, number of rows, number of lines, and dry grain mass. The hybrids 2M77, 2M80, P3898, and P4285 exhibited superior efficiency with 80 kg ha^{-1} of nitrogen, while DKB390 and P3898 demonstrated the highest responsiveness to the recommended dose of 160 kg ha^{-1} of nitrogen. The inoculation of *Trichoderma harzianum*, combined with 80 kg ha^{-1} of nitrogen, resulted in increased grain mass, in the hybrids 30A91PW, DKB390, GNZ7280, P4285, and RK3014, with variable benefits across different characteristics. However, it is advisable to limit the use of *Trichoderma harzianum* to these specific commercial cultivars.

Keywords: *Zea mays*, bioinput, biostimulant, synergism, urea

1. Introduction

In achieving high yields in maize cultivation, nitrogen (N) stands as one of the pivotal fertilizers, yet it is frequently mismanaged by producers (Ransom et al., 2020). Studies indicate that approximately 30 to 40% of applied N is absorbed by plants, while over 60% remains in the soil, commonly lost through leaching, surface runoff, denitrification, volatilization, and microbial consumption (Santos et al., 2019).

Continuous investments in the genetic enhancement of corn aiming to bolster productivity, agronomic adaptability, and resilience to climatic variations persist as concerns within the agricultural sector and for food security (Gedil & Menkir, 2019). Thus, a potential avenue could involve blending organic technologies with the utilization of microorganisms that facilitate plant development. This synergistic effect within the root zone could foster sustainability in modern agriculture, enabling producers to achieve heightened yields without added burdens (Baez-Rogelio et al., 2017).

The *Trichoderma* fungus has been extensively used in agricultural practices as a more efficient cost-effective approach, presenting itself as an enhancer in the use of endogenous nitrogen, due to its symbiotic association, its capacity encompasses the regulation of the transcription of nitrate, phytohormones (auxin, gibberellins, cytokinin and ethylene) and positively regulated in the absorption of this nutrient (Singh et al., 2019).

As per Sood et al. (2020), *Trichoderma* spp. exerts a beneficial influence on diverse physiological systems in plants, including processes like photosynthesis, stomatal conductance, gas exchange, nutrient absorption, water use efficiency, and more. Consequently, these microorganisms can enhance root growth and augment the uptake of mineral nutrients and water from the soil. In corn, Airspe-Vásquez et al. (2023) tested promotion with *T. asperellum*, *T. harzianum* and *T. longibrachiatum*, in different corn genotypes, which resulted in an increase in productivity in specific genotypes, a reduction in diseases and enabling producers to grow crops with greater profitability, especially when using *T. asperellum* - T11.

This study aimed to assess the performance of commercial corn hybrids with the application of *Trichoderma harzianum* under varying nitrogen levels.

2. Method

The experiment took place at the State University of Goiás, South Campus, Ipameri University Unit (Lat. 17° 42' 59.12" S, Long. 48°08' 40.49" W, Alt. 773 m), specifically in the unit's experimental farm, during the 2022/23 growing season. The soil used for cultivation was a Dystrophic Red Latosol (Oxisols) (Santos et al., 2018). The region's climate falls under the Tropical (Aw) classification by Köppen, characterized by dry winters, humid summers, and an average temperature of 20°C (Alvares et al., 2013).

The experiment followed a randomized block design with a factorial scheme (9 x 3) and three replications. The study involved nine distinct commercial hybrids (as detailed in Table 1) subjected to three N doses at the base: control (160 kg ha^{-1} of N), low N (80 kg ha^{-1} of N), and low N^{+} (80 kg ha^{-1} of N with the application of *Trichoderma harzianum* - Ecotrich® WP - isolate IBLF 006), and for all treatments 140 kg ha^{-1} of P_2O_5, and 90 kg ha^{-1} of K_2O, according Faria et al. (2023b). Experimental plots consisted of two 4m rows, with a row spacing of 0.45m and three plants per meter, resulting in an approximate stand of 66,000 plants.

The soil was conventionally prepared with one plowing and two harrowing's, followed by the use of a cultivator to open the sowing furrows. The soil has a medium texture and was fertilized based on the soil analysis results (Table 2). The fertilizer sources used were urea (45% N), simple superphosphate (18% P_2O_5) and potassium chloride (60% K_2O), with application in the sowing furrow and with coverage only in the control with equitable distribution between doses.

Table 1. Agronomic characteristics of the commercial corn hybrids used in the experiment

Commercial Hybrids	Availability	Hybrid Type	Main Use	Plant Height (cm)	Degree Days	Cycle	Grain Color	Grain Type
2M77	MC/SC	S	GR	240	850	PRE	AL	SD
2M80	MC/SC	S	GR	215	-	PRE	AL/AV	SD
30A91PW	MC/SC	SM	GR/SL	230	902	PRE	AM/AL	SD
ADV9860	MC/SC	S	GR	230-250	880	PRE	AL	SD
DKB390	SC	S	GR	251	870	PRE	AM/AL	SD
GNZ7280	MC/SC	S	GR	230-270	840	PRE	AL	SD
P3898	MC/SC	-	GR/SL	257	-	PRE	SI	SD
P4285	MC/SC	S	GR/SL	295	142	PRE	AM	D
RK3014	MC/SC	T	GR/SL	225-240	830	PRE	AL	D

MC- Main Crop; SFR- Second Crop; S- Simple; SM- Modified Simple; T- Triple; GR- Grains; SL- Silage; PRE- Early; AL- Orange-colored; AV- Reddish; AM- Yellowish; SD- Semi-hard; D- Hard.

The seeds were treated with *Trichoderma harzianum* – isolate IBLF 006 (Ecotrich WP; Ballagro Agro Tecnologia Ltda., Piracicaba, SP, Brazil), which was placed in direct contact with the *T. harzianum* isolate in an amount of 8 mL of suspension, at a dose of 2.5x10^{8} cells/100 g of seed, the dose being based on results obtained by Oliveira et al. (2018) in wheat, using a manual pressure sprayer (550 mL) until they were soaked and immediately in the field, manually.

Table 2. Main chemical characteristics of the soil (0-20 cm depth) without any application of fertilizer or lime. Ipameri, GO, UEG

Traits	pH	M.O.	P_{resina}	H+Al	K	Ca	Mg	SB	CTC	V%
	$CaCl_2$	g dm^{-3}	mg dm^{-3}	mmol dm^{-3}						
Solo	4.9	24.1	9.0	30.3	4.1	18.2	7.5	27.8	57.6	47.7

pH - active acidity, M.O. - Organic matter, P - Available Phosphorus, H+Al - Potential acidity, k - Available Potassium, Ca - Exchangeable Calcium, Mg - Exchangeable Magnesium, CTC - Effective Cation Exchange Capacity, V% - Base saturation.

Cultivation consisted of manual weeding to control weeds and the application of phytosanitary products, including chlorantraniliprole 100 gr L^{-1} + lambda-cyhalothrin 50 gr L^{-1} (Ampligo®) at a rate of 150 mL ha^{-1} to control cartridge caterpillars (*Spodoptera frugiperda*) according Cintra et al. (2023).

The assessment covered several characteristics: Ear Height (EH) - measured as the distance in centimeters from the ground to the main ear; Plant Height (PH) - measured as the height in centimeters from the ground to the plant's top (stem apex); Relative Chlorophyll Index (RCI) - measured with the CFL1030 (SN0359) instrument, expressed in grams of chlorophyll, taken from three fully expanded leaves in the middle section of the plants, 80 days after sowing; Stem Diameter (SD) - determined as the average diameter in millimeters of five representative plants in the plot, at the base of the plant; Number of Lines in the Ear (NLE) - the number of rows in three representative ears in the plot; Number of Rows (NR) - the number of rows in three representative ears in the plot; Grain Mass (GM) - calculated as the weight of the harvested plot (usable area) and converted to kilograms per hectare, according Faria et al. (2023a).

The collected data underwent variance analysis followed by the Scott-Knott test at a 5% probability using the Sisvar software (Ferreira, 2011).

3. Results and Discussion

Significant differences ($p \leq 0.01$) were observed for the factors of dose, hybrid, and their interaction (dose x hybrid) across all analyzed variables, except for stem diameter, indicating varied impacts of *Trichoderma harzianum* inoculation alongside nitrogen doses on both primary and secondary components in maize plants (Table 3).

Table 3. Summary of the mean square of the variables ear height (EH), plant height (PH), relative chlorophyll index (RCI), stem diameter (SD), number of rows (NR), number of lines (NL), and grain mass (GM) in nine corn hybrids under different nitrogen fertilization conditions

F.V.	df	EH	PH	RCI	SD	NR	NL	GM
Dose (D)	2	464.3**	2287.7**	139.4**	0.2$^{N.S.}$	21.5**	227.4**	5865640.2**
Hybrid (H)	8	21.3**	137.7**	31.0**	3.5**	1.4**	25.7**	139”3282.1**
D x H	16	29.6**	76.4**	11.8**	1.8**	1.7**	6.4**	2105193.3**
Block	2	3.0	9.6	6.6	0.0	0.0	2.9	51007.3
Error	52	4.7	16.2	2.5	0.3	0.3	2.2	313775.8
Cv (%)		3.4	2.2	4.3	3.3	3.4	4.0	9.1

$^{N.S.}$ not significant; ** - highly significant; * - significant; 5% probability, by F test; CV (%) - coefficient of variation.

Regarding ear height and plant height variables, hybrids 2M80, 30A91PW, and DKB390 exhibited superior performance under the low N^+ treatment (80 kg + *Trichoderma harzianum*), comparable to outcomes in the low N treatment (80 kg) and similar to the control (160 kg), refer to Table 4. For the variable ear height, the differences presented were 9.8, 16.1 and 17.2%, while for plant height they were 9.4, 8.2 and 17.5%, respectively, and it was observed than the hybrid GNZ7280, with an increase of approximately 13%, in relation to low N, with an average gain of 6.8% for ear height and 6.2% for the plant, depending on availability, which indicates the potential of the *T. harzianum* to promote growth in some corn hybrids.

According to Contreras-Cornejo et al. (2009), the promotion of plant growth is facilitated by the utilization of *Trichoderma* spp., which is linked to the production of phytohormones like auxin through indoleacetic acid (IAA) and indole acetaldehyde synthesized by *T. virens* and *T. atroviride*. These compounds are responsible for stimulating plant root growth, leading to increased biomass and the development of lateral roots in Arabidopsis seedlings. Enhanced root development results in improved soil exploration efficiency, facilitating greater uptake of water and nutrients, and consequently enhancing plant growth (both height and stem diameter).

Divergent outcomes were reported by Yang et al. (2022), who studied corn with the inoculation of arbuscular mycorrhizal fungi (AM), *T. longibrachiatum* (MF), *Glomus* sp. (Gm), *T. longibrachiatum* + *Glomus* sp. (Gm + MF), and compared them against the non-inoculated control, under two salinity levels (0 and 75 mM NaCl). Their application individually did not yield growth increases; however, combinations like AM + MF increased plant biomass by 58.3%, and Gm + MF by 68.6%, compared to the non-inoculated at 0 salinity levels. The authors concluded that dual inoculation proves more efficient for plant growth in non-saline conditions than single applications.

The promotion of both plant height and stem diameter in corn was observed by Araújo et al. (2023), with the use of *T. harzianum*, in five treatments and the largest quantity (800 ml), twice that recommended by the company, in this case, it was the one that presented the greatest promotion, with linear performance and greater benefits in other variables. It is important to report the greater growth of the root (dry mass and length) as well, which would be directly related to the absorption of water and nutrients.

The findings from this research were validated by Muter et al. (2017), who demonstrated that the introduction of *Trichoderma viride* and charcoal in maize led to a 5.6% increase in plant height (*T. viride* treatment) and 14.34% (*T. viride* + charcoal), compared to the control (without application), at 55 days after implantation. This combination promoted growth, and laser microscopy revealed a continuous, dense biofilm in soil particles sampled from the rhizosphere, responsible for immobilizing *T. viride* in the soil.

Hybrids 30A91PW, DKB390, GNZ7280, P3898, and P4285 exhibited superior performance in the relative chlorophyll index under low N^+ treatment, with increases of 18.4, 8.67, 14.2, 15.2, and 5.4%, respectively, compared to low N treatment, showing similar performance to the control. This indicated enhanced photosynthetic rates and potentially improved utilization of photoassimilates, averaging 6.6% (Table 4). Higher chlorophyll content in plants may result from increased nitrogen availability, aligning with Li et al. (2019) findings that higher nitrogen availability correlates with increased chlorophyll content and rates.

Estévez-Geffriaud et al. (2020) assessed the impact of inoculating *Trichoderma asperellum* (strain T34), with or without a chemical fungicide (Q), on maize growth and various variables under both irrigated systems and water deficiency conditions. The application proved beneficial in irrigated systems, enhancing the number and weight of grains and emphasizing hydration and photosynthetic capacity.

Yadav et al. (2018) found that the inoculation of *Trichoderma viride*, combined with fertilizer doses, positively affected the chlorophyll content of leaves and root length of the G-5414 variety. The analyses were carried out at 20, 40 and, with emphasis on 60 days, for treating *T. viride* + 75% of the recommended doses of NPK (120-60-60 kg ha^{-1}), which resulted in a chlorophyll content 42% higher than the control, therefore, the use of the fungus and a reduced dose of fertilizers were efficient in promoting plant growth and productivity.

Inoculation with *T. harzianum* isolate IBLF 006WP resulted in a 0.7% improvement in stem diameter compared to low N and a 1.3% improvement compared to the control. Commercial hybrids 30A91PW and ADV9860 in the low N^+ treatment showed 12.1 and 6.4% improvements, respectively, over low N, similar to the control (Table 4), suggesting the fungus application's potential to increase stiffness and possibly reduce losses during mechanized harvesting due to lodging.

Nepali et al. (2020) inoculated maize with 2.5 ml of a commercial product containing *Trichoderma viride* in 1 kg of seed, combined with 50% (120:60:40 kg NPK ha^{-1}) of the recommended fertilizers, resulting in a 1 cm increase in stem diameter compared to the control. Their study concluded that using *T. viride* + 50% of the recommended fertilizers effectively promoted growth and crop yield, demonstrating its potential as a biofertilizer and growth promoter.

It was found that for the variable number of rows, the 2M77 and ADV9860 hybrids were the only ones that did not show promotion when comparing low N and low N with *T. harzianum*, whereas the 30A91PW and P4285 hybrids obtained superior performance above the control (Table 5). The general averages refer to this increase, with an increase of 9.3% with the combination, but the condition is not repeated in the number of lines and, on average, the reduction was 4.4%. Steffen et al. (2021) did not find a significant difference for the number of rows in corn but detected a difference for the number of lines and an increase in yield of 17.6% in the crop.

Table 4. Ear height (EH), plant height (PH), relative chlorophyll index (RCI) and stem diameter (SD) in nine corn hybrids as a function of nitrogen doses, with *Trichoderma harzianum* application

Hybrids	----------- EH ----------			---------- PH ----------		
	- 80 kg ha^{-1} -	- 80 kg ha^{-1+} -	- 160 kg ha^{-1} -	- 80 kg ha^{-1} -	- 80 kg ha^{-1+} -	- 160 kg ha^{-1} -
2M77	63.1 aA	65.7 aA	67.8 bA	174.9 aC	182.6 bB	194.9 aA
2M80	61.2 aB	65.9 aA	68.5 bA	176.2 aB	191.2 aA	194.5 aA
30A91PW	57.6 bB	66.6 aA	67.2 bA	172.4 aB	187.9 aA	185.4 bA
ADV9860	58.1 bB	63.3 bA	63.9 cA	173.6 aB	172.6 cB	185.2 bA
DKB390	56.6 bB	68.1 aA	64.6 cA	159.4 bB	184.4 aA	190.1 bA
GNZ7280	58.2 bC	67.7 aB	73.9 aA	171.4 aB	194.0 aA	189.6 bA
P3898	61.9 aB	60.3 bB	73.4 aA	175.5 aB	179.6 bB	195.4 aA
P4285	64.7 aB	62.8 bB	68.6 bA	179.7 aC	188.3 aB	195.6 aA
RK3014	60.0 bB	61.3 bB	68.0 bA	171.8 aB	177.6 bB	188.0 bA
Means	60.2	64.6	68.4	172.8	184.2	191.0

Hybrids	---------- RCI ----------			---------- SD ----------		
	- 80 kg ha^{-1} -	- 80 kg ha^{-1+} -	- 160 kg ha^{-1} -	- 80 kg ha^{-1} -	- 80 kg ha^{-1+} -	- 160 kg ha^{-1} -
2M77	37.0 aA	35.7 bA	37.8 bA	15.2 bA	14.3 bB	15.3 bA
2M80	33.7 bB	34.5 cB	39.1 bA	15.4 bA	14.2 bB	15.3 bA
30A91PW	31.5 bB	37.3 bA	38.1 bA	15.1 bB	16.2 aA	13.8 cC
ADV9860	34.2 bB	33.7 cB	38.0 bA	14.2 cB	14.9 bA	13.8 cC
DKB390	32.3 aC	35.1 cB	39.5 bA	14.5 cA	15.3 bA	15.1 bA
GNZ7280	36.0 aB	41.1 aA	38.9 bA	15.0 bB	17.0 aA	16.5 aA
P3898	36.3 aB	41.8 aA	42.2 aA	16.4 aA	14.7 bB	16.2 aA
P4285	35.5 aB	41.4 aA	40.9 aA	14.7 cA	15.0 bA	14.3 cA
RK3014	33.2 bB	35.0 bB	38.9 bA	14.4 cA	14.3 bA	14.1 cA
Means	34.7	37.0	39.3	15.0	15.1	14.9

80 kg ha^{-1} - Low N, 80 kg ha^{-1+} - Low N with *Trichoderma harzianum* application and 160 kg ha^{-1} – Control; means followed by the same lowercase letter in the vertical and uppercase horizontally do not differ from each other by the Scott-Knott test at 5% probability.

Fu et al. (2019) inoculated *Trichoderma asperellum*, diluted in 200 ml of water, under treatments W4 - 0.7 and W6 - 1.4 g of conidia, using root irrigation. They observed that for two consecutive years, the crop was responsive, showing an increase in productivity of approximately 4.87 and 10.95% in 2015, and 5.75 and 12.41% in 2016. This led to the conclusion that the continuous use of *T. asperellum* improved crop yields over time and increased the overall abundance of bacteria in the soil, benefitting the rhizosphere. Soil microbes, in response, modify plant performance as the microflora diversity increases, leading to more frequent interactions and subsequently enhanced nutrient availability for plants.

In relation to grain mass, in the low availability condition, the performance of the one with *T. harzianum* surpassed that without application by 16.2%, in the general average, and also by 5.7% compared to the control (Table 5). The hybrids 30A91PW, GNZ7280 and P4285 outperformed even the control, indicating the high synergism and good combination between the genotype and the environment generated by the fungus (rhizosphere). The hybrids DKB390 and RK3014, in low N and *T. harzianum*, obtained the same yield seen in the control, with promotion and capacity for drastic reduction of fertilization (80 kg ha^{-1}).

Table 5. Number of rows (NR), number of lines (NLE), and grain mass (GM) in nine corn hybrids as a function of nitrogen dose, with *Trichoderma harzianum* application

Hybrids	------------ NR ------------			------------ NLE ------------		
	- 80 kg ha^{-1} -	- 80 kg ha^{-1+} -	- 160 kg ha^{-1} -	- 80 kg ha^{-1} -	- 80 kg ha^{-1+} -	- 160 kg ha^{-1} -
2M77	16.7 aB	17.5 aB	18,6 aA	37,0 bB	34,8 bB	41,0 bA
2M80	16.8 aB	18.0 aA	18,0 aA	37,6 bB	35,2 bB	41,6 bA
30A91PW	15.6 bC	18.6 aA	17,4 bB	35,3 bB	39,2 aA	39,3 bA
ADV9860	16.4 aA	16.1 bA	17,0 bA	35,2 bB	31,5 cC	39,2 bA
DKB390	15.0 bC	16.7 bB	18,4 aA	34,0 bB	32,4 cB	38,0 bA
GNZ7280	15.8 bB	18.4 aA	18,3 aA	35,6 bB	35,9 bB	39,6 bA
P3898	15.9 bB	17.7 aA	18,2 aA	36,7 bB	33,3 cC	40,7 bA
P4285	17.2 aB	18.3 aA	16,8 bB	40,6 aA	36,0 bB	44,6 aA
RK3014	16.3 aB	17.6 aA	17,3 bA	35,2 bB	34,1 cB	39,2 bA
Means	16.2	17.7	17,8	36,3	34,7	40,3

Hybrids	----------------------- GM -----------------------		
	- 80 kg ha^{-1} -	- 80 kg ha^{-1+} -	- 160 kg ha^{-1} -
2M77	6303.1 aA	6631.4 cA	6463,9 bA
2M80	6551.8 aA	7266.0 bA	5822,3 bB
30A91PW	5359.2 bB	8768.3 aA	5812,0 bB
ADV9860	5439.9 bB	4876.2 dB	6233,0 bA
DKB390	4985.7 bB	5946.3 cA	6862,7 aA
GNZ7280	5431.2 bB	7283.5 bA	6237,5 bB
P3898	6094.4 aB	5751.9 cB	7192,5 aA
P4285	6193.6 aB	7048.2 bA	5770,9 bB
RK3014	5006.2 bB	6111.0 cA	6078,3 bA
Means	5707.2	6631.4	6274.8

80 kg ha^{-1} - Low N, 80 kg ha^{-1+} - Low N with *Trichoderma harzianum* application and 160 kg ha^{-1} – Control; means followed by the same lowercase letter in the vertical and uppercase horizontally do not differ from each other by the Scott-Knott test at 5% probability.

Akladious & Abbas (2013) noted the impact of *Trichoderma harzianum* on maize, observing substantial growth promotion and vigor. Their findings showed significant outcomes in plant height, leaf area, and fresh weight of the aerial part, among other variables related to root development. Similarly, Nepali et al. (2020) evaluated *Trichoderma viride*'s capacity as a biofertilizer, suggesting its potential to enhance growth and productivity, potentially reducing the requirement for mineral fertilizers. Their study highlighted significant differences in variables such as plant height, stem diameter, and leaf area index, consistent with the findings in this research.

Qiao et al. (2019) reported that in a field experiment comparing chemical (CF), organic (OF), and bio-organic fertilizer regimes, along with *Trichoderma guizhouense* (strain NJAU 4742 - BOF), there was a corn yield increase by 216 kg acre^{-1} (533.75 kg ha^{-1}) compared to chemical fertilizers, which was comparable to organic fertilizers. The study concluded that fertilizer choice directly impacted soil microbiota and demonstrated the fungus's greater efficacy in enhancing crop yields due to improved microbiota and soil quality.

Lu et al. (2020) aimed to mitigate the impact of stem rot disease on maize by inoculating *Trichoderma asperellum* GDFS1009 granules (2, 4, 5, 6, 8, and 10 g/hole) with 45 kg/667m^2 of chemical fertilizers. The application of 10 g of *T. asperellum* in conjunction with fertilizers reduced disease impact by 72.05% and increased crop yield by 11.28% compared to the control (without *T. asperellum*). This control led to disease containment and served as a positive promoter for crop growth.

The hybrids 30A91PW, DKB390, GNZ7280 and P4285 presented higher values of plant height, relative chlorophyll index, stem diameter and number of rows, which indirectly contributed to improving plant yield, ear formation and possibly grains weight, when the isolate IBLF 006 was applied. The RK3014 hybrid only obtained promotion for the variable number of rows, without changes in other variables when the same analysis is carried out, which denotes that new characteristics must be studied in order to detect which are most important in increasing productivity.

4. Conclusion

The application of *Trichoderma harzianum* makes it possible to reduce the nitrogen dose by 80 kg ha^{-1}, promoting the improvement and maintenance of plant productivity and, in some corn hybrids, with benefits that surpass even the recommended fertilization.

The hybrids 30A91PW, DKB390, GNZ7280, P4285 and RK3014 showed greater synergism and improvement in the rhizosphere when *Trichoderma harzianum* (isolate IBLF 006) was applied, in combination with a dose of 80 kg ha^{-1}, with increment in five variables, however, the application is only indicated for these hybrids.

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