

Agronomic Performance of Corn Cultivars in Low-Altitude in the Cerrado-Amazon Ecotone

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Authors' contributions

This work was carried out in collaboration among all authors. Authors WFS and JMP designed the study and performed the analysis. Authors LRSB, LCM, OJFJ, LFS, TPSF and FBC managed the study and helped in the interpretation of the results. Author LAF managed the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

Aims: The objective of this study was to evaluate the agronomic performance of corn cultivars for grain production in the south at low altitude in the Cerrado-Amazon ecotone.

Place: The research was carried out at Sítio Vitória (8°18'32.0"S, 50°36'58.0"W, 278 MASL), in the south of the state of Pará, Brazil.

Study Design: The experimental design was randomized blocks with twelve treatments and three

replications. The treatments were eight corn hybrids: AG 1051, AG 8088, BM 3051, BR 2022, BR 205, BR 206, BRS 3046 and PR 27D28; and four open pollination populations: AL BANDEIRANTE, ANHEMBI, CATIVERDE and M 274.

Methodology: Sowed on January 28, 2019. The following characteristics were evaluated: ear height, plant height, number of grains per row, ear diameter, ear length, ear weight and grain yield.

Results: The cultivars showed a difference for all traits. The grain yield of the cultivars ranged from 4,567 kg ha⁻¹ (BR 205) to 9,450 kg ha⁻¹ (AG 1051).

Conclusion: The hybrids AG 1051 and BM 3051 were the ones that stood out the most, had the best performance in the Cerrado-Amazon ecotone.

Keywords: Grain yield; hybrids; populations of open pollination; yield components; *Zea mays* L.

1. INTRODUCTION

Corn (*Zea mays* L.) is among the most important crops worldwide, used in human and animal feed as an energy source, and in the production of fuel, polymers, and beverages [1]. In the world scenario of grain marketing, four countries lead the market: United States, Brazil, Argentina, and Ukraine, combined accounted for 86.2% of exports in 2017/18 [2].

In Brazil, production in 2020 was 100.6 million tons of grain, an increase of 0.5% over the previous year. And the planted area increased by 5.4% compared to the previous year, reaching 18.5 million hectares [3]. However, the mean yield grain is still low, due to the low technological level of production, little knowledge of cultivars adapted to low altitude and edaphoclimatic conditions.

The yield performance, resistance to pests, and crop stability are directly related to the cultivars on the market, each cultivar has ideal edaphoclimatic conditions of cultivation in each region [4]. To know this, cultivars must be tested in the producing regions. Agronomic performance studies of corn cultivars were conducted in several states, such as Mato Grosso do Sul [5], Tocantins [6], and Goiás [7]. However, it is still necessary to evaluate cultivars in the Cerrado-Amazon ecotone, aiming to select more adapted materials with desirable agronomic characteristics.

In agreement with the above, the present study aimed to evaluate the agronomic performance of corn cultivars for low-altitude grain production in the Cerrado-Amazon ecotone.

2. MATERIALS AND METHODS

The research was carried out at Sítio Vitória (8°18'32.0"S, 50°36'58.0"W, 278 MASL),

municipality of Santa Maria das Barreiras, State of Pará, located in the Cerrado-Amazon ecotone (Fig. 1). The climate of the region is type Aw according to classification of Köppen, tropical with a dry season in winter [8], with maximum rainfall between October and April (Fig. 2).

The soil of the experiment presented sandy texture, with 150 g kg⁻¹ of clay, and the following chemical attributes (0 - 20 cm): 4.8 pH CaCl₂, 17 g kg⁻¹ organic matter, 4.9 mg dm⁻³ phosphorus, 43 mg dm⁻³ potassium, 1.7 cmol_c dm⁻³ calcium, 0.3 cmol_c dm⁻³ magnesium, 0.2 cmol_c dm⁻³ aluminum, 5.21 cmol_c dm⁻³ cation exchange capacity, and 40% base saturation.

The experimental design was randomized blocks with twelve treatments and three replications. The treatments were corn cultivars (Table 1), of these eight corn hybrids: AG 1051, AG 8088, BM 3051, BR 2022, BR 205, BR 206, BRS 3046 and PR 27D28; and four open pollination populations: AL BANDEIRANTE, ANHEMBI, CATIVERDE and M 274. The experimental units were composed of four rows of 5.0 m, spaced 0.9 m between rows. The useful area was the two central rows, discarding 0.5 m from the ends.

The soil preparation was with a gentler grid followed by a leveling grid. The base fertilization was with 500 kg ha⁻¹ of N-P₂O₅-K₂O, formulation 5-25-15 + 0.5% Zn (Ribeiro et al. 1999). Sowing was performed on January 28, 2019, at a mean depth of 0.04 m. After the emergency, thinning was carried out, obtaining a population of 55,555 plants ha⁻¹.

Topdressing nitrogen fertilization was performed with 150 kg ha⁻¹ of N, urea (45% of N) was divided into two applications into stages V4 and V8 (4 and 8 completely open leaves) [11]. The control of weed, diseases, and pests was carried

out according to the technical recommendations of the crop [12].

The agronomic characteristics evaluated at the physiological maturation stage were: ear height and plant height with a measuring tape, considering the distance from the ground to the insertion of the first ear and last open leaf, respectively; ear diameter with the use of a

caliper in the middle third of the ear; ear length with a graduated ruler; number of grains per row; ear weight; and grain yield.

Variance analysis was performed and means were compared by the Scott and Knott [13] group test, at 5% significance, using the SISVAR program [14].

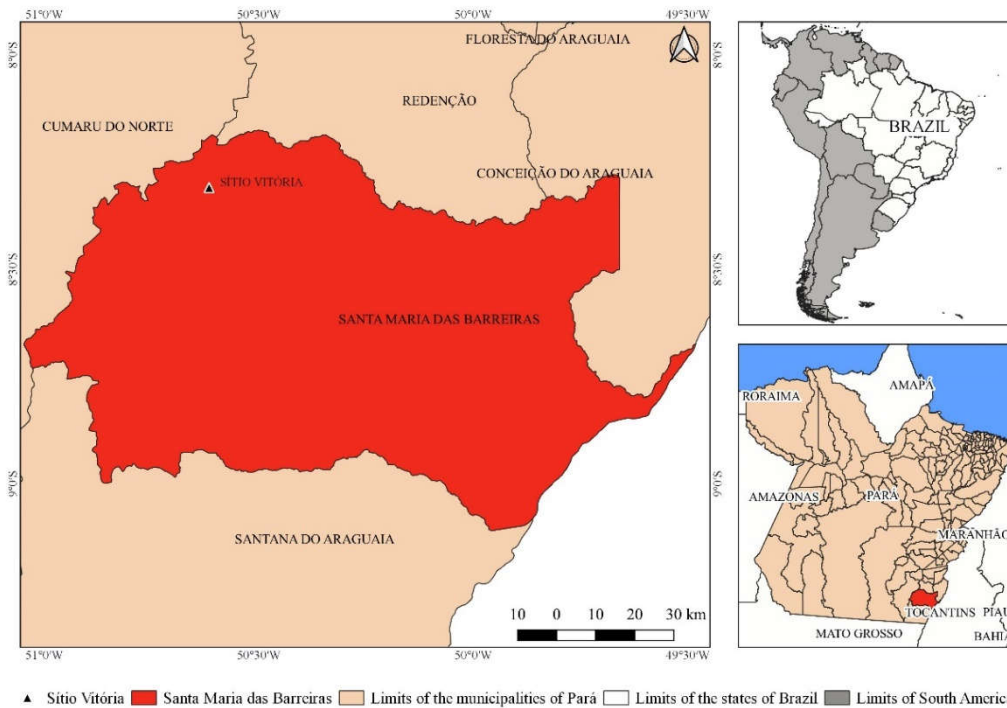


Fig. 1. Location map of Sítio Vitória state of Pará and Brazil

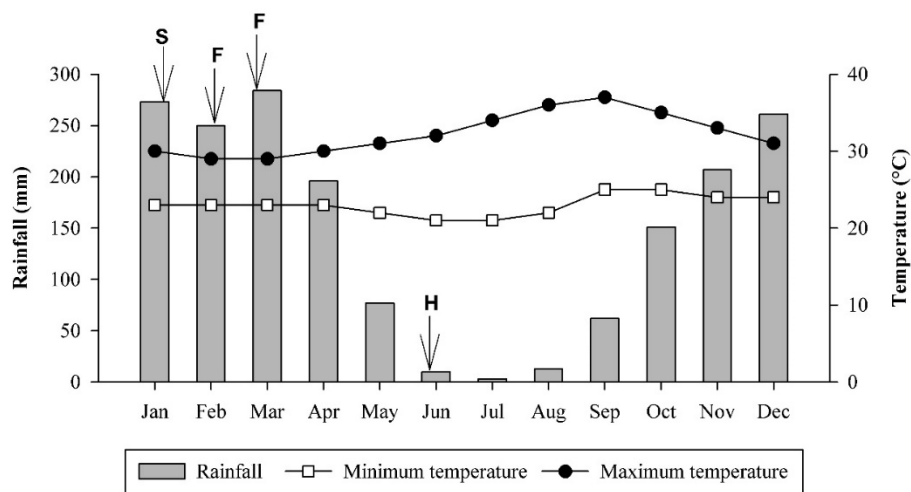


Fig. 2. Climatological means of rainfall minimum and maximum temperature of Santa Maria das Barreiras state of Pará Brazil

S: sowing, F: topdressing nitrogen fertilization, H: harvest Adapted from Climatempo [9]

Table 1. Agronomic characteristics of corn cultivars used in the experiment

Cultivar	Genetic Base	Cycle	Use	Technological Level
AG 1051	DH	SME	G/CG/WPS	M/H
AG 8088	SH	E	G/WPS	H
AL BANDEIRANTE	OP	SME	G/WPS	L/M
ANHEMBI	OP	E	G/WPS	L/M
BM 3051	DH	E	GC/WPS	M/H
BR 2022	DH	E	G/WPS	M/H
BR 205	DH	E	G/WPS	M/H
BR 206	DH	E	G/WPS	M/H
BRS 3046	TH	SME	GC	M/H
CATIVERDE	OP	SME	GC/WPS	M
M 274	OP	E	G/WPS	L/M
PR 27D28	DH	SE	G/WPS	L/M

* SH: simple hybrid; DH: double hybrid; TH: triple hybrid; OP: populations of open pollination; E: early; SME: semi-early; SE: super-early; G: grain; GC: green corn; WPS: whole plant silage; H: high; M: medium and L: low Adapted from Cruz et al. [10]

3. RESULTS AND DISCUSSION

The cultivars presented significant differences ($p < 0.05$) for all traits (Table 2), showing the presence of genetic variability.

Regarding plant height (Fig. 3A), two statistical groups were trained, with plant size ranging from 150 cm (BR 2022) to 184 cm (PR 27D28), and in the upper group were cultivars AG 1051, BM 3051, and PR 27D28. Silva et al. [15] analyzing 12 corn genotypes also observed a large range of plant height (142 to 175 cm).

For the insertion height of the first ear (Fig. 3B), there was a variation from 62 cm (AG 8080) to 107 cm (AG 1051), and two groups were also formed. The cultivars belonging to the group with the highest ears were: AG 1051, PR27D28, AL BANDEIRANTES, BR 3051, and M 274. The first two also presented higher plant height (Fig. 3A).

The minimum and maximum height of the insertion of the first ear recorded by Silva et al. [15], 64 cm and 91 cm, we're close to those observed in the present study. However, it is emphasized that higher plant height and insertion of the first ear may favor the occurrence of layered and broken plants before harvest since taller plants tend to also increase the distance between us and reduce the diameter of the stem [16].

In the evaluation of the ear diameter (Fig. 4A) three statistical groups were formed, the group of

upper cultivars was formed by AG 1051, AG 8088, BM 3051, and M 274.

The diameter of the ear is a characteristic that is directly related to the number of rows per ear, as well as grain filling [17], this characteristic together with the length of the ear, determine the productive potential of the crop [18].

The number of grains per row (Fig. 4B) was the variable that had the most cultivars in the upper group, forming only two groups. The cultivars were statistically superior: AG 1051, AG 8088, ANHEMBI, BM 3051, BR 206, M 274, and PR 27D28. In a trial of cultivars in the state of Pará, Silva et al. [19] also observed AG 1051 among the highest means. The two main factors that influence this characteristic are genetic material [20] and the efficiency of nitrogen fertilization in culture [21].

The length of the ear (Fig. 4C) ranged from 13.1 cm (BR 205) to 17.9 cm (AG 1051), and two statistical groups were formed. The cultivars AG 1051, AG 8088, BM 3051, M 274, and BR 27D28 presented longer ears. It is worth mentioning that the five cultivars that stood out in the length of the ear were also higher in the number of grains per row, which denotes the possibility of an association between these variables.

Silva et al. [19] obtained means ranging from 16.68 cm to 19.45 cm, higher than that of the present experiment. The length of the ear is a characteristic related to the nutritional status of the plant, mainly the supply of N, good water availability, and the integrity of the leaves [22].

For ear weight (Fig. 5A), the highest ear weight was recorded for AG 1051 (218 g) and the lowest weight for BR 205 (103 g). For this characteristic, four statistical groups were formed, the cultivars with higher weights were only AG 1051 and BM 3051.

Thus, as occurred with the ear weight, for grain yield (Fig. 5B) there was the formation of four statistical groups, where again the cultivars AG 1051 and BM 3051 was higher. The minimum and maximum means were 9,450 kg ha⁻¹ (AG 1051) and 4,567 kg ha⁻¹ (BR 205). The populations of open pollination were less productive.

Maciel et al. [23] analyzing 10 corn genotypes in Pará, we observed grain yield values between 5,446 kg ha⁻¹ to 11,486 kg ha⁻¹. Santos et al. [24] and Silva et al. [19], verified in their studies the superiority of hybrids, including AG 1051.

Therefore, based on the results of the studies, the potential for cultivation of hybrids AG 1051 and BM 3051 for grain production in the Cerrado-Amazon ecotone is characterized. And, the importance of evaluation programs, to ensure the correct choice of cultivars, consequently the increase of productivity and sustainability of production.

Table 2. Summary of variance analysis plant height (PH) ear height (EH) ear diameter (ED) ear length (EL) number of grains per row (NGF) ear weight (EW) and grain yield (GY) corn cultivars in low-altitude in the Cerrado-Amazon ecotone

SV	DF	Mean Square						
		PH (cm)	EH (cm)	ED (mm)	NGF (No.)	EL (cm)	EW (g)	GY (kg ha ⁻¹)
Cultivar	11	5579*	5711*	355*	421*	101*	56835*	87618761*
Block	2	5007 ^{ns}	3141 ^{ns}	40 ^{ns}	56 ^{ns}	66 ^{ns}	12928 ^{ns}	6713770 ^{ns}
Error	22	1326	1315	45	76	28	4811	5189290
Coefficient of variation (%)	68	142	47	89	108	138	106	
Mean		16497	8092	4569	3100	1539	15902	677546

* Significant and ns not significant by the F to 5% significance test SV: Source of variation; DF: Degree of freedom

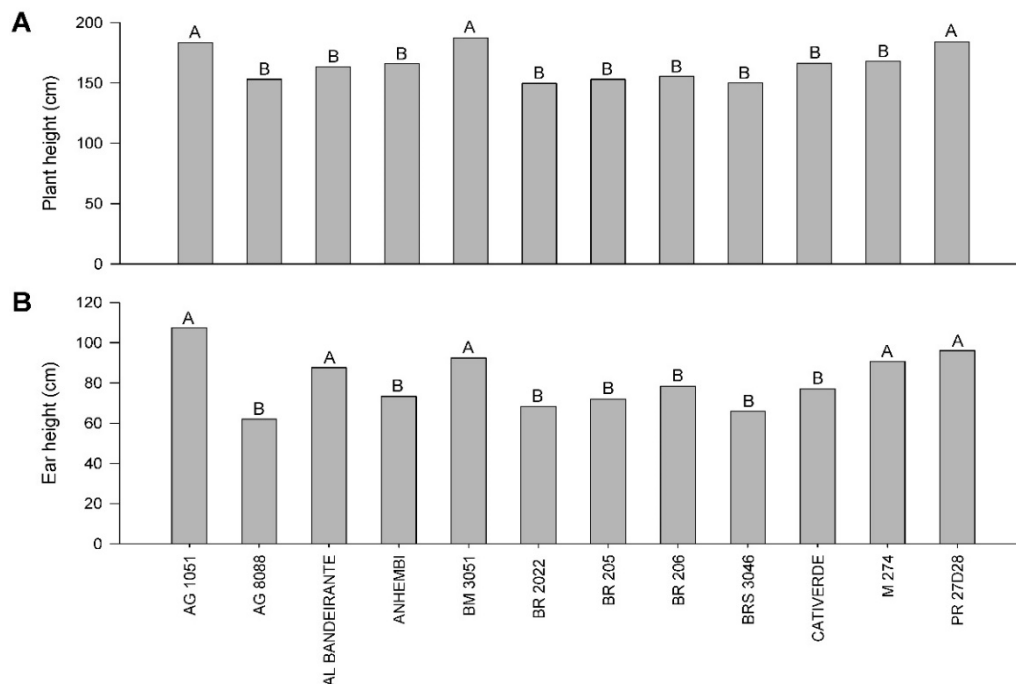


Fig. 3. Plant height (A) and ear height (B) of twelve corn cultivars in low-altitude in the Cerrado-Amazon ecotone

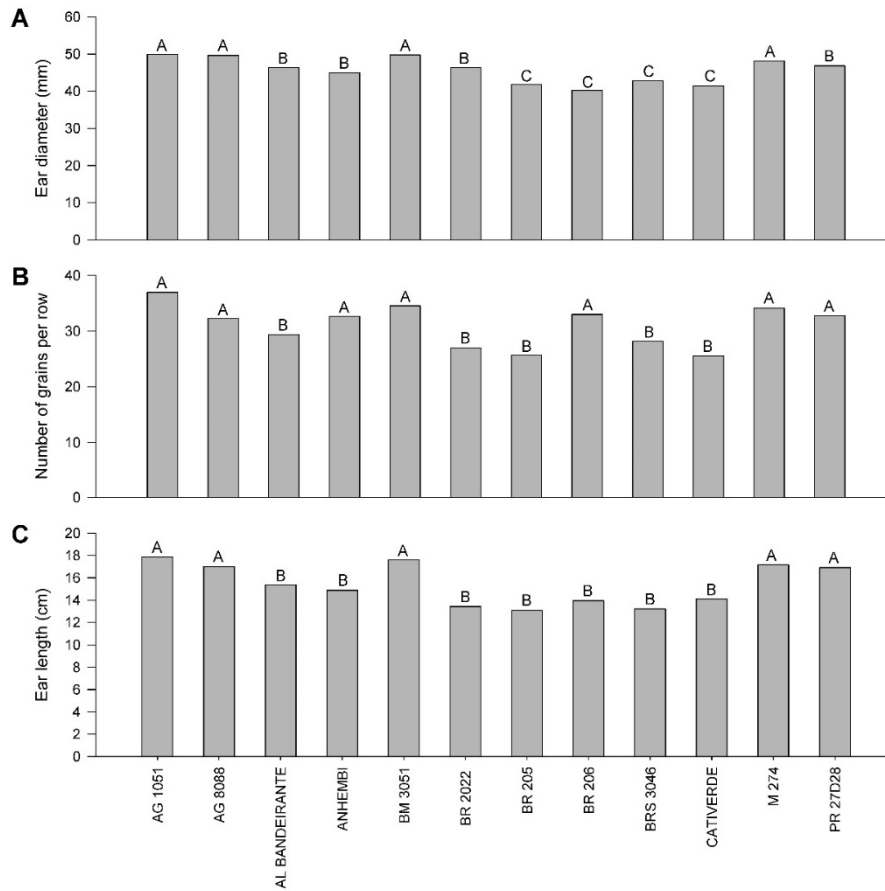


Fig. 4. Ear diameter (A) number of grains per row (B) and ear length (C) of twelve corn cultivars in low-altitude in the Cerrado-Amazon ecotone

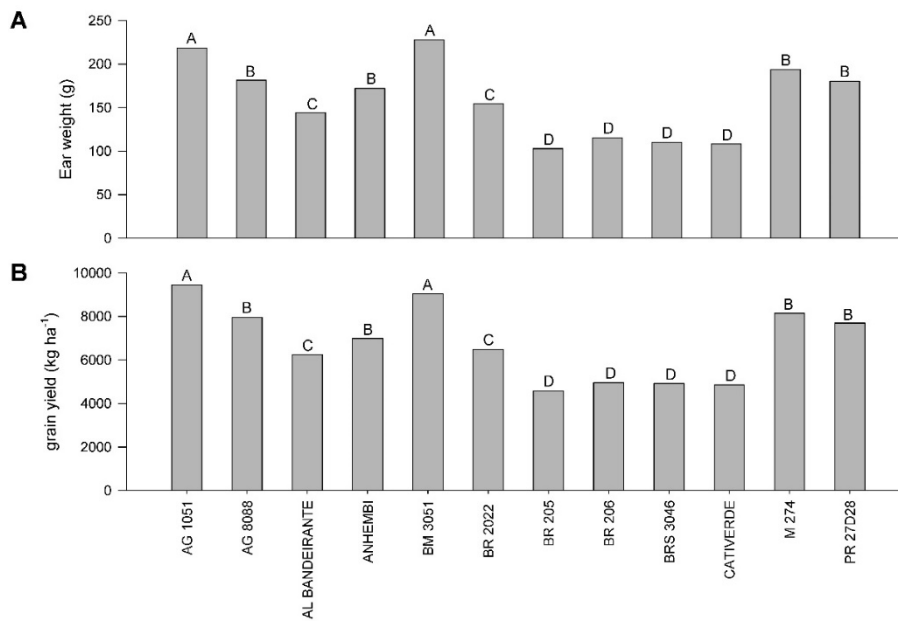


Fig. 5. Ear weight (A) and grain yield (B) of twelve corn cultivars in low-altitude in the Cerrado-Amazon ecotone

4. CONCLUSION

The grain yield of the cultivars ranged from 4,567 kg ha⁻¹ and 9,450 kg ha⁻¹, of the cultivars BR 205 and AG 1051, respectively. The hybrids AG 1051 and BM 3051 presented higher means for all characteristics, had the best performance in low altitude in the Cerrado-Amazon ecotone.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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