EUROPEAN ACADEMIC RESEARCH
Vol. IX, Issue 1/ April 2021

Impact Factor: 3.4546 (UIF)
DRJI Value: 5.9 (B+)

ISSN 2286-4822
www.euacademic.org

Agronomic Performance of Hybrids of Corn Cultivated in the Amazon Region of Brazil

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Abstract

In the context of agriculture, the choice of an adequate cultivar is of paramount importance for the success of a planting. The present

work aimed to evaluate the agronomic performance of seven maize cultivars, to then point out which of the treatments are the most recommended for Parauapebas - PA. The design used at work was in ranges with seven treatments and five replicates. The treatments were the hybrid cultivars of corn: EXP T14M774265 (C1), Balu 761 (C2), EXP T14M6520 (C3), EXP T14M713265 (C4), Balu 383 VIP 3 (C5), EXPT14M7641 (C6) and EXP 7132MT14 (C7). To evaluate the agronomic performance of the cultivars on site, the following were evaluated: Plant height (AP), stem diameter (DC), number of leaves (NF), insertion height of the first ear (AIP), number of ears (NE), mass of ears with straw (ME), grain mass (MG) and yield. As for the maximum average yield, it was cultivar C3 that presented the highest average of 8.43 t ha^{-1} not differing this tactically from C1, C4, C6 and C7. The hybrids C1, C3 and C4 are the most recommended, among the seven treatments, for the city of Parauapebas-PA in the amazon region of Brazil.

Keywords: Agriculture. Cultivar. Evaluation. Production. *Zea mays*.

INTRODUCTION

Corn (*Zea mays* L.) is grown in all regions of Brazil and is also found in more than two million agricultural establishments, in which it is a product of fundamental importance for the Brazilian agriculture scenario (CONTINI et al., 2019).

The agricultural crop is considered the largest in the world, reaching the incredible production mark of 1 billion tons, not counting, with its most diverse uses and applicability to the world market, with an estimated more than 3500 applications of cereal (CONTINI et al., 2019).

The choice of an adequate cultivar is of paramount importance for the success of a plantation, considering that in general, the cultivar is responsible for 50% of the final yield of corn (CRUZ et al., 2010). Moreover, due to the large number of existing commercial corn cultivars, the speed of their market replacements and their agronomic characteristics, professionals and producers need to make the correct

choice of which variety is best suited to their region, and for this they need information (FARINELLI et al., 2003).

Considering the productive potential in the amazon region of Brazil for the cultivation of this commodity and the scarcity of recommendations available to producers in the literature for corn cultivation in Parauapebas - PA, the present study aimed to evaluate the agronomic performance of seven maize cultivars implanted in the municipality, to then point out which treatments are the most recommended for the site.

MATERIAL AND METHODS

The work was carried out at the Technological Center of Family Agriculture, in the municipality of Parauapebas-PA, located in the geodesic coordinates 49°51'14" W latitude, 06°12'45" S longitude, with an altitude of 197m. The climate according to Köppen and Geiger is classified as tropical hot and humid – Aw, with high rainfall, where the driest season occurs between May and November, and in the rainy season, known as "rainy winter", precipitation can reach up to 2800 mm and the relative humidity of the air reaches over 90%, with average temperature throughout the year of 29ºC. The soil of the site was classified, according to Embrapa (2018), as Red-Yellow Latosol.

Soil analyses followed Embrapa's recommendation (2017), and the granulometry presented values of 51.25%, 16.82% and 31.93% of clay, silt, and sand, respectively. The chemical analysis of the soil was performed at a depth of 0.0 - 0.20 m, right after planting and presented the values of. 6.0; 0.5; 2.6; 0.5 $cmol_c$ dm^{-3} for Ca=Calcium Mg=Magnesium; H+Al= Hydrogen + Aluminum and potassium, respectively. The organic matter value was 1.3% and the pH in H2O was 6.1.

The design used at work was in ranges with seven treatments and five replicates. The treatments were the hybrid cultivars of corn: EXP T14M774265 (C1), Balu 761 (C2), EXPT14M6520 (C3), EXP T 14M713265 (C4), Balu 383 VIP 3 (C5), EXPT14M7641 (C6) and EXP 7132MT14 (C7).

The seeds were supplied by the company "Balu Seeds". Cultivar C1 is a double hybrid of experimental status; cultivar C2 is a

commercial double hybrid; cultivar C3 is a triple hybrid of experimental status; cultivar C4 is a double experimental hybrid; cultivar C5 is a single hybrid of commercial status; cultivar C6 is an experimental triple hybrid; cultivar C7 is an experimental triple hybrid.

The area was conventionally prepared by means of the watering and grading. The soil was also fertilized with 110 kg ha^{-1} nitrogen, 150 kg ha^{-1}phosphorus, 90 kg ha^{-1}potassium and 50 kg ha^{-1} FTE BR 12, which is a micronutrient cocktail.

The planting was carried out on April 3, 2019, using the mechanical fertilizer-seeding of the Brand Jumil-2040 G2 with five lines spaced of 0.70 meters, driven by 4x2 tractor, operating in the 4th gear reduced to 1700 RPM. The population density used was on average 60000 plants for all treatments.

Two data were collected during the cultivation. The first was carried out on April 27, 2019 with the purpose of evaluating the initial performance of the crop and determining the soil acidity content, such as its potential acidity, its degree of compaction and the longitudinal distribution of the plants. The second collection was carried out on June 20, which observing the milk line in the grains was found that in the period the plants were in the phenological stage R5.

To evaluate the agronomic performance of the cultivars on site, the following variables were used: Plant height (AP), stem diameter (DC), number of leaves (NF), insertion height of the first ear (IEA), number of ears per plant (NE), ear mass (ME), grain mass (MG) and the estimated productivity/ha. The variables AP, DC and NF were analyzed in both collections and were identified in this study with number 1 and 2, according to the first or second visit made. The other variables were analyzed only in the second data collection.

The height of the plants and the insertion height of the first ear were measured with traditional measuring tapes from the ground to the tassel; the stem diameter was measured with 150 mm analog universal calipers by means of two measurements in the plant 5 cm from the stem region; the number of leaves was counted visually; the masses of ears and grains were determined on digital scales and productivity was estimated in tons/hectare.

The data were submitted to variance analysis and, when the f-test value was significant at least 5% probability, the Tukey test (p less than or equal to 0.05) was used to compare the means. Statistical analysis was performed using the SISVAR software (FERREIRA, 2019).

RESULTS AND DISCUSSION

Table 1 describes the results of the variables: plant height and insertion height of the first ear.

Table 1. Analysis of variance and test of means for the variables: AP 1, AP 2, AIE

Cultivar	AP 1	AP 2	AIE
		(cm)	
C1	22.20 ± 2.64 bc	204.40 ± 12.65 ab	108.40 ± 13.67 ab
C2	23.00 ± 2.66 c	194.00 ± 27.97 ab	93.40 ± 17.48 a
C3	22.80 ± 1.85 c	184.00 ± 29.80 a	100.60 ± 21.42 ab
C4	17.20 ± 2.50 a	224.80 ± 7.66 b	114.00 ± 11.85 ab
C5	23.20 ± 1.92 c	267.60 ± 17.79 c	110.80 ± 18.67 ab
C6	20.00 ± 2.39 abc	265.40 ± 10.21 c	128.80 ± 8.39 b
C7	18.00 ± 2.89 ab	222.20 ± 23.71 ab	110.60 ± 18.76 ab
F test	0.0002*	0.0000*	0.0500*
CV (%)	10.18	8.56	14.62
SMD	4.32	38.81	32.52

Followed means of the same letter in the column do not differ from each other by the Tukey test for a 5% probability level; AP1= Plant Height in the first collection; AP2= Plant Height in the second collection. IEA=Height of ear insertion; SMD= Significant minimum difference; ns = not significant; * = significant at the 5% probability level; VC - coefficient of variation; The values represent the mean ± Standard Deviation.

For plant height, there was a difference in the first and second evaluations between treatments. The cultivar C5 stood out with the highest height indexes in both evaluations. While cultivar C3, which initially began to develop well with the second highest height index (22.8 cm), presented the lowest mean height in the final collection with 1.84 meters, not differing from C1, C2 and C7.

These results were like those found by Araújo et al. (2016), which evaluated the performance of 11 corn hybrids in the Midwest

region, found minimum height values of 2.13 m and maximum values of 2.54 m. And were still higher than those found by Santos et al. (2017), which evaluated 16 maize genotypes observed minimum values of only 1.5 m and maximum values of 2.4 m.

Zucarelli et al. (2013) classify a maize cultivar as low-sized all those with a height of less than 2.2 m in height. Based on the pattern established by the author, only the cultivars C1, C2 and C3 were considered low in size.

The values of the ear insertion height were similar. However, there was a significant difference between treatments 2 and 6. The lowest averages were cultivar C2 with 93.4 cm and the highest mean was cultivar C6 with 128 cm.

The results were lower than those found by Seraguzi et al. (2016), which evaluating 8 hybrids found amplitude between 137 and 173 cm. They were also smaller than those found by Araújo et al. (2016) in which the height of the ear ranged from 1.13 to 1.66 m.

The inferiority in values when compared to other studies is not a problem, considering that according to Casagrande and Fornasieri Filho (2002) the higher the height of the ear the more favorable to the bedtime the plant becomes.

According to Table 2, regarding the diameter of the stem, there were differences only in the first collection, in which cultivar C3 presented the best performance in this variable with mean values of 1.8 cm and cultivar C4 to lower performance with values of 1.3 cm. However, in the second collection the treatments presented remarkably similar results, in which almost all treatments presented means of 2 cm in diameter, exceeding the cultivar C5, which presented mean values of 1.8 cm.

Table 2. Analysis of variance and test of means for the variables: DC 1, DC 2, NF1 and NF2

Cultivar	DC 1	DC 2	NF 1	NF 2
	(cm)			
C1	1.74 ± 2.38 ab	2.00 ± 0.14 a	9.80 ± 1.00 a	13.08 ± 1.80 a
C2	1.72 ± 3.59 ab	2.00 ± 0.27 a	9.60 ± 1.00 a	13.00 ± 0.80 a
C3	1.80 ± 1.12 b	2.00 ± 0.17 a	10.20 ± 1.00 a	11.96 ± 0.80 a
C4	1.30 ± 2.22 a	2.00 ± 0.16 a	8.80 ± 1.00 a	13.60 ± 0.90 a
C5	1.54 ± 1.54 ab	1.80 ± 0.19 a	9.20 ± 0.00 a	13.32 ± 0.40 a
C6	1.56 ± 1.24 ab	2.00 ± 0.12 a	10.20 ± 1.00 a	12.16 ± 0.80 a
C7	1.48 ± 2.70 ab	2.00 ± 0.12 a	9.80 ± 0.40 a	12.84 ± 0.35 a

f Test	0.0285*	0.4481ns	0.0696ns	0.1086ns
VC (%)	14.41	8.57	7.86	7.36
DMS	0.46	0.34	1.54	1.92

Followed means of the same letter in the column do not differ from each other by the Tukey test for a 5% probability level; DC1= Stem diameter in the first collection; DC2= Stem diameter in the second collection. NF1= Number of leaves in the first collection; NF2= Number of leaves in the second collection; SMD= Significant minimum difference; ns = not significant; * = significant at the 5% probability level; CV - coefficient of variation. The values represent the mean ± Standard Deviation.

This similarity in the results can be explained by the population density that is the same for all cultivars, because according to Brachtvogel (2008), the population factor directly and proportionally influences the characteristics of stem diameter.

The values are remarkably like those found by Araújo et al. (2016) who obtained overall average results of 2.2 cm. However, they were lower than those found Farinelli and Lemos (2010) who obtained maximum values of up to 2.92 cm. They were also higher than the maximum value obtained by Costa et al. (2015) of 1.83 cm.

Thus, the treatments presented adequate diameter measurements, since a small diameter of stem is one of the main contributors to bed (MORAES; BRITO, 2008) and very thick stems can make mechanized harvesting difficult (COSTA et al., 2015).

For the number of leaves, there was no difference between treatments. The highest averages were cultivar C3 and 6 in the first collection (both with 10.2 leaves) and cultivar C4 in the second collection with an average of 13.6 leaves per plant. The lowest averages were cultivar C4 in the first collection (8.8 leaves) and cultivar C3 in the second collection (11.96 leaves).

Together with other factors, a small number of leaves in maize cultivars may increase plant tolerance to some problems (ARGENTA et al., 2001). The reduced number of leaves, combined with other characters, allows a greater infiltration of light in the canopy, contributing to a more efficient use of solar radiation (ARGENTA et al., 2001).

According to Table 3, there was a difference between the treatments regarding the mass of the ears. The highest mean obtained was cultivar C1 with 237.80 grams, and the lowest cultivar C5 with 133.2 grams.

Table 3. Analysis of variance and test of means for the variables: ME, MG, NE and Productivity

Cultivar	ME	MG	NE	Productivity
	(g)			(t ha^{-1})
C1	237.80 ± 23.47 b	151.43 ± 10.41 c	1.52 ± 0.10 a	7.97 ± 0.53 bc
C2	177.84 ± 32.48 ab	112.67 ± 21.35 ab	1.44 ± 0.31 a	5.38 ± 0.49 a
C3	227.20 ± 69.36 b	133.22 ± 14.52 bc	1.20 ± 0.11 a	8.43 ± 1.40 c
C4	188.92 ± 39.09 ab	134.26 ± 26.83 bc	1.12 ± 0.11 a	7.23 ± 0.57 bc
C5	128.32 ± 30.29 a	87.19 ± 6.42 a	1.60 ± 0.23 a	6.26 ± 0.97 ab
C6	173.92 ± 17.59 ab	136.60 ± 16.13 ab	1.08 ± 0.17 a	7.66 ± 0.85 bc
C7	190.12 ± 50.57 ab	134.63 ± 16.27 bc	1.20 ± 0.14 a	7.62 ± 0.78 bc
F test	0.0058*	0.0001*	0.7230ns	0.0001*
CV (%)	21.64	13.47	22.47	11.79
SMD	82.14	34.43	0.59	1.71

Followed means of the same letter in the column do not differ from each other by the Tukey test for a 5% probability level; ME= Mass of ears; MG=Grain mass; NE=Number of ears; SDM= Significant minimum difference; ns = not significant; * = significant at the 5% probability level; CV - coefficient of variation. The values represent the mean ± Standard Deviation.

The results were superior both to those found by Perin et al. (2009), which evaluated the performance of 4 hybrids obtained an average of 218.7 grams among its treatments, as well as for those found by Santos et al. (2005) that evaluated 10 cultivars, obtained a maximum value of 185 grams.

For commercial purposes, one of the main desired attributes for ears is its greater weight, that is, the greater the mass of the ear, the greater the chance of it being commercially used (ALBUQUERQUE et al., 2008).

As in the variable ear mass, the highest mean grain mass was presented by cultivar C1 and the lowest by cultivar C5.

The grain mass values were much higher than those found by Cardoso et al. (2016), which evaluated 17 corn hybrids obtained an average of only 116 grams of grains per ear.

The high value of the ears and grains can be explained through the milk line of the grains, which in the collection period was approximately 75 %, which consequently causes a starch

accumulation greater than the predecessor phenological stages, leading to an increase in grain mass and consequently of the ears.

Regarding the number of ears, although there were no differences between treatments, cultivar C5 was the one that stood out in this variable with an average of 1.6 ears per plant. This is explained by the fact that the farm cultivar is the only simple hybrid between treatments, because according to Lopes et al. (2007) simple hybrids tend to have a higher rate of ears compared to other hybrids.

These results were higher than those found by Beleze et al. (2003), which when evaluating 5 hybrids did not obtain significant differences with all averages awfully close to only one ear per plant.

The productivity results were incredibly positive for all treatments. The maximum mean was C3, 8.43 t ha $^{-1}$, not differing statistically from C1, C4, C6 and C7. The lower means were C2 and C5, with 5.38 and 6.26 t ha^{-1} respectively.

Except for the second hybrid, all treatments showed productivity in May r that the national average of 5.7 t ha^{-1} (CONAB, 2019), confirming the good productive performance of the cultivars.

Kopper et al. (2017) obtained under the same plant density of this study, yield values of 7.5 t ha $^{-1}$, a value higher than only two cultivars evaluated in this study (C2 and C5). Lower values were also found by Santos et al. (2017) evaluating 16 hybrids obtained an average of 5.8 t ha $^{-1}$.

CONCLUSION

All cultivars showed good agronomic performance in the municipality of Parauapebas-PA in the amazon region of Brazil.

The hybrid EXP T14M6520 was the one that stood out the most in the crop, obtaining the best results in most of the variables analyzed, even presenting maximum mean productivity.

The hybrids EXP T14M774265 and EXPT14M713265 were also highlighted in many variables, such as plant height and ear and grain mass, for example, confirming the good adaptability of both treatments in the municipality.

The hybrids EXP T14M6520, EXP T14M774265 and EXPT14M713265 are the most recommended, among the seven treatments, for the city of Parauapebas-PA in the amazon region of Brazil.

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