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Genetic Divergence in Corn Genotypes in the South of the State of Pará

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Abstract—*The genetic variability allows selection of superior genotypes and makes it possible to increase the frequency of favorable genes through appropriate selection methods that provide genetic material's retrieval adapted to environmental conditions prevalent in the different producing regions. Thus, this work was performed with the goal of studying the genetic divergence of populations of open pollination of corn in the South of Pará State. To this end, two tests were made of corn genotypes competition, being the first to top P (100 kg ha-1 of P) and the second for low P (50 kg ha-1 of P). The study of genetic divergence was performed using together with the data from the two trials. The experimental design used in each trial was randomized with ten treatments (open-pollinated maize genotypes) and three repetitions. The characteristics studied were: plant Height, Ear height, the diameter of the Spike, Spike length, grain in the row numbers and productivity. In the study of genetic divergence was employed the Tocher optimization method. The importance of characters, was the Foundation of Singh. Three medium-sized groups were formed, which were in the same genotypes 08 groups, and two other genotypes (AG 1051 and AL BANDEIRANTE.), were in different groups. The characters presented more collaboration for the genetic divergence were productivity, plant height and ear height.*
Keywords—Zea mays, Phosphate fertilization, Genetic improvement, Genetic variability

I. INTRODUCTION

The importance of corn, in addition to the nutritional aspect, is linked to the social aspect, because large producers do not have widespread technology and/or large tracts of land, and yet still depend on for a living. According to IBGE, this fact is evidenced by a large number of producers who use corn still on the property, about 59% of the establishments that produce this cereal [12, 14].

In the State of Pará, the corn productivity is low (3320 crop -17/18 and 2962 crop 18/19) when compared with the productivity of other regions such as the southern region (5530 –crop 17/18 and crop 18/19-6658), Southeast (5385-crop 17/18 and crop18/19 5537) and Midwest (5354- crop 17/18 and crop 18/19 6000) [9]. Several factors are responsible for the low productivity of this culture in the North and, among these, include high temperatures, the low technological level used by local farmers and a shortage of genetic material adapted to the conditions local soil and weather [2, 3, 5].

A good fertility and fertilization of soils are very important elements to the composition of an efficient production system, which can provide essential nutrients for corn, considering the actual need according to your phenology phase. For both, there is a need for an appropriate program of fertilization that consider an efficient diagnosis of soil fertility, meeting your nutritional requirement in order to facilitate the management, improve the absorption and accumulation of nutrients in the soil [7] [2]

Among the primary nutrients, phosphorus (P) is the least required by crops, in quantitative term, but plays important role in the growth of the root system of maize [19] [15]. However, it is very used in fertilization of crops in Brazil [1]. The lack of nutrients in the soil, where the deployment of culture, can cause disabilities and loss of production [1] [20].

Experiments involving genetic divergence are crucial to the understanding of genetic variety in germplasm banks, making possible the monitoring and recognition of likely duplicates, besides transfer criteria for selection of parents that, if they do, provide better

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heterotic effect, adding the chances of obtaining genotypes more promising in future generations [4] [10].

Researchers have sought the use of analysis to quantify the genetic divergence between genotypes varied species, where maize stands out. In Brazilian literature, there are many works that address the study of divergence [13] [16] which aims to identify possible parents for future breeding programs. However, studies of this nature are rare in the South of Pará.

Based on the foregoing objective with the present study, study the tensions resulting from unclear between maize genotypes grown in southern Pará.

II. MATERIALS AND METHODS

Two tests were conducted in the municipality of Santa Maria das Barreiras-PA (Aw-type climate according to Köppen (1948) [18], with an average temperature of 26.5° C and average annual rainfall of 1968 mm), under conditions of high phosphorus (100 kg ha^{-1} of P2O5) and another under low phosphorus (50 kg ha^{-1} of P2O5), in planting. Sowing was made on 23 December 2017.

In Figure 1, the average values of precipitation (mm) and temperature (°C), of the last 30 years [6].

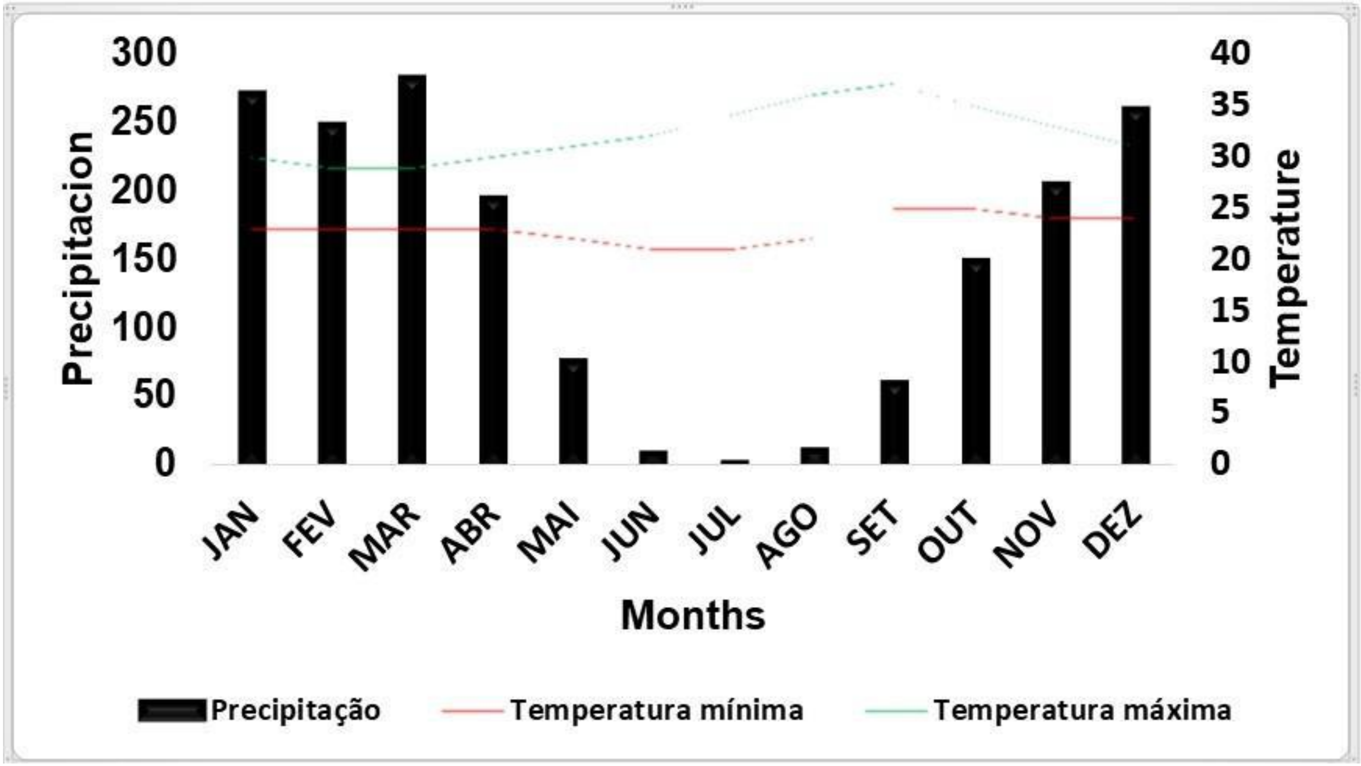

Fig. 1: Monthly values of air temperature (◦ C) and precipitation (mm) total rain in the last30 years regarding the climatic conditions in the municipality of Santa Mariadas Barreiras, State of Pará. Source: Climate (2018).

The treatments were composed of ten genotypes of open pollination (AG 8088, BRS 3046, PR27D28,CATIVERDE, 2B655PW, ANHEMBI BR 206, AG 1051, AL BANDEIRANTE and ORION), separatedinto random blocks with three replications. The experimental plot was formed by four rows of five meters away, 0.90 m considering between the lines.

In soil, preparation procedures were plowing, harrowing and sulcamento, with the application of fertilizers manually held in grooves for later deployment of culture. Phosphate fertilization levels, defined in pre-planting, consists of 100 and 50 kg ha^{-1} of Super simple for High P and low P, respectively.

The fertilization in coverage of N and K was held at the stage V4 and V8 (four and eight leaves completely open, respectively), being the nitrogen fertilization performed with urea (43% N), at a dose of 150 kg ha^{-1}, and potassium fertilization with potassium chloride (60% K) on dose of 90 kg ha^{-1}.

The seeding was done manually and the plant management, such as the control of pests, diseases, and invasive plants, was held as the need for culture [17].

The stage R6 (physiological maturity) the harvest of the ears using two lines in each row,

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disregarding-0.50 m surround themselves.

The following variables were analyzed from each plant: The plant height measurements were calculated from the base, low to the ground, until the insertion of flag leaf, using a metric measuring tape. Insert Tenon measures were calculated from the base of the plant until the insertion point using a metric measuring tape. The diameter and length of the cob were determined with the aid of a digital pachymeter, the number of grains was determined in each row by the count of the amount of grain on each ear, in order to get an estimate. Productivity was obtained through the collection of spikes and calculating the average weight of their grain. From the average weight of grains, multiplying the result by the number of plants, obtaining the average productivity for the moisture of 13% in grain.

For the study of genetic divergence was the Mahalanobis generalized distance (D2).

For the Organization of similar groups was employed the method of optimizing Tocher (RAO, 1952).

It was possible to calculate the relative contribution of the characters used for the genetic divergence and the dissimilarity between the observed total offspring using the criteria suggested by Singh (1981) [26].

The data were analyzed through the statistical program Genes, 2007 version [11].

III. RESULTS AND DISCUSSION

The genetic dissimilarity measures assumed by Mahalanobis distance (table 1), highlighted the existence of genetic variation (4.4 to 197.3) among the genotypes analyzed.

Table.1: Dissimilarity among corn genotypes in relation to features as the Mahalanobis generalized distance ($D2_{ii}$').

Genotypes	BRS 3046	PR27D28	ANHEMBI	CATIVERDE	2B655PW	BR 206	AG 1051	AL BANDEIRANTE	ORION
AG 8088	17,5	11,7	14,6	34,4	20,5	13,8	34,4	69,0	12,1
BRS 3046		27,5	6,9	26,2	24,0	43,6	19,8	134,2	24,5
PR27D28			29,5	46,0	36,1	5,5	69,5	55,4	9,7
ANHEMBI				34,8	23,1	37,9	16,8	135,3	23,9
CATIVERDE					4,4	46,6	66,1	104,0	20,0
2B655PW						32,0	54,1	89,6	12,3
BR 206							86,3	35,6	9,4
AG 1051								197,3	65,2
AL BANDEIRANTE									62,3

The shortest distance was obtained between the genotypes CATIVERDE and 2B655PW (D^2 = 4.4) followed by the PR27D28 genotypes and BR 206 (D^2 = 5.5) and BRS 3046 and ANHEMBI (D^2 = 6.9). On the other hand, the pair AG 1051 and AL BANDEIRANTE presented the biggest difference (D^2 = 197.3), followed by the combinations of ANHEMBI and AL BANDEIRANTE (D^2 = 135.3) accompanied by BRS 3046 and AL BANDEIRANTE (D2 = 134.2). The smaller the distance between the genotypes, the greater the genetic equality between them, reducing the possibility of success to obtain hybrids with a high degree of heterosis [21] [24] [22].

The study of the improvement of Tocher, based on Mahalanobis distance matrix, separated the ten genotypes in three distinct groups (table 2). The method of search Tocher distinguishes similar pair in the differentiation, i.e. the pair to submit a lower estimate of distance and have relatively similar characteristics among themselves [22]. It is observed that in Group I were eight genotypes AG 8088, BRS 3046, PR27D28, CATIVERDE, 2B655PW, ANHEMBI BR 206 and ORION genetically alike. Groups II and III were represented by only one genotype each AG 1051 and AL BANDEIRANTE, respectively.

Table 2: Grouping as Tocher method based on the generalized distance of Mahalanobis to 10 (ten) maize genotypes.

Groups	Genotypes
I	AG 8088, BRS 3046, PR27D28, ANHEMBI, CATIVERDE, 2B655PW, BR 206 e ORION
II	AG 1051
III	AL BANDEIRANTE

The main point of the study is to obtain and use only the best genetic characters to produce future parents, which bring strains resistant to pests and diseases, with higher quality and increased production[25].

The relative contribution (%) (Table 3) showed that the plant height, Spike height and productivity were the ones that contributed to the genetic diversity among the genotypes compared and studies.

Table 3: Relative contribution of genetic divergence (in %) in the study of variance of features valued at corn genotypes.

Variable	Value (%)
Plant height	11,62
Height of the Spike	55,69
COB diameter	4,24
COB length	1,42
Number of Grains in the row	4,62
Productivity	22,40

The great interest in assessing the relative importance of the characters lies in the possibility of disclaiming features that contribute little to the breakdown of the rated material, reducing in this way, time, labor, and costs spent on experimentation [21].

Therefore, the number of grains per row, COB diameter and length of the cob can be discarded, since it showed a lower contribution to the divergence.

Coimbra et al. (2010) [8] and Santos et al. (2017) [23] evaluating different genotypes of maize, also observed low relative contribution of the features number of grains per row, COB diameter and length of the spigot on genetic diversity.

IV. CONCLUSION

Among the genotypes, AG 1051 and AL BANDEIRANTE, ANHEMBI and AL BANDEIRANTE and BRS 3046 and AL BANDEIRANTE are the most divergent, enabling the attainment of superior genotypes of the farmer's interest and more sustainable production.

Tocher method was effective in the separation of the groups.

The productivity features, plant height and ear height were the ones that contributed to the study of genetic divergence.

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