Research Article

Agronomic potential and indications for the genetic breeding of sweet corn local varieties carrying the *sugary1* gene[1]

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ABSTRACT

Sweet corn (*Zea mays* L.) local varieties are important gene sources for breeding programs, mainly in participatory research models. This study aimed to evaluate the agronomic performance of seven sweet corn local varieties (2255A, 2029A, 2276A, 2514A, 3000A, 741B and 319A) carrying the *sugary1* gene under homozygotic condition and two controls, at four environments [Anchieta (altitudes: 422 and 717 m), Guaraciaba (altitude: 624 m) and Florianópolis (altitude: 5 m)], in the Santa Catarina state, Brazil. The varieties 3000A and 319A showed a good performance in the different altitudes for ear and grain length and ear yield. At intermediate altitudes (422 and 624 m), the mean husked ear yield (milky grain) of these varieties were close to 12.5 t ha^{-1} (3000A) and 10.0 t ha^{-1} (319A). The varieties 2029A, 741B, 2514A, 2276A and 2255A stood out for ear length and diameter, number of ear rows and grain length. The best performance of the sweet corn local varieties was observed in their region of origin, mainly at altitudes ranging from 400 to 650 m. These varieties are adapted to the region and are promising alternatives to be used in breeding programs focused on finding a greater potential variability for selection purposes.

KEYWORDS: *Zea mays* L., sweet corn, on-farm conservation.

RESUMO

Potencial agronômico e indicações para o melhoramento genético de variedades locais de milho doce portadoras do gene *sugary1*

Variedades locais de milho doce (*Zea mays* L.) representam importante fonte de genes para programas de melhoramento, especialmente em modelos de pesquisa participativa. Avaliou-se o desempenho agronômico de sete variedades locais de milho doce (2255A, 2029A, 2276A, 2514A, 3000A, 741B e 319A) portadoras do gene *sugary1* na condição homozigótica e duas testemunhas, em quatro ambientes [Anchieta (altitudes: 422 e 717 m), Guaraciaba (altitude: 624 m) e Florianópolis (altitude: 5 m)], no estado de Santa Catarina. As variedades 3000A e 319A apresentaram bom desempenho nas diferentes altitudes para comprimento de espiga e de grão e rendimento de espiga. Em altitudes intermediárias (422 e 624 m), as médias de rendimento de espiga sem palha (grão leitoso) destas variedades ficaram próximas a 12,5 t ha^{-1} (3000A) e 10,0 t ha^{-1} (319A). As variedades 2029A, 741B, 2514A, 2276A e 2255A destacaram-se pelo comprimento e diâmetro da espiga, número de fileiras da espiga e comprimento do grão. O melhor desempenho das variedades locais de milho doce foi observado em sua região de origem, especialmente nas altitudes entre 400 e 650 m. Essas variedades são adaptadas à região e são alternativas promissoras para utilização em programas de melhoramento que visam à obtenção de maior variabilidade potencial para a seleção.

PALAVRAS-CHAVE: *Zea mays* L., milho verde, conservação “on farm”.

INTRODUCTION

Sweet corn (*Zea mays* L.) is a special corn type whose grains present a high sugar content, due to mutant genes capable of changing the starch synthesis in the endosperm (Boyer & Shannon 1984, Tracy 2001).

This corn type presents a great use-diversification potential, since it can be used *in natura*, canned, frozen in ears or grains, dehydrated, as mini corn and for silage, among others (Tracy 2001, Zucareli et al. 2014). However, the Brazilian sweet corn production is almost entirely allocated to canned corn grains, whereas a small part of it is consumed *in natura* (Teixeira et al. 2019).

Approximately 71 thousand farms produce sweet corn in Brazil (almost 350,000 t) (IBGE 2017).

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The Santa Catarina state has approximately 1.5 thousand of these farms, accounting for 8,000 t (IBGE 2017).

The sweet corn cultivation in Brazil remains limited to some regions, due to a lack of cultivars adapted to the country's conditions (Teixeira et al. 2013) and of knowledge about this corn type and its nutritional properties by consumers (Bandeira et al. 2012). The varieties available in the country present unfavorable features, such as low germination rate and susceptibility to diseases and pests, which contribute to their low planted area rates. However, its market in Brazil has been growing due to new patterns set by consumers, such as an increasing demand for both quality (Kwiatkowski et al. 2011) and varieties presenting a higher sugar content and lesser starch, since these features provide a characteristic taste and aroma to sweet corn.

The main sweet corn breeding studies conducted in Brazil refer to programs focused on finding hybrids and improving open-pollinated varieties, based on the introduction of genetic material deriving from other countries or from few national programs (Teixeira et al. 2013). Consequently, few national varieties are available in the market, since the seed trade is mostly based on hybrid cultivars.

Accordingly, it is essential to conduct studies aimed at developing productive cultivars adapted to specific growing conditions, such as different altitudes. Altitude has a direct influence on temperature, solar radiation and thermal amplitude, which are factors capable of affecting physiological processes such as photosynthesis, plant growth, flowering, water balance, respiration and nutrient absorption (Muchow et al. 1990), as well as biotic and abiotic dynamics in the soil (Siqueira & Franco 1988). The study of genotype behavior for altitude variation allows the inference of their cultivation potential for different Brazilian conditions, such as the states of Goiás, São Paulo and Minas Gerais, which are the largest producers of sweet corn in the country (IBGE 2017) and have a tropical climate and wide variation in altitude.

Local varieties conserved *in situ*-on farm show a high adaptive potential at their places of origin (Ogliari et al. 2013). They also present an important genetic variability source for breeding programs with emphasis on sweet corn, which present a small number of accessions conserved in Brazilian germplasm banks. Local varieties that have been managed and selected by small-scale farmers for a long time are genetically diverse, locally adapted and associated with the agroecosystems they are conserved in (Zeven 1998).

Sweet corn varieties with potential to be introduced to the special corn market as sweet corn (Souza et al. 2020) are conserved by small-scale farmers in the western Santa Catarina state, which is a diversity microcenter for the *Zea* genus (Costa et al. 2016). Allelic tests have proved the incidence of recessive allele *su1* in seven local varieties grown in this area (Souza et al. 2021). The *sugary1* mutant gene has a great genetic relevance, since it is one of the first genetically verified and the oldest gene introduced in Brazil. It accounts for the sweet phenotype of most accessions conserved in the Maize Active GenBank (Maize BAG) of the Empresa Brasileira de Pesquisa Agropecuária (Embrapa) (Teixeira et al. 2019). It is noteworthy that none of the accessions conserved at the Embrapa's Maize BAG was collected in the Santa Catarina state, in southern Brazil.

Thus, this study aimed to evaluate the agronomic potential of sweet corn local varieties carrying the *sugary1* gene under homozygotic condition, in order to promote their use and conservation, as well as to guide the first steps of a genetic breeding program for the western Santa Catarina state.

MATERIAL AND METHODS

The agronomic potential of seven sweet corn *sugary1* local varieties (2255A, 2029A, 2276A, 2514A, 3000A, 741B and 319A) and two statistical control varieties were evaluated in four experiments conducted during the 2017/2018 growing season.

All the local varieties were collected in family production units in the western Santa Catarina state and featured by Souza et al. (2021) through allelic tests, in order to identify the mutant gene accounting for the sweetness of their grains. These local varieties were selected to represent the reference genetic diversity of sweet corn conserved *in situ*-on farm in the western Santa Catarina state. The selection process took into consideration traits such as ear weight, number of grains per row, ear length and grain weight, based on the methodology by Cochran (1977) and adjusted by Bartlett et al. (2001) for finite populations.

Two varieties carrying the *sugary1* genotype were used for statistical control: BR401, developed by Embrapa; and Cubano accession, from the Maize BAG maintained at the same institution. These varieties were used as control treatments in the experiments. It is worth emphasizing the lack of commercial sweet corn recommendations for southern Brazil.

Three experiments were conducted in small-scale farms in the western Santa Catarina state: Anchieta (26º32'51.33''S, 53º19'37.1"W and 717 m of altitude); Guaraciaba (26º34'49.4''S, 53º31'32.3"W and 624 m of altitude); Anchieta (26º34'58.7"S, 53º23'02.2"W and 422 m of altitude). A fourth experiment was conducted in a farm of the Universidade Federal de Santa Catarina, in the coastal region of the same state: Florianópolis (27º41'06.28"S, 48º32'38.81"W and 5 m of altitude). For the first three areas, the soils are classified as Cambissolos (Embrapa 2013) or Cambisols (FAO 2015); whereas, for the latter, as Neossolo Quartzarênico (Embrapa 2013) or Arenosol (FAO 2015).

All four experiments followed a completely randomized blocks design, with four replications. Each experimental unit was formed by two linear rows (4.0 m in length), at 1.0-m spacing between rows and 0.20-m spacing between plants, and a useful plot of 2.0 m² comprising 10 plants. The experimental areas were managed based on the system used by farmers to maintain the local varieties, and the management procedures comprised primary soil preparation, manual weeding to control invasive plants and organic fertilization with turkey manure, based on soil analysis results and following fertilization and liming recommendations for the states of Rio Grande do Sul and Santa Catarina (SBCS 2016). No pest or disease control was performed.

The rainfall and temperature data recorded for the analyzed period were collected at the Empresa de Pesquisa Agropecuária e Extensão Rural de Santa Catarina (Epagri)/Centro de Informações de Recursos Ambientais e de Hidrometeorologia de Santa Catarina (Ciram) (Epagri 2020) and estimated based on equations (depending on altitude) developed by Massignam & Pandolfo (2006). The data of mean rainfall and temperature rates used in the experiment conducted in Florianópolis were collected at the Florianópolis surface meteorological station of the Instituto de Controle do Espaço Aéreo (ICEA).

The varieties were evaluated based on descriptors set for maize (Teixeira & Costa 2010). The corn ears (at the milky grain phenological stage) were evaluated in a sample comprising 10 plants within the useful plot, taking into account the following traits: ear length, ear diameter, ear row number, grain length, unhusked and husked ear yield.

The data were subjected to analysis of variance, whereas the Lilliefors (1967) test was applied to check the variance homogeneity. The analyses of variance conducted in each environment were applied to sweet corn local varieties grown in the western Santa Catarina state, taking into consideration the random statistical-mathematical model by Searle et al. (1992): $Y_{ij} = \mu + t_i + b_j + e_{ij}$, wherein: Y_{ij} is the observation of the i-th treatment (i = 1, 2, … , 9) of the j-th block (j = 1, 2, 3, 4); μ the general mean; t_i the effect of the i-th treatment; b_j the effect of the j-th block; and e_{ij} the effect of the experimental error. The joint analysis of the experiments was performed based on the random statistical-mathematical model by Searle et al. (1992): $Y_{ijk} = \mu + t_i + a_k + ta_{ij} + b_{j(k)} + e_{ijk}$, wherein: Y_{ijk} is the observation of the i-th treatment (i = 1, 2, ... , 9) of the j-th block (j = 1, 2, 3, 4) and k-th environment (k = 1, 2, 3, 4); μ the overall mean; t_i the effect of the treatment; a_k the effect of the environments; ta_{ij} the effect of the treatment/environment interaction; $b_{j(k)}$ the effect of blocks within the environments; and e_{ijk} the effect of the experimental error.

The analyses of variance were performed in the Genes software (Cruz 2013), based on the methodology described by Stell & Torrie (1980). Variables showing significant differences between the treatments in the F test, at 5 % of probability ($p \leq 0.05$), were subjected to the Scott-Knott test, at the same significance level.

RESULTS AND DISCUSSION

The means recorded for the treatments and estimates recorded for the statistical parameters, based on the individual and joint analyses of variance applied to agronomic traits of sweet corn, are shown in Table 1. Individual analyses of variance have identified significant differences ($p \leq 0.05$) in agronomic traits such as ear length, ear diameter, ear row number and husked ear yield between the treatments, in all environments. The grain length in Florianópolis (altitude: 5 m) and unhusked ear yield in Anchieta (altitude: 422 m) did not show a significant difference between the treatments. The F test adopted for the joint analyses showed significant differences between the genotypes in all variables, whereas the genotype x environment interaction

Table 1. Means and coefficients of experimental and genetic variation estimated by individual and joint analyses of variance applied to agronomic traits of sweet corn local varieties and two control treatments carrying the *sugary1* genotype, in four environments, in the Santa Catarina state, Brazil.

Genotype	E1[1]	E2[2]	E3[3]	E4[4]	Mean	E1	E2	E3	E4	Mean
	Ear length (cm)					Ear diameter (cm)				
2255A	15.0 aB	16.5 aA	17.0 aA	15.5 aB	16.0 a	3.49 cB	3.94 cA	4.10 bA	3.57 cB	3.78 d
741B	14.0 aB	15.5 bA	15.6 bA	13.8 bB	14.7 b	4.26 bA	4.39 bA	4.47 aA	3.99 bB	4.28 b
2029A	14.3 aB	16.6 aA	17.0 aA	16.6 aA	16.1 a	4.16 bA	4.30 bA	4.11 bA	4.00 bA	4.14 c
319A	14.6 aB	17.7 aA	17.0 aA	16.6 aA	16.5 a	4.65 aA	4.71 aA	4.61 aA	4.46 aA	4.60 a
2276A	12.2 bB	15.3 bA	14.3 bA	10.7 cB	13.1 c	4.72 aA	4.88 aA	4.65 aA	4.12 bB	4.59 a
2514A	13.3 bB	14.5 bA	15.7 bA	13.6 bB	14.3 b	4.21 bB	4.30 bB	4.84 aA	3.98 bB	4.33 b
3000A	15.1 aB	17.1 aA	17.6 aA	17.7 aA	16.9 a	4.32 bB	4.51 bA	4.62 aA	4.10 bB	4.39 b
Mean	14.1 C	16.2 A	16.3 A	15.0 B	15.4	4.26 B	4.43 A	4.48 A	4.03 C	4.30
Cubano	16.9	17.1	17.3	15.9	16.8	4.44	4.60	4.53	4.07	4.41
BR401	13.9	12.8	15.2	13.5	13.9	3.38	3.47	3.30	3.33	3.36
CVe%[5]	6.95	7.57	6.12	7.15	6.88	3.74	5.67	3.96	4.80	4.86
CVg%[6]	6.57	5.71	6.27	15.56	8.44	9.27	6.31	5.94	6.05	6.37
Prob. F Test[7]	0.00**	0.02*	0.00**	0.00**		0.00**	0.00**	0.00**	0.00**	
Prob. F Test G[8]					0.00**					0.00**
Prob. F Test E[9]					0.00**					0.00**
Prob. F Test G x E interaction [10]					0.00**					0.00**
Genotype	Ear row number					Grain length (cm)				
2255A	14.3 aA	13.7 aB	14.4 cA	13.1 bB	13.9 c	1.69 bA	1.51 bA	1.57 bA	1.39 A	1.54 b
741B	14.6 aA	13.4 aB	14.7 bA	13.9 aB	14.2 b	1.92 aA	2.03 aA	2.03 aA	1.65 B	1.91 a
2029A	13.5 aA	12.9 aA	13.4 cA	13.2 bA	13.2 d	1.59 bB	1.88 aA	1.56 bB	1.58 B	1.65 b
319A	14.8 aB	14.5 aB	16.1 aA	14.5 aB	15.0 a	2.01 aA	2.03 aA	2.04 aA	1.90 A	1.99 a
2276A	14.2 aA	13.6 aA	13.7 cA	13.2 bA	13.7 c	2.17 aA	2.14 aA	1.89 aB	1.73 B	1.98 a
2514A	15.1 aA	14.0 aB	15.2 bA	13.2 bB	14.4 b	1.68 bC	1.90 aB	2.18 aA	1.58 C	1.83 a
3000A	14.6 aB	14.0 aB	15.3 bA	14.2 aB	14.5 b	1.95 aA	1.90 aA	2.05 aA	1.68 B	1.89 a
Mean	14.4 A	13.7 B	14.7 A	13.6 B	14.1	1.86 A	1.91 A	1.90 A	1.64 B	1.83
Cubano	14.3	14.0	15.2	13.3	14.2	2.09	2.17	1.96	1.64	1.95
BR401	12.2	12.4	11.9	13.0	12.4	1.30	1.37	1.28	1.67	1.41
CVe%[5]	3.54	4.60	5.06	4.72	4.80	8.38	11.08	8.96	12.75	10.41
CVg%[6]	3.04	3.04	5.87	3.53	3.87	10.51	8.91	12.14	7.06	8.63
Prob. F Test[7]	0.01**	0.04*	0.00**	0.02*		0.00**	0.02*	0.00**	0.09[ns]	
Prob. F Test G[8]					0.00**					0.00**
Prob. F Test E[9]					0.00**					0.00**
Prob. F Test G x E interaction [10]					0.27[ns]					0.02*
Genotype	Unhusked ear yield (t ha^{-1})					Husked ear yield (t ha^{-1})				
2255A	8.40 aB	13.0 bA	14.3 A	8.50 bB	11.0 c	4.6 bB	6.70 dA	7.7 bA	3.4 bB	5.6 d
741B	8.50 aB	11.9 bA	12.3 A	7.50 bB	10.0 c	7.2 aA	8.90 cA	8.6 bA	5.1 bB	7.4 c
2029A	11.8 aB	14.6 aA	14.7 A	10.9 aB	13.0 b	7.2 aA	9.00 cA	8.1 bA	6.5 aA	7.7 c
319A	10.4 aB	14.9 aA	16.2 A	12.1 aB	13.4 b	7.4 aB	10.1 bA	9.6 bA	7.6 aB	8.7 b
2276A	10.5 aB	14.9 aA	14.3 A	5.00 bC	11.2 c	7.2 aB	10.1 bA	8.3 bB	2.8 bC	7.1 c
2514A	8.90 aB	11.2 bB	14.7 A	8.00 bB	10.7 c	5.3 bB	6.90 dB	10.0 bA	5.0 bB	6.8 c
3000A	11.7 aB	17.9 aA	18.9 A	12.3 aB	15.2 a	8.4 aB	12.5 aA	12.6 aA	7.6 aB	10.3 a
Mean	10.0 B	14.1 A	15.1 A	9.2 B	12.1	6.7 B	9.2 A	9.3 A	5.5 B	7.6
Cubano	11.9	15.0	14.1	9.6	12.7	8.9	10.8	9.3	5.8	8.7
BR401	5.4	7.4	5.3	6.6	6.2	3.9	4.7	3.2	4.5	4.1
CVe%[5]	15.75	19.62	19.74	19.07	19.42	15.18	18.85	18.55	22.98	20.21
CVg%[6]		12.69	9.95	27.92	14.26	17.88	19.78	15.71	33.45	18.07
Prob. F Test [7]	0.02*	0.05*	0.13[ns]	0.00**		0.00**	0.00**	0.01*	0.00**	
Prob. F Test G[8]					0.00**					0.00**
Prob. F Test E[9]					0.00**					0.00**
Prob. F Test G x E interaction [10]					0.25[ns]					0.02*

Means followed by the same uppercase letter in the rows and lowercase letter in the columns did not differ from each other by the Scott-Knott test, at 5 % of probability, based on the joint analysis of variance conducted for the experiments. [1] E1: Anchieta (altitude: 717 m); [2] E2: Guaraciaba (altitude: 624 m); [3] E3: Anchieta (altitude: 422 m); [4] E4: Florianópolis (altitude: 5 m); [5] coefficient of experimental variation; [6] coefficient of genetic variation; [7] F test probability for genotype according to analyses of variance per environment; [8] F test probability for genotype; [9] environments; [10] genotype x environment interaction based on joint analysis. **, * and [ns]: significant at 1 and 5 % and not significant, respectively, by the F test.

(G x E) did not show a significant difference for ear row number and unhusked ear yield.

The coefficients of variation (CVe%) recorded for most the traits in the individual and joint analyses were lower than 15 %. This outcome indicated a good experimental accuracy.

The climate data analysis showed variations in rainfall and temperature rates during the experiment (Figure 1). The temperature increased with a decreasing altitude, with means of 21.3 (Anchieta; 717 m of altitude), 22.0 (Guaraciaba; 624 m of altitude), 23.2 (Anchieta; 422 m of altitude) and 23.9 ºC (Florianópolis; 5 m of altitude). The total rainfall rate was higher than the historical average for all environments. Rainfall events were well distributed at all crop development stages, except for the lower rainfall accumulation in the last developmental period.

The genotypes 3000A, 319A, 2029A and 2255A recorded the highest means for husked ear length in the four analyzed environments (16.9, 16.5, 16.1 and 16.0 cm, respectively). The varieties planted in Anchieta (altitude: 717 m) and Florianópolis (altitude: 5 m) recorded the lowest husked ear length values, on average. The control variety Cubano showed a lesser variation between the mean values for this variable in the environments (Table 1).

The varieties 319A and 2276A recorded the highest mean husked ear diameter values estimated from the four environments (4.60 and 4.59 cm, respectively) (Table 1). The genotypes 2029A and 319A showed significantly lesser changes in the mean values of this variable among the environments. Florianópolis (altitude: 5 m) was the environment where the genotypes recorded the lowest mean husked ear diameter (4.03 cm). The control variety BR401 recorded the lowest husked ear diameter means in all the environments.

All the genotypes presented significant differences for ear row number, although they maintained the ranking of variety averages at the different altitudes, except for the control variety BR401. This variety recorded a decreased mean ear row number in Anchieta (altitude: 422 m), whereas the other investigated varieties recorded increased mean values for this variable in that very same environment (Table 1). The genotype 2029A differed from the others, since it recorded a lower mean ear row number in all the four environments (13.2).

The genotypes 319A, 2276A, 741B, 3000A and 2514A recorded the highest mean grain length values (1.99, 1.98, 1.91, 1.89 and 1.83 cm, respectively). There was no significant difference in the means recorded for grain length among the environments; however, Florianópolis (altitude: 5 m) recorded the lowest mean grain length value (1.64 cm). This same environment did not show a significant difference for grain length among the genotypes.

The genotypes 3000A, 319A and 2029A recorded the best results for unhusked ear yield in all environments (15.2, 13.4 and 13.0 t ha^{-1}, on average, respectively). Guaraciaba (altitude: 624 m) and Anchieta (altitude: 422 m) presented the best unhusked ear yield means (14.1 and 15.1 t ha^{-1}, respectively) (Table 1). These results are promising, considering that the H43IN (*sugary1*) hybrid

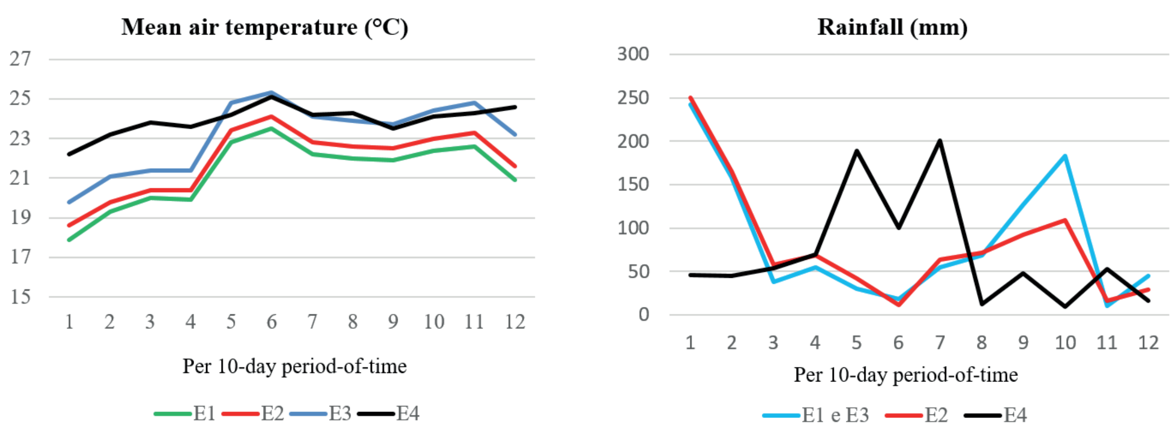

Figure 1. Mean temperature and rainfall values calculated per 10-day periods after sowing the sweet corn samples carrying the *sugary1* genotype, at four altitudes, in the Santa Catarina state, Brazil, in the 2017/2018 growing season. E1: Anchieta (altitude: 717 m); E2: Guaraciaba (altitude: 624 m); E3: Anchieta (altitude: 422 m); E4: Florianópolis (altitude: 5 m).

recorded an unhusked ear yield of 14.4 t ha^{-1} (Oliveira Junior et al. 2007).

The genotypes 3000A and 319A recorded the best overall means for husked ear yield (10.3 and 8.7 t ha^{-1}, respectively) (Table 1). The variety 3000A grown in Anchieta (altitude: 422 m) has significantly differed from the other ones in husked ear yield (12.6 t ha^{-1}), whereas the control variety BR401 recorded the lowest mean yield (3.2 t ha^{-1}). Florianópolis (altitude: 5 m) presented a higher variation in the varieties' performance, since 3000A, 319A and 2029A recorded significantly higher values (7.6, 7.6 and 6.5 t ha^{-1}, respectively). The local varieties recorded mean husked ear yield values higher than that observed for the control variety BR401 in all the sites. The varieties 3000A, 319A and 2514A planted in Anchieta (altitude: 422 m) produced 15.41 % more than the control Cubano, whereas the variety 3000A planted in Guaraciaba (altitude: 624 m) produced 15.74 % more than the Cubano variety.

The mean unhusked ear yields described for BR401 and Cubano (statistical controls) were 10.0 and 18.8 t ha^{-1} (Fornasiere Filho et al. 1988, Teixeira et al. 2019). These values were higher than those recorded in the present study. As for *sugary1* sweet corn genotypes, the *sugary1* H43IN hybrid recorded unhusked and husked ear yield values of 14.4 and 7.8 t ha^{-1}, respectively (Oliveira Junior et al. 2007).

Ear features such as mean length of 20 cm; diameter larger than, or equal to, 3.0 cm; 14 or more rows; and yield higher than, or equal to, 12 t ha^{-1} are the ideal ones to be achieved (Pereira Filho & Teixeira 2016). All local varieties investigated in the current study recorded mean ear length longer than 13 cm. The variety 3000A recorded the best yield values in Guaraciaba (altitude: 624 m) (12.5 t ha^{-1}) and Anchieta (altitude: 422 m) (12.6 t ha^{-1}), whereas the varieties 319A and 2279A recorded a yield of 10.1 t ha^{-1} in Guaraciaba (altitude: 624 m).

The joint analyses showed a significant G x E interaction in most of the evaluated traits. There was a change in the ranking of some local varieties in different environments, mainly due to the differential behavior observed for treatments subjected to different temperatures. The control variety BR401, as well as the varieties 2514A and 2276A, showed a great variation in performance due to the different environments. The variety 2514A showed a different behavior from the other one for grain length, ear diameter and unhusked ear yield, whereas the variety 2276A showed a different behavior from the other varieties for ear length, unhusked and husked ear yield. The control variety BR401 presented more variations among the altitudes and did not follow the standard performance observed for most of the evaluated traits. On the other hand, the local varieties 2255A, 319A, 3000A, 2029A and 741B showed a similar performance for ear length, ear diameter and husked ear yield at the different altitudes.

The G x E interaction was significant for husked ear yield, mainly in the varieties 2514A and 2276A (Figure 2). The variety 2514A showed a good performance in Anchieta (altitude: 422 m) for this variable (10 t ha^{-1}, on average), although it did not exceed 6.9 t ha^{-1} in the other evaluated environments. The low altitude did not favor the variety 2276A, since it recorded a mean husked ear yield of 2.8 t ha^{-1} in Florianópolis (altitude: 5 m), whereas it recorded a mean husked ear yield value higher than 7 t ha^{-1} in the other environments. The control variety BR401 presented a varying husked ear yield among the environments: mean yield of

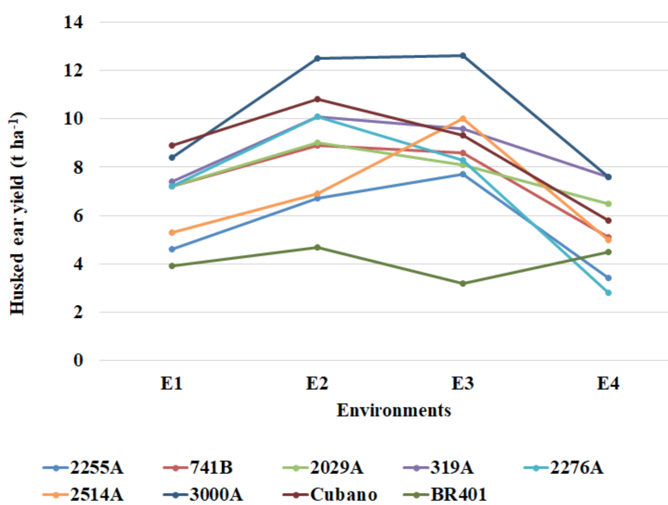

Figure 2. Mean husked ear yield values recorded for seven sweet corn local varieties and two statistical control varieties, assessed at four altitudes in the Santa Catarina State, Brazil, in the 2017/2018 growing season. E1: Anchieta (altitude: 717 m); E2: Guaraciaba (altitude: 624 m); E3: Anchieta (altitude: 422 m); E4: Florianópolis (altitude: 5 m). F-test probability: environment: 0.000; genotype: 0.000; genotype x environment interaction: 0.022; overall mean: 7.6 t ha^{-1}; CVe%: 20.21 %. Control data (BR 401; Cubano) were presented for comparison purposes.

4.5 and 4.7 t ha^{-1} in Florianópolis (altitude: 5 m) and Guaraciaba (altitude: 624 m), as well as 3.2 and 3.9 t ha^{-1} in Anchieta (altitude: 422 m) and Anchieta (altitude: 717 m), respectively, on average.

The local varieties presented the highest yields in the two places of lower altitude of the origin region of the investigated varieties, with means of 9.2 t ha^{-1} in Guaraciaba (altitude: 624 m) and 9.3 t ha^{-1} in Anchieta (altitude: 422 m). Khan et al. (2009) investigated the effect of sowing seasons on the yield of sweet corn local varieties and concluded that plant growth and development were faster as temperature and humidity increased, resulting in better results. Given that, in the present study, grain yield was associated with sowing season effects, altitude, genetic components and their interaction with the environment; then variations in temperature and genetic differences among the varieties of the western Santa Catarina state led to different yield rates and significant genotype x environment interactions.

These results must be taken into account at the time of indicating corn varieties to be grown at different altitudes. According to results of the current research, the variety 3000A can be grown at all the evaluated altitudes, whereas the genotypes 2255A and 2514A recorded the best unhusked and husked ear yield in Anchieta (altitude: 422 m). For the varieties 319A, 2029A and 741B, the best yield results were recorded in Guaraciaba (altitude: 624 m) and Anchieta (altitude: 422 m) (Table 1; Figure 2).

The sweet corn local varieties investigated in the current study have shown a genetic potential to be used as base populations in breeding programs focused on expanding genetic variability and encouraging the use of local germplasm. Based on the observed results and findings, it is possible to recommend three genetic breeding strategies: a) development of recurrent selection programs from individual varieties to explore their pre-existing variability, and hence improve the populations *per se*. In this case, the varieties 3000A and 319A could be directly used as target populations, since they have shown a good agronomic performance and better adaptation to the western Santa Catarina state conditions; b) development of composite populations to explore the additive genetic variance in recurrent cyclic selection programs; c) identification of heterotic groups for the development of hybrid cultivars. In these cases, the varieties 319A, 2029A, 741B, 2514A, 2276A and 2255A could be good options for studies on the basis of diallel analysis. These varieties have agronomic potential associated with ear yield, as shown in the current research, as well as present genetic variability and divergence in morphological ear and grain traits, as shown in previous studies (Souza et al. 2020, Souza et al. 2021), which could be used in different selection approaches.

Other studies aimed at evaluating and featuring sweet corn local varieties grown in the western Santa Catarina state should focus on analyzing the biochemical and sensory properties of sweet corn grains and the adaptive potential of varieties grown in that region.

The set of these actions involving plant breeding and characterization tends to strengthen on-farm conservation through the use of local germplasm (Ogliari et al. 2013) and, at the same time, reduce genetic erosion processes to which local varieties are constantly exposed to.

CONCLUSIONS

1. The best performance of sweet corn local varieties from the western Santa Catarina state takes place in their region of origin, mainly at altitudes ranging from 400 to 650 m;
2. The varieties 2255A, 319A, 3000A, 2029A and 741B presented a consistent behavior among the environments (altitudes) and tended to maintain the ranking recorded for ear length and diameter, as well as for unhusked and husked ear yield;
3. The varieties 3000A and 319A have potential to be used in breeding programs, since they presented a satisfactory adaptation, as well as a good ear length, grain length and unhusked and husked ear yield performance in the different altitudes of the western Santa Catarina state.

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