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Combining ability of white corn genotypes with two commercial hybrids

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Abstract

White corn is a special type of corn used to make «canjica», a dish appreciated in many regions in Brazil. However, there is a shortage of scientific information, genetic statistical estimates for breeding programs and white corn cultivars for producers to produce grits. The objectives of the present study were to assess two groups of white corn genotypes in a partial diallel cross for the main agronomic traits, estimate the combining ability of the parents and identify promising white corn hybrids for yield and grits quality. The fourteen topcross hybrids obtained from a partial Diallel (2 x 7), using seven genotypes and two commercial testers of the white maize (IPR 119 e IPR 127). The resulting hybrids and the two commercial controls were assessed in the 2011/2012 in the experimental center Agronomic Institute in Campinas (IAC) in growing season at the in Campinas and Tatuí, São Paulo state, Brazil. A randomized block design was used with four replications. The traits assessed were male flowering (MF), female flowering (FF), plant height (PH), ear height (EH), percentage of broken and lodged plants (Ld + Br) and grain yield (GY). There were two treatments for all the traits assessed in the two locations and some hybrids presented higher mean production than the commercial controls. The P_7, P_1, P_3, and P_2 genotypes presented the best general combining ability for all the traits assessed. The best estimates for specific combining ability were observed in the P_6 x P_9, P_2 x P_9, and P_7 x P_8 hybrids, indicating dominant loci systems in the genetic control of the traits PH, EH and GY.

Keywords: *Zea mays* L, topcross hybrids, diallel cross and grits corn

Introduction

White corn grits, is classified as a special type, along with mini-corn, popcorn and sweet corn and they represent specific market niches. Their production aggregates greater value to the product than common corn.

The «Canjica», Brazilian special grit, are obtained by the de-germination process that occurs either by dry or wet method, when the corn grain after processing in the wet method is separated into three parts: the endosperm, germ, and the pericarp. In dry processing, grits and meal, that consists mainly of the germ and pericarp, are obtained (MAPA, 2013).

In Brazil, white corn is widespread in the states of Paraná and São Paulo. The main producing municipalities include Londrina, Irati and Pato Branco in Paraná, where white corn is greatly used to produce cornmeal and in the state of São Paulo, in the regions of Quadras, considered the «White Corn Capital», Tatuí and Itapetininga, where white corn is used to produce grits.

Grain color is expressed by the action of the Y gene (yellow) that gives the color yellow to corn grains and dominates the recessive y form that determines the white color. The pigments controlled by these genes are present in the endosperm of the grain that is a triploid tissue (3n). Thus the endosperm with the yyy genotype is colored white and the other genotypes (Yyy, YYy, and YYY) present a deeper yellow, almost orange, color, as the number of y genes increases (Oliveira et al, 2007).

According to data from the National Company for Supply (Companhia Nacional de Abastecimento - Conab, 2012) only four white corn cultivars were available for the 2012/2013 growing season in a total of 280 corn cultivars, that shows the scarcity of white corn cultivars available on the market. Thus new cultivars are needed to supply this market niche.

Diallel crosses are outstanding among the procedures available for parent choice using the progeny performance (Ramalho et al, 2001). However, the main limitation to using complete diallels is the fact that the number of crosses to be assessed increases considerably as more parents are included in the study.

To overcome the problem of diallel crosses, Davis (1927) suggested the topcross crossing method, that allows a high number of genotypes to be assessed, crossing this group with one or more testers to eliminate those that do not have considerable merit, thus making hybrid development studies more efficient.

These crosses have been adopted in corn breeding programs mainly because they are easy to execute and supply preliminary assessment data of

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Table 1 - Description of the genotypes used to obtain the hybrids population for this study.

Genotypes	Company	Type
P_1 IA 33B	IAC	Synthetic Variety
P_2 IA 8333B	IAC	Synthetic Variety
P_3 F_2DKB 990	Dekalb/Monsanto	F_2Single Cross
P_4 IAC Pérola Piracicaba	IAC	Variety
P_5 F_2B 670	Braskalb	F_2Double Cross
P_6 F_2Murano	Syngenta	F_2Triple Cross
P_7 Al Bianco	CATI/DSMM	Variety
Testers		
P_8 IPR 119	Nascente/IAPAR*	Double Cross
P_9 IPR 127	Nascente/IAPAR*	Single Cross

*IAPAR: Agronomic Institute of Paraná (Instituto Agronômico do Paraná)

the genotypes tested by obtaining the effects of the combining ability (Hallauer and Miranda Filho, 1995; Castellanos et al, 1998; Duarte et al, 2003; Ferreira et al, 2009). According to Cruz and Regazzi (1994), these adaptations can maximize information on the group studied with a smaller number of crosses than those required in balanced diallel crosses.

A Diallel analysis provides good information on the genetic identity of genotypes especially on dominance-recessive relations and some other genetic interactions, and have been used in genetic research to determinate the inheritance of a trait among a set of genotypes and to identify superior parents for hybrid or cultivar development (Yan and Kang, 2003).

The hybrids obtained by topcrosses are assessed in a similar manner to the partial diallel crosses as proposed by Miranda Filho and Geraldi (1984), that consists of assessing the parents and their hybrids, estimating the effects of heterosis and the method called «ST Partial Diallel» by Geraldi and Miranda Filho (1988), adapting method IV by Griffing (1956), that consists of assessing hybrid combinations between two fixed groups of genotypes involving only the F_1' hybrids.

The crossing schemes of the Topcrosses, similar to the diallel cross, give information regarding the combining ability of the tested group which enables the choice of the more promising parents. According to Sprague and Tatum (1942), the concepts of general combining ability and specific combining ability are useful to characterize lines in crosses. The general combining ability (GCA) is associated mainly to genes with additive effect and specific combining ability (SCA) depends basically on genes with non-additive effect (dominance and epistasis).

The objectives of the present study were to assess two groups of white corn genotypes crossed in a diallel cross (2 x 7) for the main agronomic traits, obtain information on the parent´s combining ability and identify promising white corn hybrids for the state of São Paulo.

Materials and Methods

The white maize genotypes presented in Table 1, belonging to different heterotic group were crossed in a partial diallel cross (2 x 7), using the two commercial hybrids of white corn as testers, these commercial hybrids that stand out in Brazilian market for corn hybrids white (group I) and the seven populations of white maize (group II) at Santa Elisa Farm (IAC), in Campinas, São Paulo, Brazil.

The fourteen topcross hybrids obtained and two commercial controls (IPR 119 and IPR 127) were assessed in the 2011/12 growing season at the Santa Elisa Farm Experimental Center (IAC) in Campinas (latitude 22º54'20"S, longitude 47º03'39"W and 669 m altitude) and in the Regional Development Pole for Southwest São Paulo (APTA) in Tatuí (latitude 23º21'20"S, longitude 47º51'25"W and 645 m altitude), in the state of São Paulo. A randomized block design was used with four replications in plots consisting of six 5 m rows, 0,85 between row spacing in Campinas and 0,8 between row spacing in Tatuí and 0,2 m between plant spacing and two plants per subplot, totaling 25 plants per plot. The four central rows were considered when collecting the agronomic data.

The following agronomic traits were assessed: male flowering - MF (number of days necessary for 50% of the plants in the plot to be releasing pollen, counted from seedling emergence); female flowering - FF (number of days needed for 50% of the plants in the plot to have formed the style and stigma, counting from seedling emergence); plant height - PH (measured after the complete flowering of competitive plants sampled from each plot, taken from soil level to the insertion of the last leaf blade, in centimeters) obtained from 10 competitive plants; ear height - EH (measured after the complete flowering of competitive plants sampled in each plot, taken at soil level to the insertion of the main ear, in centimeters); percentage of broken and lodged plants - Ld + Br (obtained by counting the number of plants with < 45° angle to the soil and broken plants, respectively) and grain yield - GY (mass in kg of the grains resulting from threshing in a plot thresher, of the total plot, weighed on electronic scales).

The data for percentage of broken and lodged plants were transformed in percentage and then to $\sqrt{x+1}$ for the analysis of variance. The grain mass data were corrected to 14% moisture and ideal standard.

The individual and joint analysis of variance were carried out partitioning the treatment effect into new genotypes and the hybrid controls and their contrasts.

The model by Geraldi and Miranda Filho (1988) was used for the diallel cross analysis, that is an adaptation of the model by Griffing (1956) for partial diallel crosses:

$Yij = \mu + ½ (d_1 + d_2) + g_i + g_j + s_{ij} + \varepsilon_{ij}$, where:

Y_{ij} = mean of the cross involving the i^{th} parent of group I and the j^{th} parent of group II; μ = general mean of the diallel cross; d_1, d_2 = contrasts involving means of groups I and II and the general mean; g_i = general combining ability effect on the i^{th} parent of group I; g_j = general combining ability effect on the j^{th} parent of group II; s_{ij} = specific combining ability effect and ε_{ij} = mean experimental error.

The estimates of general combining ability ($\hat{g}_i$ and $\hat{g}_j$) and specific combining ability ($\hat{s}_{ij}$) were calculated by the expressions: $\hat{g}_i = Y_i -\ m$; $\hat{g}_j = Y_j -\ m$; $s_{ij} = Y_{ij} - (m + \hat{g}_i + \hat{g}_j)$, respectively, where Y_i is the general mean of the hybrid combinations with the i^{th} parent, and Y_j is the general mean of the hybrid combinations with the j^{th} parent.

The joint analysis of the experiments and the respective partitions of the sources of variation were carried out according to Vencovsky and Barriga (1992), considering all fixed effects.

The means were compared by the Tukey test at 5% probability, using the GENES statistical program (Cruz, 2007).

Results and Discussion

When the homogeneity of the mean squares (MS) of the residues was established, joint analysis of variance was carried out for the two locations and significant differences were observed (p < 0,01) among treatments and environments for all the traits assessed (Table 2) that allowed the performance of the hybrids assessed to be discriminated, and demonstrating the environments where were tested the traits showed presented different edaphoclimatic characteristics.

For crossing effect, the mean squares were significant for almost all the traits, except for MF, showing the genetic variability of the hybrids presented different performance between the characters evaluated.

The T x E interactions were significant for MF, FF, AE and Ld + Br while for Cr x E the traits MF, FF and Ld + Br were significant, showing that there was interference from the environment for the expression of these traits.

The estimates of the coefficients of experimental variation (CV%) of the joint analysis of variance indicated a good experimental precision, especially for GY (Scapim et al, 1995; Gomes, 1990).

The result of the Tukey test for all the characters are shown in Table 3. The P_6 x P_9 hybrid was outstanding because it presented the lowest means for the traits related to plant architecture, PH: (233 cm) and EH (137 cm).

The hybrid combinations: P_6 x P_9 (9,609 kg ha^{-1}), P_6 x P_8 (9,341 kg ha^{-1}), P_1 x P_8 (9,200 kg ha^{-1}), P_2 x P_8 (9,187 kg ha^{-1}), and P_1 x P_9 (9,168 kg ha^{-1}) were outstanding for GY, with mean production values compatible with those of the controls, IPR 127 (9,161 kg ha^{-1}) and IPR 119 (9,080 kg ha^{-1}).

Generally, the P_6 x P_9 hybrid performed favorably for all the traits assessed: MF (60 days), FF (63 days), PH (233 cm), EH (137 cm), GM (9,609 kg ha^{-1}) and Ld + Br (1,002). This hybrid presented a mean for GY approximately 104% greater than the GM of the best control, IPR 127.

These results proved that most of the hybrids assessed met the objectives proposed by breeding programs to obtain earlier and more productive hybrids.

According to results presented by Izhar and

Table 2 - Means square of the join analysis of variance to male flowering (MF) and female (FF), plant height (PH), ear height (EH), percentage of lodged and broken plants (Ld + Br) and grain yield (GY) of the fourteen white corn hybrids topcross. Campinas and Tatuí-SP, Brazil. 2011/12.

Source of variation (SV)	DF	Means Square (MS)					
		MF	FF	PH	EH	Ld + Br	GY[a]
		(days)		(cm)		$\sqrt{(x+1)}$	(kg ha^{-1})
Blocks	1	4.22	1.14	483.02	242.13	0.0019**	859.89
Treatments (T)	15	12.29*	15.11*	2,065.81**	1,008.22**	0.0125**	4,466.87**
Crosses (Cr)	13	10.36	16.20*	2,193.13**	1,088.18**	0.014**	4,914.34**
Control (C)	1	45.56**	16.00	564.06	600.25*	0.00054	5.15
Groups	1	4.01	0.07	1912.36*	376.74	0.0052	3,111.50**
Environ. (E)	1	195.03**	11.28*	37,778.13**	8,112.19**	0.1044**	95,792.78**
T x E	15	19.43**	30.53**	227.51	269.04*	0.0084**	685.11
Cr x E	13	16.43**	32.60**	256.67	215.18	0.0093**	736.86
C x E	1	45.56**	9.00	52.56	702.25*	0.0023	658.71
Groups x E	1	32.25*	25.11	23.46	535.99*	0.0028	38.73
Error	90	5.81	7.15	278.01	134.79	0.0018	449.18
Total	127						
Overall Means		60	65	260.03	151.16	1.047	8,686
Cr Means		60	65	261.5	151.81	1.05	8,627
C Means		61	65	249.81	146.62	1.03	9,098
CV (%)		3.96	4.11	6.41	7.68	4.053	7.71

[a]Means square multiplied by10^{-3}; **, * - significant at 1 and 5% of the probability, by F test.

Table 3 - Means values of the two controls and seven maize populations with two testers to male flowering (MF) and female (FF), plant height (PH), ear height (EH), percentage of lodged and broken plants (Ld + Br), and grain yield (GY) of the fourteen white corn hybrids topcross. Campinas and Tatuí-SP, Brazil. 2011/12.

	MF (days)	FF (days)	PH (cm)	EH (cm)	Ld + Br $\sqrt{(x+1)}$	GY[a] (kg ha^{-1})
controls						
IPR 127	60 a	66 a	243 b	140 cd	1.02 a	9,161 a
IPR 119	63 a	64 a	279 a	153 a-d	1.04 a	9,080 a
crosses						
P_1 x P_8	61 a	65 a	254 de	155 a-d	1.02 a	9,200 a
P_2 x P_8	60 a	66 a	267 a-d	159 a-d	1.06 a	9,187 a
P_3 x P_8	60 a	65 a	261 b-d	149 a-d	1.03 a	9,080 a
P_4 x P_8	60 a	66 a	286 a	170 ab	1.11 a	7,161 bc
P_5 x P_8	63 a	67 a	284 ab	160 a-d	1.12 a	8,616 a-c
P_6 x P_8	60 a	67 a	251 de	142 b-d	1.01 a	9,341 a
P_7 x P_8	61 a	66 a	254 de	154 a-d	1.05 a	7,969 a-c
P_1 x P_9	59 a	63 a	252 de	142 b-d	1.04 a	9,168 a
P_2 x P_9	60 a	62 a	257 cd	143 a-d	1.02 a	8,432 a-c
P_3 x P_9	60 a	64 a	252 c-e	142 b-d	1.01 a	8,929 a
P_4 x P_9	61 a	66 a	283 ab	166 a-c	1.12 a	7,018 c
P_5 x P_9	64 a	66 a	281 ab	171 a	1.06 a	8,369 a-c
P_6 x P_9	60 a	63 a	233 e	137 d	1.00 a	9,609 a
P_7 x P_9	61 a	66 a	262 d	140 cd	1.05 a	7,969 a-c
MSD (Tukey a 5%)	6	7	24.43	28.9	2.49	1,671
Overall Means	61	65	260	151	1.04	8,686
Crosses Means	60	65	261	152	1.05	8,627
Control Means	61	65	249	146	1.03	9,098

Means values with different letters in the column differ at 5% by Tukey test.

Chakraborty (2013), the estimates of the effects of general combining ability showed no desirable for all traits. However, some parental showed GCA significant positive effect and simultaneously had a high average value, indicating the per se performance of the parental. Roy et al (1998) and Hussain et al (2003) also observed similar phenomenon.

In the joint diallel cross analysis there were significant effects for the crosses, GCA in group I, GCA in group II and Environments (Table 4) for PH, EH and GY, showing unequal performance among the topcross hybrids and that the parents tested contributed differently to the crosses in which they were involved.

The significance of the SCA for GY showed that there were effects of dominance in the manifestation of yield in Campinas, and that determined hybrid combinations presented increase or decrease in GY. These results are in agreement with those reported by other authors who assessed SCA in common corn (Vacaro et al, 2002; Mohammed, 2009; Meseka et al, 2006; Meseka and Ishaaq, 2012; Kalaiyarasi et al, 2002; Pérez-Velasquez et al, 1995).

The values of the GCA of the MS of group II were significant for all the traits, except for Ld + Br. These values indicated the importance and superiority of the additive genetic effects and the genetic variability present in the traits assessed in the present study, fact observed by several authors (Zehui et al, 2000; Vacaro et al, 2002; Bayisa et al, 2008; Legesse et al, 2009).

Paterniani et al (2006) assessed common corn and also observed significant GCA values for PH, HE and GY, indicating the predominance of additive effects for the three traits.

Rodrigues et al (2006) assessed hybrids obtained from a partial diallel cross of white corn populations and reported positive GCA estimates for GY for the CMS 476, CMS 450, ZQP/B 103, ZQP/B 101 and ZQP/B 105 populations.

Kadlubiec et al (2001) using flint and dent types of maize inbred lines reported a higher proportion of GCA effects than SCA effects for yield and various other agronomic traits.

The significance of the GCA effects two genotype groups indicated greater importance of the additive effects in the control of PH, EH and GY and that there is variability of GCA effects, enabling selection among the hybrid combinations with the best GCA in both environments, that resulted in a better performance for the set of traits studied (Kostetzer et al, 2009). Similar results have been reported by several authors on corn (Kostetzer et al, 2009; Paterniani et al, 2008; Vacaro et al, 2002).

As reported by Kempthorne (1957), which provides reliable information on the general and specific combining ability effects of parents and their hybrid combinations was used to generate the information, which may indicate the breeder to control the characteristic in question thus assisting in the selection of parental promising. The design has been widely used in maize by several workers like, Joshi et al (2002) and Sharma et al (2004) and continues to be applied in quantitative genetic studies.

Significance was not observed for SCA in any of

Table 4 - Means square of the join analysis of diallel to male flowering (MF) and female (FF). plant height (PH). ear height (EH). percentage of lodged and broken plants (Ld + Br) and grain yield (GY) of the fourteen white corn hybrids topcross. Campinas and Tatuí-SP. Brazil. 2011/2012.

Source of variation (SV)	DF	Means Square					
		MF	FF	PH	EH	Ld + Br	GY[a]
		(days)		(cm)		$(\sqrt{x+1})$	(kg ha^{-1})
Crosses (Cr)	13	9.9	17.0	2,220.7**	1,072.2**	0.660	4,914.3**
GCA I	1	0.5	41.2	252.0**	252	8.510**	63.5
GCA II	6	19.6	18.8	4,426.9**	1,802.2**	0.008	9,794.7**
SCA	6	1.9	11.2	342.6	479	0.007	842.3
Environ. (E)	1	112	24.1	32,640.5**	5,945.1**	6.357	85,097.6**
Cr x E	13	163,073	31.2**	254.4	216.2	0.622	736.8
GCA I x E	1	5.1	63.0**	96.5	585.1*	8.033	1249.7
CGC II x E	6	31.9	50.8**	282.6	197.4	0.004	372.6
SCA x E	6	2.47	6.3	252.5	173.4	0.004	1015.5 *
Error	78	54,805	7.2	303	126.6	284.0	444.7
Overall Means		61	65	261.64	151.92	0.78	8,627

[a]Means square multiplied by10^{-3}; **. * - significant at 1 and 5% of the probability. by F test.

the traits assessed in the joint diallel cross analysis, indicating absence of dominance effects in the manifestation of the traits assessed in the topcross hybrids (Table 4). These results are in line with reports in the literature that show the predominance of GCA effects compared to SCA effects, as reported by Hallauer and Miranda Filho (1995), Morello et al (2002) and Kostetzer et al (2009).

The effects of environmental variation (E) were significant for MF, PH, EH and GY, showing that the environments were different. In the partitionings of G x E in Cr x E (MF and FF) and GCA I x E (FF and AE), significant differences were also observed, and it was inferred that the genotypes performed differently in the environments in which they were assessed (Table 4).

The significance observed for SCA x E for GY suggests the presence of complex interaction between hybrids in the environments that interferes in the expression of the dominant effects present in the hybrids. This fact allows inference of a differentiated response of the hybrid combinations in the face of environmental variations, and that at least in one of the environments was significant SCA. There are reports of these interactions in the literature (Rojas and Sprague, 1952; Matzinger et al, 1959; Pixley and Bjarnason, 1993; Pinto et al, 2007). Due to this fact, will be shown a table with the means square for GY in both environments (Table 5).

The mean squares for crosses showed significant differences for the character, indicating that the genotypes of white maize contributed differently in crosses that were involved to obtain hybrids. Likewise was observed significance for CGC II in both environments, which allows us to infer that there is parental control additive that compose the group II (seven populations) for this character.

However, in Campinas significant differences in SCA for GY, showing that there are also effects of dominance in the manifestation of productivity and certain hybrid combinations have increased or decreased by GY (Table 5). These results agree with those found by other authors evaluating SCA in common corn (Pérez-Velasquez et al, 1995; Vacaro et al, 2002; Vivek et al, 2009).

Though Tatuí the same source of variation (SCA) showed no significance which has already been observed by other authors working with common corn (Hallauer and Miranda Filho, 1995; Morello et al, 2002; Kostetzer et al, 2009).

The GCA estimate is an important tool for the breeder to select parents, because a low estimate, whether positive or negative, indicates that the GCA value of the parent, obtained based on its hybrid combinations, does not differ greatly from the general mean of the other populations assessed. High positive or negative GCA values indicate that the parent in question is greatly superior or inferior to the other parents of the diallel cross with relation to mean progeny performance (Cruz and Regazzi, 2001).

The populations that presented the best GCA estimates for MF and FF were: P_7 (-0.857 and -0.964 days), P_1 (-0.857 and -0.964 days) and P_2 (-0.857 and -0.357 days) that presented the lowest estimates that contributed to reduction of MF and FF that enabled earlier cultivars to be obtained (Table 6).

For PH the P_7 (PH: -19.393 cm) and P_3 (PH: -14.143 cm) populations showed negative estimates contributing to the reduction of the traits. The P_7 pop-

Table 5 - Means square of the individual analysis of diallel to grain yield (GY) of the fourteen white corn hybrids topcross. Campinas and Tatuí-SP, Brazil, 2011/2012.

SV	GL	Campinas	Tatuí
		MG[a] (kg ha^{-1})	
Cruzamentos	13	3,241,47 **	2,409,73 **
CGC I	1	938,39	374,86
CGC II	6	5,318,89 **	4,848,52 **
CEC	6	1,547,89 **	310,09
Resíduo	39	368,79	520,72
Overall Means		7755	9499

**, *: significant at 1 and 5% of the probability, by F test.

Table 6 - Estimates of the effects of general combining ability (GCA) to male flowering (MF) and female (FF), plant height (PH), ear height (EH), percentage of lodged and broken plants (Ld + Br) and grain yield (GY) of the seven populations of white corn with two testers. Campinas and Tatuí-SP, Brazil. 2011/2012.

	MF (days)	FF	PH (cm)	EH	Ld + Br $\sqrt{(x+1)}$	GY[a] (kg ha^{-1})
Group I						
P_8	0.71	-0.607	-1.5	-1.5	-0.276	-23.81
P_9	-0.71	0.607	1.5	1.5	0.276	23.81
Group II						
P_1	-0.857	-0.964	-8.393	-3.679	-0.015	557.03
P_2	-0.357	-0.964	0.607	-1.429	-0.002	182.72
P_3	-0.857	-0.464	-14.143	-6.929	-0.016	377.66
P_4	0.143	0.786	23.357	15.571	0.029	-1537.22
P_5	2.143	1.536	21.357	13.821	0.033	-134.50
P_6	0.643	1.036	-3.393	-4.929	-0.033	-293.78
P_7	-0.857	-0.964	-19.393	-12.429	-0.025	848.09

ulation presented lower estimates for the two traits for plant architecture (EH: -12.429 cm) and was considered a promising population in crosses to reduce these traits.

The greatest GCA for the GY trait were obtained by the P_7 (848.09 kg ha^{-1}) and P_1 (557.03 kg ha^{-1}) populations, classifying them as promising for participation in crosses to increase GY. Aly (2013) evaluating general combining ability in hybrid yellow corn topcrosses found significant of results for the same trait.

The following seven white corn populations were shown to be promising: P_7, that had the best GCA estimates: MF (-0.857 days), FF (-0.964 days), PH (-19.393 cm), EH (-12.429 cm), Ld + Br (-0.025) and GY (848.09 kg ha^{-1}).

Moll and Stuber (1974) reported that any combination among the parents may produce hybrid vigour over the parents which might be due to dominant, over dominant or epistatic gene action.

According to the data presented in diallel cross analysis and their interactions, indicated predominance of additive effects in most agronomic traits, highlighting the per se performance if each of them and allowing the selection of promising populations for use in breeding programs.

In the literature many authors demonstrate the predominance of additive gene effects for agronomic traits evaluated in this study, as the results presented by Doffing et al (1991) and Larish and Brewbaker (1999). The greather importance of dominance effects for GY corroborates with studies Viana and Pina Matta (2003) and Uddin et al (2006).

Well as the effect of GCA, it is also important to assess the specific interactions that reflect non-additive effects, through the SCA allows to characterize the deviations of hybrid combinations in relation to the average behavior of parents (Ferreira et al, 2002). However, in this study the significance was not observed for all traits the genotypes evaluated white corn, due to this fact not will be presented the estimates.

Even not have been found significant effects of SCA, the best estimates occurred in the crosses of populations with higher estimates of GCA (P_1 and P_3) with values medium ranging between 9,168 to 8,963 kg ha^{-1}.

Conclusions

There was genetic variability among white corn populations and the hybrids assessed.

Stood out to general combining ability of the Al Bianco, IA 33B, F2DKB 990 and IA 8333B populations to PH, EH e GY.

The following hybrid combinations were outstanding P_4 (IAC Pérola Piracicaba) x P_9 (IPR 127), P_6 (F_2 Murano) x P_9 (IPR 127) and P_6 (F_2 Murano) x P_8 (IPR 119).

Among the agronomic traits assessed there was predominated additive effects to PH, EH and GY, showing the *per se* performance of the each of the populations enabling to select of the most promising for future use in breeding programs.

There are promising hybrid combinations, with patterns of earliness, plant height and ear, percentage of broken and lodged plants and grain yield compatible or superior to commercial white corn hybrid for use in breeding programs.

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