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Estimates of genetic variance components in asparagus hybrids in two cultivation systems

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ABSTRACT - *In order to determine the genetic variance components and heritability of six pistillate and six asparagus elite plants, 18 hybrids were evaluated for yield traits in two cultivation systems (blanched and green asparagus) in two harvest periods. The circular partial diallel scheme was replicated twice in 20-plant plots in a randomized block design. The differences between the GCA and SCA effects varied depending on plant age and cultivation systems. The relative importance of the ratio of the combining ability variance showed that the additive components of variance were more important than the non-additive components. The GCA effects of three pistillate and two staminate plants as well as the SCA effects of three crosses were favorable for yield traits.*

Key words: *Asparagus officinalis* L., circular partial diallel, components of genetic variance, general and specific combining ability.

INTRODUCTION

Asparagus (*Asparagus officinalis* L.) is an allogamous, perennial and dioecious plant that grows in temperate and subtropical climates. As the temperature increases towards the end of the winter the spears, the edible part of the plant, grow from the rhizome (Ornstrup 1997). The two most common production systems are white (blanched) asparagus grown under mounded soil or green asparagus grown in raised beds (Rodríguez 1990). The great potentiality of asparagus breeding is based on the high genetic variability associated with the typical dioecy of the species (Ellison 1986). The biology of asparagus has allowed the development of progenies with both high uniformity and productivity (Ellison 1986) by hybridization of pistillate and staminate plants selected for yield. The selected parents were cloned by micropropagation and the clonal hybrid termed F_1 progenies. Although this type of hybrid is commercially well-accepted, little information about additive and non-additive components of variance is available in asparagus. In this sense, it is necessary to determine the genetic values of the parents and the yield performance of their hybrids in different cultivation systems to map out effective selective strategies. Genetic parameters, useful for the parental selection and knowledge on the nature and magnitude of the genetic

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effects involved in the determination of economically important traits, can be estimated by means of polycrosses (Cruz 2001). The partial circulant diallel cross (Kempthorne and Curnow 1961) allows the analysis of a larger number of parents than conventional complete diallels using the same number of crosses. The relative importance of the combining ability variance components can be determined as proposed by Baker (1978).

Objectives of this work were to estimate the genetic variance components of agronomically important traits in two cultivation systems in a set of asparagus hybrids and to determine the relative merit of the parents to map out future breeding strategies.

MATERIAL AND METHODS

Eighteen hybrids resulting from the combination of six pistillate (*89*, *253*, *288*, *473*, *859*, and *876*) and six staminate (*357*, *481*, *491*, *710*, *777*, and *861*) elite genotypes were analyzed through a circular partial diallel design. The hybrids were planted in 1999 on an experimental area of the National University of Rosario, Argentina (lat 33º 01' S, long 60º 53' W, alt 50 m asl), in a randomized complete block design with three replications per cultivation system and 20 plants per plot. The planting grid was spaced 2.1 m between rows and 0.4 m between plants a row. The experiment was conducted for blanched and green spear production.

Data were collected during the years 2000 and 2001 (first and second productive seasons after planting), harvesting each plot every two days. The evaluated traits were: days to first harvest (DFH), measured as the number of days from the date of the aerial mass removal to the date of the first spear harvest; days until 50% of the plants per plot were productive (D50%), days from the date of the first harvested spear to the date when 50% of the plants on the plot became productive; yield (YLD) in grams of spears produced per plot from the moment when 50% of the plants had sprouted and during a two month period; spear number (SN) and spear mean weight (SMW) obtained as the YLD/SN ratio. For these three latter traits (yield traits) we considered only those spears that reached a diameter over 10 mm at the base for green asparagus, and 12 mm at the base of the superior third for blanched spears. The spears were trimmed to a length of 15 cm before weighing.

The estimates of the general combining ability (GCA) effects of the pistillate and staminate parents ($\hat{g}_p$ and $\hat{g}_s$), the specific combining ability (SCA) effects ($\hat{s}_{ps}$) and the respective variances ($^{2}_{\hat{g}_p}$, $^{2}_{\hat{g}_s}$ and $^{2}_{\hat{s}}$) were obtained for each cultivation system in the crop seasons of both 2000 and 2001 by the GENES software (Cruz 2001). The genotypic, additive and non-additive components of variance were estimated as proposed by Miranda Filho and Vencovsky (1999), and the SCA variance ($^{2}_{SCA}$) and the broad and narrow-sense heritabilities (H^2 and h^2) were calculated with these estimates. The relative importance ratio (IR) between GCA and SCA variances for the evaluated traits (Baker 1978) was calculated for each trait considering pistillate (IRp) and staminate (IRs) parents.

Cluster analyses were performed for each cultivation systems using the STATISTICA program (StatSoft 1993), the GCA effects estimated for the parents and the SCA effects estimated for the hybrids, with the aim of identifying uniform genotype groups.

RESULTS AND DISCUSSION

The analyses of variance showed significant differences among hybrids for yield, and highly significant differences for days to first harvest and spear mean weight in the first harvest in the blanched asparagus cultivation system. Highly significant differences were found in the second year for blanched and in the first and second harvest for the green spear cultivation system for days to first harvest, days until 50% of the plants per plot were productive, yield, spear number and spear mean weight (Table 1).

The partition of sums of squares for the hybrids into its components showed that the variability observed between hybrids was determined by differences between the GCA effects of the pistillate and staminate parents, and between SCA effects of the crosses. The participation of these components of genetic variance in the observed variability varied according to plant age and cultivation systems (Table 1).

For days to first harvest the decrease in H^2 values from the first to the second productive season under the blanched spear cultivation system was more marked than the decrease in the h^2 values, suggesting that the additive component of variance was less influenced by the plant age than the non-additive component. Under the green spear cultivation system a slight increment of the additive variance was observed, and the increment in the h^2 values was greater than the increment in the H^2 values from the first to the second harvest (Table 2). The relative importance of the combining abilities for the pistillate and staminate parents (IRp and IRe) showed that in the

Table 1. Analysis of variance for days to first harvest (DFH), days to 50% of productive plants per plot (D50), yield (YLD), spear number (SN) and spear mean weight (SMW) in the first (2000) and second (2001) harvest of 18 asparagus hybrids under blanched and green spear production systems

Year	System	Sources of variation	df	DFH MS	DFH F	D50 MS	D50 F	YLD MS	YLD F	SN MS	SN F	SMW MS	SMW F
2000	Blanched	Block	2	29.2		2.4		31027.8		121.2		5.3	
		Hybrids	17	94.0	6.1**	20.7	0.7	159613.5	2.3*	195.8	1.8	21.8	5.6**
		GCAp	5	80.4	5.2**	33.3	1.1	235331.8	3.4*	320.3	3.0*	30.6	7.8**
		GCAe	5	104.8	6.8**	13.1	0.4	59913.0	0.9	109.2	1.0	13.9	3.6**
		SCA	7	82.6	5.3**	5.7	0.2	77538.1	1.1	155.6	1.4	2.3	0.6
		Error	34	15.5		29.5		69947.4		107.7		3.9	
	Green	Block	2	2.7		17.0		17911.0		75.2		0.0	
		Hybrids	17	79.9	6.8**	150.6	4.1**	32326.8	3.4**	84.9	2.6**	7.7	4.8**
		GCAp	5	80.3	6.8**	257.6	7.0**	31626.7	3.3*	170.8	5.2**	6.4	4.0**
		GCAe	5	50.0	4.7**	46.7	1.3	24923.1	2.6*	21.5	0.7	3.3	2.0
		SCA	7	95.9	8.0**	148.3	4.0**	38113.9	4.0**	69.0	2.1	11.8	7.4**
		Error	34	11.8		36.8		9636.0		32.9		1.6	
2001	Blanched	Block	2	36.1		155.6		141813.5		638.5		26.7	
		Hybrids	17	50.9	2.6**	121.7	4.3**	7296042.6	12.3**	6811.3	10.0**	43.3	11.9**
		GCAp	5	93.1	3.7**	97.7	3.4*	367953.5	6.5**	3503.6	5.2**	21.6	6.0**
		GCAe	5	17.2	0.9	57.3	2.0	7358821.6	12.4**	7676.2	10.6**	41.4	11.0**
		SCA	7	45.1	2.3*	56.9	2.0	9042294.1	15.2**	7979.9	11.7**	55.6	15.4**
		Error	34	19.5		28.6		595574.6		680.0		3.6	
	Green	Block	2	3.6		20.1		12773.3		0.2		0.1	
		Hybrids	17	80.5	8.4**	125.9	5.8**	4349680.6	36.8**	13324.3	34.5**	19.8	23.1**
		GCAp	5	45.5	4.7**	125.0	6.0**	2513674.6	21.2**	7248.8	18.8**	13.1	15.2**
		GCAe	5	99.7	10.4**	82.2	4.0**	3897532.3	38.9**	13085.9	33.9**	10.9	12.7**
		SCA	7	74.0	7.7**	47.5	2.3*	5570917.5	47.1**	15606.1	40.4**	29.3	34.2**
		Error	34	9.6		20.7		118336.7		386.3		0.9	

* $P < 0.05$, ** $P < 0.01$

blanched spear cultivation system the additive effects of both groups of parents participate in the determination of the observed variability for days to first harvest in the first productive season, while in the second season, the additive component of variance was originated by differences in the GCA effects of the pistillate parents. Under the green spear cultivation system the non-additive effects have more participation than the additive effects, and the expression of the pistillate additive component was less influenced by plant age than the staminate additive component (Table 2).

When the hybrids where cultivated for blanched spear production the differences in the expression of the genetic factors that govern the earliness were less marked in the second harvest, with a lower expression of the non-additive component of variance than the first harvest. Under the green spear cultivation system the plant age effect was less important in the second harvest, whereas the additive component of variance was more important, so the expression of the genetic factors that determine the earliness was more stable than under the blanched spear cultivation system.

The additive component of variance represented almost all the genotypic variance for days until 50% of the plants per plot were productive in the first harvest under the green spear cultivation system. This is reflected by the high H^2 and h^2 values. The additive component of variance was originated by differences in the GCA effects of pistillate parents, with a RIp value near the unity (Table 2). In the second harvest, under the blanched spear production system, the non-additive component of variance was non-significant and the additive component was originated by the variance of the GCA effects of the pistillate parents, generating a low h^2 value (Table 2). Under the green spear production system the non-additive component of variance increased and the additive component decreased in the second harvest in relation to the first, in agreement with the increase of the H^2 and the decrease of the h^2 values. The variance of the GCA effects of the pistillate parents was greater than that observed for the staminate parents, as the respective RI ratio values show (Table 2).

Considering that the additive variance integrates the variance of GCA effects of pistillate and staminate parents, and that the contribution of the staminate parents to the additive component of variance for days until 50% of the plants per plot were productive became significant in the second harvest for the green spear cultivation system, then the pistillate additive component of variance could be the major responsible of the hybrid performance for this trait.

Moderate H^2 and h^2 values were obtained for yield in the first harvest under both cultivation systems. For blanched spear production system the additive component

Table 2. Estimates of the genotypic (σ^2_G), additive (σ^2_A) and non additive (σ^2_{NA}) variance components, general combining ability variance of the pistillate ($\sigma^2_{\hat{g}p}$) and staminate ($\sigma^2_{\hat{g}s}$) parents, specific combining ability variance ($\sigma^2_{\hat{s}}$), broad-sense heritability (H^2), narrow-sense heritability (h^2), relative importance of combining ability variances of pistillate (RIp) and staminate (RIe) parents for days to first harvest (DFH), days to 50% of productive plants per plot (D50), yield (YLD), spear number (SN) and spear mean weight (SMW) in the first (2000) and second (2001) harvest of 18 asparagus hybrids in blanched and green spear production systems

		2000					***2001***				
		DFH[1]	**D50**	**YLD**	**SN**	**SMW**	**DFH**	**D50**	**YLD**	**SN**	**SMW**
Blanched	σ^2_G	78.5	-	89666.1	-	17.9	31.4	93.1	6700467.7	6131.3	39.4
	σ^2_A	47.8	-	72569.8	-	13.4	22.6	32.6	2713593.4	2631.6	15.0
	σ^2_{NA}	30.7	-	-	-	-	8.8	-	3986874.3	3499.7	24.4
	$\sigma^2_{\hat{g}p}$	9.3	-	36284.9	-	4.8	11.3	16.3	445343.2	397.0	2.7
	$\sigma^2_{\hat{g}s}$	14.6	-	-	-	1.9	-	-	911453.5	918.8	4.8
	$\sigma^2_{\hat{s}}$	7.7	-	-	-	-	2.2	-	996718.6	874.9	6.1
	H^2	0.83	-	0.56	-	0.82	0.62	0.76	0.92	0.90	0.92
	h^2	0.51	-	0.45	-	0.61	0.44	0.27	0.37	0.39	0.35
	RIp	0.71	-	1.00	-	1.00	0.91	1.00	0.47	0.48	0.47
	RIe	0.79	-	-	-	1.00	-	-	0.66	0.68	0.61
Green	σ^2_G	68.1	113.8	22690.3	52.0	6.1	70.9	105.2	4231343.9	12938.0	18.9
	σ^2_A	31.2	106.6	19022.0	41.2	1.4	38.8	65.2	1492054.2	4867.8	5.6
	σ^2_{NA}	36.9	7.2	3668.3	-	4.7	32.1	40.0	2739289.7	8070.2	13.3
	$\sigma^2_{\hat{g}p}$	9.3	53.3	6815.2	20.6	0.7	8.0	21.9	286085.4	829.9	1.6
	$\sigma^2_{\hat{g}s}$	6.3	-	2695.8	-	-	11.4	10.7	459941.7	1604.0	1.2
	$\sigma^2_{\hat{s}}$	9.2	1.8	917.1	-	1.2	8.0	10.0	684822.4	2017.6	3.3
	H^2	0.85	0.76	0.70	0.61	0.79	0.88	0.83	0.97	0.97	0.95
	h^2	0.39	0.71	0.59	0.48	0.18	0.48	0.52	0.34	0.36	0.28
	RIp	0.67	0.98	0.93	1.00	0.54	0.67	0.81	0.46	0.45	0.49
	RIe	0.58	-	0.85	-	-	0.74	0.68	0.57	0.61	0.42

[1]Coded as in Table 1, - not estimable

of variance was originated by differences in the GCA effects of the pistillate parents only (Table 2). Under the green spear production system the participation of the non-additive component of variance was minor, while the participation of the variance of GCA effects of the pistillate was superior to that observed for the staminate parents, reflected in the respective RI ratio values (Table 2). In the second harvest the H^2 values were higher and the h^2 values lower than in the first harvest due to the high expression of non-additive effect differences under both cultivation systems. The variance of the GCA effects of the staminate parents was greater than the observed for the pistillate parents in the determination of the additive variance for yield, as shown by the RIp and Rie values (Table 2).

For the trait spear number a moderate H^2 value demonstrated an important environmental component of phenotypic variance in the first harvest of the green spear cultivation system. The additive component of variance was generated only by the variance of the GCA effects of the pistillate parents. The H^2 and h^2 values were similar and the RI ratio for the pistillate parents was the unity due to the lack of differences in the non-additive effects for this trait (Table 2). In the second harvest, all components of genetic variance that control the spear number were expressed under both cultivation systems. The increment of the H^2 values and the moderate decrease of the h^2 values showed that the non-additive component of variance began to be expressed in the second harvest. In the determination of the additive component of variance, the contribution of the GCA effects of staminate parents was greater than the pistillate parents, as shown by the RI ratio values (Table 2).

High broad and narrow-sense heritability values were observed for spear mean weight under the blanched spear cultivation system. The variance of the GCA effects of the pistillate parents was twice the variance of the staminate parents, whereas the respective RI ratio values were the unity due to the lack of variance of the SCA effects (Table 2). Under the green spear cultivation system the non-additive component of variance was greater than the additive component, generating a high H^2 and a low h^2 value. The additive component was originated only by the variance of the GCA effects of the pistillate parents (Table 2). The high H^2 and the low h^2 value estimated for the second harvest in both cultivation systems showed that the differences among non-additive effects were expressed more markedly than in the first harvest. In the blanched spear cultivation system the GCA effects of the staminate parentals were more variable than the pistillate parents, while in the green spear production system the pistillate additive component was slightly greater than the staminate, as shown by the RIp and RIe ratios (Table 2).

The yield is determined by the number and size of the subterranean buds which are differentiated by a genetically determined process (Robb 1984), but related to the environment and amount of reserves accumulated in the previous season of vegetative growth of the crown. These traits could be governed by linked genes or genes with pleiotropic effects, which are not expressed completely until the plants are three years old. In young plants this expression depends to some extent on the internal and external environmental conditions. The greater expression of the non-additive component of variance observed for the yield traits in four-year-old plants than in younger plants could be due to the fact that the physiologic potential of their natural heterozygosity increases with age.

In asparagus, there is no evidence that a trait is determined exclusively by the pistillate or the staminate parental, with exception of sex (Corriols 1985). In the present contribution, the observations made on the yield performance have in common that in the first harvest the pistillate additive component of variance was the most representative cause for differences in the hybrid performance, while in the second harvest the staminate additive component of variance mainly determined the differential behaviour of the hybrids.

The complexity of information obtained for the GCA effects of all traits observed in each parental required the use of special statistical techniques. Multivariate analyses allow the simultaneous interpretation of traits that contribute to the genotypic distinction and identification and that, when crossed, will originate populations with favourable genotypic values and increase the chance of obtaining superior combinations in segregating populations (Silva et al. 1999). The different cultivation systems and plant ages led to different hybrid performances. Both groups of parents were therefore analyzed through the GCA effects in each cultivation system. This allowed the selection of parents that produce high-performing descendants for each cultivation system (Falconer and Mackay 1996). Moreover, only the GCA effects estimated for the second harvest were considered for these analyses because the hybrid performance was better represented.

Five groups of parents with uniform characteristics were obtained by cluster analyses for the blanched spear cultivation system and six groups in the green spear cultivation system. Under the blanched spear cultivation system, the third group, which included the pistillate parent *253* and staminate parents *357* and *491* showed the best mean values of GCA effect for yield, spear number and spear mean weight (Table 3). Under the green spear cultivation system, the best mean values of GCA effect for yield, spear number and spear mean weight appeared in the fifth group, which included the pistillate *89* and staminate *357* and *491* parents (Table 3). The second group under the blanched spear cultivation system made up by the pistillate *859* and *89* parents, and the third group formed under the green spear production system by the pistillate parental *859* had the second best mean values of the GCA effect for yield (Table 3) and could be considered to raise the number of parents to engender the new population of selection.

Table 3. Mean values of the general combining ability effects and standard deviations of each group of parents for days to first harvest (DFH), days to 50% of productive plants per plot (D50), yield (YLD), spear number (SN) and spear mean weight (SMW) in the second harvest of 18 asparagus hybrids under blanched and green spear production systems

	Group	Parents	DFH	D50	YLD	SN	SMW
Blanched	1	*288; 710; 777*	0.0 ± 1.5	1.6 ± 0.5	41.9 ± 23.2	-0.9 ± 4.1	0.6 ± 1.1
	2	*859; 89*	2.3 ± 4.2	-2.1 ± 5.0	417.1 ± 142.8	16.4 ± 2.1	0.7 ± 0.1
	3	*253; 357; 491*	-0.3 ± 2.3	-2.6 ± 2.4	928.8 ± 157.8	27.3 ± 9.5	1.9 ± 0.3
	4	*473; 861; 876*	-1.4 ± 3.1	1.0 ± 4.3	-788.9 ± 27.5	-22.2 ± 4.1	-2.1 ± 0.9
	5	*481*	0.4 ± 0.0	4.1 ± 0.0	-1379.4 ± 0.0	-45.4 ± 0.0	-2.6 ± 0.0
Green	1	*288; 777*	0.1 ± 2.8	0.7 ± 0.7	-13.9 ± 23.4	-0.5 ± 3.4	0.4 ± 0.2
	2	*253; 710*	1.0 ± 2.0	-0.1 ± 2.7	321.5 ± 12.0	11.4 ± 2.0	0.9 ± 0.0
	3	*859*	-1.8 ± 0.0	6.6 ± 0.0	388.6 ± 0.0	18.4 ± 0.0	-0.2 ± 0.0
	4	*473; 861; 876*	-1.4 ± 3.1	-0.7 ± 2.1	-613.1 ± 122.3	-33.2 ± 6.7	-1.3 ± 0.8
	5	*89; 357; 491*	2.6 ± 2.8	-3.5 ± 4.5	620.2 ± 67.4	39.4 ± 4.7	0.9 ± 1.0
	6	*481*	-4.1 ± 0.0	4.8 ± 0.0	-1025.0 ± 0.0	-58.9 ± 0.0	-1.4 ± 0.0

Heterosis could be used for yield breeding purposes in asparagus hybrid materials. Best hybrid combinations are those that have desirables SCA effects and at least one parent with an adequate GCA effect (Souza and Ramalho 2001). However, cultivation systems and plant age have induced a differential expression of the SCA effects in the hybrids, as observed for the GCA effects. For this reason, the same criterion used for clustering parents considering GCA effects obtained in each cultivation system were used for hybrid clustering considering their SCA effects. Seven clusters of hybrids were obtained under the blanched spear cultivation system and seven groups of hybrids under the green spear cultivation system. The crosses with the best productive profiles in both cultivation systems were *859*x*710*, *288*x*357* and *253*x*777*, which have desirable SCA effects (Table 4) and have at least one parent with a favourable GCA effect. For blanched and green spear production solely, the crosses with the best productive profiles were

Table 4. Mean values of the specific combining ability effects and standard deviations of each group of crosses for days to first harvest (DFH), days to 50% of productive plants per plot (D50), yield (YLD), spear number (SN) and spear mean weight (SMW) in the second harvest for 18 asparagus clonal hybrids under blanched and green spear production systems

	Group	Crosses	DFH	D50	YLD	SN	SMW
Blanched	1	*288*x*481*; *89*x*357*	1.6 ± 0.4	-2.2 ± 0.7	11.5 ± 140.1	4.3 ± 7.8	-0.5 ± 0.1
	2	*253*x*491*; *876*x*777*; *876*x*861*	0.7 ± 1.9	-1.2 ± 1.5	328.0 ± 85.3	16.6 ± 7.1	-0.6 ± 1.3
	3	*473*x*481*; *473*x*491*	1.6 ± 0.2	-1.0 ± 0.2	773.8 ± 179.6	22.0 ± 1.3	1.9 ± 1.7
	4	*859*x*481*; *876*x*710*	-2.8 ± 0.0	3.8 ± 0.4	-585.3 ± 36.8	-22.6 ± 3.9	0.0 ± 0.4
	5	*253*x*777*; *89*x*861*; *288*x*357*	1.1 ± 1.8	-0.3 ± 1.4	1257.4 ± 155.7	31.7 ± 7.4	3.7 ± 1.4
	6	*859*x*710*	5.5 ± 0.0	-7.1 ± 0.0	1960.8 ± 0.0	58.5 ± 0.0	3.8 ± 0.0
	7	*253*x*861*; *473*x*357*; *288*x*710*; *89*x*491*; *859*x*777*	-2.3 ± 0.8	2.1 ± 1.3	-1423.4 ± 121.0	-42.1 ± 6.2	-3.2 ± 1.0
Green	1	*89*x*357*	-2.5 ± 0.0	0.8 ± 0.0	37.2 ± 0.0	14.1 ± 0.0	-0.7 ± 0.0
	2	*253*x*491*; *859*x*481*; *288*x*481*	-0.5 ± 2.7	1.0 ± 2.2	-232.6 ± 127.0	-12.4 ± 4.2	-0.2 ± 0.4
	3	*473*x*481*; *89*x*861*; *876*x*777*; *876*x*861*	2.4 ± 2.0	-0.1 ± 2.5	401.3 ± 76.5	20.9 ± 5.3	1.0 ± 0.7
	4	*253*x*777*; *288*x*357*; *473*x*491*	1.9 ± 3.3	-1.6 ± 2.3	999.2 ± 211.8	54.6 ± 6.5	2.0 ± 0.7
	5	*253*x*861*; *876*x*710*; *89*x*481*	-2.4 ± 1.3	-1.4 ± 1.4	-665.7 ± 143.5	-37.4 ± 4.3	-1.7 ± 0.8
	6	*288*x*710*; *473*x*357*; *859*x*777*	-3.3 ± 0.3	3.1 ± 2.0	-1232.8 ± 161.3	-65.9 ± 11.8	-2.5 ± 1.6
	7	*859*x*710*	5.4 ± 0.0	-3.7 ± 0.0	1753.4 ± 0.0	85.6 ± 0.0	4.1 ± 0.0

89x861 and *473x491* respectively.

In conclusion, the traits analyzed in this work have shown significant GCA and SCA effects, implying the presence of additive and non-additive variance effects. However, the heritability values were influenced by the cultivation systems and plant age. We suggest that the pistillate parents *859*, *89* and *253* and the staminate *357* and *491* parents could be selected to generate populations with superior agronomic performance. The crosses *859*x*710*, *253*x*777* and *288*x*357* have shown desirable SCA effects for yield traits and could be used for both blanched and green spear production, while the crosses *89*x*861* and *473*x*491* could be considered for the blanched and green spear production, respectively.

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Estimativas dos componentes da variância genética em híbridos de aspargo sob dois sistemas produtivos

RESUMO - *Com o propósito de estimar os componentes da variância genética, herdabilidade e o mérito relativo para caracteres de interesse agronômico de un conjunto de seis parentais pistilados e seis estaminados de aspargo foram avaliados 18 híbridos em duas épocas produtivas, sob dois sistemas de manejo (aspargo branco e verde). Utilizou-se um esquema de cruzamentos dialélico parcial circulante em blocos completos casualizados com três repeticôes de vinte plantas. A variabilidade observada para os efeitos de CGC e CEC foi modificada pela idade das plantas e o sistemas de cultivo. Os índices da importância relativa das capacidades combinatórias mostraram que os componentes da variância aditiva foram maiores que da não aditiva. Três plantas pistiladas e duas estaminadas apresentaram efeitos favoráveis de CGC, e três cruzamentos apresentaram efeitos favoráveis de CEC nos dois sistemas de cultivo.*

Palavras-chave: *Asparagus officinalis* L., dialelo parcial circulante, componentes de variância genética, capacidade combinatória geral e específica.

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