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Heterosis studies for seed cotton yield and yield contributing traits in *desi* cotton (*Gossypium arboreum* L.)

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Abstract
Four females (lines) and six males (testers) were crossed in L x T mating design to obtain 24 crosses. These 24 hybrids along with 10 parents and 2 standard checks were evaluated in a randomised block design during *Kharif* 2021-22 at Cotton Research Station, Mahboob Baugh Farm, VNMKV, Parbhani. The data on yield and yield components were recorded *viz.*, days to 50% flowering, plant height (cm), number of sympodia per plant, number of bolls per plant, boll weight (g), seed cotton yield per plant (g) and seed index (g). Analysis of variance carried out for the characters showed significant treatment differences for all characters studied. The magnitude of heterosis, heterobeltiosis and standard heterosis for all the characters in the present study was highly appreciable. The cross PA 863 x CNA 1032 showed highest magnitude of mid parent heterosis i.e., 34.53% and the cross PA 828 x PA 08 showed highest magnitude of better parent heterosis i.e., 22.31% for seed cotton yield per plant whereas the cross PAIG 411 x PA 740 showed highest magnitude of standard heterosis for number of balls per plant to the extent of 70.56% over standard check PKVDH 1.

Keywords: Desi cotton, seed cotton yield, heterobeltiosis, standard heterosis

Introduction

Cotton is an important fiber crop and plays an important role as a cash crop in commercial industry of many countries. It is popularly known as "King of fiber" and "White Gold". Out of the four cultivated species of cotton, only two are cultivated *viz. G. hirsutum* and *G. arboreum* in Maharashtra. It has been noticed that area under *desi* cotton cultivation is reducing day by day owing to its lower productivity and inferior fiber quality as compared to tetraploid cotton in rainfed ecosystem. Hence, genetic improvement is essential to overcome the problem and this could be obtained through introduction of hybrid vigour. Various promising characters such as big boll size, medium to long staple length and short stature with sustainable yield with varying environments should be considered in developing varieties. To achieve such characteristics proper breeding strategies should be followed and this process of breeding programme depends on the magnitude of genetic variability present in breeding material.

Even after introduction of Bt gene in these hybrids, sucking pests and abiotic stresses are major problems. Asiatic cottons are known for their inherent ability of resistance against major pests and diseases in addition to high ginning outturn, low cost of management and wide adaptability under rainfed cultivation due to deep root system. In order to remain competitive in the world market, several cotton breeding efforts needed to be placed on priority in research. The economic importance of cotton in agriculture and industry lies in its yield and fibre quality. Global competition in the production and use of cotton fibre with advanced plant improvement technologies in yield and yarn manufacturing had accelerated the efforts to increase yield and improve fibre quality. Considering the importance of cotton in the Indian economy from the point of view of domestic consumption of cotton and its export, cotton improvement programme is encouraged with its main objective as development of hybrids with high yield and fiber quality.

Materials and Methods

The experimental material included in the present study comprised of four females (lines) and six males (testers) which are mated in a line X tester design to obtain 24 crosses. These 24 hybrids along with 10 parents and 2 standard checks were sown at Cotton Research Station, Mahboob Baugh Farm, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani. during *kharif* 2020-21. Two rows of each treatment having 6.0 m length and spacing of 60 cm between rows and 30 cm between plants was sown. All the recommended package of practices were followed to raise a good crop. Observations were recorded on 5 randomly selected plants in each plot on days to 50% flowering, plant height (cm), number of sympodia per plant, number of boll per plant, boll weight (g), seed cotton yield per plant (g) and seed index (g). After recording the observations for each character, the analysis of variance was carried out. Analysis for heterosis was carried out as per the method suggested by Fonesca and Patterson (1968) [12].

Results and Discussion

The analysis of variance showed significant differences among treatments for all the characters studied (Table 1). In the present study, superiority of the hybrids was observed over mid parent, better parent and standard check for all the characters. The range of heterosis over mid parent, better parent and standard check in respect of each of the character studied are presented in the Table 2.

The highest significantly positive average heterosis for seed cotton yield per plant was displayed by the cross combination PA 863 x CNA 1032 (34.53%) followed by PA 863 x PA 740 (29.93%) and PA 863 x AKA 7 (20.02%). The highest significantly negative average heterosis was recorded by the hybrid PA 809 x JLA 794 (-56.66%). Four cross combinations showed significant positive heterosis over mid-parent. The range of heterobeltiosis was from -57.66 per cent (PA 809 x JLA 794) to 32.31% (PA 863 x CNA 1032). Among twenty four cross combinations, only one hybrid PA 863 x CNA 1032 (22.31%) showed significantly positive heterosis over better parent. The significant positive heterosis over the standard check NACH 12 ranged from -39.52% (PA 809 x JLA 505) to 42.97% (PA 863 x PA 740). The cross combination PA 863 x PA 740 (64.79%) followed by PAIG 411 x PA 740 (61.37%) and PA 881 x CNA 1032 (58.44%). showed highest significant positive heterosis over the standard check PKVDH 1. Out of twenty four cross combinations, ten and eight cross combinations showed significant positive heterosis over the check PKVDH 1 and NACH 12, respectively. Heterosis for this trait was also reported by the earlier workers Wankhade *et al.* (2009) [11], Sonawane *et al.* (2013) [9], Tigga *et al*. (2017) [10], Shinde *et al.* (2018) [7] and Chinchane *et al.* (2020) [1].

The mid parent heterosis for number of bolls per plant ranged from -48.47% (PA 881 x JLA 794) to 33.56% (PA 863 x CNA 1032). The cross PA 863 x CNA 1032 (33.56%) exhibited significant positive heterosis over mid-parent followed by PA 863 x PA 740 (30.66%) and PAIG 411 x PA 740 (17.17%). The cross combination PAIG 411 x JLA 505 (42.47%) displayed significant positive heterosis over better parent followed by PAIG 411 x CNA 1032 (19.71%) and PA 863 x PA 740 (14.01%). Ten and six cross combinations each exhibited positive significant heterosis over standard check PKVDH 1 and NACH 12. PAIG 411 x PA 740 (70.56%) cross combination showed highest positive heterosis followed by PA 863 x PA 740 (64.11%) and PA 881 x CNA 1032 (60.08%) over standard check PKVDH 1. Heterosis for this trait was reported by the earlier workers Sekhar *et al.* (2012) [5], Kumar *et al*. (2014) [2], Singh *et al.* (2013) [8], Shinde *et al.* (2018) [7] and Chinchane *et al.* (2020) [1].

Higher number of sympodia plays an important role in yield, hence positive heterosis for this trait is considered desirable. The mid parent heterosis for this trait ranged from -48.59% (PA 881 x JLA 794) to 24.26% (PA 863 x PA 740). Only one hybrid exhibited significant positive heterosis over mid parent. Heterosis over better parent was ranged from -50.36% (PA 881 x JLA 794) to 11.79% (PA 863 x CNA 1032). Seventeen crosses exhibited significant negative heterosis over better parent. Heterosis over standard check NACH 12 was ranged from -30.34% (PA 809 x PA 785) to 55.15% (PAIG 411 x AKA 7). The remaining crosses having higher positive significant heterosis over standard check were PAIG 380 x AKA 7 (67.91%) and PAIG 380 x PA 812 (64.40%). Seven crosses exhibited positive significant heterosis over PKVDH 1. Four crosses showed positive significant heterosis over standard check NACH 12.Heterosis for this trait was also reported by the earlier workers Wankhade *et al.* (2009) [11], Sonawane *et al.* (2013) [9], Tigga *et al.* (2017) [10], Shinde *et al.* (2018) [7] and Chinchane *et al.*(2020) [1].

For boll weight, the cross combination PA 863 x PA 740 recorded highest significant positive heterosis over standard check PKVDH 1 (9.23%). The cross PA 863 x PA 785 (6.65% and 3.62%) exhibited highest heterosis over the standard check PKVDH 1 and NACH 12, respectively. Ten and seven crosses each recorded significant positive heterosis over standard checks PKVDH 1 and NACH 12, respectively for seed index. Heterosis over standard check PKVDH 1 was ranged from -17.37 per cent (PA 809 x JLA 505) to 8.83 per cent (PAIG 411 x PA 740). Twelve cross combinations reported positive heterosis over standard check PKVDH 1, where as fifteen hybrids recorded positive heterosis over check NACH 12.These findings are in accordance with the results obtained by Patel *et al.* (2011) [4], Kumar (2014) [2], Munir *et al.* (2017) [3] and Shinde *et al.* (2021) [6].

Table 1: Analysis of variance for Randomized Block Design

Source of Variation	d.f.	Days to 50% flowering	Number of sympodia/plant	Number of boll/plant	Boll weight (g)	Plant height (cm)	Seed cotton yield/plant	Seed index
Mean sum of squares								
Replications	1	0.347	5.800	1.051	0.048	64.950	45.761	0.002
Treatments	35	6.128**	44.848**	86.256**	0.071**	289.314**	262.472**	0.045**
Error	35	0.376	6.373	3.331	0.013	46.275	19.973	0.003

*, ** significant at 5% and 1% levels, respectively

Table 2: Estimates of heterosis in percentage over mid parent (M.P.), better parent (B.P.) and standard checks (S.C.) for various characters

Sr no	Hybrids	Days to 50% flowering					Number of sympodia/plant				
		Mean	M.P. Heterosis (%)	B.P. Heterosis (%)	% standard heterosis over		Mean	M.P. Heterosis (%)	B.P. Heterosis (%)	% standard heterosis over	
					PKVDH 1	NACH 12				PKVDH1	NACH 12
1	PA 809 x AKA 7	70.50	-0.70	-1.40	-2.08 *	-4.73 **	15.40	-28.21 **	-30.00 *	-12.99	-18.73
2	PA 809 x PA 740	69.50	-3.81 **	-4.79 **	-3.47 **	-6.08 **	14.60	-38.72 **	-43.08 **	-17.51	-22.96
3	PA 809 x PA 785	72.50	1.40	1.40	0.69	-2.03 *	13.20	-42.86 **	-45.45 **	-25.42	-30.34 *
4	PA 809 x JLA 794	73.50	0.00	-2.65 **	2.08 *	-0.68	14.10	-40.88 **	-45.14 **	-20.34	-25.59
5	PA 809 x JLA 505	70.50	-2.42 **	-3.42 **	2.08 *	-4.73 **	13.40	-34.47 **	-39.09 **	-24.29	-29.29 *
6	PA 809 x CNA 1032	72.50	0.69	0.00	0.69	-2.03 *	15.30	-31.85 **	-33.19 **	-13.56	-19.26
7	PA 881 x AKA 7	73.00	0.69	-2.01 *	1.39	-1.35	16.00	-34.02 **	-42.03 **	-9.60	-15.57
8	PA 881 x PA 740	76.00	3.05 **	2.01 *	5.56 **	2.70 **	14.20	-46.67 **	-48.55 **	-19.77	-25.07
9	PA 881 x PA 785	74.50	2.05 *	0.00	3.47 **	0.68	14.60	-43.63 **	-47.10 **	-17.51	-22.96
10	PA 881 x JLA 794	75.50	0.67	0.00	4.86 **	2.03 *	13.70	-48.59 **	-50.36 **	-22.60	-27.70 *
11	PA 881 x JLA 505	70.50	-4.41 **	-5.37 **	-2.08 *	-4.73 **	21.40	-7.96	-22.46 *	20.90	12.93
12	PA 881 x CNA 1032	74.00	0.68	-0.67	2.78 **	0.00	27.20	7.72	-1.45	53.67 **	43.54 **
13	PA 863 x AKA 7	71.50	-0.69	-2.72 **	-0.69	-3.38 **	19.80	-2.94	-5.26	11.86	4.49
14	PA 863 x PA 740	75.50	3.07 **	2.72 **	4.86 **	2.03 *	28.30	24.26 *	10.33	9.89 **	49.34 **
15	PA 863 x PA 785	73.50	1.38	0.00	2.08 *	-0.68	22.90	3.85	-5.37	29.38 *	20.84
16	PA 863 x JLA 794	72.50	-2.68 **	-3.97 **	0.69	-2.03 *	20.50	-10.09	-20.23 *	15.82	8.18
17	PA 863 x JLA 505	69.50	-5.12 **	-5.44 **	-3.47 **	-6.08 **	19.80	2.06	-0.50	11.86	4.49
18	PA 863 x CNA 1032	71.50	-2.05 *	-2.72 **	-0.69	-3.38 **	25.60	19.63	11.79	44.63 **	35.09 *
19	PAIG 411 x AKA 7	71.50	-1.04	-3.38 **	-0.69	-3.38 **	19.30	-18.22	-26.62 **	9.04	1.85
20	PAIG 411 x PA 740	73.50	0.00	-0.68	2.08 *	-0.68	29.40	13.19	11.79	66.10 **	55.15 **
21	PAIG 411 x PA 785	75.00	3.09 **	1.35	4.17 **	1.35	21.90	13.27	-16.73	23.73	15.57
22	PAIG 411 x JLA 794	70.50	-5.69 **	-6.62 **	-2.08 *	-4.73 **	23.20	-10.77	-11.79	31.07 *	22.43
23	PAIG 411 x JLA 505	72.50	-1.36	-2.03 *	0.69	-2.03 *	19.45	-13.94	-26.05 **	9.89	2.64
24	PAIG 411 x CNA 1032	73.50	0.34	-0.68	2.08 *	-0.68	23.40	-4.88	-11.03	32.20 *	23.48
	S.E.±	0.433	0.546	0.630	0.630	0.630	1.785	2.110	2.437	2.437	2.437

Sr no	Hybrids	Plant height (cm)					Number of bolls/plant				
		Mean	M.P. Heterosis (%)	B.P. Heterosis (%)	% standard heterosis over		Mean	M.P. Heterosis (%)	B.P. Heterosis (%)	% standard heterosis over	
					PKVDH 1	NACH 12				PKVDH 1	NACH 12
1	PA 809 x AKA 7	132.30	-4.34	-7.68	-3.85	-2.58	23.40	-20.41 **	-22.77 **	-5.65	-17.61 *
2	PA 809 x PA 740	126.75	-9.24	-11.55	-7.89	-6.66	21.35	-33.49 **	-40.20 **	-13.91	-24.82 **
3	PA 809 x PA 785	140.50	21.96 *	-1.95	2.11	3.46	20.60	-33.44 **	-38.32 **	-16.94 *	-27.46 **
4	PA 809 x JLA 794	136.00	-6.11	-7.10	-1.16	0.15	19.90	-39.79 **	-47.07 **	-19.76 *	-29.93 **
5	PA 809 x JLA 505	113.70	-21.99 **	-23.28 *	-17.37	-16.27	18.20	-33.82 **	-36.14 **	-26.61 **	-35.92 **
6	PA 809 x CNA 1032	128.60	-10.60	-10.94	-6.54	-5.30	25.10	-17.57 **	-22.53 **	1.21	-11.62
7	PA 881 x AKA 7	129.50	-10.60	-17.20 *	-5.89	-4.64	23.50	-30.88 **	-37.67 **	-5.24	-17.25 *
8	PA 881 x PA 740	138.80	-5.06	-11.25	0.87	2.21	22.20	-39.51 **	-41.11 **	-10.48	-21.83 **
9	PA 881 x PA 785	134.95	10.84	-13.71	-1.93	-0.63	21.20	-40.37 **	-43.77 **	-14.52	-25.35 **
10	PA 881 x JLA 794	132.70	-12.35	-15.15	-3.56	-2.28	19.40	-48.47 **	-48.54 **	-21.77 **	-31.69 **
11	PA 881 x JLA 505	136.60	-10.31	-12.66	-0.73	0.59	30.40	-5.30	-19.36 **	22.58 **	7.04
12	PA 881 x CNA 1032	141.80	-5.72	-9.34	3.05	4.42	39.70	13.27 **	5.31	60.08 **	39.79 **
13	PA 863 x AKA 7	144.90	1.12	-5.48	5.31	6.70	30.30	6.50	0.00	22.18 **	6.69
14	PA 863 x PA 740	148.30	2.52	-3.26	7.78	9.20	40.70	30.66 **	14.01 *	64.11 **	43.31 **
15	PA 863 x PA 785	144.95	20.59 *	-5.45	5.34	6.74	33.60	12.00 *	0.60	35.48 **	18.31 *
16	PA 863 x JLA 794	142.20	-5.11	-7.24	3.34	4.71	27.70	-13.71 *	-26.33 **	11.69	-2.46
17	PA 863 x JLA 505	132.85	-11.87	-13.34	-3.45	-2.17	26.50	-0.19	-7.03**	6.85	-6.69
18	PA 863 x CNA 1032	137.75	-7.46	-10.14	0.11	1.44	39.40	33.56 **	4.90**	58.87 **	38.73 **
19	PAIG 411 x AKA 7	137.50	-3.34	-9.06	-0.07	1.25	28.50	-14.67 **	9.86**	14.92	0.35
20	PAIG 411 x PA 740	149.75	4.28	-0.96	8.83	10.27	42.30	17.17 **	13.08**	70.56 **	48.94 **
21	PAIG 411 x PA 785	146.35	22.83 *	-3.21	6.36	7.77	31.20	-10.73 *	-14.48**	25.81 **	9.86
22	PAIG 411 x JLA 794	140.40	-5.65	-7.14	2.03	3.39	32.70	-11.74 *	-1.74**	31.85 **	15.14 *
23	PAIG 411 x JLA 505	135.40	-9.55	-10.45	-1.60	-0.29	27.20	-13.65 *	42.47**	9.68	-4.23
24	PAIG 411 x CNA 1032	141.00	-4.60	-6.75	2.47	3.83	30.70	-10.89 *	19.71**	23.79 **	8.10
	S.E.±	8.552	10.7834	12.451	12.451	12.451	1.290	1.615	1.865	1.865	1.865

Sr no	Hybrids	Boll weight (g)					Seed cotton yield/plant (g)				
		Mean	M.P. Heterosis (%)	B.P. Heterosis (%)	% standard heterosis over		Mean	M.P. Heterosis (%)	B.P. Heterosis (%)	% standard heterosis over	
					PKVDH 1	NACH 12				PKVDH1	NACH 12
1	PA 809 x AKA 7	2.88	15.12 **	14.09 **	8.29	7.08	37.00	-23.55 **	-24.64 *	-9.54	-18.77
2	PA 809 x PA 740	2.79	3.33	-3.13	5.08	3.91	34.00	-37.56 **	-44.44 **	-16.87	-25.36 *
3	PA 809 x PA 785	2.54	-0.97	-2.68	-4.33	-5.40	31.85	-39.51 **	-44.70 **	-22.13	-30.08 **
4	PA 809 x JLA 794	2.82	5.62	0.00	6.21	5.03	28.20	-50.66 **	-57.66 **	-31.05 **	-38.09 **
5	PA 809 x JLA 505	2.26	-11.72 **	-13.08 **	-14.88 **	-15.83 **	27.55	-40.88 **	-42.24 **	-32.64 **	-39.52 **
6	PA 809 x CNA 1032	2.63	2.83	1.35	-0.94	-2.05	39.70	-20.36 *	-23.65 *	-2.93	-12.84
7	PA 881 x AKA 7	2.55	-2.39	-7.27	-3.95	-5.03	37.60	-29.98 **	-35.51 **	-8.07	-17.45
8	PA 881 x PA 740	2.84	0.89	-1.39	6.97	5.77	36.50	-38.91 **	-40.36 **	-10.76	-19.87
9	PA 881 x PA 785	2.61	-2.61	-5.09	-1.69	-2.79	34.60	-40.29 **	-40.65 **	-15.40	-24.04 *
10	PA 881 x JLA 794	2.51	-9.87 *	-10.99 *	-5.46	-6.52	31.70	-49.24 **	-52.40 **	-22.49	-30.41 **
11	PA 881 x JLA 505	2.17	-18.88 **	-21.09 **	-18.27 **	-19.18 **	50.80	-2.12	-12.86	24.21 *	11.53
12	PA 881 x CNA 1032	2.72	1.78	-1.09	2.45	1.30	64.80	17.50 *	11.15	58.44 **	42.26 **
13	PA 863 x AKA 7	2.61	1.26	-2.61	-1.69	-2.79	55.00	20.02 *	12.02	34.47 **	20.75 *
14	PA 863 x PA 740	2.90	4.32	0.69	9.23 *	8.01	67.40	29.93 **	10.13	64.79 **	47.97 **
15	PA 863 x PA 785	2.70	2.08	0.75	1.69	0.56	57.80	15.43	0.35	41.32 **	26.89 *
16	PA 863 x JLA 794	2.78	1.09	-1.42	4.71	3.54	47.50	-12.96	-28.68 **	16.14	4.28
17	PA 863 x JLA 505	2.14	-18.94 **	-20.15 **	-19.40 **	-20.30 **	44.30	0.62	-2.64	8.31	-2.74
18	PA 863 x CNA 1032	2.67	1.23	-0.37	0.56	-0.56	63.60	34.53 **	22.31 *	55.50 **	39.63 **
19	PAIG 411 x AKA 7	2.71	8.29 *	7.11	2.07	0.93	48.30	-8.09	-13.75	18.09	6.04
20	PAIG 411 x PA 740	2.73	0.74	-5.38	2.64	1.49	66.00	12.63	7.84	61.37 **	44.90 **
21	PAIG 411 x PA 785	2.73	6.23	4.60	2.82	1.68	53.10	-6.51	-7.81	29.83 *	16.58
22	PAIG 411 x JLA 794	2.51	-6.17	-10.99 *	-5.46	6.52	56.20	-8.32	-15.62 *	37.41 **	23.38 *
23	PAIG 411 x JLA 505	2.28	-11.11 **	-12.31 **	-14.12 **	-15.08 **	48.20	-5.02	-13.93	17.85	5.82
24	PAIG 411 x CNA 1032	2.77	8.10 *	6.74	4.33	3.17	56.80	5.19	1.43	38.88 **	24.70 *
	S.E.±	0.080	0.098	0.113	0.113	0.113	3.160	3.862	4.460	4.460	4.460

Sr no	Hybrids	Lint index(g)					Seed index(g)				
		Mean	M.P. Heterosis (%)	B.P. Heterosis (%)	% standard heterosis over		Mean	M.P. Heterosis (%)	B.P. Heterosis (%)	% standard heterosis over	
					PKVDH 1	NACH 12				PKVDH1	NACH 12
1	PA 809 x AKA 7	3.92	-2.61 *	-3.81 *	1.42	-3.57 *	6.27	-0.24	-0.79	1.62	-1.26
2	PA 809 x PA 740	4.06	-0.49	-0.73	5.18 **	0.00	6.06	-6.48 **	-8.73 **	-1.78 *	-4.57 **
3	PA 809 x PA 785	3.79	-6.30 **	-6.88 **	-1.81	-6.65 **	5.95	-6.45 **	-7.03 **	-3.57 **	-6.30 **
4	PA 809 x JLA 794	3.79	-8.89 **	-10.82 **	-1.81	-6.65 **	6.13	-5.62 **	-8.10 **	-0.65	-3.46 **
5	PA 809 x JLA 505	3.94	-5.06 **	-6.86 **	2.07	-2.96 *	5.57	-12.15 **	-12.42 **	-9.72 **	-12.28 **
6	PA 809 x CNA 1032	3.93	-2.96 *	-3.44 *	1.81	-3.20 *	6.04	-4.81 **	-5.18 **	-2.11 *	-4.88 **
7	PA 881 x AKA 7	3.88	-5.48 **	-8.49 **	0.52	-4.43 **	5.90	-7.74 **	-9.79 **	-4.38 **	-7.09 **
8	PA 881 x PA 740	4.09	-1.80	-3.54 *	5.96 **	0.74	6.03	-8.50 **	-9.19 **	-2.27 **	-5.04 **
9	PA 881 x PA 785	4.07	-1.45	-4.01 **	5.44 **	0.25	6.05	-6.49 **	-7.49 **	-1.94 *	-4.72 **
10	PA 881 x JLA 794	3.77	-11.19 **	-11.29 **	-2.33	-7.14 **	5.76	-12.79 **	-13.64 **	-6.65 **	-9.29 **
11	PA 881 x JLA 505	3.89	-8.15 **	-8.25 **	0.78	-4.19 **	6.16	-4.50 **	-5.81 **	-0.16	-2.99 **
12	PA 881 x CNA 1032	4.10	-0.97	-3.42 *	6.09 **	0.86	6.56	1.63 *	0.31	6.32 **	3.31 **
13	PA 863 x AKA 7	4.01	-2.32	-5.32 **	3.76 *	-1.35	6.27	-1.10	-2.49 **	1.62	-1.26
14	PA 863 x PA 740	4.06	-2.40 *	-4.02 **	5.18 **	0.00	6.54	0.08	-1.51	6.00 **	2.99 **
15	PA 863 x PA 785	4.00	-3.03 *	-5.44 **	3.63 *	-1.48	6.58	2.57 **	2.33 **	6.65 **	3.62 **
16	PA 863 x JLA 794	3.82	-9.91 **	-10.12 **	-1.04	-5.91 **	6.29	-3.97 **	-5.70 **	1.94 *	-0.94
17	PA 863 x JLA 505	4.02	-4.96 **	-4.96 **	4.15 **	-0.99	6.16	-3.67 **	-4.20 **	-0.16	-2.99 **
18	PA 863 x CNA 1032	4.22	2.30	-0.12	9.46 **	4.06 **	6.55	2.34 **	1.87 *	6.16 **	3.15 **
19	PAIG 411 x AKA 7	4.14	4.02 **	3.76 *	7.25 **	1.97	6.34	1.52 *	1.44	2.76 **	-0.16
20	PAIG 411 x PA 740	4.36	7.92 **	6.60 **	12.95 **	7.39 **	6.52	1.24	-1.81 *	5.67 **	2.68 **
21	PAIG 411 x PA 785	4.33	8.11 **	7.71 **	12.18 **	6.65 **	6.46	2.22 **	0.94	4.70 **	1.73 *
22	PAIG 411 x JLA 794	4.05	-1.70	-4.71 **	4.92 **	-0.25	6.31	-2.25 **	-5.40 **	2.27 **	-0.63
23	PAIG 411 x JLA 505	4.03	-1.95	-4.73 **	4.40 **	-0.74	6.08	-3.49 **	-4.40 **	-1.46	-4.25 **
24	PAIG 411 x CNA 1032	4.17	-2.61 *	3.47 *	8.03 **	2.71	6.52	3.41 **	2.35 **	5.67 **	2.68 **
	S.E.±	0.039	0.047	0.055	0.055	0.055	0.035	0.042	0.049	0.049	0.049

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