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Short Communication

Analysis of midparent heterosis in a variety diallel in rainfed maize

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Basic knowledge on the genetic potential of source populations, either *per se* or in hybrids is important information in breeding programmes for the development of outstanding cultivars of cross pollinated crops such as maize. The diallel mating scheme has been widely used to provide information on the performance of parental populations and their heterotic patterns in crosses [1]. Diallel crosses also allow the identification of the heterotic groups and the prediction of performance of new populations (composites) derived from population crosses [1, 2]. The present study was conducted to analyse the midparent heterosis for its components and evaluate the genetic potential of some early and high yielding composites.

Fifteen variety crosses were generated from diallel crossing of six early high yielding yellow flint maize composites *viz.*, Kiran, Megha, Mahi Kanchan, Guj Makkai 2, Arun and Pusa Composite 1. The crosses and parents were grown in an RBD with three replications during *kharif*, 2003 under rainfed conditions at Assam Agricultural University, Jorhat. The traits reported are days to 50% pollen shed, days to 75% dry husk, plant height (cm), ear height (cm), ear length (cm), ear diameter (cm), kernel rows per ear, kernels per row, 100 kernel weight (g) and grain yield (gplant^{-1}). The data were analysed following analysis II of Gardner and Eberhart [3] and as per the procedures given by Singh [4].

Analysis of variance due to variety (v_i), total heterosis (h_{ij}) and the components of heterosis was performed for the traits (Table 1). Variations due to variety effects (v_i) were significant ($P \leq 0.01$) for the characters except ear length and indicated additive gene action for the traits. For total heterosis (h_{ij}), the variation was significant ($P \leq 0.01$) for days to 75% dry husk, ear length, ear diameter, kernels per row, 100 kernel weight and grain yield indicating non-additive gene action for these traits. Both additive and non-additive gene actions were important for the traits *viz.* days to 75% dry husk, ear diameter, kernels per row, 100 kernel weight and grain yield. Variance due to average heterosis was found significant for ear length, ear diameter, kernels per row, 100 kernel weight and grain yield. Variation due to each of the three components of total heterosis, *viz.*, average heterosis, variety heterosis and specific heterosis was found important for the grain yield and other ear traits except kernel rows per ear. For utilization of heterosis in open pollinated varieties, synthetics or composites, high variety heterosis superimposed on high average heterosis would be ideal.

The three genetic constants of heterosis *viz.*, variety effect (v_i), variety heterosis effect (h_i) and *gca* effect (g_i) were worked out for each trait (Table 2). Based on the performance *per se* (v_i effects) of the varieties, Kiran was the most promising variety for ear diameter, kernels per row, 100 kernel weight and grain yield, while Megha was for days to 50% pollen shed, ear diameter and grain yield. Intra-population improvement could be used to improve these varieties. The significant effect of variety heterosis (h_i) is a consequence of the genetic divergence of each variety with the whole set of varieties. The most heterotic varieties (i.e. varieties with high desirable h_i) were Mahi Kanchan for grain yield, Guj Makkai 2 for ear length, Arun for plant height and Pusa Composite 1 for kernels per row.

General combining ability or *gca* (g_i) effect is a function of both v_i and h_i and varied for different varieties. The high desirable g_i estimates were observed in Megha for days to 50% pollen shed, ear diameter, 100 kernel weight and grain yield, in Pusa Composite 1 for days to 75% dry husk, plant height, ear height, and kernel rows per ear, in Kiran for days to 50% pollen shed and 100 kernel weight, and in Mahi Kanchan for grain yield.

Specific heterosis effects (s_{ij}), which are due to

Table 1. Analysis of variance of heterosis in variety cross diallel for different traits

Source	df	PS	DH	PH	EH	EL	ED	KR/E	K/R	HKW	GY
Varieties (v_i)	5	4.811**	4.676**	138.317**	130.487**	0.453	0.092**	1.547**	6.678**	12.497**	91.706**
Heterosis (h_{ij})	15	0.865	1.525**	54.453	29.844	1.899**	0.099**	0.487	8.601**	4.929**	58.633**
Average ($\bar{h}$)	1	0.200	1.376	76.000	28.724	3.917**	0.158**	0.268	9.499*	7.652*	197.328*
Variety (h_i)	5	0.614	0.566	66.561	21.977	1.754**	0.082**	0.608	5.747*	6.174**	51.699**
Specific (s_{ij})	9	1.080	2.084**	45.320	25.099	1.790**	0.105**	0.455	0.090**	3.932*	47.091**
Error	40	0.817	0.494	31.840	18.535	0.350	0.014	0.341	2.220	1.608	7.556

*P≤0.05; **P≤0.01; PS = Days to 50% pollen shed, DH = Days to 75% dry husk, PH = Plant height (cm), EH = Ear height (cm), EL = Ear length (cm), ED = Ear diameter (cm), KR/E = Kernel rows per ear, K/R = Kernels per row, HKW = 100 kernel weight (g), GY = Grain yield ($gplant^{-1}$)

Table 2. Estimates of variety effects (v_i), variety heterosis effect (h_i) and general combining ability effect (g_i) of the parents for different traits

Parent	Genetic constants for traits																													
	PS			DH			PH			EH			EL			ED			KR/E			K/R			HKW			GY		
	v_i	h_i	g_i	v_i	h_i	g_i	v_i	h_i	g_i	v_i	h_i	g_i	v_i	h_i	g_i	v_i	h_i	g_i	v_i	h_i	g_i	v_i	h_i	g_i	v_i	h_i	g_i	v_i	h_i	g_i
Kiran	-0.83	-0.46	-0.71*	-0.33	0.19	-0.03	3.61	-3.11	-0.06	4.84	-2.06	1.14	0.67	-1.11**	-0.37	0.44**	-0.31**	0.02	-0.67	-0.75*	-0.81**	4.00**	-1.81	0.87	4.25**	-1.87*	0.95*	9.45**	-5.54**	1.26
Megha	-1.83*	-0.33	-1.12**	-0.33	0.13	-0.07	20.95**	-4.12	7.99**	19.84**	-3.86	7.51**	0.74	-0.76*	-0.07	0.28**	0.02	0.15**	-0.47	0.54	0.05	1.53	-0.04	0.75	1.13	1.07	1.23**	5.45*	2.13	4.06**
Guj Makkai2	0.83	0.40	0.67*	1.34*	0.28	0.85**	-6.05	2.95	-1.60	-4.82	-0.19	-2.53	-1.19*	0.82*	-0.08	-0.12	0.13	0.02	1.06**	-0.25	0.37	-1.63	-1.15	-1.53**	-3.30**	-0.94	-2.24**	-7.66**	1.41	-2.96**
Mahi Kanchan	0.83	-0.13	0.33	1.00	-0.77	0.01	-2.72	1.69	-0.22	-2.16	1.34	-0.24	0.21	0.33	0.31	0.08	0.03	0.06	-0.14	0.02	-0.06	1.00	-0.14	0.42	-0.89	1.47	0.47	2.40	3.81*	3.57**
Arun	1.83*	-0.13	0.83**	1.00	0.16	0.60*	0.61	-14.18**	-2.22	-4.16	-1.53	-3.03*	0.17	0.18	0.20	-0.26*	0.04	-0.12**	-0.34	0.30	0.02	-0.93	0.83	0.07	0.37	-0.90	-0.38	-0.48	-4.74**	-3.19**
Pusa Composite 1	-0.83	0.67	0.00	-2.33**	-0.30	-1.36*	-16.39**	6.76	-3.89*	-13.49**	6.21*	-2.86*	-0.59	0.48	0.00	-0.39**	0.10	-0.13**	0.60	0.19	0.42*	-3.63**	1.97*	-0.58	-1.55	1.19	-0.04	-9.17**	2.97	-2.74**
SE	0.82	0.58	0.29	0.64	0.45	0.23	5.15	3.64	1.82	3.92	2.77	1.39	0.54	0.38	0.19	0.11	0.07	0.04	0.53	0.37	0.19	1.35	0.96	0.48	1.15	0.81	0.41	2.50	1.77	0.89

*P≤0.05; **P≤0.01

dominance and genetic divergence (non-additive effects), were significant and high for the crosses Kiran × Pusa Composite 1 for ear length, kernels per row and grain yield, Arun × Pusa Composite 1 for days to 75% dry husk, ear diameter, 100 kernel weight and grain yield, Megha × Mahi Kanchan for days to 75% dry husk, ear diameter and grain yield, and Guj Makkai 2 × Mahi Kanchan for ear length, ear diameter and grain yield (Table 3). Irrespective of the variance due to specific heterosis, specific heterosis effects can contribute

Table 3. Estimates of specific heterosis effects (s_{ij}) for different traits

Crosses	PS	DH	PH	EH	EL	ED	KR/E	K/R	HKW	GY
Kiran × Megha	1.02	2.06**	–1.98	3.34	0.82	–0.12	0.28	–1.08	1.01	–4.93*
Kiran × Guj Makkai 2	0.00	–0.92	–4.56	–6.34	–1.35**	–0.29**	–0.10	0.90	–3.10**	–2.39
Kiran × Mahi Kanchan	–0.14	–1.37*	1.04	3.47	–0.66	0.04	–0.70	–0.19	0.94	0.66
Kiran × Arun	–0.64	1.03	–1.43	0.34	–0.86	0.07	–0.44	–5.46**	–1.06	–5.59*
Kiran × Pusa Composite 1	–0.78	–0.18	3.80	–2.74	0.95*	–0.07	0.13	4.39**	0.39	6.67**
Megha × Guj Makkai 2	0.03	0.13	–0.55	–3.37	–1.17*	0.12	–0.34	–0.93	0.65	3.03
Megha × Mahi Kanchan	–1.10	–1.97**	10.39*	3.77	0.72	0.32**	–0.15	2.28	1.44	5.50*
Megha × Arun	–1.27	0.42	–8.41	–4.36	–0.47	–0.38**	0.74	–0.62	–2.29*	–6.77**
Megha × Pusa Composite 1	0.52	–0.12	–3.52	–3.11	–0.26	0.08	–0.42	0.69	0.29	5.33*
Guj Makkai 2 × Mahi Kanchan	–0.82	0.70	–1.86	–2.24	2.31**	0.28**	–0.26	–2.54	1.64	6.46**
Guj Makkai 2 × Arun	0.68	–0.23	0.01	2.97	0.82	–0.09	–0.71	3.63*	–0.38	–0.37
Guj Makkai 2 × Pusa Composite 1	0.54	0.89	9.90*	8.89*	0.33	0.11	1.07*	–1.86	0.27	–5.42*
Mahi Kanchan × Arun	1.54*	0.99	0.61	–3.56	–0.33	0.07	0.82	2.64	–0.01	1.43
Mahi Kanchan × Pusa Composite 1	0.41	1.11*	–8.50	0.03	–1.58**	–0.37**	0.26	–1.98	–2.54*	–10.34**
Arun × Pusa Composite 1	–0.31	–1.82**	5.03	3.23	1.16*	0.47**	–0.52	1.12	2.81**	6.63**
SE	0.70	0.54	4.37	3.33	0.46	0.09	0.45	1.54	0.98	2.12

*P≤0.05; **P≤0.01

expressively to the performance of outstanding crosses. The crosses Megha × Mahi Kanchan, Guj Makkai 2 × Mahi Kanchan and Megha × Pusa Composite 1 had both high mean (data not shown) and high s_{ij} for grain yield. These crosses involved atleast one parent with good *gca* for the trait. Both the parents of Megha × Mahi Kanchan had high desirable v_i and g_i for grain yield. Megha × Mahi Kanchan was, thus, predicted the most superior cross for use as broad base population towards development of composites through population improvement methods or for derivation of superior inbred lines for use in hybridization programme.

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