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Heterosis for leaf yield and its components in mulberry (*Morus* sp.)

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ABSTRACT

Heterosis in mulberry was studied during 2005–07 for leaf yield and its attributing characters in 185 hybrid progenies developed from extensive crossing of 'Kajli (OP)' (female) and 'V-1' (male). Analysis of variance showed significant differences among the parents and hybrids. Greater variability in the parents indicated the possibility of getting higher heterosis in the progenies. None of the progenies showed uniformity in the heterosis for yield components. However, significant heterosis to the magnitude of –56.84 to 364.56% over mid parent and –61.30 to 316.49% over better parent was observed among the progenies for leaf yield. The gain over ruling check 'S 1635' was observed between –68.75 and 236.30%. Heterosis breeding in mulberry, a highly heterozygous plant, offers a great opportunity to develop new improved hybrids/genotypic recombinants. Hybrid No. 73 along with 14 others showing gain for leaf yield in excess of 100% over ruling check, seem to be highly promising for future utilization.

Key words: Heterosis, Leaf yield, Mulberry

A heterozygous individual resulting from the cross of two unlike parents is a hybrid which is usually vigorous. This increased vigour is referred to as hybrid vigour or heterosis. Exploitation of hybrid vigour is considered to be one of the outstanding achievements of plant breeding and the scope of its exploitation depends upon the direction and magnitude of gene interactions involved. To maximize the gain/unit of time, advanced generation breeding, a modified breeding approach, should be followed by the breeder (Sarkar 2000). To accomplish this goal, the improved population should be managed from the initial stage and the gain achieved in each generation needs to be documented. Simultaneously, sufficient genetic variability should be maintained to ensure continued long-term programme (Sarkar 2000).

In general, heterosis for leaf yield could always be attributed to a significant level of heterosis in at least one of the components (Vijayan *et al*. 1998). Since, in mulberry, only very few attempts have been made to obtain information on this aspect, the present study was undertaken to investigate the level of heterosis resulting from the intra and inter allelic gene interactions among mulberry varieties following advanced generation breeding aimed at improving leaf yield or its contributing characters through transgressive segregation (Singh 2000) to formulate appropriate breeding strategy to evolve varieties with higher leaf yield and better leaf quality.

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MATERIALS AND METHODS

Two improved mulberry genotypes, one female, viz 'Kajli (OP)', and one male, viz 'V 1' were crossed extensively. The female parent 'Kajli (OP)' was developed at this institute by selection from open pollinated seeds of 'Kajli', a land race of West Bengal, and the male parent 'V 1' which is regarded as high leaf yielder in southern region was developed at Central Sericultural Research and Training Institute, Mysore by crossing 'S 30' and 'Ber C 776'. The parents and 185 hybrids along with ruling check variety ('S 1635') were planted in a progeny row trial plot under 60 cm × 60 cm spacing. The recommended cultural practices were followed (Anonymous 2007). To obtain stable results, observations were made after one year of establishment of plantation. Data on morphological traits like plant height on 70th day of pruning, number of shoots/plant sprouted from the stump after pruning, internodal distance, total shoot length, shoot yield/plant, leaf shoot proportion and leaf yield/ plant were recorded in winter, summer, rainy, autumn and spring.

Analysis of variance was done for the data taking seasons as replications. Based on mean value over 5 seasons heterosis value of each hybrid progeny was worked out for each

character. Relative heterosis was calculated in each hybrid progeny for each character as the per cent deviation of the F_1 hybrid progeny from its mid parental value. Corresponding deviations over better parent were expressed as heterobeltiosis. The gain per cent in leaf yield over ruling check variety ('S 1635') was calculated to show the superiority of hybrid progenies. As per Chaudhury (1996) the heterosis was estimated.

Significance for heterosis was tested by using CD value at 1 and 5% levels for which the following formulae were utilized for relative heterosis, heterobeltiosis and gain over standard check:

(i) 't' for relative heterosis=$(F_1 - MP)/\sqrt{(3e/2r)}$; (ii) 't' for heterobeltiosis=$(F_1 - BP)/\sqrt{(2e/r)}$; and (iii) 't' for gain (%) over ruling check = $(F_1 - RC)/\sqrt{(2e/r)}$ Where, e = error variance; r = number of replications.

RESULTS AND DISCUSSION

Performance of the ruling check, parents and their selected 15 hybrid progenies based on high heterosis for leaf yield along with critical difference values and other parameters related to analysis of variance are presented in Table 1. It revealed significant differences among the parents and progenies in all the characters. Higher values of mean sum of squares for parents and hybrids indicate greater variability among them, which opens up possibility of getting more heterosis. Mean sum of squares (MSS) value for hybrids was found to be highly significant for all the characters studied, viz plant height, number of shoots/plant, internodal distance, total shoot length, shoot yield/plant, leaf shoot proportion and leaf yield plant, suggesting that these traits are under the control of additive genes. The significant difference noticed between means of parents as a group and those of hybrids for leaf yield and its attributing characters suggests that heterosis resulted from dominant genes and their interactions or from complementary gene interactions, as reported in rice (Gravois and Mc New 1993).

None of the progenies showed uniformly high heterosis in all the traits under the study except progeny 73. This indicates that mulberry is not only highly heterozygous but also highly heterogeneous by nature. The magnitude of heterosis differed widely for characters among the progenies of a single cross. Significant heterosis to the magnitude of –56.84 to 364.5% over mid parent and –61.30 to 316.49% over better parent was observed among the progenies for leaf yield (Table 2). Per cent gain over ruling check was –68.75 to 236.30. Progenies that exhibited high level of heterosis for leaf yield over the mid parent or over the better parent are most desirable for plant

Table 1 Mean performance of parents, ruling check and their selected hybrid progenies for leaf yield and its attributing characters

Parents and hybrids	Plant height (cm)	Shoots/ plant	Internodal distance (cm)	Total shoot length (cm)	Shoot yield/ plant (g)	Leaf shoot proportion	Leaf yield/ plant (g)
Parents and ruling check							
'Kajli' (op) female	98.11	5.93	4.14	690	374	0.52	199
'V 1' male	106.89	6.71	4.48	759	460	0.52	251
'S 1635' ruling check	126.47	8.84	4.71	924	543	0.52	310
Mean	110.49	7.16	4.44	791	459	0.52	253
Hybrid progenies							
2	150.80	10.20	4.36	1 173	1 283	0.55	678
3	140.00	10.40	4.65	1 160	1 272	0.55	668
13	152.00	7.40	5.27	929	1 141	0.58	638
21	137.00	8.40	4.46	898	1 221	0.55	664
66	123.40	9.00	4.05	901	1 241	0.60	708
68	119.00	7.60	3.83	727	1 106	0.62	658
71	144.00	8.60	4.78	1 026	1 298	0.53	622
73	168.00	12.20	4.76	1 509	1 919	0.60	1 044
78	142.20	10.20	5.03	1 075	1 153	0.58	656
90	137.80	9.60	4.34	987	1 196	0.55	644
104	125.20	8.80	4.78	930	1 295	0.59	694
108	122.00	10.80	4.81	1 090	1 361	0.56	734
120	124.00	10.40	4.41	1 069	1 139	0.59	654
161	136.20	12.00	4.46	1 226	1 535	0.58	866
183	124.00	11.00	4.51	1 040	1 229	0.61	690
Mean (185 hybrid progenies)	115.50	7.54	4.27	712.39	714.43	0.59	390.73
For parents, ruling check and 185 hybrid progenies							
SEm ±	14.00	1.56	0.49	155.60	178.57	0.046	85.68
F value**	7.74	5.56	3.85	9.18	10.41	2.83	15.83
CD (*P*=0.05)	17.38	1.95	0.62	193.20	248.02	0.064	106.39
CD (*P*=0.01)	22.87	2.56	0.82	254.15	326.37	0.08.	139.95

Table 2 Heterosis over mid-parent (MP) and better parent (BP) and gain over ruling check (RC) for total shoot length and leaf yield/plant in 15 selected hybrid progenies

Hybrid progeny	Total shoot length			Leaf yield/plant		
	MP	BP	RC	MP	BP	RC
2	61.88	54.51	26.93	201.70	170.48	118.40
3	60.00	52.71	25.46	197.25	166.49	115.18
13	28.14	22.30	0.47	183.90	154.52	105.52
21	23.89	18.24	–2.86	195.47	164.89	113.89
66	24.27	18.61	–2.55	215.05	182.45	128.06
68	0.27	–4.30	–21.38	192.80	162.50	111.96
71	41.52	35.07	10.97	176.78	148.14	100.36
73	108.23	98.75	63.28	364.56	316.49	236.30
78	48.36	41.60	16.33	191.91	161.70	111.31
90	36.22	30.01	6.85	186.57	156.91	107.45
104	28.27	22.43	0.58	208.82	176.86	123.56
108	50.35	43.50	17.89	226.62	192.82	136.44
120	47.50	40.79	15.66	191.02	160.90	110.67
161	69.16	61.46	32.65	285.35	245.48	178.96
183	43.48	36.94	12.50	207.04	175.26	122.27
For 185 hybrid progenies						
Minimum	–60.41	–62.21	–68.95	–56.84	–64.30	–68.75
Maximum	108.23	98.75	63.28	364.56	316.49	236.30
Average	–1.72	–6.20	–22.94	73.87	55.88	25.86
SD	29.24	27.90	22.92	67.90	60.87	49.15

breeders. For leaf yield, heterosis in 15 selected hybrid progenies ranged from 176.78 to 364.56% over mid parent and 148.14 to 316.49% over better parent. The gain over ruling check was 100.36–236.30%.

The existence of considerable gain in leaf yield exceeding 236.30% over the ruling check variety observed in one (hybrid no. 73) out of 185 progenies suggests that it is possible to obtain hybrids showing superiority over the outstanding commercial varieties (Table 2). Since an optimal strategy for consistently producing high-yielding as well as highly heterotic crosses is lacking in mulberry, the most reliable crossing combinations would have to be determined by progeny testing to identify superior varieties for hybrid development (Vasal *et al.* 1993).

Pertaining to total shoot length 14 progenies showed significant positive heterosis over mid parent ranging from 28.14 to 108.23%, 10 progenies over better parent ranging from 36.94 to 98.75% and 5 progenies showed significant gain over ruling check ranging from 25.46 to 63.28% (Table 2). Heterosis performance in respect of other yield-attributing 5 characters has been abridged.

From this investigation it is concluded that though mulberry is known to be highly heterozygous and heterogeneous, heterosis breeding is quite effective for improving its leaf yield. The improvement observed in leaf yield and its component characters in progeny 73 by following advanced generation breeding approach is in accordance with the observations of Sarkar (2000).

According to Singh (2000), transgressive segregation refers to the appearance of such plants in an F_2 generation that are superior to both the parents for one or more characters. Such plants are produced by an accumulation of plus or favourable genes from both the parents as a consequence of recombination. Obviously, the parents involved in hybridization must combine well with each other and should preferably be genetically diverse. In such a situation, each parent is expected to contribute different plus genes, which, when brought together by recombination give rise to transgressive segregants. As a result the intensity of characters in the transgressive segregant, ie the new variety, is greater than that in either of the parent. The improvement observed in progeny no. 73 in respect of all the 7 characters is in accordance with the opinion of Singh (2000) owing to the geographical as well genetic divergence of both the advanced generation improved hybrid parents. Therefore, the newly evolved progeny 73 along with 14 others are highly promising for future utilization and further evaluation.

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