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HETEROTIC STUDIES IN SPRING WHEAT

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In a line X tester cross, heterosis was studied in 24F_1 hybirds of two *Triticum timopheevi* - based Cms lines of Indian cultivars with different mutated restorer lines of exotic origin. The heterotic potential over mid and better parents was present in many crosses for yield and its components. Maximum heterosis was noted for 100 - grain weight followed by yield per plant. Next in descending order were grains per spike, spikes per plant and spikelets per spike. Fourteen out of 24F_1 hybrids showed highly significant positive heterosis over mid parent for grain yield. But incidence of significant heterosis over better parent remained a limiting factor due to the effect of male sterility in hybrid combination. It was shown that heterosis for grain yield may be an outcome of the expression of heterosis for certain or for all component studied depending upon the cross combination.

Heterosis in wheat was first reported by Freeman (1919). Since then occurrence of this phenomenon has been studied by several workers (Pal and Nek Alam 1938, Gandhi *et al.* 1961 and Hassanein *et al.* 1974). Suggestions to exploit hybrid vigour in this naturally self pollinated crop were accelerated with the discovery of cytoplasmic male sterility by Kihara (1951) and male fertility by Wilson and Ross (1962). Until recently it was believed that amount of heterosis in wheat was insufficient as reviewed by Briggle (1963) and Milohnic (1967). Now a number of wheat workers approved positive indication of heterosis in grain yield and its components (Lin and Pan, 1982 and Li *et al* , 1982). In the utilization of hybrid vigour in commercial crop, only vigour over better parent is of significance. This paper was designed to examine heterosis effects over mid and better parents for grain yield and its components among F_1 hybrids of cms-lines and restorer lines.

MATERIALS AND METHODS

The experiment was conducted at R. B. S. College Agricultural Research Farm, Bichpuri, Agra during *rabi* season of 1981-82 and 1982-1983. Twenty-four F_1 hybrids were developed by involving two *T timopheevi*-based cms-lines of Indian wheat cultivars (cms-WH 157 and cms-HP 1102) and twelve mutants (M_4generation) of R-lines namely R 1 (Wilson 8156), R 2 (3401/478466), R 3 (PE/yq 54/42267A) and R 4 (R 3401) obtained from cargill Research Farm colorado, U.S.A. As per line x tester programme of kempthorne (1957), each restorer was crossed to each cms-line by manual pollination. In next season, F_1 hybrids together with their parents were sown in randomized block design with three replications. Each entry was represented by one row of 3 metres long at 40 cm apart. Plant to plant distance was 8-10 cm. Fertilizer was supplied at 120-90-40 of kg/ha with usual agronomic practices.

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Table : Mean performance of hybrids and percentage of heterosis over mid and better parent for grain yie[ld] and its components

Cross no.	Genotypes	Mean	Spikes/plant Heterosis over M.P.	B.P.	Mena	Spikelets/spike Heterosis over M.P.	B.P.	Me[an]
1.	R 2	19.73	20.82**	12.10**	17.07	−8.90**	−9.53**	40.
2.	R 2 (25 Kr) a	15.13	6.57**	0.39	18.47	0.73	−2.17**	22.
3.	R 2 (25 Kr) b	16.20	1.67	−3.57	17.73	−7.64**	−9.21**	27.
4.	R 3 (.4% EMS)	15 93	−5.72*	−14.94**	17.87	−2.90**	−5.29**	37
5.	R 1 (.4% EMS)	15.87	6.97**	5.24*	17.20	−5.15**	−8.85**	43.
6.	R 1 (.3% EMS)a	18.27	23.15**	21.16**	19 07	2.14*	1.00	28
7.	R 1 (.3% EMS)b	12.73	−12.38**	−15.52**	19.73	11.28**	4.55**	8.
8.	R 3 (4% EMS+ 04% NMU)	11.93	−8.91**	−20.83**	16.33	−2.78**	−11 46**	37.
9.	R 1 (.4% EMS+.04% NMU)	11.93	−5.79*	−20.83**	17.20	−3.19**	−8.85**	42.
10.	R 2 (.05% NMU)	16.33	17.79**	12.34**	6.47	−6.44**	−12.77**	3[illegible]
11.	R 2 (.04% NMU)	15.27	−5.37*	−11.27**	17.67	6.21**	−6.41**	3[illegible]
12.	R 3 (.25 Kr)	12 41	−10.95**	−17.31**	17.67	5.15**	−6.15**	3[illegible]
13.	R 2	18.53	4.51	3.69	17.73	−3.97**	−4 67**	4[illegible]
14.	R 2 (25 Kr) a	15.93	2.13	−10.85**	14.00	−22.51**	−23.62**	2[illegible]
15.	R 2 (25 Kr) b	14.60	−15.77**	−18.29**	14.00	−23.94**	−26.26**	1[illegible]
16.	R 3 (.4% EMS)	14.87	−18.76**	−20 66**	14.20	−21.69**	−22.53**	29
17.	R 1 (.4% EMS)	15.33	−5.54*	−14 21**	15.40	−13.81**	−15.98**	33.
18.	R 1 (.3% EMS)	16 20	−0.21	−9.34**	14.00	−23 91**	−24 20**	28.
19.	R 1 (.3%EMS) b	15.80	1.86	−11.58**	17.80	1.91	−2.89**	39.
20.	R 3 (.4% EMS)+.04% NMU	19.00	31.03**	6.32*	15.13	−8.47**	−17.45	−21.
21.	R1 (.4% EMS+.04% NMU)	12.53	−10 90**	−29.99	15 47	−11.62**	−16.49**	20.
22.	R 2 (.05% NMU)	14.67	−3.93	−17.96**	18.53	6.92**	1.09	23.
23.	R 2 (0.4% NMU)	12.87	−26.62**	−28 03**	16.67	1.83	−9 05**	19
24.	R 3 (25 Kr)	16 00	3.96	−10.46**	15 87	−4.03**	13.42**	26.
S. E.		1.7014				0.6598		
C. D.	at 5%	4.7882				1.8484		
C. D.	at 1%	6 3762				2.4614		

* Exceeds 6% leVel
** Exceeds 1% level

Table Cont

Grains/spike Heterosis over		Mean	100-grain weight Heterosis over		Mean	Yield/plant Heterosis over	
M.P.	H.P.		M.P.	B.P.		M.P.	B.P.
34.51**	−32.74**	4.50	143**	21.62**	23.87	101.12**	0.54
−21.88*	−60.94**	5.40	133**	17.27**	16.93	16.91**	−41.54**
−10.28*	−55.14**	6.37	163**	31.67**	20.90	18.86**	−40.55**
39.87**	−30 07**	6.03	176**	37.98**	24.43	109.73**	4.84
50 06**	−24.96**	6.23	243**	71.62**	22.73	70.29**	−14.86**
−6 11	−53 39**	6.37	192**	45.53**	13.83	14.33**	−42.85**
−65.98	−53.82**	5 67	209**	54.49**	5.83	−43.64**	−71.83**
43.65**	−43.72**	6 17	222**	60.83**	15.40	30.14**	−34.74**
38.96**	−48.70**	4.87	126**	13 02**	16.83	27 69**	−36.15**
35.60**	−44.15**	5.57	157**	25 50**	25.53	115.17**	7.58
44.76**	−44.28**	6 10	108**	3.61**	14.47	−25.86**	−62.94**
56 63**	−32.31**	6 03	113**	6.34**	13 90	5.30	−47.34**
52 59**	−23.70**	4.13	123**	11.62**	20.83	75.56**	−12.22**
−24.47**	−62.23**	5 47	136**	17.62**	14 90	2.88	−48.54**
−52.52**	−76.26**	5.50	128**	13.87**	15.37	−12.61**	−56.48**
10.94*	−44.52**	5 00	129**	14.41**	18.33	57.37**	−21 48**
16.38**	−41.42**	5 53	205**	52.34**	23.10	73.09**	−13.38**
7.42	−52.53**	5.43	149**	24.25**	12.83	6.06**	−46.98**
50.71**	−24.64**	5.07	176**	37.87**	14.80	43.00**	−28.50
18.53**	−59.26**	5 50	187**	43.60**	11.23	−5.07	−52 53**
18.77**	−66.88**	5.50	156**	27.90**	11 97	−9.23	−61.64**
−12.20**	−56 11**	5.10	130**	15 12**	24.47	10.18**	−6.07
−21.90**	−60.95**	5.40	84**	−8.00**	7.67	−61.51**	−80.76**
14 12**	−27.13**	5 50	94**	−2.99**	11.17	−15.40**	−57.7**
3.5401				0.981		3.1565	
9.9628				9.9628		8.8889	
13.2671				13.2671		11 8370	

Observations were made on 10 randomly selected plants from each replication. Data for each character studied were statistically analysed on mean basis. Heterosis over mid and better parents was computed.

RESULTS AND DISCUSSION

The percentage of heterosis for yield and its related components (Table 1) revealed that out of 24 hybrids, fourteen showing positive heterosis significantly surpassed mid parent values ranging from 14.33 (Cross No.6) to 115.17 (Cross No.10) for grain yield per plant. Only four crosses numbering 1, 4, 10 and 22 showed positive heterosis over better parent but remained statistically in significant. The cross number 10 (cms-WH 157 × R 2 (0.05% NMU) showing highest heterotic potential over mid (115.17) and better (7.58) parents was also found to have highly significant heterosis for spikes per plant and 100 - grain weight. This cross also showed highly significant negative heterosis for spikelets per spike over both the parents and for grains per spike over better parent only The cross number 20 cms-HP 1102 × R 3 (.4% EMS+ .04% NMU) had highest (31.03) heterosis for spikes per plant over mid parent and gave significant value for yield per plant. This cross having highly significant negative heterosis for grains per spike showed positive heterosis for 100-grain weight.

For spiklets per spike, most of the hybrids expressed negative heterosis. However, cross No. 7, cms-WH 157 × R 1 (.3% EMS) b, had highest heterosis over both the parents for this character. Although heterosis for spikes per plant, grains per spike and yield per plant was in negative direction it might have been due to effect of male sterile cytoplasm of female parent in these cross combinations. The highly positive and negative significant heterosis for 100-grain weight and grains per spike in this cross and in some others seems to have appeared due to augmentation of photosynthetic assimilate from sterile spikelets towards fertile spikelets.

Overall highest heterotic response was observed in 100 - grain weight where almost all the hybrids manifested highly significant values over both mid and better parents. Other characters in descending order were spikes per plant, spikelets per spike and grains per spike. For spikes per plant six and five crosses exhibited significant positive heterosis over mid and better parents respectively. Cross numbers 1, 6 and 10 had significant positive heterosis over both the parents. The same was noted for cross number 7 for spikelets per spike. For grains per spike, thirteen crosses exhibited significant positive heterosis over mid parent, but none could do so over better parent. Crosses showing desirable heterosis for one character did not display positive heterosis for one or more characters related to yielding ability of the strain. Lin and Pan (1982) and Li *et al.* (1982) also analysed F_1 hybrids of *T. timopheevibased* cms - lines to different fertility restorer lines and reported significant positive heterosis for spikes per plant, grains per spike, 100-grain weight and average yield. Mikala (1982) also evaluated 29 hybirds over two years and concluded that heterosis was affected by environment as well as by genotype.

It is evident from the study that considerable amount of heterosis was obtained for grain yield in certain hybrids, whereas, most of them manifested little or negligible heterosis. This may be attributed to involvement of complete sterile female parent and capability of restorer lines for fertility restoration. Since production of hybrid wheat will depend on the use of the male sterility, expression of heterosis may be affected by male sterilie cytoplasm. It is concluded that heterosis for grain yield may be a consequence of exprssion of heterosis for certain or for all characters studied. Hence, study of individual yield component might contribute good information for yield.

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