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Heterosis in winter × spring wheat crosses

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Abstract

Heterosis in the F_1 hybrids between 13 winter wheats and four diverse testers of spring wheat was determined for grain yield and nine other traits. Two crosses IWWSN-6-110 × HPW42 and IWWSN-6-134 × HS240 showed significant economic heterosis over the standard variety HS277 and over the better parent for grain yield, grains per spike and harvest index, whereas, the cross IWWSN-6-110 × VL616 showed high heterosis over standard check only. The crosses exhibiting significant heterosis over the better parent for grain yield and yield attributing traits were IWWSN-6-110 × HS240, IWWN-6-110 × HD2380, IWWSN-6-134 × HD2380, IWWSN-6-134 × HPW42, BEIJING637 × HS240 and JCAM/EMU"S"//DOVE 'S" SWM 12314-13M-OM-9M-3M-4WM-OWH × HD 2380.

Key words : Wheat, heterosis, grain yield

Introduction

A feasible strategy to achieve a quantum jump in the yield of wheat (*Triticum aestivum* L. em. Thell) is the commercial production on hybrid varieties. A number of studies have been conducted to estimate heterosis in intervarietal crosses of either spring or winter wheats. However, literature on the extent of heterosis in the winter × spring wheat hybrids is meagre. Heterosis in such hybrids is expected to be markedly high as reported by Egorkina *et al.* [1], Thakur [2] and Chowdhary *et al.* [3]. With this objective in view, 13 winter × spring wheat crosses have been evaluated to determine the extent of heterosis in F_1 generation.

Materials and methods

Thirteen lines of winter wheat *viz.*, WW_1, WW_2, WW_3, WW_4, WW_5, WW_{10}, WW_{11}, WW_{12}, WW_{13}, WW_{14}, WW_{16}, WW_{17} and WW_{23} (pedigree in Table 1) were crossed as female with four diverse spring type bread wheat *viz.*, HS240, VL616, HD2380 and HPW42 during *rabi* 1992-93 at Himachal Pradesh Krishi Vishvavidyalaya, Palampur in a line × tester fashion. The variety HS277 used as standard check was also planted to quantify the standard heterosis. The winter wheat lines were vernalized at 4±1°C for 20 days. The parents and their F_1's were raised in single row plots of 1.25 m long and rows spaced at 25 cm in three replications. Ten randomly selected plants in each plot per replication were tagged for recording observations on grain yield per plant (g), plant height (cm), grains per spike,

Table 1. Pedigree of the parents used in crosses

Parents		Pedigree	Material received from
Females (winter wheat lines)	WW_1	IWWSN-6-110	NBPGR, New Delhi
	WW_2	IWWSN-6-49-1	"
	WW_3	IWWSN-6-134	"
	WW_4	63.11.2266.2/NO/LOV2.F_1/3/ F_1 KV2/HYSOWN 733030-10H-H-3H-OH-4M-4MM-CMM	"
	WW_5	JUP/4/CLLD "S"/3/1114.53/OOIN/C11343 1 SWM 5069-02P-IH-OH	"
	WW_{10}	BEIJING 637	"
	WW_{11}	TURKEY 13 (RESELECTION) TURKEY-IM-3MM-OWM	"
	WW_{12}	NZT/BEZ1/NLD"S"/F_1/4/F_1 NAQ/TMP/CL 12406/3/FMV"S"SW 780127B-ISIIP-4M-OM-1WM-IWM	"
	WW_{13}	TAYA 85	"
	WW_{14}	FAULESK ( ) # 14-OWM	"
	WW_{16}	JCAM/EMU"S"//DOVE"S" SWM12314-O2M-OM-4M-3M-4WM-OMM	"
	WW_{17}	JCAM/EMU"S"//DOVE"S"SW M12314-13M-OM-9M-3M-4W M-OWM	"
	WW_{23}	Acc. No. 4298	PAU, Ludhiana
Males (testers)	VL616	SKA/CPAn1507	VPKAS, Almora
	HS240	AU/KAI/Bb/WOP"S"/PVN/S	Shimla
	HD2380	HD2255 × HD 2267	IARI, New Delhi
	HPW42	VEE"S"(PVN"S"-cBB-CNO "S"xJR)/ORZS, selection	Palampur

effective tillers per plant, spike length (cm), 1000-grain weight (g) and harvest index. The data on days to maturity were recorded on plot basis. Heterosis over the better parent and standard variety (HS277) in each cross was calculated.

Results and discussion

The estimate of heterosis of only those cross combinations of winter wheat lines with the testers are presented in Table 2 which showed desirable heterosis over better parent or standard variety (HS277) for grain yield and its components. The heterosis over the better parent for grain yield ranged from 89.29% in cross IWWSN-6-110 × HPW42 to 64.49% in cross JCAM/EMU "S"//Dove "S" SWM 12314-13M-OM-9M-3M- 4WM-OWM × HD2380, whereas over the standard variety the range of heterosis varied from 17.02% in cross IWWSN-6-110 × VL616 to –69.79% in cross BEIJING637 × HD2380. The cross combinations showing significantly positive heterosis over the better parent and standard check for grain yield IWWSN-6-110 × HPW42 (89.29 and 11.84%, respectively) and IWWSN-6-134 × HS240 (38.0 and 7.75%, respectively). The crosses showing high heterosis over better parent were IWWSN-6-110 × HD2380 (40.68%), IWWSN-6-110 × HS240 (2197%), IWWSN-6-134 × HPW42 (21.49%), BEIJING 637 × HS240 (6.56%) and IWWSN-6-49-11 × HD2380 (5.31%). Whereas only one cross IWWSN-6-110 × VL616 showed high heterosis (17.06%) for grain yield over the standard check variety HS277.

The crosses exhibiting heterosis for grain yield also showed high heterosis for other desirable yield characters. Crosses IWWSN-6-110 × HPW42 and IWWSN-6-134 × HS240 showed high heterosis over both standard check and better parent for grains per spike and harvest index, whereas, only over better parent it was high for spike length in both the crosses and for tillers per plant, and 1000-grain weight in the former one. The crosses showing high heterosis for

Table 2. Estimates of heterosis (%) over better parent (BP) and standard check (SC) in the F_1 generation

Crosses	Days to maturity		Plant height		Spike length		Effective tillers/plant		Grains/spike		Grain yield/plant		1000-grain weight (g)		Harvest index	
	SC	BP	SC	BP	SC	BP	SC	BP	SC	BP	SC	BP	SC	BP	SC	BP
WW_1 × VL616	12.52*	0.14	33.80*	34.03*	–5.47	–11.88*	7.60	10.23	8.88*	3.89*	17.02*	–0.76	–7.45	–12.39*	–3.52	3.39
× HS240	12.74*	19.23*	38.18*	59.06*	2.77	33.22*	2.30	8.13	7.10*	–10.00*	–5.47*	21.97*	21.76*	–5.67*	8.45*	5.47*
× HD2380	–8.71	6.07*	7.54*	26.18*	–10.72*	15.35*	7.69	13.82	–4.79*	–0.74	–20.09*	40.68*	3.33*	–12.02*	12.45*	60.50*
× HPW42	–1.63*	5.86*	30.41*	64.86*	–8.47*	18.44**	10.00	16.26*	6.57*	11.11*	11.84*	89.29*	–13.72*	18.91*	46.12*	53.39*
WW_2 × VL616	11.56*	0.63	32.93*	41.88*	–24.75*	–32.88*	–23.07*	–41.17*	10.65*	5.59*	–1.88*	–16.40*	12.15*	0.11	2.11	–0.34
× HS240	13.83*	20.39*	25.05*	33.48*	–23.24*	–6.42*	–25.39*	–42.94*	5.86*	–11.04*	–5.09*	–7.62*	–1.96*	–4.58*	–7.45*	–10.48*
× HD2380	–7.08*	7.87*	–2.73	14.12*	–25.26*	–3.30	–20.16*	–39.41*	23.82*	–29.50*	–51.71*	–53.39*	12.35*	–4.34*	–11.61*	–13.74*
× HPW42	–6.15*	0.99	–1.64	24.34*	–37.73*	–10.62*	–25.38*	–42.91*	12.96*	–19.67*	–35.68*	–37.92*	–27.05*	23.66*	19.01*	16.15*
WW_3 × VL616	12.52*	0.14	20.13*	29.78*	9.52*	2.09	4.16	4.61	7.10*	2.20	–26.11*	–37.85*	–12.54*	–18.16*	24.29*	33.20*
× HS240	–0.70	5.01*	12.14*	21.12*	–12.97*	6.42	7.69	7.69	8.34*	8.95*	7.75*	38.00*	–18.03*	•1.18	18.30*	15.06*
× HD2380	–14.32*	–0.44	–0.98	16.17*	26.48*	–10.09*	–26.76*	–25.38*	–11.19*	–7.40	–37.86*	5.31*	3.52*	–11.85*	28.52*	55.31*
× HPW42	–8.71*	–1.75*	8.20*	16.04*	–20.48*	–2.75	–23.07*	–23.07*	–6.57*	–2.59*	–28.21*	21.49*	5.49*	83.85*	5.63*	14.50*
× HPW42	–8.71*	–1.75*	8.20*	16.04*	–20.48*	–2.75	–23.07*	–23.07*	–6.57*	–2.59*	–28.21*	21.49*	5.49*	83.85*	5.63*	14.50*
WW_{10} × VL616	–4.05*	–43.71*	29.32*	54.91*	–19.72*	–8.39*	–13.07*	15.74*	7.63*	2.71	–5.14*	–19.56*	–3.72*	14.67*	33.80*	7.68*
× HS240	6.75*	12.90*	12.80*	35.12*	–0.97	–1.83	–36.15*	–19.41*	5.86*	–52.83*	–15.04*	6.56*	–15.49*	9.11*	–1.05	–20.39*
× HD2380	–10.13*	4.45*	–10.61*	7.07*	–19.72*	–1.83	–20.76*	0.00	43.87*	–21.27*	–69.79*	–62.40*	4.31*	–27.56*	–16.19*	–32.57*
× HPW42	–11.05*	4.27*	–17.17*	4.07*	0.97	3.88	–53.84*	–41.74*	34.26*	8.51*	–47.16*	–33.68*	–1.76	18.22*	26.76*	1.98
WW_{17} × VL616	–12.74*	0.33	22.64*	22.64*	12.25*	–12.97*	–28.48*	–51.05*	4.08*	–34.92*	–37.83*	–49.75*	–11.67*	31.89*	47.88*	–21.44*
× HS240	–3.81*	1.75*	4.48	–2.45	8.02	–18.88*	–20.76*	45.78*	–22.55*	–32.20*	–52.68*	–61.79*	–20.78*	–8.62*	4.57	–15.65*
× HD2380	–10.34*	4.17*	–6.89*	9.24*	–23.48*	32.11*	–30.76*	–52.63*	28.50*	–40.67*	–56.03*	–64.49**	–10.19*	–2.29*	2.46	–7.24*
× HPW42	–10.34*	–3.51*	–18.73*	5.24	–24.53*	–2.83	–30.75*	–52.63*	–37.33*	–6.27*	–31.50*	–44.68*	–4.31*	–17.02*	12.67*	6.88*
SE ±	1.23	1.23	2.74	2.74	0.49	0.49	0.92	0.92	0.86	.86	0.64	0.64	0.64	0.31	0.31	0.68

Table 3. Mean performance of parents and hybrids for different traits in the F_1 generation

Parents vs hybrids	Days to maturity	Plant height (cm)	Spike length (cm)	Effective tillers/plant	Grains/ spike	Grain yield/plant (g)	1000-grain weight (g)	Harvest index
W_1	218.00	75.40	10.33	12.33	54.00	11.41	33.03	19.97
W_2	227.33	85.63	10.27	17.00	61.00	21.78	52.47	29.13
W_3	227.33	84.60	10.97	13.00	54.00	12.32	37.40	23.50
W_{10}	229.33	76.33	8.97	10.33	47.00	16.90	45.03	35.37
W_{17}	228.67	99.90	10.63	19.00	58.00	26.25	37.00	34.53
VL616	206.33	108.50	14.30	12.67	59.00	24.99	54.57	26.53
HS240	173.67	97.90	10.17	9.00	67.00	16.43	42.37	29.20
HD2380	158.00	77.93	10.30	9.00	48.00	12.03	59.97	18.20
HPW42	170.00	72.37	9.33	6.00	39.00	12.42	37.03	26.20
W_1 × VL616	206.67	122.33	12.67	14.00	61.33	24.81	47.23	27.70
× HS240	207.00	126.33	13.77	13.33	60.33	20.04	39.90	30.80
× HD2380	267.67	98.30	11.90	14.00	53.67	16.94	52.73	32.03
× HPW42	180.67	119.20	12.23	14.33	60.00	23.56	44.03	41.57
W_2 × VL616	205.00	121.57	12.03	10.00	62.33	20.80	57.23	29.00
× HS240	209.00	114.30	10.23	9.67	59.67	20.12	50.03	26.43
× HD2380	170.67	88.87	9.97	10.33	43.00	10.16	57.33	25.17
× HPW42	172.33	29.87	8.33	9.67	49.00	13.53	64.80	33.87
W_3 × VL616	206.67	109.83	14.60	13.67	60.33	15.54	44.67	35.27
× HS240	182.33	99.53	11.17	14.00	61.00	22.65	41.80	33.63
× HD2380	157.33	90.47	9.87	9.67	50.00	13.07	52.90	36.50
× HPW42	166.67	83.87	10.37	10.00	52.67	15.09	53.80	30.07
W_{10} × VL616	178.00	118.17	14.57	14.67	60.67	20.11	49.10	38.03
× HS240	196.00	103.07	10.13	7.67	49.67	18.01	43.10	28.13
× HD2380	165.00	81.73	9.17	10.33	31.67	6.35	54.20	23.87
× HPW42	163.33	75.73	10.73	6.00	37.00	11.20	50.10	36.00
W_{17} × VL616	207.00	112.07	10.70	10.33	43.67	13.18	40.40	27.10
× HS240	176.67	95.50	10.73	9.00	40.00	10.03	45.80	22.10
× HD2380	164.67	25.10	11.60	9.00	35.00	9.32	48.80	32.00
× HPW42	164.67	76.10	2.18	8.33	55.33	14.57	49.80	35.27
Check (HS277)	183.60	91.40	13.33	13.00	56.30	21.20	51.00	28.40

grain yield over better parent only, also showed simultaneous high heterosis for some other traits, like for spike length in IWWSN-6-110 × HD2380 and IWWSN-6-110 × HS240; tillers per plant in JCAM/EM"S"// DOVE"S"SWM 12314-13M-OM-9M-3M-4WM-OWM × HD2380 and 1000-grain weight in IWWSN-6-134 × HPW42. Significant heterosis for days to flowering, spikes per plant, grains per spike length and 1000-grain weight in spring × winter wheat crosses was also reported earlier by Thakur *et al.* [2] and, for number of spikes per plant and spike length by Sadeeque *et al.* [4] and, for grains per ear and 1000-grain weight by Krishna and Ahmad [5].

It is revealed from the present study that, on the manifestation of heterosis over standard variety and better parent for grain yield and other traits, two crosses IWWSN-6-110 × HPW42 and IWWSN-6-134 × HS240 excelled both the superior check and better parent. The cross IWSSN-6-110 × VL616 also excelled the superior check variety, HS277. Such crosses can be considered for their commercial exploitation as hybrids, if some mechanism for large scale and low seed cost production become available. Other six crosses superior over their better parents can also be utilized in subsequent breeding programmes of wheat improvement.

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