www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277-7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2022; 11(6): 1666-1670

www.thepharmajournal.com
Received: 09-03-2022
Accepted: 27-04-2022

Shiva Mohan
SVP University of Agriculture and Technology, Meerut, Uttar Pradesh, India

LK Gangwar
SVP University of Agriculture and Technology, Meerut, Uttar Pradesh, India

Pooran Chand
SVP University of Agriculture and Technology, Meerut, Uttar Pradesh, India

SK Singh
SVP University of Agriculture and Technology, Meerut, Uttar Pradesh, India

Nirdesh Kumar Chaudhary
SVP University of Agriculture and Technology, Meerut, Uttar Pradesh, India

Pushpanjali Kushawaha
SVP University of Agriculture and Technology, Meerut, Uttar Pradesh, India

Corresponding Author:
Nirdesh Kumar Chaudhary
SVP University of Agriculture and Technology, Meerut, Uttar Pradesh, India

Broad study of heterotic combination for grain yield and its related component in bread wheat (*Triticum aestivum* L.)

Shiva Mohan, LK Gangwar, Pooran Chand, SK Singh, Nirdesh Kumar Chaudhary and Pushpanjali Kushawaha

Abstract
The experiment was conducted at the CRC of SVP University of Agriculture and Technology, Meerut (Uttar Pradesh) India during Rabi 2019-20 and 2020-21 for attempting of crossing programme in a line × tester (10 lines × 4 tester). The experimentation covering 14 parents and 40 f_1 (hybrid) was arranged in Randomized Block Design with three replications. In case of grain yield per plant, heterosis over the better parent the best five highest significant and positive values (desirable) were observed for UP1109 × WR544 (42.00), UP1109 × PBW226 (41.70), HD3237 × WR544 (41.51), UP2628 × WR544 (27.59) and UP2628 × PBW226 (26.63). Heterosis over the mid parent the best five highest significant and positive values (desirable) were observed for HD3237 × WR544 (52.68), UP1109 × WR544 (46.92), UP1109 × PBW226 (45.83), UP2628 × WR544 (36.71) and K9162 × PBW226 (30.27).

Keywords: Heterosis, better parent and mid parent

Introduction
Wheat is one of the most imperative and broadly cultivated staple food crops amongst the cereals. India is one of the major producers of wheat and conquers second position after China. The overall region under cultivation approximate about 221.18 million hectares with a production of 774.74 million tons of grain with 3500 kg/ha productivity (2020-21). India wheat production has touched the landmark figure of 109.52 million tons from 31.76 million hectares and registering an all-time highest crop productivity of 3424 kg/ha. Recently climate change has increased the risk exposer of higher temperature and each degree rise in temperature cause 3-4% reduction in grain yield. This circumstance of higher temperature heterosis breeding was useful to overcome the yield barriers. The manipulation of heterosis is an important strategy for increasing the yield.

Materials and Methods
The present field experiment was conducted at the CRC of SVP University of Agriculture and Technology, Meerut (Uttar Pradesh) India during *Rabi* 2019-20 and 2020-21 for attempting of crossing programme in a line × tester (10 lines × 4 tester) was laid out in Randomized Block Design with three replications. The spacing between rows was 22.5 cm, respectively maintained by thinning. Five economical plants from each plot were randomly selected for recording observations for all the quantitative characters excluding days to flowering and days to maturity which were recorded on the experimental site basis. The Data were recorded for twelve characters namely, days to 50% flowering, days to maturity, plant height per plant cm, number of productive tillers per plant, length of peduncle per plant cm, spike length cm, spikelets per spike, number of grains per spike, 1000 grain weight g, biological yield per plant g, harvest index % and grain yield per plant g. The present study to calculate the heterosis as a percentage increase or decrease in the mean values of crosses (F_1) over better-parent and over mid parent was calculated by Fonseca and Patterson (1968).

Results and Discussion
The mean values for all the twelve traits of F_1 hybrids were matched with the values of heterosis over better parent and mid parent expressed as percentage are presented in Table 1.

Days to 50% flowering

Genotypes with early flowering habits are generally desirable and negative heterosis for days to maturity therefore a useful parameter. Heterosis over better parent for the trait days to 50% flowering ranged from -8.37 to 3.99. The best five highest significant and negative value (desirable) were observed for K9162 × HD3086 (-8.37), UP1109 × WH 1105 (-8.26), RAJ 3777 × WR544 (-6.64), HD2177 × WH1105 (-5.44) and HD2177 × WR544 (-5.20). Heterosis over mid parent for the trait days to 50% flowering ranged from -8.67% to 3.09%. The best five highest significant and negative value (desirable) were observed for UP1109 × WH 1105 (-8.67), K9162 × HD3086 (-8.65), RAJ 3777 × WR544 (-7.91), UP2628 × WR544 (-7.12) and HD2177 × PBW226 (-6.36) Jaiswal *et al.* (2010) [6].

Days to maturity

Genotypes with early maturing habits are generally desirable and negative heterosis for days to maturity therefore a useful parameter. Heterosis over the better parent varied from -4.26 to 0.50. The best five highest significant and negative values (desirable) were observed for K9162 × HD3086 (-4.26), NW5054 × HD 3086 (-4.19), PBW373 × HD3086 (-4.02), RAJ 3777 × WH1105 (-3.22) and RAJ 3777 × HD3086 (3.16). Heterosis over the mid parent varied from -5.14 to 0.26. The best five highest significant and negative values (desirable) were observed for RAJ 3777 × WR544 (-5.14), RAJ 3777 × HD3086 (-4.82), RAJ 3777 × WH1105 (-4.52), K9162 × HD3086 (-4.49) and NW5054 × HD 3086 (-4.44).

Plant height

Dwarfness is desirable trait for wheat crop hence negative heterosis is favourable to avoid lodging thus producing stable yield. Heterosis over better parent for the trait plant height ranged from -9.45 to 20.70. The best five highest significant and negative value (desirable) were observed for K9162 × WH1105 (-9.45), HD3237 × WH1105 (-8.86), UP1109 × HD3086 (-7.64), HD2177 × PBW226 (-7.44) and UP2628 × WR544 (-7.41). Heterosis over mid parent for the trait plant height ranged from -7.48 to 21.26. The best five highest significant and negative value (desirable) were observed for HD2177 × PBW226 (-7.48), UP2628 × WH1105 (-6.58), PBW175 × PBW226 (-6.33), PBW373 × WH1105 (-6.28) and HD3237 × HD3086 (-6.20) Jaiswal *et al.* (2010) [6], Kalimullah *et al*. (2011) [7] and Nagar *et al.* (2019) [10].

Number of productive tillers per plant

The significant positive value is favorable for number of productive tillers per plant, heterosis over the better parent varied from -12.17 to 58. The best five highest significant and positive values (desirable) were observed for HD3237 × PBW226 (58.33), HD3237 × HD3086 (55.56), RAJ 3777 × WR544 (50.06), UP1109 × WH 1105 (44.33) and UP1109 × HD3086 (43.21). Heterosis over the mid parent varied from -9.14 to 73.64. The best five highest significant and positive values (desirable) were observed for HD3237 × HD3086 (73.64), UP1109 × HD3086 (68.12), RAJ 3777 × HD3086 (60.84), HD3237 × PBW226 (58.33) and NW5054 × HD 3086 (53.74) Kalimullah *et al*. (2011) [7], Gite *et al.* (2014), Nawaz *et al*. (2014) [11] and Nagar *et al.* (2019) [10].

Length of peduncle

Heterosis over better parent for the trait plant height ranged from 5.31 to 17.34 The best five highest significant and positive value were observed for PBW175 × WR 544 (17.34), UP2628 × WH1105 (16.80), UP2628 × PBW226 (15.95), UP2628 × HD3086 (14.90) and HD2177 × WH1105 (14.62). Heterosis over mid parent for the trait plant height ranged from 6.63 to 24.67. The best five highest significant and positive value were observed for PBW175 × WR 544 (24.67), UP2628 × PBW226 (20.34), UP2628 × WH1105 (19.60), RAJ 3777 × WH1105 (16.73) and UP2628 × WR544 (16.52).

Spike length

Spike length is a major yield component and is directly proportional to spikelets per spike. The longer the spike length, higher will be the grain yield. Heterosis over the better parent varied from 8.30 to 26.30. The best five highest significant and positive values (desirable) were observed for RAJ 3777 × WH1105 (26.30), UP2628 × WH1105 (24.82), HD2177 × PBW226 (24.55), UP1109 × WH 1105 (24.44) and HD2177 × WR544 (24.13). Heterosis over the mid parent varied from 10.07 to 27.48. The best five highest significant and positive values (desirable) were observed for RAJ 3777 × WH1105 (27.48), HD2177 × PBW226 (26.79), UP2628 × WH1105 (25.74), UP1109 × WH 1105 (25.61) and HD2177 × WR544 (24.54) Jaiswal *et al.* (2010) [6].

Spikelets per spike

Spikelets per spike is a major yield component and is directly proportional to grain per spike. The higher number of spikelets per spike higher will be the grain yield. Heterosis over the better parent varied from -5.04 to 17.47. The best five highest significant and positive values (desirable) were observed for HD3237 × HD3086 (17.47), HD2177 × WR544 (16.83), UP1109 × WH 1105 (15.03), K9162 × HD3086 (15.01) and UP2628 × WR544 (14.84). Heterosis over the mid parent varied from 0.74 to 18.38. The best five highest significant and positive values (desirable) were observed for HD3237 × HD3086 (18.38), HD2177 × WR544 (17.30), UP1109 × WH 1105 (17.08), UP2628 × WR544 (16.41) and K9162 × HD3086 (15.45) Kalimullah *et al*. (2011) [7].

Grains per spike

Heterosis over better parent for the trait grains per spike ranged from 1.28 to 20.26 The best five highest significant and positive value were observed for DBW187 × HD3086 (20.26), HD2177 × HD3086 (16.22), K9162 × HD3086 (15.81), UP2628 × HD3086 (15.41) and HD3237 × HD3086 (13.59). Heterosis over mid parent for the trait grains per spike ranged from 3.27 to 23.42. The best five highest significant and positive value were observed for DBW187 × HD3086 (23.42), HD2177 × HD3086 (19.28), K9162 × HD3086 (17.64), UP1109 × WH 1105 (16.67) and UP2628 × HD3086 (16.27) Jaiswal *et al.* (2010) [6], Devi *et al.* (2013) [4], Gite *et al.* (2014) [5], Nawaz *et al*. (2014) [11] and Nagar *et al.* (2019) [10].

1000 grain weight

Heterosis over better parent for the trait 1000 grain weight ranged from -1.37 to 35.10 The best five highest significant and positive value were observed for PBW175 × WH1105 (35.10), DBW187 × HD3086 (17.87), RAJ 3777 × WR544 (16.89), PBW175 × HD3086 (16.75) and DBW187 × PBW226 (12.94). Heterosis over mid parent for the trait ranged from 0.25 to 42.56 The best five highest significant and positive value were observed for PBW175 × WH1105 (42.56), DBW187 × HD3086 (30.66), PBW175 × HD3086

(22.95), RAJ 3777 × WR544 (18.50) and HD3237 × WH1105 (18.46) Jaiswal *et al.* (2010) [6], Nawaz *et al.* (2014) [11] and Nagar *et al.* (2019) [10].

Biological yield per plant

In case of biological yield per plant, heterosis over the better parent varied from -15.94 to 21.89. The best five highest significant and positive values (desirable) were observed for HD3237 × WR544 (21.89), HD2177 × WR544 (19.46), UP1109 × WR544 (19.44), UP2628 × WR544 (16.86) and UP1109 × WH 1105 (16.07). Heterosis over the mid parent varied from -10.61 to 23.94. The best five highest significant and positive values (desirable) were observed for HD3237 × WR544 (23.94), HD2177 × WR544 (22.46), HD2177 × WH1105 (21.26), UP2628 × WR544 (20.84) and UP1109 × WH 1105 (20.54) Nagar *et al.* (2019) [10].

Harvest index

Heterosis over better parent for the trait harvest index ranged from -28.61 to 22.84. The best five highest significant and positive value were observed for UP1109 × PBW226 (22.84), UP1109 × WR544 (17.74), HD3237 × WR544 (16.56), RAJ 3777 × HD3086 (15.11) and K9162 × PBW226 (15.01). Heterosis over mid parent for the trait harvest index ranged from -21.13 to 30.04. The best five highest significant and positive value were observed for UP1109 × PBW226 (30.04), HD3237 × WR544 (23.74), UP1109 × WR544 (22.21), UP2628 × PBW226 (20.06) and K9162 × PBW226 (19.54). Jaiswal *et al.* (2010) [6] and Desale and Mehta (2013) [3].

Grain yield per plant: In case of grain yield per plant, heterosis over the better parent varied from -29.19 to 42.00. The best five highest significant and positive values (desirable) were observed for UP1109 × WR544 (42.00), UP1109 × PBW226 (41.70), HD3237 × WR544 (41.51), UP2628 × WR544 (27.59) and UP2628 × PBW226 (26.63). Heterosis over the mid parent varied from -16.74 to 52.68. The best five highest significant and positive values were observed for HD3237 × WR544 (52.68), UP1109 × WR544 (46.92), UP1109 × PBW226 (45.83), UP2628 × WR544 (36.71) and K9162 × PBW226 (30.27) similar result was found in Desale and Mehta (2013) [3], Barot *et al.* (2014) [2], Nawaz *et al.* (2014) [11], Ahmad *et al.* (2016) [1], Thomas *et al.* (2017) [15], Kumar *et al.* (2017) [9], Rajput and Kandalkar (2018) [12], Nagar *et al.* (2019) [10], Shah *et al.* (2018) [13], Kumar *et al.* (2020) [8], and Sharma *et al.* (2020) [14].

Table 1: Estimate heterosis for hybrids for 12 characters in wheat.

S. No	Hybrids	Days to 50% Flowering		Days to maturity		Plant height per plant		Number of productive tiller per plant		Length of peduncle (cm)		Spike length (cm)	
		BP	MP	BP	MP	BP	MP	BP	MP	BP	MP	BP	MP
1	K9162 × WR544	-1.07	-1.90	-1.48	-1.72	15.12 **	17.65 **	23.33 **	27.59 **	11.75 *	12.94 **	22.71 **	24.51 **
2	K9162 × PBW226	-0.31	-2.04	-2.95**	-3.31 **	13.94 **	16.65 **	23.33 **	37.04 **	10.69 *	11.34 **	11.55 *	11.55 *
3	K9162 × HD3086	-8.37**	-8.65 **	-4.26**	-4.49 **	20.70 **	21.26 **	25.06 **	53.13 **	9.83 *	11.82 **	20.22 **	21.76 **
4	K9162 × WH1105	-3.45*	-4.05 *	-2.37*	-2.97 **	-9.45 *	10.34 **	18.89 **	21.63 **	9.92 *	10.80 *	18.77 **	20.29 **
5	HD3237 × WR544	0.71	-0.33	0.14	-0.11	4.98	5.60	27.32 **	37.12 **	12.72 **	14.15 **	11.39 *	12.40 **
6	HD3237 × PBW226	1.81	-0.16	-0.49	-0.86	4.18	4.60	58.33 **	58.33 **	10.12 *	10.99 **	17.73 **	18.39 **
7	HD3237 × HD3086	-0.40	-0.90	-2.22*	-2.46 *	2.86	-6.20 *	55.56 **	73.64 **	9.70 *	11.46 **	23.00 **	23.88 **
8	HD3237 × WH1105	-2.09	-2.51	-1.00	-1.60	-8.86 *	11.02 **	27.98 **	39.28 **	13.55 **	14.22 **	17.93 **	18.77 **
9	HD2177 × WR544	-5.20**	-5.87 **	-1.23	-1.83	10.38 **	10.63 **	13.33 *	17.24 **	6.94	8.39 *	24.13 **	24.54 **
10	HD2177 × PBW226	-4.84**	-6.36 **	-0.49	-1.22	-7.44 *	-7.48 *	21.17 **	34.63 **	12.26 *	13.24 **	24.55 **	26.79 **
11	HD2177 × HD3086	-0.47	-0.64	-1.46	-1.58	10.00 **	13.18 **	20.00 **	46.94 **	10.10 *	11.76 **	12.96 *	13.55 **
12	HD2177 × WH1105	-5.44**	-6.16 **	0.00	-0.24	12.28 **	14.09 **	18.89 **	21.63 **	14.62 **	15.20 **	16.30 **	16.90 **
13	UP1109 × WR544	-0.36	-2.26	-0.19	-0.68	10.07 **	10.56 **	27.38 **	29.70 **	6.17	6.98	11.86 *	12.70 **
14	UP1109 × PBW226	1.61	-1.24	-0.27	-0.88	9.89 **	10.18 **	39.51 **	47.71 **	5.31	6.63	15.52 **	18.08 **
15	UP1109 × HD3086	-3.05*	-4.38 **	-2.02	-2.02	-7.64 *	10.98 **	43.21 **	68.12 **	5.69	9.54 *	18.52 **	19.63 **
16	UP1109 × WH 1105	-8.26**	-8.67 **	-2.99**	-3.35 **	3.74	5.64	44.33 **	48.61 **	5.80	8.58 *	24.44 **	25.61 **
17	RAJ 3777 × WR544	-6.64**	-7.91 **	-3.01**	-5.14 **	4.25	4.75	50.06 **	51.82 **	7.32	11.51 **	20.45 **	21.35 **
18	RAJ 3777 × PBW226	2.50	0.18	-1.23	-3.52 **	2.49	2.79	34.83 **	46.77 **	8.37	12.07 **	21.62 **	24.32 **
19	RAJ 3777 × HD3086	-2.11	-2.93	-3.16**	-4.82 **	2.12	5.33	33.72 **	60.84 **	16.38 **	17.58 **	23.33 **	24.49 **
20	RAJ 3777 × WH1105	-2.35	-2.45	-3.22**	-4.52 **	5.13	7.09 *	25.58 **	25.62 **	14.40 **	16.73 **	26.30 **	27.48 **
21	UP2628 × WR544	-1.42	-7.12 **	-0.49	-2.76 *	-7.41 *	9.35 **	30.89 **	31.68 **	11.75 *	16.52 **	20.44 **	21.55 **
22	UP2628 × PBW226	3.99**	-2.95	-1.54	-3.90 **	3.17	5.23	37.35 **	47.10 **	15.95 **	20.34 **	19.89 **	20.54 **
23	UP2628 × HD3086	0.83	-4.47 **	-1.73	-3.49 **	14.13 **	15.11 **	28.92 **	52.86 **	14.90 **	16.50 **	14.96 **	15.81 **
24	UP2628 × WH1105	-0.73	-5.01 **	-0.24	-1.66	6.13	-6.58 *	37.29 **	39.69 **	16.80 **	19.60 **	24.82 **	25.74 **
25	PBW373 × WR544	0.36	-0.05	-1.70	-2.06	4.59	5.22	29.17 **	29.17 **	8.01	10.89 *	20.95 **	21.42 **
26	PBW373 × PBW226	0.73	-0.59	-1.97	-2.45 *	4.43	5.25	25.54 **	35.19 **	8.56	10.93 *	11.23 *	12.42 **
27	PBW373 × HD3086	0.95	0.83	-4.02**	-4.14 **	4.05	6.20	28.57 **	53.19 **	12.20 *	12.42 **	11.40 *	11.62 *
28	PBW373 × WH1105	-1.52	-2.56	-1.46	-1.94	5.45	-6.28 *	24.49 **	25.92 **	10.79 *	11.68 **	11.03 *	11.25 *
29	DBW187 × WR544	-2.02	-2.37	-2.21*	-3.44 **	0.66	1.00	30.37 **	31.86 **	11.56 *	12.42 **	13.04 *	14.50 **
30	DBW187 × PBW226	-0.70	-1.94	0.00	-1.38	4.32	4.47	29.14 **	40.55 **	9.73 *	10.04 *	10.47 *	10.67 *
31	DBW187 × HD3086	-3.61*	-3.78 *	-1.22	-1.97	2.06	5.12	25.65 **	51.10 **	5.46	7.68	15.22 **	16.48 **
32	DBW187 × WH1105	-2.36	-3.44 *	-1.69	-2.08	-0.37	1.35	28.56 **	28.56 **	11.73 *	12.95 **	13.80 **	15.05 **
33	NW5054 × WR544	0.49	-0.96	0.49	0.26	4.84	5.45	-12.17 *	-9.14	8.09	9.46 *	12.27 *	12.46 **
34	NW5054 × PBW226	3.66*	3.09	0.50	0.14	2.27	2.68	21.11 **	34.57 **	9.34	10.20 *	8.30	10.07 *
35	NW5054 × HD 3086	-1.75	-3.69 *	-4.19**	-4.44 **	6.67	10.14 **	25.56 **	53.74 **	10.08 *	11.85 **	14.07 **	14.48 **
36	NW5054 × WH 1105	1.83	-1.13	-3.02**	-3.63 **	2.82	4.85	20.00 **	22.76 **	6.72	7.36	17.04 **	17.45 **
37	PBW175 × WR 544	-1.90	-4.29 **	0.00	-0.42	16.26 **	16.44 **	32.86 **	33.69 **	17.34 **	24.67 **	15.71 **	18.03 **
38	PBW175 × PBW226	1.81	-1.59	-0.49	-1.03	5.98	-6.33 *	37.57 **	49.00 **	7.98	14.20 **	15.71 **	16.34 **
39	PBW175 × HD3086	-0.62	-2.52	-1.58	-1.64	4.68	7.31 *	26.98 **	52.06 **	7.65	11.29 *	12.14 *	14.18 **
40	PBW175 × WH1105	-2.90*	-3.85 *	-2.71*	-3.13 **	3.57	4.85	24.49 **	25.15 **	11.99 *	16.90 **	16.79 **	18.91 **
	S.Ed. ±	1.81	1.57	1.82	1.57	3.22	2.78	0.35	0.31	1.66	1.44	0.49	0.42
	CD at 5%	3.73	3.23	3.73	3.23	6.61	5.72	0.72	0.63	3.41	2.96	1.00	0.86

S.No	Hybrids	Spikelet per spike		Grain per spike		1000 Grain weight (g)		Biological yield per plant (g)		Harvest index (%)		Grain yield per plant (g)	
		BP	MP	BP	MP	BP	MP	BP	MP	BP	MP	BP	MP
1	K9162 × WR544	6.84	7.27	3.06	5.38	5.19	6.50	-4.94	-1.09	-2.64	3.11	0.39	2.20
2	K9162 × PBW226	6.07	6.08	4.86	6.52	7.18	8.75	4.63	9.11 *	15.01 *	19.54 **	20.44 **	30.27 **
3	K9162 × HD3086	15.01 **	15.45 **	15.81 **	17.64 **	8.03	16.65 **	-0.83	2.69	-4.90	-0.20	-5.59	2.41
4	K9162 × WH1105	14.21 *	14.65 **	7.80	10.66 **	8.21	17.07 **	10.91 *	11.75 **	4.88	13.12 *	17.78 **	25.88 **
5	HD3237 × WR544	5.57	7.21	3.30	3.78	2.90	5.55	21.89 **	23.94 **	16.56 **	23.74 **	41.51 **	52.68 **
6	HD3237 × PBW226	9.81	11.09 *	5.15	6.35	5.08	8.01	0.72	7.43 *	-1.05	6.99	13.72 **	15.47 **
7	HD3237 × HD3086	17.47 **	18.38 **	13.59 **	14.89 **	7.96	15.16 **	1.47	7.48 *	-10.28	-3.90	2.20	3.44
8	HD3237 × WH1105	12.09 *	12.96 **	7.52	7.60 *	10.83	18.46 **	14.40 **	16.26 **	0.24	4.45	18.33 **	21.67 **
9	HD2177 × WR544	16.83 **	17.30 **	9.47 *	13.08 **	2.21	2.38	19.46 **	22.46 **	-3.31	1.43	21.09 **	24.06 **
10	HD2177 × PBW226	9.63	10.50 *	6.35	9.15 *	9.98	10.04 *	1.27	12.22 **	-2.32	4.39	13.49 **	17.94 **
11	HD2177 × HD3086	13.84 *	15.19 **	16.22 **	19.28 **	2.64	12.28 *	1.65	11.91 **	-0.99	4.81	13.16 **	17.95 **
12	HD2177 × WH1105	11.11 *	12.43 *	4.62	8.49 *	4.48	14.51 **	14.60 **	21.26 **	-2.64	0.22	18.43 **	21.54 **
13	UP1109 × WR544	8.53	9.62	4.14	8.03 *	7.75	7.79	19.44 **	20.09 **	17.74 **	22.31 **	42.00 **	46.92 **
14	UP1109 × PBW226	6.88	8.37	4.86	8.08 *	2.90	3.08	3.07	12.21 **	22.84 **	30.04 **	41.70 **	45.83 **
15	UP1109 × HD3086	8.77	10.71 *	8.92	12.26 **	1.32	10.70 *	6.73	15.42 **	0.54	5.40	18.12 **	21.94 **
16	UP1109 × WH 1105	15.03 **	17.08 **	12.04 **	16.67 **	7.38	17.55 **	16.07 **	20.54 **	3.19	5.18	24.91 **	26.94 **
17	RAJ 3777 × WR544	10.34	13.11 **	7.90	8.35 *	16.89 **	18.50 **	-4.14	-2.73	-11.36	-10.53	-15.00 **	-12.91 **
18	RAJ 3777 × PBW226	10.00	12.33 **	11.99 **	13.21 **	2.45	4.09	2.53	9.57 *	9.94	13.15 *	19.50 **	24.18 **
19	RAJ 3777 × HD3086	6.59	8.43	8.17	9.34 *	5.70	13.99 **	4.59	11.01 **	15.11 *	17.30 **	24.97 **	30.26 **
20	RAJ 3777 × WH1105	10.00	11.90 *	7.50	7.52	9.40	18.22 **	13.20 **	15.28 **	-7.47	-6.53	5.20	7.96
21	UP2628 × WR544	14.84 **	16.41 **	10.54 *	12.11 **	4.75	6.58	16.86 **	20.84 **	9.04	13.12 *	27.59 **	36.71 **
22	UP2628 × PBW226	8.67	9.73 *	8.92	9.73 *	8.32	10.45 *	1.08	6.07	13.57 *	20.06 **	26.63 **	27.61 **
23	UP2628 × HD3086	13.68 *	14.34 **	15.41 **	16.27 **	7.30	15.33 **	-1.26	2.90	-1.19	3.46	5.91	6.41
24	UP2628 × WH1105	12.89 *	13.55 **	7.67	9.63 *	8.39	16.73 **	10.78 *	10.89 **	2.72	4.55	13.93 **	16.29 **
25	PBW373 × WR544	7.94	9.01	4.38	4.66	12.59 *	13.18 **	14.78 **	17.07 **	-3.70	2.15	10.60 *	19.54 **
26	PBW373 × PBW226	7.16	7.80	3.71	4.69	8.05	8.86	-15.94 **	-10.61 **	-12.25 *	-5.20	-16.13 **	-14.70 **
27	PBW373 × HD3086	11.43 *	11.66 *	6.09	7.09	4.89	14.01 **	3.68	9.51 *	-4.96	1.72	10.30 *	11.85 **
28	PBW373 × WH1105	8.74	8.96	3.17	3.31	6.21	15.67 **	10.80 *	12.26 **	-0.35	3.76	13.34 **	16.74 **
29	DBW187 × WR544	-2.61	3.70	1.28	3.27	-1.37	0.25	-3.53	6.39	-14.58 **	-3.98	-17.65 **	0.84
30	DBW187 × PBW226	-5.04	0.74	2.22	4.92	12.94 *	14.54 **	6.04	8.14 *	-0.58	13.69 **	5.20	22.37 **
31	DBW187 × HD3086	2.63	8.47	20.26 **	23.42 **	17.87 **	30.66 **	2.73	5.51	-1.08	12.13 *	0.90	17.06 **
32	DBW187 × WH1105	1.91	7.72	4.48	6.12	-0.76	10.22 *	-0.58	6.38	-28.61 **	-21.13 **	-29.19 **	-16.74 **
33	NW5054 × WR544	10.04	10.47 *	4.54	5.67	9.76	11.13 *	3.83	10.77 **	8.35	9.40	12.24 **	20.79 **
34	NW5054 × PBW226	12.38 *	12.38 *	7.57	8.01 *	0.27	1.74	0.54	2.21	12.63	15.95 **	17.11 **	18.58 **
35	NW5054 × HD 3086	7.19	7.61	7.70	8.13 *	4.23	12.56 *	1.83	2.78	8.58	10.68	12.85 **	13.91 **
36	NW5054 × WH 1105	9.16	9.59 *	3.70	5.23	5.49	14.14 **	4.10	7.62 *	7.57	8.63	14.38 **	17.30 **
37	PBW175 × WR 544	5.68	6.10	5.73	8.48 *	3.09	7.14	5.55	13.09 **	12.39	12.45 *	19.34 **	27.33 **
38	PBW175 × PBW226	9.61	9.62 *	5.14	7.16	0.69	4.87	1.63	2.83	14.89 *	17.22 **	20.90 **	21.30 **
39	PBW175 × HD3086	4.48	4.88	5.26	7.29	16.75 **	22.95 **	2.94	3.41	8.34	9.44	13.71 **	13.73 **
40	PBW175 × WH1105	9.18	9.60 *	6.49	9.68 *	35.10 **	42.56 **	-3.54	0.18	-7.55	-5.78	-6.28	-4.76
	S.Ed. ±	0.95	0.82	2.24	1.94	2.05	1.77	1.48	1.29	2.02	1.75	0.51	0.44
	CD at 5%	1.94	1.68	4.61	4.00	4.21	3.64	3.05	2.64	4.15	3.60	1.06	0.91

Conclusion

In case of grain yield per plant heterosis over better parent the best cross was observed for UP1109 × WR544, Heterosis over the mid parent the best crosses was observed for HD3237 × WR544.

Reference

1. Ahmad E, Kamar A, Jaiswal JP. Identifying heterotic combinations for yield and quality traits in Bread Wheat (*Triticum aestivum* L.). Electronic Journal of Plant Breeding. 2016;7(2):352-361.
2. Barot HG, Patel MS, Sheikh WA, Patel LP, Allam CR. Heterosis and combining ability analysis for yield and its component traits in wheat [*Triticum aestivum* L.] Electronic Journal of Plant Breeding. 2014;5(3):350-359.
3. Desale CS, Mehta DR. Heterosis and combining ability analysis for grain yield and quality traits in bread wheat (*Triticum aestivum* L.). Electronic Journal of Plant Breeding. 2013;4(3):1205-1213.
4. Devi L, Goel SP, Singh MAMTA, Jaiswal JP. Heterosis studies for yield and yield contributing traits in bread wheat (*Triticum aestivum* L.). The Bioscan. 2013;8(3):905-909.
5. Gite VD, Mali AR, Idhol BD, Bagwan JH. Estimation of heterosis for yield and some yield components in bread wheat (*Triticum aestivum* L.). The Bioscan. 2014;9(2):767-770.
6. Jaiswal KK, Praveen Pandey, Shailesh M, Anurag PJ. Heterosis studies for improvement in yield potential of wheat (*Triticum aestivum* L.). AAB-Bioflux, 2010;2(3):273-278.
7. Kalimullah. Heterosis of certain important yield components in the population of wheat (*Triticum aestivum* L.) crosses. Electronic J of Plant Breeding. 2011;2(2):239-243.
8. Kumar D, Panwar IS, Singh V, Choudhary RR. Heterosis studies using Diallel analysis in bread wheat (*Triticum aestivum* L.). IJCS. 2020;8(4):2353-2357.
9. Kumar J, Kumar A, Kumar M, Singh SK, Singh L, Singh GP. Heterosis and inbreeding depression in relation to

heterotic parameters in bread wheat (*Triticum aestivum* L.) under late sown condition. Journal of Wheat Research. 2017;9(1):32-41.
10. Nagar SS, Kumar P, Singh C, Gupta V, Singh G, Tyagi BS. Assessment of heterosis and inbreeding depression for grain yield and contributing traits in bread wheat. Journal of Cereal Research. 2019;11(2):125-130.
11. Nawaz MS, Ansari BA, Kumbhar MB, Keerio MI. Heterotic and heterobeltiotic performance of some inter varietal hybrids of bread wheat (*Triticum aestivum* L.) for major yield associated traits. Int. J of Bio. And Biotech. 2014;11(2/3):439-444.
12. Rajput RS, Kandalkar VS. Combining ability and heterosis for grain yield and its attributing traits in bread wheat (*Triticum aestivum* L.) Journal of Pharmacognosy and Phytochemistry. 2018;7(2):113-119.
13. Shah AA, Mondal SK, Khurshid H, Wani AA. Heterosis for yield and yield component traits in F1 and F2 generation of winter and spring wheat derivatives (line x tester) Journal of Pharmacognosy and Phytochemistry. 2018;7(5):644-648.
14. Sharma V. Heterosis for yield and Physio-biochemical traits in bread wheat (*Triticum aestivum* L.) under different environmental conditions. Bangladesh Journal of Botany. 2020;49(3):515-520.
15. Thomas N, Marker S, Lal GM, Dayal A. Study of heterosis for grain yield and its components in wheat (*Triticum aestivum*) over normal and heat stress condition. J of Pharmacognosy and Phytochemistry. 2017;6(4):824-830.