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Estimation of heterosis for yield and its components under normal and sodic soil in barley (*Hordeum vulgare* L.)

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Abstract
Manipulation of heterosis is considered to be a vital approach to enhance the yield potential of barley and is as accepted to be a safe strategy to overcome barriers in barley yield. Thirteen diverse Indian genotypes were crossed to obtain a series of crosses to estimate the level of heterosis and heterobeltiosis among F1 hybrids along with their parents under two contrasting environments: normal and sodic soil. Estimates revealed a significant relationship between the mean performance of F1 hybrids and their parents under sodic stress regime only. The presence of significant heterosis for grain yield was also accompanied by heterosis for yield components, such as days to 50% flowering, plant height, number of effective tillers /plant, number of spikelets /spike, number of grains/ spike, days to maturity,1000- grain weight, biological yield / plant, grain yield / plant and harvest index. The cross NDB 1245 X NDB 943 was an elite cultivar and showed significant heterobeltiosis. The study suggests that the obtained hybrids surpassed their better parents' effects, indicative of commercial heterosis, and are thus candidates for the commercial production of hybrid barley.

Keywords: Barley, heterosis, grain yield, *Hordeum vulgare*, standard variety

Introduction

Barley (*Hordeum vulgare* L. 2n=14, sub family Poaceae) an important winter *rabi* cereal rank fourth after wheat, rice and maize. Since time immemorial, Barley is considered as crop of rainfed and problematic soil conditions i.e. saline alkaline, drought and diara, marginal/coastal area of river. Barley florish well under less resource of irrigation and fertilizers. Thus, this crop has great elasticity of adaptation under various stress situations. Barley being essentially a temperate crop is grown mainly in Russia, China, United States, Africa, France, Canada, USA, Spain, Australia, Germany, Syria, Netherland and Ireland. In India, it is grown to a limited area particularly in States of Rajasthan, Uttar Pradesh, Madhya Pradesh, Haryana, Punjab, Bihar, Himanchal Pradesh, Uttarakhand and Jammu & Kashmir. Barley production has been estimated at 1.73 million tonnes from 0.66 million hectares with an average national productivity of 2617 kg/ha.

India has about 6.6 lacs ha area with production of 17.3 lacs metric tonnes and productivity of 26.17 q/ha (2018-19) Annonymous (2019) [1]. In Uttar Pradesh, barley occupied an area of 1.67 lacs ha with a total production of 4.81 lacs mt with productivity of 28.80 q/ha (2014). Uttar Pradesh alone contributes more than one fourth of India's total production of barley. The heterosis breeding has been extensively utilized in improving yield particularly in allogamous crops. The exploitation of heterosis in barley has been limited due to its autogamous nature. For a successful hybrid breeding programme, it is essential that a significant heterosis must be available in the F_1 populations and that a method is available for commercial seed production economically. Significant level of heterosis with respect to grain yield and its component traits have been reported with hybrids showing greater advantage under adverse environmental conditions.

Materials and Methods

The present study was carried out during *Rabi* seasons of 2014-15 & 2015-2016 at Genetics and Plant Breeding Research Farm of Narendra Deva University of Agriculture & Technology, Narendra Nagar (Kumarganj), Faizabad. The experimental materials comprised of thirteen genetically diverse varieties/strains and their 30 crosses. The 13 parents were involved in a crossing programme to develop a line × tester set (10 lines + 3 testers) during *Rabi* season of 201-2015. The experimental material was evaluated in Randomized Block design (RBD) with three replications in two environments i.e. under normal fertile soil and saline sodic soil condition. The observations were recorded on ten characters, namely, days to 50% flowering, plant height, number of effective tillers /plant, number of spikelets /spike, number of grains/ spike, days to maturity,1000- grain weight, biological yield / plant, grain yield / plant and harvest index. The data on different characters from two experiments were subjected to nature and magnitude of heterosis (Hayes *et al.*, 1955), The data from 30 crosses obtained by crossing 10 lines with three testers (NDB-943, BHS-352 and DWR 28) along with parents formed the line × testers set which was utilized for estimation of heterosis over better parent and standard variety.

Estimation of heterosis

The percentage increase or decrease of F1 hybrids over better parents as well as standard variety value was calculated to estimate possible heterotic effects for the above-mentioned parameters by following the equation of Gebrekidan and Rasmusson (1970) [2].

Heterosis% = (F1-BP/F1-BP)*100 and Heterosis% = (F1-SV/F1-SV)*100

where F1 = mean performance of the F1 hybrid; BP = batter-parent value. SV= standard variety value.

Result and Discussion

The best crosses for positive and significant heterobeltiosis were, Azad X BHS 352 (12.22%), NDB 1592 X NDB 943 (11.07%), HUB 113 X BHS 352 (10.84%) and NDB 1245 X NDB 943 (10.82%) The heterosis over better parent ranged from -32.49 (DWRUB 64 X DWR 28) to 12.22 per cent (Azad X BHS 352) with an overall mean of -12.18 per cent. Promising crosses over SV_1 in order of merit were NDB 1245 X NDB 943 (53.44%), DWRUB 64 X NDB 943 (50.61%), HUB 113 X BHS 352 (44.94%), NDB 1465 X DWR 28 (42.51%) and NDB 1173 X NDB 943 (41.70%). The range of standard heterosis over SV was -0.40 (RD 2794 X DWR 28) to 53.44 percent (NDB 1245 X NDB 943), respectively. On the other hand, 21 and none crosses expressed significant and negative heterosis over BP and SV_1, respectively, under normal soil condition (E_1).

Heterosis over better parent and standard variety (SV) ranged from -8.47 (BH 902 X NDB 943) to 35.61 percent (HUB 113 X NDB 943) and from 4.59 (NDB 1592 X BHS 352) to 47.45 percent (NDB 1465 X NDB 943) respectively. The five best crosses for positive heterobeltiosis were, HUB 113 X NDB 943 (35.61%), NDB 1173 X NDB 943 (33.00), RD 2794 X BHS 352 (28.85%), Karan 741 X BHS 352 (23.56%) and NDB 1173 X BHS 352 (22.60%). Promising crosses for SV in order of merit were NDB 1465 X NDB 943 (47.45%), HUB 113 X NDB 943 (41.84%), NDB 1245 X NDB 943 (38.78%), NDB 1173 X NDB 943 (37.76%) and RD 2794 X BHS 352 (36.73%). On the other hand, 1 and none crosses possessed significant and negative heterosis over BP and SV_1, respectively, under saline-sodic condition (E_2).

A perusal of Table 1, 2 and 3 revealed that heterosis in grain yield was proportional to the heterosis observed for yield components. In majority of cases heterosis in most of the components registered heterosis for grain yield. The top four crosses showing significant heterobeltiosis for grain yield were also found to register significant positive heterobeltiosis under normal soil (E_1). However, top ten crosses, which showed positive heterosis over SV for grain yield, were also having positive and significant standard heterosis for almost characters while, in case of saline soil (E_2) significant heterobeltiosis for grain yield were found to register significant positive heterobeltiosis. However, top ten crosses, which showed positive heterosis over SV for grain yield, were also having positive and significant standard heterosis for almost characters.

Obviously, plant height, number of effective tillers/plant, number of spiklets/spike, number of grains/spike, biological yield/plant, 1000-grains weight most important components associated with manifestation of heterosis for seed yield. This confirms the view that heterosis for grain yield is reflected through superiority of yield components. These observations correlates with the findings of Singh *et al.* (1999) [6], Yilmoz and Konak (2003) [9], Singh *et al.* (2003) [7], Rugen *et al.* (2004) [4], Saad *et al.* (2005) [5], Varzaru *et al.* (2012) [8] and Pesaraklu *et al.* (2016) [3]. Besides yield, considerable heterosis has been observed for other characters also, but its degree considerably depends upon the characters. Under normal soil, twelve crosses showed heterobeltiosis in desirable direction for days to 50 per cent flowering and twenty crosses for days to maturity. However, twenty one crosses for days to 50 per cent flowering and eighteen crosses for days to maturity showed standard heterosis in desirable direction over SV (NDB 943), while in case of saline sodic soil (E_2) twelve crosses showed heterobeltiosis in desirable direction for days to 50 per cent flowering and eighteen crosses for days to maturity. However, twenty one crosses for days to 50 per cent flowering and thirty crosses for days to maturity showed standard heterosis in desirable direction over SV (NDB 943).

Table 1: Estimation of per cent heterosis over better parent (BP) and standard variety i.e. NDB 943 (SV) for 10 characters for grain yield per plant (g) in barley.

S. No.	Crosses	heterosis over better parent (BP)		heterosis over standard variety (SV)	
		Normal	Sodic	Normal	Sodic
1	NDB 1245 X NDB 943	10.82**	12.86**	53.44**	38.78**
2	NDB 1245 X BHS 352	-11.11**	-5.39	23.08**	16.33**
3	NDB 1245 X DWR 28	-12.57**	-7.47	21.05**	13.78**
4	NDB 1592 X NDB 943	11.07**	18.88**	34.01**	18.88**
5	NDB 1592 X BHS 352	3.36	-1.44	24.70**	4.59
6	NDB 1592 X DWR 28	-12.42**	15.34**	5.67	11.22*
7	NDB 1465 X NDB 943	-23.24**	21.99**	19.03**	47.45**
8	NDB 1465 X BHS 352	-23.24**	-2.91	19.03**	17.35**
9	NDB 1465 X DWR 28	-8.09*	-7.98	42.51**	11.22*
10	NDB 1173 X NDB 943	-2.78	33.00**	41.70**	37.76**
11	NDB 1173 X BHS 352	-15.56**	22.60**	23.08**	30.10**
12	NDB 1173 X DWR 28	-27.50**	7.88	5.67	11.73*
13	Karan 741 X NDB 943	-19.57**	11.73*	19.84**	11.73*
14	Karan 741 X BHS 352	-11.96**	23.56**	31.17**	31.12**
15	Karan 741 X DWR 28	-8.70*	20.57**	36.03**	19.34**
16	DWRUB 64 X NDB 943	-6.30	5.80	50.61**	20.92**
17	DWRUB 64 X BHS 352	-18.14**	7.14	31.58**	22.45**
18	DWRUB 64 X DWR 28	-32.49**	-4.91	8.50	8.67
19	RD 2794 X NDB 943	-7.71*	12.24*	30.77**	12.24*
20	RD 2794 X BHS 352	-22.86**	28.85**	9.31	36.73**
21	RD 2794 X DWR 28	-29.71**	16.85**	-0.40	9.69
22	HUB 113 X NDB 943	-11.46**	35.61**	15.79**	41.84**
23	HUB 113 X BHS 352	10.84**	18.75**	44.94**	26.02**
24	HUB 113 X DWR 28	-19.81**	20.00**	4.86	25.51**
25	BH 902 X NDB 943	-22.28**	-8.47*	15.79**	10.20*
26	BH 902 X BHS 352	-24.73**	13.14**	12.15*	36.22**
27	BH 902 X DWR 28	-29.08**	0.42	5.67	20.92**
28	Azad X NDB 943	-1.29	6.39	24.29**	18.88**
29	Azad X BHS 352	12.22**	8.68	41.30**	21.43**
30	Azad X DWR 28	-11.25**	12.79**	11.74*	26.02**
Mean heterosis (%)		-12.18	11.22	23.56	21.97
No of crosses with significant positive heterosis		4	17	22	27
No. of crosses with significant negative heterosis		21	1	0	0
Range of heterosis		-32.49-12.22	-8.47-35.61	-0.40-53.44	4.59-47.45

Table 2: Relationship of positive heterobeltiosis for seed yield with heterobeltiosis of other characters (Environment-I &II)

S. No.	Characters / Crosses	Grain Yield/ Plant		Plant height		Effective Tillers/ Plant		Spikelets/ Spike		Grains/ Spike		Days to maturity		Days to 50% flowering		1000 grains weight		Biological yield /plant		Harvest Index	
		N	S	N	S	N	S	N	S	N	S	N	S	N	S	N	S	N	S	N	S
1.	NDB 1245 X NDB 943	+	+	0	-	0	+	+	0	+	+	0	-	0	0	+	0	0	0	+	+
2.	HUB 113 X BHS 352	+	+	-	-	0	0	0	0	+	+	-	-	0	-	0	+	+	+	-	+
3.	NDB 1592 X NDB 943	+	+	-	-	0	0	0	+	0	+	-	+	-	-	+	-	+	-	0	+
4.	Azad X BHS 352	+	+	-	-	+	0	-	0	-	+	-	0	-	0	+	0	+	+	0	0
5.	NDB 1592 X BHS 352	0	+	-	-	+	0	0	0	0	+	-	+	0	-	0	-	0	+	0	+
6.	Azad X NDB 943	0	+	-	-	0	+	0	0	0	+	-	-	-	-	0	+	0	-	0	+
7.	NDB 1173 X NDB 943	0	+	-	+	0	0	+	0	+	+	-	0	-	-	0	-	0	+	0	0
8.	DWRUB 64 X NDB 943	0	+	-	+	+	0	+	0	+	+	0	0	0	0	+	-	-	-	0	0
9.	RD 2794 X NDB 943	-	+	-	-	+	+	+	-	+	-	-	-	-	0	0	+	-	+	+	+
10.	Karan 741 X DWR 28	-	+	-	-	0	+	+	-	+	0	-	0	-	0	+	+	0	0	0	+

Where,
+ = Good combiner (Significant and Positive) **-** = Poor combiner (Significant/Non Significant and Negative) O = Average combiner (Positive but not significant)

Table 3: Relationship of positive heterobeltiosis SV for seed yield with heterobeltiosis of other characters (Environment-I &II)

S. No.	Characters / Crosses	Grain Yield/ Plant		Plant height		Effective Tillers/ Plant		Spikelets/ Spike		Grains/ Spike		Days to maturity		Days to 50% flowering		1000 grains weight		Biological yield /plant		Harvest Index	
		N	S	N	S	N	S	N	S	N	S	N	S	N	S	N	S	N	S	N	S
1.	NDB 1245 X NDB 943	+	+	-	-	+	+	0	0	+	+	-	-	-	-	+	+	0	0	+	+
2.	HUB 113 X BHS 352	+	+	-	-	+	+	0	0	+	+	-	-	0	0	0	0	+	+	+	+
3.	NDB 1592 X NDB 943	+	+	-	-	-	+	0	+	0	+	-	-	-	0	+	+	+	+	+	+
4.	Azad X BHS 352	+	+	-	-	0	0	+	0	+	+	-	-	-	-	+	+	+	+	+	+
5.	NDB 1592 X BHS 352	+	+	-	-	+	+	+	+	+	+	-	-	-	-	+	-	+	0	+	+
6.	Azad X NDB 943	+	+	-	-	+	+	0	-	0	0	-	-	-	-	+	+	+	0	+	+
7.	NDB 1173 X NDB 943	+	+	-	-	+	+	+	0	+	+	-	-	-	-	+	+	+	+	+	0
8.	DWRUB 64 X NDB 943	+	+	-	-	0	+	+	0	+	+	-	-	-	-	+	+	+	+	+	0
9.	RD 2794 X NDB 943	+	+	0	0	+	+	+	0	+	0	0	-	0	-	+	+	+	+	+	+
10.	Karan 741 X DWR 28	+	+	0	-	+	+	+	0	+	+	-	-	-	-	+	+	0	+	+	0

Where,
+ = Good combiner (Significant and Positive)
- = Poor combiner (Significant/Non Significant and Negative)
O = Average combiner (Positive but not significant)

Reference

1. Annonymous. Annual report ICAR- Indian institute of wheat and barley research, Karnal-132001, Haryana, India, 2019.
2. Gebrekidan B, Rasmusson DC. Evaluating cultivars for use in hybrids and heterosis in barley. Crop Sci. 1970; 10:500-502.
3. Pesaraklu H, Soltanloo H, Ramezanpour SS, Arabi MK, Nasrollah Nejad Ghomi AA. An estimation of the combining ability of barley genotypes and heterosis for some quantitative traits. Iran Agricultural Research. 2016; 35(1):73-80.
4. Rugen XU, Chao LU, Li Zhou meixue, Huidmg. Studies on the heterosis of barley (*Hordeum vulgare* L.). J Acta Agronomica Sinica. 2004; 30:668-674.
5. Saad FF, Hindi LHA, Abd. El. Shafi MA, Youssef MHA. Heterosis and combining ability analysis in barley (*Hordeum vulgare* L.). Bulletin of faculty of agriculture, Cairo University. 2005; 56:455-467.
6. Singh I, Dashara SI, Sharma SN, Divakara EV. Inheritance of some quantitative characters in six-rowed barley. Annals of Arid Zone. 1999; 36:133-137.
7. Singh SRJ, Yadav HS, Singh SM. Assessment of yield contributing characters in rainfed barley. Advances in Plant Sciences. 2003; 16:325-327.
8. Varzaru S, Ciulca S. Assessment of heterosis for grain yield per spike in winter barley. Analele Universitatii din Craiova - Biologie, Horticultura, Tehnologia Prelucrarii Produselor Agricole, Ingineria Mediului. 2012; 17:859-862.
9. Yilmoz R, Konak C. Heterosis effects regarding salt tolerance in some characters of barley. Turiksh Journal of Agriculture and Forestry. 2003; 24:643-648.