Original Research Article

Heterosis in Bread Wheat (*Triticum aestivum* L.) for Earliness and Heat Tolerant Traits over the Environments

ABSTRACT

The present study was carried out in 9 diverse parents, their 36 hybrids and 2 checks evaluated during Rabi 2020-21 at Rajasthan College of Agriculture, Mpuat, Udaipur in RBD with three replications in three different environments in wheat for earliness and heat tolerant traits *viz.*, days to 50 per cent flowering, leaf canopy temperature, total protein content in grains, heat injury, proline content and total chlorophyll content on pooled basis. The pooled analysis for above characters revealed that mean squares due to environments, genotypes, parents, crosses as well as parents v/s. crosses were significant indicating presence of overall heterosis for the traits. Out of thirty six crosses 5 crosses viz., GJW 463 x RAJ 4120, DBW 173 x RAJ 4120, GJW 463 x DBW 173, GW 451 x LOK 1 and DBW 173 x RAJ 3777 were found superior with maximum significant heterobeltiosis and economic heterosis for heat tolerant traits and earliness over the environments. These genotypes could be used to maintain transgressive segregants in future breeding programme.

Keywords: Better parent heterosis, Bread wheat, Economic heterosis and Heat tolerant traits

INTRODUCTION

Bread wheat (*Triticum aestivum* L.) is a hexaploid and self pollinated plant with 2n = 6x = 42 chromosome number, belongs to order cyperales, genus *Triticum* and family Poaceae. It is cultivated as winter sown crop and most important staple food crop globally. According to Vavilov (1992), the centre of origin for diploid wheat (*T. monococcum*, 2n=14) is Asia Minor, for tetraploid wheat (*T. durum*, 2n=28) is Mediterranean bassin and Abyssinia and for hexaploid wheat (*T. aestivum*, 2n=42) is Afghanistan. In India, wheat is grown on an area of 30.55 million ha (13.43% of global area) with the production of 107.18 million tonnes and productivity of

3508 kg/ha. (Annual Report of IIW&BR, Karnal, 2021). It is mostly grown in Northern, North Western and Central India. Major wheat growing states in India are Uttar Pradesh, Punjab, Haryana, Madhya Pradesh, Rajasthan, Bihar and Gujarat.

Heterosis in wheat can be accomplished through the development and identification of high performance of vigorous parental lines and their subsequent evaluation for combining ability in cross combinations to identify hybrids with high heterotic effects. Manipulation of heterosis is an important strategy for increasing the yield potential of wheat (Rauf *et al.*, 2012). Wheat production can be enhanced through the development of new cultivars having wider genetic base and better performance under various agro-climatic conditions. Hybrid wheat technology can play an effective role in enhancing grain production (Kalhoro *et al.*, 2015). Therefore, the present study was conducted to evaluate the performances of 36 hybrid combinations which were developed through diallel (without reciprocals) analysis for better grain yield along with heat tolerance traits under three different environments.

MATERIAL AND METHODS

The experimental material was comprised of nine wheat genotypes and two check varieties *viz.*, RAJ 4079 and HI 1544. The genotypes were selected on the basis of their origin, adaptability, diversity and morpho-physiological characters *viz*., earliness, high yield potential and heat tolerance. These 9 genotypes were crossed in diallel without reciprocals design to develop a total thirty six crosses during *Rabi* 2019-20. All 47 genotypes (9 parents, 36 crosses and 2 checks) were evaluated in randomized block design with three replications and three different environments during *Rabi* 2020-21 at Department of Genetics and Plant Breeding, Rajasthan College of Agriculture (RCA), Udaipur. Plant to plant and row to row distance was maintained 10 cm and 23 cm, respectively and row length was 3 meter. Three different environments were created by sowing the experimental material in three different dates as early sown (15-20 October), normal sown (10-15 November) and late sown (10-15 December). Observations were recorded on five competitive plants from each genotype were randomly selected in all the environments. Heterobeltiosis and economic heterosis were calculated according to the method suggested by Fonseca and Patterson (1968) and Meredith and Bridge (1972), respectively.

RESULTS AND DISCUSSION

The pooled analysis for above characters revealed that mean squares due to environments, genotypes, parents, crosses as well as parents *v/s.* crosses were significant indicating presence of overall heterosis for these traits. Mean squares due to genotypes x environments interactions were significant for all the characters above characters reflecting the influence of different environments on the expression of genotypes.

The mean squares due to crosses x environments were significant for above characters indicated that crosses interacted differentially with different environments for these characters. The mean squares due to parents x environments were significant for proline content and total chlorophyll content. This suggested that parents performed differentially in different environments for the characters. Similar results were also reported by Lohithaswa *et al.,* (2014), Singh *et al.,* (2014), Ismail and Samier (2015), Kumar *et al.,* (2017) and Singh *et al.,* (2018).

Days to 50 per cent flowering

Maximum negative significant heterobeltiosis was expressed by GW 451 X JW 3336 in E_1 (-8.15%), E_2 (-5.41%) and GJW 463 X JW 3336 in E_3 (-3.32%). Cross, GW 451 X JW 3336 was expressed maximum (-5.39%) negative significant heterobeltiosis for this trait on pooled basis. The negative significant economic heterosis were expressed by cross GW 451 x JW 3336 (-4.89%), GW 451 x LOK 1 (-4.00%), GW 451 x RAJ 3777 (-3.11%) and GW 451 x HI 1620 (-2.22%) in E_1, HD 2967 x RAJ 3777 and GJW 463 x RAJ 4120 in E_2 (1.88%). On pooled basis GW 451 x LOK 1 (-1.87%) reported maximum negative significant economic heterosis over the best check variety HI 1544.

Flag leaf area

Flag leaf area helps to increase the grain yield in stressed environments. The range of significant positive heterobeltiosis varied from 3.09% (GJW 463 x JW 3336) to 18.79% (GJW 463 x RAJ 4120) in E_1, 3.00% (DBW 173 x LOK 1) to 19.30% (GJW 463 x RAJ 4120) in E_2 and 4.34% (RAJ 4120 x JW 3336) to 17.91% (GJW 463 x RAJ 4120) in E_3 environment for Flag leaf area. The maximum magnitude of heterobeltiosis was observed in cross GJW 463 x RAJ 4120 (18.68%) on the basis of pooled analysis. DBW 173 x RAJ 4120 in E1, E2 and pooled basis while GJW 463 x RAJ 4120 in all the environments as well as pooled basis exhibited significant positive economic heterosis over best check RAJ 4079 for this trait.

Total protein content in grains

Three, four and two crosses in E_1, E_2 and E_3 environments, respectively expressed significant economic heterosis. Three crosses *viz.* DBW 173 x RAJ 4120 (3.51%), GW 451 x RAJ 4120 (4.22%) and DBW 173 x GW 451 (4.95%) were found significant positive economic heterosis over the best check variety RAJ 4079 over the environments for this trait. Economic heterosis was ranged from DBW 173 x RAJ 4120 (3.51%) to DBW 173 x GW 451 (4.95%) on pooled basis for this trait

Heat injury

Two crosses in E_1 *viz.*, HD 2967 x GW 451 (-7.41%) and DBW 173 x GW 451 (-2.19%), one cross in E_2 *viz.*, HD 2967 x GW 451 (-6.46%) were expressed negative significant better parent heterosis for this trait. On pooled basis only one cross HD 2967 x GW 451 (-4.73%) had negative significant heterobeltiosis.

Proline content

Maximum heterosis over better parent was expressed by Cross GW 451 x RAJ 3777 (10.81%) and DBW 173 x RAJ 4120 (10.59%) in E_1, JW 3336 x HI 1620 (10.25%) in E_2, DBW 173 x RAJ 4120 (30.95%) in E_3. Nine crosses were observed significant positive heterosis over better parent on the basis of pooled analysis. Among them, DBW 173 x RAJ 4120 was exhibited maximum heterobeltiosis (15.65%) for this trait.

Positive significant economic heterosis expressed by cross DBW 173 x RAJ 3777 in E_1 (9.52%), GJW 463 x DBW 173 in E_2 (9.63%) and E_3 (15.28%) environment. On pooled basis, six crosses showed significant positive economic heterosis for this trait. Among them GJW 463 x DBW 173 depicted maximum heterosis (10.01%) over the best check RAJ 4079.

Total chlorophyll content

Two crosses *viz.*, GJW 463 x RAJ 4120 (32.47%) and GW 451 x RAJ 3777 (31.20%) in E_1, while GJW 463 x RAJ 4120 (21.54%) and GJW 463 x RAJ 3777 (15.32%) in E3 were expressed positive significant heterobeltiosis for this trait.

Similar findings were reported by Desale and Mehta (2013), Barot *et al.*, (2014), Kalhoro *et al.*, (2015), Thomas *et al.*, (2017), Patel (2018), Kumar *et al.* (2019), Dhoot *et al.*, (2020), Joshi and Kumar (2020) and Singh *et al.*, (2020) for above traits in wheat.

Conclusion

It may be concluded that out of 36 crosses 5 crosses *viz.*, GJW 463 x RAJ 4120, DBW 173 x RAJ 4120, GJW 463 x DBW 173, GW 451 x LOK 1 and DBW 173 x RAJ 3777 were found superior with maximum significant heterobeltiosis and economic heterosis for heat tolerant traits and earliness over the environments. These genotypes could be used to maintain transgressive segregants in future breeding programme.

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Table 1. Pooled Analysis of variance for various traits in wheat

SN	Characters	Env	Rep/Env	Genotype	Parents	F1	P vs F1	GxE	PxE	F1xE	PvsF1xE	Pool Error
1	**Days to 50 per cent flowering**	1593.53**	1.18	14.61**	9.64**	16.09**	2.30	4.29**	1.63*	4.91**	4.18**	0.83
2	**Heat injury (%)**	755.74**	0.67**	57.99**	43.92**	50.97**	416.39**	1.17**	1.34**	1.01**	5.70**	0.16
3	**Proline content (µg/100mg)**	923.20**	0.24**	28.85**	33.38**	25.69**	102.94**	1.60**	2.06**	1.48**	2.22**	0.03

4	**Total Chlorophyll content (mg/g)**	276.81**	0.21**	30.11**	12.01**	30.88**	147.70**	0.68**	0.90**	0.46**	6.61**	0.04

*, ** Significant at 5 and 1 per cent, respectively.

Table 2. Maximum desirable significant heterosis over better parent (BP) and standard check for days to 50 per cent flowering, heat injury, proline content and total chlorophyll content on pooled basis

Characters	**Maximum heterobeltiosis**	**Maximum economic heterosis**
Days to 50 per cent flowering	GW 451 x JW 3336 (-5.39%)	GW 451 x LOK 1 (-1.87%)
Heat injury	HD 2967 x GW 451 (-4.73%)	
Proline content	DBW 173 x RAJ 4120 (15.65%)	GJW 463 x DBW 173 (10.01 %)
Total chlorophyll content	GJW 463 x RAJ 4120 (27.19 %)	