Heterosis for Earliness and Heat Tolerant Trait in Bread Wheat [Triticum aestivum (L.)] over the Environments

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A B S T R A C T

Tools for yield prediction are requisite to any successful heterosis breeding program. In this study, heterosis was evaluated by 42 crosses develop by line x tester design (14 lines and 3 testers) along with 2 checks in RBD with 3 replications in wheat for earliness and heat tolerant traits viz., days to 50 per cent flowering, 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 these traits. Out of forty two crosses, six crosses for days to 50 per cent flowering, 1 cross for heat injury, 2 crosses for proline content and 3 crosses for total chlorophyll content expressed desirable significant better-parent heterosis. In case of economic heterosis, one different cross showed desirable significant economic heterosis for days to 50 per cent flowering, heat injury and proline content.

Keywords
better parent heterosis, economic heterosis, heat tolerant traits, wheat

Introduction

Bread wheat [Triticum aestivum (L.) em. Thell] is the most important food crop in the world which belongs to genus Triticum and family Poaceae. The species of genus Triticum which the cultivated wheat belongs are divided into diploid, tetraploid and hexaploid groups, with chromosome number 2n=14, 28 and 42, respectively. These 21 chromosomes of the hexaploid wheat have been divided into seven homeologous group, each homologous group having a partially homologous chromosome from each of the A, B, and D genomes.

Heterosis is common in self-pollinated crops such as wheat, providing an option for
commercial utilization of wheat (Singh et al., 2004). According to Rauf et al., (2012) manipulation of heterosis is an important strategy for increasing the yield potential of wheat. The genetic improvement in wheat genotypes for high yielding potential is a dire need. For fulfill this purpose, the exploitation of maximum genetic potential from available desirable genetic resources of wheat is a pre-requisite.

Materials and Methods

The experimental material comprised of seventeen wheat genotypes (14 lines and 3 testers) and two check varieties viz., MP 3288 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 genotypes were crossed in Line × Tester design to develop a total forty two crosses during rabi 2016-17. All the 61 genotypes (17 parents, 42 crosses and 2 checks) were evaluated in a randomized block design with three replications in three different environments during rabi 2017-18 at Department of Genetics and Plant Breeding, Rajasthan College of Agriculture (RCA), MPUAT, Udaipur. Each genotype was accommodated in one row plot of 3 meter length. Row to row and plant to plant distances were 22.5 cm and 10 cm, respectively.

Heterobeltiosis and economic heterosis, expressed as per cent deviation toward desirable direction over better parent and standard check, respectively. 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 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 these characters.

The mean squares due to parents v/s crosses x environments were significant for only proline content suggested that the average performance of crosses was different from that of the parents in different environments and existence of overall heterosis for these traits. Similar results were also reported by Ameen 2012, Barot et al., 2013, Lohithaswa et al., 2014, Singh et al., 2014, Ismail 2015, Jat et al., 2015, Verma et al., 2016, Kumar et al., 2017 and Singh et al., 2018.

Days to 50 per cent flowering

Among parents, DBW-71 and Raj 4120 found earliest in E₁ (75.33 days), while Raj 4120 also expressed minimum days to 50 per cent flowering in E₂ (73 days) and E₃ (68.33 days). Among crosses, earliest flowering was observed for HUW-677 x RAJ 4037 in E₁ (71 days); HS-547 x RAJ 4037, HUW-677 x RAJ 4037 and DBW-179 x RAJ 4079 in E₂ (69.67
days) and GW-463 x RAJ 4120 and HPW-360 x RAJ 4037 in E3 (67.33 days). On pooled basis, parent RAJ 4120 showed minimum days to 50 per cent flowering (72.22 days) followed by parent DBW-71 and RAJ 4037 (73.11 days), parents DBW 129 and RAJ 4079 (73.67 days). While among crosses, cross HS-547 x RAJ 4037 expressed minimum days to 50 per cent flowering (70.22 days) followed by cross HUW 677 x RAJ 4037 (70.33 days), HS 595 x RAJ 4037 (70.67 days) and HPW 360 x RAJ 4037 (70.78 days).

The estimates of heterobeltiosis for days to 50 per cent flowering revealed that out of forty two crosses, 5, 7, 6 crosses exhibited negative significant heterobeltiosis in E1, E2 and on pooled basis respectively. Maximum negative significant heterobeltiosis for days to 50 per cent flowering expressed by HUW-677 x RAJ 4037 (-7.79 %) in E1, crosses HS-547 x RAJ 4037, HUW-677 x RAJ 4037, DBW-179 x RAJ 4079 (-5.00%) in E2 and HS-547 x RAJ 4037 (-3.95%) on pooled basis. While none of the crosses exhibited negative significant heterobeltiosis in E3 environment. The magnitude of heterobeltiosis for this trait varied from -3.95% (HS-547 x RAJ 4037) to -2.26 % (HUW-677 x RAJ 4079) on pooled basis. The negative significant economic heterosis for days to 50 per cent flowering was expressed by cross HUW-677 x RAJ 4037 (-5.33%) in E1 and HS-547 x RAJ 4037 (-1.71%) over the earliest check HI-1544 on pooled basis.

**Heat injury**

Among parents, minimum mean values for heat injury were recorded for parent HPW-360 in E1 (30.03%) and E2 (32.3%), while parent RAJ 4120 in E3 (34.02 %). Among crosses, cross HS-595 x RAJ 4120 in E1 (29.73 %), cross HPW-360 x RAJ 4120 in E2 (31.06 %) and cross HS-595 x RAJ 4037 in E3 (32.52%) had minimum heat injury. On pooled basis parent HPW-360 had minimum heat injury (32.68%) followed by RAJ-4120 (32.73%), DBW-17 (32.94%) and HPW-368 (32.98%). While among crosses, cross HPW-360 x RAJ 4120 had minimum mean value for heat injury (31.23%) followed by cross HS-595 x RAJ 4037 (31.28%) and cross HS-595 x RAJ 4120 (32.56%).

One cross HS-595 x RAJ 4037 was expressed negative significant heterobeltiosis for heat injury in E3 with magnitude of -9.40%. Heterobeltiosis was negative significant for cross HS-595 x RAJ 4037 over the environments with magnitude of -8.58% for heat injury. The negative significant economic heterosis was exhibited by only one cross HPW-360 x RAJ 4120 (-4.39%) over the best check MP 3288 for this trait on pooled basis.

**Proline content**

Among parents PBW-701 in E1 (18.06 µg) and HS-595 in E2 (21.69 µg), E3 (24.34µg) had maximum mean values for proline content. Similarly, among crosses PBW-701 x RAJ 4120 in E1 (18.67 µg), HS-595 x RAJ 4120 in E2 (21.07 µg) and HUW-677 x RAJ 4037 in E3 (27.74 µg) showed maximum proline content. Parent HS-595 showed maximum mean values for proline content (21.31µg) on pooled basis followed by PBW- 701 (20.57 µg), HPW-360 (19.10 µg) and DBW-93 (18.86 µg). Among crosses, cross HS-595 x RAJ 4120 (21.86 µg) followed by PBW-701 x RAJ 4120 (21.36 µg) and HUW-677 x RAJ 4037 (21.07 µg) expressed maximum mean values for proline content. The range of proline content over the environments for parents varied from 13.04 µg (HPW-368) to 21.69 µg (HS-595) and in crosses from 11.26 µg (HPW-368 x RAJ 4079) to 21.86 µg (HS-595 x RAJ 4120).
Heterosis over better parent was significant for 2, 1 and 6 crosses in E1, E2 and E3, respectively. The maximum positive significant heterobeltiosis for proline content was depicted by cross HUW-677 x RAJ 4037 in E1 (9.59 %) and E3 (28.11 %) whereas cross DBW 179 x RAJ 4079 (8.92 %) in E2. On pooled basis, 2 crosses viz., HUW 677 x RAJ 4037 (14.97 %) and PBW-701 x RAJ 4120 (3.82 %) expressed positive significant heterobeltiosis.

For proline content, the economic heterosis was positive significant for 1, 2 and 5 crosses in E1, E2 and E3, respectively. The maximum economic heterosis was expressed by cross PBW 701 x RAJ 4120 (4.88 %) in E1, HS 595 x RAJ 4120 (5.95 %) in E2 and HUW 677 x RAJ 4037 (14.00 %) in E3 for this trait. Cross also showed positive significant economic heterosis for proline content over the best check MP 3288 on pooled basis.

**Total chlorophyll content**

The mean values for chlorophyll content for both parents and crosses were higher in environment E2 as compared to environment E1 and E3. Among parents, RAJ 4037 in E1 (1.91 mg/g), RAJ 4120 in E2 (2.2 mg/g) and HPW 360 in E3 (1.84 mg/g) showed maximum mean values for chlorophyll content. While, among crosses, cross HS-595 x RAJ 4037 was expressed maximum chlorophyll content 2.27 mg/g in E1, 2.39 mg/g in E2 and 2.12 mg/g in E3 environment. The range of chlorophyll content over the environments among parents varied from 1.03 mg/g (DBW 71) to 1.94 mg/g (HPW 360) and among crosses from 1.02 mg/g (DBW-179 x RAJ 4037 and DBW-71 x RAJ 4079) to 2.26 mg/g (HS-595 x RAJ 4037).

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

| SN | Source       | Df | Days to 50% flowering | Heat injury (%) | Proline content (µg per100 mg) | Total Chlorophyll content (mg/g) |
|----|--------------|----|-----------------------|----------------|---------------------------------|--------------------------------|
| 1. | Environment  | 2  | 2170.86**             | 1200.76**      | 2589.19**                      | 3.23**                         |
| 2. | Rep./Env    | 6  | 1.33                  | 5.86           | 0.60                           | 0.01                           |
| 3. | Genotype    | 60 | 12.29**               | 158.61**       | 59.75**                        | 0.96**                         |
|    | Parent       | 16 | 4.96**                | 116.86**       | 55.76**                        | 0.68**                         |
|    | Tester       | 2  | 4.78**                | 48.69**        | 13.94**                        | 0.01                           |
|    | Line         | 13 | 2.85**                | 127.27**       | 64.67**                        | 0.51**                         |
|    | P v/s C      | 1  | 154.36**              | 721.03**       | 14.05**                        | 0.06**                         |
|    | Cross        | 41 | 11.48**               | 158.70**       | 62.60**                        | 0.94**                         |
| 4. | G x E        | 120| 4.46**                | 6.04**         | 4.08**                         | 0.02**                         |
|    | P x E        | 32 | 2.19                  | 6.20           | 3.27**                         | 0.02**                         |
|    | T x E        | 4  | 0.89                  | 2.05           | 2.02**                         | 0.03**                         |
|    | L x E        | 26 | 2.39                  | 6.62*          | 3.14**                         | 0.02**                         |
|    | P v/s C x E  | 2  | 3.97                  | 2.22           | 11.28**                        | 0.01                           |
|    | Cross x E    | 82 | 5.47**                | 6.33**         | 3.93**                         | 0.01**                         |
| 5. | Pooled Error | 360| 2.85                  | 4.31           | 0.38                           | 0.01                           |

*, ** Significant at 5 and 1 per cent, respectively.
Table 2 Maximum desirable significant heterosis over better parent (BP) and standard check (SC) 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      | HS-547 x RAJ 4037 (-3.95%)        | HS-547 x RAJ 4037 (-1.71%) |
| Heat injury                        | HS-595 x RAJ 4037 (-8.58%)        | HPW-360 x RAJ 4120 (-4.39%) |
| Proline content                    | HUW 677 x RAJ 4037 (14.97 %)      | HS 595 x RAJ 4120 (2.95 %)  |
| Total chlorophyll content          | PBW 701 x RAJ 4120 (19.05 %)      | -                         |

Crosses 3, 1 and 3 are expressed positive significant heterosis over the better parent in $E_1$, $E_2$ and $E_3$, respectively for total chlorophyll content. The maximum heterobeltiosis was observed in cross PBW 701 x RAJ 4120 (30.74%) in $E_1$ and (24.65%) in $E_3$ while HS 595 x RAJ 4037 (15.48 %) in $E_2$ for this trait. Heterobeltiosis was significant for 3 crosses on pooled basis for total chlorophyll content with maximum magnitude of 19.05% (PBW 701 x RAJ 4120) for this trait. None of the crosses showed significant economic heterosis for this trait in any of the environments.

Similar findings were obtained by Saxena and Rawat 2011, Jain and Sastry 2012, Singh et al., 2012, Beche et al., 2013, Desale and Mehta 2013, Singh et al., 2013, Barot et al., 2014, Gogas and Sotiriou 2014, Kumar and Kerkhi 2014, Ismail 2015, Kalhor et al., 2015, Desale et al., 2016, Kumar et al., 2016, Thomas et al., 2017, Yadav et al., 2017, Patel 2018, Rajput and Kandalkar 2018, Saini et al., 2018 and Saren et al., 2018.

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