Data Article

Dataset of phenotyping recombinant inbred lines population of wheat under heat stress conditions

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\textbf{ABSTRACT}

Heat stress is a genetically complex and physiologically diverse phenomenon. To overcome the effect of heat stress identification of genomic locations associated with heat stress tolerance is essential. This article provides the dataset of phenotyping used in the research article entitled “Mapping QTLs for grain yield components in wheat under heat stress”. The presented data included the phenotyping of the 249 RIL population of F\textsubscript{8} and F\textsubscript{9} generations under timely and late sown conditions during the 2013-14 and 2014-15 crop seasons, respectively. The RIL population was derived from the cross between HUW510 and HD2808 wheat genotypes. A total of eight agronomic traits were subjected to phenotype and the heat susceptibility index (HSI) of these traits was estimated to identify the effect of heat stress on the parents and RIL population. The presented dataset could be utilized to understand the genetic basis for heat stress tolerance in wheat.

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Specifications Table

| Subject                  | Agricultural Science                                      |
|--------------------------|----------------------------------------------------------|
| Specific subject area    | Agronomy and Crop sciences                                |
| Type of data             | Tables and Figure                                         |
| How the data were acquired| Data were acquired from field observation, measurements, and sampling during the cropping period and after harvesting. The phenological traits were recorded when 50% of the plants in the plot attained the stage. GFD was measured as the period between anthesis and maturity. Grain yield was recorded by harvesting the plot. GWS and GNS were recorded by hand threshing five spikes per plot. TGW was calculated by weighing a random sample of 500 grains. GFR is the ratio between single grain weight and GFD. | |
| Data format              | Raw and analysed mean data                                 |
| Description of data collection | A mapping population of 249 RILs and parents were planted under timely sown (normal) and late sown (heat stress) conditions for two consecutive crop seasons. The heat stress condition was created by the late sowing of the complete set of RILs at F$_{8/9}$ stages during December 2013 and 2014 respectively. Data were recorded for the following traits: days to anthesis (Z64-65), days to physiological maturity (Z91–92), grain filling duration (Z64-292), grain yield (GY) (at harvesting), and post-harvest data was recorded for grain weight/main spike (GWS), grain numbers/main spike (GNS), 1000 grain weight (TGW), and grain filling rate (GFR). The heat susceptibility index (HSI) as the measure of heat tolerance for each trait was calculated using the formula given by Fischer and Maurer [1]. | |
| Data source location     | Division of crop improvement, ICAR- Indian Institute Wheat and Barley Research, Karnal, India |
| Data accessibility       | The raw dataset of this article is provided as Microsoft Excel (.xlsx) can be found in Mendeley repository data. (https://data.mendeley.com/datasets/fzv5ynzc89/1 [2]) |
| Related research article | [3] N. Bhusal, A. K. Sarial, P. Sharma, S. Sareen, Mapping QTLs for grain yield components in wheat under heat stress. PloS One, 12(12), e0189594 (2017).https://doi.org/10.1371/journal.pone.0189594 |

Value of the Data

- The presented dataset provides the performance of RILs for the different agronomic traits under normal and heat stress conditions.
- The presented dataset could help researchers to identify suitable lines for heat stress tolerance
- The data is beneficial for those researchers who are involved in the identification of the genetic basis of heat stress tolerance and the combined effect of heat and drought stress tolerance in wheat

1. Data Description

The experiment was conducted under field conditions under timely and late sown conditions during crop seasons 2013–14 and 2014–15. The descriptions of the average weekly minimum temperature, maximum temperature, and total rainfall during the crop seasons of both years were presented in Fig. 1. The obtained mean phenotyping data were used to estimate the heat susceptibility index during both years and transformed by the natural logarithm (reflected) method based on skewness ((http://www.vassarstats.net/trans1.html)). The analysis of variance
Fig. 1. Environment during the growth period.
Table 1

| Components | Genetic coefficient of variability (GCV) % | Phenotypic coefficient of variability (PCV) % | Heritability (h²) % |
|------------|------------------------------------------|---------------------------------------------|--------------------|
|            | 2013-14 | 2014-15 | 2013-14 | 2014-15 | 2013-14 | 2014-15 | 2013-14 | 2014-15 |
| DA         | TS      | LS      | TS      | LS      | TS      | LS      | TS      | LS      |
| PM         | 2.80    | 2.95    | 2.37    | 3.31    | 2.98    | 3.13    | 2.48    | 3.38    |
| GFD        | 4.70    | 5.27    | 3.77    | 4.13    | 5.08    | 5.75    | 5.25    | 4.66    |
| GFR        | 22.00   | 20.01   | 20.66   | 19.35   | 22.74   | 21.43   | 23.1    | 21.89   |
| GWS        | 20.70   | 16.8    | 19.22   | 14.8    | 21.21   | 17.98   | 21.26   | 17.06   |
| GNS        | 12.70   | 13.24   | 11.21   | 12.38   | 13.82   | 14.99   | 12.34   | 14.4    |
| TGW        | 9.60    | 8.39    | 8.49    | 6.1     | 11.88   | 10.39   | 10.48   | 7.98    |
| GY         | 24.40   | 20.59   | 20.48   | 19.53   | 25.17   | 21.81   | 22.43   | 21.88   |
| HSI-DA     | 12.79   | 8.05    | 13.66   | 9.07    | 87.68   | 78.80   |
| HSI-PM     | 9.09    | 7.04    | 9.63    | 8.52    | 88.99   | 86.26   |
| HSI-GFD    | 9.65    | 9.84    | 10.65   | 12.67   | 82.09   | 80.30   |
| HSI-GFR    | 12.71   | 17.62   | 25.90   | 23.52   | 24.07   | 56.12   |
| HSI-GWS    | 21.41   | 15.29   | 22.9    | 19.49   | 87.46   | 61.56   |
| HSI-GNS    | 18.37   | 15.95   | 21.39   | 19.12   | 73.77   | 69.60   |
| HSI-TGW    | 17.29   | 20.66   | 23.88   | 29.77   | 52.42   | 48.15   |
| HSI-GY     | 18.33   | 15.15   | 19.74   | 18.93   | 86.17   | 63.98   |

DA: Days to anthesis, PM: Days to physiological maturity, GFD: Grain filling duration, GFR: Grain filling rate, GWS: Grains weight per main spike, GNS: Grain number per main spike, TGW: Thousands grain weight, GY: Grain yield m⁻².

Based on the transformed heat susceptibility index for all the studied traits during both the crop seasons 2013–14 and 2014–15 was presented in Supplementary Table 2. The mean phenotyping data of the studied traits and HSI of these traits were separately used to analyze the genotypic coefficient of variability (GCV), phenotypic coefficient of variability (PCV), and heritability (h²) presented in Table 1. The mean performance of the studied RIL population showed the presence of RIL lines that could surpass the parental performance (transgressive segregants) for most of the studied traits and the frequency distribution of the traits was presented in Supplementary Fig. 1. The percent reduction of the traits i.e., grain filling duration (GFD), grain filling rate (GFR), grain weight per main spike (GWS), grain number per main spike (GNS), Thousand grains weight (TGW), and grain yield (GY) during both the years was presented in Fig. 2. To determine the degree of association between studied traits Pearson’s correlation coefficients were estimated. The correlation coefficients of the studied traits and the HSI of these traits were presented in Table 2. The mean phenotypic data of the studied traits and HSI of these traits (non-transformed and transformed were available at https://data.mendeley.com/datasets/fzv5ynzc89/1) [2].
Fig. 2. Percent reduction in the studied traits in parents and RIL population.
Table 2
Correlation’s coefficients of various traits of recombinant inbred lines (RILs) derived from the cross **HD 2808** (heat tolerant) and **HUWS10** (heat susceptible) of wheat.

| Traits     | DA  | PM  | GFD | GWS | GNS | TGW | GY  | GFR |
|------------|-----|-----|-----|-----|-----|-----|-----|-----|
| **During 2013-14 timely (Below diagonal) and late sown (above diagonal)** |     |     |     |     |     |     |     |     |
| DA         | 1   | 0.765** | -0.678** | -0.104* | -0.018 | -0.102* | -0.061 | 0.088* |
| PM         | 0.727** | 1   | -0.046 | -0.005 | 0.072 | -0.064 | 0.041 | 0.035 |
| GFD        | -0.460** | 0.273** | 1   | 0.156** | 0.110* | 0.086 | 0.141** | -0.096* |
| GWS        | 0.167** | 0.240** | 0.077 | 1   | 0.590** | 0.178** | 0.771** | 0.712** |
| GNS        | 0.175** | 0.162** | -0.032 | 0.584** | 1   | 0.064 | 0.501** | 0.443** |
| TGW        | 0.013 | 0.119** | 0.140** | 0.486** | 0.229** | 1   | 0.161** | 0.135** |
| GY         | 0.130** | 0.196** | 0.076 | 0.821** | 0.521** | 0.408** | 1   | 0.937** |
| GFR        | 0.206** | 0.151** | -0.090* | 0.779** | 0.507** | 0.377** | 0.951** | 1   |
| **During 2014-15 timely (Below diagonal) and late sown (above diagonal)** |     |     |     |     |     |     |     |     |
| DA         | 1   | 0.852** | -0.278** | 0.152** | 0.041 | -0.002 | 0.097* | 0.157** |
| PM         | 0.615 | 1   | 0.265** | 0.226** | 0.091* | -0.007 | 0.167** | 0.110* |
| GFD        | -0.499** | 0.377** | 1   | 0.135** | 0.091* | -0.008 | 0.128** | -0.086* |
| GWS        | 0.354** | 0.275** | -0.114* | 1   | 0.630** | 0.173 | 0.633** | 0.607** |
| GNS        | 0.301** | 0.161** | -0.177** | 0.564** | 1   | 0.018 | 0.401** | 0.381** |
| TGW        | 0.122** | 0.04 | -0.099* | 0.420** | 0.101* | 1   | 0.143** | 0.150** |
| GY         | 0.150** | 0.192** | 0.024 | 0.612** | 0.431** | 0.242** | 1   | 0.975** |
| GFR        | 0.292** | 0.113* | -0.218** | 0.632** | 0.472** | 0.261** | 0.968** | 1   |

| Traits     | DA  | PM  | GFD | GWS | GNS | TGW | GY  | GFR |
|------------|-----|-----|-----|-----|-----|-----|-----|-----|
| **HSI under 2013-14 (Below diagonal) and 2014-15 (above diagonal)** |     |     |     |     |     |     |     |     |
| DA         | 1   | 0.437** | -0.374** | 0.061 | -0.285** | -0.246** | -0.156** | -0.022 |
| PM         | 0.771** | 1   | 0.657** | 0.003 | -0.161** | -0.218** | -0.047 | -0.266** |
| GFD        | -0.516** | 0.128** | 1   | -0.049 | 0.078 | -0.006 | 0.090* | -0.245** |
| GWS        | 0.008 | 0.106* | 0.160** | 1   | 0.01 | -0.003 | 0.079 | 0.088* |
| GNS        | 0.095* | 0.165** | 0.078 | 0.073 | 1   | 0.514** | 0.611** | 0.564** |
| TGW        | 0.125** | 0.157** | 0.021 | 0.047 | 0.493** | 1   | 0.318** | 0.303** |
| GY         | 0.08 | 0.160** | 0.098* | 0.102* | 0.833** | 0.429** | 1   | 0.929** |
| GFR        | 0.199** | 0.101* | -0.164** | 0.069 | 0.715** | 0.378** | 0.824** | 1   |

**DA**: Days to anthesis, **PM**: Days to physiological maturity, **GFD**: Grain filling duration, **GFR**: Grain filling rate, **GWS**: Grains weight per main spike, **GNS**: Grain number per main spike, **TGW**: Thousands grain weight and **GY**: Grain yield m$^{-2}$.

2. Experimental Design, Materials and Methods

2.1. Plant Material

The recombinant inbred lines derived from a cross between heat tolerant and heat susceptible genotypes were used as plant material. The RIL population was developed by the author at ICAR-IIWBR Karnal. The description and the pedigree of parental genotypes were presented in Supplementary Table 1. The 249 RIL population has been generated by the advancement of the generations following the single seed descent method up to F6 generation at IIWBR, Karnal (main season), and Dalang Maidan experimental station of IIWBR, Karnal (off-season). The subsequent RILs along with parents were then evaluated during 2013–14 and 2014–15 crop seasons under timely and late sown conditions.

2.2. Evaluation for Heat Stress

The heat stress conditions were created by late sowing (mid-December) of RILs along with parents, during the 2013–14 and 2014–15 crop seasons. The daily mean maximum and mean
minimum temperatures were recorded for the characterization of environments. To observe the effect of the environment morphological data were collected using the automatic weather station (Watch Dog 2900). The daily meteorological data of both years (minimum, maximum temperature, rainfall, and relative humidity %) were available https://data.mendeley.com/datasets/fzv5ynzc89/1 [2]

3. Experimental Design

The randomized complete block design (RBD) with two replications was used as the experimental design. The plot area was 0.69m² (3 rows of 1m length and 0.23m of row spacing). All the experiments were conducted under irrigated conditions with the same planting approach in both years. The seeds of 249 RILs along with parents were hand sown in the plot. The seed rate was kept at 100 kg ha⁻¹. Standard agronomic practices were followed for conducting the experiments. The first irrigation was given at 25 days after sowing (DAS) and subsequent irrigations were given as required under both timely and late sown conditions during both years. Tilt was sprayed to protect the crop from the disease [4].

3.1. Phenotyping

The phenotyping data were recorded for following traits

a) Days to anthesis (DA) (Z64-65): Date on which anthers were extruded in >50% spikes of individual plot were recorded, to estimate the days were calculated from date of sowing to extrusion of anthers and considered as DA

b) Days to physiological maturity (PM) (Z91–92): Date on which >50% spikes of individual plot became pale yellow were recorded, to estimate the days were calculated from date of sowing to date of physiological maturity

c) Grain filling duration (GFD) (Z64-92): Days between anthesis (Z64-65) to physiological maturity (Z91–92) was estimated to obtain GFD.

d) Grain filling rate (GFR): The ratio of single kernel weight to grain filling duration was estimated to obtain GFR.

e) Grain yield (GY): The whole plant material from the individual experimental plot was harvested and threshed to obtain the grain that were weighted in g.

f) Grain weight/ main spike (GWS): At harvesting five random main spikes of individual plots were harvested, hand threshed, and weighted in g separately. The mean weight was calculated to obtain GWS.

g) Grain numbers/ main spike (GNS): As in GWS, at harvesting five random main spikes of individual plots were harvested, hand threshed, and counted separately. The mean numbers were calculated to obtain GNS.

h) Thousand grain weight (TGW): The random samples of 500 grains from plot yield of each genotype was counted and weighed in g. TGW was measured by taking multiplying the obtained weight by two.

i) Heat susceptibility index (HSI): The mean data of each genotype under timely sown and late sown conditions for each trait were used to obtain HSI of the traits using the formula given by Fischer and Maurer [1] as \([1-(Xh/Yh)]/ [1-(X/Y)]\) where, Xh and Yh are the phenotypic means for each genotype under heat stress and control condition and X and Y are the phenotypic means for all the genotypes together under heat stress and control conditions, respectively.
3.2. Statistical Analysis

The obtained data were subjected to statistical analysis using software CROPSTAT 7.2 [5] and SAS 9.3 (SAS Institute Inc., Cary, NC) [6]. The coefficient of correlations of mean data was computed using SAS 9.3 software. The mean data of studied traits under timely and late sown were presented in the supplementary table 1 of (Bhusal et al. 2017).

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Supplementary Fig. 1: Frequency distribution of studied traits in RIL population under timely and late sown conditions

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

Dataset of phenotyping recombinant inbred lines population of wheat under heat stress conditions (Original data) (Mendeley Data).

CRediT Author Statement

Nabin Bhusal: Investigation, Writing – original draft; Ashok Kumar Sarial: Conceptualization, Methodology, Supervision, Writing – review & editing; Pradeep Sharma: Conceptualization, Methodology; Sindhu Sareen: Conceptualization, Funding acquisition, Investigation, Methodology, Project administration, Writing – review & editing.

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Supplementary Materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.dib.2022.108772.

References

[1] R.A Fischer, R. Maurer, Drought resistance in spring wheat cultivars. I. Grain yield responses, Austr. J. Agric. Res. 5 (1978) 897–912.
[2] N. Bhusal, A.K. Sarial, P. Sharma, S. Sareen, Dataset of phenotyping recombinant inbred lines population of wheat under heat stress conditions, Mendley Data (2022) v1, doi:10.17632/fzv5ynzc89.1.
[3] N. Bhusal, A.K. Sarial, P. Sharma, S. Sareen, Mapping QTLs for grain yield components in wheat under heat stress, PLoS One 12 (12) (2017) e0189594, doi:10.1371/journal.pone.0189594.
[4] N. Bhusal, A.K. Sarial, R.P. Saharan, R. Munjal, B.K. Meena, S. Sareen, Phenotyping of RIL population derived from heat tolerant and susceptible parents for grain yield and its components in wheat under terminal heat stress, Adv. Life Sci. 12 (2016) 5021–5028.

[5] International Rice Research Institute (IRRI) CROPSTAT for Windows, version 7.2, International Rice Research Institute, Manila, the Philippines, 2007.

[6] SAS Institute Version 9.3, SAS Institute, Cary, 2014.