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Dataset: Eleven commercial wheat cultivars for water and saline stress studies

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Abstract: Wheat is a vital crop for global food security, but its productivity is increasingly threatened by water and salinity stress, exacerbated by climate change. These environmental challenges affect wheat growth at multiple stages, leading to reduced germination, stunted development, and lower yields. Given that over 20% of cultivated land worldwide is affected by salinity, there is an urgent need to develop saline stress-tolerant wheat cultivars. This study presents a dataset of 11 commercial wheat cultivars, with a focus on their responses to water and salinity stress. The dataset includes comprehensive measurements such as germination rate, shoot and root length, and biomass under control, water, and saline conditions. By analyzing these data, researchers can better understand the genetic and phenotypic traits associated with drought and salinity tolerance. This research offers valuable insights into breeding strategies aimed at enhancing stress resistance, contributing to the development of wheat varieties capable of withstand harsh environmental conditions and ensuring global food security. This dataset provides a foundation for further exploration into the mechanisms of stress tolerance in wheat and opens new avenues for improving agricultural sustainability.

Keywords: *Triticum aestivum* L.; sustainability; food security; agriculture.

1. Introduction

Wheat (*Triticum aestivum* L.), a staple food for a significant portion of the global population, faces increasing challenges due to abiotic stresses such as drought and salinity. These stresses, exacerbated by climate change, significantly impact wheat productivity, leading to concerns about food security. The development of wheat cultivars that are resilient to these environmental challenges is crucial for sustainable agriculture and global food production.

Water and salinity stress can adversely affect wheat growth and development at various stages, leading to reduced germination rates, stunted growth, impaired photosynthesis, and ultimately, reduced yield (Nezhadahmadi et al., 2013; Sallam et al., 2019). Salt stress, in particular, affects more than 20% of cultivated land worldwide, posing a significant threat to wheat production (Hasanuzzaman et al., 2017). Both water and salinity stress can disrupt plant physiology, leading to changes in water relationships, ion balance, nutrient uptake, and antioxidant defense systems (Poudel & Poudel, 2020).

To address these challenges, researchers have focused on understanding the mechanisms underlying wheat tolerance to water and salinity stress and developing strategies to increase tolerance. Various approaches have been explored, including physiological and biochemical adaptations, breeding programs, and genetic research (Hasanuzzaman et al., 2017; Nezhadahmadi et al., 2013; Poudel & Poudel, 2020; Sallam et al., 2019; Yadav et al., 2022). These studies revealed that wheat can respond various of stresses, such as stomatal closure, osmoprotectant accumulation, and antioxidant defense system activation.

Despite these advances, the development of wheat cultivars with robust tolerance to water and salinity stress remains a complex challenge. This is due to the polygenic nature of these traits and the complex interactions between genetic factors and environmental conditions. However, the availability of a comprehensive database of wheat cultivars subjected to these stresses can significantly accelerate research efforts and facilitate the development of new and improved cultivars.

This paper presents a dataset of 11 wheat cultivars whose response to water and salinity stress has been evaluated. This dataset provides a valuable resource for researchers studying cultivar selection, stress analysis, and the development of tools and methodologies for sustainable agriculture. By understanding the genetic and phenotypic variation among these cultivars, researchers can identify key traits associated with stress tolerance and develop breeding strategies to incorporate these traits into new cultivars and approaches to managing agricultural product complements to address deficiencies resulting from stresses. In addition, this dataset can contribute to the development of new and improved cultivars that are better adapted to the challenges of climate change and ensure food security for future generations.

2. The experiment

2.1 Plant material and stress treatments

Seeds from a total of 11 commercial wheat cultivars (*Triticum aestivum* L.) recommended for the Brazilian Cerrado region were used. Before the experiment began, the water content, thousand seed weight, germination rate, and emergence rate were determined as previously described in the Official Rules for Seed Analysis (MAPA, 2009). The results obtained for the 11 wheat cultivars are shown in Table 1.

Table 1. Agronomic characteristics, water content, thousand-seed mass and germination rate of the 11 Brazilian wheat cultivars used in this study.

Cultivar	Agronomic characteristics	Water content (%)	1,000-seed weight (g)	Germination rate (%)	Emergence rate (%)
	Cycle				
Tbio Aton	Mean	12.7	37.88 b	95 a	100 a
Tbio Sintonia	Early	12.5	32.55 e	86 a	82 d
BRS 404	Early/Mean	12.8	38.73 b	89 a	92 b
BRS 264	Super Early	12.7	36.13 d	92 a	100 a
Tbio Calibre	Super Early	12.5	35.05 d	88 a	100 a
Bio 190057	Mean/Early	12.6	37.08 c	83 b	100 a
Tbio Duque	Early	12.9	34.68 d	91 a	100 a
Bio 190038	Early	12.7	37.20 c	79 b	100 a
Tbio Sossego	Mean	12.6	34.90 d	88 a	100 a
Ors Feroz	Super Early	12.5	40.10 a	94 a	100 a
Tbio Convicto	Mean/Late	12.8	40.33 a	82 b	84 c

The means followed by distinct letters on the columns for the soybean cultivars are significantly different according to the Scott–Knott test at the 0.05 level of confidence.

To compare the effects of water or salt stress on germination rates and seedling growth rates, the seeds of each wheat cultivar were exposed to -0.30 MPa iso-osmotic solutions with polyethylene glycol (PEG-6000) or NaCl. The amount of PEG-6000 added to obtain a solution with an osmotic pressure of -0.20 MPa was determined via the following equation [12]: $\Psi s = [-(1.18 \times 10^{-2})C - (1.18 \times 10^{-4})C^2 + (2.67 \times 10^{-4})CT + (8.39 \times 10^{-7})\,C^2T]/10$, where Ψs is the osmotic potential (MPa); C is the concentration (g L^{-1} PEG-6000 in water); and T is the temperature (°C). The NaCl concentration added to obtain an osmotic pressure of –0.20 MPa was calculated via the van't Hoff equation [13]: $\Psi s = -RTCi$, where R is the ideal gas constant (0.008314 MPa mol^{-1} K^{-1}); T is the absolute temperature (273.15 + °C); C is the concentration in molarity of the solute (mol L^{-1}); and i is the van't Hoff factor, the ratio of the number of particles in solution to the number of formula units dissolved [i.e., for NaCl, this value is 2.0 (Na^+ and Cl^-)]. As a control, a solution with an osmotic potential of $\Psi s = 0.00$ MPa was used.

2.2 Measurements of seedling growth and tolerance indices

After 12 days of exposure to water and salt stress, the shoot length, primary root length, and total seedling length were measured via a meter scale. The shoot dry matter, root dry matter, and total seedling dry matter contents were recorded after oven drying at 65 °C for 48 h.

2.3 Variables evaluated

- **Germination:** The seeds were distributed on Germitest paper towels with a volume of distilled water (control) or PEG and NaCl solutions with an osmotic pressure of –0.3 MPa, in an amount equal to 2.5 times the dry mass of the substrate in the form of rolls. Vitavax–Thiram® was added to the solutions at a concentration of 0.2% (v/v) to control fungal infection. They were then placed in a BOD-type germinator at a temperature of 25 °C. The evaluation was carried out on the 12th day after sowing, according to the criteria established in (MAPA, 2009).
- **Shoot length, root length and total length:** Twenty normal seedlings were randomly selected after total germination (12th day) was recorded via a ruler. The shoot length was subsequently added to the root length to form the total length.
- **Shoot dry mass, root dry mass and total dry mass:** All the seedlings obtained at the end of the germination period (12 days) were separated into shoots and roots, dried in an oven at 65°C for three days and then weighed. The total dry matter was obtained from the sum of the dry matter of the shoots and roots.

2.4 Experimental design and statistical data analyses

The experiment was arranged in a completely randomized design, in a 3×11 factorial design, with three osmotic stress treatments (control, saline or water stress) and eleven wheat cultivars, with four replications.

3. Data Description

For each cultivar, there were four replications in each treatment. Therefore, there are $11 \times 4 \times 3 = 132$ data samples. The data are organized in tabular form. The columns are "Cultivar", "Stress", "Repetition", "Germination", "Shoot length", "Root length", "Total length", "Shoot dry mass", "Root dry mass" and "Total dry mass". Table 3 shows the data types. Table 4 shows an example of the dataset for one cultivar only. Table 5 provides a statistical summary of the dataset.

Table 3. Data types and values assumed in the dataset.

Column	Data type	Values
Stress	Categorical	Control, Saline, Water
Cultivar	Categorical	Cultivar names according to Table 2.
Repetition	Integer	1, 2, 3 or 4
Germination, Shoot length, Root length, Total length, Shoot dry mass, Root dry mass, Total dry mass	Continuous	Ranging from 2.90 to 100.00

Table 4. Example dataset for the "Tbio Aton" cultivar.

Cultivar	Stress	Rep.	Germination	Shoot length	Root length	Total length	Shoot dry mass	Root dry mass	Total dry mass
Tbio Aton	Control	1	100	13.28	5.18	18.47	10.54	4.83	15.37
Tbio Aton	Control	2	94	12.30	5.00	17.30	10.72	4.53	15.26
Tbio Aton	Control	3	88	13.82	5.01	18.84	13.22	4.34	17.56
Tbio Aton	Control	4	96	13.24	5.01	18.25	13.93	6.20	20.13
Tbio Aton	Saline	1	80	11.14	4.13	15.27	9.56	4.19	13.75
Tbio Aton	Saline	2	92	11.13	3.75	14.88	10.36	3.75	14.12
Tbio Aton	Saline	3	84	13.5	4.73	18.23	10.96	3.58	14.55
Tbio Aton	Saline	4	84	12.0	4.87	16.87	10.61	3.34	13.96
Tbio Aton	Water	1	80	10.35	4.00	14.35	9.94	3.90	13.84
Tbio Aton	Water	2	80	10.18	4.88	15.06	9.94	3.90	13.84
Tbio Aton	Water	3	80	10.48	4.98	15.46	10.20	3.87	14.08
Tbio Aton	Water	4	88	9.89	4.80	14.69	9.27	3.52	12.80

"Rep." means repetition.

Table 5. Dataset summary with approximate values to two decimal places.

	Rep.	Germination	Shoot part length	Root length	Total length	Shoot dry matter	Root dry mass	Total dry mass
mean	2.50	79.22	12.06	5.33	17.40	12.10	3.97	16.08
std	1.12	9.48	2.19	1.10	2.60	1.71	0.64	2.13
min	1.00	56.00	8.04	3.42	12.66	8.52	2.90	11.86
25%	1.75	72.00	10.41	4.47	15.58	10.87	3.37	14.28
50%	2.50	80.00	12.03	5.20	16.94	12.00	3.98	15.85
75%	3.25	84.00	13.41	6.08	18.84	13.06	4.44	17.34

"Std." means standard deviation. "Rep." means repetition.

4. Availability

The dataset is available in .csv format (separated by a comma) and as a Google Colab (Bisong, 2019) notebook with Python (Van Rossum & Drake, 2009) and Pandas (McKinney, 2010) library instructions for reading the file:

- https://archive.ics.uci.edu/dataset/1069/eleven+commercial+wheat+cultivars+for+water+and+saline+stress+studies
- https://github.com/brunobro/dataset-eleven-commercial-wheat-cultivars-for-water-and-saline-stress-studies

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6. Additional Information

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6.3 Conflicts of Interest

We declare that there are no conflicts of interest.