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Data Article

Dataset on the use of MGIDI index in screening drought-tolerant wild wheat accessions at the early growth stage

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ABSTRACT

The dataset herein indicated the novelty of the article entitled “Dataset on the use of MGIDI in screening drought-tolerant wild wheat accessions at the early growth stage”. Data were gathered during 2018–2019 on a set of wild wheat germplasm under two control and water deficit stress conditions. One hundred and forty-six accessions belonging to *Ae. tauschii*, *Ae. cylindrica*, and *Ae. crassa* were assessed under optimal glasshouse conditions to screen the drought-tolerant samples at the early growth stage. Nine drought tolerance and susceptibility indices along with the multi-trait genotype-ideotype distance index (MGIDI) were used to visualize the dataset. The obtained data can highlight the potential of the MGIDI index in accelerating screening of a large number of plant materials using multiple traits or selection indices in crop breeding programs, especially at the early growth stage.

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Specifications Table

Subject	Data analysis (Agricultural and Biological Science)
Specific subject area	Agronomy and Crop Science
Type of data	Tables and Figures
How data were acquired	Data were obtained by a study conducted under controlled greenhouse conditions on a set of wild progenitors of wheat belonging to three *Aegilops* species, such as *Ae. cylindrica, Ae. crassa*, and *Ae. tauschii*. Data tables and figures were obtained by calculating nine drought tolerance and susceptibility indices using iPASTIC software. The multi-trait genotype-ideotype distance index (MGIDI) was used to rank the accessions based on information of multiple indices. The MGIDI index was calculated in the R software using the 'metan' package.
Data format	Raw
Parameters for data collection	The conditions considered for data collection were controlled greenhouse conditions of the experiment.
Description of data collection	A total of 146 accessions of three *Aegilops* accessions were investigated under two control and water deficit stress treatments (Field capacity [FC] = 95 ± 5% and 30 ± 5%, respectively). A factorial experiment was performed in a randomized complete block design with three replications in a research greenhouse at the Agronomy and Plant Breeding Department, Tehran University, Karaj, Iran, during the 2018–2019 growing seasons. Thirty days after sowing and water deficit treatment, shoot dry biomass was recorded in all samples. Based on both dry biomass under control (Yp) and water deficit treatment (Ys) of tested samples, nine drought tolerance and susceptibility indices, including tolerance index (TOL), mean productivity (MP), geometric mean productivity (GMP), harmonic mean (HM), stress susceptibility index (SSI), stress tolerance index (STI), yield index (YI), yield stability index (YSI), and relative drought index (RSI) were calculated.
Data source location	Department of Agronomy and Plant Breeding, Agricultural College, University of Tehran, Karaj
Data accessibility	The raw data associated to this article are provided on Mendeley dataset http://dx.doi.org/10.17632/4tw2hrrdfp.1.
Related research article	[1] A. Pour-Aboughadareh, M. Omidi, M.R. Naghavi, A. Etminan, A.A. Mehrabi, P. Poczai, H. Bayat, Effect of water deficit stress on seedling biomass and physio-chemical characteristics in different species of wheat possessing the D genome, Agronomy. 9 (2019) 522. https://doi.org/10.3390/agronomy9090522

Value of the Data

- The dataset analyzed in this work indicates an overview of the potential of some wild relatives for increasing drought tolerance in wheat breeding programs. Indeed, this dataset provides information for wheat breeders on the breeding capacity of this germplasm to further studies on tolerance mechanisms and discovering new tolerance-related genes or even alleles in alien genomes.
- The presented drought tolerance and susceptibility indices are important mathematical parameters that are widely used by researchers. However, the multi-trait genotype-ideotype distance index (MGIDI) was used to make a unique index for facilitating the selection of superior genotypes.
- This dataset can highlight the applicability of the MGIDI index in accelerating the screening of a large number of plant materials using multiple traits or growth parameters in crop breeding programs, especially at the early growth stage.

1. Data Description

Climate change is expected to result in fluctuations in precipitation patterns, including enhanced severity and accelerated frequency of droughts. Under these circumstances, agricultural

Table 1
Mathematical formulas of nine drought tolerance and susceptibility indices.

No.	Index	Formula	Pattern of selection	Reference
1	Tolerance Index	$\mathrm{TOL} = \mathrm{Y_P} - \mathrm{Y_S}$	Minimum value	[8]
2	Mean Productivity	$MP = \frac{\mathrm{Y_P}+\mathrm{Y_S}}{2}$	Maximum value	[8]
3	Geometric Mean Productivity	$\mathrm{GMP} = \sqrt{\mathrm{Y_S} \times \mathrm{Y_P}}$	Maximum value	[9]
4	Harmonic Mean	$\mathrm{HM} = \frac{2(\mathrm{Y_S} \times \mathrm{Y_P})}{(\mathrm{Y_S}+\mathrm{Y_P})}$	Maximum value	[10]
5	Stress Susceptibility Index	$\mathrm{SSI} = \frac{1-(\mathrm{Y_S}/\mathrm{Y_P})}{1-(\bar{\mathrm{Y}}_\mathrm{S}/\bar{\mathrm{Y}}_\mathrm{P})}$	Minimum value	[11]
6	Stress Tolerance Index	$\mathrm{STI} = \frac{\mathrm{Y_S} \times \mathrm{Y_P}}{(\bar{\mathrm{Y}}_\mathrm{P})^2}$	Maximum value	[9]
7	Yield Index	$\mathrm{YI} = \frac{\mathrm{Y_S}}{\bar{\mathrm{Y}}_\mathrm{s}}$	Maximum value	[12]
8	Yield Stability Index	$\mathrm{YSI} = \frac{\mathrm{Y_S}}{\mathrm{Y_P}}$	Maximum value	[13]
9	Relative Stress Index	$\mathrm{RSI} = \frac{(\mathrm{Y_S}/\mathrm{Y_P})}{(\bar{\mathrm{Y}}_\mathrm{S}/\bar{\mathrm{Y}}_\mathrm{P})}$	Maximum value	[14]

production is mainly affected by water limitation. Indeed, water deficit is one of the destructive abiotic stresses that decrease crop growth and yield performance in many areas across the world [2]. Wild relatives of wheat are a valuable genetic resource that harbors many genes related to various abiotic stresses. *Aegilops* species plays an important role in wheat domestication and improvement breeding programs due to its interesting potential [3–6]. Hence, this germplasm can be a benchmark for wheat breeding programs.

The dataset is presented in two tables and two figures that describe the ability of the MGIDI index to screen for drought-tolerant accessions. Table 2 presents drought tolerance and susceptibility indices in the 146 investigated *Aegilops* accessions. Based on the indices values in Table 2, accession numbers G150, G153, G157, G160, G164, G175, G180, G183, G184, and G195 form *Ae. crassa* showed the lowest percent reduction in their shoot dry matter due to water deficit stress compared with control conditions. Table 3 shows the ranking pattern of the investigated accessions based on each calculated index. This table also shows the average sum of ranks and standard deviation of ranks (SD) through Yp, Ys, and other indices. As shown in Table 3, accession numbers G150, G153, G154, G157, G160, G164, G180, G182, G192, and G195 were selected as the top 10 tolerant accessions. Fig. 1 presents the results of screening of the investigated *Aegilops* accessions based on the MGIDI index. In Fig. 1, the red circle shows the cutpoint according to the selection pressure (SI = 10%). The MGIDI index identified 15 samples as more desirable accessions than others. Except for one accession (G71) that belongs to *Ae. tauschii*, other selected accessions belong to *Ae. crassa*. Fig. 2 shows the strengths and weaknesses view of the selected genotypes as shown as the proportion of each factor on the computed MGIDI index. Thus, the MGIDI index can identify the best drought-tolerant genotypes at the early growth stage. The raw data associated to this article are provided on Mendeley dataset.

2. Experimental Design, Materials and Methods

2.1. Plant materials

The plant materials consisted of 146 accessions form *Ae. tauschii* (DD-genome) *Ae. cylindrica* (DDCC-genome), and *Ae. crassa* (DDMM-genome). Additional information on the studied materials is shown in supplementary Table S1. These accessions were accessed from Ilam University Genbank (IUGB).

2.2. Experimental design

Before sowing, seeds of all accessions were stored to 4 °C for 72 h for break dormancy. Five seeds per accession were sown in plastic pots that were filled with a mixture of sand, soil, and humus (1:1:1). All pots were arranged in a factorial experimental based on a randomized complete block in three replications under an optimal growing photoperiod (16 h light, 8 h dark) and temperature (25 °C day, 20±2 °C night) conditions. Seedlings were exposed to the following water treatments at the three-leaf growth stage: (1) well-watered (full field capacity [FC] = 95 ± 5%) as the control and (2) water-stressed (FC = 30 ± 5%) conditions. Thirty days after sowing and applying stress treatment, shoot samples were harvested and exposed to 70 °C for 72 h to measure shoot dry matter.

2.3. Data collection

The data used in this work were collected by measuring Yp and Ys as the shoot dry matter under control and stress conditions, respectively. Nine drought tolerance and susceptibility indices (Table 1), including tolerance index (TOL), mean productivity (MP), geometric mean productivity (GMP), harmonic mean (HM), stress susceptibility index (SSI), stress tolerance index (STI), yield index (YI), yield stability index (YSI), and relative drought index (RSI), were then calculated using iPASTIC software [7].

Table 2
Calculated drought tolerance and susceptibility indices in 146 *Aegilops* accessions.

Code	Yp	Ys	RC	TOL	MP	GMP	HM	SSI	STI	YI	YSI	RSI
G1	0.73	0.32	55.63	0.41	0.53	0.48	0.45	1.01	0.55	1.09	0.44	0.99
G2	0.73	0.28	60.99	0.44	0.51	0.45	0.41	1.11	0.48	0.96	0.39	0.87
G3	0.75	0.34	54.29	0.41	0.54	0.50	0.47	0.99	0.59	1.16	0.46	1.02
G4	0.73	0.33	54.98	0.40	0.53	0.49	0.46	1.00	0.56	1.12	0.45	1.00
G5	0.69	0.30	57.02	0.39	0.49	0.45	0.42	1.04	0.48	1.01	0.43	0.95
G6	0.85	0.30	64.48	0.55	0.58	0.51	0.45	1.17	0.60	1.03	0.36	0.79
G7	0.76	0.30	60.63	0.46	0.53	0.47	0.43	1.10	0.53	1.01	0.39	0.87
G8	0.72	0.29	59.30	0.42	0.50	0.46	0.41	1.08	0.48	0.99	0.41	0.90
G9	0.69	0.27	60.38	0.42	0.48	0.43	0.39	1.10	0.44	0.93	0.40	0.88
G10	0.79	0.27	65.91	0.52	0.53	0.46	0.40	1.20	0.50	0.91	0.34	0.76
G11	0.74	0.33	55.05	0.41	0.54	0.50	0.46	1.00	0.58	1.13	0.45	1.00
G12	0.72	0.27	62.14	0.45	0.50	0.44	0.40	1.13	0.46	0.93	0.38	0.84
G13	0.74	0.38	48.71	0.36	0.56	0.53	0.50	0.89	0.65	1.28	0.51	1.14
G14	0.71	0.26	63.38	0.45	0.49	0.43	0.38	1.15	0.43	0.88	0.37	0.81
G15	0.74	0.29	60.27	0.44	0.51	0.46	0.42	1.10	0.50	0.99	0.40	0.88
G16	0.74	0.23	69.37	0.51	0.48	0.41	0.35	1.26	0.39	0.77	0.31	0.68
G17	0.70	0.26	62.30	0.43	0.48	0.43	0.38	1.13	0.42	0.89	0.38	0.84
G18	0.72	0.28	61.00	0.44	0.50	0.45	0.40	1.11	0.47	0.95	0.39	0.87
G19	0.68	0.34	50.15	0.34	0.51	0.48	0.45	0.91	0.53	1.15	0.50	1.11
G20	0.70	0.24	65.34	0.46	0.47	0.41	0.36	1.19	0.40	0.83	0.35	0.77
G21	0.70	0.39	43.71	0.31	0.55	0.53	0.50	0.80	0.64	1.34	0.56	1.25
G22	0.70	0.32	54.20	0.38	0.51	0.48	0.44	0.99	0.53	1.09	0.46	1.02
G23	0.71	0.32	55.32	0.39	0.51	0.47	0.44	1.01	0.52	1.07	0.45	0.99
G24	0.67	0.27	60.30	0.40	0.47	0.42	0.38	1.10	0.41	0.90	0.40	0.88
G25	0.73	0.30	58.98	0.43	0.51	0.47	0.42	1.07	0.51	1.01	0.41	0.91
G26	0.66	0.23	65.14	0.43	0.44	0.39	0.34	1.18	0.35	0.78	0.35	0.77
G27	0.75	0.26	64.75	0.48	0.50	0.44	0.39	1.18	0.46	0.89	0.35	0.78
G28	0.70	0.24	65.62	0.46	0.47	0.41	0.36	1.19	0.39	0.82	0.34	0.76
G29	0.66	0.25	61.93	0.41	0.46	0.41	0.37	1.13	0.39	0.85	0.38	0.85
G30	0.72	0.28	60.34	0.43	0.50	0.45	0.41	1.10	0.47	0.96	0.40	0.88
G31	0.73	0.28	61.92	0.45	0.50	0.45	0.40	1.13	0.47	0.94	0.38	0.85
G32	0.67	0.31	53.44	0.36	0.49	0.46	0.42	0.97	0.48	1.05	0.47	1.03
G33	0.65	0.25	62.33	0.41	0.45	0.40	0.36	1.13	0.37	0.83	0.38	0.84

(*continued on next page*)

Table 2 (*continued*)

Code	Yp	Ys	RC	TOL	MP	GMP	HM	SSI	STI	YI	YSI	RSI
G34	0.73	0.24	66.62	0.48	0.48	0.42	0.36	1.21	0.41	0.82	0.33	0.74
G35	0.85	0.32	62.85	0.53	0.58	0.52	0.46	1.14	0.62	1.07	0.37	0.83
G36	0.64	0.25	61.15	0.39	0.45	0.40	0.36	1.11	0.37	0.84	0.39	0.86
G37	0.68	0.25	62.90	0.43	0.47	0.42	0.37	1.14	0.40	0.86	0.37	0.82
G38	0.69	0.33	52.39	0.36	0.51	0.48	0.45	0.95	0.53	1.11	0.48	1.06
G39	0.75	0.29	61.42	0.46	0.52	0.47	0.42	1.12	0.50	0.98	0.39	0.86
G40	0.71	0.32	55.16	0.39	0.51	0.47	0.44	1.00	0.52	1.07	0.45	1.00
G41	0.72	0.33	54.22	0.39	0.53	0.49	0.45	0.99	0.56	1.12	0.46	1.02
G42	0.68	0.31	55.34	0.38	0.49	0.46	0.42	1.01	0.48	1.03	0.45	0.99
G43	0.72	0.26	63.64	0.46	0.49	0.43	0.38	1.16	0.43	0.88	0.36	0.81
G44	0.70	0.27	61.23	0.43	0.49	0.44	0.39	1.11	0.44	0.92	0.39	0.86
G45	0.68	0.34	50.29	0.34	0.51	0.48	0.45	0.91	0.53	1.15	0.50	1.10
G46	0.70	0.28	60.23	0.42	0.49	0.44	0.40	1.10	0.45	0.94	0.40	0.88
G47	0.68	0.35	49.49	0.34	0.51	0.49	0.46	0.90	0.55	1.17	0.51	1.12
G48	0.68	0.29	56.64	0.38	0.49	0.45	0.41	1.03	0.46	1.00	0.43	0.96
G49	0.82	0.27	66.99	0.55	0.55	0.47	0.41	1.22	0.52	0.92	0.33	0.73
G50	0.59	0.14	76.24	0.45	0.36	0.29	0.22	1.39	0.19	0.47	0.24	0.53
G51	0.67	0.19	71.28	0.48	0.43	0.36	0.30	1.30	0.30	0.65	0.29	0.64
G52	0.67	0.16	75.63	0.51	0.42	0.33	0.26	1.38	0.26	0.56	0.24	0.54
G53	0.63	0.18	70.98	0.45	0.41	0.34	0.29	1.29	0.27	0.62	0.29	0.64
G54	0.78	0.23	70.23	0.55	0.50	0.42	0.36	1.28	0.42	0.78	0.30	0.66
G55	0.61	0.17	71.92	0.44	0.39	0.32	0.27	1.31	0.24	0.58	0.28	0.62
G56	0.61	0.19	69.06	0.42	0.40	0.34	0.29	1.26	0.27	0.64	0.31	0.69
G57	0.55	0.30	45.72	0.25	0.42	0.40	0.39	0.83	0.38	1.01	0.54	1.21
G58	0.55	0.18	66.42	0.36	0.37	0.32	0.28	1.21	0.23	0.62	0.34	0.75
G59	0.54	0.21	60.71	0.33	0.37	0.34	0.30	1.10	0.26	0.72	0.39	0.87
G60	0.50	0.29	41.77	0.21	0.39	0.38	0.37	0.76	0.34	0.98	0.58	1.29
G61	0.57	0.19	67.02	0.38	0.38	0.33	0.28	1.22	0.25	0.63	0.33	0.73
G62	0.64	0.21	67.29	0.43	0.42	0.37	0.31	1.22	0.31	0.71	0.33	0.73
G63	0.61	0.20	66.94	0.41	0.40	0.35	0.30	1.22	0.28	0.68	0.33	0.73
G64	0.59	0.16	72.74	0.43	0.37	0.31	0.25	1.32	0.22	0.54	0.27	0.61
G65	0.65	0.16	75.69	0.49	0.40	0.32	0.25	1.38	0.24	0.54	0.24	0.54
G66	0.65	0.21	67.85	0.44	0.43	0.37	0.31	1.23	0.31	0.70	0.32	0.71
G67	0.67	0.18	73.76	0.49	0.42	0.34	0.28	1.34	0.27	0.59	0.26	0.58
G68	0.59	0.17	71.09	0.42	0.38	0.32	0.26	1.29	0.23	0.58	0.29	0.64
G69	0.54	0.19	64.86	0.35	0.36	0.32	0.28	1.18	0.23	0.64	0.35	0.78
G70	0.51	0.19	62.89	0.32	0.35	0.31	0.28	1.14	0.23	0.64	0.37	0.82
G71	0.55	0.17	69.64	0.38	0.36	0.30	0.26	1.27	0.21	0.57	0.30	0.67
G72	0.63	0.20	68.62	0.43	0.41	0.35	0.30	1.25	0.29	0.67	0.31	0.70
G73	0.70	0.14	79.57	0.55	0.42	0.31	0.24	1.45	0.23	0.48	0.20	0.45
G74	0.61	0.15	74.88	0.45	0.38	0.30	0.24	1.36	0.21	0.52	0.25	0.56
G75	0.55	0.19	65.70	0.36	0.37	0.32	0.28	1.19	0.24	0.64	0.34	0.76
G76	0.59	0.18	68.77	0.40	0.38	0.33	0.28	1.25	0.25	0.62	0.31	0.69
G77	0.54	0.17	69.32	0.38	0.35	0.30	0.25	1.26	0.21	0.56	0.31	0.68
G78	0.54	0.17	69.27	0.37	0.35	0.30	0.25	1.26	0.21	0.56	0.31	0.68
G79	0.55	0.18	67.52	0.37	0.36	0.31	0.27	1.23	0.23	0.60	0.32	0.72
G80	0.58	0.27	53.57	0.31	0.42	0.39	0.36	0.97	0.36	0.90	0.46	1.03
G81	0.57	0.21	63.33	0.36	0.39	0.35	0.31	1.15	0.28	0.71	0.37	0.81
G82	0.63	0.19	70.29	0.44	0.41	0.34	0.29	1.28	0.27	0.63	0.30	0.66
G83	0.56	0.23	58.09	0.32	0.39	0.36	0.33	1.06	0.30	0.79	0.42	0.93
G84	0.61	0.24	60.56	0.37	0.43	0.38	0.35	1.10	0.34	0.82	0.39	0.88
G85	0.61	0.25	59.54	0.37	0.43	0.39	0.35	1.08	0.35	0.84	0.40	0.90
G86	0.64	0.20	67.87	0.43	0.42	0.36	0.31	1.23	0.30	0.69	0.32	0.71
G87	0.56	0.24	56.89	0.32	0.40	0.37	0.34	1.03	0.31	0.82	0.43	0.96
G88	0.56	0.23	59.79	0.34	0.39	0.36	0.32	1.09	0.30	0.77	0.40	0.89
G89	0.54	0.18	66.85	0.36	0.36	0.31	0.27	1.22	0.22	0.61	0.33	0.74
G90	0.53	0.25	53.23	0.28	0.39	0.36	0.34	0.97	0.30	0.83	0.47	1.04
G91	0.54	0.20	63.36	0.34	0.37	0.32	0.29	1.15	0.24	0.66	0.37	0.81
G92	0.62	0.21	66.83	0.42	0.42	0.36	0.31	1.22	0.30	0.70	0.33	0.74
G93	0.59	0.23	61.02	0.36	0.41	0.37	0.33	1.11	0.32	0.78	0.39	0.87

(*continued on next page*)

Table 2 (*continued*)

Code	Yp	Ys	RC	TOL	MP	GMP	HM	SSI	STI	YI	YSI	RSI
G94	0.55	0.18	67.76	0.37	0.36	0.31	0.27	1.23	0.23	0.60	0.32	0.72
G95	0.63	0.17	72.48	0.45	0.40	0.33	0.27	1.32	0.25	0.58	0.28	0.61
G96	0.64	0.22	66.41	0.43	0.43	0.37	0.32	1.21	0.32	0.73	0.34	0.75
G97	0.55	0.25	53.83	0.30	0.40	0.37	0.35	0.98	0.32	0.86	0.46	1.03
G98	0.68	0.33	51.75	0.35	0.51	0.48	0.45	0.94	0.53	1.12	0.48	1.07
G99	0.71	0.40	43.86	0.31	0.55	0.53	0.51	0.80	0.66	1.35	0.56	1.25
G100	0.65	0.45	30.15	0.20	0.55	0.54	0.53	0.55	0.69	1.54	0.70	1.55
G101	0.60	0.38	37.33	0.22	0.49	0.47	0.46	0.68	0.53	1.27	0.63	1.39
G102	0.79	0.40	49.62	0.39	0.59	0.56	0.53	0.90	0.73	1.35	0.50	1.12
G103	0.62	0.43	30.63	0.19	0.52	0.51	0.51	0.56	0.61	1.45	0.69	1.54
G104	0.66	0.42	36.23	0.24	0.54	0.52	0.51	0.66	0.64	1.42	0.64	1.42
G105	0.76	0.40	47.63	0.36	0.58	0.55	0.52	0.87	0.70	1.35	0.52	1.16
G106	0.67	0.38	43.32	0.29	0.53	0.51	0.49	0.79	0.60	1.29	0.57	1.26
G107	0.65	0.44	31.89	0.21	0.54	0.53	0.52	0.58	0.66	1.49	0.68	1.51
G108	0.69	0.38	45.53	0.32	0.54	0.51	0.49	0.83	0.61	1.28	0.54	1.21
G109	0.66	0.36	45.92	0.30	0.51	0.49	0.46	0.84	0.55	1.21	0.54	1.20
G110	0.63	0.51	19.59	0.12	0.57	0.57	0.56	0.36	0.75	1.72	0.80	1.79
G111	0.65	0.38	40.93	0.26	0.51	0.50	0.48	0.74	0.57	1.29	0.59	1.31
G112	0.66	0.40	39.27	0.26	0.53	0.51	0.50	0.71	0.61	1.35	0.61	1.35
G113	0.74	0.39	46.94	0.35	0.56	0.54	0.51	0.85	0.67	1.32	0.53	1.18
G114	0.61	0.45	25.78	0.16	0.53	0.52	0.52	0.47	0.64	1.53	0.74	1.65
G115	0.66	0.38	42.88	0.28	0.52	0.50	0.48	0.78	0.58	1.28	0.57	1.27
G116	0.71	0.37	47.90	0.34	0.54	0.52	0.49	0.87	0.62	1.26	0.52	1.16
G117	0.64	0.40	38.16	0.25	0.52	0.50	0.49	0.69	0.59	1.35	0.62	1.37
G118	0.68	0.35	48.09	0.33	0.52	0.49	0.46	0.87	0.56	1.20	0.52	1.15
G119	0.68	0.35	47.71	0.32	0.52	0.49	0.46	0.87	0.56	1.20	0.52	1.16
G120	0.67	0.39	41.84	0.28	0.53	0.51	0.50	0.76	0.61	1.33	0.58	1.29
G121	0.63	0.34	45.44	0.28	0.48	0.46	0.44	0.83	0.50	1.16	0.55	1.21
G122	0.67	0.39	42.09	0.28	0.53	0.51	0.49	0.77	0.61	1.31	0.58	1.29
G123	0.60	0.39	34.23	0.20	0.49	0.48	0.47	0.62	0.54	1.33	0.66	1.46
G124	0.62	0.39	38.00	0.24	0.50	0.49	0.48	0.69	0.56	1.30	0.62	1.38
G125	0.62	0.42	31.22	0.19	0.52	0.51	0.50	0.57	0.61	1.43	0.69	1.53
G126	0.65	0.36	44.80	0.29	0.51	0.49	0.47	0.81	0.55	1.22	0.55	1.23
G127	0.62	0.35	43.82	0.27	0.49	0.47	0.45	0.80	0.51	1.19	0.56	1.25
G128	0.63	0.39	37.32	0.23	0.51	0.50	0.48	0.68	0.57	1.33	0.63	1.39
G129	0.69	0.38	45.19	0.31	0.53	0.51	0.49	0.82	0.60	1.27	0.55	1.22
G130	0.64	0.46	27.24	0.17	0.55	0.54	0.53	0.50	0.68	1.57	0.73	1.62
G131	0.63	0.41	35.14	0.22	0.52	0.50	0.49	0.64	0.59	1.38	0.65	1.44
G132	0.66	0.43	34.69	0.23	0.55	0.54	0.52	0.63	0.67	1.47	0.65	1.45
G133	0.61	0.40	33.94	0.21	0.50	0.49	0.48	0.62	0.57	1.36	0.66	1.47
G134	0.61	0.41	32.67	0.20	0.51	0.50	0.49	0.59	0.58	1.38	0.67	1.50
G135	0.69	0.39	43.06	0.30	0.54	0.52	0.50	0.78	0.63	1.34	0.57	1.26
G136	0.76	0.37	51.51	0.39	0.57	0.53	0.50	0.94	0.65	1.25	0.48	1.08
G137	0.65	0.38	41.55	0.27	0.51	0.49	0.48	0.76	0.57	1.28	0.58	1.30
G138	0.60	0.36	40.00	0.24	0.48	0.46	0.45	0.73	0.50	1.22	0.60	1.33
G139	0.66	0.35	47.35	0.31	0.50	0.48	0.46	0.86	0.54	1.18	0.53	1.17
G140	0.67	0.38	43.24	0.29	0.53	0.51	0.49	0.79	0.60	1.29	0.57	1.26
G141	0.62	0.39	36.51	0.23	0.51	0.49	0.48	0.66	0.57	1.33	0.63	1.41
G142	0.66	0.41	38.18	0.25	0.53	0.52	0.50	0.69	0.63	1.38	0.62	1.37
G143	0.66	0.37	43.36	0.28	0.51	0.49	0.47	0.79	0.57	1.26	0.57	1.26
G144	0.64	0.38	40.50	0.26	0.51	0.49	0.48	0.74	0.56	1.28	0.59	1.32
G145	0.64	0.42	34.01	0.22	0.53	0.52	0.51	0.62	0.63	1.43	0.66	1.47
G146	0.63	0.37	41.23	0.26	0.50	0.49	0.47	0.75	0.55	1.26	0.59	1.31

2.4. Statistical analysis

The multi-trait genotype-ideotype distance index (MGIDI) was used to rank the accessions based on information of multiple indices as proposed by Olivoto and Nardino [15]. In the first

Table 3
Ranking pattern of the 146 *Aegilops* accessions based on the shoot biomass-based indices.

Code	Yp	Ys	TOL	MP	GMP	HM	SSI	STI	YI	YSI	RSI	AR	SD
G1	21	60	93	35	52	58	70	52	60	70	70	58.3	19.1
G2	21	77	121	62	75	76	87	75	77	87	87	76.8	23.7
G3	11	51	93	15	31	42	64	31	51	64	64	47.0	24.2
G4	18	57	90	24	42	52	65	42	57	65	65	52.5	20.3
G5	45	71	89	75	76	72	73	76	71	73	73	72.2	10.3
G6	1	67	144	4	26	59	105	26	67	105	105	64.5	46.8
G7	9	69	130	33	61	66	85	61	69	85	85	68.5	30.9
G8	28	74	103	69	73	73	76	73	74	76	76	72.3	17.2
G9	47	82	99	89	85	83	83	85	82	83	83	81.9	12.6
G10	4	86	141	25	70	79	112	70	86	112	112	81.5	39.8
G11	13	55	97	19	34	48	66	34	55	66	66	50.3	24.2
G12	25	82	123	74	81	82	95	81	82	95	95	83.2	23.4
G13	15	33	64	8	11	18	50	11	33	50	50	31.2	19.8
G14	31	91	124	84	87	89	103	87	91	103	103	90.3	22.8
G15	16	73	120	46	69	70	80	69	73	80	80	70.5	25.1
G16	14	109	140	86	95	102	131	95	109	131	131	103.9	34.8
G17	41	90	114	91	88	90	96	88	90	96	96	89.1	17.6
G18	26	79	116	73	79	78	88	79	79	88	88	79.4	21.1
G19	55	53	57	57	56	55	53	56	53	53	53	54.6	1.7
G20	35	100	131	92	93	96	109	93	100	109	109	97.0	23.5
G21	38	20	42	14	12	15	35	12	20	35	35	25.3	11.7
G22	36	61	80	49	58	62	62	58	61	62	62	59.2	10.6
G23	34	63	83	52	64	65	68	64	63	68	68	62.9	12.0
G24	63	88	92	94	90	88	81	90	88	81	81	85.1	8.6
G25	20	68	110	44	66	68	75	66	68	75	75	66.8	21.9
G26	73	108	108	99	102	105	108	102	108	108	108	102.6	10.3
G27	11	89	135	64	82	85	106	82	89	106	106	86.8	31.2
G28	37	102	131	93	94	97	110	94	102	110	110	98.2	23.1
G29	68	95	98	96	96	93	94	96	95	94	94	92.6	8.3
G30	27	77	113	72	77	77	82	77	77	82	82	76.6	19.7
G31	19	80	126	66	78	80	93	78	80	93	93	80.5	25.6
G32	65	65	63	78	74	67	59	74	65	59	59	66.2	6.6
G33	78	98	96	97	98	99	97	98	98	97	97	95.7	5.9
G34	23	101	135	87	91	95	115	91	101	115	115	97.2	28.5
G35	2	63	142	2	18	49	98	18	63	98	98	59.2	46.3
G36	87	96	87	98	99	98	90	99	96	90	90	93.6	4.8
G37	52	93	109	95	92	91	100	92	93	100	100	92.5	14.5
G38	45	59	68	52	57	60	57	57	59	57	57	57.1	5.5
G39	10	76	133	38	67	71	92	67	76	92	92	74.0	31.6
G40	33	62	83	50	63	64	67	63	62	67	67	61.9	12.3
G41	24	56	86	34	46	53	63	46	56	63	63	53.6	16.4
G42	50	66	78	75	72	69	69	72	66	69	69	68.6	7.2
G43	28	91	129	81	86	87	104	86	91	104	104	90.1	24.7
G44	39	85	107	84	84	84	91	84	85	91	91	84.1	16.4
G45	53	53	59	56	55	54	54	55	53	54	54	54.5	1.8
G46	39	80	102	79	83	81	79	83	80	79	79	78.5	14.7
G47	50	50	55	44	50	50	51	50	50	51	51	50.2	2.5
G48	55	72	82	83	80	74	71	80	72	71	71	73.7	7.8
G49	3	84	145	12	62	75	119	62	84	119	119	80.4	44.8
G50	124	146	122	140	146	146	145	146	146	145	145	141.0	9.1
G51	62	121	134	100	111	120	137	111	121	137	137	117.4	22.2
G52	60	141	139	110	125	138	143	125	141	143	143	128.0	24.9
G53	93	128	125	115	122	124	135	122	128	135	135	123.8	12.0
G54	6	106	143	68	89	100	133	89	106	133	133	100.5	39.1
G55	111	136	116	126	130	136	138	130	136	138	138	130.5	9.3
G56	108	122	103	119	121	121	128	121	122	128	128	120.1	8.0
G57	133	69	22	106	97	86	42	97	69	42	42	73.2	33.9
G58	135	128	71	136	133	131	114	133	128	114	114	121.5	18.8
G59	140	112	52	133	124	117	86	124	112	86	86	106.5	26.2
G60	146	75	11	124	104	92	27	104	75	27	27	73.8	45.2

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Table 3 (*continued*)

Code	Yp	Ys	TOL	MP	GMP	HM	SSI	STI	YI	YSI	RSI	AR	SD
G61	127	126	79	132	128	126	120	128	126	120	120	121.1	14.5
G62	88	113	111	105	110	112	121	110	113	121	121	111.4	9.4
G63	115	118	93	118	118	119	118	118	118	118	118	115.5	7.5
G64	122	142	105	134	141	143	140	141	142	140	140	135.5	11.7
G65	79	143	137	117	132	140	144	132	143	144	144	132.3	19.5
G66	81	115	118	103	109	113	124	109	115	124	124	112.3	12.4
G67	66	134	138	107	120	129	141	120	134	141	141	124.6	22.3
G68	121	137	101	130	135	137	136	135	137	136	136	131.0	11.0
G69	142	125	61	141	134	128	107	134	125	107	107	119.2	23.3
G70	145	122	49	146	138	130	99	138	122	99	99	117.0	28.8
G71	132	138	81	143	143	139	132	143	138	132	132	132.1	17.6
G72	96	119	115	113	117	118	126	117	119	126	126	117.5	8.4
G73	41	145	146	111	136	145	146	136	145	146	146	131.2	31.7
G74	115	144	127	131	142	144	142	142	144	142	142	137.7	9.4
G75	131	124	70	135	130	125	111	130	124	111	111	118.4	18.2
G76	123	130	90	129	127	127	127	127	130	127	127	124.0	11.4
G77	138	139	77	144	144	141	130	144	139	130	130	132.4	19.2
G78	140	140	75	145	145	142	129	145	140	129	129	132.6	20.2
G79	135	132	74	138	137	134	122	137	132	122	122	125.9	18.3
G80	125	87	43	108	100	94	60	100	87	60	60	84.0	25.1
G81	126	113	66	127	119	116	101	119	113	101	101	109.3	17.1
G82	98	127	119	116	123	123	134	123	127	134	134	123.5	10.4
G83	130	105	50	123	112	109	74	112	105	74	74	97.1	25.1
G84	110	102	73	104	103	104	84	103	102	84	84	95.7	12.1
G85	109	97	72	101	101	101	77	101	97	77	77	91.8	13.2
G86	91	117	112	109	113	115	125	113	117	125	125	114.7	9.7
G87	129	102	48	121	108	106	72	108	102	72	72	94.5	24.9
G88	128	110	54	124	116	111	78	116	110	78	78	100.3	24.0
G89	139	131	67	142	140	133	117	140	131	117	117	124.9	21.5
G90	144	98	30	128	114	107	58	114	98	58	58	91.5	35.5
G91	142	120	56	137	129	122	102	129	120	102	102	114.6	23.9
G92	102	116	100	112	115	114	116	115	116	116	116	112.5	5.9
G93	120	107	65	114	107	108	89	107	107	89	89	100.2	15.6
G94	133	133	76	138	139	135	123	139	133	123	123	126.8	18.0
G95	100	135	128	122	126	132	139	126	135	139	139	129.2	11.4
G96	85	111	106	102	105	110	113	105	111	113	113	106.7	8.2
G97	135	93	39	120	106	103	61	106	93	61	61	88.9	29.6
G98	49	57	62	60	59	61	56	59	57	56	56	57.5	3.5
G99	32	16	45	9	9	10	37	9	16	37	37	23.4	14.2
G100	79	3	6	10	4	3	4	4	3	4	4	11.3	22.6
G101	117	37	14	80	60	47	17	60	37	17	17	45.7	32.1
G102	5	18	85	1	2	4	52	2	18	52	52	26.5	28.9
G103	106	7	4	36	21	13	5	21	7	5	5	20.9	29.9
G104	73	10	19	20	13	9	14	13	10	14	14	19.0	18.2
G105	8	16	69	3	3	7	46	3	16	46	46	23.9	23.4
G106	58	29	37	30	28	28	33	28	29	33	33	33.3	8.7
G107	82	5	10	16	8	6	7	8	5	7	7	14.6	22.5
G108	43	33	47	21	22	25	41	22	33	41	41	33.5	9.7
G109	68	45	41	52	48	46	43	48	45	43	43	47.5	7.5
G110	94	1	1	5	1	1	1	1	1	1	1	9.8	27.9
G111	83	31	27	47	37	35	24	37	31	24	24	36.4	17.0
G112	73	15	24	30	23	20	21	23	15	21	21	26.0	16.1
G113	16	26	60	7	7	11	44	7	26	44	44	26.5	18.8
G114	111	4	2	27	14	8	2	14	4	2	2	17.3	32.1
G115	71	35	33	40	33	34	30	33	35	30	30	36.7	11.7
G116	30	39	58	17	19	26	48	19	39	48	48	35.5	14.2
G117	86	18	21	37	30	24	19	30	18	19	19	29.2	19.9
G118	53	47	53	41	44	45	49	44	47	49	49	47.4	3.7
G119	57	46	50	43	45	44	47	45	46	47	47	47.0	3.8

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Table 3 (*continued*)

Code	Yp	Ys	TOL	MP	GMP	HM	SSI	STI	YI	YSI	RSI	AR	SD
G120	58	24	31	23	20	21	28	20	24	28	28	27.7	10.7
G121	100	51	34	88	71	63	40	71	51	40	40	59.0	21.6
G122	63	27	31	29	25	23	29	25	27	29	29	30.6	11.0
G123	119	24	8	75	53	40	11	53	24	11	11	39.0	34.4
G124	104	28	18	69	47	37	18	47	28	18	18	39.3	26.9
G125	107	8	5	38	24	17	6	24	8	6	6	22.6	29.9
G126	77	43	38	59	49	43	38	49	43	38	38	46.8	11.9
G127	103	48	29	82	65	57	36	65	48	36	36	55.0	22.6
G128	97	22	17	52	36	31	16	36	22	16	16	32.8	24.2
G129	48	37	44	25	27	30	39	27	37	39	39	35.6	7.4
G130	91	2	3	11	5	2	3	5	2	3	3	11.8	26.4
G131	98	13	13	42	32	22	13	32	13	13	13	27.6	25.5
G132	67	6	16	12	6	5	12	6	6	12	12	14.5	17.8
G133	113	14	9	66	38	32	9	38	14	9	9	31.9	32.5
G134	114	11	7	60	35	27	8	35	11	8	8	29.5	32.7
G135	44	20	40	17	15	16	31	15	20	31	31	25.5	10.4
G136	7	42	87	6	10	19	55	10	42	55	55	35.3	26.7
G137	83	35	28	51	40	36	26	40	35	26	26	38.7	16.6
G138	117	44	20	90	68	56	22	68	44	22	22	52.1	31.7
G139	70	49	46	64	54	51	45	54	49	45	45	52.0	8.2
G140	60	29	36	32	29	29	32	29	29	32	32	33.5	9.0
G141	105	22	15	62	39	33	15	39	22	15	15	34.7	27.6
G142	71	11	23	22	16	14	20	16	11	20	20	22.2	16.7
G143	76	41	35	47	41	39	34	41	41	34	34	42.1	12.0
G144	90	32	24	57	43	38	23	43	32	23	23	38.9	20.1
G145	89	9	12	28	17	12	10	17	9	10	10	20.3	23.5
G146	94	39	26	71	51	41	25	51	39	25	25	44.3	21.9

step, each trait (rX_{ij}) was rescaled using the following equation:

$$rX_{ij} = \frac{\eta_{nj} - \varphi_{nj}}{\eta_{oj} - \varphi_{oj}} \times (\theta_{ij} - \eta_{oj}) + \eta_{nj}$$

Where φ_{oj} and η_{oj} are the original minimum and maximum values for the index j, respectively; φ_{nj} and η_{nj} are the new minimum and maximum values for index j after rescaling, respectively; and θ_{ij} is the original value for jth index of the ith accession. The values for η_{nj} and φ_{nj} were chosen as follows: for the indices in which positive gains are desired, $\varphi_{nj} = 0$ and $\eta_{nj} = 100$ should be used, while for the indices in which negative gains are desired, $\varphi_{nj} = 100$ and $\eta_{nj} = 0$ should be used [15]. In the next step, a factor analysis (FA) was performed to account for the dimensionality reduction of the data and relationships structure. This analysis was performed according to following model:

$$F = Z\left(A^T R^{-1}\right)^T$$

where F is a $g \times f$ matrix with the factorial score; Z is a $g \times p$ matrix with the rescaled means; A is a $p \times f$ matrix of canonical loading, and R is a $p \times p$ correlation matrix between the indices. Furthermore, g, f, and p indicate the number of accessions, factor retained, and calculated indices, respectively. In the third step, a $[1 \times p]$ vector was considered as the *ideotype* matrix. In the last step, Euclidean distance between the scores of accessions and the ideal accessions was computed as the MGIDI index using following equation:

$$MGIDI = \sum\nolimits_{j=1}^{f} \left[(\gamma_{ij} - \gamma_j)^2 \right]^{0.5}$$

where γ_{ij} is the score of the ith accession in the jth factor ($i = 1, 2, \ldots, t$; $j = 1, 2, \ldots, f$), being t and f the number of accessions and factors, respectively; and γ_j is the jth score of the ideal accession. The accession with the lowest MGIDI is then closer to the ideal accession and thus indicates desired values for all the calculated indices. The selection differential for all traits

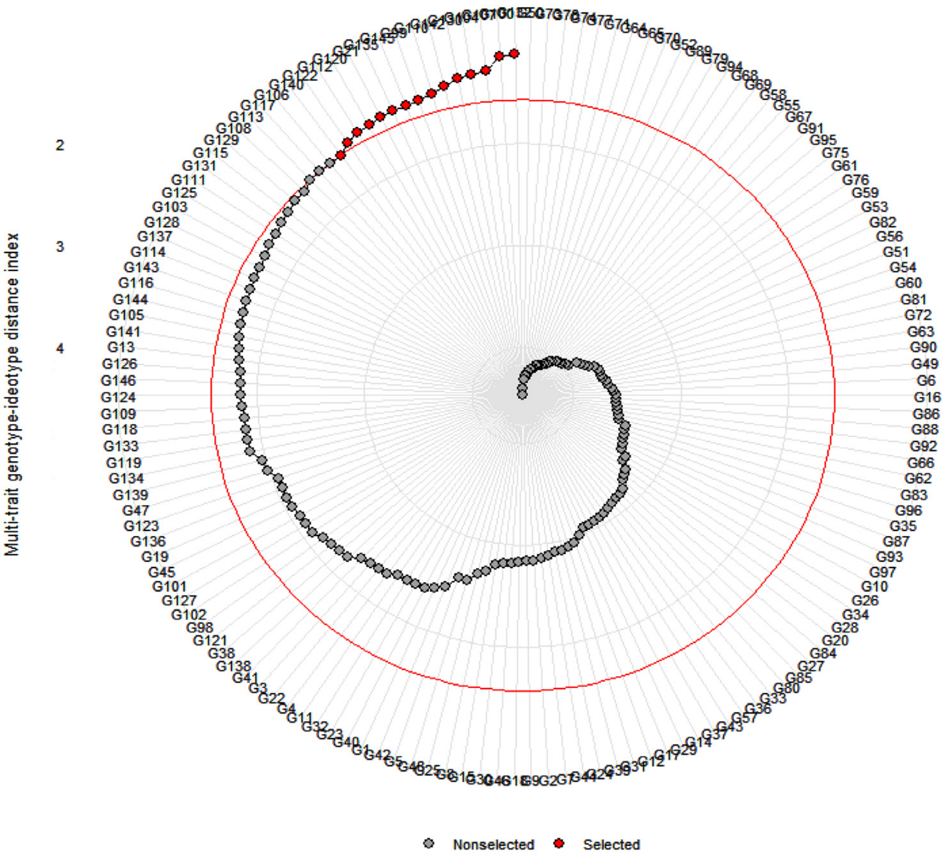

Fig. 1. Genotype ranking in ascending order for the MGIDI index. The selected genotypes based on this index are shown in red. The central red circle represents the cutpoint according to the selection pressure.

was performed considering a selection intensity of approximately 10%. Data manipulation and the index computation were performed in the R software using the 'metan' package [15].

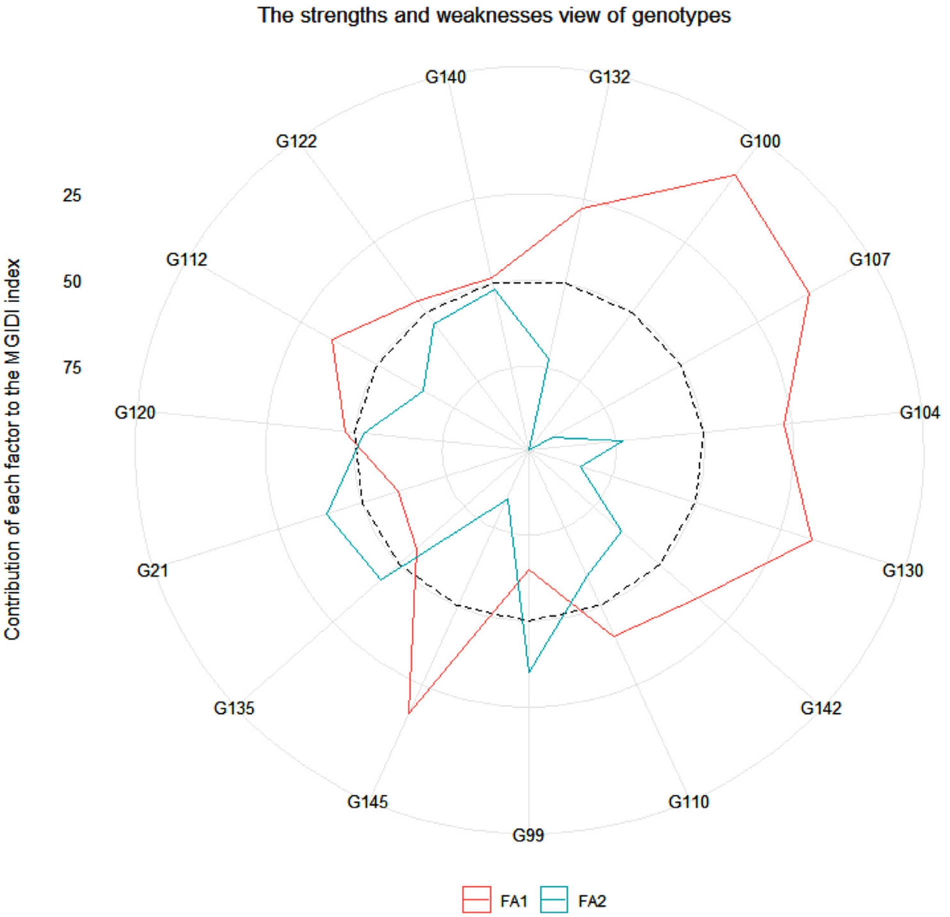

Fig. 2. Strengths and weaknesses view of the selected genotypes is shown as the proportion of each factor on the computed MGIDI index. The smallest the proportion explained by a factor (closer to the external edge), the closer the traits within that factor are to the ideotype. The dashed line indicates the theoretical value if all factors had contributed equally.

Ethics Statement

The paper is not currently being considered for publication elsewhere.

CRediT Author Statement

Alireza Pour-Aboughadareh: Conceptualization, Methodology, Software, Data curtion, Writing original draft, Investigation; **Peter Poczai:** Visualization, Writing review & editing.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships which have, or could be perceived to have, influenced the work reported in this article.

Supplementary Materials

Supplementary material associated with this article can be found in the online version at doi:10.1016/j.dib.2021.107096.

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