

REGULAR ARTICLE

Morphological and agronomical characterization of common wheat landraces (*Triticum aestivum* L.) from the National Wheat Collection of Bulgaria

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Abstract

The knowledge about the extent of variability, the distribution and the relationship between descriptors within local germplasm collection are a high value for the improvement and the efficient genetic diversity maintenance and utilization of plant species. The objective of this study was to assess the morphological and agronomic characteristics of original germplasm of common wheat (*Triticum aestivum* L.), maintained in *ex situ* collection in IPGR-Sadovo. Fifty-five accessions of *Triticum aestivum* L. stored for more than 10 years in the National gene bank of IPGR-Sadovo were planted under field condition and their agro-morphological characters such as plant shape (at tillering), leaf-flag attitude (at the beginning of heading), spike attitude (at full ripeness), spike awnedness, spike color and spike shape, length of vegetative growth phase, plant height, length of spike, spikelets per spike and 1000 grain mass were recorded. The variation analysis showed that the most relative variable character during the period of study is the length of spike (C.V. %=15.09%), following to 1000 grain mass (C.V. %=8.04%) and spikelets per spike (C.V. %=7.66%). PC-analysis was applied to group accessions according to similarity on the basis of five traits (length of vegetative growth phase, plant height, spike length, spikelets per spike and 1000 seed weight) in two components in the factor plane. The analysis shows that the first component explains 30.349% of the total variation and the second -26.001%. Two factors explain total 56.350% of the variation in the experience. A database with assessment information of regenerated accessions was created. The results of this study will support efforts of conservation and utilization of landraces in winter bread wheat breeding programs.

Key words: Accessions, *Ex situ* conservation, Collection, Genetic resources, *Triticum aestivum* L.

Introduction

In the recent years increasingly recognize the importance of genetic resources on the prosperity of breeding selection, agriculture and ecology (Anonymous, 1999; Stoyanova et al., 1998). Narrowing the range of genetic variation observed in the common and durum wheat as a result of using of conventional breeding selection practices reducing the ability to improve productivity of crops (Hadjiivanova et al., 2010). By approaching the limits of biological productivity of wheat in the recent years has greatly increased the need of new initial material (Hailegiorgis, 2011; Graybosch and Peterson, 2010; Lanning et al., 2010). In this regard the formation of the current gene pool of wheat, its planned and targeted research has been and is a

major priority in the researching activity.

Collections of wheat as a genetic resource are maintained in the National Gene bank in the Institute of Plant Genetic Resources-Sadovo (12,539 accessions), (<http://eurisco.ecpgr.org>). The collections contain a large genetic diversity: local populations, breeding materials (mutants, hybrids, introduced cultivars and lines) and wild species originating from the country as well of all over the world (Odzhakova et al., 2007; Kolev and Stoyanova, 2005; Popova, 2003). The National collection of common wheat includes 9,591 accessions, from which 1,051 accessions originating from Bulgaria. The study of *ex situ* collections is done according the international descriptors lists (Anonymous, 1984). Comprehensive evaluation of collections is a major source of information to create a database with assessment information of plant genetic diversity (Kolev, 2001; Angelova and Popova, 1998). This assessment is carried out on a number of morphological and agronomical characteristics of the samples and ranges from 10 to 68 indicators depending on the type of culture and biology.

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The objective of this study was to assess the morphological and agronomic characteristics of original germplasm of common wheat (*Triticum aestivum* L.), maintained in *ex situ* collection in IPGR-Sadovo.

Materials and Methods

During the period 2010-2012 in the experimental field of Institute of Plant Genetic Resources-Sadovo are reproduced 55 accessions of common wheat (Table 1). All accessions originating from Bulgaria and characterized as “original germplasm” created in this region. The seeds been stored for more 10 year for long-term conservation under -18°C.

Sowings were made in the optimal time for this area: 10-15 October. Six rows were planted from each accession with row spacing 20/5 cm and 1 m

length. The standard variety –Sadovo1 was sown as a systematic check. Regular field management operations were performed during the cropping season.

Observations and evaluations of morphological, biological and agronomic traits were carried out according to international descriptors lists (Anonymous, 1984). The agronomic characters were taken after harvesting the plants. From each accession, 20 plants were collected for biometrical measurements.

Statistical analyses were performed using the statistical program SPSS 13.0. PC-analysis was applied to group accessions according to similarity on the basis of five traits (length of vegetative growth phase, plant height, spike length, spikelets per spike and 1000 seed weight) in two components in the factor plane.

Table 1. Inventory of local (native) *Triticum aestivum* L. accessions stored for more than 10 years in the National gene bank of IPGR-Sadovo.

No.	Accession number	Variety/ Line	No.	Accession number	Variety/ Line
1	1978-TRT-AE-122	2981-2988-3-2	29	1998-TRT-AE-17	KM-105
2	2000-TRT-AE-85	P-208	30	2000-TRT-AE-41	C-28
3	2000-TRT-AE-144	P-245	31	2000-TRT-AE-60	P-30
4	2000-TRT-AE-143	P-244	32	2000-TRT-AE-67	P-204
5	1978-TRT-AE-200	7285-8-1-7-4	33	2000-TRT-AE-97	P-154
6	1978-TRT-AE-203	7285-7-31-7-1-3	34	2000-TRT-AE-92	P-131
7	2000-TRT-AE-142	P-243	35	2000-TRT-AE-89	P-212
8	1980-TRT-AE-616	7293-3-41-4-5-1	36	2000-TRT-AE-84	P-126
9	1978-TRT-AE-199	7285-11-21-1-3-7	37	2000-TRT-AE-83	P-125
10	1997-TRT-AE-31	582	38	2000-TRT-AE-75	P-104
11	2000-TRT-AE-141	P-242	39	2000-TRT-AE-107	P-220
12	1998-TRT-AE-18	EI-106	40	2000-TRT-AE-111	P-172
13	2000-TRT-AE-35	C-17	41	2000-TRT-AE-113	P-183
14	2000-TRT-AE-40	C-27	42	2000-TRT-AE-121	P-229
15	2000-TRT-AE-42	C-31	43	2000-TRT-AE-127	P-235
16	2000-TRT-AE-49	C-46	44	2000-TRT-AE-128	P-187
17	2000-TRT-AE-50	C-47	45	2000-TRT-AE-129	P-190
18	2000-TRT-AE-102	P-215	46	2000-TRT-AE-145	P-246
19	2000-TRT-AE-101	P-214	47	2001-TRT-AE-295	BORIANA
20	2000-TRT-AE-100	P-213	48	2001-TRT-AE-296	JUNAK
21	2000-TRT-AE-98	P-159	49	1978-TRT-AE-157	SADOVO1
22	2000-TRT-AE-80	P-113	50	2001-TRT-AE-180	SADOVO 772
23	2000-TRT-AE-104	P-217	51	2000-TRT-AE-8	BONONIA
24	2000-TRT-AE-117	P-225	52	2000-TRT-AE-9	SADOVSKA BELIA
25	2000-TRT-AE-119	P-227	53	2000-TRT-AE-7	POBEDA
26	2000-TRT-AE-120	P-228	54	2000-TRT-AE-10	DIAMANT
27	2000-TRT-AE-130	P-191	55	1997-TRT-AE-1	MURGAVEC
28	1998-TRT-AE-16	EI-104			

Results and Discussion

Morphological characters

During the study, accessions were characterized by following morphological characters: plant shape (at tillering), leaf-flag attitude (at the beginning of heading), spike attitude (at full ripeness), spike awnedness, spike color and spike shape.

According to the plant shape investigated accessions were divided into 3 groups: semi-erect, drooping and strongly declined (Table 2). The largest numbers of accessions were with drooping plant shape (37 accessions) and strongly declined (17 accessions). Only one accession (2001-TRT-AE-296) was with semi erect plant shape (Table 2). The leaf-flag attitude of 45 accessions was semi-upright (15-45°) and upright (< 15°) at 7 accessions. Dominated the accessions with white color and cylindrical shape of spike and 39 accessions were without awns. In thirteen of them the lengths of the awns were less 21 mm. Only two accessions were with length of awns within the borders of 61-100 mm (2000-TRT-AE-235, 1997-TRT-AE-1).

According to the spike attitude accessions were grouped into 4 groups: erect, semi-erect, horizontal and nodding. The accessions with semi-erect attitude of spike were thirty and these with nodding attitude of spike only four (Table 2).

Agronomic characters

The biometrical measurements in this study included: length of vegetative growth phase, plant height, length of spike, spikelets per spike and 1000 grain mass (Table 3). The results show that the length of spike in the study varied from 5 to 11 cm. The highest values of this character (11 cm) were registered in 3 accessions (2000-TRT-AE-117, 2000-TRT-AE-113 and 2000-TRT-AE-84). The numbers of spikelets per spike were between 15 and 20. The mean value of plant height was 93.9 cm. Accessions with tall plants (90 to 100 cm) and heavy kernels (1000 grain mass from 36 to 40 g) dominated this set of accessions (Table 3). The length of vegetative growth phase (from growing to heading) varied from 183 to 187 days.

Table 2. Summary of morphological characters of 55 accessions of *Triticum aestivum* L.

Plant shape				
Groups	semi-erect (25-45°)	drooping (46-55°)	strongly declined (56-70°)	prostrate (>70°)
Total number of accessions	1	37	17	0
Leaf-flag-attitude				
Groups	semi-upright (15-45°)	horizontal (46-90°)	drooping (91-135°)	very drooping (>135°)
Total number of accessions	7	45	3	0
Spike-attitude				
Groups	Erect (<15°)	semi-erect (15-45°)	Horizontal (46-90°)	Nodding (91-135°)
Total number of accessions	2	30	19	4
Spike - shape				
Groups	pyramidal	cylindrical	clavate	fusiform
Total number of accessions	17	33	5	0
Spike-color				
Groups	white	red		
Total number of accessions	55	0		
Spike-awnedness				
Groups	absent	Awnless (<21 mm)	semi-awnes (21-60 mm)	Awned (61-100 mm)
Total number of accessions	39	13	1	2

Table 3. Biometrical descriptors of 55 accessions of *Triticum aestivum* L.

Plant height, cm		Spike lengt, cm		Spikelets per spike		1000 grain mass, g	
cm	Total number of accessions	cm	Total number of accessions	ns	Total number of accessions	g	Total number of accessions
<80	0	<6	1	<14	0	<30	0
80-90	17	6,1-8	22	15-17	28	31-35	22
91-100	36	8,1-10	29	18-20	27	36-40	29
>100	2	10,1-12	3	21-23	0	41-45	3
		>12	0	>24	0	46-50	1

The basic statistics of the main descriptive characteristics (mean, minimum and maximum, std.error of means, std. deviation, variance and coefficient of variation) of five characters are shown in Table 4. The values of coefficient of variation (C.V. %) are from 0.6 to 15.09 %. The analysis show that the most relative variable character during the period of study is the length of spike (15.09 %), following to 1000 grain mass (8.04 %) and spikelets per spike (7.66 %). The values of these coefficients confirm that these traits are more susceptible to change under the influence of different factors. Relatively the least variable for the period of study indicated the length of vegetative growth phase.

PC-analysis was applied to group accessions according to similarity on the basis of five traits (length of vegetative growth phase, plant height, spike length, spikelets per spike and 1000 seed weight) in two components in the factor plane. The values of the two components to each of the study parameters were calculated empirically (Table 5). The analysis shows that the first component explains 30.349 % of the total variation and the second -26.001 %. Two factors explain total 56.350 % of the variation in the experience. This relatively small percentage illustrated the existence of complex relationships between the studied characters. For example the characters: length of spike, number of spikelets per spike and 1000 grain mass are associated with the first component. The

second component is in correlation with length of vegetative growth phase and plant height (Figure 1).

The evaluation of phenotypic variability by multivariate analysis gives the possibility to include a large number of accessions and to identify the most suitable resources for special trait (Stoilova, 2007). Distribution of evaluated accessions in the coordinate system of PC1 and PC2, presents the grouping of accessions according to similarity of traits: length of vegetative growth phase, plant height, spike length, spikelets per spike and 1000 seed weight (Figure 2). Some of the accessions are separated as “detached” from other. The accession № 41 (2000-TRT-AE-113) in the upper right quadrant is characterized with least 1000 grain mass, long vegetative growth phase and largest length of spike. Sample № 46 (2000-TRT-AE-145) located to the opposite in the lower right quadrant is with largest number of spikelets of spike. The samples № 2, 3, 14, 49 (2000-TRT-AE-85, 2000-TRT-AE-144, 2000-TRT-AE-40 and 1978-TRT-AE-157) in the left lower quadrant are with the largest 1000 grain mass. The accessions №21 (2000-TRT-AE-98) and №5 (1978-TRT-AE-200) in the upper left quadrant are characterized with small length of spike and spikelets of spike and the bigger 1000 grain mass. These samples represent a certain interest to hybridization by different traits and can be recommended as donors in the breeding selection of winter bread wheat.

Table 4. The basic statistics of the main descriptive characteristics in accessions of *Triticum aestivum* L.

Parameters	Length of vegetative growth phase, days	Plant height, cm	Spike length, cm	Spikelets Per spike, ns	1000 grain mass, g
Mean	186.00	93.95	8.43	17.55	40.59
Std. Error of Mean	0.15	0.67	0.17	0.18	0.44
Std. Deviation	1.12	4.97	1.27	1.34	3.26
Variance	1.26	24.70	1.61	1.81	10.66
Minimum	183.00	80.00	5.00	15.00	31.80
Maximum	187.00	102.50	11.00	20.00	48.20
Coefficient of variation, %	0.60	5.29	15.04	7.66	8.04

Table 5. Weighted factors (PC1 and PC2) of descriptive characteristics on the rotated matrix with two factors.

Characters	PC 1	PC 2
Length of vegetative period, days	0.214	0.820
Plant height, cm	-0.162	0.815
Length of spike, cm	0.687	-0.140
Spikelets per spike, ns	0.561	0.013
1000 grain mass, g	-0.749	-0.205
% of total variance explained	30.345	26.001
Cumulative variation, %	30.345	56.350

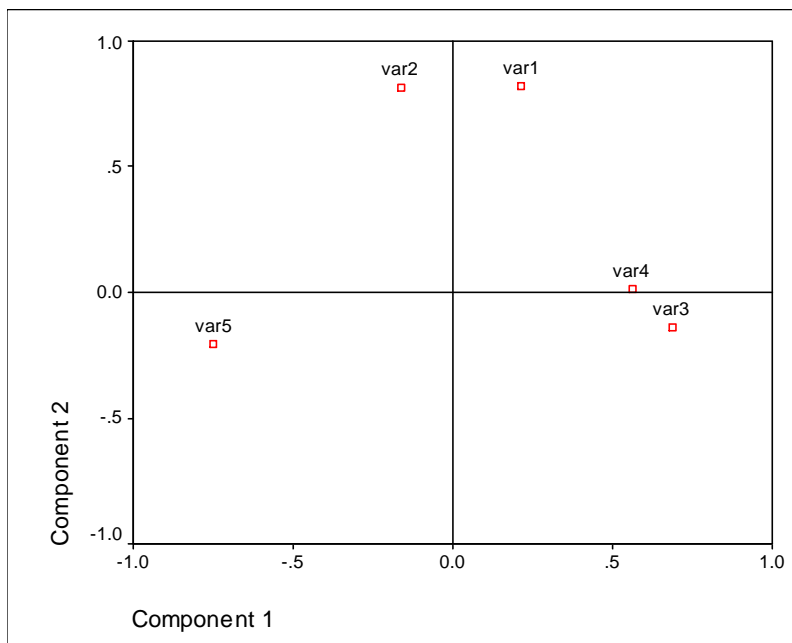


Figure 1. Projection of the traits on the factor plane (1 x 2): Length of vegetative growth phase, days (var1), Plant height, cm (var2), Spike length, cm (var3), Spikelets per spike (var4), 1000 grain mass, g (var5).

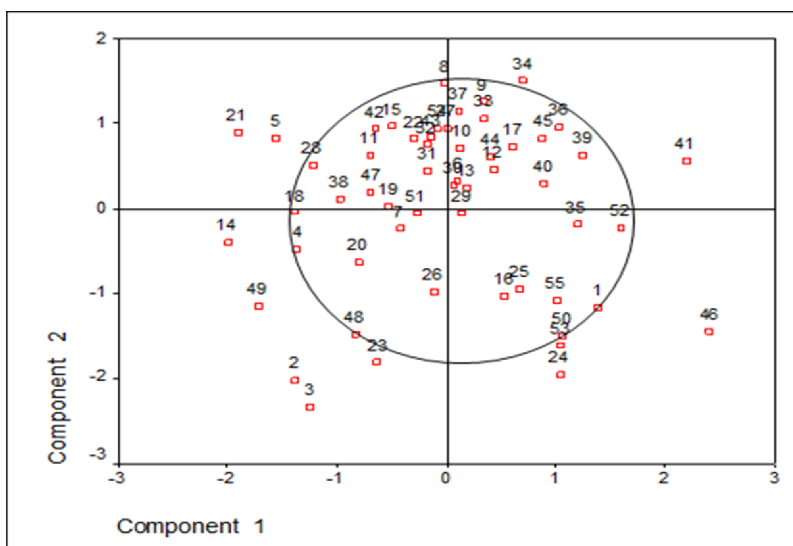


Figure 2. Distribution of evaluated accessions within the factor plane. The accessions presented with the conditional numbers 1-55 of the graph correspond to the description in Table 1.

Conclusion

The present research provided information on genotype studied and its grouping.

The most relative variable character during the period of study is the length of spike (C.V.-15.09%), following to 1000 grain mass (C.V.-8.04%) and spikelets per spike (C.V.-7.66%). Relatively the least variable for the period of study indicated the length of vegetative growth phase.

PC-analysis was applied to group accessions according to similarity on the basis of five traits in two components in the factor plane. The accessions: *2000-TRT-AE-145*, *2000-TRT-AE-85*, *2000-TRT-AE-144*, *2000-TRT-AE-40* and *1978-TRT-AE-157* can be recommended as donors by different traits in the breeding selection of winter bread wheat.

A database with assessment information of investigated accessions in electronic format was created.

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