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Original article

Genetic Diversity in Triticale Breeding Lines, Stored in IPGR Sadovo

Evgeniy Dimitrov [a], Nikolaya Velcheva [a] & Zlatina Peycheva Uhr [a, *]

[a] Institute of Plant Genetic Resources "K. Malkov" – Sadovo, Bulgaria.

Abstract

A three-year study (2015-2017) of 24 breeding lines and varieties of triticale in the experimental field of IPGR Sadovo was conducted. The experience is sown in a block scheme in 3 replications, with a randomized distribution of repeat variants with a plot size of 10 m^2. As a standard in the comparative assessment were used the varieties Sadovo 1 and AD72-91. The following indicators are obtained: date of heading and morphological features: plant height (cm), weight of 1000 grains (g) and average yield (kg/da). The aim of the study is to establish the variation of economical traits and the presence of genetic diversity in the triticale breeding lines in order their more effectively utilization in the breeding process. Under the specific conditions of the test period the yields ranged from 516.40 kg/da for A1BM0132 (T-139) to 711.40 kg/da for A6BM0193 (T-218), and the average crop yield for the three-year period was 644.3 kg/da. Only two breeding lines – A1BM0018 (TC-128 Sadovetz) and A6BM0193 (T-218) have a yield above 700 kg/da. On the basis of the cluster analysis performed on economical traits, the studied triticale collection is divided into four groups with genotypes with similar characteristics.

Keywords: Genofund, Triticosecale, Economical traits, Variance, Cluster analysis.

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* **Corresponding author:**

Zlatina Peycheva Uhr, Institute of Plant Genetic Resources "K. Malkov" – Sadovo, Bulgaria.
Email: zlatinapg@abv.bg

INTRODUCTION

The triticale is a relatively new cereal crop. It is grown as a green mass with higher protein content than wheat and rye, and for feed grain. The bread from wheat and triticale flour, in proportion respectively 75% and 25%, has a high protein and lysine content. The triticale flour is very suitable for making pastries because it contains little gluten with low quality. The best results are obtained when the flour is with low protein content and low glutenins content in gluten (Leon et al., 1996; Leon et al., 1998).

The chemical composition of the triticale grain makes it a suitable raw material for the spirits and brewing industries (Wang et al., 1999; Creydt et al., 1999).

The beer made from triticale is characterized by low tannin content, high protein content, good foam color, impressive aroma and freshness (Annemuller et al., 1999).

The green mass of triticale hay flour is richer with carotenoids and mineral substances. Compared to other cereals, the triticale has the following valuable qualities and traits: high productive capacities and high nutritional value of grain and green mass; less requirements for soil and climate conditions and the ability to grow on poorer soils; a higher protein content in biomass and grain, and a greater amount of essential amino acids, especially lysine; resistance to fungal diseases; high dry and cold resistance in some forms of the crop (Terziev, 2000).

To ensure a sustainable supply of forages and food products in changing environmental and climate conditions, huge hopes are directed on plant breeding. Protecting the genetic diversity of plant resources is a good alternative for making the correct selection of sources as the initial material for successful crop improvement. The created breeding lines are testing and the samples which are showing the best complex of economical features are offering for varieties or conserve as genetic material for future breeding programs (Popov and Matsov, 1980; Popov et al., 1981).

The success of triticale breeding programs as well as in other crops depends to a great extent on the precise investigation of the initial material, selection of suitable parental pairs for crosses and maximum involvement of productive potential in them (Georgiev et al., 2013). On the other side, it is also important to evaluation the mathematical variability of the studied economic features as well as the grouping of the breeding materials for the efficient use of the conserved genetic resources.

The aim of the study is to establish the variation of economical traits and the presence of genetic diversity in the triticale breeding lines in order their more effectively utilization in the breeding process.

Material and methods

Status of Triticosecale genofund, stored in the National Genebank of IPGR Sadovo

IPGR Sadovo is a coordinator of the National Program for Plant Genetic Resources and in the fund of Institute Genebank are maintained lines and varieties from the Bulgarian crop breeding under conditions of short and long-term storage.

The *Triticosecale* collection includes breeding lines and varieties (294 samples) with Bulgarian origin, as well as introduced genotypes with foreign origin from the international free germplasm exchange (397 samples), mainly from Mexico, USA, Canada, Russia, France, Germany, Belarus, Poland, England and others. The total status number of the stored IPGR genofund is 691 seed samples.

All received seed samples are registered in the *Phyto 2000* electronic database by 20 passports descriptors, according to the international standards of FAO, ECPGR and Bioversity International.

Plant material and studied traits

In the period 2015-2017 a three-year study of 24 breeding lines and varieties of triticale in the experimental field of IPGR Sadovo was conducted. The experience is sown in a block scheme in 3 replications, with a randomized distribution of repeat variants with a plot size of 10 m^2.

As a standard in the comparative assessment were used the varieties Sadovo 1 (common winter wheat) and AD72-91. Variety AD72-91 was obtained in the Institute of Sadovo through a selection of materials, originated and introduced from Mexico.

Date of heading and morphological features: plant height (cm), weight of 1000 grains (g) and average yield (kg/da) are obtained.

The indicators characterizing the average value of each of the traits and their degree of variability by the variance coefficient (CV%) were calculated. It is accepted that the variability is weak if the variation coefficient does not exceed 10%, average – when it is more than 10% and less than 20%, strong (significant) – when it is over 20% (Dimova and Marinkov, 1999).

Statistical data processing

Variance and cluster analyses have been applied (Lindanski, 1988). The experimental data is averaged and standardized. The SPSS 13.0 statistical package have been used to process the survey results.

Results and discussion

In Table 1 the passport data of breeding lines and varieties involved in the investigation were shown. All the studied samples are originated from Bulgaria and are stored in the collection of the National Genbank in IPGR Sadovo.

Table 1. Passport information for the samples included in the study*

№	Cat. №	Year of registration	Taxonomical description	Name of the sample	Type of the sample	Origin
1	A1BM0012	2001	*Triticosecale*	Priboi	Breeding line	BGR
2	A1BM0018	2001	*Triticosecale*	TC-128 Sadovetz	Breeding line	BGR
3	A1BM0029	2001	*Triticosecale*	TC-177 Prevala	Breeding line	BGR
4	A1BM0035	2001	*Triticosecale*	TC-210 Rozhen	Breeding line	BGR
5	A1BM0037	2001	*Triticosecale*	TC-238	Breeding line	BGR
6	A1BM0067	2001	*Triticosecale*	TC-370	Breeding line	BGR
7	A1BM0068	2001	*Triticosecale*	T-4	Breeding line	BGR
8	A1BM0078	2001	*Triticosecale*	T-119	Breeding line	BGR
9	A1BM0082	2001	*Triticosecale*	T-123	Breeding line	BGR
10	A1BM0088	2001	*Triticosecale*	T-39	Breeding line	BGR
11	A1BM0089	2001	*Triticosecale*	T-40	Breeding line	BGR
12	A1BM0096	2001	*Triticosecale*	T-74	Breeding line	BGR
13	A1BM0102	2001	*Triticosecale*	T-130	Breeding line	BGR
14	A1BM0110	2001	*Triticosecale*	T-88	Breeding line	BGR
15	A1BM0132	2001	*Triticosecale*	T-139	Breeding line	BGR
16	A6BM0189	2006	*Triticosecale*	T-148	Breeding line	BGR
17	A6BM0190	2006	*Triticosecale*	T-197	Breeding line	BGR
18	A6BM0191	2006	*Triticosecale*	T-213	Breeding line	BGR
19	A6BM0192	2006	*Triticosecale*	T-193	Breeding line	BGR
20	A6BM0193	2006	*Triticosecale*	T-218	Breeding line	BGR
21	A6BM0194	2006	*Triticosecale*	T-220	Breeding line	BGR
22	A6BM0195	2006	*Triticosecale*	T-221	Breeding line	BGR
23	St.		*Triticum aestivum L.*	Sadovo 1	Variety	BGR
24	St.		*Triticosecale*	AD72-91	Variety	BGR

* *The data source is the National Register Phyto 2000 (IPGR Sadovo)*

In Table 2 the mean values of the traits, obtained for the three year studied period, are shown.

Under the specific conditions of the testing period, the crop yields ranged from 516,40 of A1BM0132 (T-139) to 711.40 kg/da of A6BM0193 (T-218). The average crop yield for the three-year period is 644,3 kg/da. Yield above 700 kg/da were obtained of only 2 samples – A1BM0018 (T-218 Sadovetz) and A6BM0193 (T-218). As well as on other authors' research works (Popov and Matsov, 1980; Popov et al., 1981; Kolev et al., 2003), the standard AD72-91 shows a higher yield than Sadovo 1. Line TC-128 Sadovetz is one of the highest yielding genotype. Similar results have been reported by Terziev (2000) in comparative testing of wheat, barley and triticale.

The weight of 1000 grains in the studied collection is over 40 g. Only 4 samples show grain weight over 50 g. The triticale breeding lines characterized by the largest grains are: A1BM0035/TC-210 Rozhen, A1BM0068/T-4, A1BM0082/T-123, A6BM0194/T-220 (Table 2).

The heading on May 3 for A6BM0192/T-193 and A1BM0110/T-88 was reported and up to May 14 for Sadovo 1. Most of the samples were heading in the period from May 6 until May 8.

Table 2. Agrobiological study of triticale breeding lines under the conditions of IPGR Sadovo (2015-2017)

№	Cat. №/ Name of the sample	Average crop yield, kg/da	Plant height, cm	Weight of 1000 grains, g	Date of heading	Cluster
1	A6BM0190/T-197	638.60	104.80	45.00	07.V.	I
2	A1BM0110/T-88	637.60	100.40	42.90	**03.V.**	I
3	A1BM0037/TC-238	649.80	96.30	41.20	08.V.	I
4	A1BM0096/T-74	651.80	98.60	46.10	04.V.	I
5	A1BM0012/Priboi	632.80	134.40	45.40	13.V.	I
6	A6BM0195/T-221	643.90	124.30	47.00	12.V.	I
7	A6BM0191/T-213	614.20	101.70	44.30	07.V.	I
8	St. Sadovo 1	605.70	98.00	47.00	14.V.	I
9	A1BM0082/T-123	619.50	113.40	50.30	07.V.	I
10	A6BM0192/T-193	621.40	108.80	46.30	**03.V.**	I
11	A1BM0078/T-119	627.40	112.10	47.70	07.V.	I
12	A1BM0102/T-130	627.70	106.80	42.90	07.V.	I
13	St. AD72-91	633.60	111.90	43.20	08.V.	I
14	A6BM0194/T-220	622.80	123.70	**58.30**	12.V.	I
15	A1BM0018/TC-128 Sadovetz	702.80	104.00	44.70	08.V.	II
16	A6BM0193/T-220	**711.40**	121.80	47.60	06.V.	II
17	A6BM0189/T-148	656.90	111.10	45.10	07.V.	III
18	A1BM0029/TC-177 Prevala	659.80	103.60	47.00	05.V.	III
19	A1BM0067/TC-370	666.80	109.80	45.10	07.V.	III
20	A1BM0088/T-39	678.40	108.20	43.60	06.V.	III
21	A1BM0089/T-40	681.90	102.80	47.90	06.V.	III
22	A1BM0068/T-4	676.90	116.80	50.30	08.V.	III
23	A1BM0035/TC-210 Rozhen	684.60	**135.00**	50.20	08.V.	III
24	A1BM0132/T-139	516.40	103.30	41.50	07.V.	IV

In the collection of triticale breeding lines genetic diversity with respect to the investigated morphological features is found.

The performed analysis of variance showed that for all three quantitative traits the variability is low – less than 10%. The highest variable indicator is the height of the plant, which is with the biggest response for the available diversity in the studied triticale collection (Table 3).

Table 3. Variation of quantitative traits in the studied triticale genotypes

Indicators	Mean	Min	Max	Std. deviation	CV%	Stand. Error
Average crop yield, kg/da	644.30	516.40	711.40	39.20	6.10	8.00
Plant height, cm	110.50	96.30	135.00	10.70	9.70	2.20
Weight of 1000 grains, g	46.30	41.20	58.30	3.60	7.80	0.70

The cluster analysis of experimental data grouped the triticale breeding lines based on their similarity by the studied morphological traits. The results are presented by dendrogram, showing the sequence of clustering of genotypes in four clusters (Fig. 1).

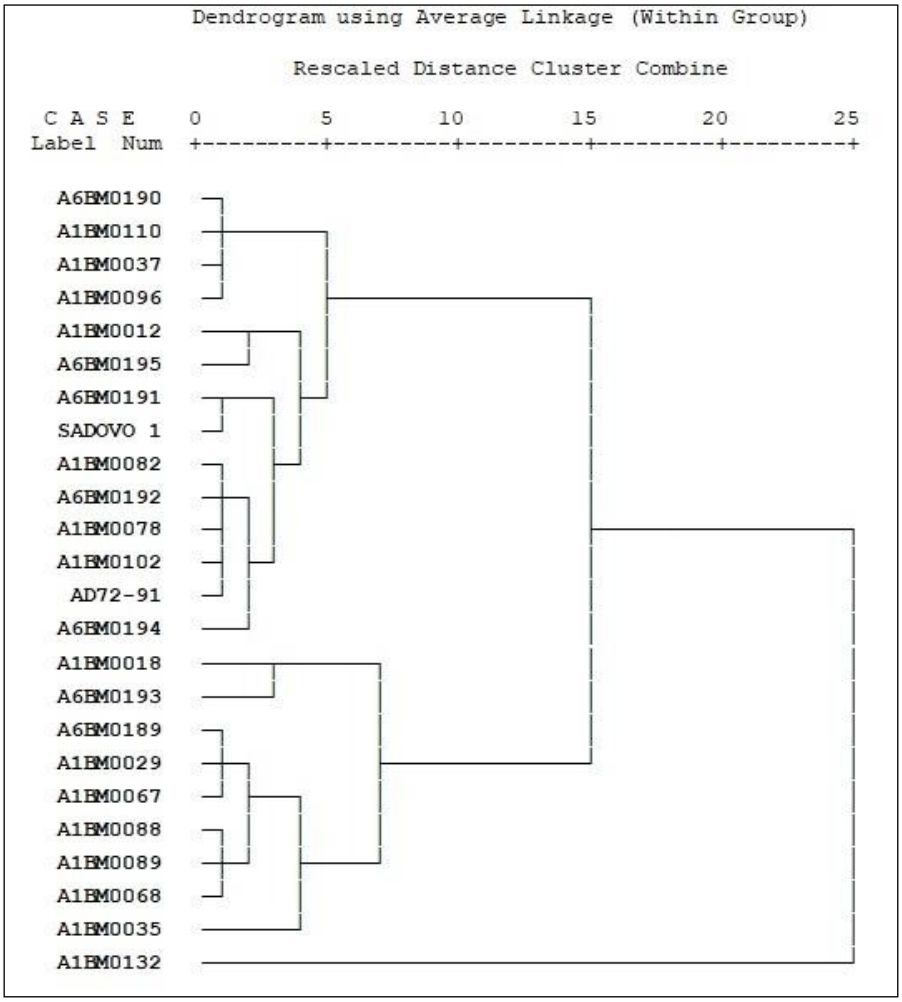

Figure 1. Dendrogram of grouping of *Triticosecale* breeding lines by using of hierarchical cluster analysis

Average crop yield is one of the most important indicator of economical importance of the triticale regarding its use like forages and food. The dendrogram on Fig. 1 and the data in Table 2 show that the highest yield samples are included in the same cluster – T-218 (A6BM0193) and TC-128 Sadovetz (A1BM0018). They are characterized by an average crop yield of more than 700kg/da, respectively 711.40 and 702.80 kg/da, exceeding the standards Sadovo 1 and AD72-91. Regarding to height of the plant, breeding line T-218 exceeds the value of the two control varieties.

Breeding lines, which are showing crop yield exceeding the standards in the range of 684.60 to 659.80 kg/da formed a single cluster group. It includes line TC-210 Rozhen with Cat. № A1BM0035, characterized by the highest height of the plant (135.00 cm) in the studied triticale collection.

The largest cluster includes the varieties Sadovo 1 and AD72-91, as well as 12 breeding lines with average crop yield, approaching to the standard varieties by this indicator. The samples also show a genetic similarity to controls by the other investigated economical traits. The line T-220 with Cat. № A6BM0194 made an impression with the highest weight of 1000 grains (58.30 g) for the collection. Two of the genotypes, lines T-88 (A1BM0110) and T-193 (A6BM0192), are the earliest by the date of heading for the tested breeding materials on the average three-year period.

The line T-139 (A1BM0132) is characterized with the lowest yield (516.40 kg/da) in the studied triticale collection. On the dendogram (Fig. 1) it is visible that the sample forms a single cluster and shows the the greatest diverse from the other genotypes included in the study.

From the analysis it could be concluded that the main indicator responsible for the clustering of the collection is the average crop yield.

Conclusion

In the investigated collection of triticale breeding lines a genetic diversity by the studied economical traits is established.

Based on the cluster analysis, the triticale collection is divided into four groups, combining samples with similar morphological characteristics.

It was found that with defining importance for the clustering of the studied collection is average crop yield.

The breeding lines T-218 (A6BM0193) and TC-128 Sadovetz (A1BM0018) are the most perspective in the studied triticale collection for the crop improvement purposes. They show the best economic qualities and exceed the accepted standards by average yield.

The results of this investigation support the breeding-improvement programs in culture by identifying of genotypes with valuable economical traits.

REFERENCES

Annemuller, G., B. Mietla, G. Creydt, F. Rath, R. Schildbach and T. Tuszynski (1999). Triticale and triticale malt: III. First brewing trials with triticale malts. Monatsschrift fur Brauwissenschaft, 52, 7-8, 131-135.

Creydt, G., B. Mietla, F. Rath, G. Annemuller, R. Schildbach and T. Tuszynski (1999). Triticale and triticale malt: II. Oriented malting of triticale. Monatsschrift fur Brauwissenschaft, 52, 7-8, 126-130.

Dimova, D. and E. Marinkov (1999). Experimental Case and Biometrics. Academic Publishing House of AU, Plovdiv, 263 pp.

Georgiev, St., St. Stamatov, N. Ganusheva and M. Deshev (2013). Approaches and methods as a model in the breeding of self-pollinated crops. Academic Publishing House of Agricultural University. Plovdiv. 276.

Kolev, T., I. Stankov and J. Terziev (2003). Productivity of new triticale genotypes. Plant Sci., 40, 4, 308-310.

Leon, A. E., A. Rubiolo and M. C. Anon (1996). Use of triticale flours in cookies: quality factors. Cereal chem., 37, 6, 779-784.

Leon, A. E., G. Jovanovich and M. C. Anon (1998). Gelatinization profiles of triticale starch in cookies as influenced by moisture and solutes. Cereal chem., 75, 5, 617-623.

Lidanski, T. (1988). Statistical methods in biology and in agriculture. Ed. Zemizdat.

Popov, P. and B. Matzov (1980). Study on the biological and economical qualities of Mexican triticale in view of the possibilities for their introduction in the country. Plant Sci., 17, 2, 24-29.

Popov, P., D. Dimitrov and K. Gvozdiev. 1981. Results of Triticale Study in Elena Region. Plant Sci., 18, 4, 44-51.

SPSS for Windows. Base System User`s Guide. Release 13.

Terziev, G. (2000). Yield and grain quality in several varieties of wheat, triticale and barley. Plant Sci., 37, 7, 431-435.

Wang, S., K. C. Thomas, K. Sosulski, W. M. Ingledew and F. M. Sosulski (1999). Grain pearling and very high gravity fermentation technologies for fuel alcohol production from rye and triticale. Proc. Biochem., 34, 5, 421-428.