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Agro-morphological and biochemical characterization of Georgian common wheat (*T. aestivum*) – „Dolis puri" sub-varieties

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ABSTRACT

Wheat is one of the most important cereal grains in the world, which requires continuous yield and quality improvement. As one of the centers of wheat domestication, Georgia is distinguished by its diversity of local common wheat (*Triticum aestivum*) varieties. Overall, there are 40 varieties of bread wheat described in Georgia and among them, „Dolis puri" sub-varieties are one of the oldest and widely distributed throughout the different regions and altitudes of Georgia. With the accelerated genetic erosion and loss of agricultural biodiversity worldwide, conservation and characterization of genetic diversity in regional breeding pools are very urgent and important steps for their preservation. In this study, we characterized and evaluated Georgian common wheat (*T. aestivum*) – „Dolis puri" local varieties kept in different genebanks to assess their remaining genetic diversity. Complete agro-morphological and biochemical characterization of each accession were performed during 2 years of regeneration, in field and laboratory conditions. Overall, 28 traits were measured in 115 common wheat accessions, and 69 of them were taxonomically identified as 9 local sub-varieties of Dolis puri. Selected accessions were studied on seed quality (biochemical) traits and classified in core-collections according to their traditional distribution regions. Among all studied sub-varieties, white Dolis Puri sub-varieties were revealed to have better spike morphology characteristics and overall higher grain yield. The Tsiteli (red) Dolis puri sub-varieties were distinguished with higher gluten content and better grain quality traits, compared to studied white Dolis Puri sub-varieties. According to characterization data, we revealed the real value of conserved samples and increased possibilities to improve their use in research, breeding and educational programs.

Keywords: Common wheat, Dolis puri, *Triticum aestivum*, Agro-morphological, Biochemical characterization, Educational programs.

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Introduction

Wheat is one of the widely cultivated crops worldwide and the second most-produced cereal after maize [1-3]. Due to seeds composition and unique properties of gluten proteins, wheat holds a special place in the food supply of the world's population and demand for yield improvement is one of the main goals of scientists globally [4-5].

More than 90% of the worldwide produced wheat is cultivated common wheat (*Triticum aestivum* L.), also known as bread wheat [6-11]. Common wheat is an allohexaploid, combining the genomes of three ancestral diploid grass species [12], and this is undoubtedly contributing to its adaptability to different regions and climatic conditions of the world [13].

Georgia is distinguished by its great diversity of cultural plants and wild flora. These are due to a wide range of soil-climatic conditions - overall, there are described four climatic zones and 17 major soil types on the territory of Georgia [14].

Georgia is known as a hotspot for wheat diversity and endemism according to N. Vavilov, V. Menabde and their followers [15-18]. Wheat is one of the ancient and characteristic crops of Georgia. According to the findings from the various archeological sites of Georgia (Arukhlo, Khramis Gora, Shulaveri, Chikhori, Kheltubani), the cultivation of wheat in Georgia began in the VI-V century BC and continued through the whole history of the country [19-21]. So far, 27 cultivated and wild species of wheat have been described around the world out of which 14 species are found in Georgia [17, 22].

Among other domesticated wheat species present in Georgia, the great diversity of local common wheat (*T. aestivum*) is noteworthy. Many of these varieties are endemic, and a diversity of genetic variations was established during the centuries in very different natural-historical conditions. Overall, there are 40 varieties of bread wheat described in Georgia and among them, the most widespread ones are - var. *aestivum*, var. *ferrugineum*, var. *lutescens*, var. *milturum* [17, 20, 21]. All these forms are diverse according to their ecological, biological and morphological properties. Among them are varieties of comparatively dry and humid regions of East Georgia, humid regions of Western Georgia and mountainous zone of South Georgia.

Dolis puri is one of the oldest common wheat varieties in Georgia. The term "Doli" was mentioned in written documents dated back to the VIII-IX century, but I. Djavakhishvili [23] was indicating on its cultivation since much earlier times. Dolis puri used to be the principal wheat variety in Georgia during the centuries due to its high milling value, good backing property and tasty aromatic bread produced from it. Dolis puri was widely distributed throughout the different regions and altitudes of Georgia – in the high mountainous regions - Svaneti and Racha, it could grow at elevations as high as 2,000 m [24].

Like other countries worldwide, Georgia experiencing accelerated genetic erosion of agricultural biodiversity since the second half of the 20th century. It is expected soon, that this process will take an even broader scale, which will lead to large losses of local plant genetic resources *in-situ*. Modern improved higher-yielding varieties have largely replaced and have almost entirely driven away local traditional varieties from Georgian farming. Currently, problems facing plant breeders are the reduction in the diversity of the genetic material available for breeding purposes.

Nowadays *ex-situ* conservation is one of the main methods applied to preserve plant genetic resources. This method has some advantages comparing to other methods of conservation such as *in situ* or *on-farm*. Seed samples that are stored in genebank storage facilities maintain their genetic integrity. If the seed sample contains a sufficient amount of seed, it can fully represent the genetic structure of both self- and cross-pollinated plants. Seed samples are stored in appropriate conditions, they are regenerated and the chance of their loss is very low. It is easy to characterize and evaluate *ex-situ* collections, as all accessions are well-documented and it is easy to access them for research and breeding purposes [25].

Undoubtedly, conservation and characterization of genetic diversity in regional breeding pools are very urgent and important steps for their preservation.

Thus, the main goals of our study were to: (1) assess the genetic diversity of local common wheat - Dolis puri germplasm; (2) perform complete agro-morphological and biochemical characterization of each accession (3) evaluate agronomic properties and diseases and pests resistance in the field conditions; (4) identify the taxonomic classification of each accession (5) and assemble the core collection covering the complete diversity of Dolis puri sub-species ever recorded and described in Georgia [20, 21].

Materials and Methods

Plant material

The wheat accessions from the Bank of Plant Genetic Resources (Genebank) of the Agricultural University of Georgia and wheat local germplasm received from foreign genebanks, such as Leibniz Institute of Plant Genetics and Crop Plant Research (IPK), USDA Agricultural Research Service (ARS), International Maize and Wheat Improvement Center (CIMMYT) were used for this study. This is because, that since there was not a genebank until 2004 in Georgia, a great diversity of local wheat germplasm collected on the territory of Georgia during the last century, currently is stored and protected in different international genebanks. In total, 115 common wheat accessions were regenerated and characterized during this study.

Experimental Section

Experiments were carried out at the Genebank regeneration field (Mukhrani field station of the

Agricultural University of Georgia) (N41°57′42″, E44°34′31″, altitude 549 m). The soil texture of the experimental area has an argillaceous-sandy, slightly alkaline reaction and unsalted.

Agro-morphological characterization

Local Genebank accessions and wheat samples received from the foreign genebanks were regenerated and multiplied in two-years replicated agricultural experiments. In autumn of 2017 and 2018, 20 g of each accession were sown on a 1.5-2 m^2 plot for field characterization. During the regeneration and multiplication process characterization and evaluation of each accession were performed based on traits that are indicated in the international descriptors of the crop [26].

Plant characterization data - growth class (seasonality), growth habit, pre-harvest sprouting tendency, lodging susceptibility, sowing date, flowering time and harvest date were recorded during all plant development stages – from the germination to plant maturity.

Plant height was measured by the main shoot length without a spike. The number of tillers, tillering capacity and the number of fertile tillers per plant were counted manually.

Ten mature plants from each plot were harvested manually for further characterization and phenotypic measurements in the laboratory.

In addition to plant phenotypic measurements in the field, we examined spike and grain morphology traits at the physiological maturity stage. For each accession spike data - density, awnedness, glume color, glume hairiness, number of seeds per spike, grain average number per spikelet - were recorded, also seed characteristics – seed color, size, vitreousness, and degree of shriveling - were measured. The results of measurements for each accession were averaged and means and standard deviations were calculated using the Excel program.

Measurement of grain yield components and quality traits

Usually, in small-grain cereals, spike morphology and spikelets number are crucial in determining grain yield [27-30]. Besides the tiller formation capacity and morphology of spike, grain number and grain weight are also important factors affecting grain yield [31-34].

Ten spikes from each accession were randomly selected for quantitative trait measurements. Spike length (without awn) in (cm), fertile spikelet number per spike, grain number per spike and thousand kernel weight (TKW) (g) were measured. Besides, spikelet density was determined (spikelet number per centimeter of spike length) as a ratio of spikelet number per spike to spike length [28]. Spikelet fertility (%) was identified as a ratio of fertile spikelet number per spike to total spikelet number per spike. Grain yield was calculated according to grain weight per spike and was adjusted to moisture content.

Overall, 28 traits were measured in 115 studied accessions and each was described according to their bio-morphological and agronomic traits and evaluated on grain yield.

In the selected taxonomically identified samples seed quality traits were studied. Grain's main biochemical characteristics - the content of protein, gluten, starch, fiber was measured.

Measurement of the protein, gluten, starch, and fiber content

The total protein content was measured on the Perten Inframatic 8800 NIR grain analyzer, equipped with a diode-array detector, on the wavelength range 850-1050 nm, calibrated to measure wheat parameters ten times per set. In each seed sample content of protein, wet gluten and moisture were measured in triplicate experiments and results were averaged.

The total starch content was determined via the polarimetric method specified for the determination of the starch content of native starch [35]. For the measurements, wheat grains were grounded, sifted to specific particle size and obtained flour was used for biochemical measurements. A 100 mg fraction of each sample was used to determine starch contents. Polarimeter POLAX-2L was used with an Interference filter at 589 nm and minimal indication unit: Angle of rotation 0.05°.

The crude fiber was measured following GOST 31675 [36]. This method applies to the determination of the crude fiber value in cereals and cereal products. The main principle is as follows - after boiling the sample flour with a mixture of acetic, nitric and trichloro-acetic acids, the undissolved residue is separated and ignited. The crude fiber value is calculated from the ignition loss.

Evaluation of resistance to diseases and pests

During the regeneration and field characterization, samples were evaluated on diseases and pest

susceptibility or resistance. Mainly fungal diseases and common pests for the region were evaluated according to CIMMYT's handbook on field identification of wheat diseases and pests [37]. A list of identified diseases and pests were recorded from each plot for every sample with a simultaneous reading of severity and reaction together with percent of disease spread severity according to plants Scoring Guide (IPO and CIMMYT) and scale for appraising the intensity of foliar diseases in wheat [38].

Results and Discussion

Characterization and evaluation of genebank accession is the most important procedure, which provides better access to samples to improve their use in research and breeding. Characterization implies the description of biological-morphological and agronomic traits with simple inheritance, for which international crop descriptors can be used, while the evaluation is mostly concentrated on agronomically important traits that have quantitative inheritance such as yield and quality. Characterization and evaluation of the samples enabled us to identify samples with unique traits and assemble them in core-collections to facilitate their further use.

Based on the performed complete agro-morphological characterization data, overall 69 accessions were taxonomically identified and classified in 9 local Dolis puri sub-varieties (Fig. 1). A set of bio-morphological characteristics, available etalons and photo material from the books were used to distinguish specific sub-verities of Dolis puri amongst the whole population of 115 samples [18, 19]. The identified samples were grouped according to their traditional distribution regions in Georgia - as sub-varieties of comparatively dry regions of East Georgia, the humid regions of East Georgia, the humid regions of West Georgia and the mountain zone of Southern Georgia (Table 1) (Fig. 1, Fig. 2).

Besides, plant characterization data, recorded during the regeneration, were gathered and averaged for each sub-species and compared to the literature data for each sub-varieties to ensure correct taxonomic identification of each accession (Table 2). From all studied samples plant growth class (seasonality) was mainly winter, except Tetri (white) Dolis puri, which is spring type. All samples had an upright growth habit of a young plant, naked grains, and a low pre-harvest sprouting tendency. The planting date of all samples was the same, but according to the

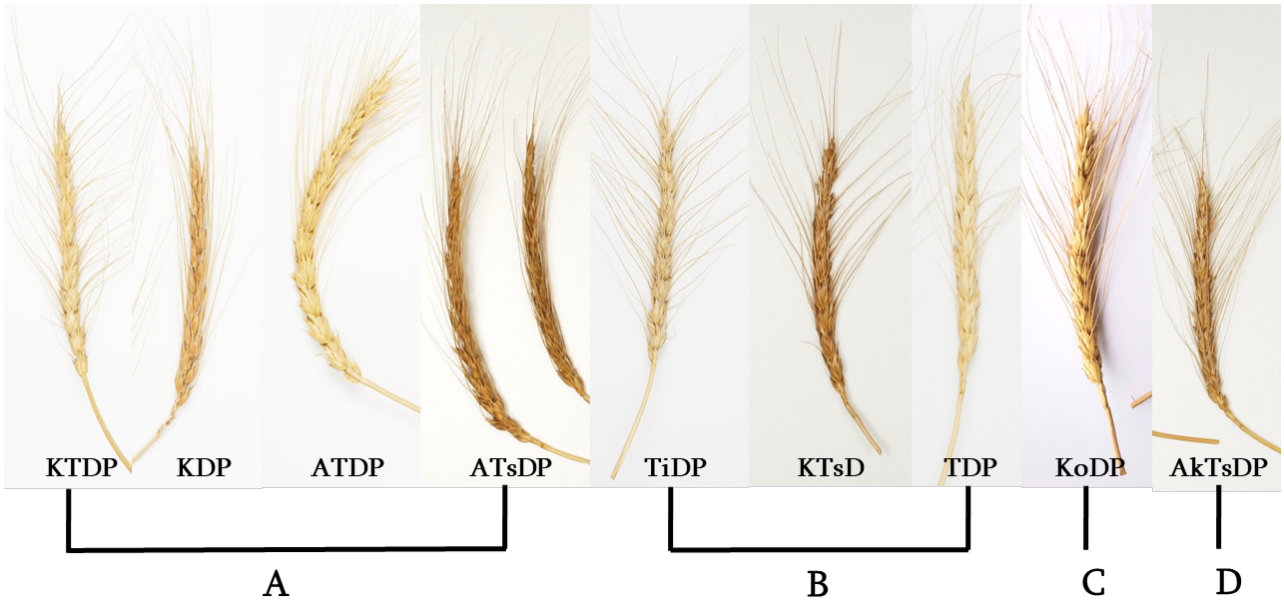

Fig. 1. *Taxonomically identified Dolis puri local varieties according to their morpho-physiological characterization data: A – sub-varieties of comparatively dry regions of East Georgia, B - sub-varieties of the humid regions of East Georgia, C - sub-varieties of the humid regions of Western Georgia, D - sub-varieties of a mountain zone of Southern Georgia. KTDP - Kartlis Tetri (White) Dolis puri, KDP - Kakhuri Dolis puri, ATDP - Adgilobrivi (local) Tetri (white) Dolis puri, ATsDP – Adgilobrivi (local) Tsiteli (red) Dolis puri, TiDP - Tianeturi Dolis puri, KTsD - Kartlis Tsiteli (red) Dolis puri, TDP - Tetri (white) Dolis puri, KoDP - Korboulis Dolis puri, AkTsDP - Akhaltsikhis tsiteli (red) Dolis puri.*

Table 1. *The list of the identified Dolis puri local varieties according to the morpho-physiological characterization data. The Dolis puri local names: Kartlis, Kakhuri, Tianeturi, Akhaltsikhis, Korboulis means respective regions - Kartli, Kakheti and Tianeti, district Akhaltsikhe and also village Korbouli in Georgia. In Georgian „Tetri" means white, „Tsiteli" - red and „Adgilobrivi" - local.*

	Local names	Accession Number #	Scientific name	Abbreviation
1. Sub-varieties of comparatively dry regions of East Georgia				
1	Kartlis Tetri (White) Dolis puri	GEO3062	*Triticum aestivum* var. *aestivum* (var. *erythrospermum* Korn)	KTDP
2	Kakhuri Dolis puri	GEO3066, GEO3067, GEO3068, GEO3069, GEO3070, GEO3071, GEO3072, GEO3073	*Triticum aestivum* var. *aestivum* (var. *erythrospermum* Korn)	KDP
3	Adgilobrivi Tetri (white) Dolis puri	GEO0055, GEO3079, GEO3081, GEO3082, GEO3083, GEO3084, GEO3085, GEO3086, GEO3087, GEO3088, GEO3089, GEO3090, GEO3091	*Triticum aestivum* var. *aestivum* (var. *erythrospermum* Korn)	ATDP
4	Adgilobrivi Tsiteli (red) Dolis puri	GEO0156, GEO3107, GEO3108, GEO3109, GEO3110, GEO3111	*Triticum aestivum* L. var. *ferrugineum* (Alef.) Mansf.	ATsDP
2. Sub-varieties of the humid regions of East Georgia				
5	Tianeturi Dolis puri	GEO3063, GEO3064, GEO3065	*Triticum aestivum* var. *aestivum* (var. *erythrospermum* Korn)	TiDP
6	Kartlis Tsiteli (red) Dolis puri	GEO0053, GEO0054, GEO3095, GEO3096, GEO3097, GEO3098, GEO3099	*Triticum aestivum* L. var. *ferrugineum* (Alef.) Mansf.	KTsD
7	Tetri (white) Dolis puri	GEO3046, GEO3047, GEO3048, GEO3049, GEO3050, GEO3051, GEO3052, GEO3053, GEO3054, GEO3055, GEO3056, GEO3057, GEO3058, GEO3059, GEO3060, GEO3061	*Triticum aestivum* var. *aestivum* (var. *erythrospermum* Korn)	TDP
3. Sub-varieties of the humid regions of Western Georgia				
8	Korboulis Dolis puri	GEO0056, GEO0057, GEO0058, GEO3092	*Triticum aestivum* var. *aestivum* (var. *erythrospermum* Korn)	KoDP
Sub-varieties of a mountain zone of Southern Georgia				
9	Akhaltsikhis Tsiteli (red) Dolis puri (Meskhuri)	GEO0050, GEO0051, GEO0052, GEO0492, GEO3100, GEO3101, GEO3102, GEO3103, GEO3104, GEO3105, GEO3106	*Triticum aestivum* L. var. *ferrugineum* (Alef.) Mansf.	AkTsDP

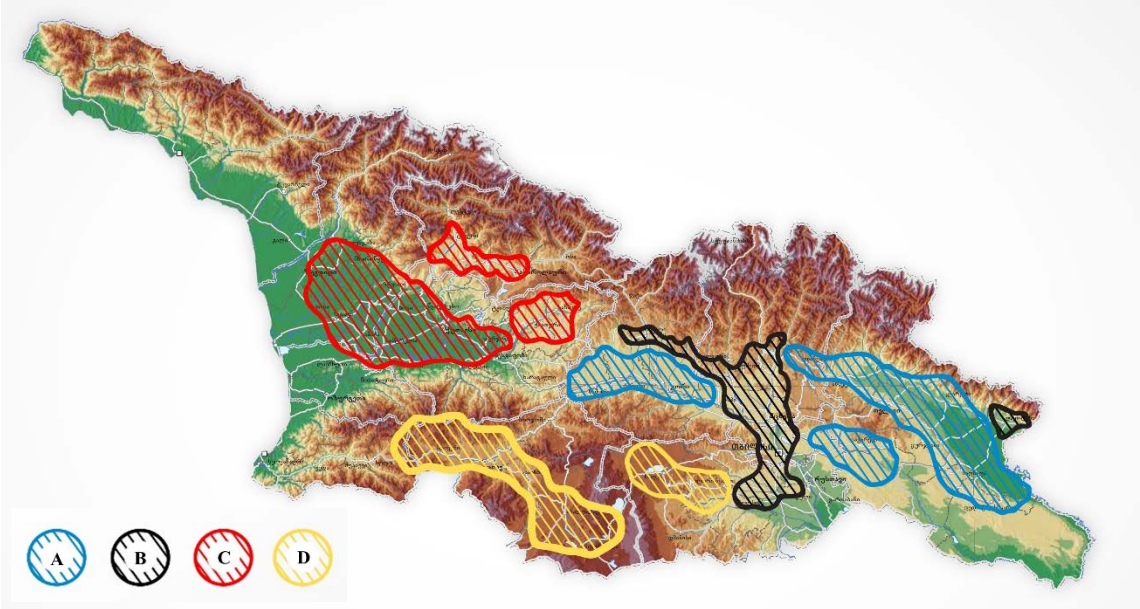

Fig. 2. *Main regions of Georgia with the spread of local Dolis Puri sub-varieties: A – Comparatively dry regions of East Georgia (Kakheti, Kartli and Mtskheta-Mtianeti regions); B - Relatively humid regions of East Georgia (Shida Kartli region); C - The humid regions of Western Georgia (Imereti, Racha-Lechkhumi, Samegrelo and Svaneti Regions); D - Mountain zone of Southern Georgia (Samtskhe-Javakheti region). Modified from the Atlas of natural hazards and risks of Georgia, Tbilisi, Georgia, 2018. Map source: ASTER GDEM is a product of METI and NASA; CENN/IT (p.11); Climate data was used from the Climate Atlas (p.17), Source: Atlas of Georgia, 1964; Data on the distribution of Dolis puri's sub-varieties are presented from Naskidashvili et. al. 1983; Samadashvili et. al. 2019 [18, 19, 39].*

Table 2. *Field characterization data of studied Dolis puri accessions: growth class (seasonality), the growth habit of young plant, pre-harvest sprouting tendency, sowing date, days to flower, harvest date. The abbreviation is explained in table 1.*

#	Variety	Growth class	Growth habit of young plant	Pre-harvest sprouting tendency	Sowing date	Days to flower	Harvest date	Grain hull	Lodging susceptibility
1	KTDP	Winter	Erect	Low	28.10.18	212.5	05.08.19	Naked	Yes
2	KDP	Winter	Erect	Low	28.10.18	214	30.07.19	Naked	Yes
3	ATDP	Winter	Erect	Low	28.10.18	216	25.07.19	Naked	Yes
4	ATsDP	Winter	Erect	Low	28.10.18	214.5	30.07.19	Naked	No
5	TiDP	Winter	Erect	Low	28.10.18	219.5	30.07.19	Naked	Yes
6	KTsD	Winter	Erect	Low	28.10.18	222	30.07.19	Naked	Yes
7	TDP	Spring	Erect	Low	28.10.18	221.5	30.07.19	Naked	Yes
8	KoDP	Winter	Erect	Low	28.10.18	217	30.07.19	Naked	No
9	AkTsDP	Winter	Erect	Low	28.10.18	220	30.07.19	Naked	Yes

Table 3. *Plant, spike and grain characterization data of studied Dolis puri accessions: plant height (cm), tillering capacity (number of fertile tillers), spike density, awnedness, glume color, glume hairiness, number of spikelets per spike, number of seeds per spike, grain number per spikelet. The abbreviation is explained in table 1.*

Variety	KTDP	KDP	ATDP	ATsDP	TiDP	KTsD	TDP	KoDP	AkTsDP
#	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
Plant height (cm)	86.6±14.6	105.7±9.6	98.9±9.8	106.2±10.8	103.3±8.7	108.3±5.3	105.8±8.5	107.0±10.6	105.4±13.7
Tillering capacity	4.70±1.42	7.71±2.35	7.98±1.99	8.32±2.23	9.25±1.57	6.00±2.04	8.35±2.09	7.40±3.37	6.88±2.35
Spike density	Interm.	Interm.	Dense	Interm.	Interm.	Dense	Interm.	Interm.	Dense
Awnedness	Awned	Awned	Awned	Awnletted	Awned	Awned	Awned	Awned	Awnletted
Glume color	White	Red-brown	White	Red-brown	White	Red-brown	White	White	Red-brown
Glume hairiness	Absent	Absent	Absent	Low	Absent	Absent	Absent	Absent	Low
Grain number per spikelet	2-3	2-3	2-3	2-3	2-3	2-3	2-3	2-3	2-3
Seed colour	Red	Red	Red	Purple	Red	Purple	Red	Purple	Red
Seed size	Interm.	Interm.	Interm.	Interm.	Interm.	Interm.	Interm.	Interm.	Interm.
Seed vitreousness	Partly vitreous	Not vitreous	Not vitreous	Vitreous	Not vitreous	Not vitreous	Not vitreous	Not vitreous	Not vitreous
Degree of seed shriveling	Plump	Plump	Plump	Plump	Plump	Plump	Plump	Plump	Plump

harvest date, Kartlis Tetri (White) Dolis puri needed more time until maturity. Most of the samples were susceptible to lodging, except for Adgilobrivi Tsiteli (red) Dolis puri and Korboulis Dolis puri.

Characterization of the Dolis Puri sub-varieties revealed quite differences between studied varieties even within the distribution region. Sub-varieties of East Georgia, both – comparatively dry and humid regions were characterized by higher tillering capacity. Adgilobrivi Tetri (white) Dolis puri, Adgilobrivi Tsiteli (red) Dolis puri, Tianeturi Dolis puri, Kakhuri Dolis puri and Tetri (white) Dolis puri have a high number of fertile tillers (7-9) comparing to other studied varieties. Among them, the highest tillering number was recorded in the case of Tianeturi Dolis puri. The Kartlis Tetri (White) Dolis puri was revealed to have the lowest tillering capacity among all studied varieties (Table 3).

As a result of our study, Korboulis Dolis puri was revealed to have the highest spike length, grain number per spike, grain weight per spike, and spikelet number per spike compared to other studied varieties. All these spike components undoubtedly contributed to the final grain yield per spike and resulted in the highest grain weight per spike and in overall, grain yield observed in the case of Korboulis Dolis puri (Table 4). Adgilobrivi Tetri (white) Dolis puri revealed to have also profound spike and grain characteristics and consequently high grain yield.

Table 4. *Grain yield components of studied Dolis puri accessions: spike length, spikelet number per spike, grain number per spike, thousand kernel weight (TKW), spikelet fertility, spikelet density, grain weight per spike, grain yield. The abbreviation is explained in table 1.*

#	Variety	Spike length (cm)	Spikelet number per spike	Grain number per spike	Thousand kernel weight (g)	Spikelet fertility (%)	Spikelet density	Grain weight per spike (g)	Grain yield (g)
1	KTDP	11.08±0.17	21.33±1.15	50.00±9.00	23.55±0.73	87.18±5.32	1.94±0.10	1.17±0.18	1.05±0.18
2	KDP	12.50±0.50	22.00±2.00	40.33±2.52	37.90±2.71	86.47±7.55	1.76±0.09	1.53±0.14	1.37±0.14
3	ATDP	12.65±0.35	20.67±0.58	58.50±9.19	39.93±1.45	85.17±8.05	1.68±0.10	2.33±0.28	2.08±0.28
4	ATsDP	11.55±1.02	18.40±1.58	35.20±7.45	31.04±2.76	-	1.60±0.08	1.09±0.26	0.98±0.26
5	TiDP	10.67±0.58	20.00±2.00	55.67±1.53	28.17±0.94	86.23±8.51	1.87±0.11	1.57±0.06	1.41±0.06
6	KTsD	11.26±2.86	18.94±1.80	26.36±5.38	33.41±7.13	-	1.74±0.29	0.89±0.21	0.80±0.21
7	TDP	12.53±0.15	22.33±2.08	35.00±2.83	39.72±0.47	83.63±6.60	1.76±0.23	1.39±0.13	1.25±0.13
8	KoDP	14.50±0.71	22.33±0.58	68.50±0.71	41.58±1.41	89.79±3.53	1.52±0.07	2.89±0.07	2.59±0.07
9	AkTsDP	10.83±1.20	18.03±1.64	32.08±8.43	26.53±8.23	88.12±5.44	1.69±0.13	0.86±0.32	0.77±0.32

Table 5. *Biochemical characteristics: protein, gluten, starch and crude fiber content in seeds of selected samples. The abbreviation is explained in table 1.*

Variety	KTDP	KDP	ATDP	ATsDP	TiDP	KTsD	TDP	KoDP	AkTsDP
#	1	2	3	4	5	6	7	8	9
Protein, DW* (%)	16.13±0.21	18.03±0.21	16.47±0.15	19.77±0.21	18.97±0.12	19.53±0.25	17.90±0.10	19.13±0.23	19.60±0.10
Gluten, FW** (%)	34.73±0.35	38.20±0.53	33.70±0.35	42.10±0.30	40.23±0.42	41.83±0.42	37.67±0.42	40.83±0.67	42.40±0.46
Starch, DW (%)	66.73±0.39	64.39±0.19	67.34±0.08	65.82±1.16	64.39±0.78	65.74±0.06	60.78±0.39	66.08±0.39	65.18±0.59
Crude Fiber, DW (%)	4.26	4.44	3.95	2.97	4.86	3.43	5.01	3.90	4.02
Moisture (%)	10.60±0.00	10.53±0.06	10.60±0.00	10.20±0.00	10.40±0.00	10.37±0.06	10.40±0.00	10.30±0.00	10.37±0.06

DW* - Dry weight
FW ** - Fresh weight

Among Dolis puri sub-varieties, Tsiteli Doli (Triticum aestivum var. ferrugineum), or "red wheat," is a landrace of winter bearded (or awned) soft wheat. There are several local varieties of Tsiteli Doli, one of which is from Akhaltsikhe, in the southern Georgian region of Samtskhe-Javakheti (Fig. 2). They are well known for their grain quality traits and the high quality of bread produced from them. According to our study, spike characteristics of the Tsiteli Dolis Puri sub-varieties are less profound, but taking into account their tillers formation capacity and grain quality traits, they are valuable varieties for Georgian agriculture (Table 4, Fig. 1).

Grain quality traits

Selected Dolis puri varieties' seed biochemical composition is given in Table 5. Tsiteli (red) Dolis puri sub-varieties turned out to have an incredibly high amount of protein content – more than 19 % per seed dry weight (Table 5, Fig. 1). From Tetri (white) Dolis puri sub-varieties - Korboulis, Tianeturi, and Kakhuri Dolis puri revealed to have high protein content, 19.13 %, 18.97 %, and 18.03 %, respectively. Consequently, the Tsiteli (red) Dolis puri sub-varieties were distinguished with higher gluten content compared to white Dolis Puri sub-varieties (Table 5).

However, Tetri (white) Dolis Puri sub-varieties demonstrated higher starch content in the grain. Kartlis Tetri Dolis puri, Adgilobrivi Tetri Dolis puri, and Korboulis Dolis puri are distinguished with high starch content in the seed, — 66.82 %, 66.2%, and 66.08% respectively. The crude fiber content in studied varieties was ranging from 2.97 to 5.01.

Evaluation of diseases and pests

According to field evaluation data, most of the studied samples are expressing moderate resistance (5-10%) to the leaf rust (Table 6). For Fusarium head blight of wheat (FHB), also called head scab, which is caused by the fungus *Fusarium graminearum*, from studied Dolis Puri sub-varieties Korboulis Dolis puri was least resistant to this infection (10%). Dolis Puri sub-varieties of East Georgia revealed higher resistance to Fusarium head blight of wheat.

Aphids infestation was rarely observed, only in the case of Adgilobrivi Tetri Dolis Puri it was identified.

Conclusion

The field experiments and agro-morphological characterization of the studied accessions revealed differences between all identified Dolis puri local sub-varieties. Korboulis Dolis puri was revealed to have better spike morphology traits, compared to other studied varieties and as a result, the highest grain weight per spike and overall grain yield. Also, Adgilobrivi Tetri (white) Dolis Puri revealed to have profound spike and grain characteristics and consequently higher grain yield.

Among Dolis puri sub-varieties, Tsiteli (red) Dolis puri (*Triticum aestivum* var. *ferrugineum*) sub-varieties have less profound spike and grain characteristics, but good tillers formation capacity and excellent protein content. The Tsiteli (red) Dolis puri sub-varieties were also distinguished with higher gluten content and other grain quality traits, compared to studied white Dolis Puri sub-varieties,

Table 6. *Evaluation of diseases and pests: susceptibility to leaf rust, Fusarium head blight of wheat (FHB) (Fusarium graminearum) and Aphids (Diuraphis noxia). The abbreviation is explained in table 1. Disease reactions were recorded as - no visible infection (0), resistant (R), moderately resistant (MR); reading of severity and reaction was recorded together with percent of the severity of the infection.*

	Variety	Susceptibility to leaf rust	Susceptibility to Fusarium head blight	Aphids infestation
1	KTDP	5 MR	0	-
2	KDP	5 MR	1 R	-
3	ATDP	10 MR	5 MR	yes
4	ATsDP	5 MR	1 R	-
5	TIDP	5 MR	0	-
6	KTsD	5 MR	0	-
7	TDP	10 MR	5 MR	-
8	KoDP	5 MR	10 MR	-
9	AkTsDP	5 MR	5 MR	-

as it was supposedly because they are traditionally known for their perfect bread baking characteristics.

According to bio-morphological characterization and evaluation data, we are assembling the core collection covering the complete diversity of Dolis puri varieties ever recorded and described in Georgia. As a result, we revealed the real value of conserved samples and increased possibilities to improve their use in research and breeding to facilitate variety improvement, as well as in phylogenetic studies and educational programs.

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