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Original article

Characterization Data of Cereal, Legumes and Technical Plants by the International Descriptors Lists

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Abstract

As in many fields, the possibilities of the information technologies have been widely used in the field of agriculture. Creation, *ex-situ* conservation, documentation and digitalization of the national plant collections are the great importance in an era when natural plant resources and traditional breeding materials are disappearing. In our republic special attention was paid to the creation of information systems, as well as a central database in the Law of the Azerbaijan (2011) about the conservation of genetic resources of cultivated plants and its efficient use. From 2004 has been created an information system on PGR at the Institute of Genetic Resources. This database consists of the information about national *ex situ* collection of plant genetic resources collected in the Azerbaijan environment in the format of passport descriptors and characterization data. The importance of plant characterization databases in agricultural research introduction in the field of agriculture, the accurate characterization of plant species is crucial for various research and development purposes. The passport descriptor data is the data such as taxonomy data, geographical, storage, recovery, exchange, introduction and reintroduction, organizations in the field of study, conservation and utilization of plant gene pool, farmers, information about breeders and donors, what about the characterization data, this is a data about morphological analyses, quality indicators, physiological analyzes and biochemical analyzes. This data is crucial for prioritizing and managing germplasm collections to ensure the conservation of genetic diversity. As a result of these studies, plant seed accessions were characterized using special descriptors lists based on international standards issued by International Biodiversity and ICARDA. In the Central Database, the characterization data is reflected in the "Characterization" tables created for each plant groups with characterization information. These tables are linked with other relevant tables that form the core of the database to obtain taxonomy data, accession number, biological status and other such important information about plant genetic resources. As a result, it was created a trait collection for 12 plant groups. Thus, the results of relevant researches (morphological analyses, quality indicators, physiological analyzes and biochemical analyzes results), carried out by the cereals and leguminous plants and the technical plant laboratories of the institute which accessions taken from Genbank are reflected in those databases. Plant breeders use such databases to identify desirable traits in plant varieties for breeding programs. By accessing information on the genetic traits of different varieties, breeders can make informed decisions on which plants to cross to develop new varieties with improved characteristics.

Keywords: Descriptors Lists, Genbank, Characterization Data, Evaluation Data, Database, Cereals, Legumes, Technical Crops.

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INTRODUCTION

The rich diversity of the cultivated plants on the territory of the Azerbaijan Republic is represented by 4,500 species, which makes up 64% of the flora of the Caucasus and 11% of the flora of our planet.

In the Law of the Azerbaijan Republic on the protection and effective use of genetic resources of cultivated plants, special attention was paid to the creation of information systems, as well as the central database (Law, 2011a).

The adoption of the National Program for the protection of biodiversity in Azerbaijan, and the activities about it, with the establishment of the National Genbank at the Institute of Genetic Resources, the existing plant collections in the country created a need to improve the database with more complete information (characterization and evaluation data) about those existing accessions. Characterization is a scientific description of plant germplasm (Law, 2011a; Z.I. Akparov et al.,2018).

The characterization data has more complete detailed information about the plant, such as the results of the experiment, scientific research and observations carried out during the research period. This information is essential for the development of new crop varieties with improved traits such as higher yield, better nutritional quality, and enhanced resilience to environmental stresses. Moreover, plant characterization databases enable researchers to compare and contrast different plant varieties, identify genetic markers associated with desirable traits, and predict the potential outcomes of plant breeding experiments. It should be noted that although the passport descriptors are common for all plant diversity, plant descriptors for characterization and evaluation categories are compiled individually for each plant or plant group (Utpal and Nabarun, 2017b; WIEWS et al.,2011b). It means, the same plant descriptor lists cannot be used for wheat and lentils. In particular, it should be noted that even the plant descriptor lists compiled for cultivated and wild wheat species significantly differ from each other.

To increase the value, quality and usability of conserved seeds, for the purpose of revealing their valuable features were used the international plant descriptors adopted by Europe and many other countries in accordance with world standards (Weise and et al., 2017c; Link, 2024a). These standards were presented to the breeders, plant researchers, then the investigations and evaluations were carried out based on these standards (Mammadov, 2014; Mirzaliyeva, 2021; Mirzaliyeva et al., 2017a). The plant genetic resources were collected and inventoried in the environment of Azerbaijan and preserved in national *ex situ* collections (Akparov et al., 2013). As a research result the passport descriptors and the characterization data on plant genetic resources are reflected in the characterization databases created for each plant or plant group within the Central Database of the Institute.

MATERIALS and METHODS

As the research work materials for the creation of the national gene pool characterization databases, it was taken from the National Genebank bread and durum wheat (*Triticum aestivum* L.,

Triticum durum Desf.), barley (*Hordeum vulgare* L.), maize (*Zea mays* L.), rye (*Secale* L.), triticale (*Triticosecale*), bean (*Phaseolus* L.), cow pea (*Vigna* Savi), vetch (*Vicia* L.), horse bean (*Vicia faba*), lentil (*Lens culinaris* L.), pea (*Cicer* L.), grass pea (*Lathyrus* L.) and gossypium (*hirsutum, barbadense*) L. collections, including passport, environmental, climate, geobotanical, taxonomic, storage, restoration, exchange, introduction, characterization data standardized by appropriate technologies. Field and laboratory journals, breeder records, catalogs, articles, other related literature, genealogical material reports, and descriptors lists played an important role as the primary source for collecting data. Standardization, digitalization, collection, and processing of research results on plant studies were performed using international passport descriptor and evaluation descriptors (IBPGR and ICARDA,1985; IPGRI,2000). Specification and evaluation descriptors provide more detailed information about each plant or plant group individually. Quantitative and qualitative criteria for comparison and characterization, statistical processing was used in the analysis of collected information. Also, a number of classical and modern methods, including Database Management Systems and software packages and database servers, other open software, internet resources, and SQL programming language to write in-base small programs (Mirzaliyeva,2021).

During the selection of descriptors for the characterization data and the structuring of the data were used the systems on the bases of the International Biodiversity and ICARDA (International Center of Agriculture in Dry Areas) (IBPGR,1982; IBPGR and ICARDA,1985; IBPGR et al., 1993). Based on those international standards, plant seed samples were characterized using special descriptors established by the International Biodiversity Institute. Descriptors lists are standardized sets of descriptive terms used to characterize and document the traits and attributes of plant genetic resources. These descriptors are widely used in the field of plant genetic resources conservation and management. This documentation helps in maintaining a comprehensive inventory of plant genetic resources for future reference and utilization. Standardized descriptors facilitate the exchange of plant genetic materials between institutions and countries. By using a common set of descriptors, researchers and organizations can accurately communicate the characteristics of plant germplasm being exchanged, enabling effective collaboration and sharing of genetic resources (Mirzaliyeva, 2021).

During the investigation was taken bread and durum wheat, barley, maize, rye, triticale, bean, cowpea, vetch, horse bean, lentil, chickpea and cotton collections conserved in the National Genbank and their standardized passport, environmental, climate, geobotanical, taxonomy, conservation, regeneration, exchange, introduction, characterization data as the research materials (IBPGR and ICARDA,1985; IBPGR et al., 1993; IPGRI, 2000).

Characterization databases for cereals, legumes and technical plants have been established within the Central Database System. The results of appropriate investigation carried out by the institute relevant laboratories on plant accessions which taken from the Genbank, as a result, the data have been reflected

in those databases, due to this the database has been enriched with the characterization data of the individual plants or plant groups. And this is a big opportunity for the plant breeders to make selections in other research works on plant in the future.

Thus, have been developed interfaces and methods that facilitate the provision of information support for their effective use in future breeding and other plant research by analyzing data from complex studies conducted on plant gene pool accessions.

Results

In our research work we use results of breeding and other plant research work according to the relevant studies conducted (morphological analyses, quality indicators, physiological analyses) in previous years on cereals, leguminous, technical plant samples taken from the National Genbank. Created databases which can give the selection possibilities due to the characterization data on international descriptors to ensure the level of information which useful for plant breeding and research works. Also, analysis on characterization data has been the one of our essential goals. For this purpose, within the structure of the Central Database of the National Genbank of the Genetic Resources Institute have been created, databases on cereal, leguminous and technical plants.

In the Microsoft Visual FoxPro database management system of the Central Database created "Characterization" tables for each plant groups which reflected characterization data. These tables are linked with other relevant tables of the central database that make the basic composition of the database in order to obtain the information about taxonomy, accession number, plant biological status and such other important information (Mirzaliyeva et al., 2017a).

In MS Excel spreadsheet files where we included characterization data for each plant group the trait fields were different based on the list of international descriptors. For example, the trait fields of Excel spreadsheets tables in which we entered the characterization data of cereal crops (wheat, barley, maize, triticale) differ according to the number and type of the data fields of legumes (beans, cowpeas, lentils, chickpeas, field peas, horse beans, chickpeas). In particular, it can be noted that even the plants in the same group (for example, cereal crops) has different type and number of traits in the characterization database (Table 1.)(IBPGR,1982; IBPGR,1984; IBPGR and ICARDA,1985; IBPGR et al.,; IPGRI,2000).

Table 1. Characterization traits and number of characterized plants

Characterized plant	Characterization traits	Number of traits
Bread and durum wheat *Triticum aestivum* L. and *Triticum durum* Desf.,	plant height, number of productive tillers, spike length, number of splikelets, spike weight, number of kernels per spike, spike density, 1000 kernels weight,1000 kernels weight	9
Barley *Hordeum vulgare* L.	growth class (seasonality), number of fertile tillers per plant, sowing day, days to flower, plant height, number of spikelet groups per spike, awn roughness, spike length, number of grains per spike, weight of seeds per spike, harvest year, powdery mild, looce smut, common bunt, type of awn , spike weight, number of common tillers per plant, row number (lateral florets), awnedness, spike density, 1000 kernels weight	21
Maize *Zea mays* L.	vegetation period, plant height, number of leaves, number of ears per plant, length of an ear, diameter of an ear, number of rows per an ear, number of kernels per row, weight of the kernel per an ear, percentage of kernels per an ear	10
Rye *Secale* L. and Tritikale × *Triticosecale*	growth type, crop year, productive bush, plant height, spike length, number of spikelets, tolerance to desease, number of grains per spike, mass of grains per spike, 1000 kernels weight	9
Bean *Phaseolus vulgaris* L.	days to 50% flowering, flower ground colour, days to maturity (when 90% of plants have mature pods), leaf type, plant height, growing habitat, leaf size, number of beans per bean, bean length, plant hairiness, bean color, plant pigmentation, leaf type, pod shedding, planting season, protein content %, weight of 100 kernels, etc.	20
Cow pea *Vigna unguiculata* (L.)Walp.	days to 50% flowering, flower ground colour, days to maturity (when 90% of plants have mature pods), leaf type, plant height, growing habitat, leaf size, number of beans per bean, bean length, plant hairiness, bean color, plant pigmentation, leaf type, pod shedding, planting season, protein content %, weight of 100 kernels, etc.	19
Grass pea *Lathyrus* L., Vetch *Vicia* L. and faba bean *Vicia faba* L.	Days to 50% flowering, flower ground colour, days to maturity, height of plant, protein content, growth habit, leaf size, number of bean in plant, number of grains in bean, color of grain, plant hairiness, plant pigmentation, number of ground flower, number of ground pods, pod shedding, pod dehiscence (at maturity), length of bean, weight of 100 kernels, planting season, leaflet number per leaf (from median part of plant), productivity 1 squ.m, protein quantity, leaf type, seed color and ets.	24
Lentil *Lens culinaris* L.	days to 50% flowering, flower ground colour (ground colour of the standard petal), days to maturity (when 90% of plants have mature pods), growth habit, leaf size, seed type, seed color, seed surface, planting season, leaflet size (medial pair of leaflets), plant hairiness, plant pigmentation, number of flowers, year of evaluation, drought tolerance, cold tolerance, emergence time, plant height, number of branches, number of primary branches, number of secondary branches, number of pods per plant, pod width, pod length, number of seeds per pod days to podding, seed yield per spot, seed yield per 1m2, dry protein content, fusarium resistance, anthracnose resistance, mosaic, tryptophan content, weight of 100 kernels, and ets.	33

Chickpea *Cicer arietinum* L.	50% flowering period, flower color, days to maturity, growth habitat, leaf size, seed type, seed color, seed surface, planting season, plant hairiness, plant pigmentation, number of flowers per bed, evaluation year, drought tolerance, cold tolerance, plant height, number of primary branches, number of secondary branches, number of branches, number of pods per plant, pod width, pod length, number of seeds per pod, seed yield per patch, seeds per seedbed yield, plant production, dry protein content %, resistance to fusarium, resistance to anthracnose, amount of tryptophan, weight of 100 kernels, etc.	33
Cotton *Gossypium* (hirsutum, barbadense) L.	days to 50% flowering , 50% maturity days of plant height, mass of one boll, raw cotton yield per plant, fiber yield, weight of 1000 kernels, viral disease,	7

Table 2. The number of accessions and traits by plant groups which have characterization dat

N	Botanical name of plants	Local name of plant	Number of accession	Number of traits
1	*Triticum aestivum L.*	Bread wheat	1052	9
2	*Triticum durum Desf.*	Durum wheat		
3	*Hordeum (distichon,vulgare) L.*	Barley	199	21
4	*Secale (sereale,segetale) L.*	Rye	135	9
5	*Triticale x triticosecale*	Triticale	19	9
6	*Zea mays L.*	Maize	178	10
7	*Cicer arietinum L.*	Chickpea	553	33
8	*Phaseolus vulgaris L.*	Lobya	93	20
9	*Vicia faba L.*	Horse bean	89	22
10	*Lens culinaris (esculentha,ervoides) L.*	Lentil	277	33
11	*Lathyrus sativus L.*	Grass pea	67	24
12	*Vicia (evilia,grandiflora,hirsute,lathyroides, narbonensis,sativa,tetrasperma,truncatula, variabilis,variegate,villosa)* L.	Vetch	149	24
13	*Vigna* (*unguiculata,radiata,sinensis*) L.	Cow pea	25	19
14	*Gossypium (hirsutum,barbadense)* L.	Cotton	308	7
Total			3144	240

As a result of the study, 3144 samples were characterized according to international standards on a total of 240 traits. The created characterization bases were classified into 12 plant groups, including cereals, legumes and technical plants (Table 2.).

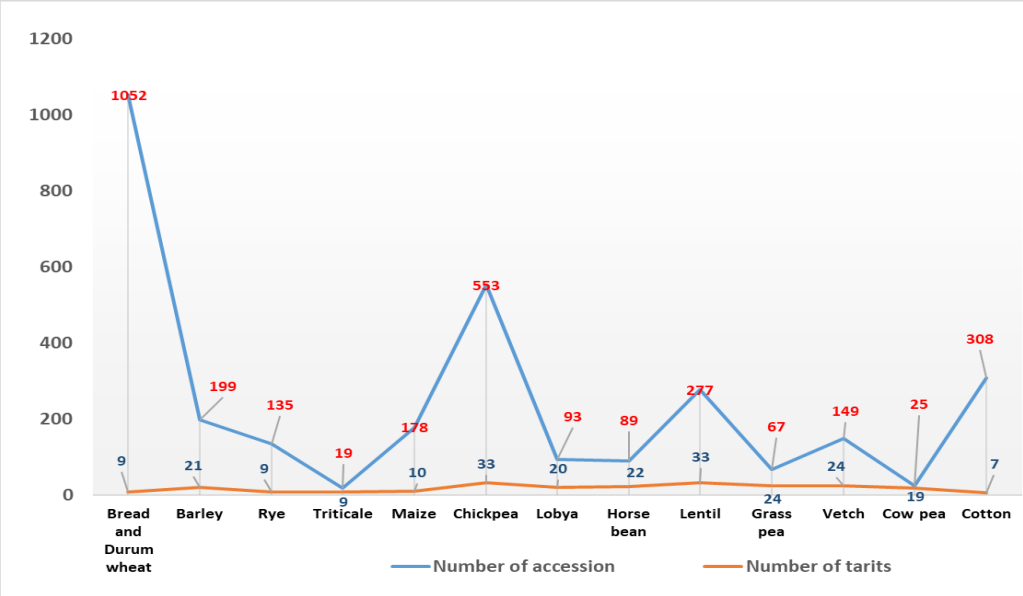

Figure1. Characterized accessions and trait numbers by plant groups

By creating the characterization databases of cereals, legumes, and technical plants, also have been created the trait collections of those plants, which is very important for plant selection. The creation of characterization databases helps to evaluate priority collections and samples, to find valuable genes in the collections, to keep them under control, and to reveal deficiencies and problems. It is possible to use the existing databases as a model for the creation of characterization databases of other plants and plant groups. Also, a selected part of the characterization data is available in the international web-based networks, for example The European Search Catalogue for Plant Genetic Resources (EURISCO) (https://eurisco.ipk-gatersleben.de/apex/eurisco_ws/r/eurisco/c-e-data), (Link,2024b) and the GENESYS portal (https://www.genesys-pgr.org/geo/AZE) (Link,2024c). EURISCO provides information on a wide range of crop plants, including characterization data. GENESYS is a global portal for plant genetic resources that provides access to information about plant genetic resources held in worldwide Genbanks. It offers access to passport data, characterization data, and more. It is possible to view this information by logging into the relevant portals or download any segment to a computer by separating it from the general context.

In our research work, we explored the significance of plant characterization databases and traits collections in advancing agricultural research and improving crop productivity. Plant characterization databases are comprehensive repositories of information that document the genetic diversity, morphological, physiological, and molecular traits of plant species. These databases contain data on various aspects of plant biology, including growth habits, disease resistance, yield potential, nutritional content, and environmental adaptability.

In conclusion, plant characterization databases and traits collections are essential tools in agricultural research for understanding the genetic diversity, traits, and characteristics of plant species. These resources provide valuable information that can be used to improve crop productivity, develop new crop varieties with desirable traits, and conserve plant genetic resources. By leveraging the data and germplasm available in plant characterization databases and traits collections, researchers and breeders can accelerate crop improvement efforts and address the challenges of global food security and sustainability

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