GENETICA, BIOLOGIA MOLECULARĂ ŞI AMELIORAREA

DOCUMENTATION OF THE *SOLANACEAE* GENETIC RESOURCES IN REPUBLIC OF MOLDOVA

Romanciuc Gabriela, Gaevscaia Valentina, Mihnea Nadejda, Focşa Nina

Institute of Genetics, Physiology and Plant Protection, Academy of Sciences of Moldova

Introduction

În cadrul Laboratorului de Resurse Genetice Vegetale a Institutului de Genetică, Fiziologie şi Protecţie a Plantelor, al Academiei de Ştiinţe a Moldovei, a fost elaborat şi implementat în practică sistemul de documentare ReGen, ce conţine date privind colecţiile de plante existente în banca de gene.

În această lucrare sunt aduse date privind documentarea colecţiei de germoplasmă a familiei *Solanaceae* conservate *ex situ*. În studiu au fost incluse trei specii: tomatele (*Solanum lycopersicum* L.), ardeiul (*Capsicum annuum* L.) şi pătlăgele vinete (*Solanum melongena* L.). În baza de date ReGen sunt stocate datele de paşaport şi datele de evaluare şi caracterizare a 583 mostre de tomate, 152 mostre de ardei şi 48 mostre de pătlăgele vinete. Fiecare mostră este însoţită de un set de informaţii standardizate, cuprinse în aşa-numiţii descriptori de paşaport, elaboraţi de Institutul de Resurse Genetice Vegetale (Bioversity International) şi care permit atât identificarea probelor, precum şi schimbul de informaţii la nivel naţional şi internaţional. Structura datelor de evaluare şi caracterizare corespund standardelor internaţionale (FAO/ Bioversity International).

Cuvinte cheie: sistem de documentare, resurse genetice vegetale, baza de date, descriptori, familia *Solanaceae*

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Adresa pentru corespondenţă: Romanciuc Gabriela, Institutul de Genetică, Fiziologie şi Protecţie a Plantelor al Academiei de Ştiinţe a Moldovei, str. Pădurii, 20, MD-2002 Chişinău, Republica Moldova; e-mail: gabriela.romanciuc@gmail.com; tel: 022556264

Introducere

With the increased environmental crisis (genetic erosion) and of political importance of plant genetic resources (PGR) the role of information on germplasm has grown dramatically.

Initial plant genetic resources approach has been focused to the study and conservation of genetic diversity, now the attention is given to the management and effective utilization of existing germplasm collections in the gene banks. This fact has led to the emphasis of the importance of information on plant genetic resources, which has become in some aspects more important than germplasm itself. It's means that the information determines significantly the value of plant genetic resources [4]. In order to strengthen the conservation and to enhance the utilization of plant genetic resources, there is a strong need for the development of better and more accessible information and documentation systems. Documentation skills are essential resources for any genebank. Much of the information acquired and generated by a genebank is of interest and of value to the scientific community.

In field of plant genetic resources, documentation is an imperative for planning and implementing genebank's activities, related to their conservation, sustainable utilization and equitable sharing of benefits arising from their use. The need of PGR documentation is related in the Article 7d, 17 of the Convention of Biological Diversity (CBD, 1993), and the Activities 17, 18 of the Global Plan Action (FAO, 1996) [1, 6]. Documentation refers to compilation, analysis, classification, storage and dissemination of information. In plant genetic resources, documentation means dissemination of information about various activities such as collections, evaluation, conservation, storage and retrieval of data. Now the term documentation is more appropriately known as information system.

Documentation plays the role of common service at all levels of plant genetic resources work. It is follows all PGR activities: sample gathering (passport information), description of sample (characterization and evaluation), and conservation of sample (storage information). The documentation is a source of information on the stored material. It allows to check the amount of genetic erosion occurring in different areas, to decide about the opportunity of organizing further missions for collecting germplasm, to know the amount of material available for distribution, its germinability, and the need for rejuvenation. It is a source of information necessary for taking further decisions.

The collection, maintenance, characterization and documentation of crop plants and their wild relatives are important contributions towards the preservation of biological diversity. Globally, there are about 1.800 genebanks and/or germplasm collections exist. According to FAO (2010), these holdings are distributed as follows: Africa maintains 5 % of the world's germplasm accessions; Asia, 31 %; Europe, 23 %; Latin America and the Caribbean, 14 %; Near East, 6 %; North America 10 %; and international and regional gene banks, 1.5 %. In addition, there are also substantial *ex situ* collections in the over 2,500 botanical gardens worldwide [3].

Genebanks holding approximately 7.4 million accessions of which an estimated 2 million are unique (FAO, 2010). Of the 3.8 million accessions with status information available, about 700.000 (18%) are crop wild relatives (CWR) and 1.700.000 (44%) landrace accessions, held in respectively 724 and 901 genebanks. In Europe, approximately 625 genebanks and/or germplasm collections have been reported, holding more than 2 million accessions of which 30-40% have been estimated to be unique (FAO, 2010). Further, approximately 84.500 accessions of the 1.1 million accessions are wild species (including CWR) and 268.840 landrace accessions maintained in respectively 120 and 223 genebanks [5].

Peeters and Williams estimated that 65% of the 2 million plant germplasm accessions held in genebanks worldwide lack basic data on the source and a greater proportion of those accessions lack characterization and evaluation data vital for its subsequent use in plant breeding and enhancement. This has to be improved, because if no information is available on the resources conserved, chances are that they will never be requested and used in research and plant improvement programmes which should be the ultimate goal of any conservation strategy [7].

The four largest national collections in the world are located in the USA, Russia, India and China. In terms of total number of accessions, the largest genera are those of wheat (*Triticum*), rice (*Oryza*), barley (*Hordeum*), maize (*Zea*), common bean (*Phaseolus*), sorghum (*Sorghum*), soybean (*Glycine*), cowpea (*Vigna*), potato, tomato and eggplant (*Solanum*), oat (*Avena*), groundnut (*Arachis*), cotton

(*Gossypium*) and, cabbage (*Brassica*), all with more than 100,000 accessions stored in genebanks globally [13].

The documentation of germplasm accessions is important issue in the facilitation of sustainable use of genetic resources. Many gene banks developed comprehensive documentation system for managing their genetic resources data, providing basic information for decision making and identifying useful materials for research and variety development [14]. It is recognized that many of the world's *ex situ* germplasm collections are insufficiently and poorly documented. While some countries have fully computerized documentation systems and complete accession data (most European Countries, the USA, Canada, Australia, Japan, China, India, Brazil etc.), many countries have only partial computerization of documentation systems and much more limited data on accessions. The most known international information system on plant genetic resources at the international level are SINGER, WIEWS, ECP/GR platform, IPGRI Crop Directories, as well as to the national level GRIN in USA, GENRES in Germany, Nordic Gene Bank in Scandinavia etc.

In order to effectively use the information on the germplasm collections in Republic of Moldova, *ReGen* – that represents the information system on plant genetic resources in the Republic of Moldova was established.

The main objective of the present work is to provide a review of the *Solanaceae* collection documentation focused on actual status in Republic of Moldova, and to analyze available information with regard to these collections maintained in genebanks worldwide.

Materials and methods

The main subject of this paper is *Solanaceae* collections conserved in the Laboratory of Plant Genetic Resources of Institute of Genetics, Physiology and Plant Protection, Academy of Sciences of Moldova. Especially, will be analyzing the three species *Solanum lycopersicum*, *Capsicum annuum* L. and *Solanum melongena* L. It is about active collections, stored under medium term conditions at a temperature of +4°C. The data of *Solanaceae* collections is total computerized, especially passport data and partial evaluation and characterization data.

The system for the documentation of plant genetic resources in Republic of Moldova named *ReGen* represents unified information system that includes three basic functional blocks: *ex situ* (seed collections), *in situ* - maintenance of plant genetic resources in natural habitats, data that are obtained as a result of *plant* collecting expeditions carried out in different regions of country, and finally, data on crops and crop varieties grown *on-farm* [10]

The genetic resources database at the *ReGen* is based on a relational data model. The schema consists of tables, which can be classified into two categories: passport data, and characteristics/evaluation data. Between tables through indexation may establish certain relationships that allow fast search of necessary information. Each table has "dbf". extension. Databases containing specific information and can be manage separately, or linked when is necessary to combine information from different database [9, 11].

Passport data are the core of the genetic resources database. To identify individual genetic resources, accession numbers are assigned to every genetic resource when passport data are entered into the database. The accession number is a key descriptor linking the mentioned above the data categories.

For elaboration of ReGen system was used programming language Visual Fox Pro 9.0. The system was set up for operation system Microsoft Windows 2000 and XP. For the standardization of data are used common international descriptors, developed by the Bioversity International with the participation of FAO. In case of passport data are used the List of Multi-Crop Passport Descriptors (MCPD), and for evaluation and characterization – IPGRI Crop descriptors.

Results and discussion

Presently, many institutions maintaining germplasm collections have the information concerning their holdings. Proper management and availability of data are essential to promote the use of crop diversity for research, breeding etc. Concerning the data on *Solanaceae* family, it is documented at the global level, and as well as national.

Documentation of *Solanaceae* collections at the Global level and in Europe

Tomato documentation

Worldwide, in 1987 the estimated number of seed bank entries for tomato (and their relatives) was 32,000. Now, it is estimated over 83 720 accessions of *Solanum lycopersicum*, maintained in more than 120 countries [12]. The biggest tomato collection is in United State, where the United States Department of Agriculture (USDA) Plant Genetic Resources Unit holds about 6000 accessions, with 15%wild species and the Tomato Genetic Resources Center (TGRC) in the Department of Vegetable Crops of the University of California Davis holds about 3700 accessions, of which 30% are wild and 30% monogenic stocks. In Asia, the biggest collection is hosted by the Asian Vegetable Research and Development Center (AVDRC) in Tainan in Taiwan, hosting more than 7200 accessions, 14% are wild. Other important genebanks for tomato germplasm worldwide are in Germany, at the Genebank of the Institute for Plant Genetics and Crop Plant Research (IPK) at Gatersleben (>3000 entries), in the Russian Federation at the N.I. Vavilov All-Russian Scientific Research Institute of Plant Industry, and in the Philippines, at the National Plant Genetic Resources Laboratory.

At the European Level, through the *Solanaceae* working group of the European Cooperative Programme for Plant Genetic Resources (ECPGR) was established the collaborative programme among most European countries. The aim of this programme is the facilitating long-term conservation and utilization of plant genetic resources in Europe. In additional, was created the Tomato Database, hosted at the Wageningen Agricultural University, the Netherlands. This database contained the passport data for more than 21000 accessions of tomato and tomato relatives held by 38 institutions in 26 European countries. The data base has been developed according to the IPGRI /FAO Multicrop Passport Descriptors List [2].

Pepper documentation

Large collections of pepper are kept ex situ in various genebanks of the world. AVRDC – The world Vegetable Center, hosts one of the largest genebanks in the world for *Capsicum*, conserves one of the most diverse collections of *Capsicum* germplasm and contains eight species comprising 7500 accessions from 95 countries. The USDA collection contains several thousand accessions of all cultivated species.

In Europe, the Vegetable Research Institute of Budapest focuses exclusively on pepper. ECPGR estimated over 20000 accessions. The European Database for pepper is being developed by the Aegean Agricultural Research Institute (AARI), Izmir, Turkey, including especially passport data [2].

Eggplant documentation

Genetic resources of eggplant are conserved *ex situ* in various genebanks worldwide, with large collections maintained in China. In India, the centre of eggplant domestication, the National Bureau of Plant Genetic Resources (NGPGR) maintains over 2500 accessions. Other genebanks that collect and keep eggplant accessions and related species are the National Institute and Agrobiological Resources in Japan, the AVRDC in Taiwan, the USDA Beltsville Research Station in the USA, and the Vavilov Institute in Russia. The European genebanks containing eggplant accessions are at INRA (France), Nijmegen Botanical Garden (The Netherlands), and the University of Birmingham in the UK. A European project and network EGGNET connects all the European eggplant collections and has developed primary and secondary descriptors for eggplant germplasm characterization. The European eggplant database contains about 6000 accessions and provides passport data and some secondary data [2].

The Solanaceae family holds an important place in vegetable cultivation in Republic of Moldova. Cultivated species of this family are *S. lycopersicum L*., *S. tuberosum, Capsicum annuum L., S. melongena* L. etc. *Solanaceous* vegetable crops are among the most economically important vegetables cultivated at the national level.

The *Solanaceae* germplasm collections are held at the Institute of Genetics, Physiology and Plant Protection, Academy of Sciences of Moldova. In the information system *ReGen* is included 847 accessions of cultivated and wild species belonging to 2 genera. The taxonomic composition of the collections is shown in Table 1. The genus *Solanum* is represented by eight species, *Capsicum* by one.

Table 1. Taxonomic composition of the *Solanaceae* collections

Genus/species	No. of accessions
Tomato *(Solanum lycopersicum*)	
Solanum lycopersicum.	**583**
S. lycopersicum var. *cerasiforme*	17
S. lycopersicum var. *pruniforme*	2
S. lycopersicum var. *racemigerum*	5
S. lycopersicum var. *pyriforme*	1
S. lycopersicum var. *succenturiatum*	1
Solanum pimpinellifolium L.	**13**
Solanum cheesmaniae (L. Riley) Fosberg	**1**
Solanum peruvianum L.	**33**
Solanum habrochaites S. Knapp & D.M Spooner *(L.hirsutum)*	**11**
Solanum corneliomuelleri J.F. Macbr. (L. glandulosum)	**4**
Solanum chilense (Dunal) Reiche	**2**
Total tomato	**647**
Pepper *(Capsicum* L.)	
Capsicum annuum L.	152
Total pepper	**152**
Eggplant (*Solanum* L.)	
Solanum melongena L.	48
Total eggplant	**48**
Total *Solanaceae*	847

The pepper accessions belong to *Capsicum annuum* (152) while *S. lycopersicum* (583) is the most represented species in the tomato collection. The eggplant collection is the smallest one and includes 48 entries of *S. melongena.* These collections cover

different origin and types of accessions such as cultivars (CV) and hybrids from domestic and foreign breeding, landraces (LR), wild relatives (W), and a number of mutant lines (M). The collections are increased by collecting missions, germplasm exchange between genebanks, or acquisition of new initial breedin

Table 2. Status of samples in the pepper, tomato and eggplant collections in IGPPP.

Crop	Nr. of accessions				
	Total	W	LR	CV	M
Tomato	647	64	9	391	183
Pepper	152			152	
Eggplant	48			48	
Total	847	64	9	591	183

1. Structure of the *Solanaceae* collections

Tomato. Currently, the collection of tomato includes 647 accessions. Many recorded samples are cultivars originated mostly from European countries: the Netherlands, Germany, Hungary, Italy etc. The number of accessions from USA, Russian Federation and Canada is significant (Table 3).

Table 3. Structure of the *Solanaceae* collections according to country of origin.

Species	Country of origin	Nr. of accessions
Solanum lycopersicum	Republic of Moldova	64
	Ukraine	22
	Russian Federation	71
	Hungary	13
	Germany	17
	USA	148
	Canada	16
	Netherlands	13
	Italy	16
	Bulgaria	10
	Poland	8
	Other	249
Capsicum annuum L.	Republic of Moldova	131
	Poland	2
	Ukraine	5
	Russian Federation	1
	Belarus	7
	Romania	6
Solanum melongena L.	Republic of Moldova	45
	Ukraine	1
	Russian Federation	2

Tomato genetic resources comprise the single cultivated species *Solanum lycopersicum* maintained in IGPPP, which includes cultivated tomato varieties, foreign varieties (583 accessions), hybrid and a large mutant collection (183). Wild species include *S. habrochaites* S. Knapp & D.M Spooner (11 accessions), *Solanum corneliomuelleri* J.F. Macbr. (4), *Solanum cheesmaniae* (L. Riley) Fosberg (1), *S. peruvianum L.* (33), S. chilense (Dunal) Reiche (2) and S. *pimpinellifolium* (13).

Pepper and eggplant. The collection consists of foreign and local cultivars. The foreign accessions originate from Poland, Romania, Russian Federation, and Ukraine (Table 3). Most of material is used in breeding programme.

2. Documentation of Solanaceae family

Passport data are recorded for all accessions according to IPGRI Multi-crop Passport Descriptors and FAO WIEWS Descriptors (Table 4). All passport, characterization and evaluation data are computerized.

Passport data includes thirty-three fields such as: institute code, accession number, collecting number, genus, species, accession name, acquisition date, country of origin, geographical description, biological status, collecting source, pedigree, donor institution etc (Fig.1).

Table 4. Documentation status of the *Solanaceae* collections

Species	Nr. of accessions	Passport data	Evaluation/ Characterization data	Conservation status
Solanum lycopersicum	647	647	34	Active collection/ medium term
Capsicum annuum	152	152	152	Active collection/ medium term
Solanum melongena	48	48	48	Active collection/ medium term
Total	841	812	234	

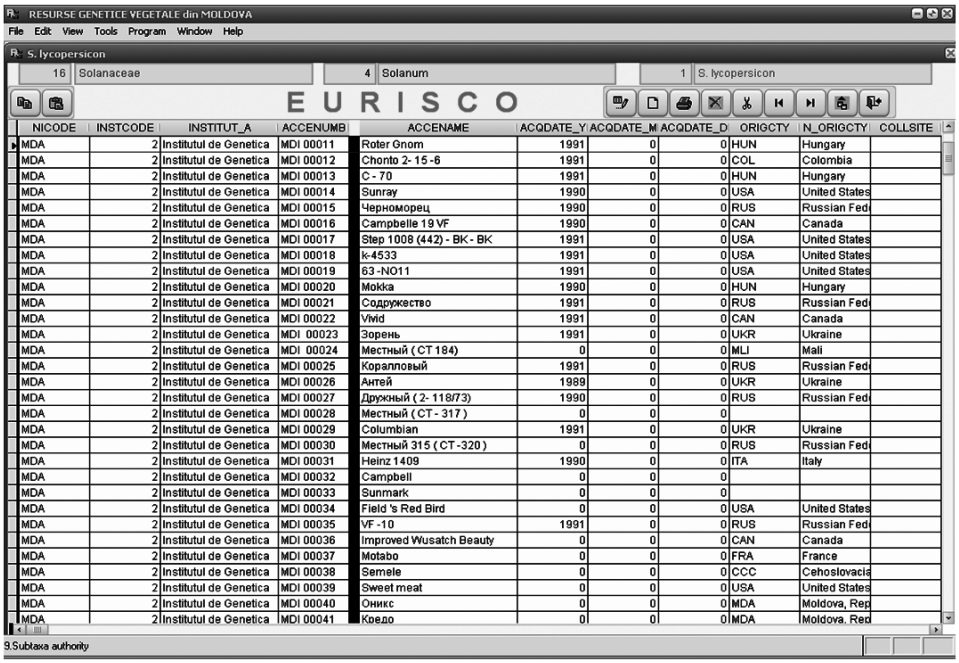
Characterization and evaluation have been made for 234 accessions (34 -tomato, 152 peppers and 48 eggplants (Table 4).

Descriptors used for the evaluation of eggplant, pepper and tomato include morphological characters (plant, leaf, flower, fruit, seed), biological characters (phenology, vegetation period, disease resistance) and agronomic characters (yield, chemical composition). IPGRI and UPOV descriptor lists are used for characterization and evaluation.

Phenological characters include: number of days from emergence to flowering, number of days from emergence to first fruit formation, number of days from flowering to first fruit formation, number of days from emergence to technological ripeness.

Morphological characters refer to: plant height; stem - height of main stem, stem – foliage, stem – pubescence; leaf size (cm), leaf type, leaf surface, leaf color; inflorescence type, inflorescence texture; flower size, flower type; fruit type, fruit weight (g), fruit surface; fruit color; seeds - seed number per fruit, seeds - 1000 seed-weight; color.

Agronomic characters cover the information on yield of marketable fruits per hectare (kg). The accessibility of collections depends largely on the information available on them. Accurate passport and characterization/evaluation data are the first requirements in genebank activities.



NICODE	INSTCODE	INSTITUT_A	ACCENUMB	ACCENAME	ACQDATE_Y	ACQDATE_M	ACQDATE_D	ORIGCTY	N_ORIGCTY	COLLSITE
MDA	2	Institutul de Genetica	MDI 00011	Roter Gnom	1991	0	0	HUN	Hungary	
MDA	2	Institutul de Genetica	MDI 00012	Chonto 2- 15 -6	1991	0	0	COL	Colombia	
MDA	2	Institutul de Genetica	MDI 00013	C - 70	1991	0	0	HUN	Hungary	
MDA	2	Institutul de Genetica	MDI 00014	Sunray	1990	0	0	USA	United States	
MDA	2	Institutul de Genetica	MDI 00015	Черноморец	1990	0	0	RUS	Russian Fed	
MDA	2	Institutul de Genetica	MDI 00016	Campbelle 19 VF	1990	0	0	CAN	Canada	
MDA	2	Institutul de Genetica	MDI 00017	Step 1008 (442) - BK - BK	1991	0	0	USA	United States	
MDA	2	Institutul de Genetica	MDI 00018	k-4533	1991	0	0	USA	United States	
MDA	2	Institutul de Genetica	MDI 00019	63 -NO11	1991	0	0	USA	United States	
MDA	2	Institutul de Genetica	MDI 00020	Mokka	1990	0	0	HUN	Hungary	
MDA	2	Institutul de Genetica	MDI 00021	Содружество	1991	0	0	RUS	Russian Fed	
MDA	2	Institutul de Genetica	MDI 00022	Vivid	1991	0	0	CAN	Canada	
MDA	2	Institutul de Genetica	MDI 00023	Зорень	1991	0	0	UKR	Ukraine	
MDA	2	Institutul de Genetica	MDI 00024	Местный (CT 184)	0	0	0	MLI	Mali	
MDA	2	Institutul de Genetica	MDI 00025	Коралловый	1991	0	0	RUS	Russian Fed	
MDA	2	Institutul de Genetica	MDI 00026	Антей	1989	0	0	UKR	Ukraine	
MDA	2	Institutul de Genetica	MDI 00027	Дружный (2- 118/73)	1990	0	0	RUS	Russian Fed	
MDA	2	Institutul de Genetica	MDI 00028	Местный (CT - 317)	0	0	0			
MDA	2	Institutul de Genetica	MDI 00029	Columbian	1991	0	0	UKR	Ukraine	
MDA	2	Institutul de Genetica	MDI 00030	Местный 315 (CT -320)	0	0	0	RUS	Russian Fed	
MDA	2	Institutul de Genetica	MDI 00031	Heinz 1409	1990	0	0	ITA	Italy	
MDA	2	Institutul de Genetica	MDI 00032	Campbell	0	0	0			
MDA	2	Institutul de Genetica	MDI 00033	Sunmark	0	0	0			
MDA	2	Institutul de Genetica	MDI 00034	Field 's Red Bird	0	0	0	USA	United States	
MDA	2	Institutul de Genetica	MDI 00035	VF -10	1991	0	0	RUS	Russian Fed	
MDA	2	Institutul de Genetica	MDI 00036	Improved Wusatch Beauty	0	0	0	CAN	Canada	
MDA	2	Institutul de Genetica	MDI 00037	Motabo	0	0	0	FRA	France	
MDA	2	Institutul de Genetica	MDI 00038	Semele	0	0	0	CCC	Cehoslovacia	
MDA	2	Institutul de Genetica	MDI 00039	Sweet meat	0	0	0	USA	United States	
MDA	2	Institutul de Genetica	MDI 00040	Оникс	0	0	0	MDA	Moldova, Rep	
MDA	2	Institutul de Genetica	MDI 00041	Кредо	0	0	0	MDA	Moldova, Rep	

Fig.1. Passport data of *Solanum lycopersicon* in ReGen

Conclusions

Many gene banks developed comprehensive documentation system for managing their genetic resources data, providing basic information for decision making and identifying useful materials for research and variety development. ReGen – information system of Plant Genetic Resources in Republic of Moldova was established. The main objective of ReGen is to integrate and monitor the available data on existing germplasm collections at the national level. This system is an important source of information for researchers and plant breeders.

References

1. Agrawai R.C., Innaiah Pudota. Plant genetic resources passport information management system (PGRPIMS).//J. Ind. Soc. Agril. Statist. 60(2), 2006, p.100-107

2. Bebeli P., Mazzucato A. The Solanaceae – A review of recent research on genetic resources and advances in the breeding of tomato, pepper and eggplant.//The European Journal of Plant Science and Biotechnology 2 (Special Issue 1), 2008, p.3-30

3. Carvalho Miguel, Bebeli Penelope, Bettencourt Eliseu, Costa Graça, Dias Sonia, Santos Teresa, Slaski Jan. Cereal landraces genetic resources in worldwide GeneBanks. A review. //Agron. Sustain. Dev., 2013, 33, p.177–203 DOI 10.1007/s13593-012-0090-0

4. Documentation of genetic resources. //In: Peter R. Day et al. Managing Global Genetic Resources: Agricultural Crop Issues and Policies. The National Academies Press, 1993, 480p. ISBN: 978-0-309-13186-5 DOI: 10.17226/2116. p.205-217

5. Engels J. M.M., Maggioni L. AEGIS: a regionally based approach to PGR conservation. //In: Agrobiodiversity Conservation: Securing the Diversity of Crop Wild Relatives and Landraces, Editors: N. Maxted; M. Ehsan Dulloo; Brian. V. Ford-Lloyd, othar Frese; Jose Iriondo; Miguel A.A. Pinheiro Carvalho, Publisher: CAB International, 2016,Chapter: 41

6. Harrer S.,Begemann F., Jimenez Krause J.D., Roscher S. Distributed databases retrieval systems in Germany as a National Approach in an international context. //In: Managing plant

genetic resources. Engels J.M.M., Ramanatha Rao V., Brown A. H. D., Jackson M. IPGRI, 2002, p. 179-185

7. *Laliberté, Brigitte.* Botanic Garden Seed Banks/Genebanks Worldwide, their Facilities, Collections and Networks. //Botanic Gardens Conservation International, Volume 2 Number 9 - December 1997

8. Rios Ortiz R. Plant Breeding in the Omics Era. //Chapter 2. Plant Genetic Resources for Food and Agriculture. Springer International Publishing, Switzerland, 2015, p.19-39*,* DOI 10.1007/978-3-319-20532-8_2

9. Romanciuc G., Ganea A. Plant Genetic Resources Information System in Republic of Moldova. Studii şi cercetări ştiinţifice, seria Biologie. Universitatea "Vasile Alecsandri", Bacău, 2014, vol. 23, Nr.2, p.5-11. ISSN 1224-919X

10. Romanciuc G., Gaevscaia V. Creation of unified information system of plant genetic resources. //Simpozionul naţional cu participare internaţională "Biotehnologii avansate – realizări şi perspective", Chişinău, 2013. p. 172

11. Romanciuc G. ReGen - sistemul de documentare a resurselor genetice vegetale din Republica Moldova. //Comunicare în sesiune la Conferinţa ştiinţifică internaţională „Genetica, fiziologia şi ameliorarea plantelor", ed.a V-a, Chişinău, 23-24 octombrie, 2014

12. The Second Report on The State of the World's Plant Genetic Resources for Food and Agriculture. Food and Agriculture Organization of the United Nations, Rome (FAO), 2010, 399p.

13. Westengen Ola T., Jeppson Simon, Guarino Luigi. Global *ex-situ* crop diversity conservation and the Svalbard global seed Vault: assessing the current status. //PLoS One. 2013; 8(5): e64146.

14. Zongw en Zhang, Quek P. Plant genetic resources information management and indigenous knowledge documentation. //In: Plant genetic resources conservation and use in China. Proceedings of National Workshop on Conservation and Utilization of Plant Genetic Resources, 25-27 October, 2002, Beijing, China, 1999, p.89-94