

The Ukrainian grain legume genetic resources collection

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Status of the National grain legume collection

In 1992 a special scientific program devoted to creation and carrying out of the National Bank for Plant Genetic Resources was initiated in Ukraine. During 20 years of its fulfillment, 34 Ukrainian leading breeding and research institutions under scientific-methodological leadership and coordination arranged by the National Centre for Plant Genetic Resources of Ukraine (NCPGRU), working as a part of the Institute for Plant Production n.a. V.J.Yurjev, have formed a Ukrainian National Plant Genebank which in the end of 2012 included 139.200 accessions belonging to 388 crops (among them 65 700 accessions of 109 field crops, 368 plant species). About 51 100 accessions, or 36,9% are of Ukrainian origin. There are 76 000 collection accessions which are unique and represented in only one institution of Ukrainian Plant Genetic Resources System, therefore they require a special attention.

Leguminous crops collections (13 crops, 104 species) of the National Plant Genebank of Ukraine located in 9 scientific and breeding institutions, counted 20 138 accessions in the end of 2012. There is a pea collection – 3700 accessions; soybeans – 2864; kidney beans – 5204; grass pea – 1268; chickpea – 2642; lentil – 1018; beans – 294; lupin – 2109 accessions; vetch – 910, cowpea – 123; dolichos – 6 accessions (table 1). According to biological status of the accessions, the National collection is divided into breeding cultivars – 182 accessions, breeding lines – 5321, genetic lines – 49, landraces – 6068, wild – 1137. 23% (4668 accessions) generate from Ukraine (table 2).

In the last 5 years, the National grain legume collection has increased by 1703 samples (table 3).

Table 3. Changes in the content of the National grain legume collection of Ukraine (2007-2012)

Crops	No. of accessions, 2007 year	No. of accessions, 2012 year	Change the number of accessions, ±
Pea	3085	3700	+615
Kidney bean	5327	5204	-123
Soybean	2872	2864	-8
Chick pea	2056	2642	+586
Lupin	1983	2109	+126
Lentil	1079	1018	-61
Grass pea	1124	1268	+144
Vetch	607	908	+301
Faba bean	258	294	+36
Cow pea	42	123	+81
Dolichos	2	6	+4
Total	18435	20138	+1703

Table 1. The composition of grain legume collections located in Ukrainian research institutions (number of accessions), 2012

Crop	Kidney bean	Pea	Soybean	Chick pea	Lupin	Grass pea	Lentil	Vetch	Faba bean	Cow pea	Dolichos	<i>Total</i>
Total accessions number in the collections of the institutions	5204	3700	2864	2642	2109	1268	1018	910	294	123	6	20138
Institute for Plant Production nd.a. V. Ya. Yurjev of NAAS (UKR001), Kharkiv reg.	2199	2615	2124	1852			1018			44	6	9858
Ustymivka Experimental Station for Plant Production (UKR008), Poltava reg.	2579				503	1268		595		79		5024
Luhans'k State Agricultural Experimental Station (UKR0009), Luhans'k reg.		1085		790								1875
Institute of Agriculture of the Carpathian Region of NAAS (UKR007, Lviv reg.)	426					111		151	294			982
Institute of Agriculture of NAAS (UKR004), Kyiv reg.					863							863
Institute of Agricultural Microbiology and Agricultural Production of NAAS (UKR099), Kyiv reg.					632							632
Institute of irrigated agriculture NAAS (UKR006), Kherson reg.			445									445
Institute of Oil Crops of NAAS (UKR012), Zaporizhzhia reg.			295									295
Poltava State Agricultural Experimental Station nd.a. N.I. Vavilov (UKR093), Poltava reg.								164				164

Table 2. Structure of grain legume collection of the Ukrainian research institutes (number of accessions) (2012)

Crop	Kidney bean	Pea	Soybean	Chick pea	Lupin	Grass pea	Lentil	Vetch	Faba bean	Cow pea	Dolichos	Total
Total number of accessions in the collections of institutions	5204	3700	2864	2642	2109	1268	1018	910	294	123	6	20138
Including of Ukrainian origin	2028	636	711	268	528	72	63	237	113	11	1	4668
Cultivars	1703	2190	1693	306	636	73	178	280	108	15		7182
Including of Ukrainian origin	129	355	472	50	143	24	24	127	16	2		1542
Landraces	3126	444	127	450	325	717	388	275	103	107	6	6068
Including of Ukrainian origin	1783	51	39	36	19	41	15	36	88	8	1	2117
Breeder's lines	172	1044	720	1857	981		440	46	60	1		5321
Including of Ukrainian origin	55	230	156	182	358		17	18	9	1		1026
Genetic line		20	16					1	12			49
Including of Ukrainian origin		0										0
Wild	202	2	124	29	23	478	12	267				1137
Including of Ukrainian origin	61				6	7	7	44				125
Sample status is not defined	1		184		144			41	11			381
Including of Ukrainian origin			44					12				56

Cultivation of grain legumes in Ukraine

Legumes occupy in Ukraine 1 790 500 ha (less than 7% of total cultivation area) (table 4).

Table 4. Sown areas of grain legume in Ukraine

Area under agricultural crops	Sown areas, 1000 ha		The structure of sown areas, %		The share of households in total sown area, %	
	2012	2012 to 2011, ±	2012	2011	2012	2011 .
Sown area total	27480,4	-190,1	100,0	100,0	30,2	29,6
Soybean	1470,7	336,5	5,4	4,1	6,4	5,2
Pea	220,4	-34,0	0,8	1,0	10,7	8,5
Kidney bean	26,4	4,0	0,1	0,08	93,2	88,9
Lupin	24,4	-5,5	0,09	0,1	2,0	1,3
Vetch	17,0	-4,2	0,06	0,08	6,5	4,9
Other species (Chick pea, Grass pea, Green gram and other)	31,5	6,4	0,1	0,09	2,9	2,4
Grain legumes total	1790,4	337,2	6,6	5,5	36,2	33,6

In the "State Register of Plant Varieties allowed to distribution in Ukraine in 2013", are registered 235 Ukrainian varieties of grain legume crops and 99 foreign (table 5).

Table 5. Number of registered grain legume varieties in the Ukraine (2013)

Species	No. of varieties	
	total	Ukrainian
<i>Glycine max. (L.) Mer.</i>	118	92
<i>Pisum sativum L. convar. Sativum</i>	45	27
<i>Pisum sativum L. convar. medullare Alef. emend. C.O.Lehm</i>	45	17
<i>Pisum sativum L. convar. axiphium Alef emend. C.O.Lehm</i>		
<i>Pisum arvense L.</i>	4	4
<i>Phaseolus vulgaris L. (vegetable)</i>	38	13
<i>Phaseolus vulgaris L. (grain)</i>	14	13
<i>Vicia sativa L.</i>	30	30
<i>Vicia faba L.var. major Harz.</i>	5	4
<i>Vicia faba L.var. minor</i>	1	1
<i>Lupinus albus L.</i>	11	11
<i>Lupinus luteus L.</i>	8	8
<i>Lupinus angustifolius L.</i>	2	2
<i>Cicer arietinum L.</i>	7	7
<i>Lens culinaris Medik.</i>	4	4
<i>Lathyrus sativus L.</i>	1	1
<i>Lathyrus sylvestris L.x Lathyrus latifolius L.</i>	1	1
Total	334	235

The genepool diversity maintained in the National Plant Genebank of Ukraine is widely used as source material in cultivars breeding in state and private institutions of Ukraine since it contain carriers of valuable inherited traits: productivity, endurance to biotic and abiotic stresses, high consumers' grain quality, suitability to mechanized growing etc.

Introduction

During the last two decades, 10 364 samples were involved to the grain legume collection, including 6 303 from Ukraine. Local field crops varieties are being included to the Genebank through the personal contacts with the owners of private plots, amateurs etc., wild related species – through collecting them in a wild habitats. 31 expedition has been conducted for this purpose, including 14 international ones with the participation of the employees of N.I. Vavilov Research Institute of Plant Industry and Saint Petersburg State University (Russia, 2007, 2008, 2009, 2010), Horticulture institute of Poland and Plant Breeding and Acclimatization Institute (IHAR) (Poland, 1995, 1996, 1997, 1999, 2006), National plant gene banks of the USA (2000, 2002, 2008), South Korea (2008) and Canada (2007, 2008, 2009) etc. In North-Western and Central regions of Russian Federation, during a joint international expedition (N.I. Vavilov Research Institute of Plant Industry, State University of Utah, Logan, USA and Ustymivska Experimental Station of plant production), genepool samples of grain legumes were gathered which show a remarkable winter resistance, sustainability to damping-off. During the expeditions more than 4 000 grain legume samples were gathered.

Being involved in the international collaboration, the institutions of National Plant Genetic Resources System participate in grain legume plants germplasm trial (chickpea, lentil, beans, kidney beans, vetch), which is being organized by International Centre of Agricultural Researches on Dry Areas (ICARDA, Syria).

As a result, the studying involved 12 650 samples from 20 world countries, among them about 1 000 samples appeared to be the bearers of valuable economical and biological traits.

Serious attention is dedicated to studying and preserving Ukrainian local flora *ex-situ*. Thus, in Carpathian region (Chernivtsy, Ivano-Frankivsk, Lviv, Transcarpathian regions) the most part of collected material is a diversity of common bean (*Phaseolus vulgaris*), runner bean (*Ph. coccineus*) and lima bean (*Ph. Lunatus*) and also local ancient samples of beans (*Vicia faba*). In the South (Kherson, Mykolaiv, Kirovograd regions, Autonomous Republic of Crimea) and South-Western regions (Odesa region), accessions of legume species adapted to drought conditions were collected – kidney beans, chickpeas, grass peas, vetch, wild species of lentil and so on.

Characterization, evaluation and utilization of collections

The System of Plant Genetic Resources of Ukraine studies annually 25-30 thousands of collection accessions for a complex of economically valuable and biological traits. According to the results of a comprehensive research of plant genepool collection, in last 20 years there were 21.4 thousand accessions were

selected and 3.3 thousand were created, which have become the new sources and donors of economically valuable and biological traits and standards of their manifestation levels. More than 600 varieties have been created in last five years based on the genetic background of the gene pool samples. Annually, about 5000 genepool samples are transferred from the genebank to the breeding and research institutions and educational facilities of Ukraine in order to be used in scientific, breeding and educational programs, among them about 300 legumes.

For a more effective preservation and usage of genepool samples and their centralization in the National Plant Genebank, the NCPGRU carries out registration of valuable collections and accessions. At the end of 2012, in total 61 collection and 485 valuable accessions of legume crops were registered.

According to the "Regulations on the Registration of plant gene pool collections and accessions in the NCPGRU" scientific institutions have formed and registered 29 collection of grain legumes – 4 basic (soybeans, kidney beans, grass peas, chickpeas), 21 trait and special, 3 working collections (table 6).

Table 6. Registered collections of plant genetic resources of genebank of Ukraine

Crop	Collection type	No. of accessions
Soybean	Trait special for photoperiodic reaction	36
	Trait for resistance to diseases and pests	46
	Special for the features of variability	85
	Special trait for mowing direction of usage	50
	Basic	2046
Kidney bean	Trait for the group resistance against bacterial spotting and fusarium in complex with economically valuable traits	127
	Trait for yield and resistance to diseases	81
	Trait for biochemical contents of the seeds	58
	Trait for suitability to mechanical harvesting and early ripeness	57
	Special	141
	Basic	4489
Grass pea	Basic	1173
Chick pea	Basic	1612
	Special for the features of variability	79
	Trait special for the reaction to nitrogenization with strain 065 Mesorhizobium ciceri	44
	Trait	262
Lentil	Special for the features of variability	90

Conservation

For long term preservation of seed samples, the National vault for seeds of plants genepool samples (Kharkiv, Institute for Plant Production n.a. V.J.Yurjev) was created, in which at the end of 2012 there were 59.5 thousand samples of 635 plant species are stored; among them, according to the international standards, 32.9 thousand samples at a temperature of -20°C ; 13.5 thousand samples in the

refrigeration chamber (4° C), 13 thousand samples in the conditions of unregulated temperatures in hermetically closed containers. Seeds of 25.7 thousand samples, which belong to 114 plant species, are deposited in the Doublet vault of Ustymivka Experimental Station for Plant Production (Ustymivka, Poltava region), including 15.1 thousand samples in the low temperature chamber at the temperature of 4 °C. Preservation of *on-farm* local genepool plant samples is also done; these species are characterized by valuable consumer features of output and sustainability to adverse biotic and abiotic environmental factors. In 2012, a databases of CWR and LR genepool samples was created, they maintain data of 254 samples *in situ* and 484 *on farm*. In general, National storage contains 60,0 % of National Genebank samples, which are reproduced with the seeds.

A method of accelerate ageing for seeds of leguminous crops (Fabaceae) representatives (declaration patent No. 68028 of 12.03.2012) was worked out.

On 4/01/2013, 14598 samples of leguminous plants (11 crops, 70 species) were deposited in the National storage (Table 2). This represents about 70% of the legume collection of National Plant Genebank. 6031 samples were stored at -20 °C, 3382 samples at +4 ° C (Table 7). The depositing of the accessions on longterm conservation continues.

Table 7. Grain legume collections deposited in the National Genepool Seed Vault of Ukraine (Kharkiv, 2013)

Crops	Total amount given for storage, pcs.	Number of accessions in storage, pcs.		
		stored under -20 °C	stored under +4 °C	stored under irregulated temperature
Pea	2819	690	480	1649
Soybean	2759	1137	1378	244
Kidney bean	2763	786	647	1330
Grass pea	650	229	-	421
Vetch	510	346	156	8
Faba bean	341	165	-	176
Lupin	1452	837	275	340
Cow pea	76	60	16	-
Chick pea	2174	867	290	1017
Dolichos	6	6	-	-
Lentil	1048	908	140	-
Total	14598	6031	3382	5185

5024 grain legume samples are being kept in glass containers and aluminum multilayer packages in the Doublet vault of Ustymivska Experimental Station. Dried and packed in airtight containers, the seeds are mostly stored in the half basement building with a temperature of about 10-15 °C (table 8).

Table 8. Preservation of grain legume crops genepool collection in Ustymivska Experimental station for Plant Production (Ustymivka, 2013)

Crop	Total accessions number	Number of accessions,		
		total	stored under +10-15 °C	stored under +4 °C
Kidney bean	2579	2579	2342	237
Grass pea	1268	1268	1268	-
Vetch	595	595	595	-
Lupin	503	503	503	-
Cow pea	79	79	79	-
Total	5024	5024	4787	237

Documentation

An Information System “Plant genepool” created in the NCPGRU provides an effective managing of genepool collections of the National Genebank, and at the moment it gives opportunity to have a prompt access to 94 667 thousand samples of 388 crops.

Passport databases for 13 858 samples of 10 grain legume crops (pea, kidney bean, cow peas, vetch, chickpea, lentil, soybean, lupin, faba bean) from 12 breeding and research organizations of Ukraine are included into the European Internet Search Catalogue (EURISCO), which gives new opportunities for international exchange of genepool samples and information about them. National database of passport information contains 44 fields, 35 of them have been formed according to the requirements of European Catalogue EURISCO.

Participation in international programs

Since 2008, Ukraine is a member of European Cooperative Program on Plant Genetic Resources (ECPGR), in framework of which it participates in creating European Integrated Collections (AEGIS).

The National Centre of Plant Genetic Resources of Ukraine participated in the project of regeneration and insured storage of genepool samples in permafrost conditions in Svalbard Global Seed Vault (Norway, isl. Svalbard), to which 1 430 grain legume samples have been deposited (790 kidney beans, 280 chickpeas, 300 grass peas, 60 lentil samples). For the same purpose, 391 accessions of kidney beans were transferred to the Genebank of Netherlands (CGN-DLO), 215 samples of chickpea, 256 grass pea, 60 lentil – to the International Centre for Agricultural Research in the Dry Areas (ICARDA, Syria).

Ukrainian Institutions of the Plant Genetic Resources System work in international collaboration with genebanks of Russia, Belorussia, Moldova, Poland, France, Germany, Great Britain, Japan, Canada, USA etc., international centers of agricultural researches: International Maize and Wheat Improvement Center (CIMMYT, Mexico); International Centre for Agricultural Research in Dry Areas (ICARDA, Syria).

Future activities planned

- Enrichment of the national collection with new samples – sources of economically valuable traits;
- Carrying out an Information System for documentation of National Plant Genebank collections;
- Studying genepool samples and revealing sources and donors of valuable breeding traits and standard samples according to their features;
- Creating and registration of basic, trait, special, educational and other collections;
- Longterm preservation of genepool samples in the National and Doublet vaults and in active collections of the institutions of the Ukrainian Plant Genetic Resources System;
- Providing genepool samples for its usage in breeding, research, educational and other programs;
- Participating in the international activities of genetic resources of grain legume plants: creating joint European collections (AEGIS), European Catalogue EURISCO, laying out seed samples of grain legumes in Svalbard Global Seed Vault, exchanging genepool samples and information about them;
- Promoting plant varieties preservation and usage activities in Ukraine, Europe, and worldwide.