

THE INTERNATIONAL COLLECTION OF LEGUME CROPS MAINTAINED BY THE BIOLOGY OF AGROSISTEMS GROUP AT THE MBG-CSIC

Antonio M. DE RON* ; A. Paula Rodiño; J. Dorinda Pose; J. Leonardo TEJADA**

Misión Biológica de Galicia (MBG). Spanish National Research Council (Consejo Superior de Investigaciones Científicas - CSIC). Pontevedra, Spain

* amderon@mbg.csic.es

** Current address: University San Luis Gonzaga. Ica, Peru

Received: September-15, 2022

Accepted: October-23, 2022

Published on-line: December-6, 2022

Citation:

De Ron AM, Rodiño AP, Pose JD, Tejada JL. 2022. The international collection of legume crops maintained by the Biology of Agrosistemas Group at the MBG-CSIC. Mol 22: 7

Abstract

In the MBG-CSIC there is an international collection of seeds of legume crops maintained by the research Group Biology of Agrosystems (BAS). This collection was founded in 1987 and currently includes landraces, wild populations and breeding lines of beans (*Phaseolus* spp.), pea (*Pisum sativum* L), cowpeas (*Vigna* spp.) and lupins (*Lupinus* spp.). This germplasm is the basis for biodiversity, evolutive and genetic studies as well as for breeding programs.

Resumen

En la MBG-CSIC existe una colección internacional de semillas de leguminosas mantenida por el Grupo de investigación Biología de Agrosistemas (BAS). Esta colección se fundó en 1987 y actualmente incluye variedades locales, poblaciones silvestres y líneas de mejora de judías (*Phaseolus* spp.), guisante (*Pisum sativum* L.), caupí o judía carilla (*Vigna* spp.) y altramuces (*Lupinus* spp.). Este germoplasma es la base para estudios de biodiversidad, evolutivos y genéticos, así como para programas de mejora genética.

Introduction

Plant genetic resources collections

Plant genetic resources (PGR) *ex-situ* collections such as genebanks, germplasm collections and breeders collections are the storehouses of PGR, providing the basic material for the genetic improvement of crops (Vavilov 1950). They play a key role in contributing to the sustainable development of agriculture, helping to increase food production and thus to overcome hunger and poverty. The seeds contained in genebanks are a vital and irreplaceable resource, a heritage which must be conserved to provide future agricultural options in a world facing climate change and other unforeseen challenges. The sustainable conservation of genetic resources depends on effective actions by genebank staff, who play a critical role in ensuring that germplasm is effectively and efficiently conserved (Rao et al. 2006).

Adequate seed-handling procedures in genebanks are fundamental to the long-term, cost-effective and efficient conservation of PGR. They ensure that seeds placed in storage are of the highest quality and achieve maximum longevity maintaining high-viability accessions. Advances in the knowledge of seed biology have led to a deep understanding of seed physiology and seed-storage behaviour, which makes seeds the easiest and most convenient means of long-term conservation (Rao et al. 2006).

PGR, plant genetics and breeding

Knowledge of the genetic variation of crops is a fundamental for their improvement, which aims to obtain varieties with better qualities, higher production and/or tolerance to biotic and abiotic stresses. For this reason, any process of plant genetic improvement requires prior knowledge of the variation within the species, and this genetic variation is what is preserved in banks or germplasm collections.

Therefore, breeders search germplasm banks and collections to obtain basic material that can later be selected or hybridized to obtain improved varieties that could be transferred to the productive sector. In addition, genetic and evolutionary studies of plants require extensive collections of varieties or populations, and these materials are also found in germplasm banks and collections.

PGR in the Iberian Peninsula

In the northern Iberian Peninsula there is still a considerable amount of genetic diversity in many cultivated plants, owing to the small size of the farms in this area and the persistence of traditional methods of agriculture. But new methods and new varieties are being introduced in several areas of northern Spain and Portugal and in the last years the old landraces are in a process of genetic erosion in these areas (Esquinas-Alcázar 1987).

For this reason, the MBG-CSIC, a research institute devoted mainly to plant breeding, is carrying out a programme of collecting and maintaining landraces and ecotypes of several important crops from the northern areas of the Iberian Peninsula. The main goal is to conserve genetic diversity. But there is also a long-term objective: to characterize the material for agronomic traits, nutritional quality and biotic and abiotic stresses resistance. Landraces with desirable traits are incorporated to the breeding programmes of the institute (De Ron et al. 1991).

Material and methods

Collecting missions

Many accessions of the current legume collection were received from germplasm banks and collections, but the BAS group carried out different collection missions in areas where traditional farming methods have encouraged the presence of old varieties, to acquire genetic material as well as information from farmers.

During 1988, five collecting missions were made in the north and northwest of Spain and in 1989 and 1990, two more were made in the north of Spain. In 1988, 1993 and 2001, with the University of Tras-os-Montes e Alto Douro (UTAD, Vila Real, Portugal), collecting was done in the north of Portugal. The last expeditions, in 1996 and 1997, in northwestern Argentina and southern Bolivia, were in cooperation with the Argentinian Consejo Nacional de Investigaciones Científicas y Técnicas (CONICET), the University of Buenos Aires (UBA) and the Argentinian Instituto Nacional de Tecnología Agropecuaria (INTA) (De Ron et al. 1997, De Ron et al. 2016b).



Figure 1. Seed samples of the legume collection.

Conservation and regeneration of seeds

The seeds are maintained in a climatic chamber at 3-4 °C and 40% relative humidity. Regeneration of varieties, when needed, is done mainly in the experimental fields of the MBG-CSIC (Pontevedra, Spain, 42°38' N, 8°08' W, 20 masl, average temperature 14°C and 1600 mm annual rainfall). The viability of the seeds maintained in the collection is periodically monitored through germination tests and their moisture content is also controlled (figures 1 and 2).

Results and Discussion

The description of the collections currently maintained by the BAS Group, as well as the reference to the research carried out on the different crops, is described next (tables 1, 2, 3 and 4).



Figure 2. Germplasm conservation chamber.

Table 1. Beans collection.

ORIGIN	<i>Phaseolus vulgaris</i>				<i>Phaseolus coccineus</i>		
	Accessions	Landraces	Wild	Primitive	Accessions	Landraces	Wild
ARGENTINA	103	40	25	38			
BELGIUM					2	2	
BOLIVIA	1	1					
CAPE VERDE	1	1					
CHILE					1	1	
GREECE	6	6					
HONDURAS	1	1					
ITALY					2	2	
JAPAN	18	18					
MEXICO	3	3			3	2	1
PORTUGAL	116	116			4	4	
SPAIN	469	468		1	30	30	
USA	1	1					
SUBTOTAL	719	655	25	39	42	41	1
COMMERCIAL	22						
BREEDING LINES	59						
TOTAL	800				42		

Table 2. Pea collection.

ORIGIN	<i>Pisum sativum</i>	
	Accessions	Landraces
CZECH REPUBLIC	14	14
PORTUGAL	29	29
SPAIN	135	135
SUBTOTAL	178	178
COMMERCIAL	36	
BREEDING LINES	47	
TOTAL	261	

The research in beans is focussed to the following topics:

- Biodiversity and breeding systems (Gil and De Ron 1992, Rodiño et al. 2001b, Rodiño et al. 2003, Santalla et al 2004, De Ron et al. 2018b).
- Evolution of populations (Santalla et al. 2002, De Ron et al. 2016a).
- Food quality (Casquero et al. 2005).
- Tolerance to biotic and abiotic stresses (Monteagudo et al. 2006, Rodiño et al. 2007).
- Symbiotic interactions with soil microbiota (Rodiño et al. 2011).
- Obtaining of new improved varieties (Rodiño et al. 2001a).

The research in pea is focussed to the following topics:

- Biodiversity (Amurrio et al. 1993, Amurrio et al. 1996).
- Food quality (Santalla et al. 2001a).
- Symbiotic interactions with soil microbiota (Santalla et al. 2001b).
- Obtaining of new improved varieties (De Ron et al. 2005, De Ron et al. 2018a).

Table 3. Cowpea collection.

ORIGIN	ACCESSIONS	<i>Vigna</i>		
		<i>Vigna spp.</i>	<i>V. radiata</i>	<i>V. unguiculata</i> (L.) Walp.
CANADA	1		1	
CHINA	1		1	
IVORY COAST	4	4		
SPAIN	43		2	41
MAURITANIA	1	1		
NIGER	1	1		
PHILIPPINES	1		1	
PORTUGAL	48		1	47
SUBTOTAL	100	6	6	88
COMMERCIAL	3			3
BREEDING LINES	1			1
TOTAL	104	6	6	92

In Spain the cowpea is currently a rare crop, although it is common in Portugal and in Mediterranean countries such as Algeria, where Echikh et al. (1997) described a wide diversity in cowpea landraces.

Table 4. Lupins collection.

ORIGIN	ACCESSIONS	<i>Lupinus</i>				
		<i>L. angustifolius</i>	<i>L. hispanicus</i>	<i>L. luteus</i>	<i>L. albus</i>	<i>L. nootkatensis</i>
SPAIN	199	88	42	69		
FRANCE	1				1	
ICELAND	1					1
POLAND	9	3		3	3	
PORTUGAL	1			1		
SUBTOTAL	211	91	42	73	4	1
COMMERCIAL	4	2		1	1	
TOTAL	215	93	42	74	5	1

The research in cowpea is focussed to the following topics:

- Biodiversity (De Ron et al. 2003).
- Obtaining of new improved varieties

The research in lupins is focussed to the following topics:

- Biodiversity (Lema et al. 2005).
- Ecology

Acknowledgements

The authors thank the support by the CSIC (Spain) projects INIA-RFP2015-00008-C04-03, 2016SU0004, 202040E190 and 202240E032, to the Diputación of Pontevedra (Spain) for farm facilities and the project OTR07562 and to the Xunta de Galicia (Spain) for the project IN607A2021/03.

References

- Amurrio JM, De Ron AM, Escribano MR. 1993. Evaluation of *Pisum sativum* landraces from the Northwest of the Iberian peninsula and their breeding value. *Euphytica* 66: 1-10.
- Amurrio JM, De Ron AM, Santalla M. 1996. Horticultural and potential breeding value of sugar pea landraces from the Northwestern Spain. *HorstScience* 31: 843-845.
- Casquero PA, González AM, Santalla M, De Ron AM. 2005. Assessment of dual culinary use potential of common bean landraces in sustainable agriculture. *Biological Agriculture and Horticulture* 22: 335-347
- De Ron A M, Lindner R, Malvar RA, Ordás A, Baladrón JJ, Gil J. 1991. Germplasm collecting and characterization in the north of the Iberian Peninsula. *Plant Genetic Resources Newsletter* 87: 17-19.
- De Ron AM, Santalla M, Barcala N, Rodiño AP, Casquero PA, Menéndez MC. 1997. Beans (*Phaseolus* spp.) collection at the MBG-CSIC in Spain. *Plant Genetic Resources Newsletter* 112: 100.
- De Ron AM, González AM, Monteagudo AB, Lema M, Santalla M. 2003. Colección de *Vigna* spp. de la MBG – CSIC. *Actas de la Asociación Española de Leguminosas* 2: 121-123

- De Ron AM, Magallanes JJ, Martínez O, Rodiño AP, Santalla M. 2005. Identifying superior snow pea breeding lines. *HortScience* 40: 1216-1220.
- De Ron AM, González AM, Rodiño AP, Santalla M, Godoy L, Papa R. 2016a. History of the common bean crop: its evolution beyond its areas of origin and domestication. *Arbor* 192 (779): a317.
- De Ron AM, Menéndez-Sevillano MC, Ferreyra MJ. 2016b. Legumes germplasm at the MBG-CSIC, Spain: collection missions and species diversity. *Mol* 16: 41-47
- De Ron AM. 2018a. The tear pea: a new vegetable for innovation in horticulture. *JOJ Horticulture Arboriculture* 1(3): 555566.
- De Ron AM, Bebeli PJ, Negri V, Vaz Pato MC, Revilla P. 2018b. Warm season grain legume landraces from the south of Europe for germplasm conservation and genetic improvement. *Frontiers in Plant Science (Topic: Rediscovering local landraces: Shaping horticulture for the future)* 9: 1524.
- Echikh N, Ahmed-Said T, Brac de la Perriere RA. 1997. Collecting local *Vigna unguiculata* L. (Walp.) landraces in Algeria. *Plant Genetic Resources Newsletter* 112: 73-76.
- Esquinas-Alcázar JT. 1987. Plant genetic resources: a base for food security. *Ceres* 118:39-45.
- Gil J, De Ron AM. 1992. Variation in *Phaseolus vulgaris* in the northwest of the Iberian Peninsula. *Plant Breeding* 109: 313-319.
- Lema M, Santalla M, Rodiño AP, De Ron AM. 2005. Field performance of natural narrow-leafed lupin from the northwestern Spain. *Euphytica* 144: 341-351.
- Monteagudo AB, Rodiño AP, Lema M, De la Fuente M, Santalla M, De Ron AM, Singh SP. 2006. Resistance to fungal, bacterial and viral diseases in a common bean core collection from the Iberian Peninsula. *HortScience* 41: 319-322.
- Rao NK, Hanson J, Dulloo ME, Ghosh K, Nowell D, Larinde M. 2006. Manual of seed handling in genebanks. *Handbooks for Genebanks No. 8*. Bioversity International, Rome, Italy. 147 pp.
- Rodiño AP, Monteagudo AB, Santalla M, De Ron AM. 2001a. Naming and release of “Judía Peregrina”, “Alubia de Enfesta”, “Garbanzo Grande de Tuy”, “Garbanzo Capelán” and “Mourisca”, five new breeding pure lines from Spain. *Annual Report Bean Improvement Cooperative* 44: 191-192.
- Rodiño AP, Santalla M, Montero I, Casquero PA, De Ron AM. 2001b. Diversity in common bean germplasm (*Phaseolus vulgaris* L.) from Portugal. *Genetic Resources and Crop Evolution* 48:409-417.
- Rodiño AP, Santalla M, De Ron AM, Singh SP. 2003. A core collection of common bean from the Iberian Peninsula. *Euphytica* 131: 165-175.
- Rodiño AP, Lema M, Pérez-Barbeito M, Santalla M, De Ron AM. 2007. Assessment of runner bean (*Phaseolus coccineus* L.) germplasm for tolerance to low temperature during early seedling growth. *Euphytica* 155: 63-70.
- Rodiño AP, De La Fuente M, De Ron AM, Lema MJ, Drevon JJ, Santalla M. 2011. Variation for nodulation and plant yield of common bean genotypes and environmental effects on the genotype expression. *Plant and Soil* 346: 349-361.
- Santalla M, Amurrio JM, De Ron AM. 2001a. Food and feed potential breeding value of green, dry and vegetable pea germplasm. *Canadian Journal of Plant Science* 81: 601-610.
- Santalla M, Amurrio JM, De Ron AM. 2001b. Symbiotic interactions between *Rhizobium leguminosarum* strains and elite cultivars of *Pisum sativum* L. *Journal of Agronomy and Crop Science*: 187: 59-68.
- Santalla M, Rodiño AP, De Ron AM. 2002. Allozyme evidence supporting southwestern Europe as a secondary center of genetic diversity for common bean. *Theoretical Applied Genetics* 104: 934-944.
- Santalla M, Monteagudo AB, González AM, De Ron AM. 2004. Agronomical and quality traits of runner bean germplasm and implications for breeding. *Euphytica* 135: 205-215.
- Vavilov NI. 1950. The phylogeographic basis of plant breeding. In: Chester KS (translator) *The origin, variation, immunity, and breeding of cultivated plants*. *Chronica Botanica* pp 13–54. Massachusetts, USA.