

HU, JINGUO* and BARBARA HELLIER, U.S. Department of Agriculture, Agriculture Research Service, Western Regional Plant Introduction Station, Washington State University, Pullman, WA 99164. **Sugar beet germplasm collection in the National Plant Germplasm System.**

ABSTRACT

The National Plant Germplasm System (NPGS) holds more than 500,000 accessions of crop plant and related species that are maintained, characterized, regenerated and distributed by four major Plant Introduction Stations and an additional 21 special clonal and seed germplasm repositories. The Western Regional Plant Introduction Station (WRPIS) is responsible for managing approximately 80,000 accessions including the collection of sugar beet and related species. As of March 26, 2009, there were 2,551 *Beta* accessions with 2,333 belonging to *B. vulgaris* (29), *B. vulgaris* subsp. *vulgaris* (1,731) and *B. vulgaris* subsp. *maritima* (571). The remaining 218 accessions belong to a dozen wild *Beta* species with the number of accessions in each varying from two to 48. The whole collection is maintained in seed form in Pullman, WA with 1,926 accessions that are backed-up at the National Center for Genetic Resources Preservation in Fort Collins, CO. The data associated with each accession are stored in the Germplasm Resource Information Network (GRIN) database which can be accessed worldwide through the Internet for browsing the data or ordering seed samples (<http://www.ars-grin.gov/npgs/>). The purposes for maintaining the collection include preserving viable seeds harboring genetic diversity of *Beta* species, collecting information on biological and agronomic characteristics and finally, supplying seed samples to the sugar beet research community for genetic improvement of the crop. During regeneration great emphasis is placed on retaining the genetic integrity of the original seed samples. Together with our collaborators, we have collected and entered into GRIN 28,903 descriptor and evaluation records. We have distributed 6,050 seed samples to requesters worldwide with 5,119 to addresses in USA and 931 outside the USA since 1996. WRPIS welcomes suggestions, support, and collaborative efforts to achieve our goal of maintaining a healthy and available sugar beet germplasm collection. We would also like to thank the BSFD and others for their on going support.

The collection:

The NPGS sugar beet germplasm collection was originally assigned to The North Central Regional Plant Introduction Station in Ames, Iowa and was transferred to WRPIS in Pullman, WA in 1994. The origins of the collection include germplasm exchanges with other national genetic resource conservation programs around the world, donations by U. S. citizens in the public and private sector breeding programs and seed samples collected during plant exploration expeditions. As of February 17, 2009, there were 2,550 *Beta* accessions with 2,332 belonging to *B. vulgaris* (29), *B. vulgaris* subsp. *vulgaris* (1,731) and *B. vulgaris* subsp. *maritima* (571). The remaining 218 accessions belong to a dozen wild *Beta* species with the number of accessions in each varying from two to 48. Table 1 lists the number of accessions held in Pullman for each cultivated and wild *Beta* species.

Table 1. Number of accessions in each cultivated and wild *Beta* species.

Species	Number of accessions
<i>Beta corolliflora</i>	4
<i>Beta hybrid</i>	2
<i>Beta lomatogona</i>	29
<i>Beta macrocarpa</i>	15
<i>Beta macrorhiza</i>	20
<i>Beta nana</i>	21
<i>Beta patellaris</i>	29
<i>Beta patula</i>	3
<i>Beta procumbens</i>	15
<i>Beta sp.</i>	16
<i>Beta trigyna</i>	48
<i>Beta vulgaris</i>	6
<i>Beta vulgaris</i>	24
<i>Beta vulgaris subsp. maritima</i>	572
<i>Beta vulgaris subsp. vulgaris</i>	9
<i>Beta vulgaris subsp. vulgaris</i>	1722
<i>Beta webbiana</i>	8
<i>Beta x intermedia</i>	8
Total	2550

At the WRPIS, the active collection for distribution is stored at 4 °C and 28% relative humidity (Fig. 1). Original seed samples for regeneration are stored at -18 °C.



Fig. 1. Sugar beet germplasm managed by the WRPIS. A: Active seed packages stored at 4°C with 28% relative humidity in Pullman, WA.

There are 1926 accessions backed up at the National Center for Genetic Resources Preservation in Fort Collins, Colorado for long term storage. These back-up samples are stored at either -18 °C or under liquid nitrogen (LN, vapor phase). The collection contains material from 56 different countries. The cultivated accessions include landraces, old varieties, and advanced breeding lines developed by the USDA-ARS sugar

beet research programs across the country. The oldest extant *Beta* accession, PI 103042, was purchased in Beijing, China in 1933. The newest accession, PI 655308, is a public breeding line developed by Dr. McGrath in Michigan. Our collection harbors a wide range of genetic diversity possessed by cultivated sugar beet and its wild relatives which is useful for the genetic improvement of the sugar beet crop.

Regeneration and seed increase:

Even with optimized seed storage conditions, seed viability decreases after a certain period of time. The rate of decrease depends on the species and the initial seed quality. Periodic regeneration is required to keep stored seed alive. Regeneration is also required when demand decreases the quantity of stored seed below a minimum amount (500 seed).



Fig. Fig 2. Sugar beet germplasm seed increase or regeneration in the greenhouse. Upper left: Seedlings are transplanted into two-gallon pots; Upper right: Seedlings are in a cold room at 4°C for to achieve a uniform bolting; Lower left: Marie Pavelka, Biological Science Technician, is using bamboo sticks to support the flowering branches; and Lower right: A healthy blooming plant.

Regeneration and seed increase are carried out either in the greenhouse (Fig. 2) or in the field (Fig. 3). Great emphasis is put on retaining the genetic integrity of the original seed samples by following established protocols. Since sugar beet is an open-pollinated species with wind dispersed pollen, isolation is achieved by using pollen-

blocking cloth cages (Fig. 3B) in the field or by growing one accession per room in the greenhouse. Seedlings of all but annual *Beta* accessions are vernalized at 4°C for 4 months (Fig. 2B).



Fig. Fig. 3. Sugar beet germplasm seed increase or regeneration in the field. Upper left: Seedlings are transplanted into field; Lower left: Plants in the field before bolting; Upper right: Pollen-blocking cloth cages are used to isolate individual accessions to prevent cross-pollination among accessions; and Lower right: A leaf blower is used to disperse pollen among the plants in the screen tent at the blooming time.

Evaluation of morphological and agronomical characteristics:

Over the years, we have, in collaboration with researchers in the sugar beet community, evaluated the morphological and agronomical characteristics of the accessions in the collection using established descriptors. Data for each accession is



Fi Fig. 4. A screen shot of GRIN database showing the example of passport data of PI 169023.

uploaded to the GRIN database. It can be viewed online or downloaded in spreadsheet form. Fig. 4 shows a screen shot of the GRIN database showing the passport data for PI 169023. The observation data can be browsed by following the hyperlink in the passport data page.

Distribution to researchers worldwide:

Interested parties can request seeds of the available *Beta* accessions through the Internet and we promptly ship seed free of charge. During the past five years, the WRPIS distributed 2,591 seed packets to requesters from 16 countries. Researchers in the US received 2,036 packets, approximately 79% of the total distribution (Fig. 6).

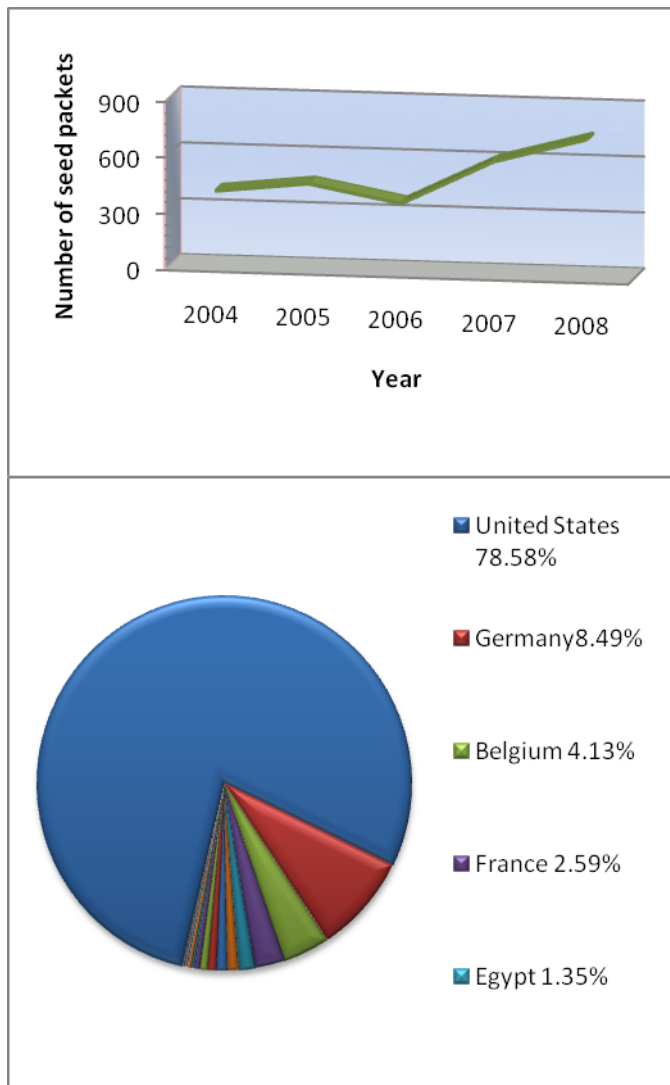


Fig. 5. Distribution of sugar beet germplasm of the WRPIS in the past five years. Upper: number of seed packets sent out each year; Lower: relative proportion of seed packets received by the 17 recipient countries.

Researchers have been using the distributed germplasm, for mining the desirable traits such as disease resistance, stress tolerance and improved quality, investigating the genetic basis of these traits and incorporate these valuable traits into elite sugar beet cultivars.

Future directions:

We will continue to improve seed management practices, especially on fine tuning conditions for seed increase and regeneration to preserve valuable genetic resources. We will continue to collaborate and welcome new collaborations with researchers to characterize and identify needed agronomic traits for sugar beet improvement. We will strategically expand the genetic diversity of our collection. We will facilitate information sharing through the GRIN database to promote the utilization of the available germplasm to strengthen economically sustainable sugar beet production in the United States.

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