

BETA GERMPLASM EVALUATION DATA IN TWO DATABASES, GRIN & IDBB

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ABSTRACT

Since it was established in 1983, the Sugarbeet Crop Germplasm Committee (CGC) has aggressively managed the evaluation of the accessions of *Beta* germplasm held by the USDA-ARS National Plant Germplasm System (NPGS). Currently, the NPGS holds 2,441 accessions, ranging from wild sugarbeet relatives to heritage open-pollinated varieties, and released germplasm registered in *Crop Science*. There are more than 4,500 records of evaluations of accessions for resistance to twelve major pests and diseases of sugarbeet. These data and more information are contained in the Genetic Resources Information Network (GRIN) database, managed by the USDA-ARS NPGS. GRIN can be publicly accessed through the World Wide Web – URL: <http://www.ars-grin.gov/npgs>.

Between 1996 and 2002 the U.S. evaluation activities have been complemented by the project "Evaluation and enhancement of *Beta* collections for the extension of agricultural production" (GENRES CT95 42). This project was funded by the Commission of the European Countries. Eleven project partners in six European countries collaborated in core collection development, seed multiplication, germplasm evaluation and data documentation. Project partners in Germany, Greece, Sweden, the United Kingdom, Italy and The Netherlands did the screening for resistance to seedling diseases (*Aphanomyces cochlioides*, *Phoma betae*), leaf diseases (*Cercospora beticola*, *Erysiphe betae*, BYV, BMYV) and root diseases (Rhizomania, *Rhizoctonia solani*), as well as drought tolerance. In total 16397 characterizations and 5248 evaluation data have been recorded.

KURZFASSUNG

Seit seiner Gründung im Jahre 1983 gelang es dem Sugarbeet Crop Germplasm Committee (CGC) in zunehmendem Maße im USDA-ARS National Germplasm System (NPGS) gehaltene Muster genetischer Ressourcen der Beta-Rübe zu evaluieren. Gegenwärtig lagern am NPGS 2.441 Muster mit der Zuckerrübe nahe verwandter Wildarten, offen bestäubte Sorten und in Crop Science registriertes Basismaterial. Es gibt mehr als 4.500 Evaluierungsdaten zur Resistenz der Zuckerrübe gegen 12 der wichtigsten Schädlinge und Krankheiten. Diese Daten und weitere Informationen sind in der Datenbank im

Genetic Resources Information Network (GRIN) enthalten, die durch das USDA-ARS NPGS verwaltet wird. GRIN bietet eine öffentlich zugängliche Recherchemöglichkeit über das World Wide Web – URL: <http://www.ars-grin.gov/npgs> an.

In den Jahren 1996 bis 2002 wurden die U.S. Evaluierungsaktivitäten durch das Projekt "Evaluierung und Optimierung von Beta-Sammlungen zur Extensivierung der landwirtschaftlichen Produktion" (GENRES CT95 42) ergänzt. Dieses Projekt finanzierte die Kommission der Europäischen Union. Elf Projektpartner in sechs europäischen Ländern kooperierten im Bereich der Entwicklung einer Kernsammlung, der Saatgutvermehrung, Evaluierung und Datendokumentation. Projektpartner in Deutschland, dem Vereinigten Königreich, Italien und in den Niederlanden testeten Muster auf Resistenz gegen Sämlingskrankheiten (*Aphanomyces cochlioides*, *Phoma betae*), Blattkrankheiten (*Cercospora beticola*, *Erysiphe betae*, BYV, BMYV) und Wurzelkrankheiten (*Rhizomania*, *Rhizoctonia solani*) sowie auf Trockentoleranz. Insgesamt wurden 16397 Charakterisierungs- und 5248 Evaluierungsdaten aufgezeichnet.

INTRODUCTION

The GRIN database is much more than an NPGS inventory of seed on hand. There also are botanical, morphological, and agronomic evaluation data; more than 200 photographs of accessions; *Beta* taxonomic information; contact information for the Sugarbeet CGC; pedigrees of registered germplasm; photographs illustrating disease scale ratings; and descriptions of evaluation trials, as well as citations of publications, which describe the performance of these accessions. The Sugarbeet CGC has also been working with the GRIN programmers to develop the capacity to enter molecular marker and accession level population data to this database. This information makes the GRIN database an extremely valuable tool for public and private sugar beet breeders who have learned how to access and use the full array of information in the GRIN system. In this presentation the available data on *Beta* accessions are detailed and instructions on how to access this information are given.

Using the International Data Base for Beta (IDBB), an international core collection comprising 805 accessions held by various genebanks in Europe and around the world has been developed (Frese L., 2000; Panella, L. et al., 2000). Between 300 and 700 accessions of the core collection were used by project partners in Germany, Greece, Sweden, the United Kingdom, Italy and The Netherlands to screen for resistance to seedling diseases (*Aphanomyces cochlioides*, *Phoma betae*), leaf diseases (*Cercospora beticola*, *Erysiphe betae*, BYV, BMYV) and root diseases (*Rhizomania*, *Rhizoctonia solani*) as well as drought tolerance.

1.- DISCUSSION

1.1.- GERMPLASM CONTAINED WITHIN THE USDA-ARS NPGS GRIN DATABASE

The GRIN system has 2,447 *Beta* accessions, the majority of which are *Beta vulgaris* subsp. *vulgaris* (Table 1) and represent improved germplasm early open-pollinated varieties developed in the United States and throughout the world (Table 4). Some of the most interesting accessions are those in the taxon, *Beta vulgaris* subsp. *maritima*, which are a rich source of disease resistance genes and are being aggressively evaluated (Panella, L. et al., 2003) – 23,419 evaluations through 1999 (descriptors * accessions evaluated – See Table 2). The USDA-ARS NPGS *Beta* Core Collection (Hannan, R.M. et al., 2000) consists of 110 accessions from *B. v.* subsp. *maritima* (68 accessions of the 572 in the collection) and *B. v.* subsp. *vulgaris* (42 accessions). The improved sugarbeet germplasm, which makes up the bulk of the 1,667 *B. v.* subsp. *vulgaris* accessions, has not been integrated into the core collection at this point.

Table 1. *Beta* accessions maintained in the USDA-ARS NPGS.

TAXON	SITE	TOTAL
<i>Beta corolliflora</i>	WRPIS*	4
<i>Beta hybrid</i>	WRPIS	2
<i>Beta lomatogona</i>	WRPIS	29
<i>Beta macrocarpa</i>	WRPIS	16
<i>Beta macrorhiza</i>	WRPIS	19
<i>Beta nana</i>	WRPIS	1
<i>Beta patellaris</i>	WRPIS	29
<i>Beta patula</i>	WRPIS	3
<i>Beta procumbens</i>	WRPIS	15
<i>Beta sp.</i>	WRPIS	16
<i>Beta trigyna</i>	WRPIS	47
<i>Beta vulgaris</i>	WRPIS	3
<i>Beta vulgaris</i> subsp. <i>maritima</i>	WRPIS	572
<i>Beta vulgaris</i> subsp. <i>vulgaris</i> **	NCGRP***	8
<i>Beta vulgaris</i> subsp. <i>vulgaris</i>	WRPIS	1,667
<i>Beta webbiana</i>	WRPIS	8
<i>Beta x intermedia</i>	WRPIS	8
Total		2,447

*Western Regional Plant Introduction Station in Pullman, Washington.

**These eight accessions are vouchers for a set of trisomics.

***National Center for Genetic Resources Preservation (formerly National Seed Storage Laboratory).

Table 2. USDA-ARS National Plant Germplasm System's Beta Collection - Summary of descriptors evaluated sorted by taxon

Descriptor Name	<i>B. v. ssp. maritima</i>	<i>B. v. ssp. vulgaris</i>	TOTAL (all taxa)
100 Seed Weight	502	1,402	2,075
A-amino-N Ck %t	4	74	79
Aphanomyces	87	299	388
Beet Cyst Nematode	182	202	392
Beet W Yellows Virus	48	207	260
Bolting Tendency 1	230	352	594
Cercospora	121	396	519
Core Subset	67	40	107
Crown Height Max		79	79
Crown Height Min		79	79
Crown Width Max		79	79
Crown Width Min		79	79
Curly Top	158	184	351
Cuticle Thickness	74	90	164
Diameter Maximum		80	80
Diameter Minimum		80	80
End Use	34	423	463
Erwinia Rot	38	113	161
Erysiphe	96	121	227
Flesh Color	31	245	277
Fusarium	22	56	80
Germination	438	1,205	1,694
Gross Sugar	1	80	81
Growth Habit	151	230	383
Height Maximum		80	80
Height Minimum		80	80
Hypocotyl Color	138	106	247
Intern. Core Subset	62	84	150
Isolation	104	12	116
Leaf Blade Wd Max	80	124	204
Leaf Hairiness	80	124	204
Leaf Length Max	80	124	204
Leaf Length Min	80	124	204
Leaf Pigmentation	109	330	441
Leaf Width Min	80	124	204
Lifeform	521	887	1,560
Male Sterility	30	4	34
Multigermicity	39	82	121
Nitrogen	63	154	218
Nitrogen-sucrose	1	45	46
Number	104	132	236
Petiole Color	178	386	568
Petiole Length - Max	80	124	204
Petiole Length - Min	80	124	204
Petiole Width - Max	80	124	204
Petiole Width - Min	80	124	204

Descriptor Name	<i>B. v. ssp. maritima</i>	<i>B. v. ssp. vulgaris</i>	TOTAL (all taxa)
Picture/image	47	185	239
Ploidy Level	522	904	1,499
Polymyxa	15	24	39
Potassium	63	154	218
Potassium Check %	4	74	79
Potassium-sucrose	1	45	46
Recoverable Sugar	1	130	131
Rhizoctonia	136	384	531
Rhizomania	90	243	345
Ring Color	35	227	263
Root Aphids	70	79	152
Root Color	51	351	402
Root Division	34	213	247
Root Length Max		253	253
Root Length Min		259	259
Root Maggot	65	165	237
Root Position	10	211	221
Root Shape	31	243	274
Root Width Max		227	227
Root Width Min		228	228
Rosette	14	198	212
Sample Area	104	12	116
Sodium	63	154	218
Sodium Check %	4	74	79
Sodium-sucrose	1	45	46
Stem Pigmentation	96	84	180
Sucrose	4	186	191
Sugar Absolute	60		60
Sugar Check %	61	95	156
Suture		93	93
Tare Check %	3	51	55
Tare Percent	3	51	55
Type of Beet	523	420	1,090
Uniformity	123	248	371
White Sugar Yld	1	24	25
Yield	2	75	78
TOTAL	6,590	16,102	23,419

1.2.- ACCESSING GRIN AND DESCRIPTOR DATA

These Data can be accessed at the Web-site of the USDA-ARS NPGS at <http://www.ars-grin.gov/npgs/> by clicking on the choice "Search GRIN" then on "Research Crops and Descriptor/Evaluation Data Queries". At this point there is a list of crop species and one can page down to "SUGARBEET" and click on "Query on multiple descriptors". At this point, there is a list of all of the

descriptors each with an operator (=, >, <, etc.) and a code value choice and one can design their own search strategy. For example, page down to Rhizoctonia and set the choice to "Less than 3", continue down to the bottom of the page and press the button marked "Submit Query" – a list of 33 accessions is generated. Is this the point where the plant breeder should take the list and request the germplasm? What more can be learned?

First, it is well worth the plant breeder's time to look a little deeper into the database. As an example, choose number 16 on the list, which is PI 535845 or ANNOMONO. Click on "PI 535845" to find more information on the individual accession. One finds that it is a cultivar received from Poland in 1989 and at the bottom of the page are photographs of both the leaves and root. Click on "Observations" to see for which traits this accession has been evaluated in addition to its resistance to Rhizoctonia root rot – it has been evaluated for 36 different descriptors, including sucrose, yield, and resistance to a number of different diseases. For each of those evaluations there is more data to be found by searching a little deeper.

To find out more information on the Rhizoctonia root rot (as an example – this is the same for each descriptor observation) evaluations, one can click on the descriptor "RHIZOCTONI" and a page comes up with all of the evaluations completed for resistance to Rhizoctonia in this format:

- SUGARBEET.CAC.RHIZOC.1 (224 Accessions)
- SUGARBEET.RHIZOCTONI.87.RUPPEL (42 Accessions)
- ⋮
- ⋮
- ⋮
- SUGARBEET.RHIZOCTONI.98.PANELLA (30 Accessions)
- SUGARBEET.RHIZOCTONI.99.PANELLA (24 Accessions)

If one clicks on the test – e.g., "SUGARBEET.RHIZOCTONI.99.PANELLA", there is a page with a description of the conditions of that particular test (these are more complete in more recent tests). If one clicks on the accessions, -- e.g., "(24 Accessions)", all the accession in that test are listed along with their score, and, in the more recent ones, also listed are: 1) minimum and maximum value, 2) mean value, 3) standard deviation, and 4) sample size. Finally at the bottom of the pages is a little button, "Code values", which gives the values and, for Rhizoctonia, also photographs of the roots representing the different ratings. All of this added information can help one make an more informed breeding decision.

1.3.- "EVALUATION AND ENHANCEMENT OF BETA COLLECTIONS FOR THE EXTENSIFICATION OF AGRICULTURAL PRODUCTION" (GENRES CT95 42)

The EC/GRP project "Evaluation and enhancement of *Beta* collections for the extensification of agricultural production" (GENRES CT95 42) was a collaboration of eleven partners in six European countries. This research collaboration yielded 16,397 characterizations and 5,248 evaluation data that have been entered into the IDBB (Table 3).

Table 3 Characterisation and evaluation data generated by partners of the GENRES CT 95 42 project. These data were documented in the IDBB as of December 2002.

GENRES project partner	Traits	No. of data
Characterization traits		
Federal Centre for Breeding Research on Cultivated Plants (Germany)	Growth habit, etc.	12145
Institute of Crop Genetics and Crop Plant Research (Germany)	Growth habit, etc.	2605
Greek Gene Bank (Greece)	Growth habit, etc.	284
Kleinwanzlebener Saatzucht AG (Germany)	Growth habit, etc.	315
Syngenta AB (Sweden)	Growth habit, etc.	1048
Seedling diseases		
IACR Broom's Barn (U.K.)	<i>Aphanomyces cochlioides</i>	600
IACR Broom's Barn (U.K.)	<i>Phoma betae</i>	597
Leaf diseases		
IACR Broom's Barn (U.K.)	BYV	595
IACR Broom's Barn (U.K.)	BMV	597
IACR Broom's Barn (U.K.)	<i>Erysiphe betae</i>	590
Istituto Sperimentale per le Colture Industriali / Societa Produttori Sementi Bologna (Italy)	<i>Cercospora beticola</i>	514
Root diseases		
Kleinwanzlebener Saatzucht AG (Germany)	<i>Rhizoctonia solani</i>	699
Istituto Sperimentale per le Colture Industriali / Societa Produttori Sementi Bologna (Italy)	Rhizomania (field test)	300
Plant Research International (The Netherlands)	Rhizomania (laboratory test)	137
Abiotic stress		
IACR Broom's Barn (U.K.)	Drought tolerance	569

1.4.- “PROMOTION OF THE USE OF EAST EUROPEAN *BETA VULGARIS* GERMLASM COLLECTIONS

Additionally, from 1997-1999, the European Cooperative Program for Crop Genetic Resources Networks (ECP/GR) funded a project called “Promotion of the use of East European *Beta vulgaris* germplasm collections” with three project partners in the Czech Republic, Poland and Russia. In additions to data on horticultural traits, this project yielded data on nitrogen accumulation of accessions of a highly diverse garden beet collection (Grzebelus, D. & Baranski, R., 2001) and characterization data on the beet collections held by the Vavilov-Institute in St. Petersburg and the Czech genebank in Prague.

The task of the BAZ Gene Bank consisted in the co-ordination of both projects, as well as in the collection and compilation of all evaluation and characterization data into the International Database for *Beta* (IDBB). Project partners frequently had recorded single plant data, which allowed the estimation of statistical parameters, such as standard deviation, range, and the coefficient of variation, in addition to the mean value. The single observations concept that had already been rudimentarily implemented in the old version of the IDBB was elaborated in detail from the year 1999 onwards (Germeier, C.U. & Frese, L., 2000). Today, the “Beta-version “of the redesigned database is available on the World Wide Web and can be accessed at this URL: <http://ice.zadi.de/idbbonline/beta.php>. Users can query passport, characterization and evaluation data (including statistical parameters) and download the results as excel files.

CONCLUSION

Evaluations of selected germplasm accessions from the USDA-ARS *Beta* Collection have been coordinated by the U.S. Sugarbeet Crop Germplasm Committee since 1985 and, therefore, each year the collection has been housed at WRPIS. In addition, starting in 2001, digital images have been acquired for each accession increased at WRPIS and these images have been loaded onto GRIN. To date, images of 239 accessions have been loaded onto GRIN from WRPIS and by other evaluators. Dr. Hodgdon at WRPIS has compiled descriptions of 584 accessions as they have been increased in the field and greenhouse. Theses data are being loaded into GRIN. This information can be found in GRIN at the NPGS World Wide Web home page of <http://www.ars-grin.gov/npgs/> and the specific site of the *Beta* germplasm descriptors (Rhizoctonia, Cercospora, Root Maggot, Curly Top and Rhizomania are accompanied in “code values” list by photographs that illustrate the values) and is at <http://www.ars-grin.gov/cgi-bin/npgs/html/desclist.pl?49>

GENRES CT95 42 project partners from six countries have collaborated in core collection development, seed multiplication, germplasm evaluation and data documentation to screen between 300 and 700 *Beta* accessions for resistance to seedling diseases (*Aphanomyces cochlioides*, *Phoma betae*), leaf diseases (*Cercospora beticola*, *Erysiphe betae*, BYV, BMYV) and root diseases (*Rhizomania*, *Rhizoctonia solani*) as well as drought tolerance. In total 16397 characterization and 5248 evaluation data have been recorded. Additionally, the “Promotion of the use of East European *Beta vulgaris* germplasm

collections" project has screened horticultural traits, nitrogen accumulation and characterized beet collections held by the Vavilov-Institute in St. Petersburg and the Czech genebank in Prague. Data from both can be accessed at the URL: <http://ice.zadi.de/idbbonline/beta.php> and users can query passport, characterization and evaluation data (including statistical parameters) and download the results as excel files.

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