Using the GRIN-Global System to Identify Useful Plant Genetic Resources & Information

2012 C08 Division, CSSA Meeting

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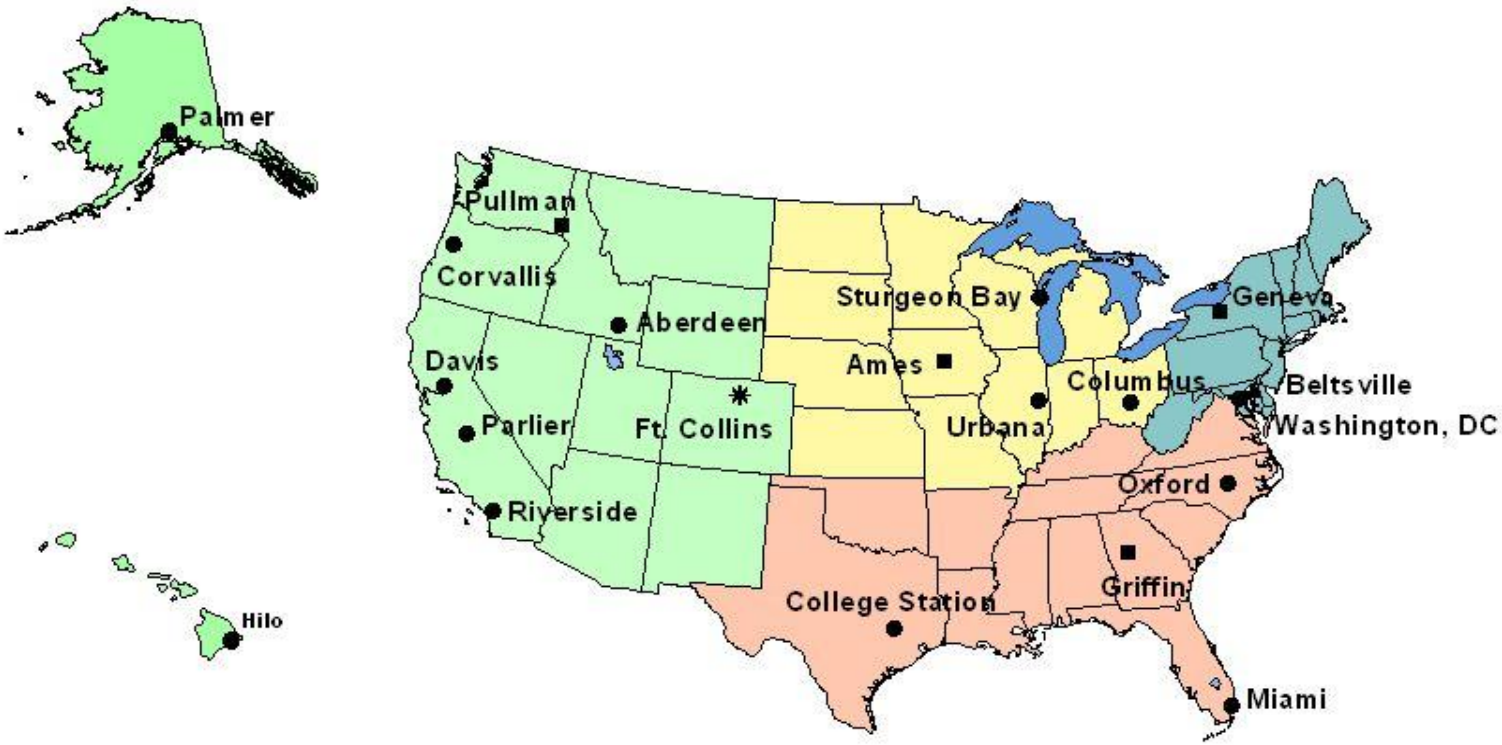
National Germplasm Repositories



■ Regional Plant Introduction Station
● National Germplasm Repository
✱ National Center for Genetic Resources Preservation
▲ National Germplasm Resources Laboratory

The NPGS exists to conserve and provide

- plant genetic resources that serve as the raw materials for genes and traits of value for crop improvement to provide feed, food, fiber, and fuel to meet society's needs
- associated information on their provenance, reproductive biology, adaptation, genetic character, phenotypic traits and attributes

Researchers access these diverse resources to target accessions which meet their objectives.

The availability of high quality plant genetic resources of known provenance, associated with geo-reference information, is fundamental to the development of crops to meet adaptive requirements for production, or for specific end-use requirements.

Plant Genetic Resource Utilization

The value of high quality plant genetic resources is enhanced by thorough, high quality documentation that supports efforts to target utilization for a wide array of specific objectives.

In 2011, the North Central Regional Plant Introduction Station in Ames distributed 38,400 packets of seed or plants of 18,600 accessions to 1,200 recipients. The entire NPGS likely distributed 200,000 units.

Evolution of the GRIN System

- The national collections of seven countries, including the U.S., account for 45% of all PGR worldwide conservation efforts (FAO, 2010b).

- The importance of well-curated and documented biological collections is likely to expand, as the emerging era of high throughput genomics and proteomics research provides new insights (Dosmann and Groover, 2012).

The first version of GRIN (GRIP) became operational in 1984; enhanced versions were released in 1987 and 1994. The first two versions used Prime DBMS.

In 1990, the DBMU initiated a thorough analysis of NPGS needs; Oracle, a relational database management system, and Sun Microsystems computers were purchased.

The system information was displayed on the World Wide Web in 1992. From the late 1990's through the mid 2000's, the curatorial software and public website were enhanced incrementally on the Oracle platform.

Since information became available on the web, international germplasm distributions have grown significantly, to 35-40% of annual distributions.

GRIN Plant Collections page - Windows Internet Explorer

http://www.ars-grin.gov/npgs/searchgrin.html

File Edit View Favorites Tools Help

Favorites | Global Crop Diversity Trust | http--www.ars-grin.gov-np... | FP&M Rates and Fees | Suggested Sites | Get More Add-ons | Customize Links

GRIN Plant ... | NCRPIS Intrane... | Home - NCRPIS... | Iowa State Uni... | ARS : Home

USDA ars United States Department Of Agriculture Agricultural Research Service

Germplasm Resources Information Network

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Search

Enter Keywords Go

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Browse By Subject

- Home
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  - Search GRIN
  - Request Germplasm
  - pcGRIN
  - Crop Germplasm Committees
  - Repository Home Pages
  - FAQ
  - Links
- About Us
- Research
- Products & Services
- People & Places
- News & Events
- Partnering
- Careers

National Plant Germplasm System

Accession Area Queries

Crop Science Registration

Plant Variety Protection

Taxonomic Queries

Research Crops and Descriptor/Evaluation Data Queries

Search Multiple Databases

Updated 13-Nov-2008

Done | Internet | 100%

Documentation and Access Needs

- A next generation GRIN system was needed to meet the evolving information needs of both curatorial personnel and stakeholders.

- The Global Crop Diversity Trust, a unique non-governmental organization dedicated to assuring conservation of global plant genetic diversity, recognized that documentation of national genebank resources is a critical factor in successful conservation and utilization.

Collaborative Development of GRIN-Global

In 2008, ARS entered into a collaborative agreement with Bioversity International and the Global Crop Diversity Trust to develop the GRIN-Global System.

Purpose of the GRIN-Global System

Designed to provide the world's crop genebanks with a powerful, flexible, easy-to-use global plant genetic resource information management system.

GG will constitute the keystone for an effective global network of genebanks to permanently safeguard plant genetic resources vital to global food security, and encourage the use of these resources by researchers, breeders, and farmer-producers.

Benefits of the System

By improving the capability of genebanks to provide data to a global accession-level information system under the leadership of Bioversity International, it will be possible to

- more accurately assess the “State of the World” for plant genetic resources and
- identify priority global needs for plant genetic resource conservation.

Feedback from the international community during the international project and from the NPGS community provides use cases and information on workflows that form the basis for wizard design and functionality considerations.

CURRENT PROGRESS

- GRIN-Global v1.0 was released internationally in December, 2011.
- To date, three major national and CGIAR genebanks are in the process of migrating their data from existing systems for 2012 deployment
- Other national genebanks are exploring
- The U.S. NPGS is engaged in gap analysis activities prior to implementation in 2013

http://www.grin-global.org/index.php/Main_Page
Main Page - GRIN-Global W...
Fujitsu: IT and Business Service...
Convert
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Main Page

GRIN-Global Version 1.5 Announced
8 August 2012

The GRIN-Global developers are currently testing a new schema, "1.5." The objective for this schema change is to eliminate redundancies
inventory tables. The changes will not eliminate any data, but will involve the rearranging of several tables. For details, please read: GRIN-

GRIN-Global Version 1.0 Released
14 December 2011

The USDA/ARS, Bioversity International, and the Global Crop Diversity Trust announced the release of GRIN-Global System version 1.0.
announcement: GRIN-Global 1.0 Announcement(.pdf)

Contents [hide]

1 The GRIN-Global Project
2 Goal of the GRIN-Global Project
3 Technical Steering Group
4 Project Activities and Approaches
5 Development Team
6 Training & Documentation Resources
7 Screenshots
8 Logo Images Gallery
9 System Development Process, Products, and Implementation

The GRIN-Global Project

The GRIN-Global project's mission is to create a new scalable, version of the Germplasm Resource Information Network (GRIN), used by
System. The GRIN-Global database platform will be suitable for use by any interested genebank in the world. It is being developed in a jo
Bioversity International , and the Agricultural Research Service of the USDA (read the ARS press release). (For information on the Ge
system, see [1].)

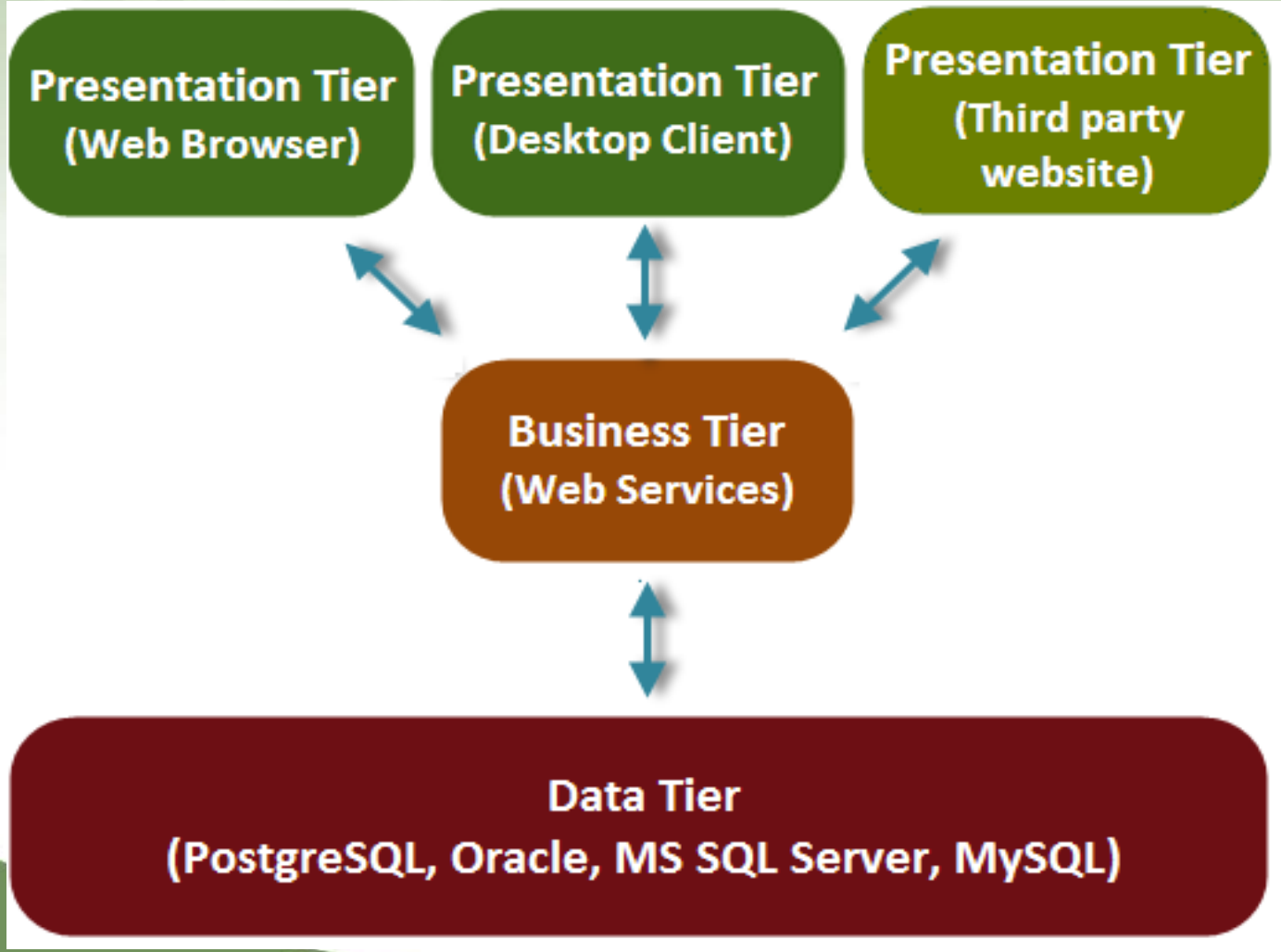
System Requirements

- Database flexible (MS SQL Server, MySQL, Oracle, Postgres)
- Scalable –deploy on single PCs or networked systems
- No recurring licensing fees required for use
- Ability to translate all interface components to support multiple languages
  (currently Arabic, English, French, Russian, Spanish)
- Ease of use
- Software developed freely available
- Enable global community development and system evolution

Essential GRIN-Global IM Functions

- Accession acquisition information
  - Provenance, eco-geographic, breeding & development history, IPR, taxonomy
- Phenotypic information
- Genotypic information
- Inventory information
  - Germplasm availability and health
- Regeneration Information
  - Environments, propagation methods, pollinators
- Distribution Information
  - Order management & fulfillment, SMTA & IPR Management

System Design



Schema Design Goals

- Discoverability – intuitive, non-abbreviated, descriptive names for tables and columns
- Auditability – ability to audit data in all tables – who/when created/ modified/owns records
- Multilingual – support for multiple languages simultaneously
- Multiple Database Engine Support – conform to database engine specific limitations for all four db engines
- Consistency – overall naming and data typing consistency

Three Tier Architecture

- Web Service-based, uses XML standard language for bi-directional communications
- Adaptable and flexible
  - More adaptable to changes in operating systems (client can be ported to many platforms)
  - Easier to make changes to individual tiers without affecting the other tiers (extensibility)
- MaizeGDB – proof of concept web service to provide accession inventory information real-time at their website.
  - The web service is written using .NET 3.5
  - Client application (to consume the data from the .NET web service) at MaizeGDB is written in PHP

Development Environment

Written using software development tools that are free

- Microsoft .NET Framework 3.5
- SVN version control system
- Visual Studio Express 2008

The *Business Tier* relies on IIS (Internet Information Systems) and manages the exchange of information stored in the database and desktop applications using standard XML (Extensible Markup Language), the industry standard for data exchange.

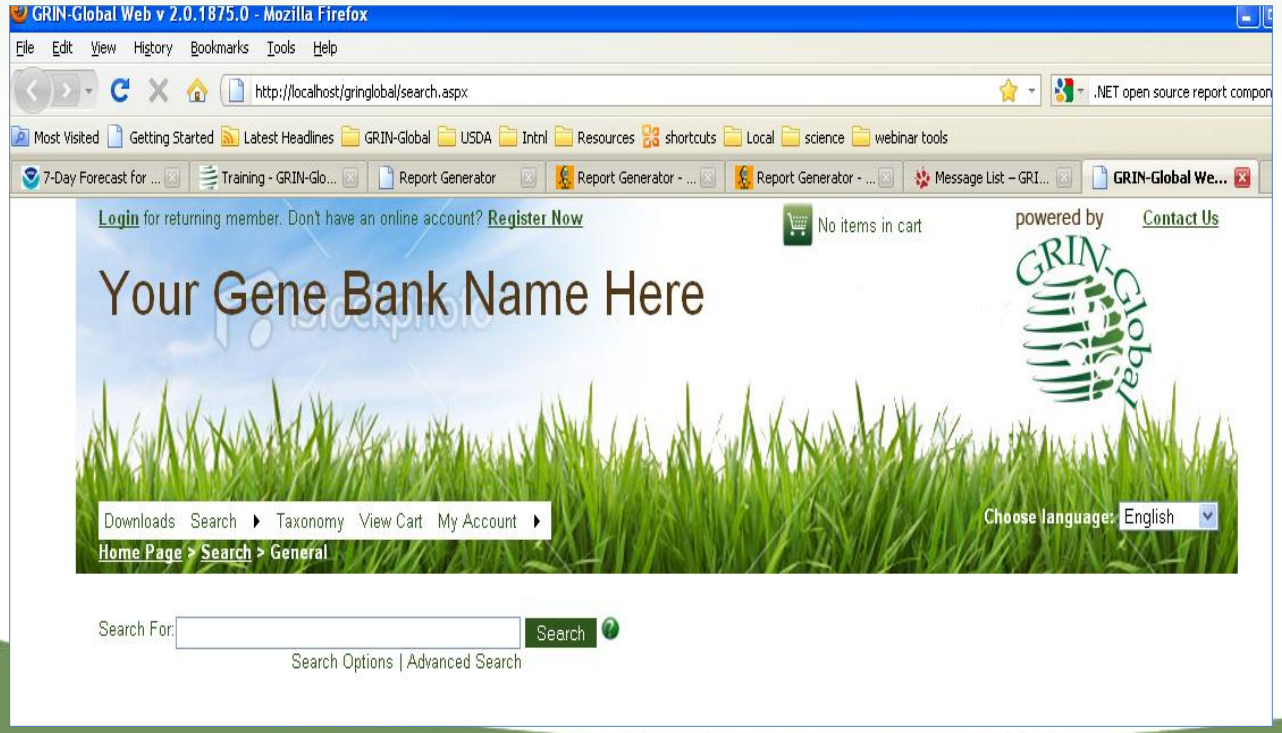
The Business Tier is the basis of the system's flexibility, and allows enhancements of other system components without adversely affecting other components (within technical parameters).

The *Presentation Tier* includes applications which retrieve and present database information. These include the *Curator Tool (CT), the desktop client*, and the browser-based *Public Website (PW)* which is used to search for information and/or order germplasm.

The Presentation Tier enables interoperability such that GG data can be exchanged with third party websites such as Genbank or model crop databases or mobile devices including personal data assistants (PDAs), cell phones, etc.

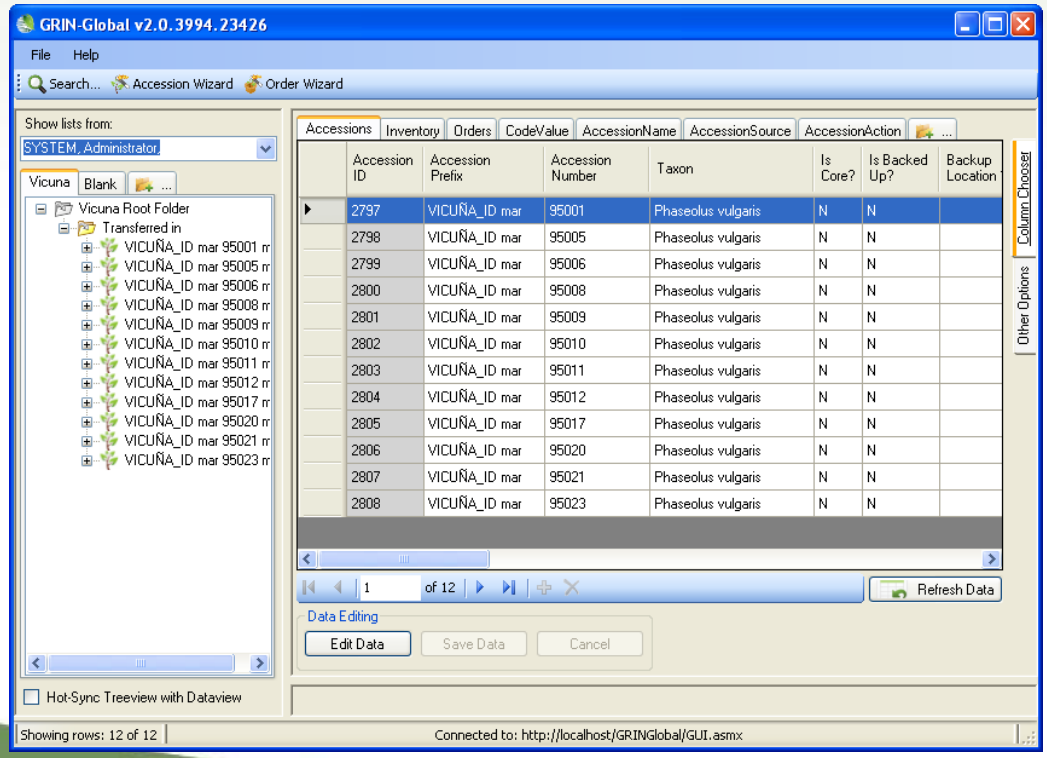
Public Website

Through the Public Website and web services, clientele can access germplasm information; search the entire GRIN-Global database; and order germplasm from the genebank through a "shopping cart facility."



Curator Tool

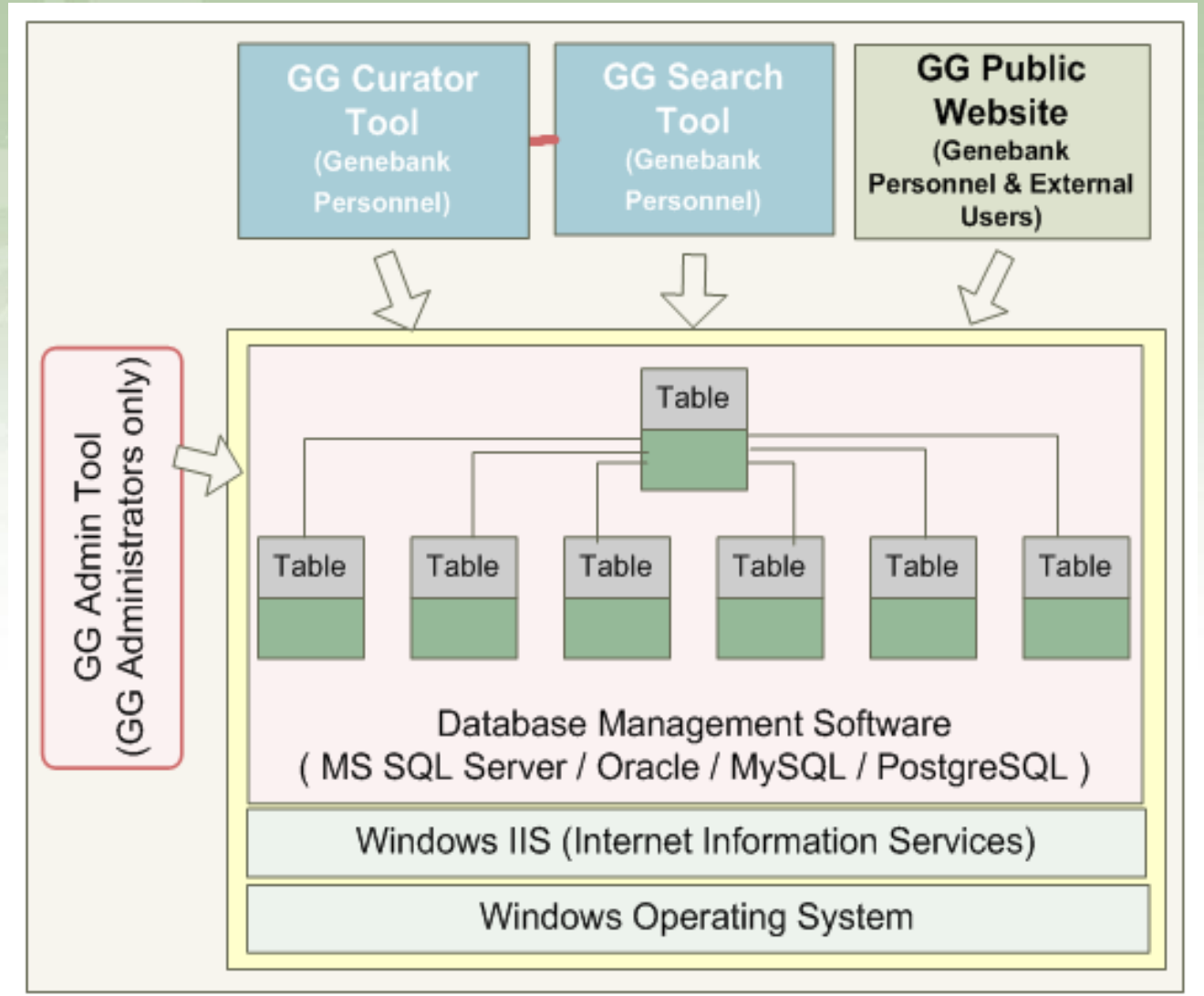
The Curator Tool is a GRIN-Global application designed primarily for curators and genebank workers who will create and manage their genebank's data



The Data Tier supports the free versions of four major database engines: MS SQL Server, MySQL, Oracle, and PostgreSQL.

System development was primarily conducted using the free version of MS SQL Server.

GRIN-Global Environment



Dialog interfaces referred to as "*wizards"* are useful for loading of large data sets such as passport and provenance information (*accession wizard*), bulk loading of digital images (*image wizard*), and crop trait, inventory and taxonomy information.

Wizards are the primary vehicle for extending the features and functionality of the client application (application add-ons).

Dataviews are programmed searches that retrieve and present data in both the CT and the PW interface.

Dataviews are used to create/ read/ update/ delete data. Dataviews incorporate SQL (Structured Query Language, a language for querying relational databases).

Dataviews enable extensibility of the Business and Data Tiers.

There is no limit to the number of wizards and dataviews that GRIN-Global can accommodate for managing information.

GRIN-Global Public Interface

FEATURES OVERVIEW

Features Overview

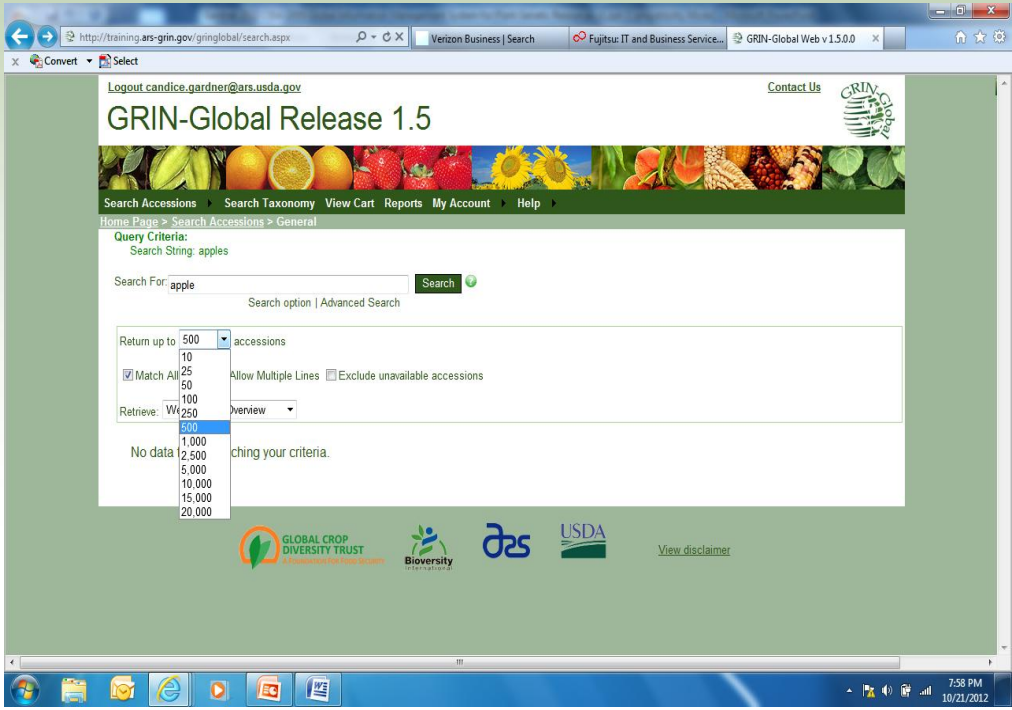
- Search Engine

  The search engine provides an easy-to-use interface. Type a term or phrase, and the search engine parses through the data to determine the most relevant results based on your search terms.

Features Overview

- Search Results

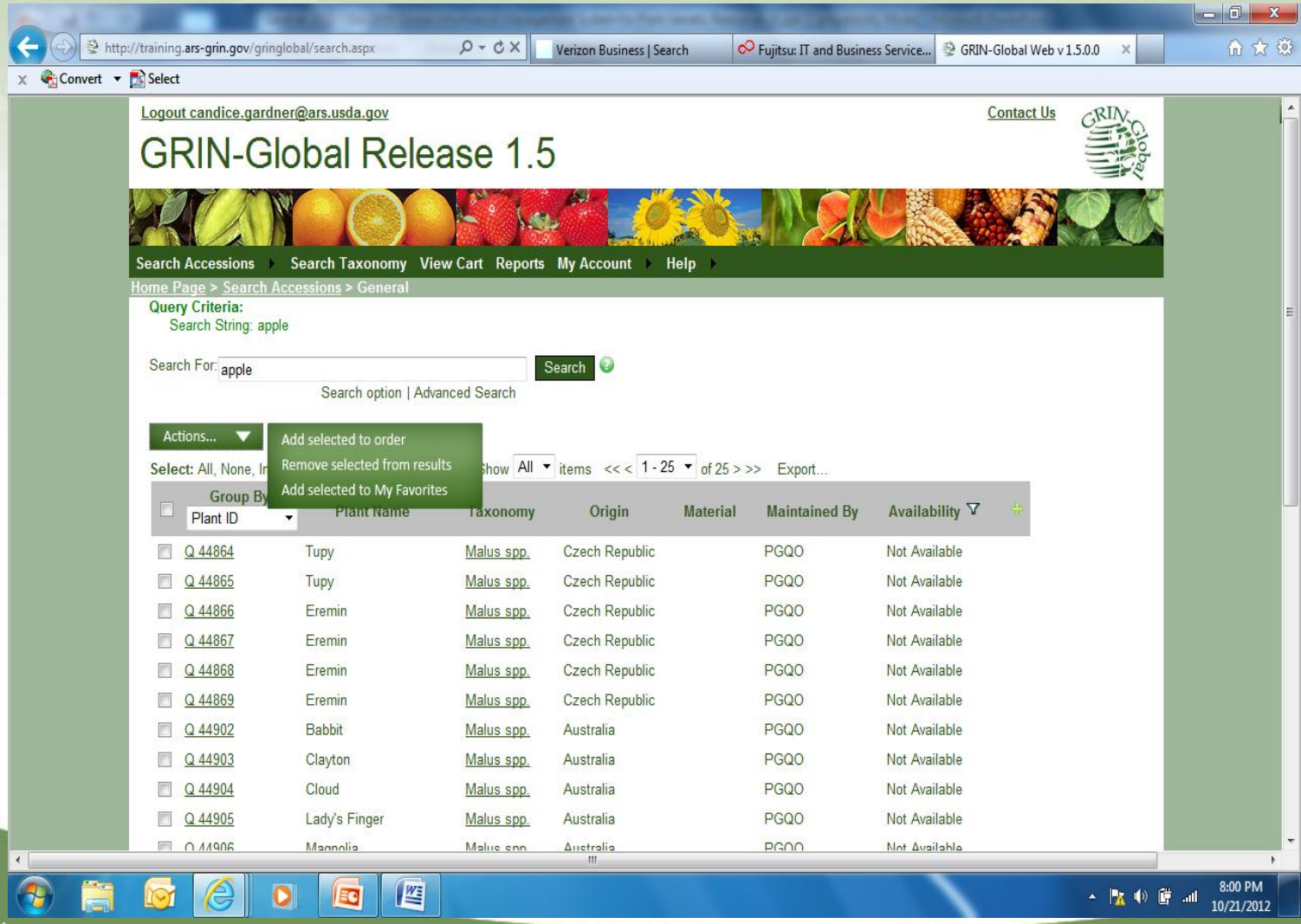
  The results returned by the search engine are formatted to provide the most useful information right away. Users can modify their preferences to meet their specific needs.



Features Overview

Data Features

- Group by
  - Plant ID (default)
  - Plant Name
  - Taxonomy
  - Origin
  - Maintained by
  - Availability
  - Material

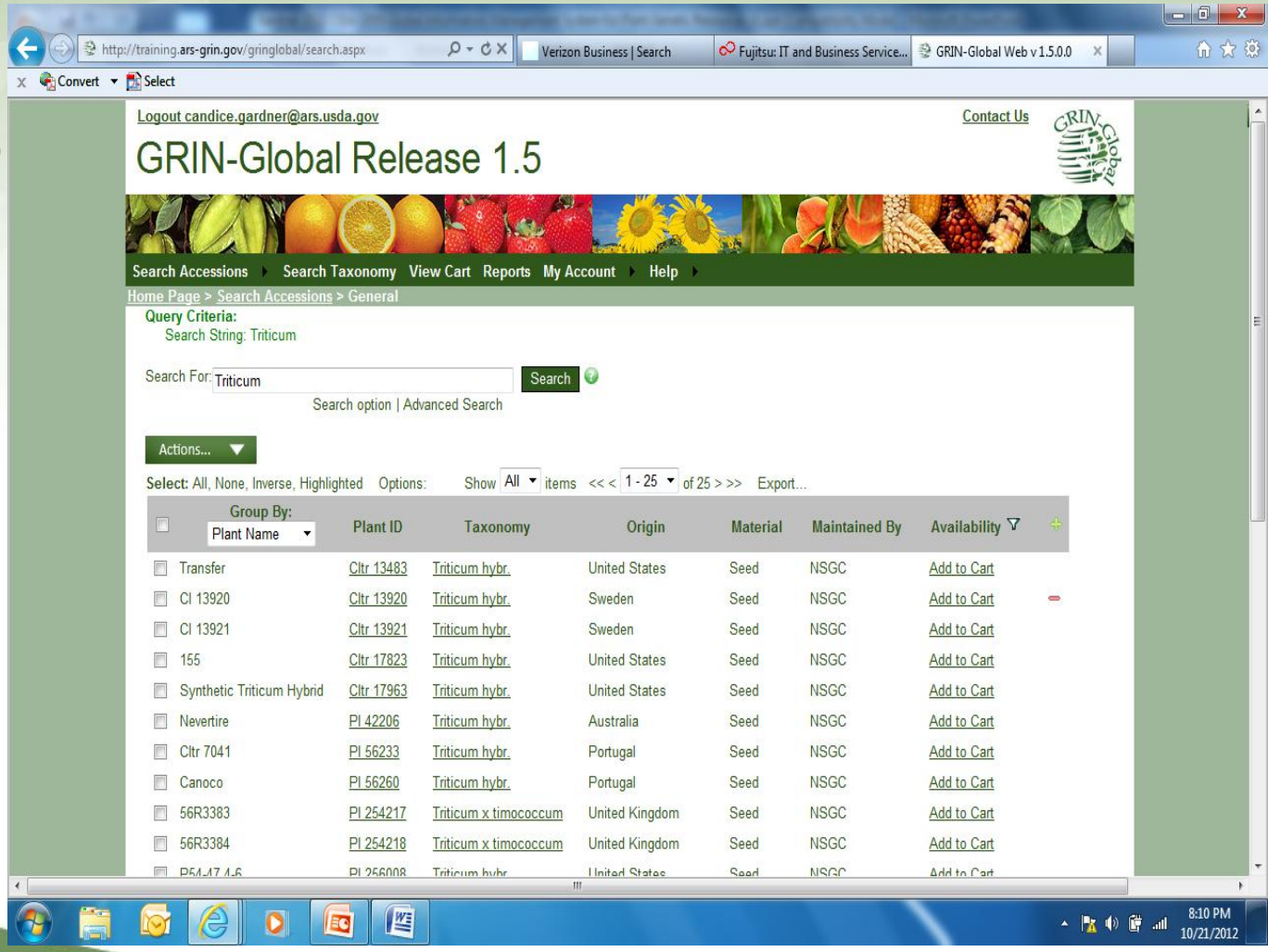


Features Overview

Search Results

Data Features

- Plant Name
- Taxonomy (linked)
- Origin
- Material Type
- Maintained By
- Availability



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Search Accessions rt Reports My Account Help

Home Page > Search

Search For: Search

Search

Choose Criterion 1: Equal To Zea Clear Criterion 1

Choose Criterion 2: - Select - Clear Criterion 2

Add More Criter

accession source habitat type
accession source location
accession source type
accession status
cooperator category
cooperator discipline
cooperator status
germplasm form
germplasm repository site
improvement level
inventory availability status
inventory pollination method
organization region
pathogen status
reproductive uniformity
site type
taxonomy common name
taxonomy family name
taxonomy fertization method
taxonomy genus name
taxonomy genus qualifier
taxonomy geography status
taxonomy noxious level
taxonomy noxious type
taxonomy plant part
taxonomy restriction
taxonomy species name
taxonomy species qualifier
taxonomy suprafamily
taxonomy usage

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Search Accessions | Search Taxonomy | View Cart | Reports | My Account | Help

Home Page > Search Accessions > General

Search For: [ ] Search

Search option | Advanced Search

Choose Criterion 1: taxonomy genus name | Equal To | Zea | Clear Criterion 1

Choose Criterion 2: taxonomy species name | Equal To | mays | Clear Criterion 2

Choose Criterion 3: accession source location | Clear Criterion 3

Accession source country	State
Peru	

Choose Criterion 4: -- Select One -- | - Select - | Clear Criterion 4

Add More Criteria | Clear All Criteria

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Home Page > Search Accessions > General

Query Criteria:

Search String:
'taxonomy genus name' equal to 'Zea'
'taxonomy species name' equal to 'mays'
'accession source' Country equals Peru

Search For: Search

Search option | Advanced Search

Actions...

Select: All, None, Inverse, Highlighted Options: Show 25 items << < 1 - 25 of 500 > >> Export...

Group By: Plant ID	Plant Name	Taxonomy	Origin	Material	Maintained By
Ames 96	Ames 96	Zea mays subsp. mays	Peru	Seed	NC7
Ames 1061	Red Maize Morado	Zea mays subsp. mays	Peru	Seed	NC7
Ames 1422	Maize Blanco	Zea mays subsp. mays	Peru	Seed	NC7
Ames 1904	Ames 1904	Zea mays subsp. mays	Peru	Seed	NC7
NSL 4092 CYMT	BLANCO GIGANTE DE CUZCO	Zea mays subsp. mays	South America	Seed	INACTIVE
NSL 4093 CYMT	BLANCO SAN GERONIMO	Zea mays subsp. mays	South America	Seed	INACTIVE
NSL 4094 CYMT	AMARILLO ANCASH (KULLI)	Zea mays subsp. mays	South America	Seed	INACTIVE
NSL 4095 CYMT	AMARILLO CUZCO (YAURI)	Zea mays subsp. mays	South America	Seed	INACTIVE
NSL 4096 CYMT	CHULPI	Zea mays subsp. mays	South America	Seed	INACTIVE

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Convert | Select

Search Accessions | Search Taxonomy | View Cart | Reports | My Account | Help

Home Page > Search Accessions > General

Query Criteria:

Search String:
'taxonomy genus name' equal to 'Zea'
'taxonomy species name' equal to 'mays'
'accession source' Country equals Peru

Search For: Search

Search option | Advanced Search

Actions...

Selec

of 500 > >> Export...

Sorted Columns

Plant ID

Plant Name

Filtered Columns

Availability Filter:

Add to Cart

Remove All Sorting

Remove All Filters

Row Height Limit

Small | Medium | Large> | Unlimited

Done

			Origin	Material	Maintained By
			u	Seed	NC7
			u	Seed	NC7
			u	Seed	NC7
			u	Seed	NC7
			th erica	Seed	INACTIVE
NSL 4093 CYMT	BLANCO SAN GERONIMO	Zea mays subsp. mays	South America	Seed	INACTIVE
NSL 4094 CYMT	AMARILLO ANCASH (KULLI)	Zea mays subsp. mays	South America	Seed	INACTIVE
NSL 4095 CYMT	AMARILLO CUZCO (YAURI)	Zea mays subsp. mays	South America	Seed	INACTIVE
NSL 4096 CYMT	CHULPI	Zea mays subsp.	South	Seed	INACTIVE

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Convert | Select

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Home Page > Search Accessions > General

Query Criteria:

Search String:
'taxonomy genus name' equal to 'Zea'
'taxonomy species name' equal to 'mays'
'accession source' Country equals Peru

Search For: Search

Search option | Advanced Search

Actions...

Select: All, None, Inverse, Highlighted Options: Show All items <<

All Rows
Comma Separated (csv)
7 rows to export
Export Data
Why does 'Information Bar' appear?
Drag to spreadsheet...
Done

Group By: Plant ID	Plant Name	Taxonomy	Orig			Availability
Ames 8451	Ancash 2	Zea mays subsp. mays	Peru			Add to Cart
Ames 8452	Ancash 3	Zea mays subsp. mays	Peru			Add to Cart
Ames 8454	Ancash 7	Zea mays subsp. mays	Peru			Add to Cart
Ames 8455	Ancash 8	Zea mays subsp. mays	Peru			Add to Cart
Ames 8457	Ancash 20	Zea mays subsp. mays	Peru			Add to Cart
Ames 8458	Ancash 21	Zea mays subsp. mays	Peru			Add to Cart
Ames 8461	Ancash 24	Zea mays subsp. mays	Peru	Seed	NC7	Add to Cart

Show All items << < 1 - 7 of 7 > >>

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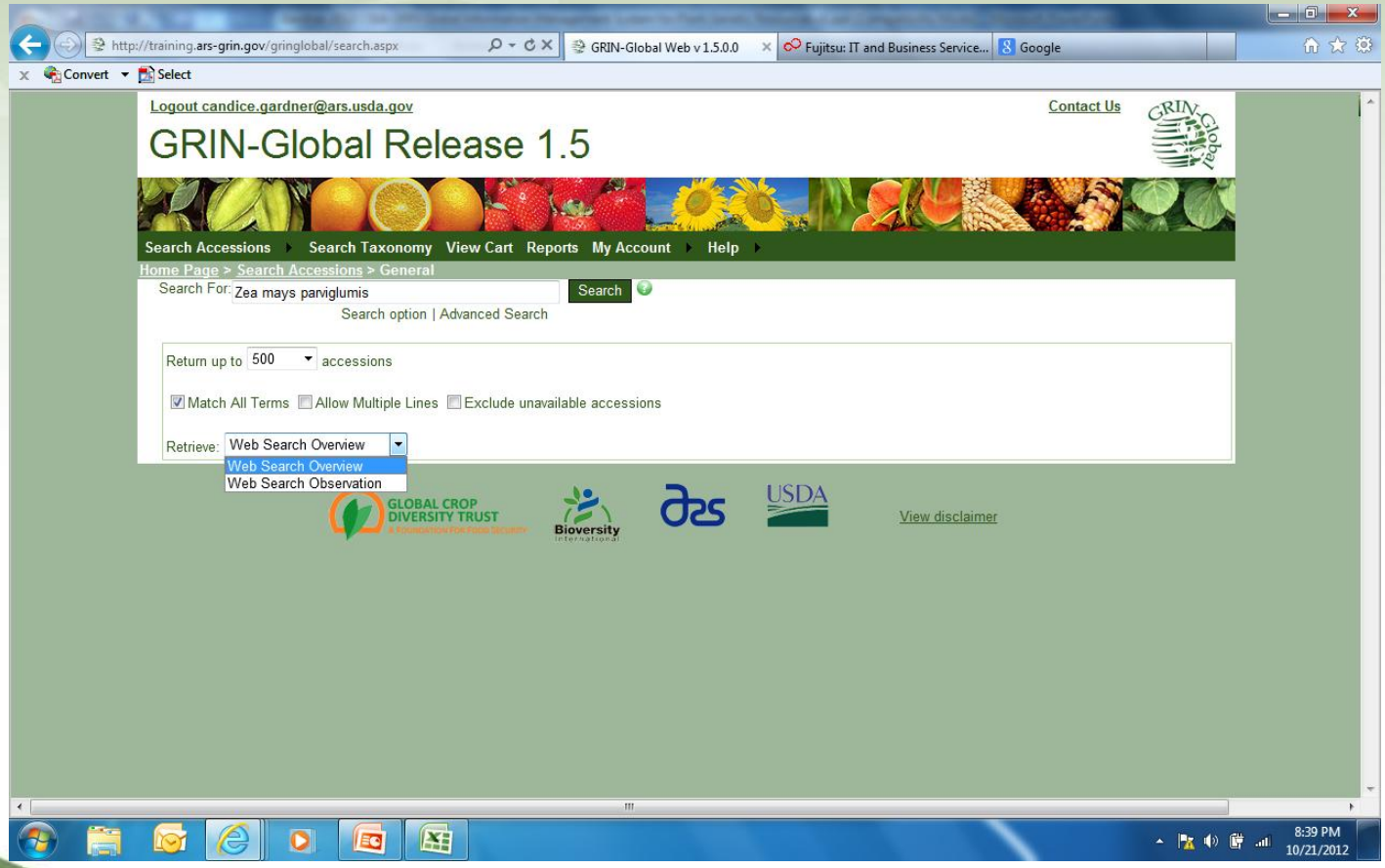
export_2012_10_21_09_32_38.csv [Read-Only] - Microsoft Excel

	A	B	C	D	E	F	G	H	I	J
1	Plant ID	Plant Nam	Taxonomy	Origin	Material	Maintaine	Availability			
2	Ames 845	Ancash 2	Zea mays	Peru	Seed	NC7	Add to Cart			
3	Ames 845	Ancash 3	Zea mays	Peru	Seed	NC7	Add to Cart			
4	Ames 845	Ancash 7	Zea mays	Peru	Seed	NC7	Add to Cart			
5	Ames 845	Ancash 8	Zea mays	Peru	Seed	NC7	Add to Cart			
6	Ames 845	Ancash 20	Zea mays	Peru	Seed	NC7	Add to Cart			
7	Ames 845	Ancash 21	Zea mays	Peru	Seed	NC7	Add to Cart			
8	Ames 846	Ancash 24	Zea mays	Peru	Seed	NC7	Add to Cart			

Functional Feature

- Highlight
- Select
  (based on click status)
- Actions
- Page Size
  (# of items displayed)
- Paging w quick jur
- Export
  (csv/tab delimi file, drag & dro Excel)

Web search observations



http://training.ars-grin.gov/gringlobal/taxonomybrowse.aspx

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Convert | Select

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Search Accessions | Search Taxonomy | View Cart | Reports | My Account | Help

Home Page > Taxonomy

Browse By Taxonomy

Restrict to Genus that exactly match : Zea

Restrict to Species that exactly match :

Exclude Empty Items

Group By: Family Genus Species

Order By: Name Accession Count

Go

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Order By: Name Accession Count

Go

Zea curagua (=Zea mays subsp. mays) (0)
Zea diploperennis (14)
Zea hybr. (7)
Zea indentata (=Zea mays subsp. mays) (0)
Zea indurata (=Zea mays subsp. mays) (0)
Zea japonica (=Zea mays subsp. mays) (0)
Zea luxurians (24)
Zea mays (3,688)
Zea mays subsp. huehuetenangensis (8)
Zea mays subsp. luxurians (0)
Zea mays subsp. mays (44,236)
Zea mays subsp. mexicana (561)
Zea mays subsp. parviglumis (212)
Zea mays var. alba (=Zea mays subsp. mays) (0)
Zea mays var. flavorubra (=Zea mays subsp. mays) (0)
Zea mays var. huehuetenangensis (0)
Zea mays var. indentata (=Zea mays subsp. mays) (0)
Zea mays var. indurata (=Zea mays subsp. mays) (0)
Zea mays var. japonica (=Zea mays subsp. mays) (0)
Zea mays var. leucodon (=Zea mays subsp. mays) (0)
Zea mays var. parviglumis (=Zea mays subsp. parviglumis) (0)
Zea mays var. saccharata (=Zea mays subsp. mays) (0)
Zea mays var. tunicata (=Zea mays subsp. mays) (0)
Zea mays var. vulgata (=Zea mays subsp. mays) (0)
Zea mexicana (0)
Zea nicaraguensis (15)
Zea perennis (12)
Zea saccharata (=Zea mays subsp. mays) (0)

Results of Taxonomic Search

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Taxon: ***Zea mays L. subsp. parviglumis H. H. Iltis & Doebley***

Genus:	Zea
Family:	Poaceae
Subfamily:	Panicoideae
Tribe:	Andropogoneae
Nomen number:	400366
Place of publication:	Amer. J. Bot. 67:1001. 1980
Name Verified on:	07-Oct-1994 by Blanca Leon **Last Changed:** 14-Jan-2006
Species priority site is:	North Central Regional PI Station (NC7)
Accessions:	212 in National Plant Germplasm System (GoogleMap)

Other conspecific taxa:

- Zea mays (3688 accessions)
- Zea mays subsp. huehuetenangensis (8 accessions)
- Zea mays subsp. mays (44236 accessions)
- Zea mays subsp. mexicana (561 accessions)

Common names:

- Zea mays subsp. mays (44236 accessions)
- Zea mays subsp. mexicana (561 accessions)

Common names:

- **Balsas teosinte** (Source: Amer J Bot) - English
- **Guerrero teosinte** - English

Economic Importance:

- **Gene sources:** primary genetic relative of maize (fide Amer J Bot 1980; Matsuoka et al. 2002)
- **Gene sources:** progenitor of maize (fide Amer J Bot 1980; Matsuoka et al. 2002)

Distributional Range:

Native:

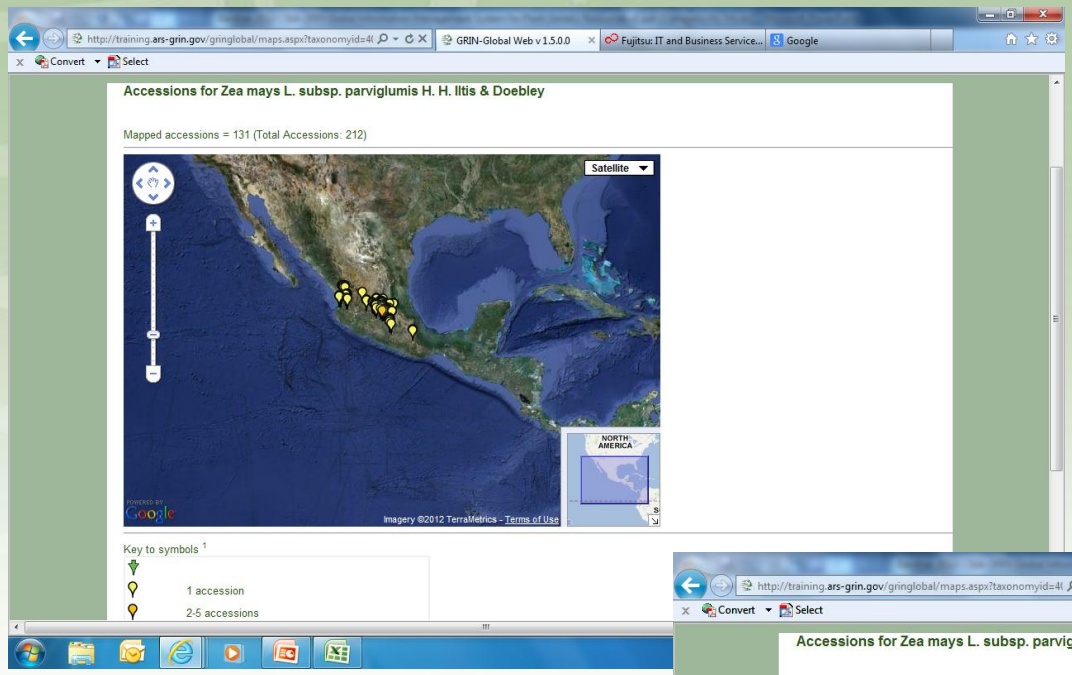
- **Northern America**
  - *Southern Mexico:* **Mexico** - Guerrero, - Jalisco, - Mexico, - Michoacan, - Oaxaca

References:

- **Doebley, J. F.** 1990. Molecular systematics of Zea (Gramineae) (Maydica) 35:143-150.
- **Gonzalez, G. et al.** 2004. GISH Genomic in situ hybridization reveals cryptic genetic differences between maize and its putative wild progenitor *Zea mays* subsp. *parviglumis* (Genome) 47:947-953. [1]
- **Porcher, M. H. et al.** Searchable World Wide Web Multilingual Multiscript Plant Name Database (MMPND) (on-line resource). (PI Names) [44]
- **Wiersema, J. H. & B. León** World economic plants: a standard reference. 1999 (World Econ Pl) [12]
- **Zuloaga, F. O. et al.** 2003. Catalogue of New World grasses (Poaceae): III. Subfamilies Panicoideae, Aristidoideae, Arundinoideae, and Danthonioideae Contr. U.S. Natl. Herb. 46:637-638.

Synonyms:

- Zea mays var. parviglumis H. H. Iltis & Doebley


http://training.ars-grin.gov/gringlobal/maps.aspx?taxonomyid=4(
GRIN-Global Web v 1.5.0.0
Fujitsu: IT and Business Service...
Google
Convert
Select
Accessions for Zea mays L. subsp. parviglumis H. H. Iltis & Doebley
Mapped accessions = 131 (Total Accessions: 212)
Satellite
NORTH AMERICA
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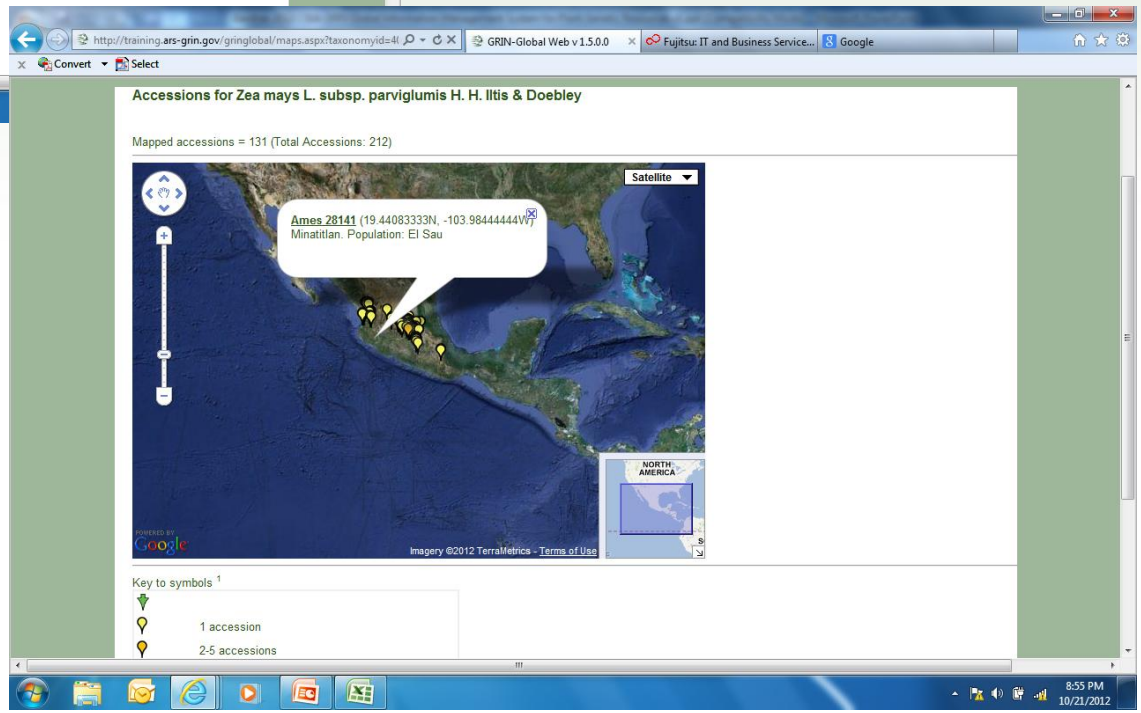
Key to symbols 1
1 accession
2-5 accessions


http://training.ars-grin.gov/gringlobal/maps.aspx?taxonomyid=4(
GRIN-Global Web v 1.5.0.0
Fujitsu: IT and Business Service...
Google
Convert
Select
Accessions for Zea mays L. subsp. parviglumis H. H. Iltis & Doebley
Mapped accessions = 131 (Total Accessions: 212)
Satellite
Ames 28141 (19.44083333N, -103.98444444W)
Minatitlan. Population: El Sau
NORTH AMERICA
Imagery ©2012 TerraMetrics - Terms of Use
Key to symbols 1
1 accession
2-5 accessions
8:55 PM
10/21/2012

http://training.ars-grin.gov/gringlobal/accessiondetail.aspx?id=16

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Choose language: English

Ames 28141

Zea mays L. subsp. parviglumis H. H. Iltis & Doebley

Status: Not Available
Amt Distributed: Not Available

Add to My Favorites

(Not available to order)

Collected from:	Colima Mexico
Maintained by:	North Central Regional PI Station
NPGS received:	27-Feb-2006
PI assigned:	2006
Inventory volume:	1955
Backup location:	
Life form:	ANNUAL
Pedigree:	
Improvement status:	WILD
Reproductive uniformity:	POPULATION
Form received:	Seed

Accession names and identifiers

JSG-RMM-LCL-554

http://training.ars-grin.gov/gringlobal/accessiondetail.aspx?id=16

Accession names and identifiers

JSG-RMM-LCL-554

Type:	COLLECTOR
Cooperator:	Doebley, John University of Wisconsin

FS1893

Type:	DONOR
Cooperator:	Doebley, John University of Wisconsin

Ames 28141

Type:	SITE
Group:	AMES
Comment:	NC-7 Research Numbers

Source History

- Accession was collected. NEAR 01-Nov-2003. Colima Mexico
  Locality: Minatitlan. Population: El Sauz. Latitude: 19 deg. 26 min. 26 sec. North (19.44083333), Longitude: -103 deg. -59 min. -3 sec. West (-103.98444444)
  GoogleMap it. Elevation: 1103 meters.
  Collectors:
  1. de Jesus Sanchez Gonzalez, Jose, Centro Universitario de Ciencias Biologicas y Agropecuarias
- Accession was donated. 27-Feb-2006. Wisconsin United States
  Donors:
  1. Doebley, John, University of Wisconsin

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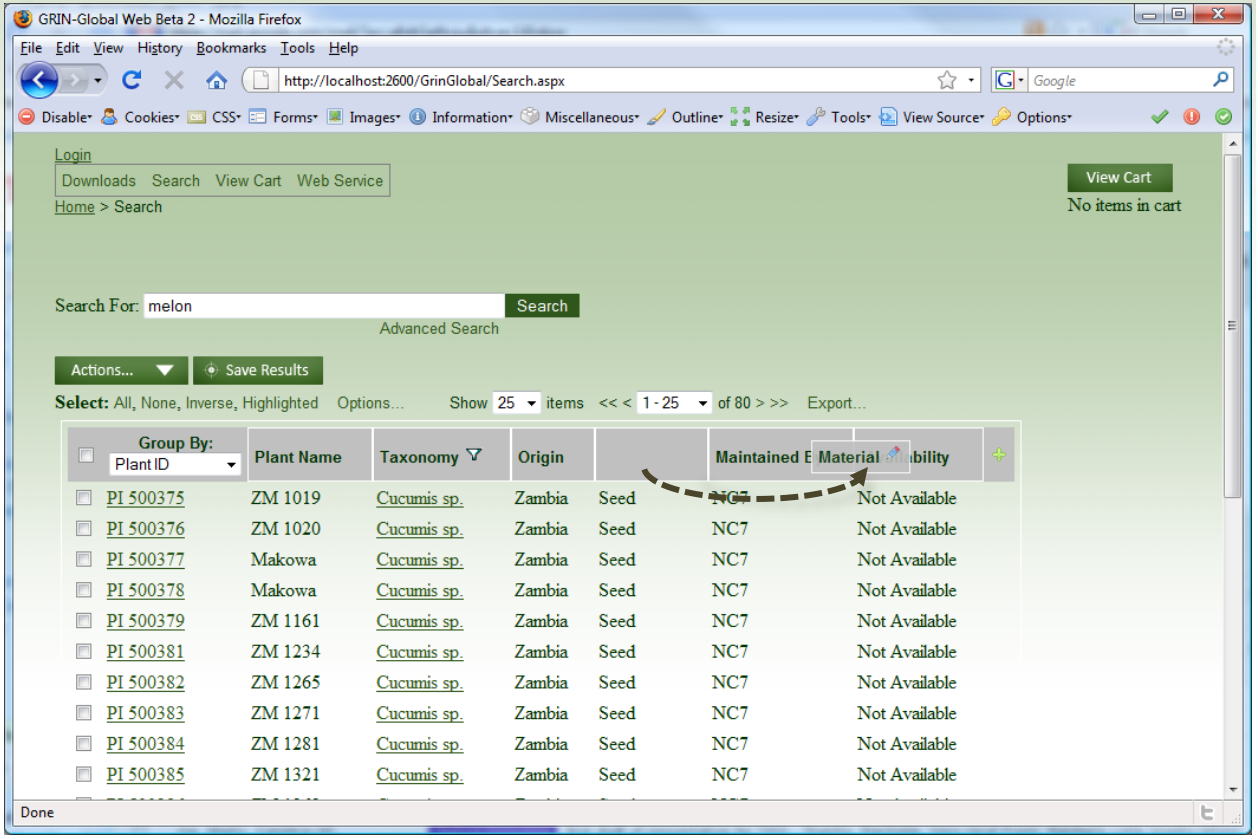
Features Overview

Search Results

Functional Features

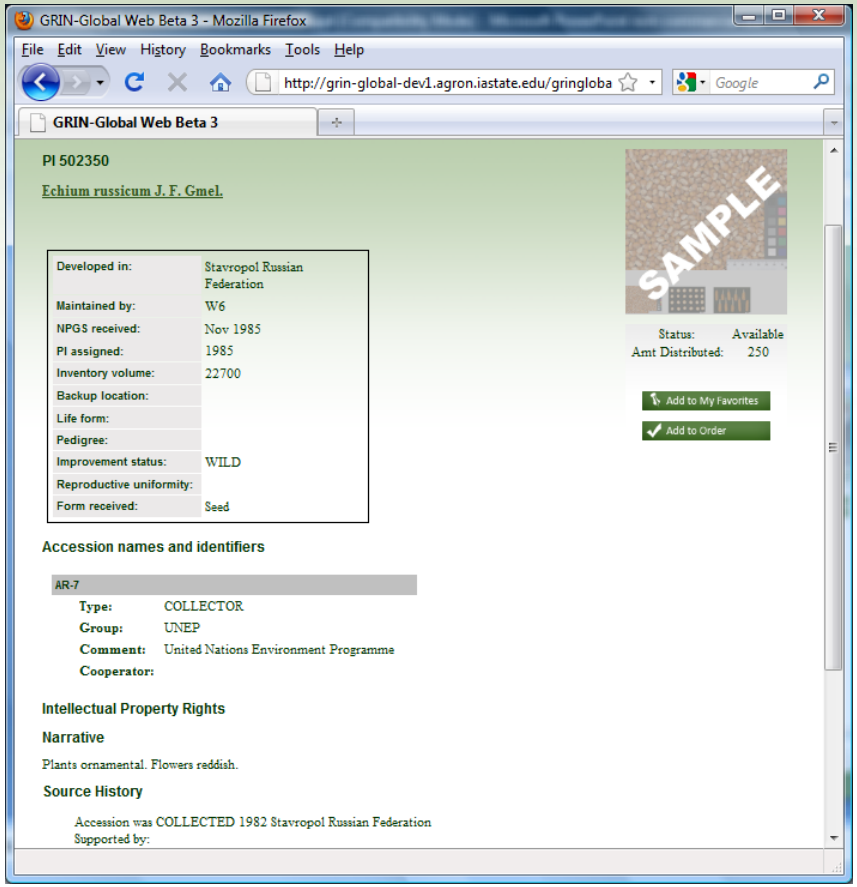
- Rearrange Columns
  (drag & drop or interface)
- Column-specific Preferences
  - Sorting
  - Filtering
  - Hide
- Grid Preferences
  - Show/Hide Cols
  - Show Filtered Rows



Features Overview

- Accession Detail

  General format has stayed the same as in GRIN, with the addition of some improvements.

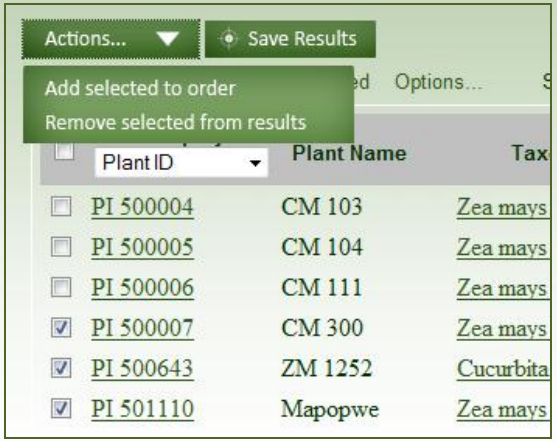


Features Overview

- Add Items to Cart

  Items can be added to an order directly from the search results, or from the Accession Detail page.

  Preventative measures keep “unavailable” items from making it to the cart.

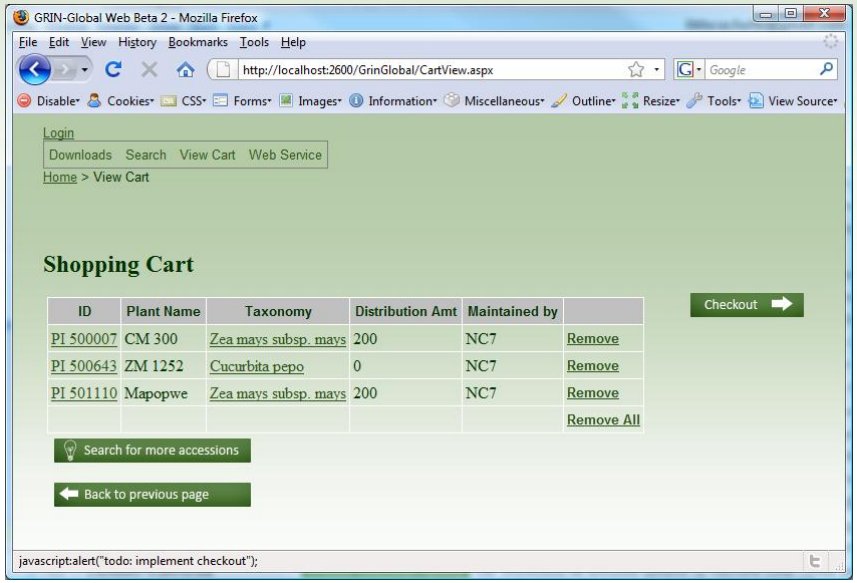


Features Overview

- View Cart

Easily jump back to the Accession Detail page for any item in the cart, or even to the Taxonomy Overview page.

Ability to remove one item at a time or empty the entire cart.



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PI 550473

Zea mays L. subsp. mays

'B73'

Developed from:	Iowa United States
Maintained by:	North Central Regional PI Station
NPGS received:	01-Mar-1972
PI assigned:	1972
Inventory volume:	53534
Backup location:	National Center for Genetic Resources Preservation
Life form:	ANNUAL
Pedigree:	Selected from advanced recurrent selection population (C5) of Iowa Stiff Stalk Synthetic (BSSS).
Improvement status:	BREEDING
Reproductive uniformity:	INBRED
Form received:	Seed

Status: Available
Amt Distributed: 100

Add to My Favorites

Add to Order

Accession names and identifiers

Form received:	Seed

Accession names and identifiers

B73

Type:	CULTIVAR

id=47638

Type:	OTHER
Group:	MAIZEGDB-STOCK-ID
Comment:	Link to MaizeGDB database stock record ID number.
Cooperator:	Millard, Mark J. Iowa State University

V924-1

Type:	OTHER
Comment:	OTHER idtype is field/row number.
Cooperator:	Coe, Jr., Edward H. USDA, ARS

V924-4

Type:	OTHER
Comment:	OTHER idtype is field/row number.
Cooperator:	Coe, Jr., Edward H. USDA, ARS

V924-6

Type:	OTHER
Comment:	OTHER idtype is field/row number.
Cooperator:	Coe, Jr., Edward H. USDA, ARS

3093-2/00

Type:	OTHER
Comment:	Row and nursery year.
Cooperator:	Goodman, Major North Carolina State University

Intellectual Property Rights

Comment:	Row and nursery year.
Cooperator:	Goodman, Major North Carolina State University

Intellectual Property Rights

Crop Science Registration
Identifier: PL-17 Crop: MAIZE . Date Issued: 01 Sep 1972. Current Status

Narrative

Plant vigorous. Leaves erect. Pollen production average. Seed smooth dent. Maturity is AES800. This is the accession of B73 that was used for the first complete maize genome sequence. See http://www.maizesequence.org/index.html for details.

Source History

- Accession was donated. 1972. Iowa United States
  Donors:
  1. Iowa Agricultural Experiment Station
- Accession was developed. Iowa United States
  Developers:
  1. Russell, W. A., Iowa State University

Pedigree

Selected from advanced recurrent selection population (C5) of Iowa Stiff Stalk Synthetic (BSSS).

Citations

- Reference: Edward S. Buckler, et al.. 2009. The Genetic Architecture of Maize Flowering Time. Science 325:714-718. Comment:
- Reference: Michael D. McMullen, et al.. 2009. Genetic Properties of the Maize Nested Association Mapping Population. Science 325:737-740. Comment:
- Reference: Sherry A. Flint-Garcia, Anne-Celine Thuillet, Jianming Yu, Gael Pressoir, Susan M. Romero, Sharon E. Mitchell, John Doebley, Stephen Kresovich, Major M. Goodman, Edward S. Buckler. 2005. Maize association population: a high-resolution platform for quantitative trait locus dissection. Plant J 44 (6), 1054-1064. Comment:
- Reference: R.A. Moreau, V. Singh, and K.B. Hicks. 2001. Comparison of Oil and Phytosterol Levels in Germplasm Accessions of Corn, Teosinte, and Job's Tears. J Agric Food Chem 49:3793-3795. Comment:
- Reference: W.A. Russell. 1972. . Crop Sci 12(5):721 [5]. Comment: PL-17

Observations

Category	CHEMICAL						
Descriptor	OIL				PROTEIN	STARCH	
Value	4.1	4.2	4.3	3.8	10.4	70.3	SOUT
Study/Environment	MAIZE.NIR.DUPONT-PIONEER.2000	MAIZE.NIR.DUPONT-PIONEER.2000	MAIZE.NIR.DUPONT-PIONEER.2000	MAIZE.NIR.POLLAK-DUVICK.1999	MAIZE.NIR.POLLAK-DUVICK.1999	MAIZE.NIR.POLLAK-DUVICK.1999	MAIZ

Click link below to see detailed observation data:
Detailed Accession Observation Page

View disclaimer

B73 web obs search

OIL	4.3	MAIZE.NIR.DUPONT-PIONEER.2000	PI 550473 97ncex02 SD
OIL	3.8	MAIZE.NIR.POLLAK-DUVICK.1999	
PROTEIN	10.4	MAIZE.NIR.POLLAK-DUVICK.1999	
STARCH	70.3	MAIZE.NIR.POLLAK-DUVICK.1999	
COMMENT Descriptors			
NOTES	SOUTHERN-LEAF-BLIGHT-RESIS_NO	MAIZE.COOPERATOR.OBSERVATIONS	
NOTES	LEAVES-UPRIGHT_YES	MAIZE.CURATOR.REVIEW	
NOTES	OBSERVATION-NURSERY_YES	MAIZE.OBS.INBRED.DIVERSITY.2010.NCIANYMO	PI 550473 08ncai01 SD
NOTES	OBSERVATION-NURSERY_YES	MAIZE.OBS.INBRED.DIVERSITY.2010.NCIANYMO	PI 550473 08ncai02 SD
DISEASE Descriptors			
ANTHRACNOSE-STALK-ROT	8 - (8) (0 = NO SYMPTOMS OBSERVED, 9 = SEVERE DISEASE DEVELOPMENT)	MAIZE.ANTHRACNOSE.PIONEER.WINTERVIL.2000	PI 550473 92ncab01 SD
EYESPOT	3 - (3) Numerous lesions on leaves below the ear, but no evidence of lesion coalescence.	MAIZE.EYESPOT.ISU.2000	PI 550473 92ncab01 SD
GRAY-LEAF-SPOT		MAIZE.GRAYLEAF.MONSANTO.MONMOUTH_IL.2000	PI 550473 92ncab01 SD
GRAY-LEAF-SPOT	8 - (8) Highly susceptible.	MAIZE.GRAYLEAF.USDA.NC_STATE.2000	PI 550473 92ncab01 SD
GRAY-LEAF-SPOT		MAIZE.GRAYLEAF.VIRGINIA_TECH.2000	PI 550473 92ncab01 SD
MDMV	7 - 3 WHERE (1 = RESISTANT, 9 = SEVERE DISEASE DEVLOPMENT)	MAIZE.MDMV.VIRGINIA_TECH.2000	PI 550473 92ncab01 SD
MDMV	7 - 3 WHERE (1 = RESISTANT, 9 = SEVERE DISEASE DEVLOPMENT)	MAIZE.MDMV.VIRGINIA_TECH.2001	PI 550473 94ncai01 SD
NORTHERN-LEAF-BLIGHT	6 - (6) (0 = NO SYMPTOMS OBSERVED, 9 = SEVERE DISEASE DEVELOPMENT)	MAIZE.NLB.PIONEER.JOHNSTON.2003	PI 550473 94ncai01 SD
NORTHERN-LEAF-BLIGHT	7 - (7) (0 = NO SYMPTOMS OBSERVED, 9 = SEVERE DISEASE DEVELOPMENT)	MAIZE.NLB.PIONEER.JOHNSTON.2004	PI 550473 94ncai01 SD
STEWARTS-WILT	5 - (5) Minimal systemic infection as small, linear streaks on non-inoculated leaves.	MAIZE.STEWARTS.NCRPIS.2000	PI 550473 92ncab01 SD
STEWARTS-WILT	4 - (4) Abundant spread bi-directionally in inoculated leaves only.	MAIZE.STEWARTS.NCRPIS.2002	PI 550473 94ncai01 SD
STEWARTS-WILT	4 - (4) Abundant spread bi-directionally in inoculated leaves only.	MAIZE.STEWARTS.U_OF_ILLINOIS.1997	PI 550473 92ncab01 SD

DAYS-TO-SILK_LAT40-49	75	MAIZE.INC.AMES.2003.MID1	PI 550473 92ncai01 SD
DAYS-TO-SILK_LAT40-49	72	MAIZE.INC.AMES.2004.MID2	PI 550473 94ncai01 SD
DAYS-TO-SILK_LAT40-49	74	MAIZE.INC.AMES.2004.MID2	PI 550473 03ncai01 SD
DAYS-TO-SILK_LAT40-49	73	MAIZE.INC.AMES.2005	PI 550473 94ncai02 SD
DAYS-TO-SILK_LAT40-49	85	MAIZE.INC.AMES.2006.MID	PI 550473 94ncai02 SD
DAYS-TO-SILK_LAT40-49	86	MAIZE.INC.AMES.2006.MID	PI 550473 94ncai02 SD
DAYS-TO-SILK_LAT40-49	78	MAIZE.INC.AMES.2007.MID1	PI 550473 03ncai01 SD
DAYS-TO-SILK_LAT40-49	72	MAIZE.INC.AMES.2007.MID2	PI 550473 03ncai01 SD
DAYS-TO-SILK_LAT40-49	90	MAIZE.INC.AMES.2009.PLANTING1	PI 550473 03ncai01 SD
DAYS-TO-SILK_LAT40-49	93	MAIZE.INC.AMES.2009.PLANTING2	PI 550473 03ncai01 SD
DAYS-TO-SILK_LAT40-49	78	MAIZE.OBSERVATION.AMES.2000	PI 550473 92ncab01 SD
PRODUCTION Descriptors			
HETEROTIC	SS - (SS) Belongs to stiff stalk combining group.	MAIZE.CURATOR.AND.MAIZE.EXPERT.REVIEW	
HETEROTIC	SS - (SS) Belongs to stiff stalk combining group.	MAIZE.DONOR.ACC.NARRATIVE	
KERNEL-WEIGHT-1000	238	MAIZE.INC.AMES.2003.MID1	PI 550473 03ncai01 SD

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PI 222285

Zea mays L. subsp. mays

Status:	Available
Amt Distributed:	100

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Collected from:	Arizona United States
Maintained by:	North Central Regional PI Station
NPGS received:	30-Nov-1954
PI assigned:	1954
Inventory volume:	4028
Backup location:	National Center for Genetic Resources Preservation
Life form:	ANNUAL
Pedigree:	
Improvement status:	LANDRACE
Reproductive uniformity:	POPULATION
Form received:	Seed

Accession names and identifiers

D-12

Type: INSTITUTE
Comment: Wiidakas, North Dakota State

Cudu

Type: UNVERIFIED

Narrative

Believed to be Navajo Cudei or Sacred Corn listed by G. F. Will and G. E. Hyde in Corn among the Indians of the Upper Missouri published in 1917.

Annotations

Action	Date	By	Old Name	New Name
NOM-CHANGE	01 Dec 1989		Zea mays	Zea mays subsp. mays

Source History

- Accession was donated. 30-Nov-1954. Iowa United States
  Donors:
  1. USDA, ARS, NCRPIS

  Comment: Plant Inventory, unlike current custom, indicates donation from a Regional Station.

Form received: Seed

Accession names and identifiers

D-12

Type: INSTITUTE
Comment: Wiidakas, North Dakota State

Cudu

Type: UNVERIFIED

Narrative

Believed to be Navajo Cudei or Sacred Corn listed by G. F. Will and G. E. Hyde in Corn among the Indians of the Upper Missouri published in 1917.

Annotations

Action	Date	By	Old Name	New Name
NOM-CHANGE	01 Dec 1989		Zea mays	Zea mays subsp. mays

Source History

- Accession was donated. 30-Nov-1954. Iowa United States
  Donors:
  1. USDA, ARS, NCRPIS

  Comment: Plant Inventory, unlike current custom, indicates donation from a Regional Station.

- Accession was collected. PRE 1914. Arizona United States
  Collectors:
  1.

  Comment: Believed to have been obtained by Will from Navajo.

Observations

Characterization and Evaluation Data:

Category	CHEMICAL	COMMENT	DISEASE			
Descriptor	OIL	ETHNIC-GROUP	COMMON-SMUT	DIPLODIA-STALK-ROT	NORTHERN-LEAF-BLIGHT	EUROPEAN-CORNBORER1
Value	7.8	Navajo Tribe of AZ, NM, and UT	7 - MANY PLANTS INFECTED; MOST GALLS LARGE.	7 - 66-95% OF INOCULATED INTERNODE ROTTED	7 - (7) (0 = NO SYMPTOMS OBSERVED, 9 = SEVERE DISEASE DEVELOPMENT)	5 - (5) Intermediate response. Several leav with elongated lesions.
Study/Environment	MAIZE.NIR.DUPONT-PIONEER.2000	MAIZE.DONOR	MAIZE.INC.AMES.COMP	MAIZE.DIPLODIA.MULT	MAIZE.INC.AMES.COMP	MAIZE.ECB1.AMES.M

Click link below to see detailed observation data:
Detailed Accession Observation Page

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Observations for accession PI 222285

Characterization and Evaluation Data:

Descriptor	Value	Study/Environment	Inventory ID
	CHEMICAL Descriptors		
OIL	7.8	MAIZE.NIR.DUPONT-PIONEER.2000	PI 222285 85ncab01 SD
	COMMENT Descriptors		
ETHNIC-GROUP	Navajo Tribe of AZ, NM, and UT	MAIZE.DONOR	
	DISEASE Descriptors		
COMMON-SMUT	7 - MANY PLANTS INFECTED; MOST GALLS LARGE.	MAIZE.INC.AMES.COMP	
DIPLODIA-STALK-ROT	7 - 66-95% OF INOCULATED INTERNODE ROTTED	MAIZE.DIPLODIA.MULT	
NORTHERN-LEAF-BLIGHT	7 - (7) (0 = NO SYMPTOMS OBSERVED, 9 = SEVERE DISEASE DEVELOPMENT)	MAIZE.INC.AMES.COMP	
	INSECT Descriptors		
EUROPEAN-CORNBORER1	5 - (5) Intermediate response. Several leaves with elongated lesions.	MAIZE.ECB1.AMES.MULT	
EUROPEAN-CORNBORER2	8 - (8) (1 = RESISTANT, 9 = SUSCEPTIBLE	MAIZE.ECB2.AMES.MULT	
SPIDERMITE	9 - (9) Susceptible.	MAIZE.SPIDERMIT.MULT	
	MORPHOLOGY Descriptors		
ALEURONE-COLOR	11 - COLORLESS / UNIFORM	MAIZE.INC.AMES.2010.PLANTING4	PI 222285 10ncai01 SD
ALEURONE-COLOR	41 - PURPLE / UNIFORM	MAIZE.INC.AMES.2010.PLANTING4	PI 222285 10ncai01 SD
ALEURONE-COLOR	43 - PURPLE / CAP	MAIZE.INC.AMES.2010.PLANTING4	PI 222285 10ncai01 SD
COB-COLOR	1 - WHITE	MAIZE.INC.AMES.2010.PLANTING4	PI 222285 10ncai01 SD
EAR-DIAMETER	0	MAIZE.INC.AMES.2010.PLANTING4	PI 222285 10ncai01 SD
EAR-DIAMETER	3.5	MAIZE.INC.AMES.2010.PLANTING4	PI 222285 10ncai01 SD
EAR-LENGTH	0	MAIZE.INC.AMES.2010.PLANTING4	PI 222285 10ncai01 SD
EAR-SHAPE	1 - CYLINDRICAL	MAIZE.INC.AMES.2010.PLANTING4	PI 222285 10ncai01 SD
EAR-SHAPE	2 - CYLINDRICAL - CONICAL	MAIZE.INC.AMES.2010.PLANTING4	PI 222285 10ncai01 SD
ENDOSPERM-COLOR	1 - WHITE	MAIZE.INC.AMES.2010.PLANTING4	PI 222285 10ncai01 SD
GLUME-DEVELOPMENT	1 - None	MAIZE.INC.AMES.2010.PLANTING4	PI 222285 10ncai01 SD
KERNEL-COLOR	A - WHITE	MAIZE.INC.AMES.2010.PLANTING4	PI 222285 10ncai01 SD
KERNEL-COLOR	C - PURPLE	MAIZE.INC.AMES.2010.PLANTING4	PI 222285 10ncai01 SD
KERNEL-COLOR	P - PURPLE CAP	MAIZE.INC.AMES.2010.PLANTING4	PI 222285 10ncai01 SD
KERNEL-COLOR	A - WHITE	MAIZE.INC.AMES.COMP	
KERNEL-COLOR	O - BLUE CAP	MAIZE.INC.AMES.COMP	

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ALEURONE-COLOR	11 - COLORLESS / UNIFORM	MAIZE.INC.AMES.2010.PLANTING4	PI 222285 10ncai01 SD
ALEURONE-COLOR	41 - PURPLE / UNIFORM	MAIZE.INC.AMES.2010.PLANTING4	PI 222285 10ncai01 SD
ALEURONE-COLOR	43 - PURPLE / CAP	MAIZE.INC.AMES.2010.PLANTING4	PI 222285 10ncai01 SD
COB-COLOR	1 - WHITE	MAIZE.INC.AMES.2010.PLANTING4	PI 222285 10ncai01 SD
EAR-DIAMETER	0	MAIZE.INC.AMES.2010.PLANTING4	PI 222285 10ncai01 SD
EAR-DIAMETER	3.5	MAIZE.INC.AMES.2010.PLANTING4	PI 222285 10ncai01 SD
EAR-LENGTH	0	MAIZE.INC.AMES.2010.PLANTING4	PI 222285 10ncai01 SD
EAR-SHAPE	1 - CYLINDRICAL	MAIZE.INC.AMES.2010.PLANTING4	PI 222285 10ncai01 SD
EAR-SHAPE	2 - CYLINDRICAL - CONICAL	MAIZE.INC.AMES.2010.PLANTING4	PI 222285 10ncai01 SD
ENDOSPERM-COLOR	1 - WHITE	MAIZE.INC.AMES.2010.PLANTING4	PI 222285 10ncai01 SD
GLUME-DEVELOPMENT	1 - None	MAIZE.INC.AMES.2010.PLANTING4	PI 222285 10ncai01 SD
KERNEL-COLOR	A - WHITE	MAIZE.INC.AMES.2010.PLANTING4	PI 222285 10ncai01 SD
KERNEL-COLOR	C - PURPLE	MAIZE.INC.AMES.2010.PLANTING4	PI 222285 10ncai01 SD
KERNEL-COLOR	P - PURPLE CAP	MAIZE.INC.AMES.2010.PLANTING4	PI 222285 10ncai01 SD
KERNEL-COLOR	A - WHITE	MAIZE.INC.AMES.COMP	
KERNEL-COLOR	O - BLUE CAP	MAIZE.INC.AMES.COMP	
KERNEL-ROW-ARRANGEMENT	1 - REGULAR	MAIZE.INC.AMES.2010.PLANTING4	PI 222285 10ncai01 SD
KERNEL-ROW-ARRANGEMENT	4 - SPIRAL	MAIZE.INC.AMES.2010.PLANTING4	PI 222285 10ncai01 SD
KERNEL-ROW-NUMBER	0	MAIZE.INC.AMES.2010.PLANTING4	PI 222285 10ncai01 SD
KERNEL-TYPE	A - FLOURY	MAIZE.INC.AMES.2010.PLANTING4	PI 222285 10ncai01 SD
KERNEL-TYPE	A - FLOURY	MAIZE.INC.AMES.COMP	
PERICARP-COLOR	11 - COLORLESS / UNIFORM	MAIZE.INC.AMES.2010.PLANTING4	PI 222285 10ncai01 SD
SILK-SCAR	Y - Colored silk scar is present	MAIZE.INC.AMES.2010.PLANTING4	PI 222285 10ncai01 SD
UPPER-KERNEL-SHAPE	4 - ROUNDED	MAIZE.INC.AMES.2010.PLANTING4	PI 222285 10ncai01 SD
PHENOLOGY Descriptors			
DAYS-TO-SILK_LAT40-49	60	MAIZE.OBSERVATION.AMES.2000	PI 222285 85ncab01 SD
TAXONOMIC Descriptors			
PRIMARY-RACE	NNAFF - Northeastern North American Flints & Flours	MAIZE.CURATOR.REVIEW	

Export Phenotype Data to Excel

phenotype.csv - Microsoft Excel

phenotype data for PI 222285

Category	Descriptor	Value	Study/Environment	Inventory ID
CHEMICAL	OIL	7.8	MAIZE.NIR.DUPONT-PIONEER.2000	PI 222285 85ncab01 SD
COMMENT	ETHNIC-GROUP	Navajo Tribe of AZ, NM,	MAIZE.DONOR	PI 222285 **
DISEASE	COMMON-SMUT	7 - MANY PLANTS INFEC	MAIZE.INC.AMES.COMP	PI 222285 **
DISEASE	DIPLODIA-STALK-ROT	7 - 66-95% OF INOCULAT	MAIZE.DIPLODIA.MULT	PI 222285 **
DISEASE	NORTHERN-LEAF-BLIGH	7 - (7) (0 = NO SYMPTOM	MAIZE.INC.AMES.COMP	PI 222285 **
INSECT	EUROPEAN-CORNBOREF	5 - (5) Intermediate resp	MAIZE.ECB1.AMES.MULT	PI 222285 **
INSECT	EUROPEAN-CORNBOREF	8 - (8) (1 = RESISTANT, 9	MAIZE.ECB2.AMES.MULT	PI 222285 **
INSECT	SPIDERMITE	9 - (9) Susceptible.	MAIZE.SPIDERMIT.MULT	PI 222285 **
MORPHOLOGY	ALEURONE-COLOR	11 - COLORLESS / UNIFO	MAIZE.INC.AMES.2010.PLANTING4	PI 222285 10ncai01 SD
MORPHOLOGY	ALEURONE-COLOR	41 - PURPLE / UNIFORM	MAIZE.INC.AMES.2010.PLANTING4	PI 222285 10ncai01 SD
MORPHOLOGY	ALEURONE-COLOR	43 - PURPLE / CAP	MAIZE.INC.AMES.2010.PLANTING4	PI 222285 10ncai01 SD
MORPHOLOGY	COB-COLOR	1 - WHITE	MAIZE.INC.AMES.2010.PLANTING4	PI 222285 10ncai01 SD
MORPHOLOGY	EAR-DIAMETER	0	MAIZE.INC.AMES.2010.PLANTING4	PI 222285 10ncai01 SD
MORPHOLOGY	EAR-DIAMETER	3.5	MAIZE.INC.AMES.2010.PLANTING4	PI 222285 10ncai01 SD
MORPHOLOGY	EAR-LENGTH	0	MAIZE.INC.AMES.2010.PLANTING4	PI 222285 10ncai01 SD
MORPHOLOGY	EAR-SHAPE	1 - CYLINDRICAL	MAIZE.INC.AMES.2010.PLANTING4	PI 222285 10ncai01 SD
MORPHOLOGY	EAR-SHAPE	2 - CYLINDRICAL - CONIC	MAIZE.INC.AMES.2010.PLANTING4	PI 222285 10ncai01 SD
MORPHOLOGY	ENDOSPERM-COLOR	1 - WHITE	MAIZE.INC.AMES.2010.PLANTING4	PI 222285 10ncai01 SD
MORPHOLOGY	GLUME-DEVELOPMENT	1 - None	MAIZE.INC.AMES.2010.PLANTING4	PI 222285 10ncai01 SD
MORPHOLOGY	KERNEL-COLOR	A - WHITE	MAIZE.INC.AMES.2010.PLANTING4	PI 222285 10ncai01 SD
MORPHOLOGY	KERNEL-COLOR	C - PURPLE	MAIZE.INC.AMES.2010.PLANTING4	PI 222285 10ncai01 SD
MORPHOLOGY	KERNEL-COLOR	P - PURPLE CAP	MAIZE.INC.AMES.2010.PLANTING4	PI 222285 10ncai01 SD
MORPHOLOGY	KERNEL-COLOR	A - WHITE	MAIZE.INC.AMES.COMP	PI 222285 **
MORPHOLOGY	KERNEL-COLOR	O - BLUE CAP	MAIZE.INC.AMES.COMP	PI 222285 **
MORPHOLOGY	KERNEL-ROW-ARRANGE	1 - REGULAR	MAIZE.INC.AMES.2010.PLANTING4	PI 222285 10ncai01 SD
MORPHOLOGY	KERNEL-ROW-ARRANGE	4 - SPIRAL	MAIZE.INC.AMES.2010.PLANTING4	PI 222285 10ncai01 SD
MORPHOLOGY	KERNEL-ROW-NUMBER	0	MAIZE.INC.AMES.2010.PLANTING4	PI 222285 10ncai01 SD
MORPHOLOGY	KERNEL-TYPE	A - FLOURY	MAIZE.INC.AMES.2010.PLANTING4	PI 222285 10ncai01 SD
MORPHOLOGY	KERNEL-TYPE	A - FLOURY	MAIZE.INC.AMES.COMP	PI 222285 **
MORPHOLOGY	PERICARP-COLOR	11 - COLORLESS / UNIFO	MAIZE.INC.AMES.2010.PLANTING4	PI 222285 10ncai01 SD
MORPHOLOGY	SILK-SCAR	Y - Colored silk scar is pr	MAIZE.INC.AMES.2010.PLANTING4	PI 222285 10ncai01 SD
MORPHOLOGY	UPPER-KERNEL-SHAPE	4 - ROUNDED	MAIZE.INC.AMES.2010.PLANTING4	PI 222285 10ncai01 SD
PHENOLOGY	DAYS-TO-SILK_LAT40-49	60	MAIZE.OBSERVATION.AMES.2000	PI 222285 85ncab01 SD
TAXONOMIC	PRIMARY-RACE	NNAFF - Northeastern N	MAIZE.CURATOR.REVIEW	PI 222285 **

Request for Testing and Feedback

- Please test the public web 1.5 version and provide feedback to support system functionality and enhancement.
- Use cases, descriptions of search functions you would like to be able to use, screen shots, etc. can be shared.
- Our goal is to develop the schema in such a way that all relevant information is searchable, and develop interfaces that support intuitive searching, retrieval and reporting of accession information.

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