

The Gramene Database

A closer look at the Genetic Diversity Module

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June 15, 2009

USDA-ARS Dale Bumpers National Rice Research Center, Stuttgart, AR

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A Resource for Comparative Grass Genomics

Release #29

March 2009
Release Notes

News

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A new and improved Gramene Genetic Diversity website was rolled out today. The major goal of the...
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- NEW** OpenHelix Tutorial and Exercises (coming soon), as well as older [Archived Tutorials, V26](#) - See what you can do and how to do it.
- Ask questions through [Feedback](#) or [Email](#).
- See [FAQ](#).

Quick Start

- GENOMES:** Browse assembled genomes for *Oryza sativa indica* and *japonica*, *O. glaberrima*, *O. rufipogon*, *Zea mays*, *Sorghum bicolor*, *Arabidopsis thaliana*, *Arabidopsis lyrata*, *Vitis vinifera*, and *Populus trichocarpa*. Look for rice/maize synten. Narrow your search with [GrameneMart](#). Search for sequence alignment with [BLAST](#). Search by [Gene Ontology](#).
- PROTEINS:** Search by [PFam](#) or [ProSite](#) or Browse by Gene Ontology using [GO Slim](#).
- COMPARATIVE MAPS:** Browse genetic or physical maps for [Wild Rice \(Oryza sp. from OMAP\)](#), [Rice](#), [Maize](#), [Wheat](#), [Barley](#), [Oats](#), [Sorghum](#), and other grasses, or use the Comparative Map Viewer ([CMap](#)) to compare maps of different types and species. [View map detail information](#)
- MARKERS:** Search for Genetic markers (RFLPs, SSRs, etc.), DNA Probes (Primers, Overgos, etc.), Genomic Regions (Clones, FPContigs, etc.), and Sequences (GSSs, ESTs, etc.). Search by species such as [Sorghum](#), by type such as [RFLP](#), or by species and type such as [Rice SSR](#). Use the Simple Sequence Repeat Identification Tool ([SSRIT](#)).
- TRAITS:** Search the [Genes](#) or [QTL](#) database for important phenotype-related loci such as [Rice Genes](#), [Rice QTL](#), [Maize QTL](#). Don't forget to explore traits in [Ontologies](#).
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Rice Data in Gramene

4 *Oryza* genomes:
japonica, *indica*, *glaberrima*, *rufipogon*

Markers	7,266,251
Genes	2,713
QTL	8,646
Proteins	158,224
Map studies	102
Pathways	350
Diversity experiments	16

gramene.org/species/oryza/rice_stat.html

Gramene Genetic Diversity

- **Focus:** experiments which study the genetics of variation within populations of grasses and how this relates to observable traits, so that **associations between genotype and phenotype** can be discovered
- **Data types:** alleles, trait measurements, germplasm
- **Marker types:** QTL, SSR, RFLP, SNP
- **Species:** rice, maize, wheat, *Sorghum*, *Arabidopsis*

Gramene Genetic Diversity

Gramene: Genetic Diversity Database

Find: In: Species:

E.g., Germplasm "IRGC 3575", RA4969, Basmati 1, Marker/locus RM22.

Diversity Overview The Gramene Diversity database contains genotype and phenotype experiments in rice, maize, wheat, sorghum, and soon, arabidopsis, which study the genetics of variation within populations and how this relates to quantitative and observable traits. Characterizing the genetic basis of variation within populations and linking this with observable traits provides an important framework for understanding population structure and evolutionary patterns, and for increasing the efficiency of plant breeding programs.

Database summary

	species	data types	experiments	germplasm	traits	genotype markers
rice	<i>Oryza sativa</i> , <i>O. glaberrima</i> , <i>O. rufipogon</i>	SNP, SSR, RFLP, phenotype data, QTL, passport descriptions	16	841	28	1617
maize	<i>Zea spp.</i>	SNP, SSR, RFLP, sequence data, phenotype data, passport descriptions	31	8037	150	13075
arabidopsis	<i>Arabidopsis thaliana</i>	250K SNP chip, 362 lines assayed	2 pending	362 pending	0	1,126,177 pending
wheat	<i>Triticum aestivum</i> , <i>Aegilops spp.</i>	SNP, sequence data, passport descriptions	1	48	0	4097
sorghum	<i>Sorghum species</i>	SNP, SSR, sequence data, Isozyme, RFLP, AFLP, INDEL polymorphism, CAPS (Cleaved amplified polymorphic site)	6	1993	0	544

Basic Search

- Search for experiments that contain a germplasm named
- Search for experiments that contain a marker named

Advanced Search

Perform an advanced search of the Genetic Diversity database with several parameters. Search scripts provided by the [Panzea project](#).

- [Germplasm Search](#)
- [Geographic Map Viewer](#)
- [Molecular Diversity Search](#)
- [Gene/Locus Search](#)
- [Phenotype Search](#)
- [Polymorphism Between Accessions](#)

Tools



TASSEL - Java program for evaluating trait associations, evolutionary patterns, and linkage disequilibrium.



GDPC Browser - Java program for performing complex queries and data format manipulations.

Download data

- All Diversity datasets can be downloaded in bulk from [the Gramene FTP archive](#). Files with 'diversity_' prefix contain the Diversity data.
- Also available are [association data](#) from the TASSEL program.

Gramene Genetic Diversity Module

GRAMENE Genetic Diversity

Diversity

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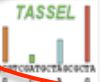
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Gramene Genetic Diversity Module

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Gramene: Genetic Diversity Database

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In: --Any--

Species: Rice

E.g., Germplasm "IRGC 3575", RA4969, Basmati 1, Marker/locus RM22.

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Search for rice experiments that contain a germplasm

Submit

Search for rice experiments that contain a marker named

Submit

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Germplasm Search

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Rice Data in Gramene Diversity

Experiments 16

Markers (SSR,RFLP,SNP) 1,617

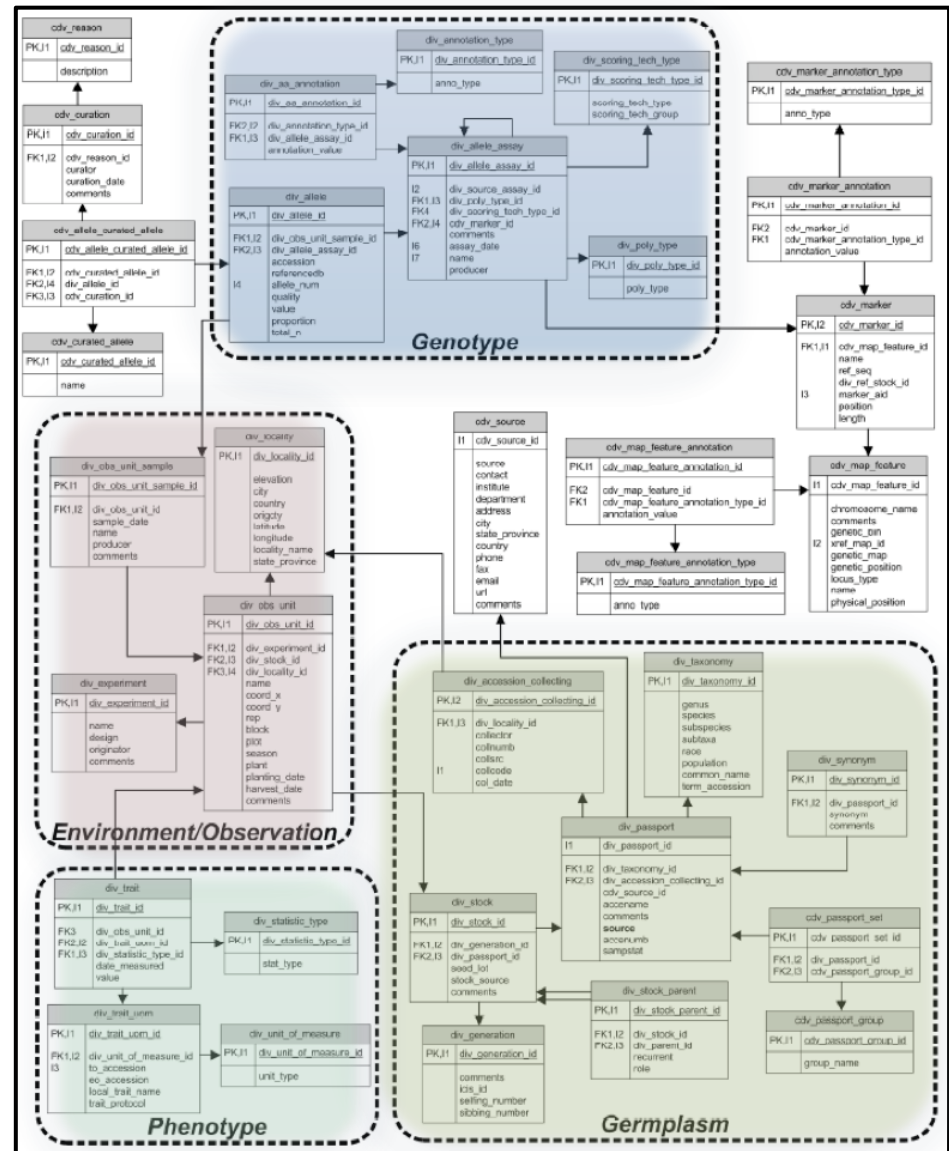
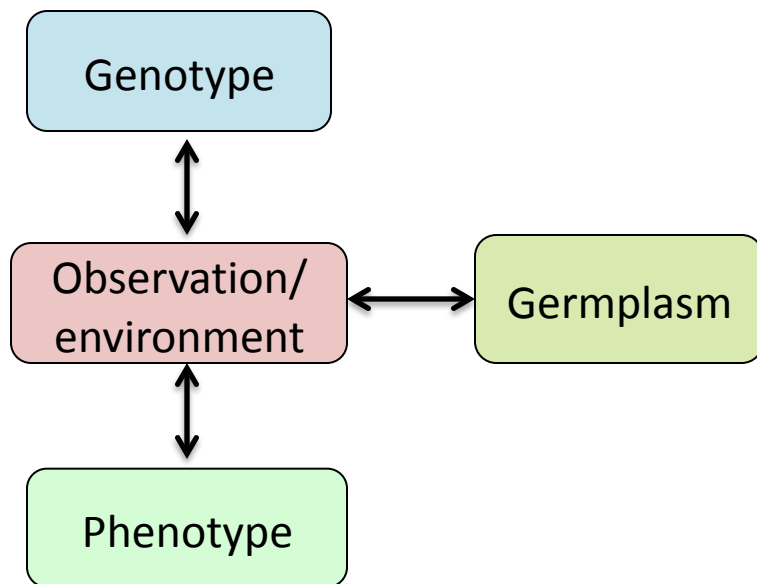
Germplasm 841

Traits 28

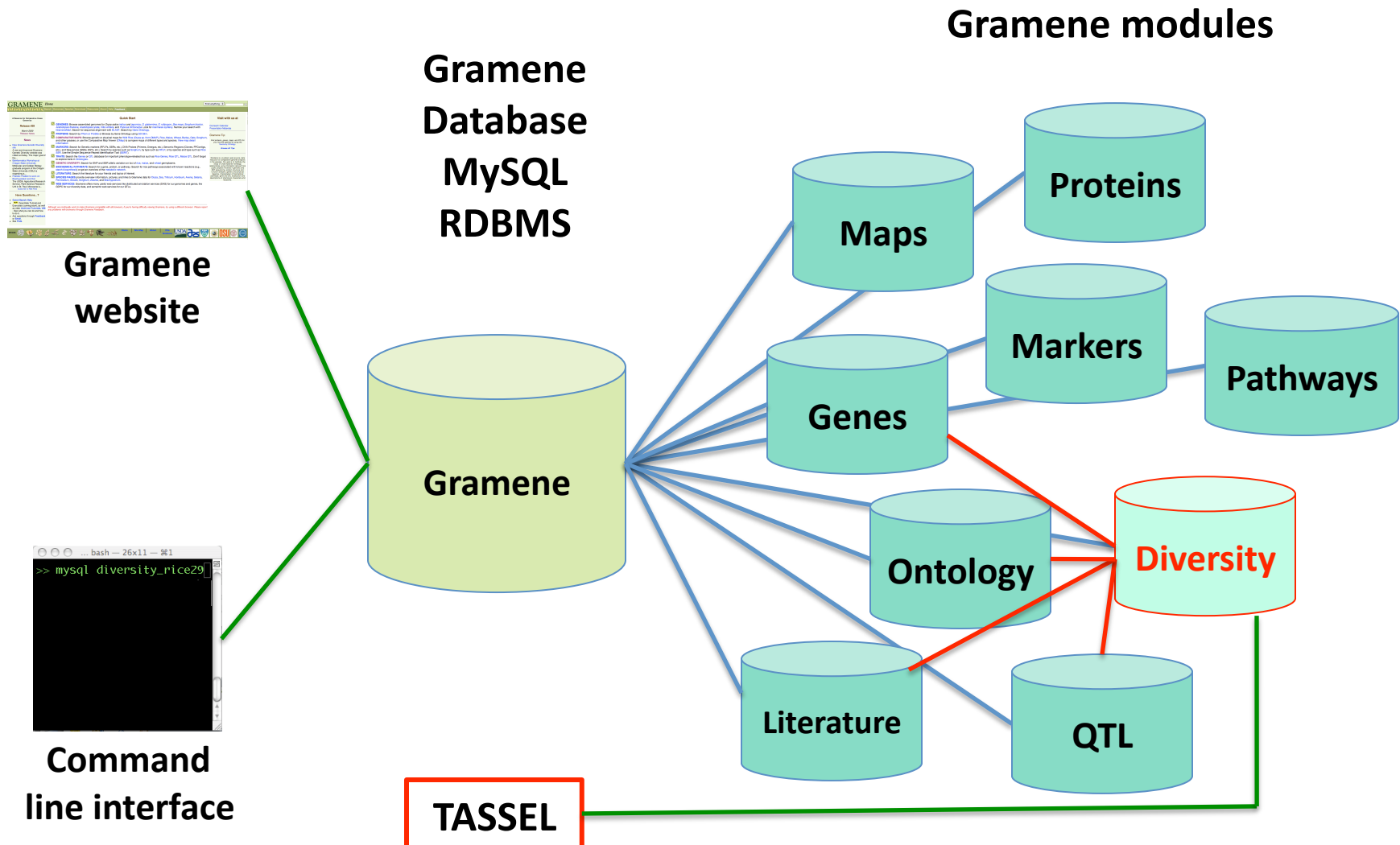
QTL (raw data) 336

Diversity Database Design

- GDPDM schema**
(Genomic Diversity and Phenotype Data Model)

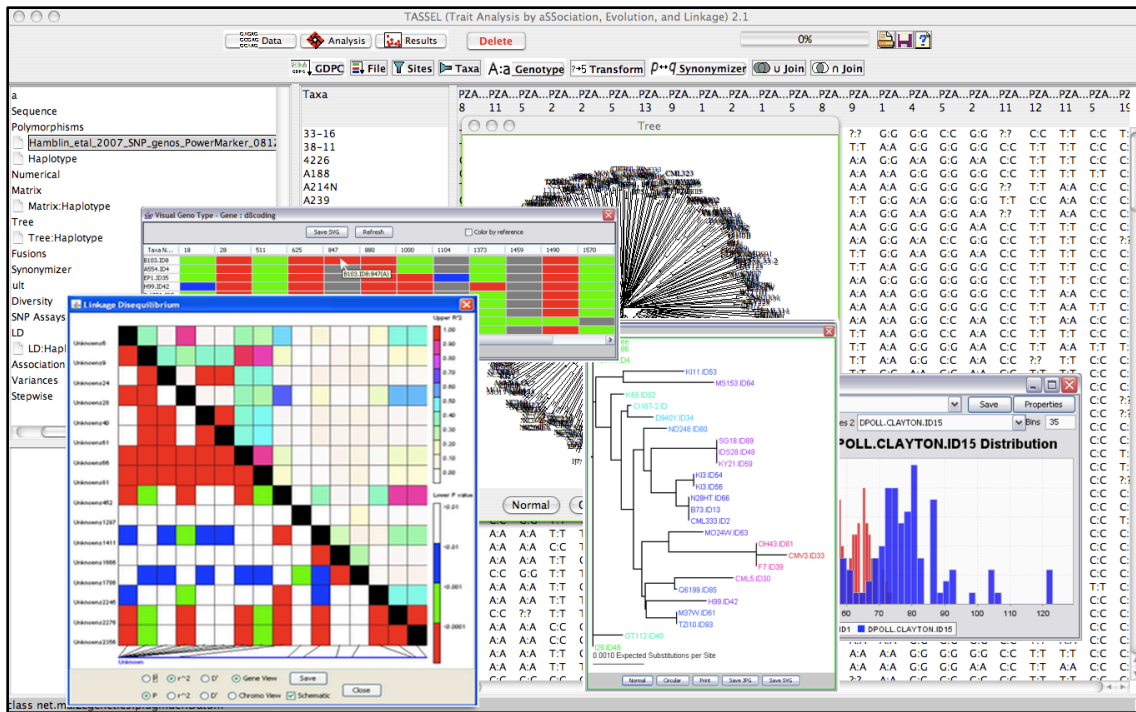


Diversity Database



TASSEL

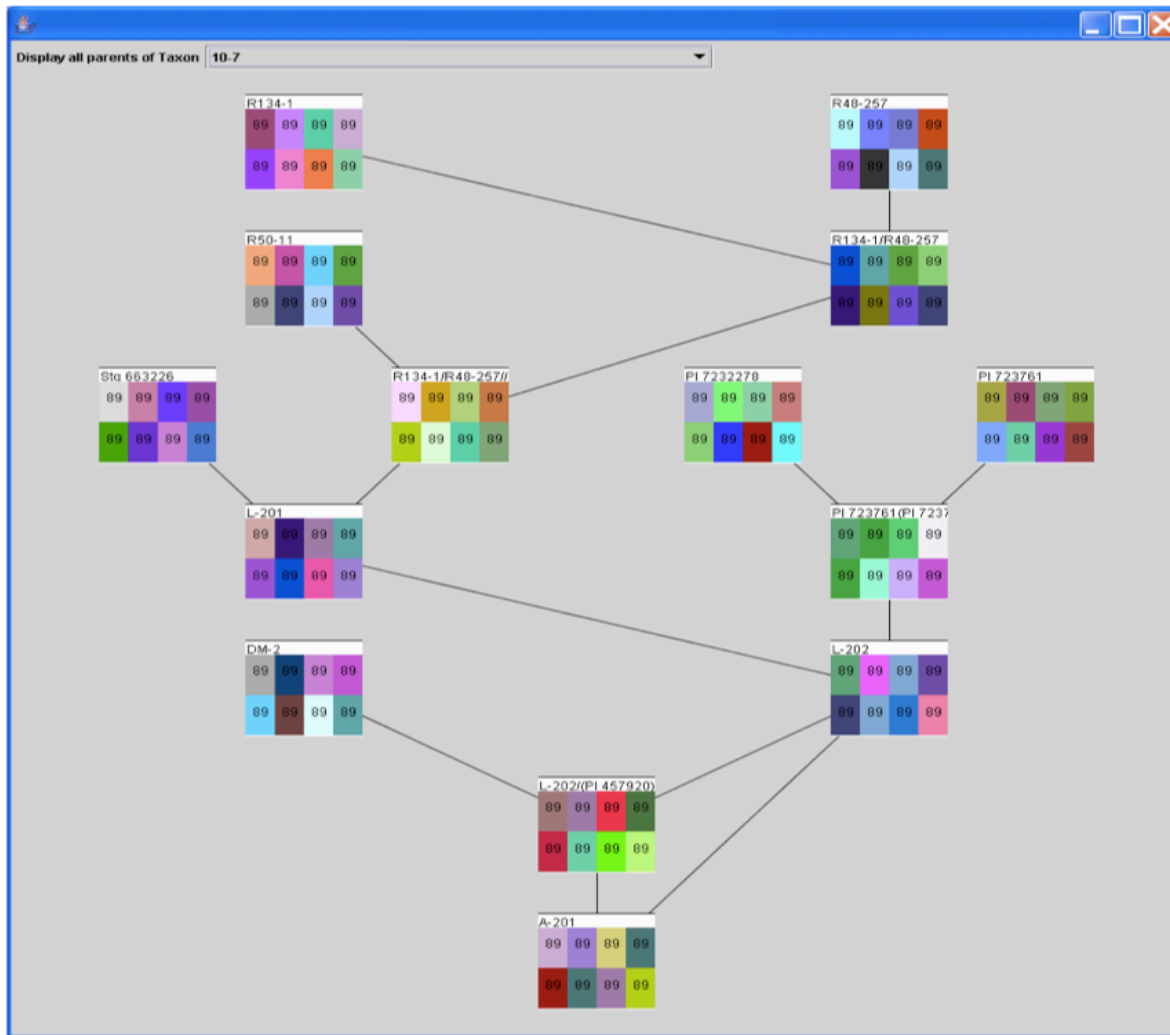
Trait Analysis by aSSociation, Evolution and Linkage



- Evaluate trait associations
- Discover evolutionary patterns
- Calculate linkage disequilibrium
- Use new statistical approaches (GLM, MLM)*
- Stand-alone Java package
- Interfaces directly with Diversity database

* See paper “Unified Mixed-Model Method for Association Mapping”, *Nat Genet.* 2006 Feb;38(2):203-8.

Pedigree viewer



- Prototyped, proposed for TASSEL
- *network* diagram drawn on-the-fly based on data loaded in TASSEL
- Estimates of breeding values
- Highlight key polymorphisms

Demos...

- Diversity module
 - **Example #1:** *Search for allele profile of Bonnet 73*
 - **Example #2:** *View all rice germplasm records related to a particular trait*

Diversity example #1

169 Bonnet 73 alleles found

Items 1 to 25 of 169. Page 1 of 7 Next							
[Download]							
Germplasm Accession Name	Germplasm Accession Number	Subsp. & subtaxa	Country of Origin	Stock Number	Locus name	Genotype	View All Genotypes on Marker
Bonnet 73	Clor 9654	United States of America	japonica, tropical japonica	RA1792	OSR13	98	View all "OSR13" genotypes
Bonnet 73	Clor 9654	United States of America	japonica, tropical japonica	RA1792	RM1	88	View all "RM1" genotypes
Bonnet 73	Clor 9654	United States of America	japonica, tropical japonica	RA1792	RM104	222	View all "RM104" genotypes
Bonnet 73	Clor 9654	United States of America	japonica, tropical japonica	RA1792	RM105	129	View all "RM105" genotypes
Bonnet 73	Clor 9654	United States of America	japonica, tropical japonica	RA1792	RM106	293	View all "RM106" genotypes
Bonnet 73	Clor 9654	United States of America	japonica, tropical japonica	RA1792	RM108	81	View all "RM108" genotypes
Bonnet 73	Clor 9654	United States of America	japonica, tropical japonica	RA1792	RM109	97	View all "RM109" genotypes
Bonnet 73	Clor 9654	United States of America	japonica, tropical japonica	RA1792	RM11	129	View all "RM11" genotypes
Bonnet 73	Clor 9654	United States of America	japonica, tropical japonica	RA1792	RM112	136, 142	View all "RM112" genotypes

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germplasm_accession_name	country_of_origin	accession_number	stock_number	locus_name	genotype		
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Bonnet 73	United States of America	CIor 9654	RA1792	RM116	279		
Bonnet 73	United States of America	CIor 9654	RA1792	RM1167	175		
Bonnet 73	United States of America	CIor 9654	RA1792	RM118	158		
Bonnet 73	United States of America	CIor 9654	RA1792	RM1189	176		
Bonnet 73	United States of America	CIor 9654	RA1792	RM119	164		
Bonnet 73	United States of America	CIor 9654	RA1792	RM120	186		
Bonnet 73	United States of America	CIor 9654	RA1792	RM122	229		
Bonnet 73	United States of America	CIor 9654	RA1792	RM124	271		
Bonnet 73	United States of America	CIor 9654	RA1792	RM125	126		
Bonnet 73	United States of America	CIor 9654	RA1792	RM13	127		

Text data dump of
all 169 genotype
measurements

Diversity example #1

All genotypes of marker 'RM1'

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Germplasm Accession Name	Germplasm Accession Number	Subsp. & subtaxa	Country of Origin	Stock Number	Locus name	Genotype	View All Genotypes on Germplasm
Badkalamakati		Bangladesh	indica, indica	RA4991	RM1	76	View all "Badkalamakati" genotypes
Lemont	PI 475833	United States of America	japonica	RA6270	RM1	86	View all "Lemont" genotypes
L-202	PI 483097	United States of America	japonica	RA6273	RM1	86	View all "L-202" genotypes
M-101	CI 9970	United States of America	japonica	RA5002	RM1	84, 88	View all "M-101" genotypes
Calrose 76		United States of America	japonica, temperate japonica	RA1810	RM1	84	View all "Calrose 76" genotypes
M-201	CI 9980	United States of America	japonica, temperate japonica	RA5008	RM1	88	View all "M-201" genotypes
Vegold	CI 9836	United States of America	japonica	RA5040	RM1	86	View all "Vegold" genotypes
Belle Patna	CI 9433	United States of America	japonica	RA1791	RM1	86	View all "Belle Patna" genotypes
Della	CI 9483	United States of America	indica	RA6389	RM1	86	View all "Della" genotypes

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All genotypes of marker 'RM1'

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Germplasm Accession Name	Germplasm Accession Number	Subsp. & subtaxa	Country of Origin	Stock Number	Locus name	Genotype	View All Genotypes on Germplasm
Badkalamakati		Bangladesh	indica, indica	RA4991	RM1	76	View all "Badkalamakati" genotypes
Lemont	PI 475833	United States of America	japonica	RA6270	RM1	86	View all "Lemont" genotypes
L-202	PI 483097	United States of America	japonica	RA6273	RM1	86	View all "L-202" genotypes
M-101	CI 9970	United States of America	japonica	RA5002	RM1	84, 88	View all "M-101" genotypes
Calrose 76		United States of America	japonica, temperate japonica	RA1810	RM1	84	View all "Calrose 76" genotypes
M-201	CI 9990	United States of America	japonica, temperate japonica	RA5008	RM1	88	View all "M-201" genotypes
Vegold				RA5040	RM1	86	View all "Vegold" genotypes
Belle Patna				791	RM1	86	View all "Belle Patna" genotypes
Della				389	RM1	86	View all "Della" genotypes

Oryza sativa Indica Group SSR "RM1"

ID 24985466

Name RM1

Synonyms (3) GA12 RM001
RM1 (K)

Type SSR

Species [Oryza sativa Indica Group \(Indian rice\)](#) [GR_tax:013682]

Germplasm [IR36](#)

Analysis

- [fpc_loader](#)
- [Rice_SSRs](#)

Description

Tags (0) None

[Source/Library](#)

[Details](#)

[Database Cross-References \(1\)](#)

[Sequences \(5\)](#)

[Map Positions \(21\)](#)

Gramene Marker record for RM1

Diversity example #2

View all rice germplasm records related to a particular trait

GRAMENE Genetic Diversity

Diversity

SearchGenomesSpeciesDownloadResourcesAboutHelpFeedback

Diversity Home | Tools | Tutorials | FAQ | Release Notes

Gramene: Genetic Diversity Database

Find: In: --Any-- Species: Rice

E.g., Germplasm "IRGC 3575", RA4969, Basmati 1, Marker/locus RM22

Diversity Overview

The Gramene Diversity database contains genotype and phenotype experiments in rice, maize, wheat, sorghum, and soon, arabidopsis, which study the genetics of variation within populations and how this relates to quantitative and observable traits. Characterizing the genetic basis of variation within populations and linking this with observable traits provides an important framework for understanding population structure and evolutionary patterns, and for increasing the efficiency of plant breeding programs.

Database summary

	species	data types	experiments	germplasm	traits	genotype markers
rice	<i>Oryza sativa</i> , <i>O. glaberrima</i> , <i>O. rufipogon</i>	SNP, SSR, RFLP, phenotype data, QTL, passport descriptions	16	841	28	1617
maize	<i>Zea spp.</i>	SNP, SSR, RFLP, sequence data, phenotype data, passport descriptions	31	8037	150	13075
arabidopsis	<i>Arabidopsis thaliana</i>	250K SNP chip, 362 lines assayed	2 pending	362 pending	0	126,177 pending
wheat	<i>Triticum aestivum</i> , <i>Aegilops spp.</i>	SNP, sequence data, passport descriptions	1	48	0	4097
sorghum	<i>Sorghum</i> species	SNP, SSR, sequence data, Isozyme, RFLP, AFLP, INDEL polymorphism, CAPS (Cleaved amplified polymorphic site)	6	1993	0	514

Basic Search


- Search for rice experiments that contain a germplasm named
- Search for rice experiments that contain a marker named


Advanced Search

Perform an advanced search of the Genetic Diversity database with several parameters. Search scripts provided by the [Panzea project](#).

- [Germplasm Search](#)
- [Geographic Map Viewer](#)
- [Molecular Diversity Search](#)
- [Gene/Locus Search](#)
- [Phenotype Search](#)
- [Polymorphism Between Accessions](#)

Tools

**TASSEL** - Java program for evaluating trait associations, evolutionary patterns, and linkage disequilibrium.

**GDPC Browser** - Java program for performing complex queries and data format manipulations.

Download data

- All Diversity datasets can be downloaded in bulk from [the Gramene FTP archive](#). Files with 'diversity_' prefix contain the Diversity data.
- Also available are [association data](#) from the TASSEL program.

Click on the trait number hyperlink for rice

Diversity example #2

View all rice germplasm records related to a particular trait

Traits 1 to 25 of 28. Page 1 of 2 | [Next](#)

[\[Download \]](#)

Local Trait Name	Trait Protocol	Trait Ontology Id	Unit Type	
Panicle number	Panicles per plant was calculated as the average number of panicles per plant at harvest.	TO:0000152	count	View
Germination rate	Percent germination was determined using 30 kernels that had been harvested 30 days after the panicle had flowered, dried at 45 °C for 4 days, soaked in water for 2 days, and then transferred to mo...	TO:0000430	percent	View
Grains per panicle	Grains per panicle was measured as the average number of filled spikelets per panicle on the primary panicle of each plant.	TO:0000450	count	View
100-grain weight	Grain weight was measured, in grams, as the average weight of 100 kernels.	TO:0000269	g	View
Plant height	Plant height was measured in centimeters from the soil surface to the tip of the tallest panicle, excluding the awns.	TO:0000207	cm	View
Awn length	Awns were ranked in five categories. 1-5 scale. from no awns to awns over 1 cm in length.	TO:0000072	1-5	View

View trait details for
“Grains per panicle”

Diversity example #2

View all rice germplasm records related to a particular trait

259 germplasm/stock
records found related
to "Grains per panicle"

Trait "Grains per panicle"		to "Grains per panicle"		
Trait Name	Grains per panicle			
Trait Ontology ID	TO:0000450			
Trait Protocol	Grains per panicle was measured as the average number of filled spikelets per panicle on the primary panicle of each plant.			
Unit of measure	count			
Experiments (1)				
Related Germplasm (259)				
Passport Accession Name		Seed Lot Name	Stock Source	Comments
Jefferson x Oryza rufipogon		BC2F2 Line 144	McCouch Lab	
Jefferson x Oryza rufipogon		BC2F2 Line 226	McCouch Lab	
Jefferson x Oryza rufipogon		BC2F2 Line 5	McCouch Lab	
Jefferson x Oryza rufipogon		BC2F2 Line 207	McCouch Lab	
Jefferson x Oryza rufipogon		BC2F2 Line 92	McCouch Lab	
Jefferson x Oryza rufipogon		BC2F2 Line 164	McCouch Lab	
Jefferson x Oryza rufipogon		BC2F2 Line 16	McCouch Lab	

Diversity example #2

*View all rice germplasm records related to a particular trait
...and display the trait measurement data*

On the same “Grains per panicle” record page, we can also view all the trait values measured for each stock

page, we can also view all the trait values measured for each stock

Trait "Grains per panicle"			
Trait Name	Grains per panicle		
Trait Ontology ID	TO:0000450		
Trait Protocol	Grains per panicle was measured as the average number of filled spikelets per plant.		
Unit of measure	count		
Experiments (1)			
Related Germplasm (259)			
Trait Measurements (988)			
Plant Observation Unit name	Experiment ID	trait_name	Value
BC2F2 Line 144	7	Grains per panicle	138.70
BC2F2 Line 226	7	Grains per panicle	94.50
BC2F2 Line 5	7	Grains per panicle	97.90
BC2F2 Line 207	7	Grains per panicle	155.00
BC2F2 Line 92	7	Grains per panicle	61.00
BC2F2 Line 164	7	Grains per panicle	156.00
BC2F2 Line 16	7	Grains per panicle	78.20
BC2F2 Line 127	7	Grains per panicle	101.60

Diversity example #2

*View all rice germplasm records related to a particular trait
...and display the related experiments*

Display all associated experiments with in Diversity with “Grains per panicle” trait measurements. There is only 1 related experiment in this case

Trait "Grains per panicle"							
Trait Name		Grains per panicle					
Trait Ontology ID		TO:0000450					
Trait Protocol		Grains per panicle was measured as the average number of filled spikelets per panicle. There is only 1 related experiment in this case					
Unit of measure		count					
Experiments (1)							
ID	Title	Design	Polymorphism Type	Allele Scoring Protocol	PI(s)	Comments	Data
7	Mapping quantitative trait loci for yield, yield components and morphological traits in an advanced backcross population between <i>Oryza rufipogon</i> and the <i>Oryza sativa</i> cultivar Jefferson	Phenotypic evaluation was done in a greenhouse for 353 BC ₂ F ₁ families and in three field trials for 258 BC ₂ F ₂ families. Genotyping (104 SSRs and 49 RFLPs) was done on the 353 BC ₂ F ₂ families	N/A		McCouch-S-R	Seventy-six QTLs were identified using interval mapping and composite interval mapping. A putative QTL was reported if detected in at least one environment at an experiment-wise significance threshold of P < 0.01. Reference: Thomson et al., 2003.	Show Trait Measurements
Related Germplasm (259)							
Trait Measurements (988)							

Your ideas

- What queries would you like to see?
- What tools do breeders need?
- Ideas about the website?
- What datasets would you like to see in Gramene Diversity?

Data formatting

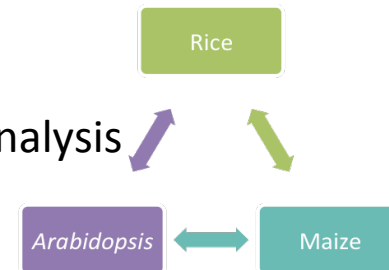
- Regular (machine readable) format
 - Tab-delimited, csv
 - Uniform usage of delimiters
- Usage of controlled vocabulary/ontology
 - Gramene Trait Ontology (T.O.)
 - Universal identifiers (e.g. GRIN ID, dbSNP id)

“Bonnet 73”  “bonnet73”

Gramene Diversity

upcoming

- Fine curation on all diversity data sets (ongoing!)
- Much more data!
 - **Rice**: NSF TV 44K SNP chip, 600K chip...
 - **Maize**: millions of SNPs from Maize HapMap project; large scale data from NAM population with over 5000 RILs. (panzea.org)
 - **Arabidopsis**: 250K SNP chip data; genotypes from 1001 genomes project
- Developing Germplasm module
- More analysis tools
 - Additional TASSEL modules (association stats, *pedigree networks*)
 - Ensembl Genome Browser (variation plots, heatmaps)
- Cross species association analysis
 - New Diversity member Charles Chen, statistical analysis



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