

100 years of

Plant Biology



2024 | HONOLULU, HAWAII
JUNE 22-26

Gramene 2024

*Sunita Kumari,
Cold Spring Harbor Lab*

Gramene Timeline (dates from publications)



2002: Pre-genomic era for crop genomes. Rice maps projections to other species.

2006: Only rice had been sequenced and annotated. Provided syntenic relationships.

2007: Introduced pathways for functional annotation of rice genes

2009: Formal Collaboration with Ensembl Genomes - core databases



Sara Dyer

2013 : **Plant Reactome** portal brings curated rice pathways

2016: Drupal CMS, Archive site, **EBI Expression Atlas**

2018: Integrated search interface embedded genomic views

2021: Pan genome sites

2022: CLIM Tools

2023-24: BAR eFPseq browser



Irene Papatheodorou



Pankaj Jaiswal



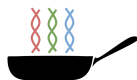
CLIMtools



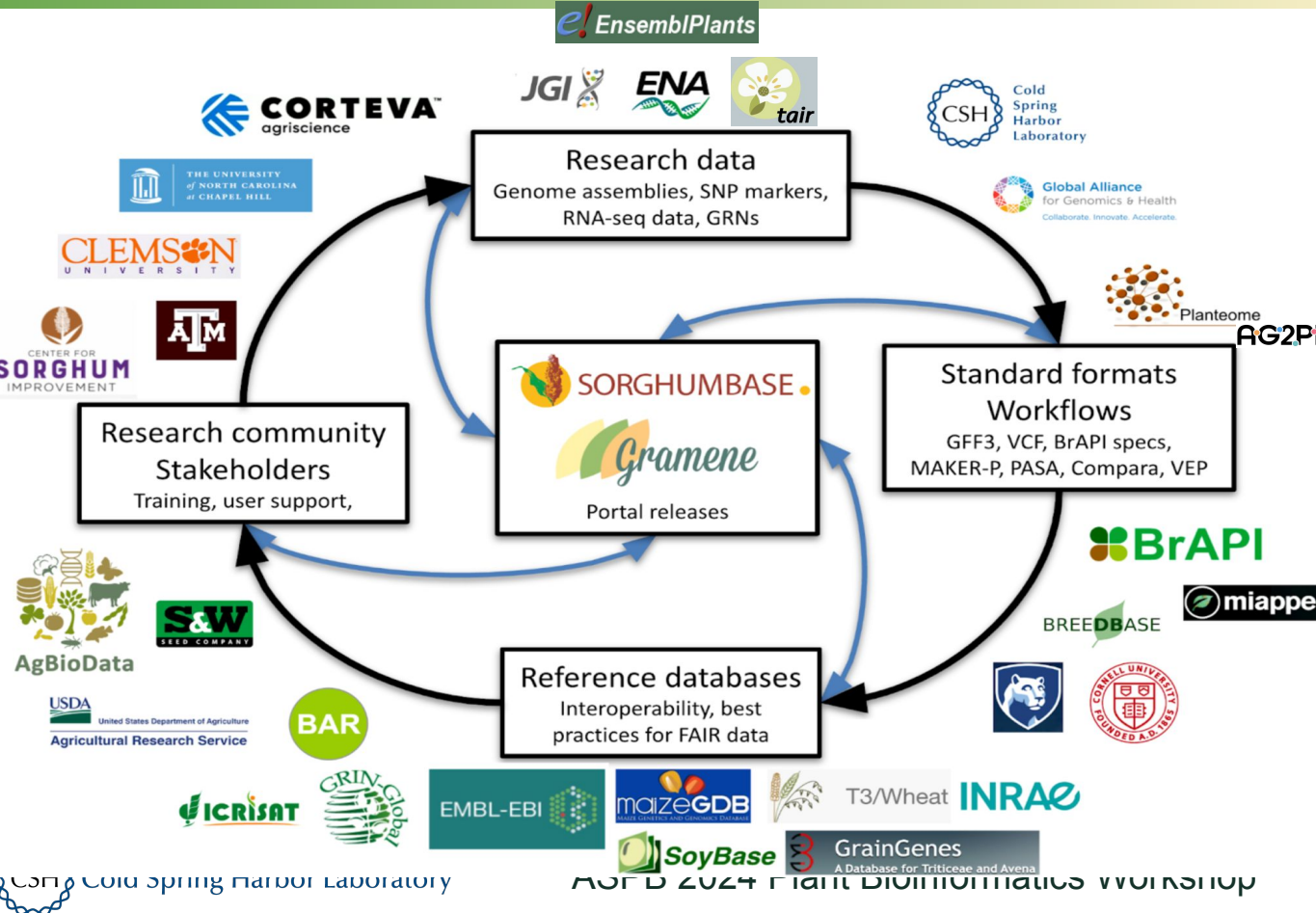
Sally Assmann



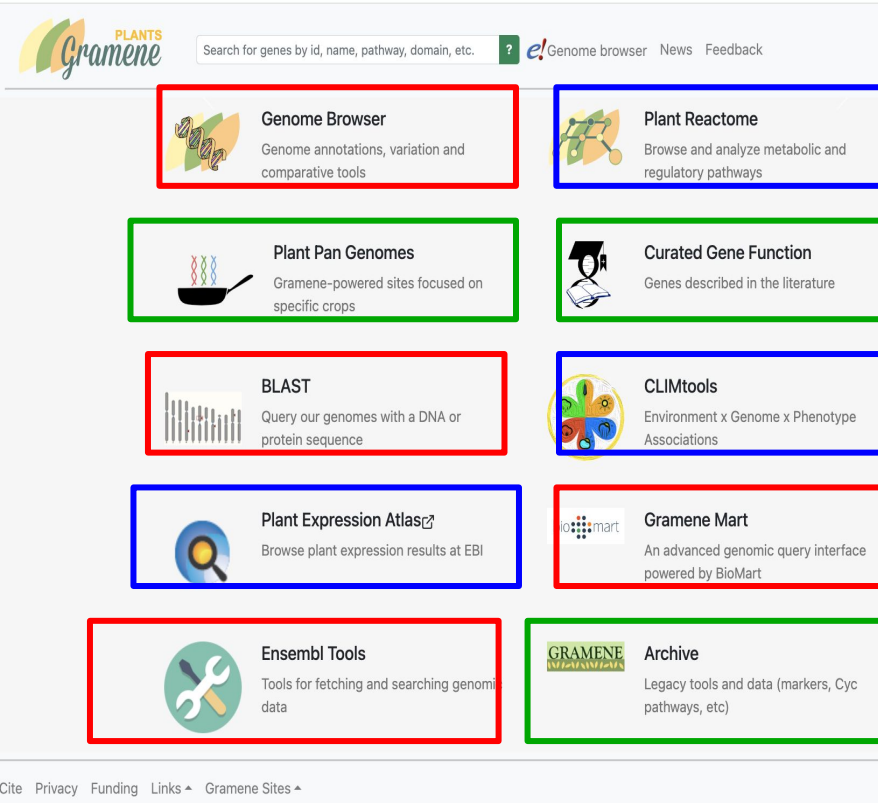
Nick Provart



FAIR principles with Research Community



- ### Follow FAIR Principles
1. Integrated Genomic Resources
 2. Identify and apply standard formats in developing and deploying analysis workflows
 3. Support Interoperability with reference databases
 4. Provide training and support to the research community and stakeholders



PLANTS Gramene

Search for genes by id, name, pathway, domain, etc. ? e! Genome browser News Feedback

- Genome Browser** (red box): Genome annotations, variation and comparative tools
- Plant Reactome** (blue box): Browse and analyze metabolic and regulatory pathways
- Plant Pan Genomes** (green box): Gramene-powered sites focused on specific crops
- Curated Gene Function** (green box): Genes described in the literature
- BLAST** (red box): Query our genomes with a DNA or protein sequence
- CLIMtools** (blue box): Environment x Genome x Phenotype Associations
- Plant Expression Atlas** (blue box): Browse plant expression results at EBI
- Gramene Mart** (red box): An advanced genomic query interface powered by BioMart
- Ensembl Tools** (red box): Tools for fetching and searching genomic data
- GRAMENE Archive** (green box): Legacy tools and data (markers, Cyc pathways, etc)

Cite Privacy Funding Links Gramene Sites

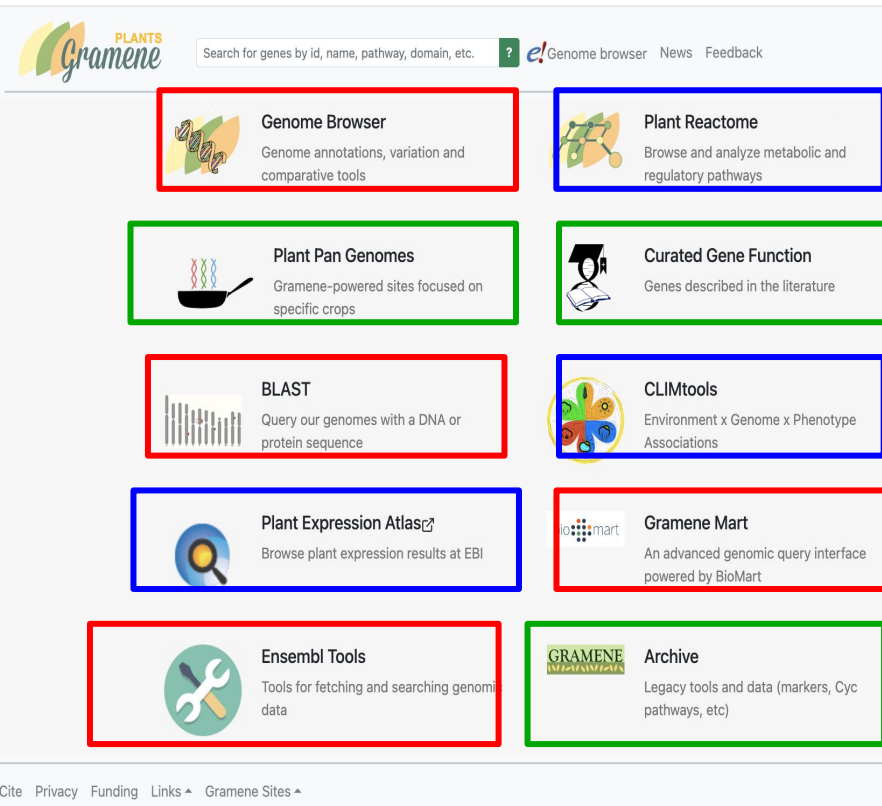
Genome Browser - Genome Annotation, Variation and Comparative tools

BLAST - sequence similarity

Ensembl Tools - Tools for fetching data

Gramene Mart - Download the data





The screenshot shows the Gramene Plants website interface. At the top left is the 'PLANTS Gramene' logo. A search bar contains the text 'Search for genes by id, name, pathway, domain, etc.' followed by a question mark icon and the text 'e! Genome browser News Feedback'. Below the search bar are several tool cards arranged in a grid. Each card has an icon, a title, and a brief description. The cards are: 'Genome Browser' (red border), 'Plant Reactome' (blue border), 'Plant Pan Genomes' (green border), 'Curated Gene Function' (green border), 'BLAST' (red border), 'CLIMtools' (blue border), 'Plant Expression Atlas' (blue border), 'Gramene Mart' (red border), 'Ensembl Tools' (red border), and 'GRAMENE Archive' (green border). At the bottom left, there are links for 'Cite', 'Privacy', 'Funding', 'Links', and 'Gramene Sites'.

Plant Expression Atlas - Plant expression results at EBI and **eFP from BAR**
Plant Reactome - curated metabolic pathways of rice and other genomes.
CLIM Tools - E x G x P associations in Arabidopsis and Rice.



PLANTS Gramene

Search for genes by id, name, pathway, domain, etc. ? e! Genome browser News Feedback

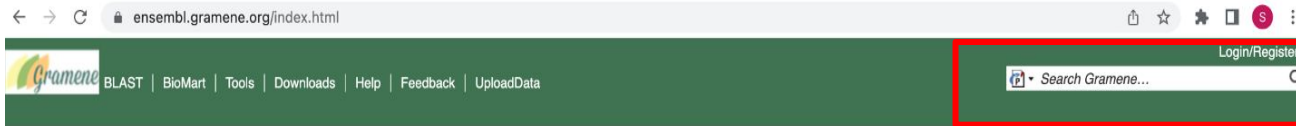
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Cite Privacy Funding Links Gramene Sites

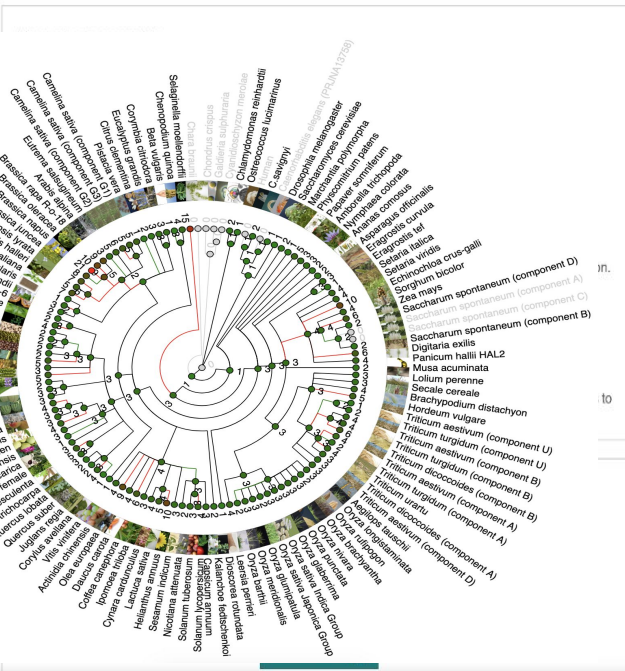
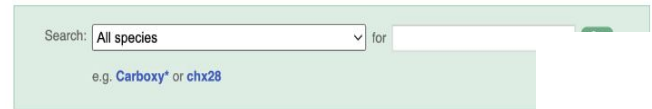
Plant PanGenomes: 4 pan sites
Curated Gene Function- from literature
Archive - Legacy data on QTLs, markers



Gramene 150 Plant Genomes



Search for genomic regions, genes, transcripts, variants, phenotypes etc.



• Access to 150 Plant Genomes; Gene models with functional & structural annotations.

• 279 pairwise alignments, 80 synteny maps.


Genetic variation data from 19 species; amounts to >238 M markers including SNPs, QTLs, SSR/RFLPs and EMS-induced variants.

Tools For Processing Data

Tools




We provide a number of ready-made tools for processing both our data and yours. We routinely delete results from our servers after 10 days.

Processing your data

Name	Description
Variant Effect Predictor 	Analyse your own variants and predict the functional consequences of known and unknown variants via our Variant Effect Predictor (VEP) tool.
HMMER	Quickly search our genomes for your protein sequence.
BLAST/BLAT	Search our genomes for your DNA or protein sequence.
Assembly Converter	Map (liftover) your data's coordinates to the current assembly.
ID History Converter	Convert a set of Ensembl IDs from a previous release into their current equivalents.

For larger datasets we provide an API script that can be downloaded (you will also need to install our Perl API, below, to run the script).

Accessing Ensembl Plants data

Name	Description	Get it from:	Documentation
BioMart	Use this data-mining tool to export custom datasets from Ensembl Plants.	Ensembl Plants BioMart	
Ensembl Perl API	Programmatic access to all Ensembl data using simple Perl scripts	GitHub or FTP download (current release only)	
Ensembl Genomes REST server	Access Ensembl data using your favourite programming language		

Ensembl Tools For Processing Your Data

- Variant Effect Predictor
- HMMER
- BLAST/BLAT
- Assembly Converter
- ID History Converter

In this section

- Control Panel
- Find a Data Display
- Adding Custom Tracks
 - BED File Format
 - Large File Formats
 - Pairwise Interactions File Format
 - GFF/GTF File Format
 - GFF3 File Format
 - PSL File Format
 - Variation File Format
 - WIG File Format
 - Coordinate Systems for custom tracks
- Track Hubs
 - Adding Track Hubs
 - Track Hub Support in Ensembl
 - RNA-Seq studies in plants
- Glossary
- Supported browsers

Using this website

Find a Data Display

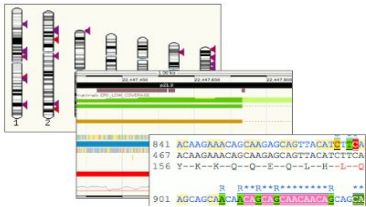
Not sure how to find the data visualisation you need? Choose the type of data you are interested in, then browse a selection of relevant visualisations!

Species:

Feature type:

- Genes
- Genomic locations
- Variants

Identifier:



Upload Data

Adding Custom Tracks:

- BED File Format
- Large File Formats
- Pairwise Interactions File Format
- GFF/GTF File Format
- GFF3 File Format
- PSL File Format
- Variation File Format
- WIG File Format

Downloads

Gramene BLAST | BioMart | Tools | **Downloads** | Help | Feedback | UploadData Login/Register

Download a sequence or region

Export data

CAGATGAT
AAATGTTCT
AAGAAGCA
CTGTCATGC
ATAAAGAA
AGTGATACT

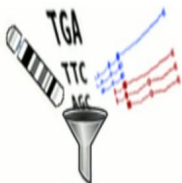


Click on the 'Export data' button in the lefthand menu of most pages to export:

- FASTA sequence
- GTF or GFF features

...and more!

Customise your download



Custom datasets can be retrieved using the BioMart data-mining tool.

You may find exploring this web-based query tool easier than extracting information direct from our databases.

Fetch data programmatically



Write your own Perl scripts to retrieve small-to-medium datasets. All our data, as well as added functionality, is available through the Ensembl Perl API.

Use the API to retrieve gene and transcript sets, fetch alignments between sequences, compare allele frequencies and much more!

You can also use our **REST API** to retrieve data to process in the programming language of your choice.

Download databases & software



All of our data and software, including pipelines and web code, is available free.

- [Download data via FTP](#)
- [Ensembl pipeline on GitHub](#)
- [Set up your own Ensembl Plants website](#)

Download data:

- Export data
- Customize download using Biomart
- Fetch data programmatically using REST APIs
- Download data via FTP Or Github

Gramene Mart - Data Export



ensembl.gramene.org/biomart/martview/21213f50a7508d59d3542a78df0acb8e

BLAST **BioMart** Tools | Downloads | Help | Feedback | UploadData Search Gramene...

New Count Results URL XML Perl Help

Please select columns to be included in the output and hit 'Results' when ready

Dataset
Arabidopsis thaliana genes (TAIR10)

Filters
[None selected]

Attributes
Gene stable ID
Transcript stable ID

GO

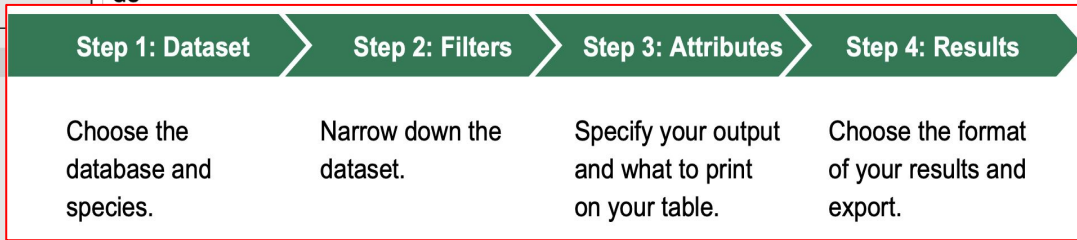
External References (max 3)
 BioGRID Interaction data, The General Repository for Interaction Datasets
 ChEMBL ID
 EntrezGene transcript name ID
 European Nucleotide Archive ID
 RefSeq DNA ID
 RefSeq mRNA ID
 RefSeq ncRNA ID
 RefSeq peptide ID
 RNAcentral ID

Variant (Germline)
 Sequences

Features
 Structures
 Homologues (Max select 6 orthologues)

GENE:

EXTERNAL:



Biological queries made easy.

- Query multiple things (gene / variants) at once:
- ID conversions
 - gene locations
 - download sequences
 - Export large amounts of data

NEW partnership with eFP Browser at Gramene



The "electronic fluorescent pictograph browser" (eFP browser), developed by the BAR team facilitates the interpretation of gene expression data through pictographic representation of experimental samples

Recently, Gramene added the eFP browser tool for 4 plant genomes for **Arabidopsis**, **sorghum**, **maize**, and **soybean**.



Asher Pasha

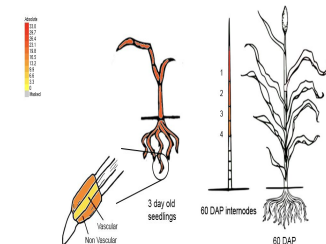


Nick Provar



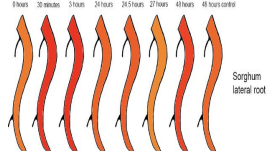
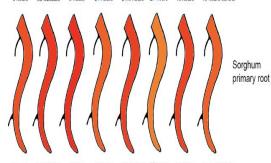
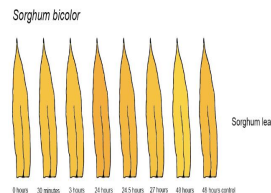
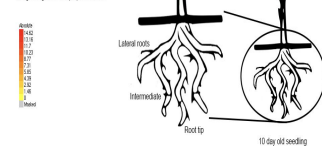
UNIVERSITY OF TORONTO

Internode & Vascularization eFP Browser

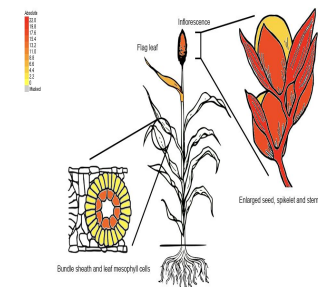


Phosphorus Study BTx623 WareLab Internal Dataset

Sorghum grown in aqueous tanks



Bundle Sheath of Sorghum bicolor Btx623



Sufficient Phosphorus



Limiting Phosphorus



Expression Data in Gramene

Explore gene expression data across species, tissues, cells, and conditions in Gramene for cross-species hypothesis generation.

- 1011 experimental studies across 26 plant genomes, funded by Gramene
- Collaboration on prioritizing, curating, validating, and configuring expression data.
- Tailored bulk and single-cell expression data for Gramene pan-genome sites.



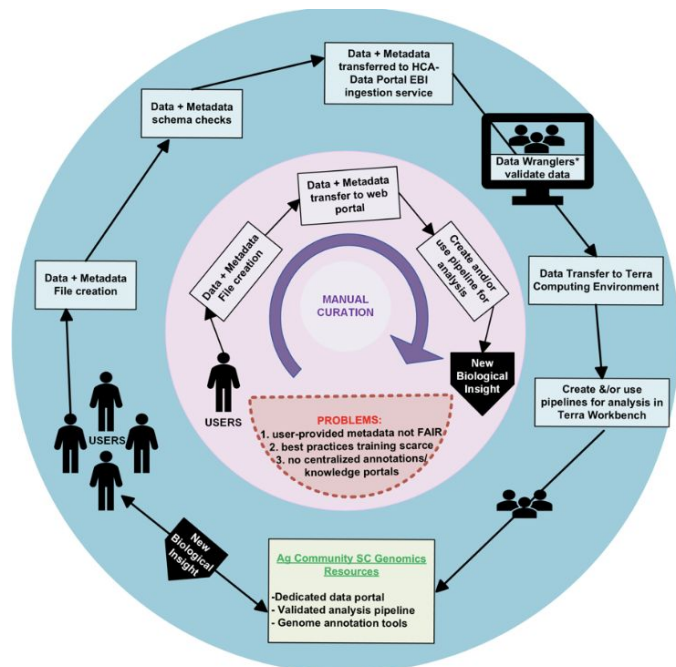
Nancy George



Irene Papatheodorou

Genomes	Bulk Expression		Single Cell
	Baseline	Differential	
<i>Arabidopsis thaliana</i>	17	606	13
<i>Sorghum bicolor</i>	8	3	
<i>Oryza sativa</i>	15	95	3
<i>Vitis vinifera</i>	10	23	
<i>Zea mays</i>	32	32	2

AgBioData sc RNAseq Biocuration WG



The current and possible future process in agricultural SC data ingestion into portal as well as data analysis. The inner circle emphasizes the existing problems, and the outer circle demonstrates a potential future environment with FAIR data and Computational tools to use such data.



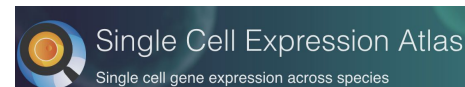
Sunita Kumari



Chris Tuggle

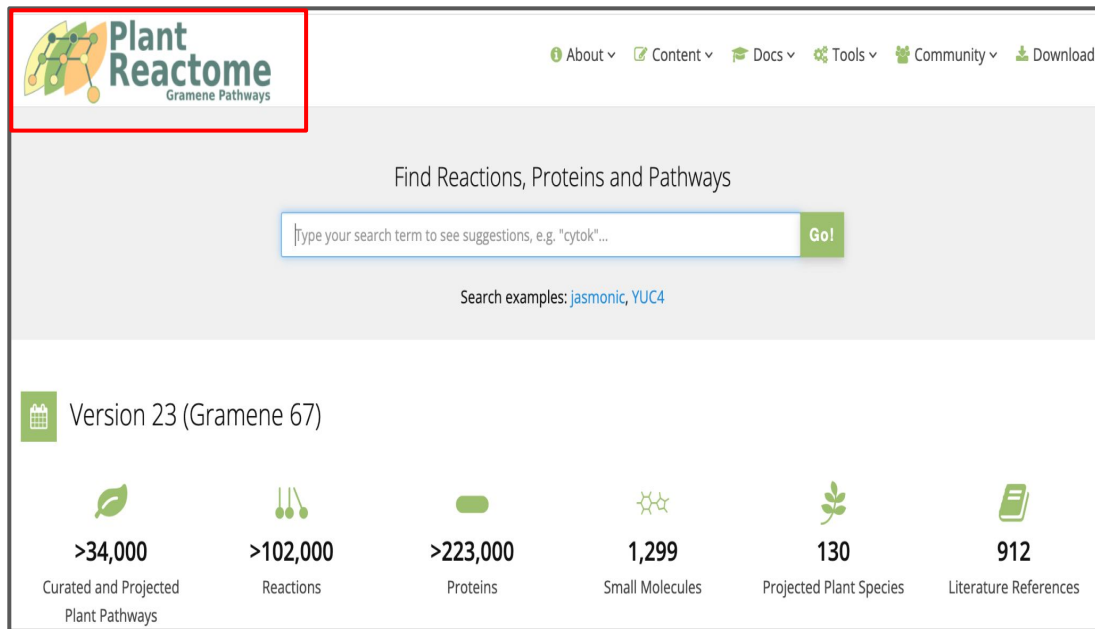


PLANT CELL ATLAS



Plant Reactome at Gramene

<http://plantreactome.gramene.org>



The screenshot shows the Plant Reactome website interface. At the top left, the Plant Reactome logo is highlighted with a red box. The navigation bar includes links for About, Content, Docs, Tools, Community, and Download. The main search area features a search bar with the placeholder text "Type your search term to see suggestions, e.g. 'cytok'..." and a "Go!" button. Below the search bar, search examples "jasmonic, YUC4" are provided. The bottom section displays statistics for Version 23 (Gramene 67):

Category	Count
Curated and Projected Plant Pathways	>34,000
Reactions	>102,000
Proteins	>223,000
Small Molecules	1,299
Projected Plant Species	130
Literature References	912

>34,000 curated and projected plant pathways.
Orthology-based projections for 130 species allow inter-species comparisons



Sushma Naithani



CLIMtools: Environment × Genome × Phenotype Associations



AraCLIM V2: Interactive spatial analysis of local Arabidopsis environments



GenoCLIM V2: Genetic variation associated with environmental variables

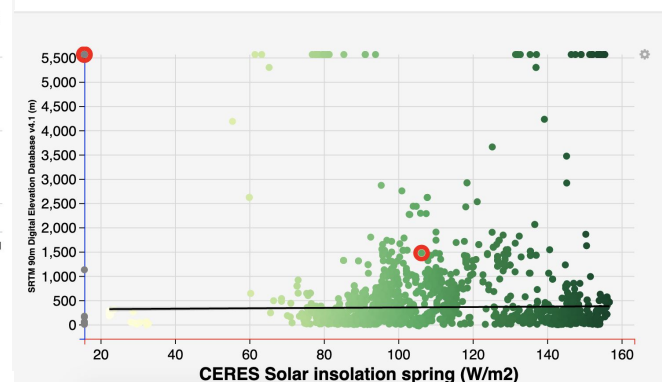
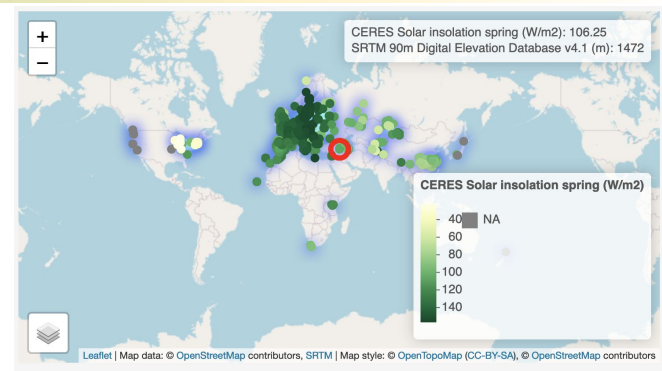
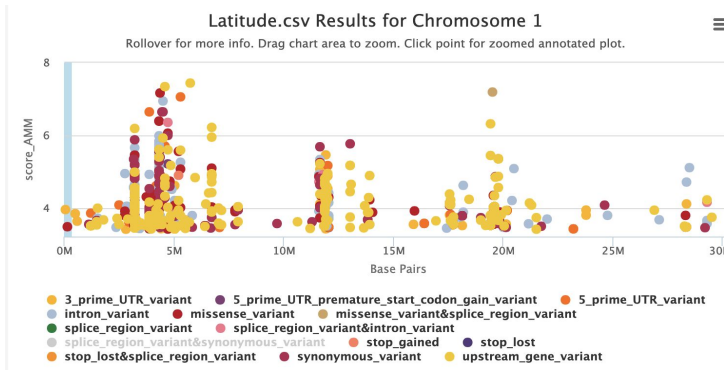


CLIMGeno V2: Environmental variation associated with genes or variants



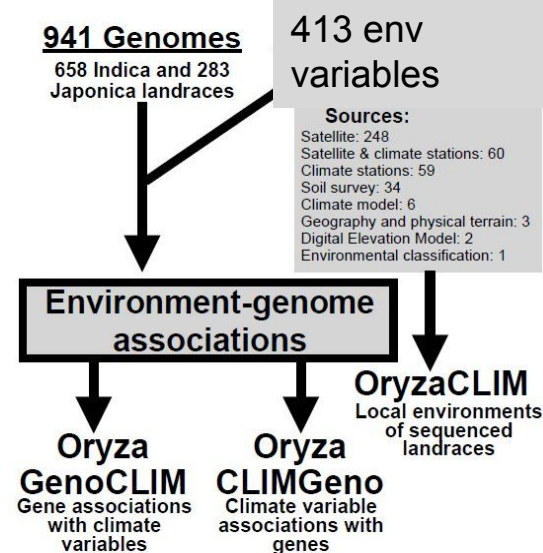
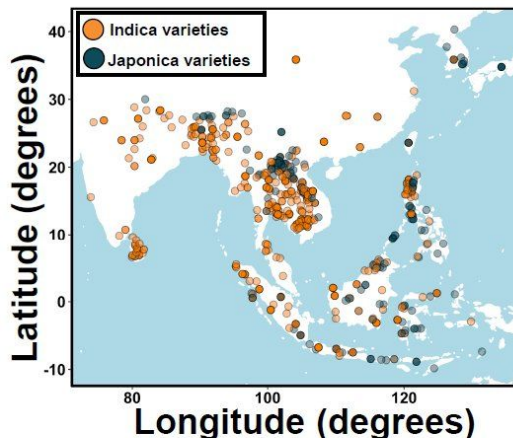
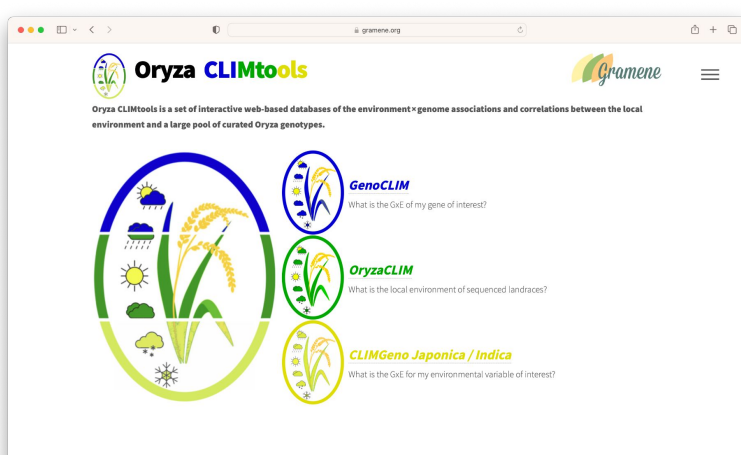
T-CLIM V2: Association between expression and environmental variables

RiboSNitch prediction
SNPs that change RNA secondary structure between the reference & the alternative allele.



Ferrero-Serrano *et al* (2022) 10.1186/s13059-022-02656-4

CLIMtools at Gramene: Oryza v1.0



Plant Communications



Oryza CLIMtools: A Genome-Environment Association Resource Reveals Adaptive Roles for Heterotrimeric G Proteins in the Regulation of Rice Agronomic Traits.

Ángel Ferrero-Serrano • David Chakravorty • Kobie J. Kirven • Sarah M. Assmann

<https://doi.org/10.1016/j.xplc.2024.100813>

Release 67 (August 2023)



Comparative plant genomics focused on rice varieties

28 Rice
(R7, August 2023)



Comparative plant genomics focused on maize varieties

38 Maize
(R4, Feb 2024)



Comparative plant genomics focused on grapevine varieties

29 Grapevine
(R4, Feb 2024)



Genomic resources for the sorghum research community

29 Sorghum
(R7, March 2024)

Common reference genomes (8)


- *Maize B73*
- *Rice Nipponbare*
- *Grapevine PN40024*
- *Sorghum BTx623*
- *Populus trichocarpa*
- *Arabidopsis thaliana*
- *Selaginella moellendorffii*
- *Chlamydomonas reinhardtii*



Sharon Wei

Community Engagement



- Targeted news feeds for Gramene sites
- Release notes and user guides
-  video-tutorials - 50 Videos
- Conferences: PAG, ASPB, etc.
- AgBioData: standards and best practices
- **Contact us for training, workshops, webinars and support**

<https://gramene.org/feedback>

Gramene Database

@gramenedatabase3929 · 166 subscribers · 50 videos

A screenshot of the Gramene Database YouTube channel page. The channel name is "Gramene Database" with the handle "@gramenedatabase3929", 155 subscribers, and 50 videos. Below the channel name are navigation tabs for HOME, VIDEOS, PLAYLISTS, COMMUNITY, CHANNELS, and ABOUT. A grid of video thumbnails is displayed, each with a title, view count, and upload time. The videos include: "15 b - Identify a sorghum EMS line in Gramene" (53 views, 1 year ago), "15 Explore a genetic variant and identify an EMS mutant line" (26 views, 1 year ago), "14 - Identify mutant lines bearing an EMS-induced mutation in Gramene" (27 views, 1 year ago), "13 - Genetic variation table in Gramene" (27 views, 1 year ago), "12 - Gene variation image in Gramene" (43 views, 1 year ago), "11 - Explore radial tree views in Gramene" (30 views, 1 year ago), "10 - Genomic Region Comparison view in Gramene" (35 views, 1 year ago), and "09 - Gramene Synteny Maps" (99 views, 1 year ago).

 Follow @GrameneDatabase



Acknowledgements



Ware Lab 2024



AgBioData Booth #406



5 Posters

- #700-52 - rsIDs
- #700-59 - GRAS TFs
- #900-22 - NUE
- #900-52 - Gramene
- #900-61 - SorghumBase



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