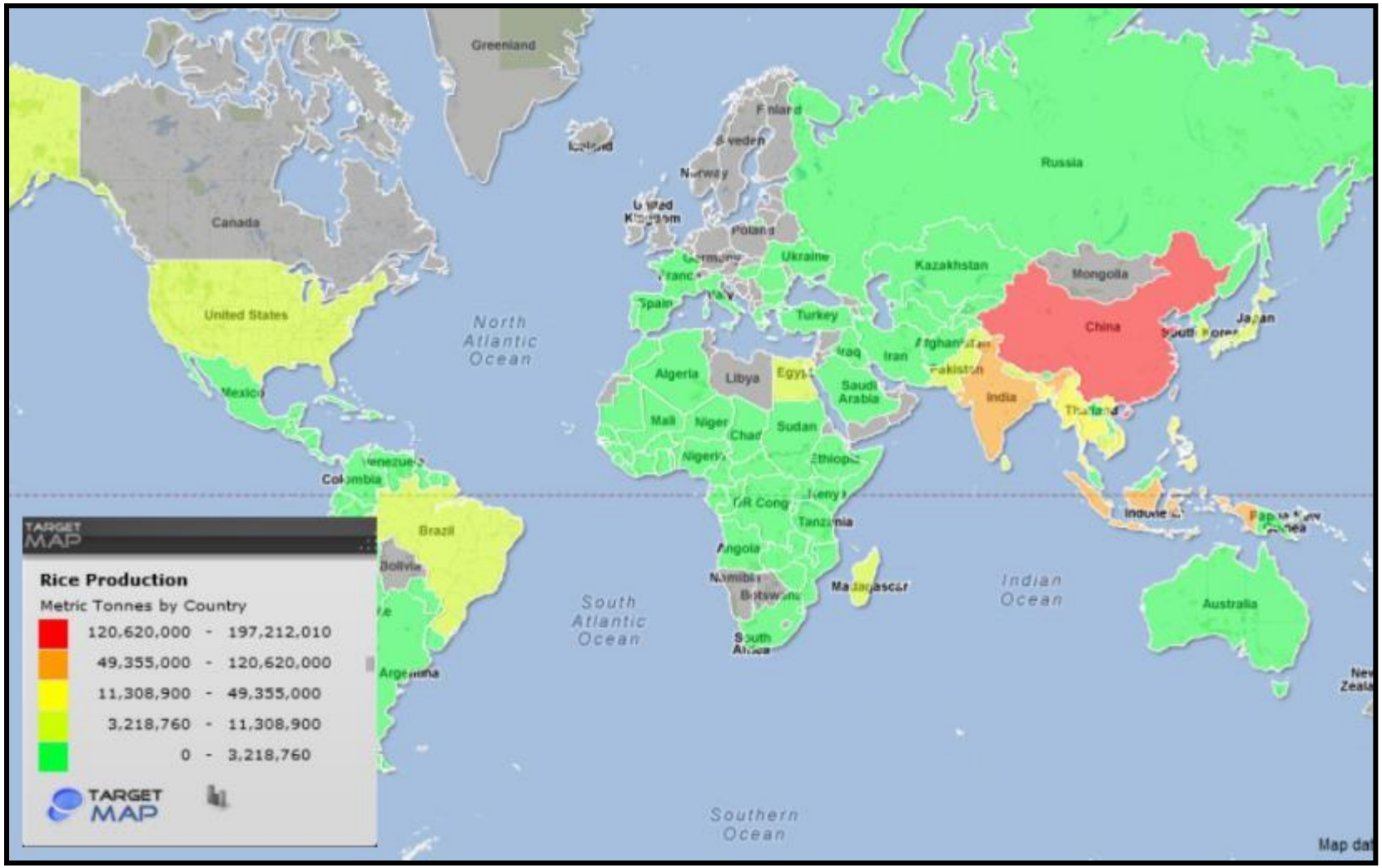
Dale Bumpers National Rice Research Center

USDA

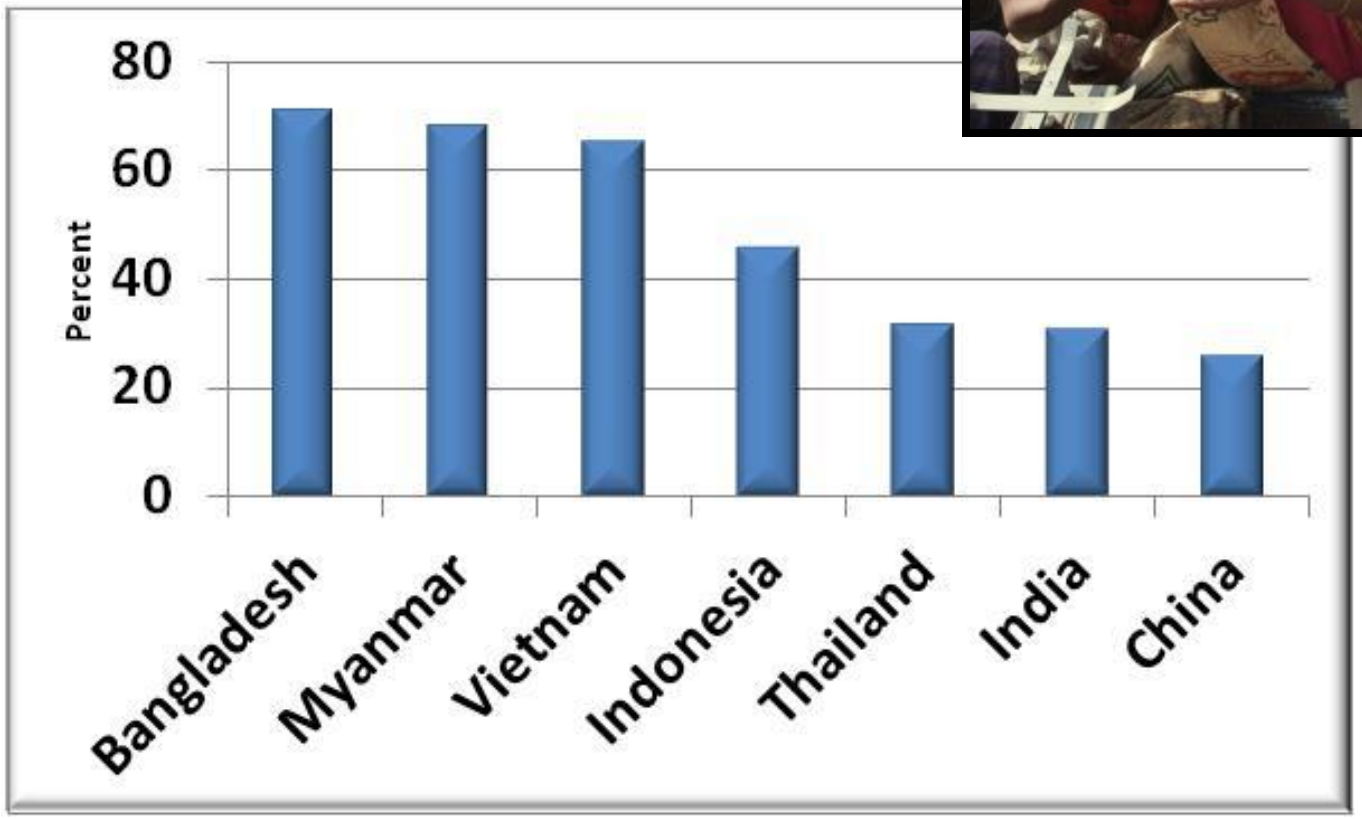
Agricultural Research Service

Stuttgart, AR

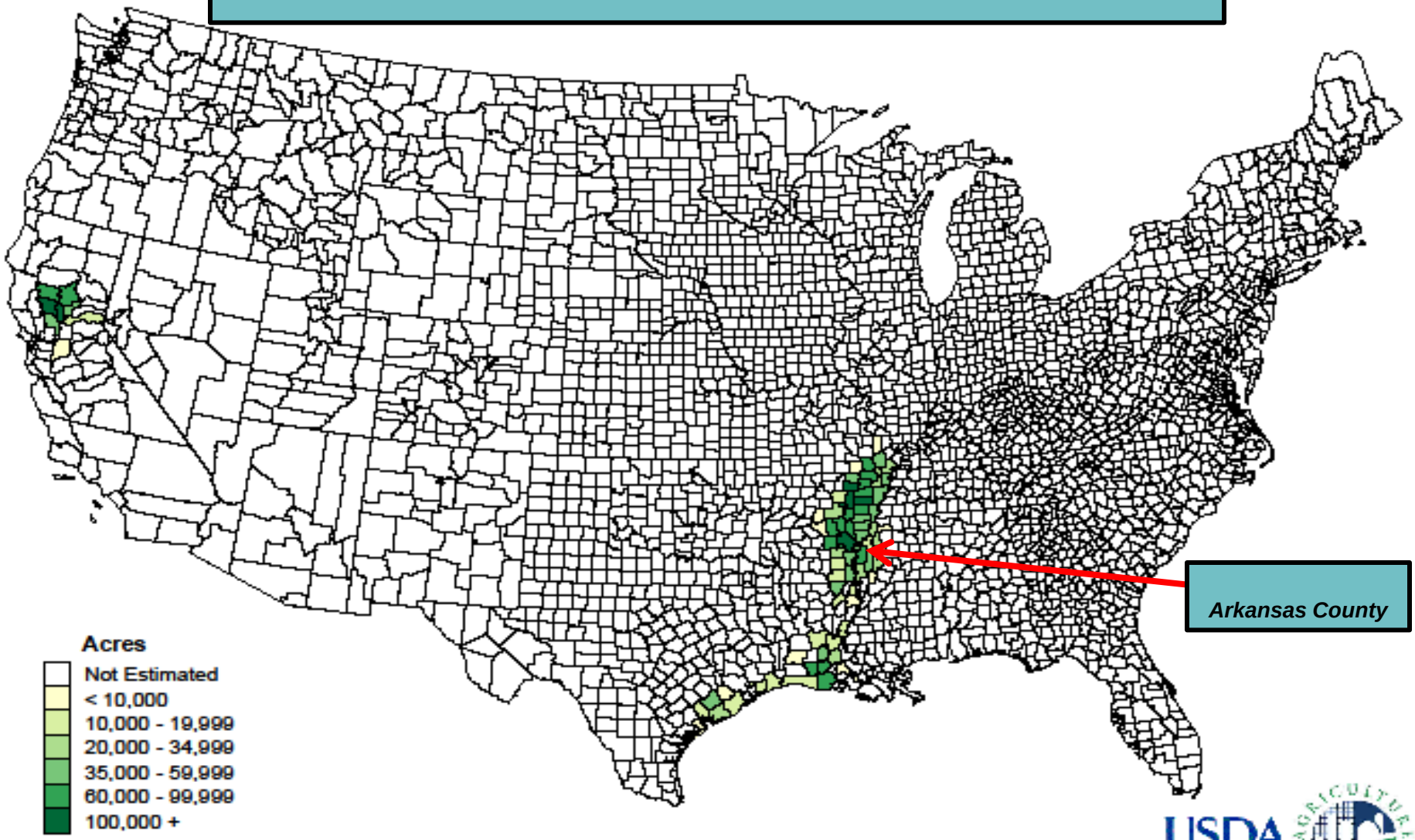
Rice Is Produced All Over the World



Percent of Daily Calorie Consumption Coming From Rice



Where Rice is Produced in the United States



U.S. Department of Agriculture, National Agricultural Statistics Service

Arkansas is Famous for Its Rice Production

DBNRRC is Responsible for Maintaining the USDA Rice World Collection – 18,000+ Cultivars From Around the World

USDA ARS United States Department Of Agriculture Agricultural Research Service

Germplasm Resources Information Network

ARS Home | About ARS | Help | Contact Us

Email this page

Search

Enter Keywords Go

Advanced Search

Browse By Subject

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

National Plant Germplasm System

NPGS is a cooperative effort by public (State and Federal) and private organizations to preserve the genetic diversity of plants.

The world's food supply is based on intensive agriculture, which relies on genetic uniformity. But this uniformity increases crop vulnerability to pests and stresses.

Scientists must have access to genetic diversity to help bring forth new varieties that can resist pests, diseases, and environmental stresses. The NPGS aids the scientists and the need for genetic diversity by:

- acquiring crop germplasm
- preserving crop germplasm
- evaluating crop germplasm
- documenting crop germplasm
- distributing crop germplasm

Internet 100%

Agronomic Characterization of USDA World Rice Collection

Most Commercial Rice Varieties Have Brown Colored Bran but There are Other Bran Colors in the World Collection


Seed of the World Rice Collection is Produced and Distributed to National and International Researchers
2007 9

Rondo a rice variety developed by USDA ARS has resistance to all biotypes of blast disease found in the USA.

New Sources of Blast Disease Resistance Have Been Found in the World Rice Collection

Straighthead is a physiological disease that causes the seedhead to be sterile

USA Cultivar Cocodrie - Susceptible

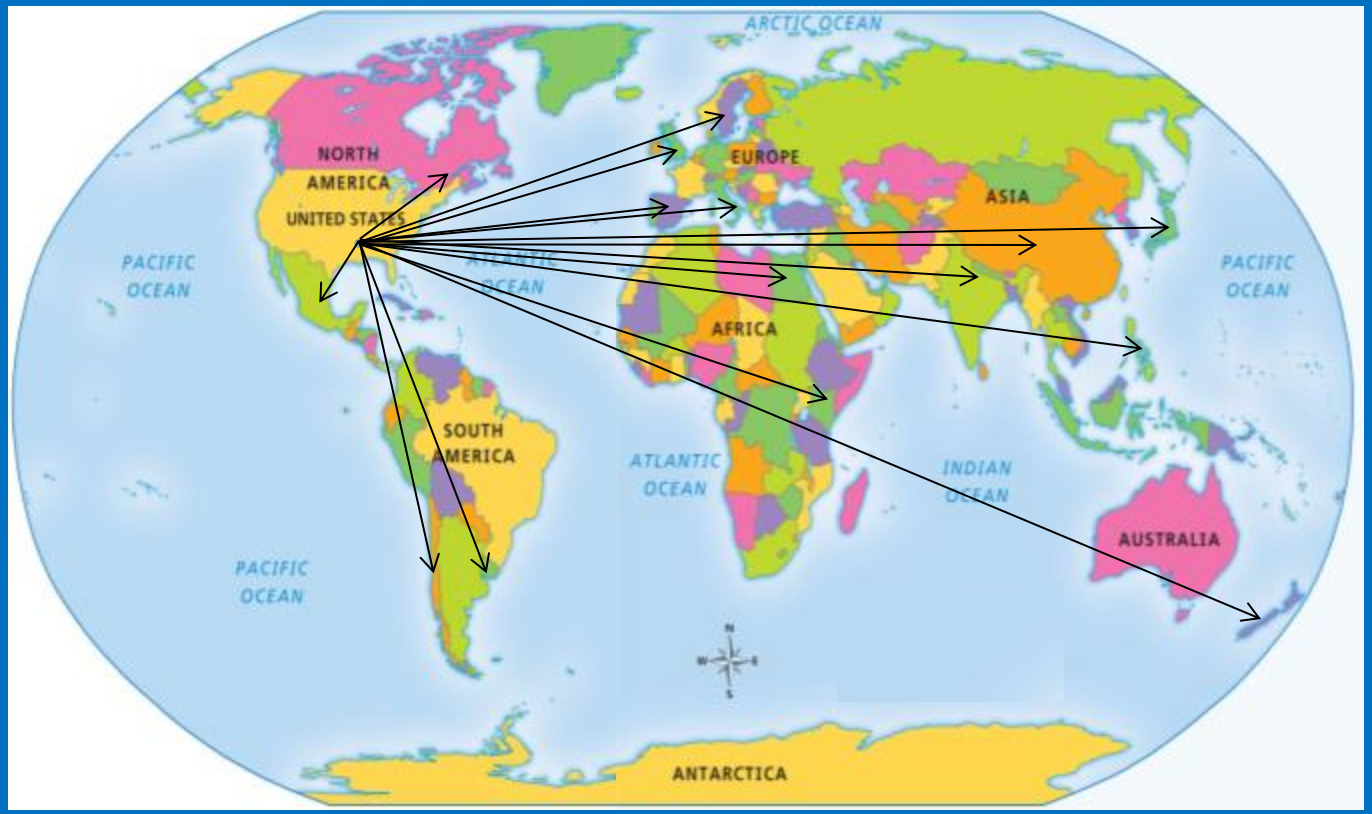
Jing 185 Cultivar from China - Resistant

Genetic Stocks *Oryza* (GSOR) Collection

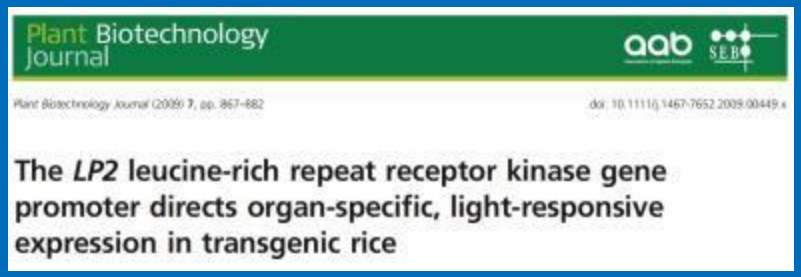
A collection of over 36,000 rice accessions used in genetic studies.

Genetic Stock-*Oryza* (GSOR) Collection

Since 2004, we have distributed over 40,000 rice genetic stocks to researchers around the world.



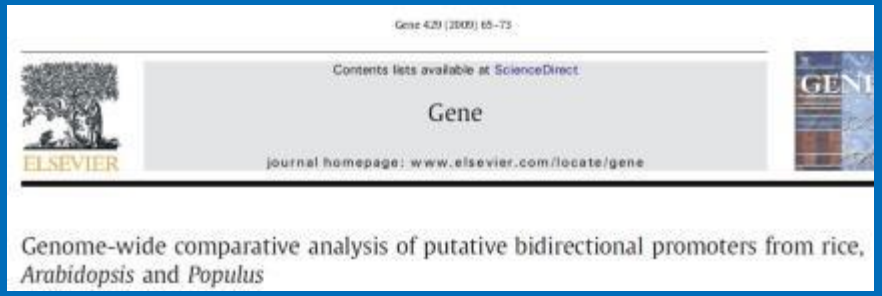
Rice genetic stocks provided by GSOR have been used in research published in many scientific journal articles.


Plant Biotechnology Journal

aab SEB

Plant Biotechnology Journal (2009) 7, pp. 867–882 doi: 10.1111/j.1467-7652.2009.00449.x

The *LP2* leucine-rich repeat receptor kinase gene promoter directs organ-specific, light-responsive expression in transgenic rice


Gene 429 (2009) 65–73

Contents lists available at ScienceDirect

Gene

journal homepage: www.elsevier.com/locate/gene

ELSEVIER

Genome-wide comparative analysis of putative bidirectional promoters from rice, *Arabidopsis* and *Populus*


Molecular Plant Advance Access published February 10, 2011

Molecular Plant • Pages 1–9, 2011 REVIEW ARTICLE

The Oligopeptide Transporters: A Small Gene Family with a Diverse Group of Substrates and Functions?


the plant journal

SEB Society for Experimental Biology

The Plant Journal (2012) 71, 750–762 doi: 10.1111/j.1365-313X.2012.05031.x

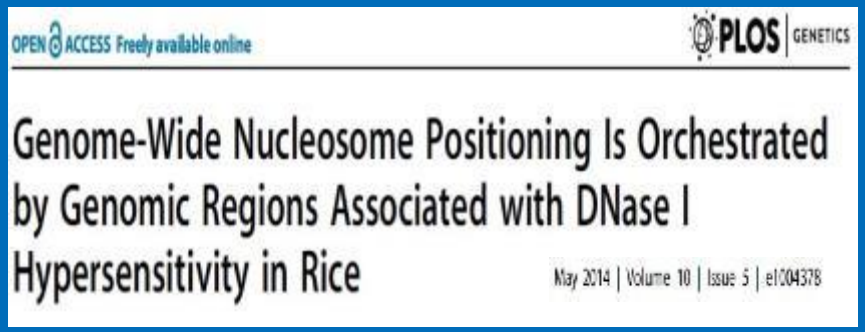
HKT2;2/1, a K^+-permeable transporter identified in a salt-tolerant rice cultivar through surveys of natural genetic polymorphism


Environmental Science & Technology

Article

dx.doi.org/10.1021/es301977w | Environ. Sci. Technol. 2012, 46, 12391–12398

Effect of Surface Charge on the Uptake and Distribution of Gold Nanoparticles in Four Plant Species


OPEN ACCESS Freely available online

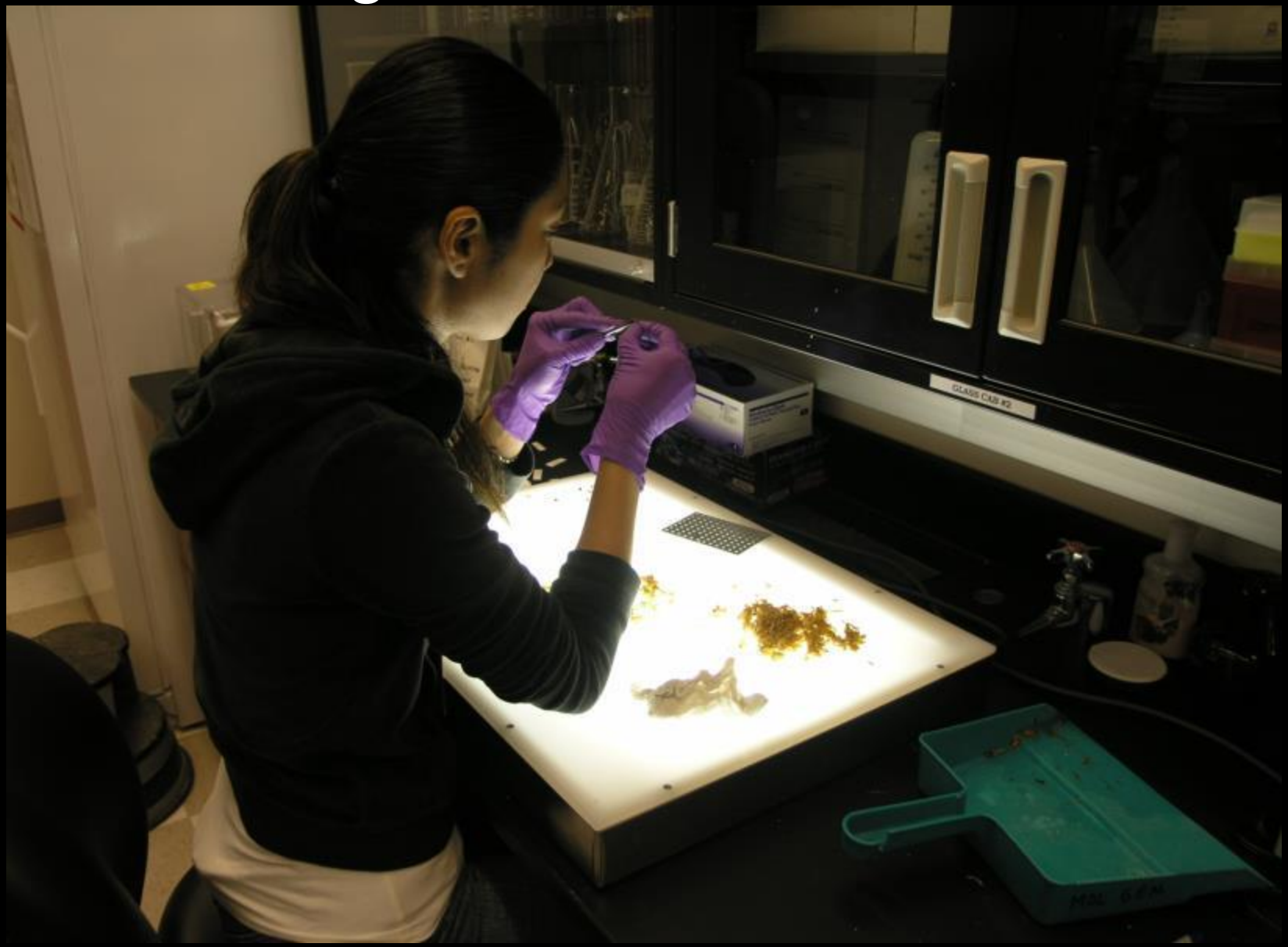
PLOS | GENETICS

Genome-Wide Nucleosome Positioning Is Orchestrated by Genomic Regions Associated with DNase I Hypersensitivity in Rice

May 2014 | Volume 10 | Issue 5 | e1004378

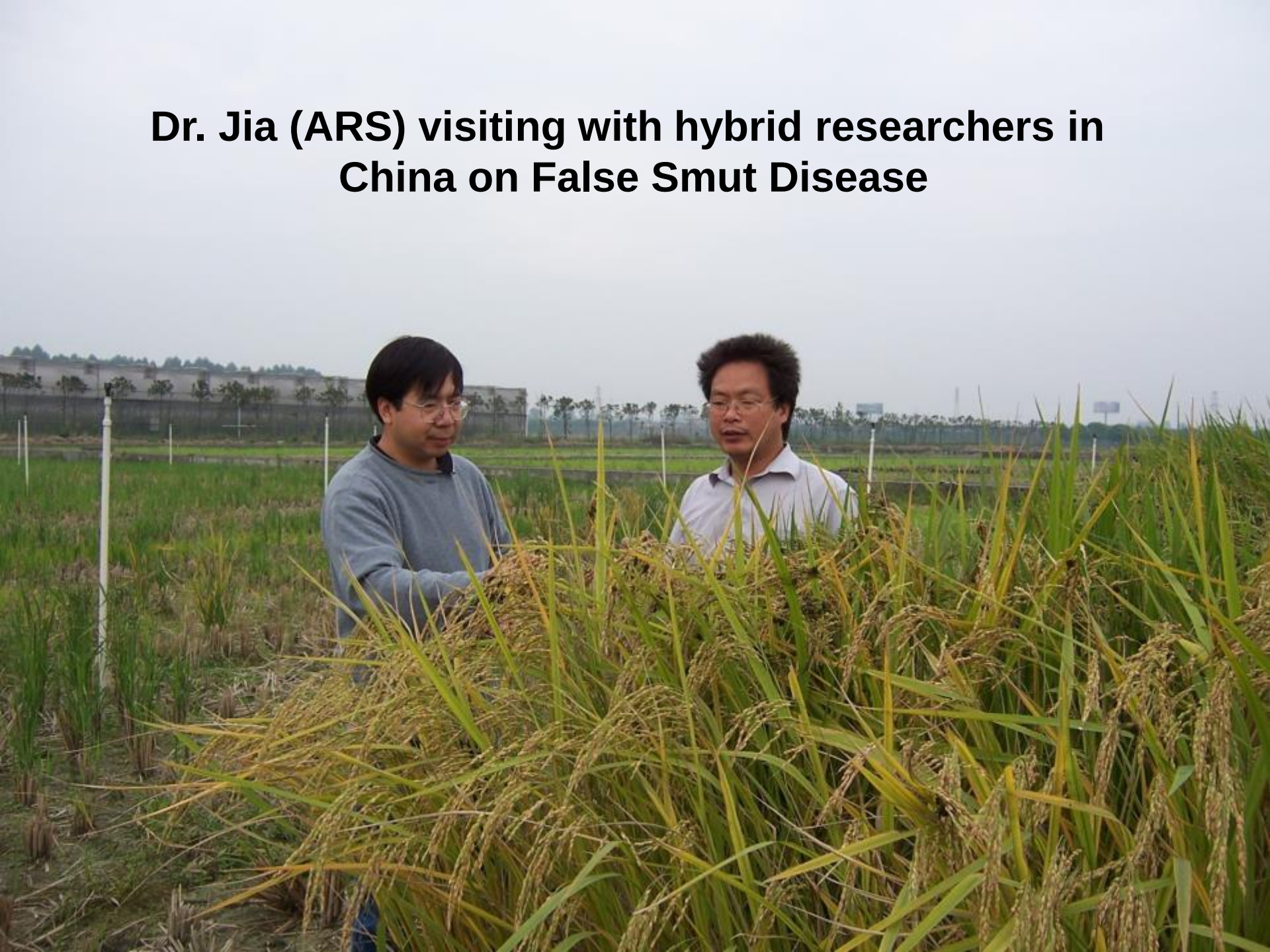
Kernel Smut – A Disease That Goes Undetected Until Its Too Late

Determining the Amount of Kernel Smut




False Smut
Affects Rice Yield and Quality

Dr. Jia (ARS) visiting with hybrid researchers in China on False Smut Disease

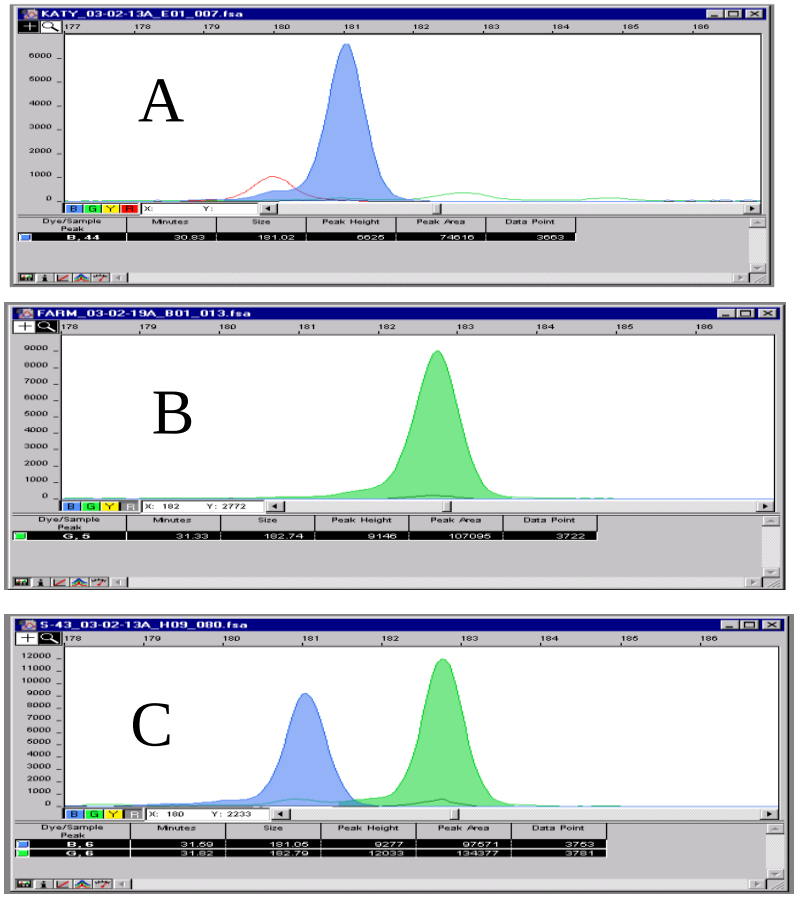


Experimental plot yield trials to identify high-yielding genetic lines from the World Collection

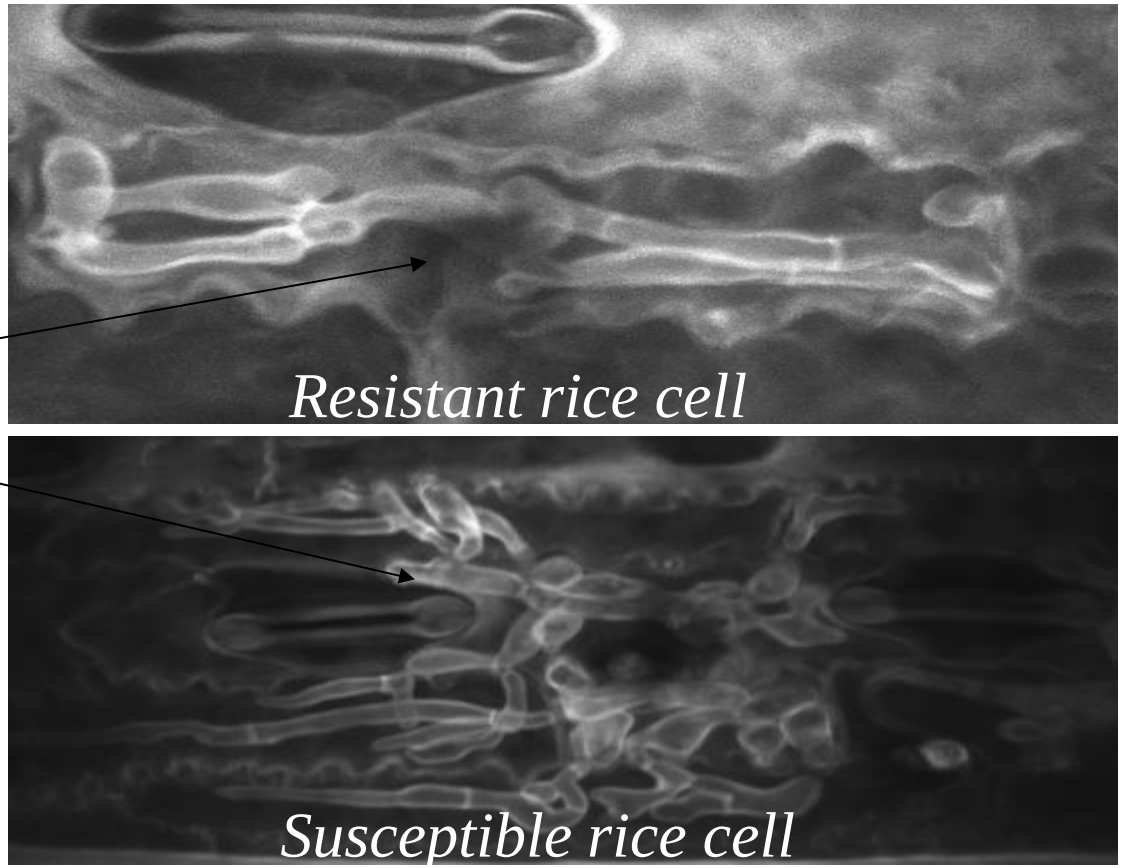
Blast is a serious disease in rice growing areas worldwide. The *Pi-ta* blast resistance gene in rice plays a central role for protection of rice in the Southern US.

With Pi-ta resistance gene

Without Pi-ta resistance gene



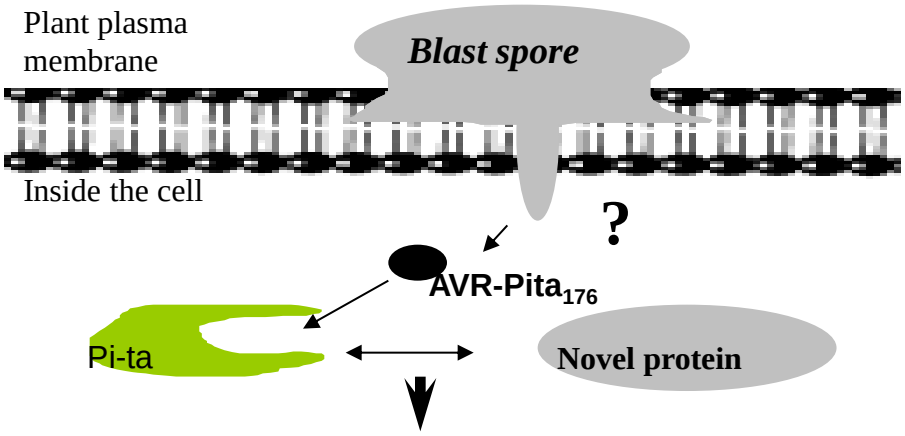
DNA marker analysis can help breeders introduce the resistance gene *Pi-ta* into their new cultivars. A. breeding line fixed for the *Pi-ta/Pi-ta* resistance gene, B. breeding line fixed for the susceptible gene *pi-ta/pi-ta* and C. breeding line still segregating for resistance and susceptibility.



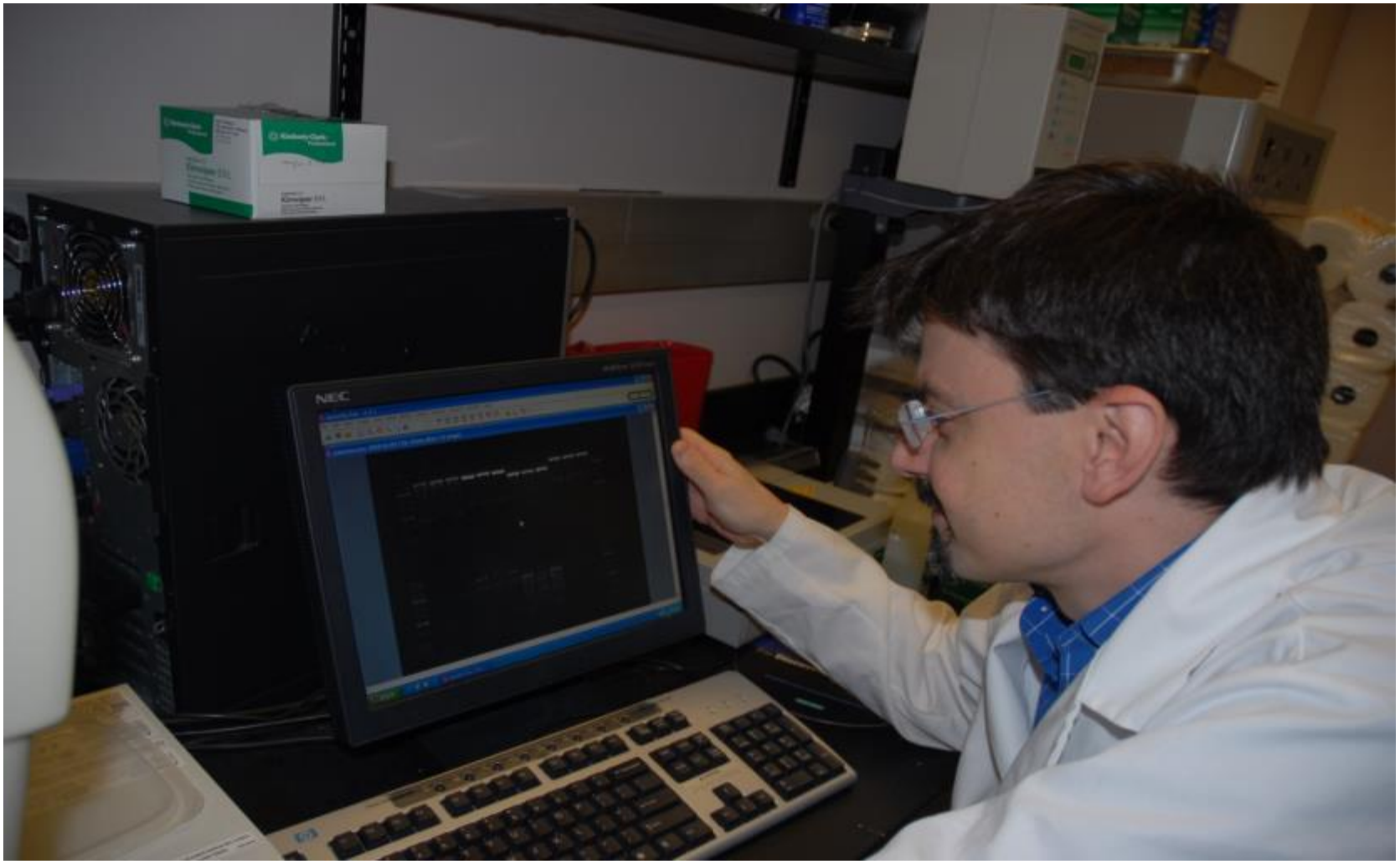
Recent studies show that the blast fungus can grow in resistant cells but without showing signs of disease. This shows growth of the blast pathogen in the rice leaves 36 hours after inoculation.

A detached leaf inoculation method is used to examine resistance to the rice blast pathogen. A spore suspension is used to inoculate a detached leaf (left) and response to the disease is measured after a few days. This method differentiates resistant from susceptible plants.

A working model of *Pi-ta* gene mediated blast resistance



The blast spore introduces an elicitor into the plant cell that binds with a protein produced by the plant's *Pi-ta* resistance gene. This activates a defense response by the plant.



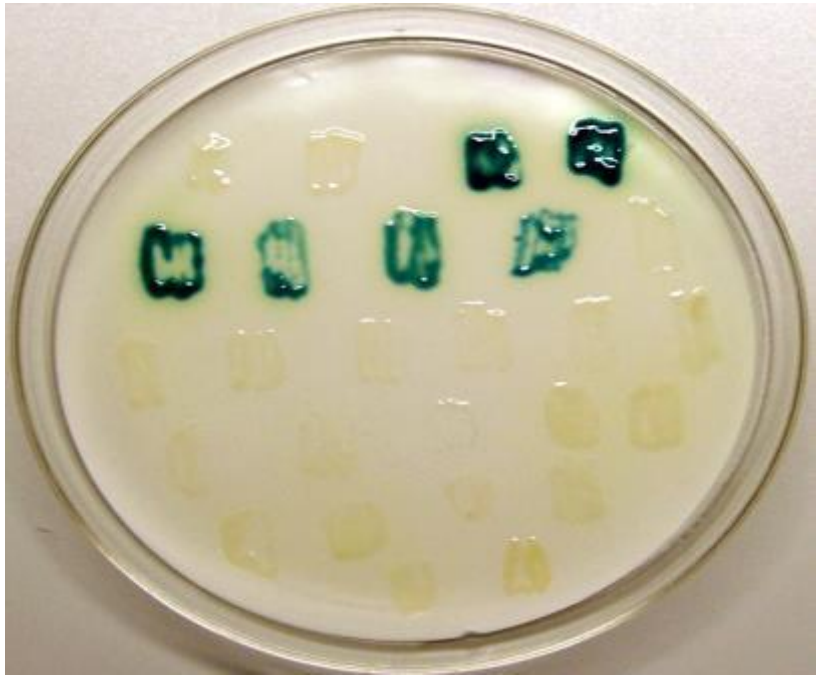
Research Associate Dr. Stefano Costanzo analyzes DNA fragments to determine the function of different proteins produced by a single gene in rice.

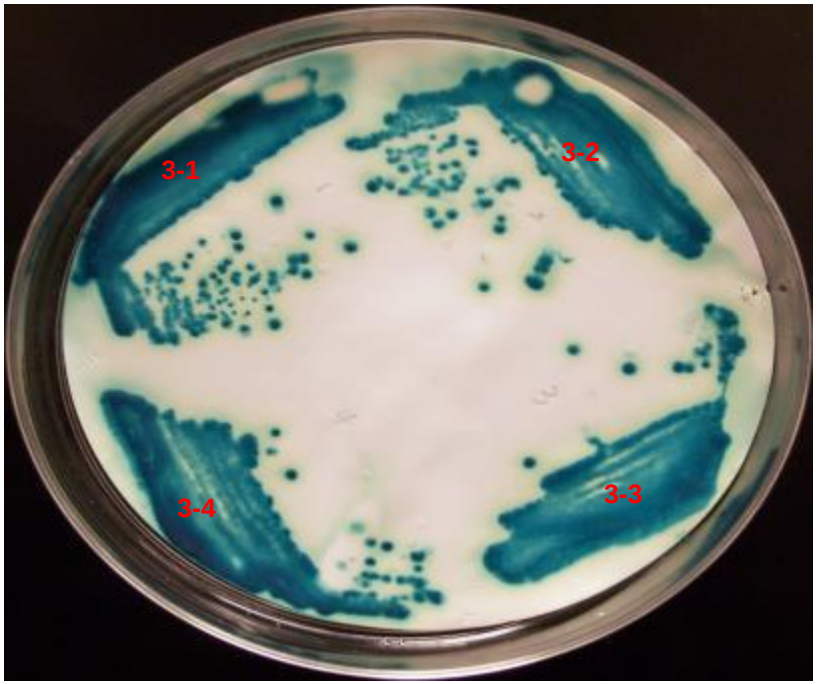
Dr. Yulin Jia, Molecular Plant Pathologist, developed 20,000 random mutant lines from an adapted US long grain cultivar Katy to determine the function various genes.

Biological Science Lab Technician Michael Lin evaluates resistance of rice after the plants were treated with the blast pathogen in a greenhouse.

Summer student Mr. Eli Eggerman loads DNA samples into a PCR machine for DNA amplification to study mechanisms of disease resistance.

Yeast has been used to identify important genes for the control of rice disease. Positive interacting proteins are blue, negatives are white.

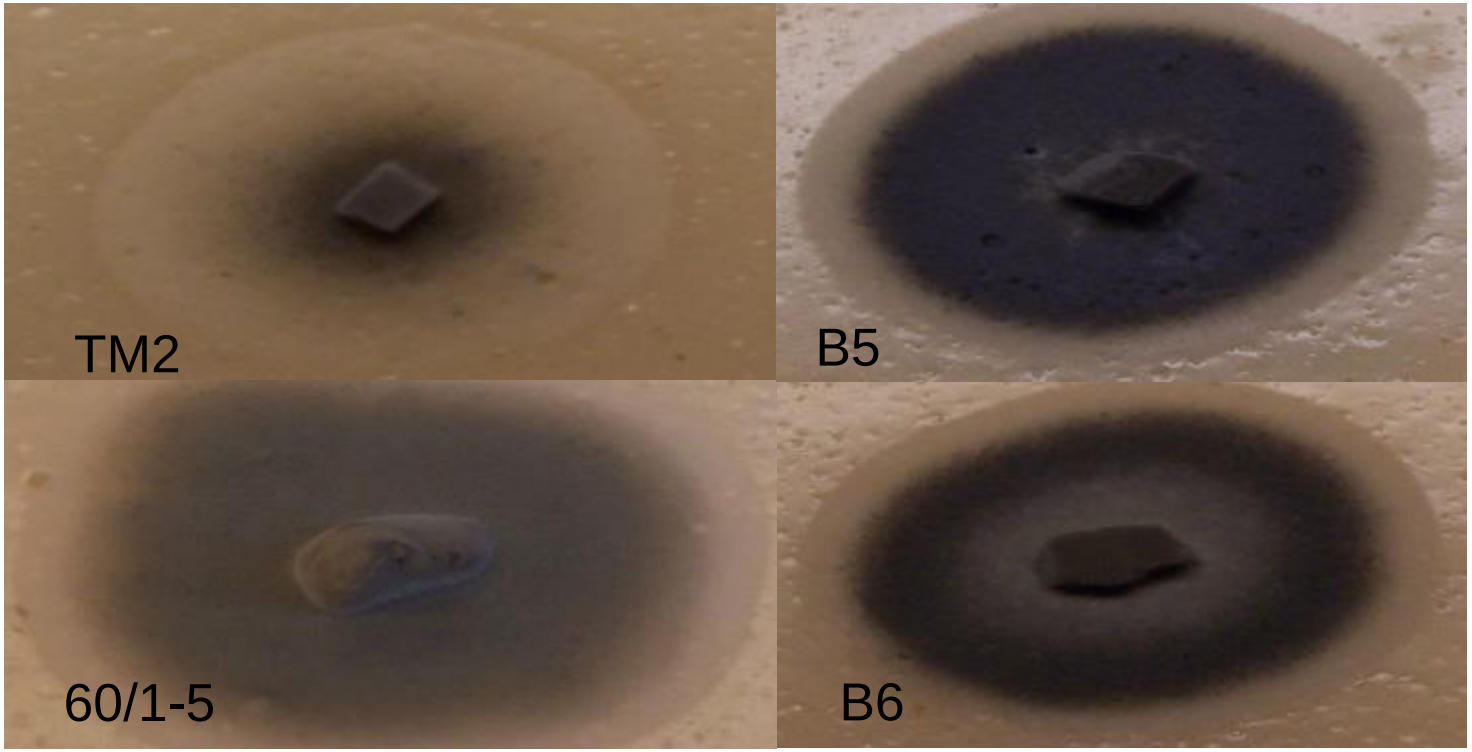




DNA sequences are being used to study the evolutionary origin of red rice in the US – a possible source of new pest resistance genes

Red rice in the field

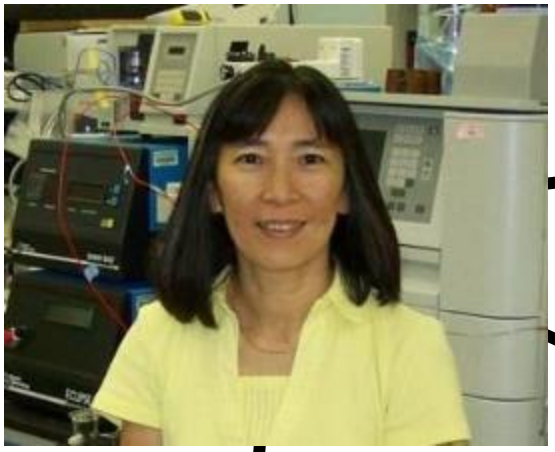
DNA sequence alignment



Diverse isolates of rice blast pathogen show different amounts of fungal growth after 5 days of culture

Research Projects on Grain Quality

Ming-Hsuan Chen heads the research on grain quality



Rice Grain Functional properties

Nutritional Properties

Storage stability of whole-grain

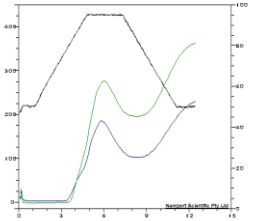
Rice Grain Quality

Cooked rice functional properties:

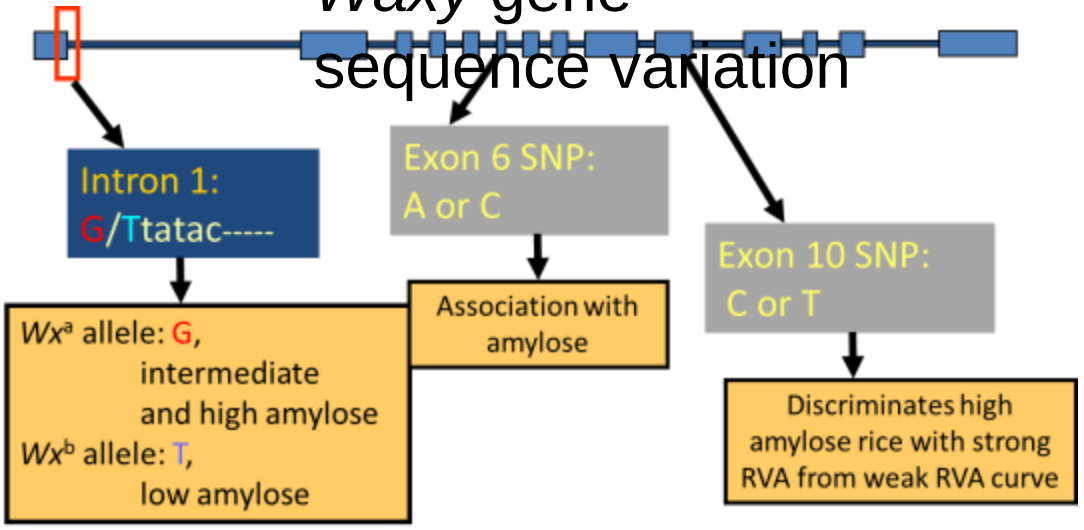
Texture

Amylose

Paste viscosity



Association *with* *Waxy* gene sequence variation

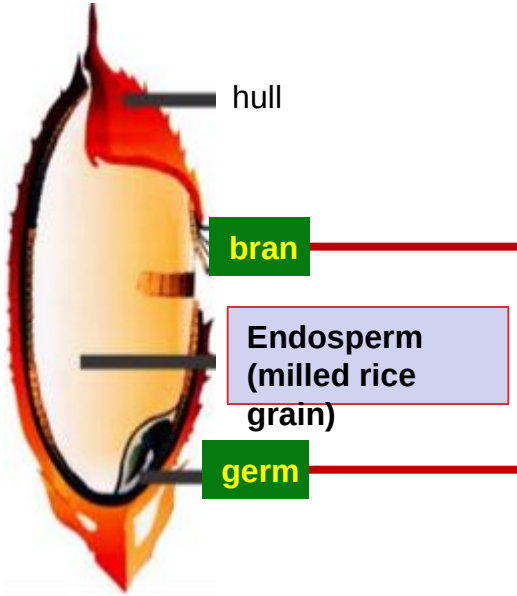


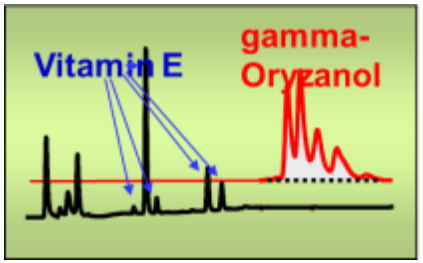
Rice grain image: http://www.mkmelite.com/agro.php

Rice Grain Quality

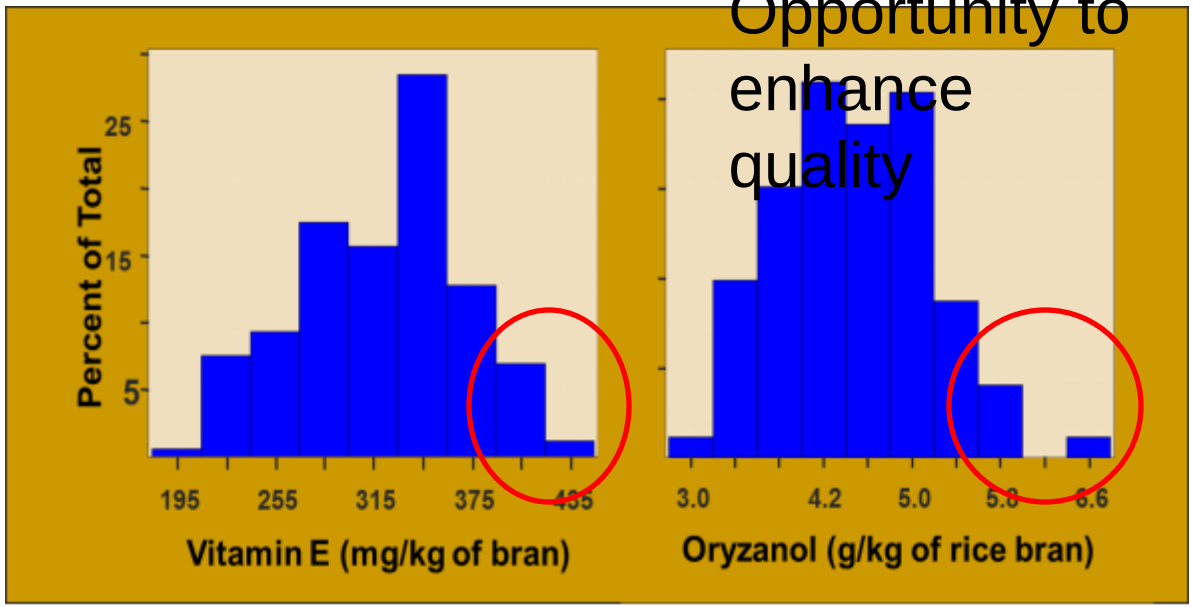
Nutritional properties:

- **Vitamin E compounds and oryzanol are antioxidants in whole grain rice and have health benefits.**



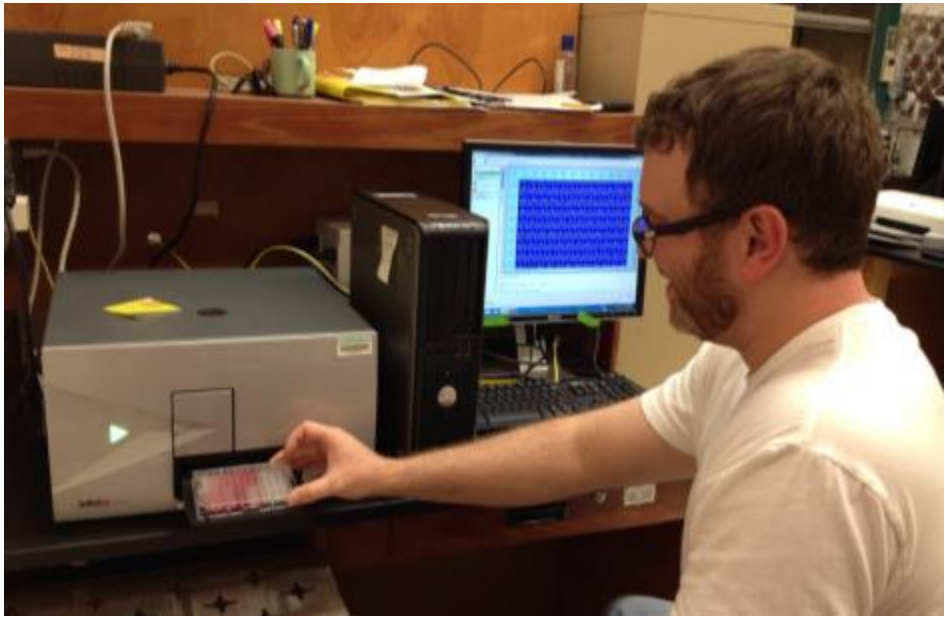


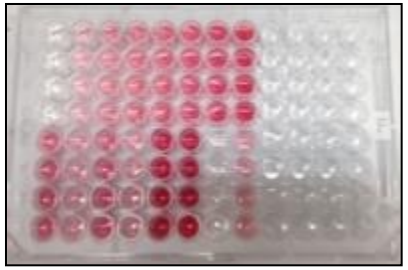
Rice varieties with high concentrations found: Opportunity to enhance quality



Bergman and Chen, 2006

Rice of Different Bran Color Varies in Polyphenol Contents and Antioxidant Capacity

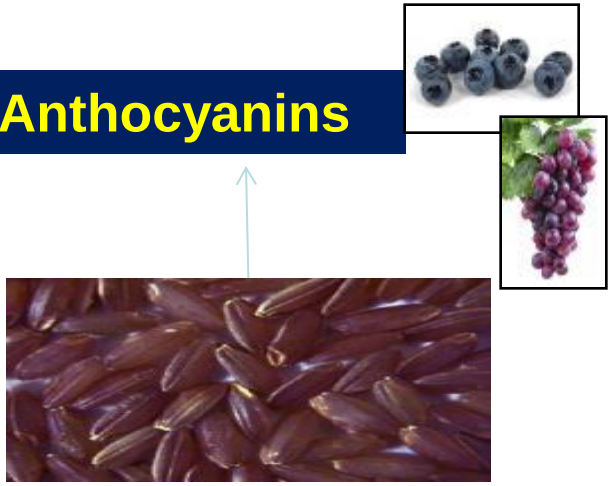


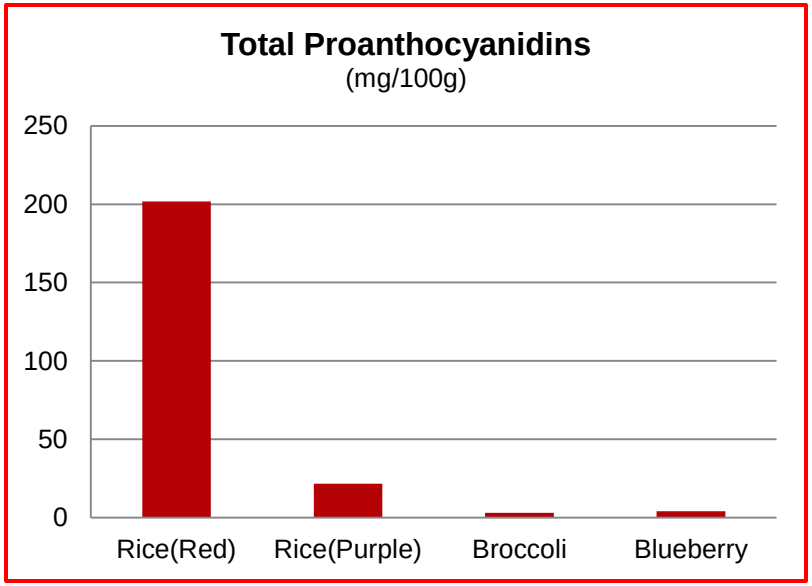


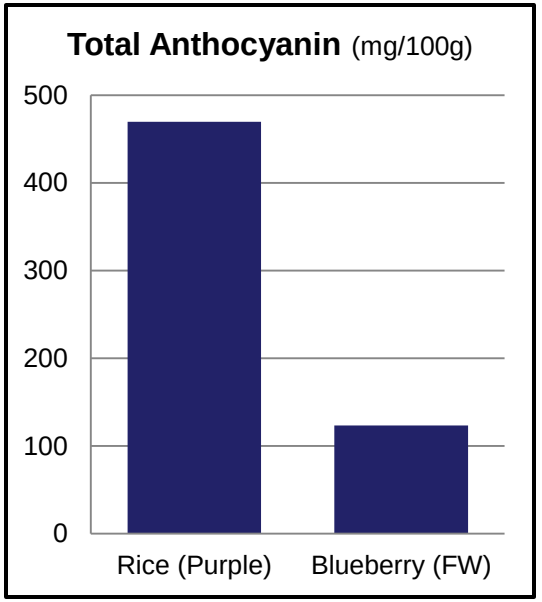
Pigmented Rice Contains Bioactive Compound

Proanthocyanidins

Anthocyanins







Cereal Chemist Rolfe Bryant leads the Stuttgart program identifying value-added grain traits.

Weighing rice flour samples to determine amylose content

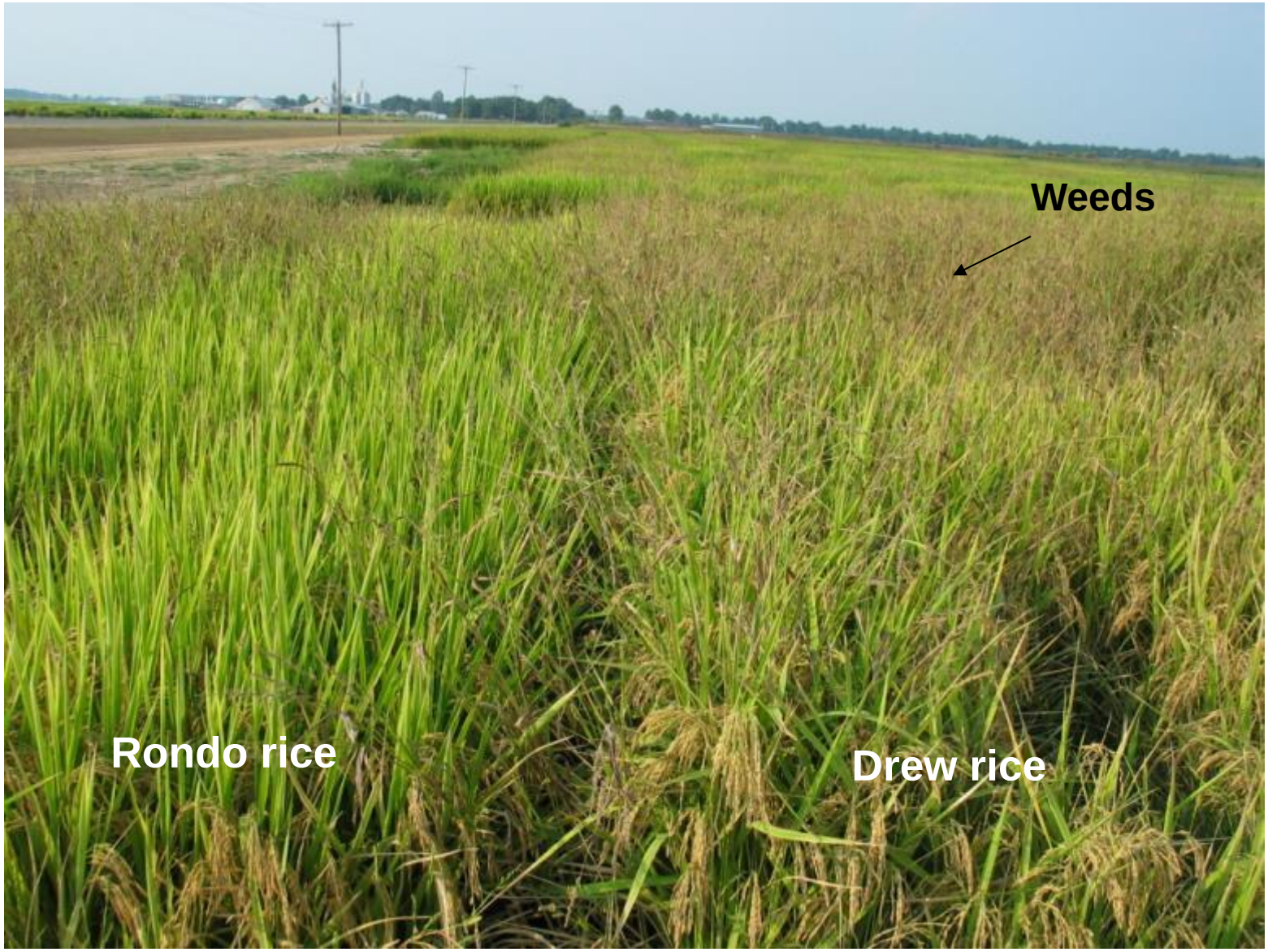
Amylose content determines the stickiness of rice.

Long grain rice usually has high amylose and it is less sticky, compared to short grain rice.

Isolating rice protein fractions.

Weed Physiology Group

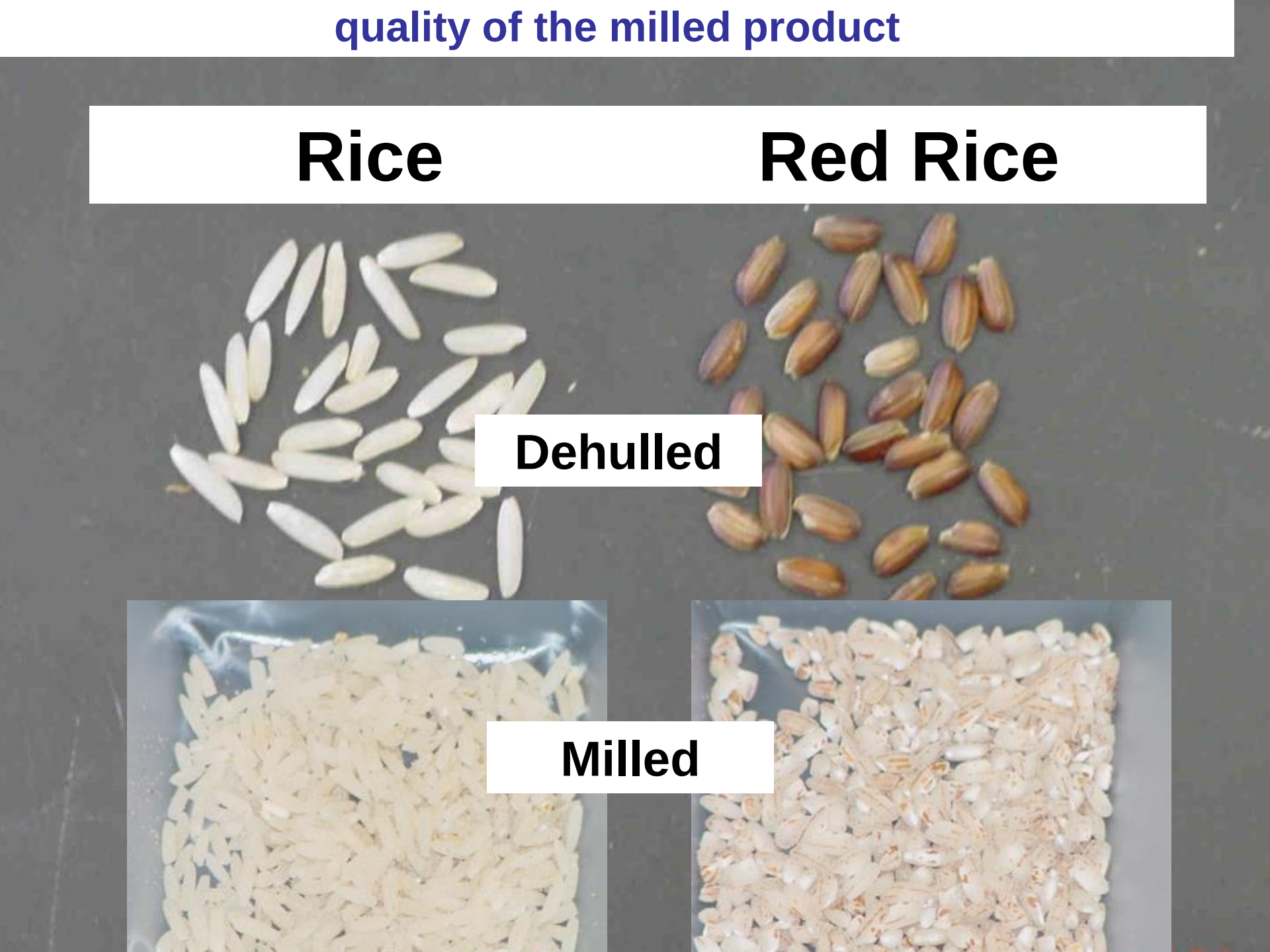
Identification of Cultivars that Naturally Suppress Barnyardgrass
Stuttgart, AR, 2007



David Gealy, Plant Physiologist

quality of the milled product

Rice	Red Rice

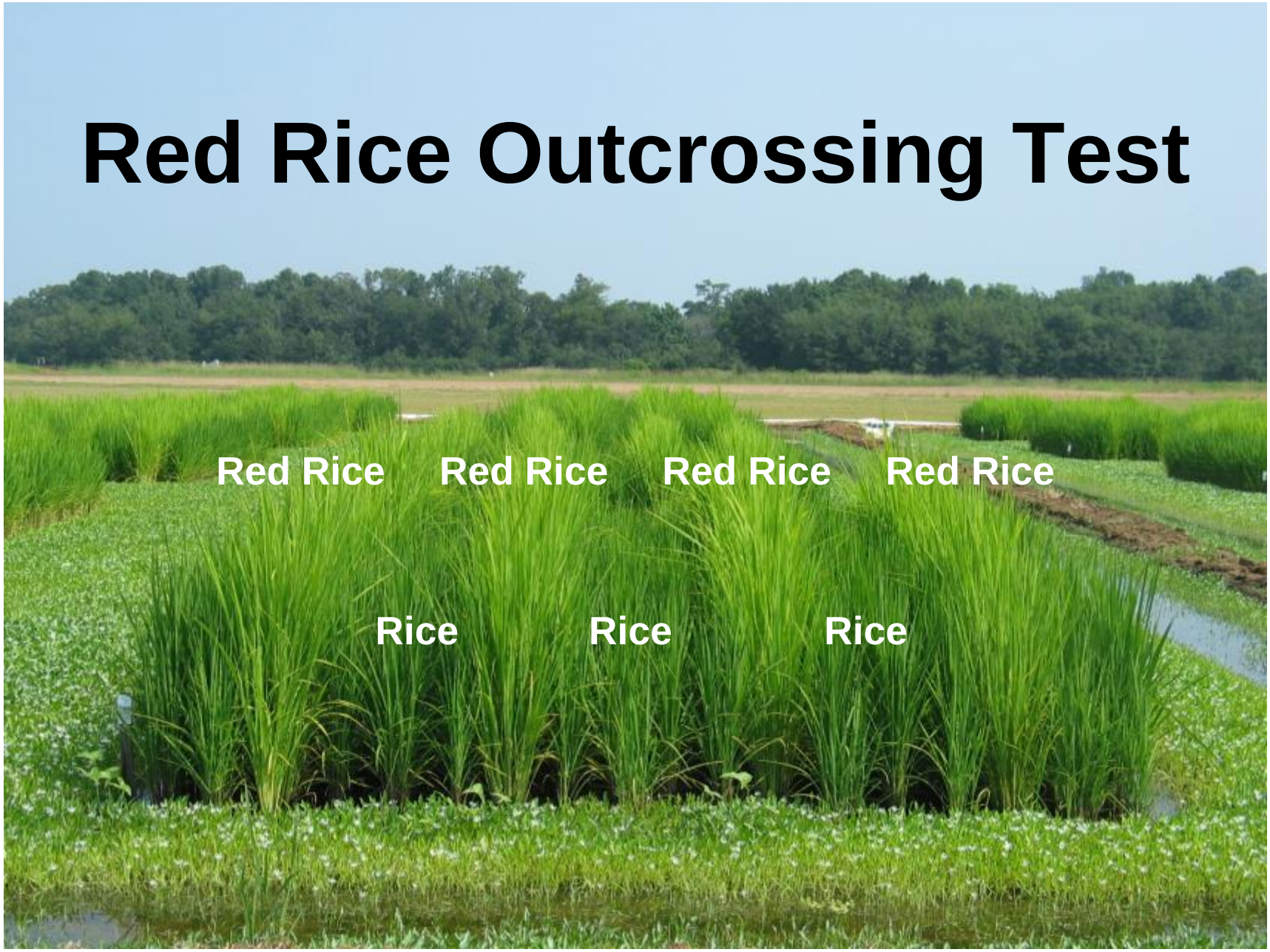


Identifying traits to distinguish outcrosses between cultivated and red rice

Pink-awned rice as a result of an outcross

Collecting Seed from Red Rice Biotypes

Red Rice Outcrossing Test

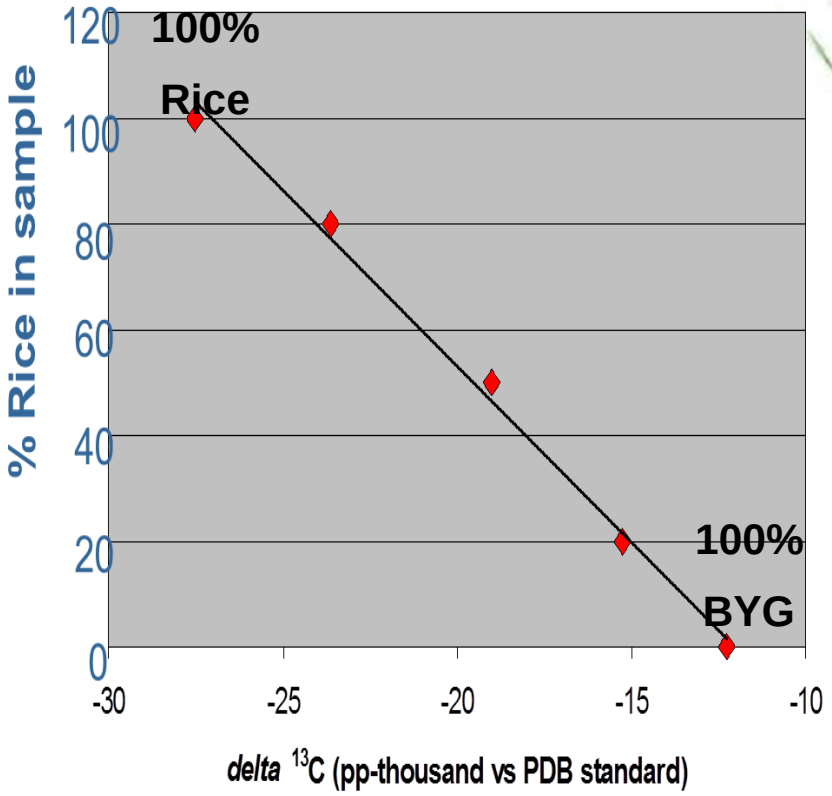


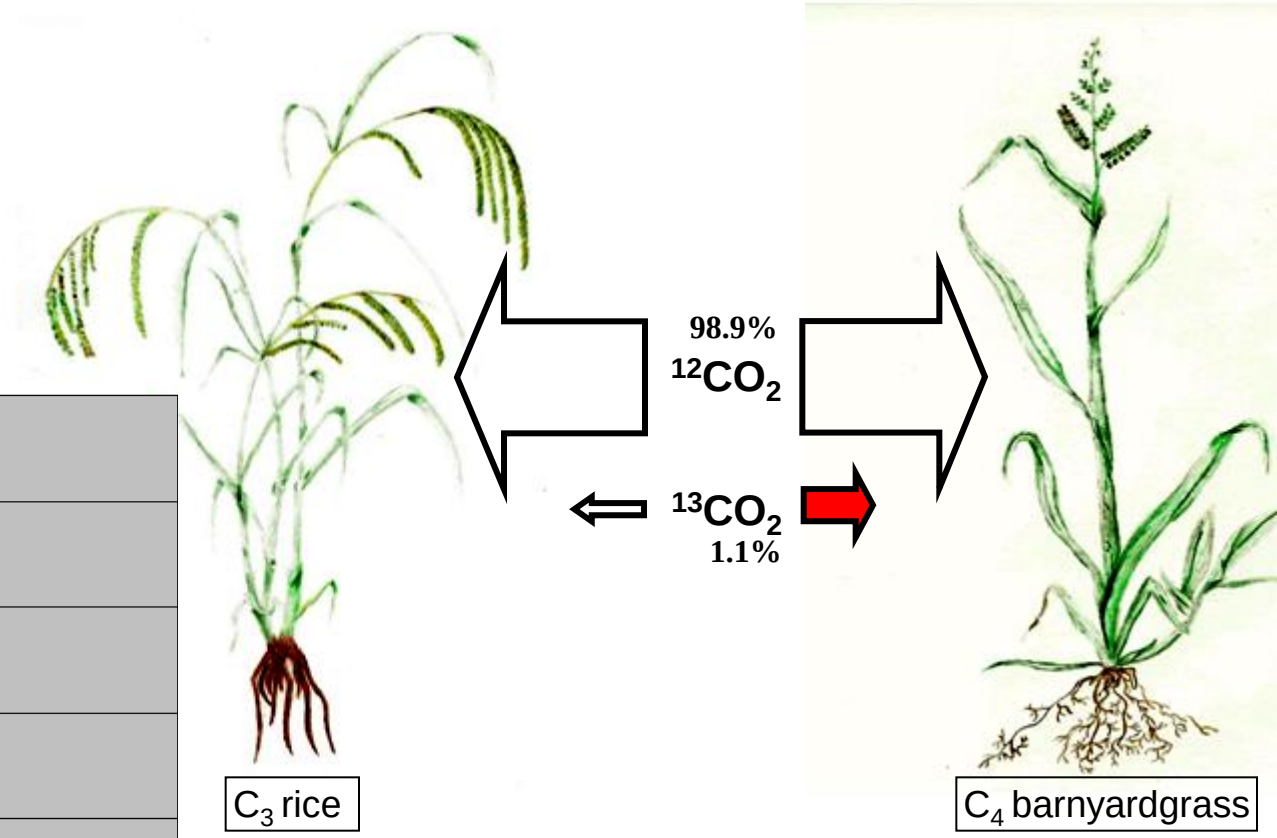
Strawhull red rice hybrid: matures late, green stem

Blackhull red rice hybrid: pink awns, red stem

Finding rice varieties with weed suppressive abilities (allelopathy)

C-13 Analysis can Measure Root Distribution of Weed and Rice Mixtures





Analysis with 'isotope ratio mass spectrometer'

Gealy and Fischer, 2010

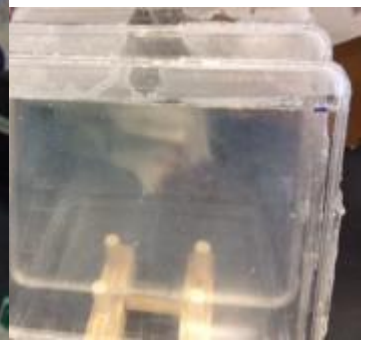
Adrian harvests leaf samples for DNA analysis

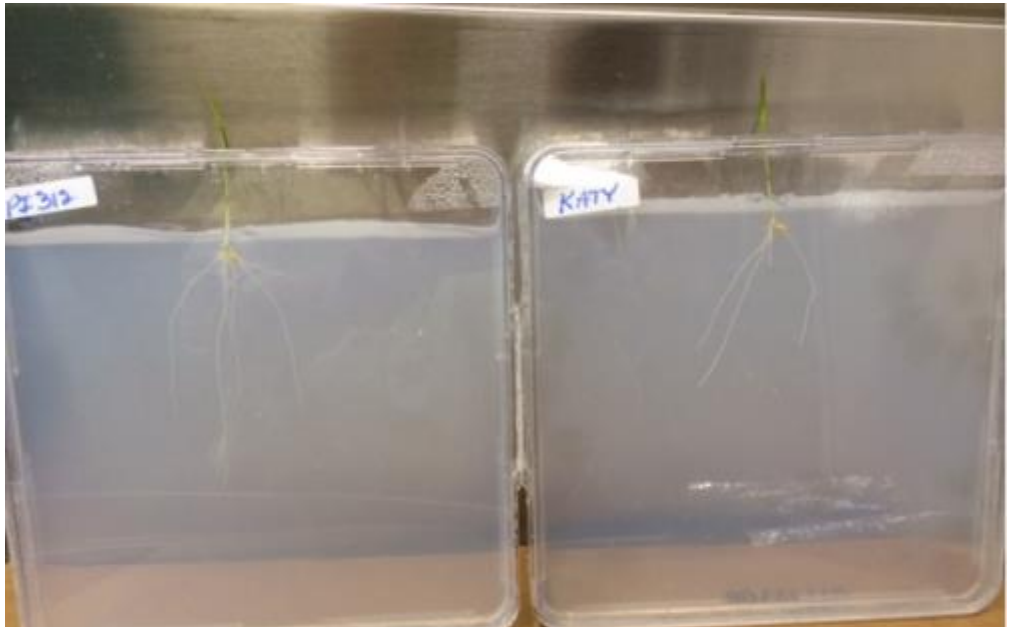
Angie prepares rice leaf samples for DNA extraction

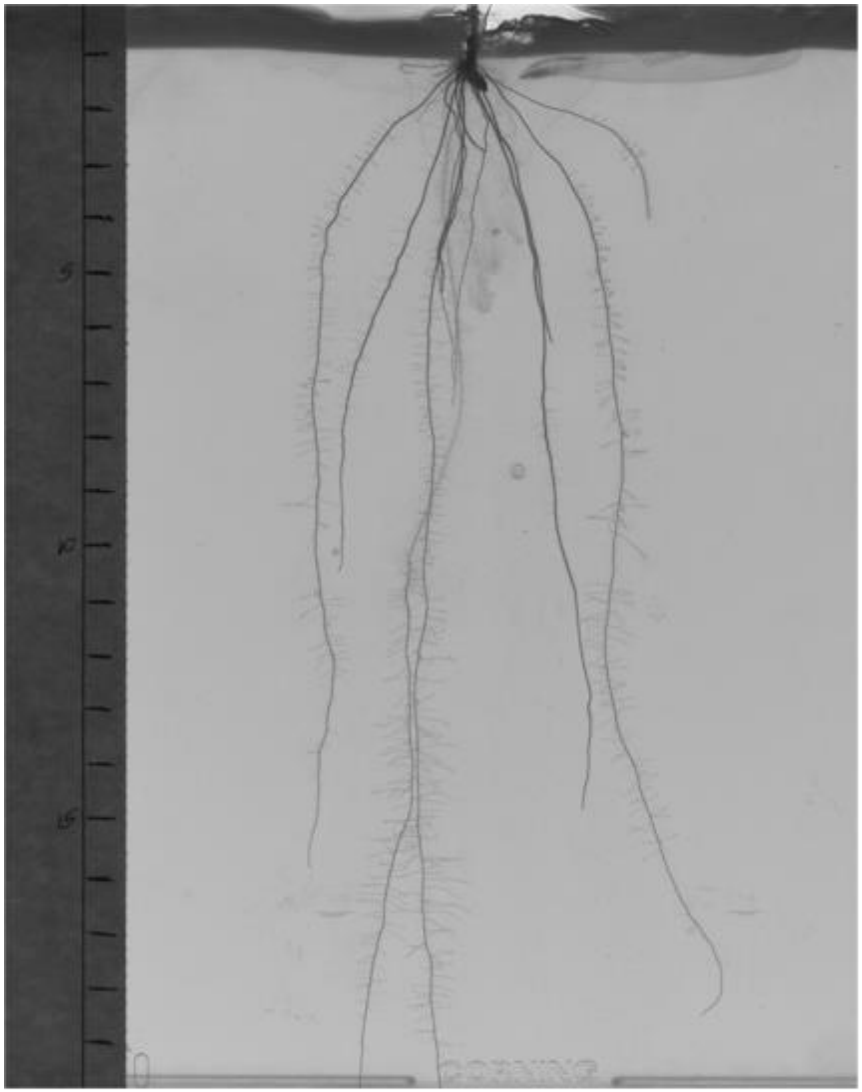
Adrian and Angie harvest rice leaves for DNA marker analysis


Bill Luebke and Howard Black pour agar for root development assays

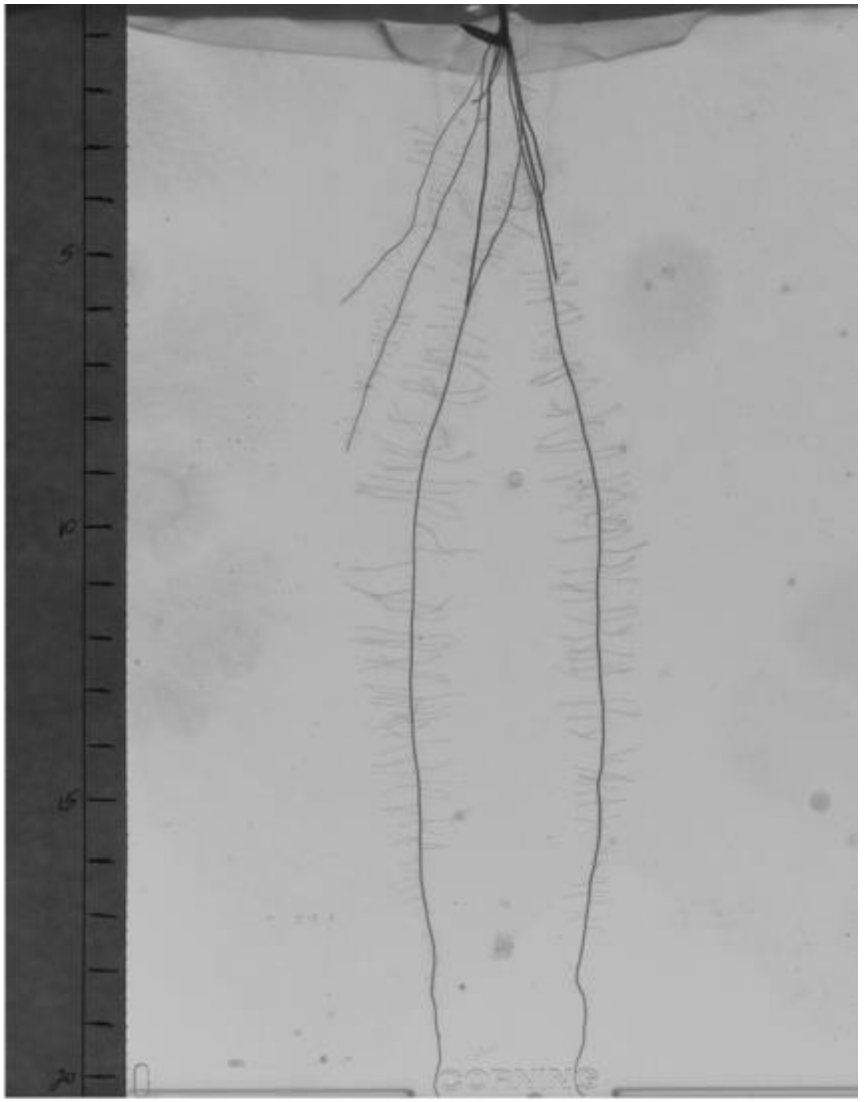
Evaluating competitive traits of rice roots in agar assays





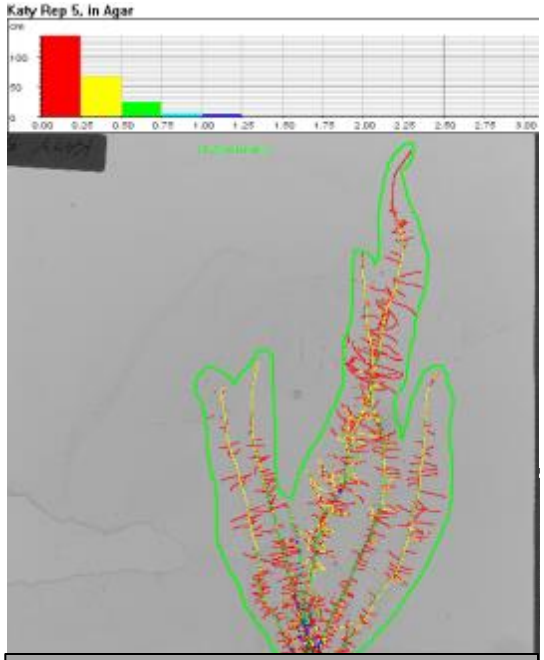


Extensive Root Growth of a Weed-suppressive Variety

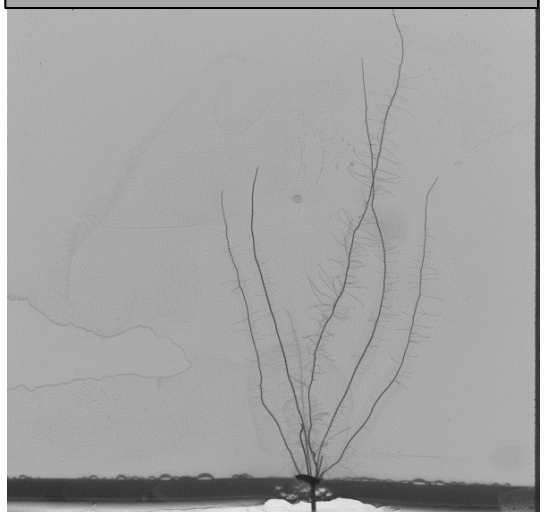


Typical Root Growth of a Non-suppressive Variety

Root Scans in Agar:

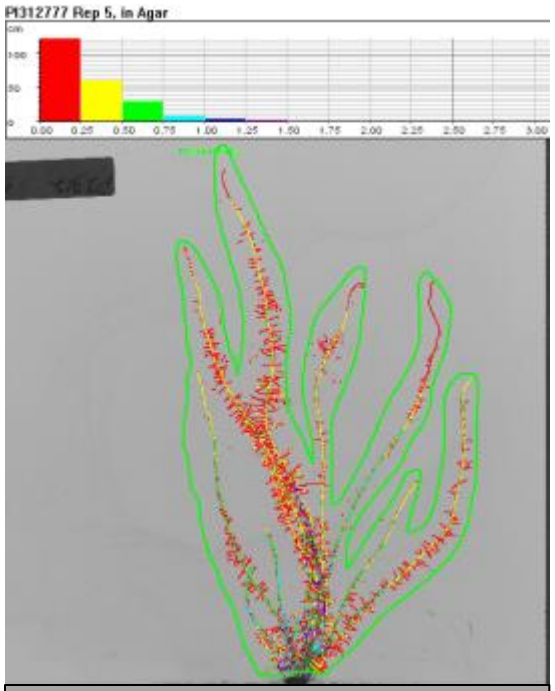


Katy

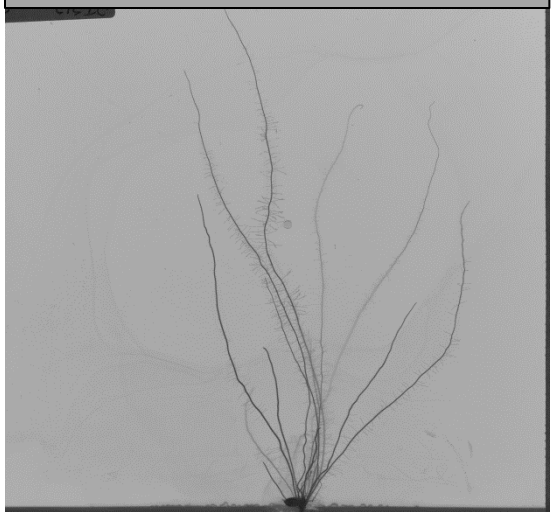


Root diameters grouped by color

Original scan



PI312777



Herbicide-Resistant Hybrid Red Rice Weeds From Arkansas Farms

Screening for Herbicide-Resistant Red Rice-Crop Rice Hybrids

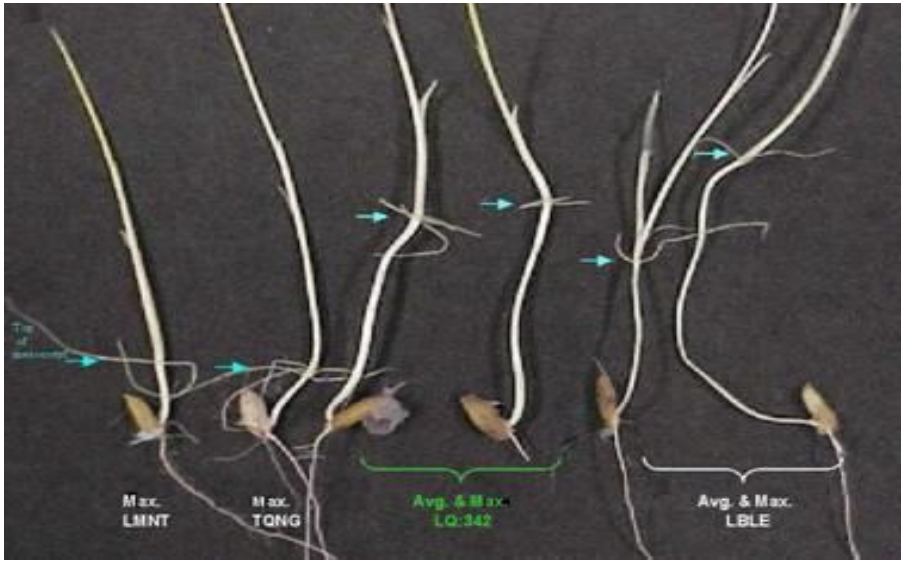
Red Rice-Crop Rice

Weedy Red Rice Infestation

Weedy Red Rice

Red Rice Weeds

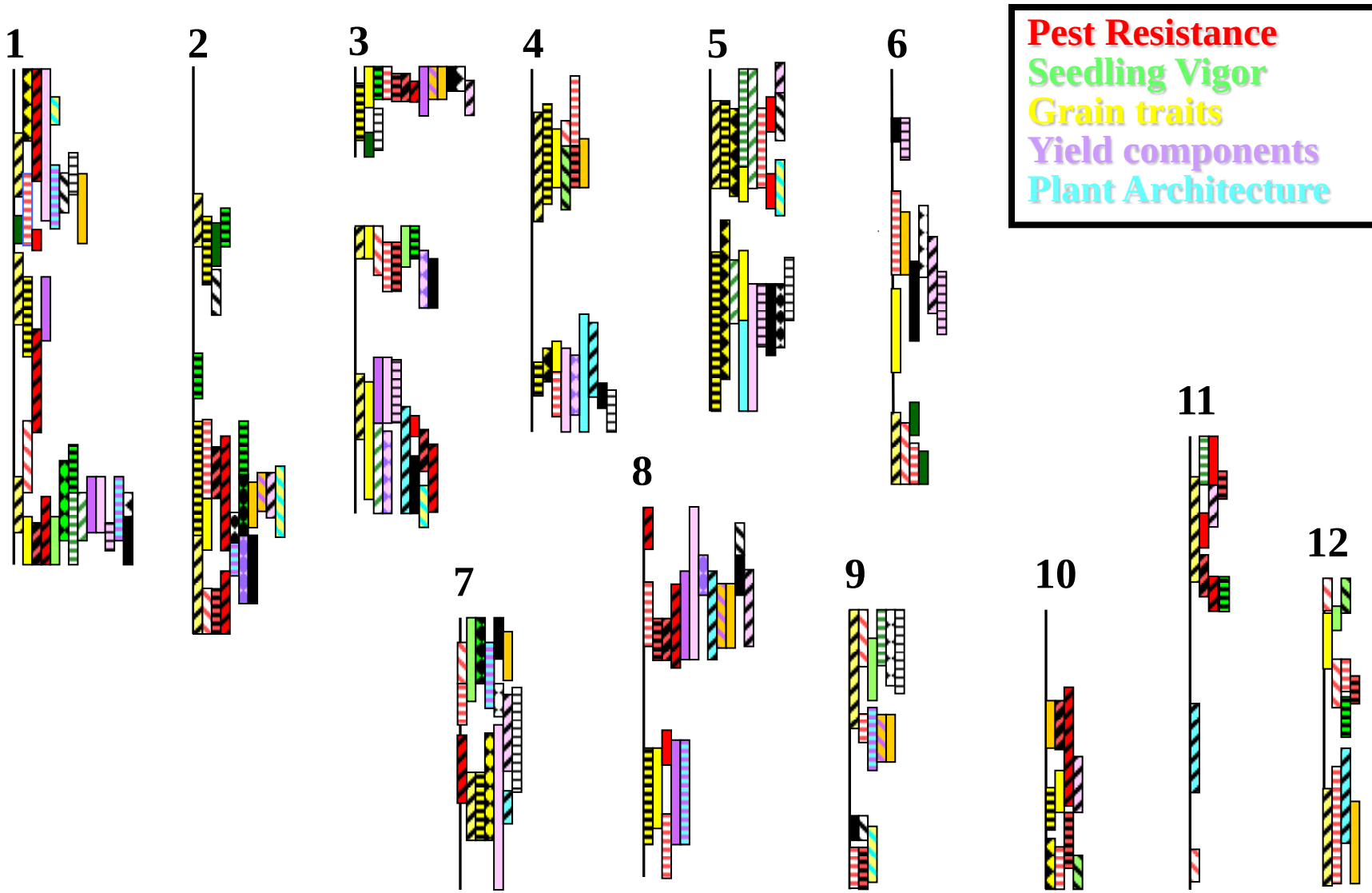
Increasing mesocotyl length enhances seedling vigor.



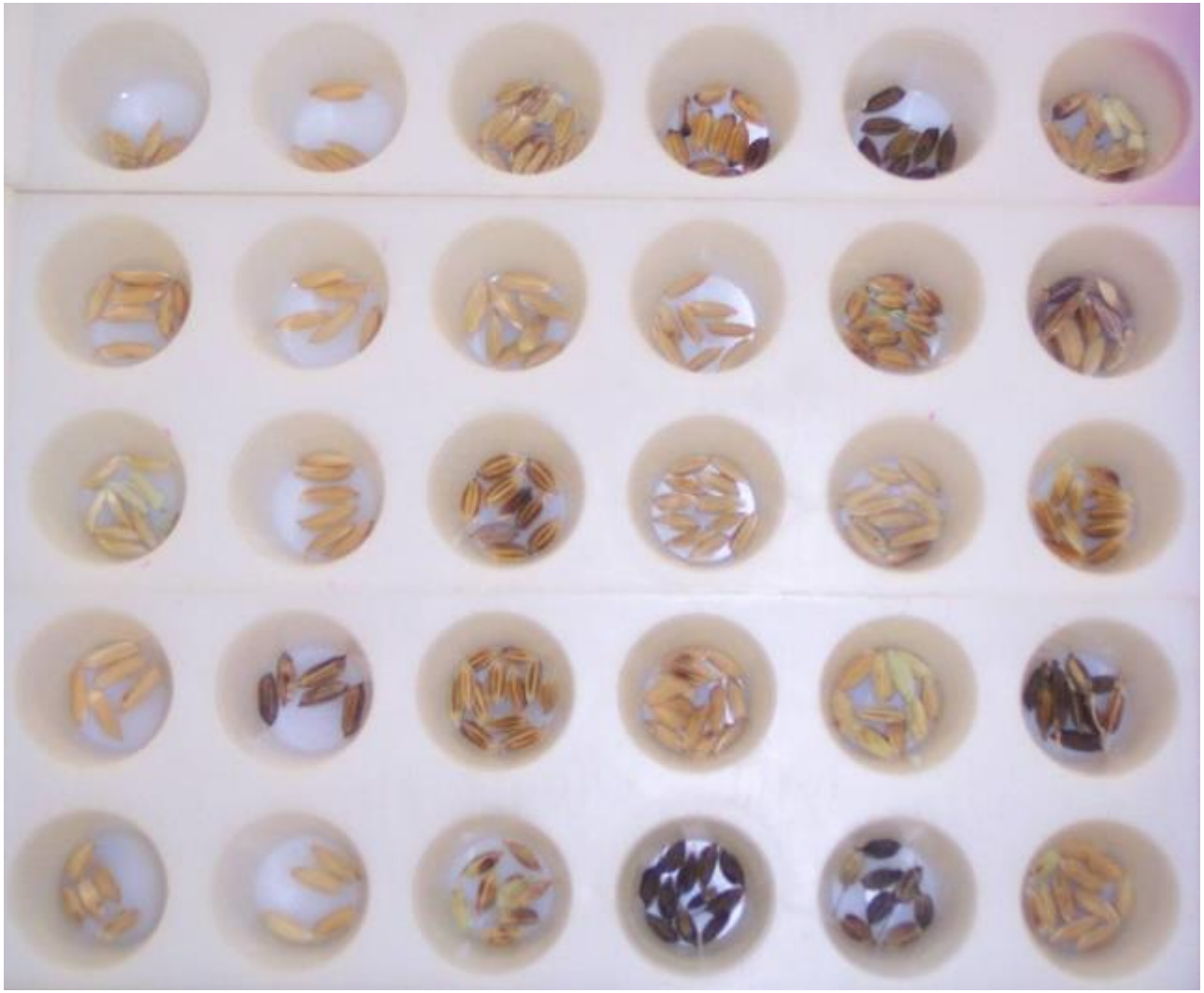
Rice with long mesocotyls emerges faster allowing it to establish stands and begin tillering. Standard U.S. semidwarf rices have short mesocotyls, reducing seedling vigor.

Genetically Mapping Rice Genes

Locating where important genes are on the 12 chromosomes of rice helps breeders to efficiently incorporate desired genes into improved rice varieties.



The USDA-ARS maintains a Core Germplasm Collection comprised of 1800 rice lines originating from around the world. This set of lines is proving to be highly useful in identifying new genes for important traits



Improving the Nutritional Quality of Rice

Within the USDA Core Collection, Dr. Pinson and crew are finding some rice cultivars that are more nutritious because they are high in nutrients like iron, zinc, and magnesium.

Cypress = Fissure Resistant

LaGrue = Fissure Susceptible

.

Rice that resists fissuring (cracking) breaks less during dehulling and milling.

More whole kernels = more income for producers, millers, and marketers.

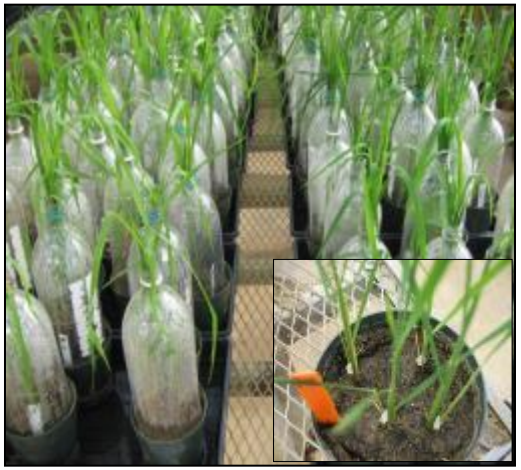
Increased production of early tillers can increase rice yields and grain quality.

6 tillers + main stem

3 tillers + main stem

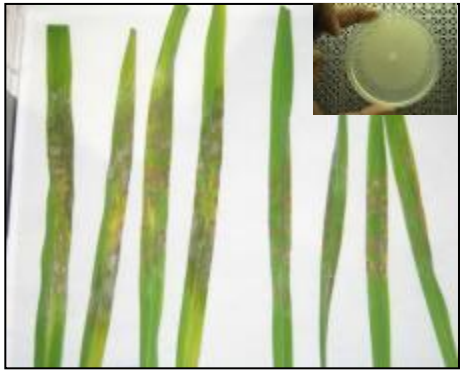
Discovering genes that enhance early tiller production.

Methods to identify sheath blight resistance in rice wild relatives



Micro-chamber method

Toothpick inoculation



Detached leaf evaluated

Counting the number of tillers

Dr. Eizenga's Field crew

Variation in rice seed

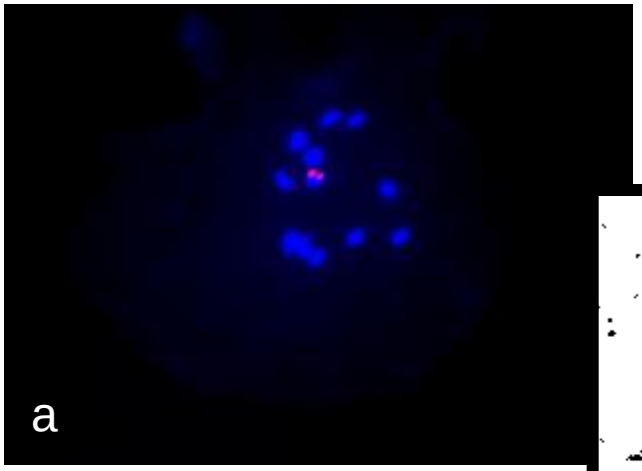
Adding an Extra Chromosome Changes Rice Plant Growth and Development

Normal plant

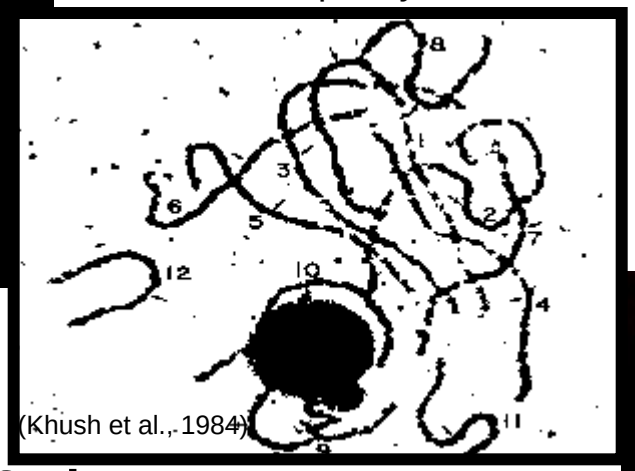
Rice Cytogenetics

Rice chromosomes as seen with a microscope

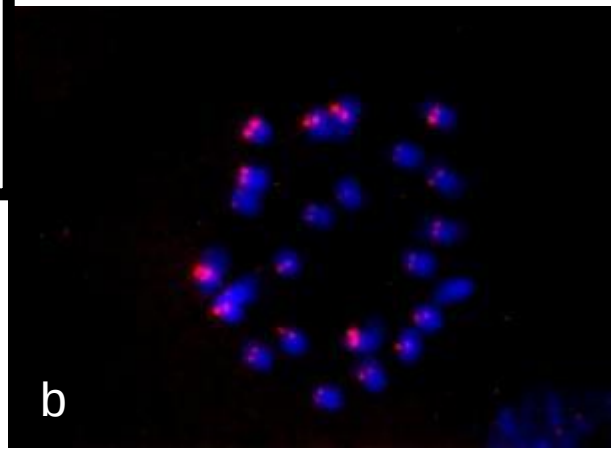
Root tip in metaphase



Anther in pachytene



Root tip in metaphase



Rice has two sets of 12 chromosomes, one set from each parent

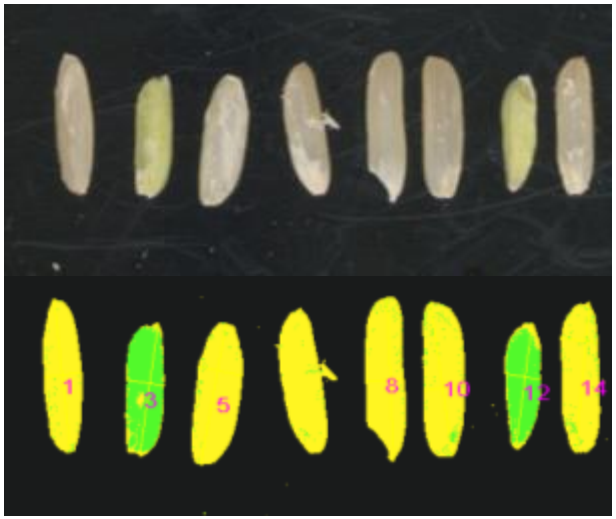
Root tip pictures:

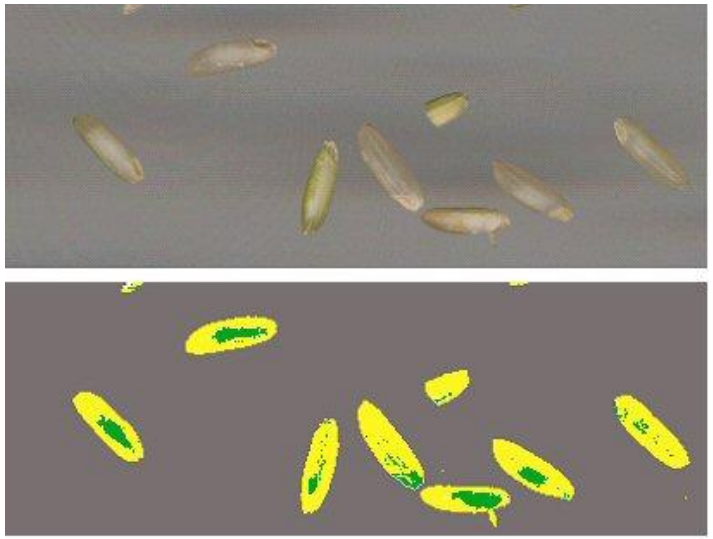
blue = rice chromosomes

red = a) nucleolar organizer region or b) centromere

Genetic Factors Which Reduce Grain Fissures and Increase Milling Quality

Using Image Analysis to Study Factors Which Affect Milling Quality

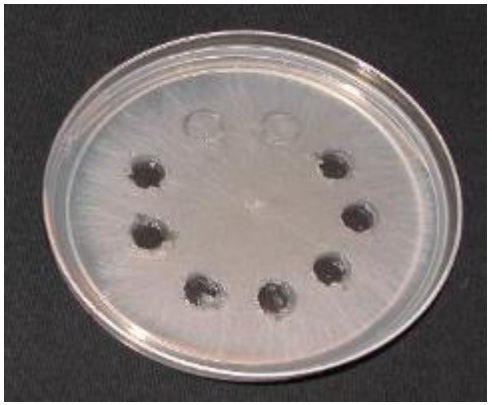




Quantification of green “immature” kernels and chalky areas

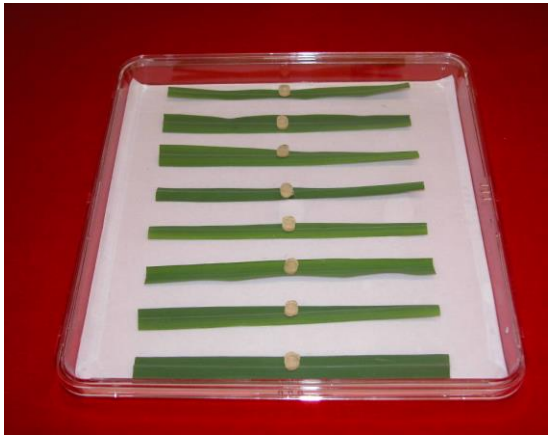
Discovery of genes associated with sheath blight resistance

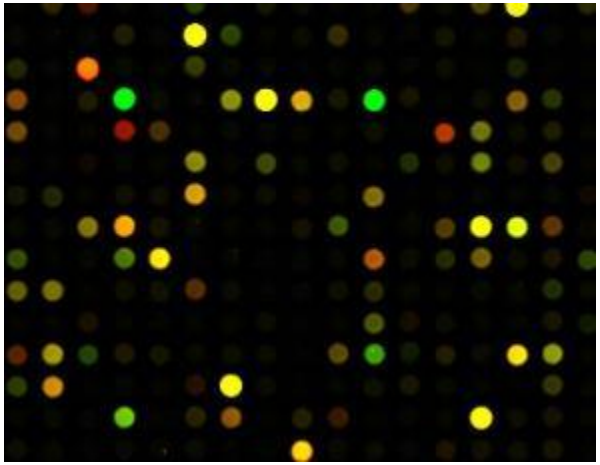
- Plant genetic response to attack by the sheath blight pathogen



Pathogen

Inoculation





After 16 hrs, no disease can be seen but over 300 genes have been turned on response to the pathogen

Winter Nursery Facilities in Lajas, Puerto Rico Are Used for Genetic Evaluation and Seed Increase

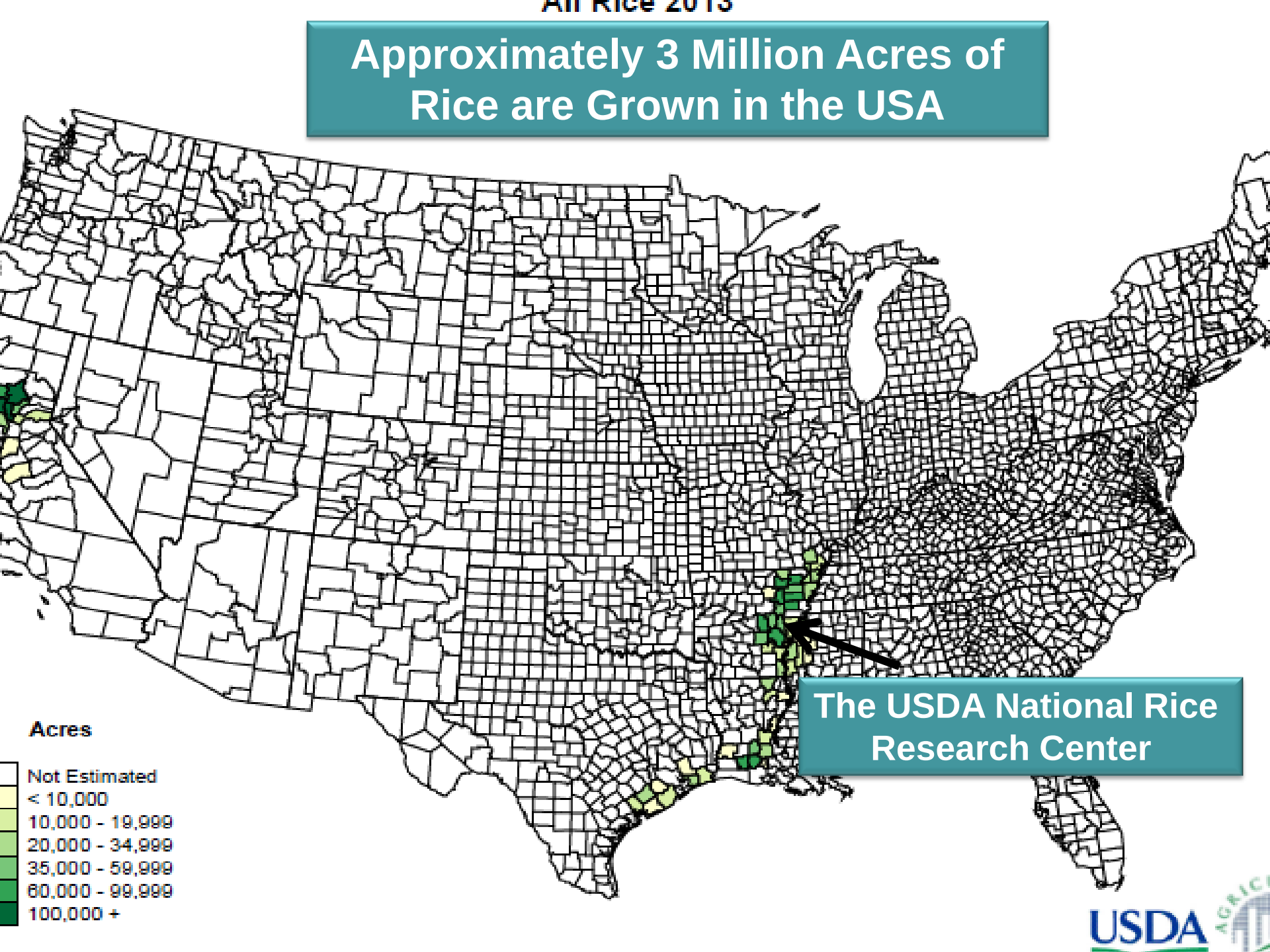
Planting Field Study at Stuttgart, AR

Genetic Marker Analysis


Carolina Gold Rice
An Heirloom
Variety Grown in
the USA Since the
17th Century

All Rice 2013

Approximately 3 Million Acres of Rice are Grown in the USA

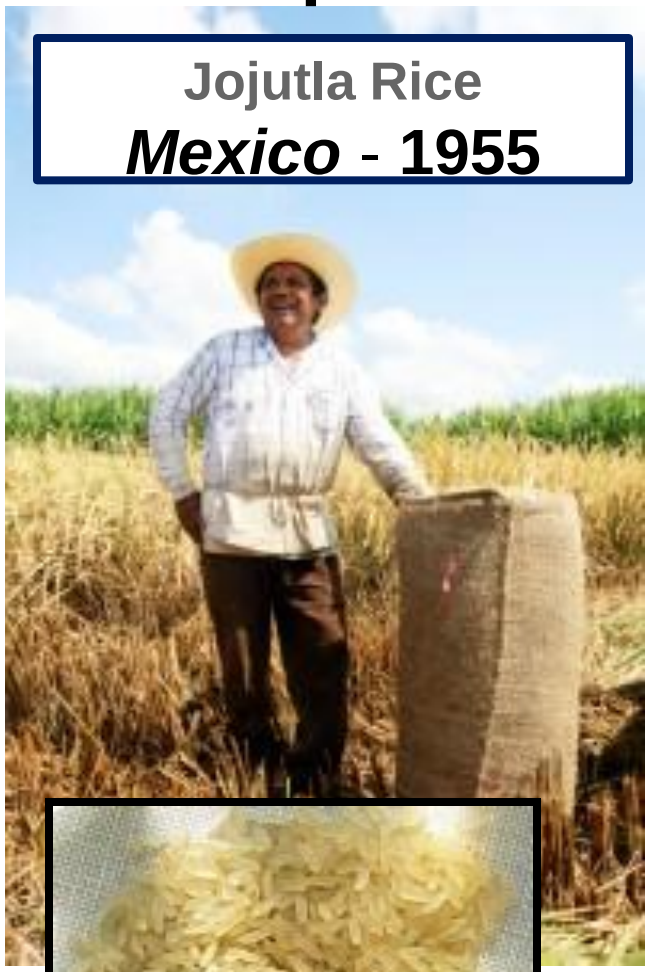


The USDA National Rice Research Center

USDA

A Rice Variety from Mexico is The Source of Superior Parboil and Canning Quality

Jojutla Rice
***Mexico* - 1955**



USA Rice Varieties with Pedigrees That Trace to Jojutla

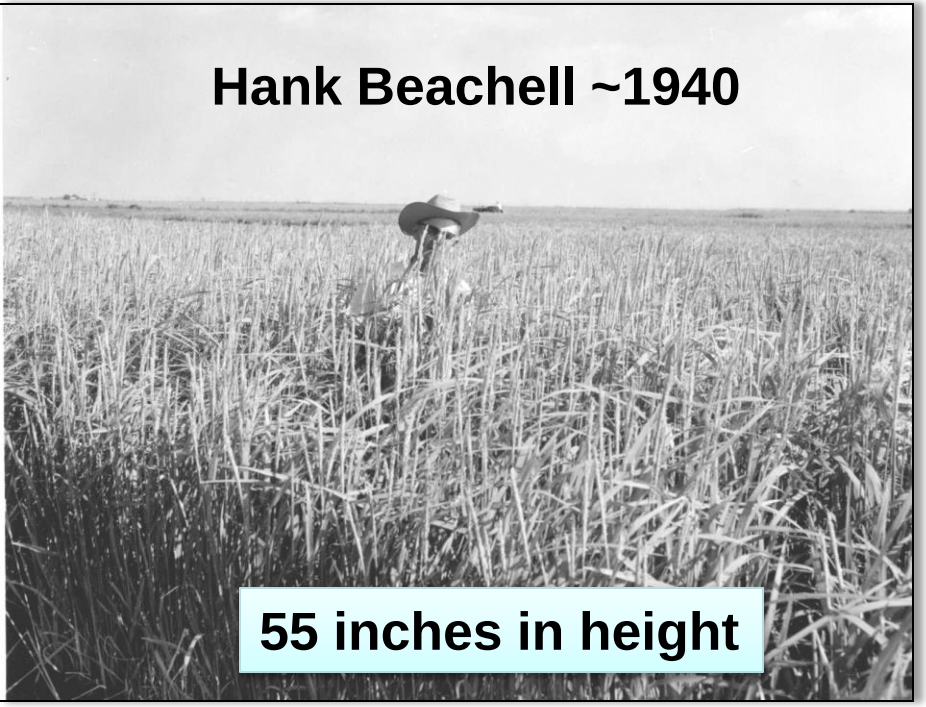
- Dixiebelle
- Newrex
- Sierra
- L205
- Sabine
- Rexmont
- Bowman

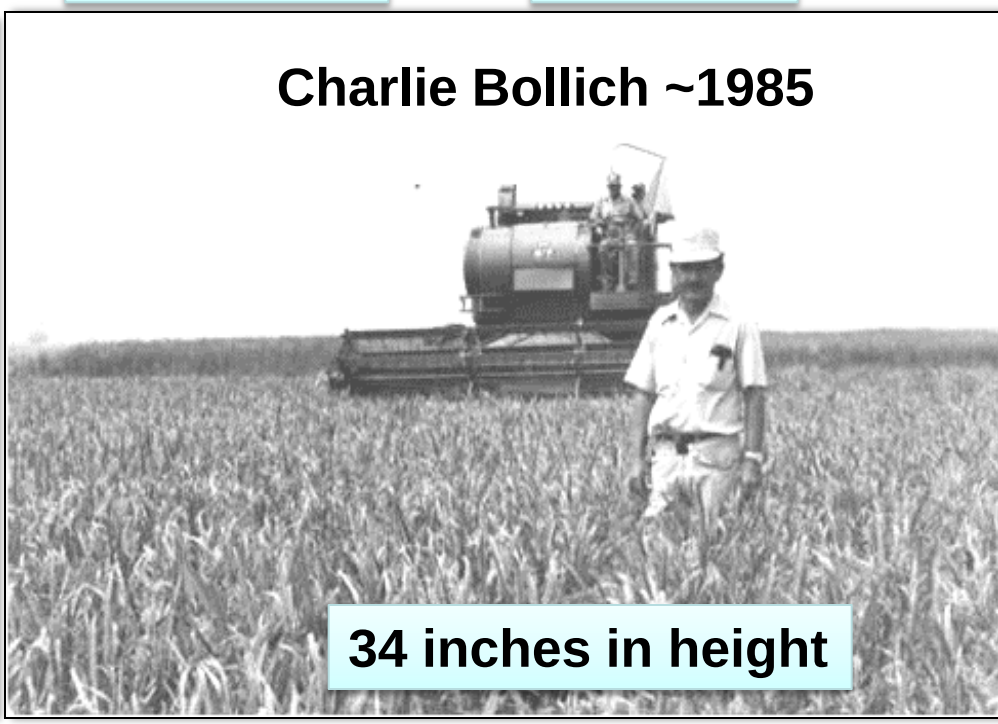
Examples of US Products Using Parboiled Rice

Green Revolution Rice Comes to the USA

USDA ARS Scientists Were Responsible for Incorporating the Semidwarf Gene from Taichung Native 1, a Variety from Taiwan

IR 8 Released 1966 → 6*Bluebelle X TN1 1968 → Crossing in Texas 1971-74 → Lemont Released 1986





Rice Variety from Vietnam Serves as Source of Durable Disease Resistance In USA Varieties

Tetep Rice
Originated from Vietnam

→ USA Cross Made 1979 →

Katy 1989

Rice Blast A Potentially Devasting Disease Found Worldwide

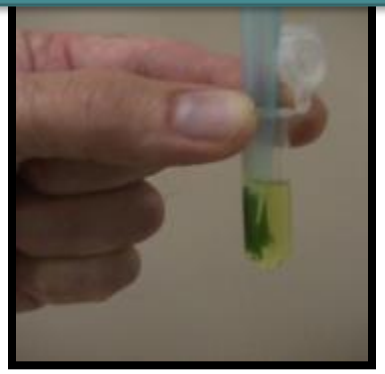
Source of Resistance in Many Other USA Varieties

- Kaybonnet
- Spring
- Drew
- Madison
- Catahoula
- Cybonnet
- Templeton
- CL111

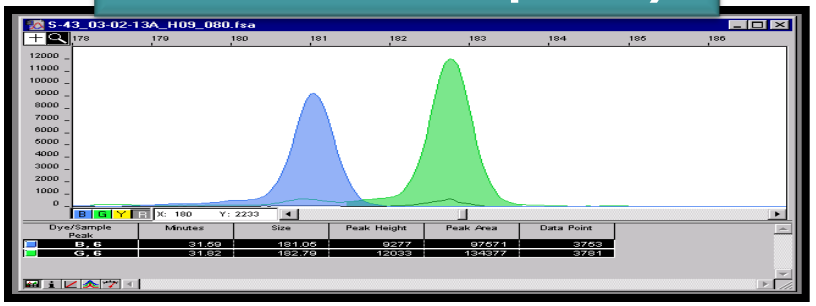
USDA ARS Maintains a Collection of Over 18,000 Rice Varieties from Around the World

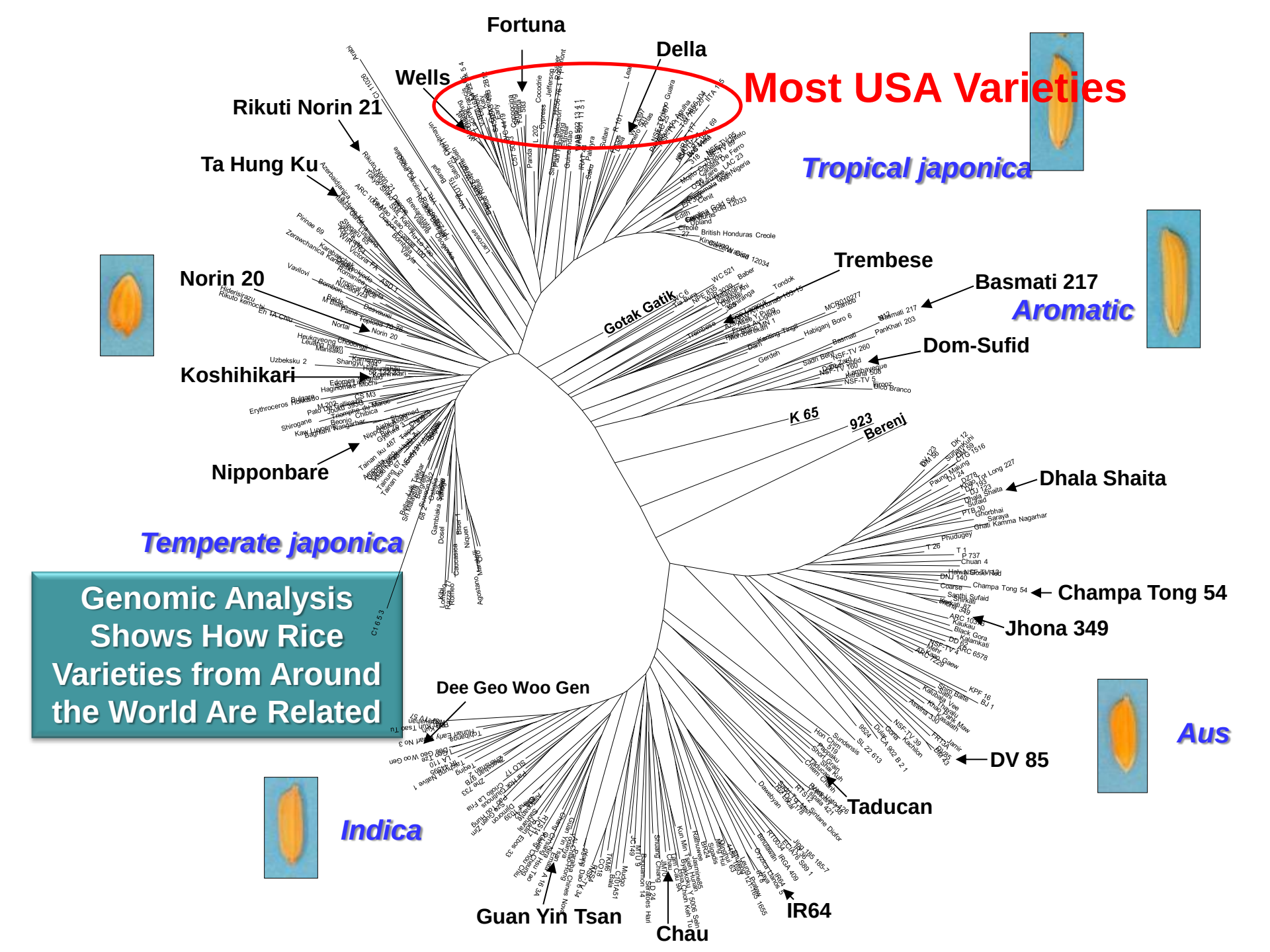
Characterized for Important Plant Traits

DNA Extraction for Genetic Marker Analysis



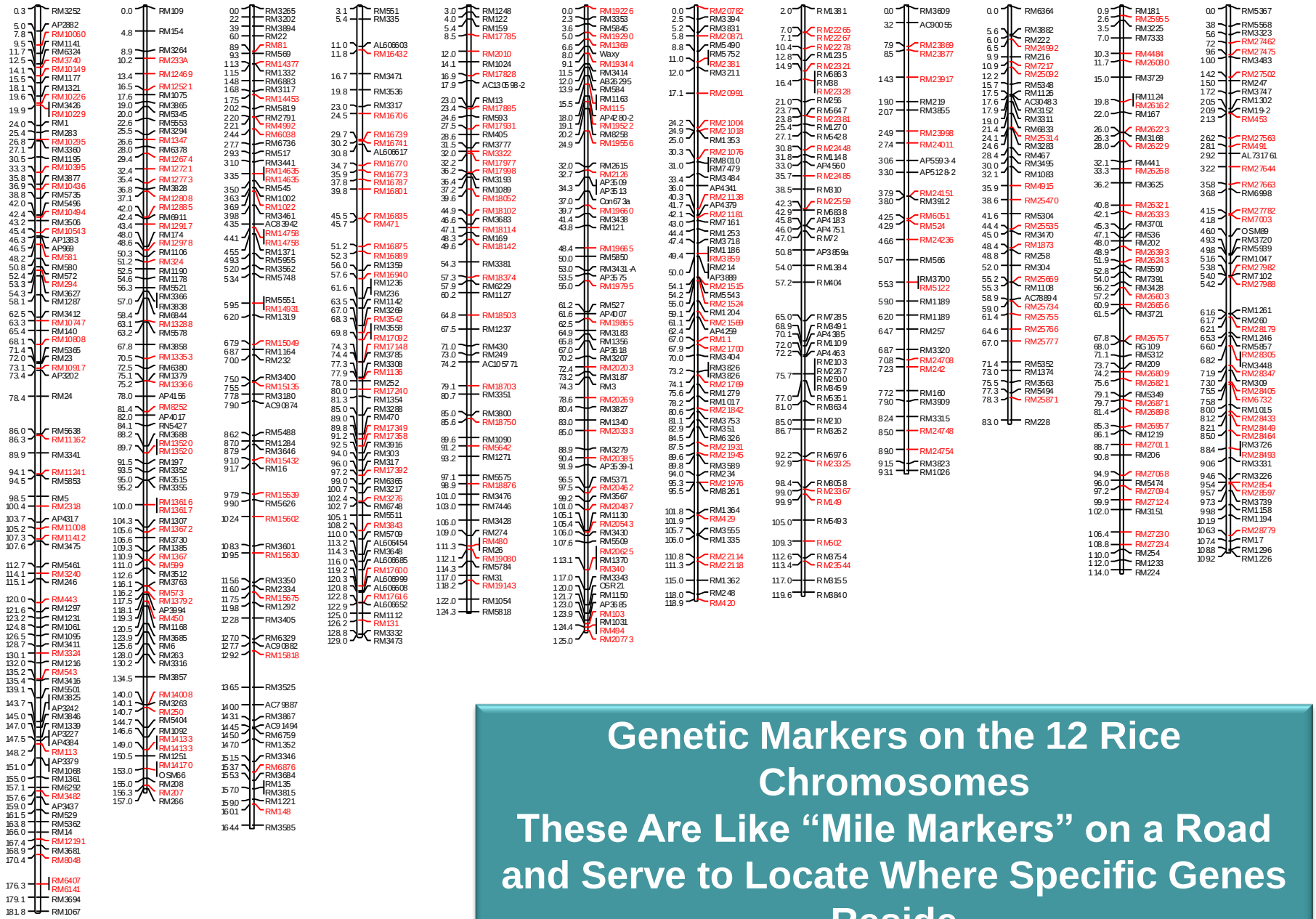
Example of Two Forms of a Gene (i.e. disease resistant, disease susceptible)



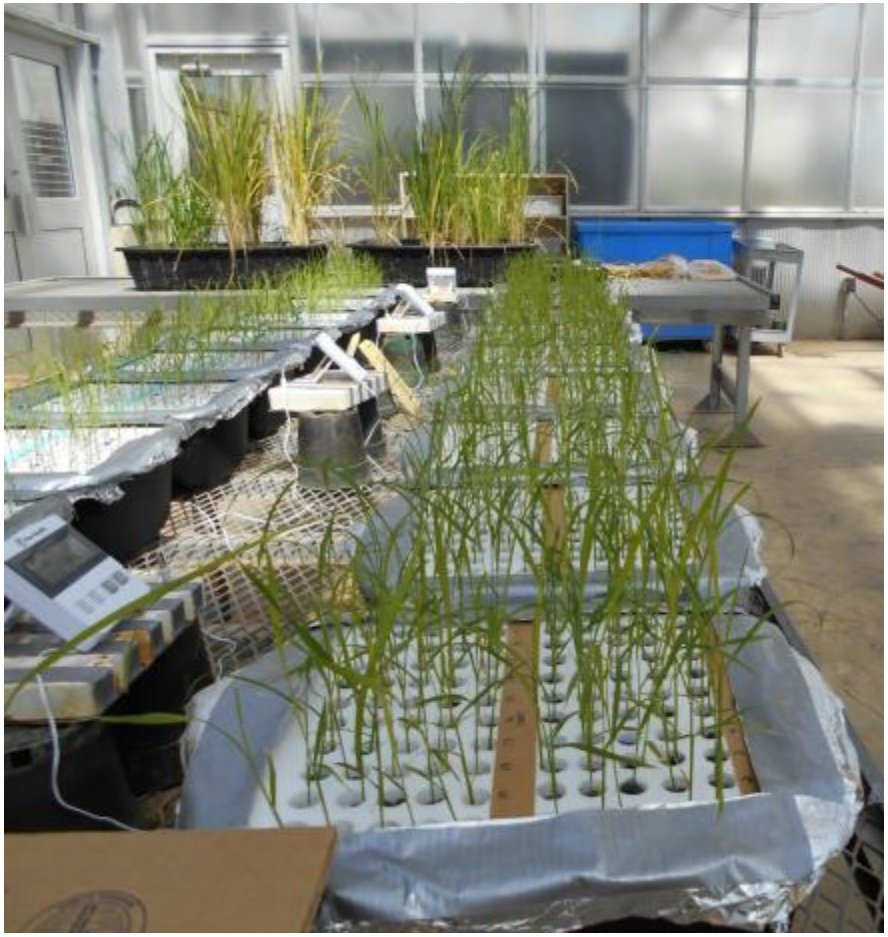

Fortuna
Della
Wells
Most USA Varieties
Rikuti Norin 21
Ta Hung Ku
Tropical japonica
Trembese
Basmati 217
Aromatic
Norin 20
Gotak Gatik
Dom-Sufid
Koshihikari
K 65
923
Bereni
Nipponbare
Dhala Shaita
Temperate japonica
Champa Tong 54
Jhona 349
Genomic Analysis Shows How Rice Varieties from Around the World Are Related
Dee Geo Woo Gen
Aus
DV 85
Taducan
Indica
Guan Yin Tsan
Chau
IR64

EXAMPLES OF DIVERSE SPECIES OF RICE

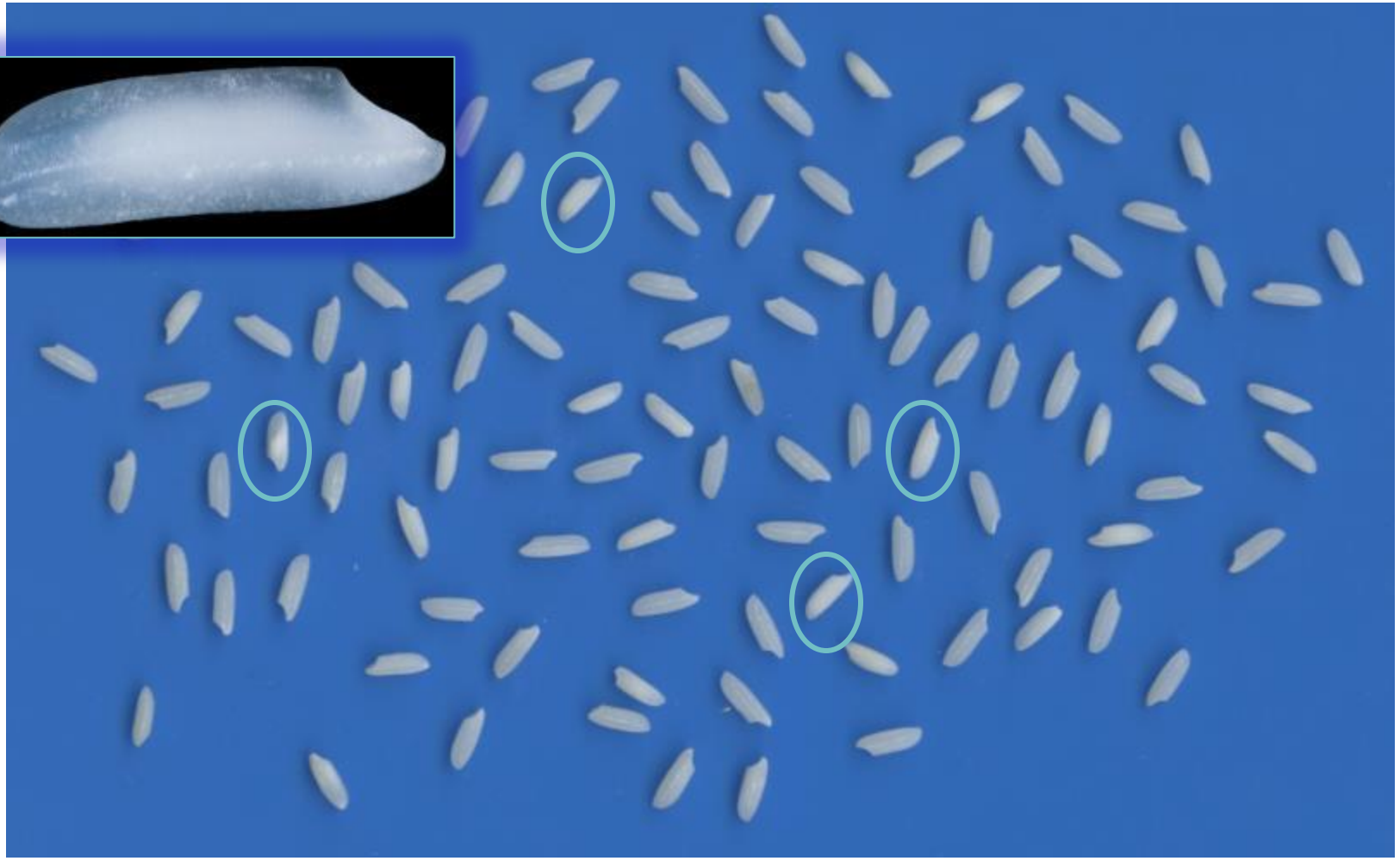
IRRI


CH-1
CH-2
CH-3
CH-4
CH-5
CH-6
CH-7
CH-8
CH-9
CH-10
CH-11
CH-12
Genetic Markers on the 12 Rice Chromosomes
These Are Like “Mile Markers” on a Road and Serve to Locate Where Specific Genes Reside

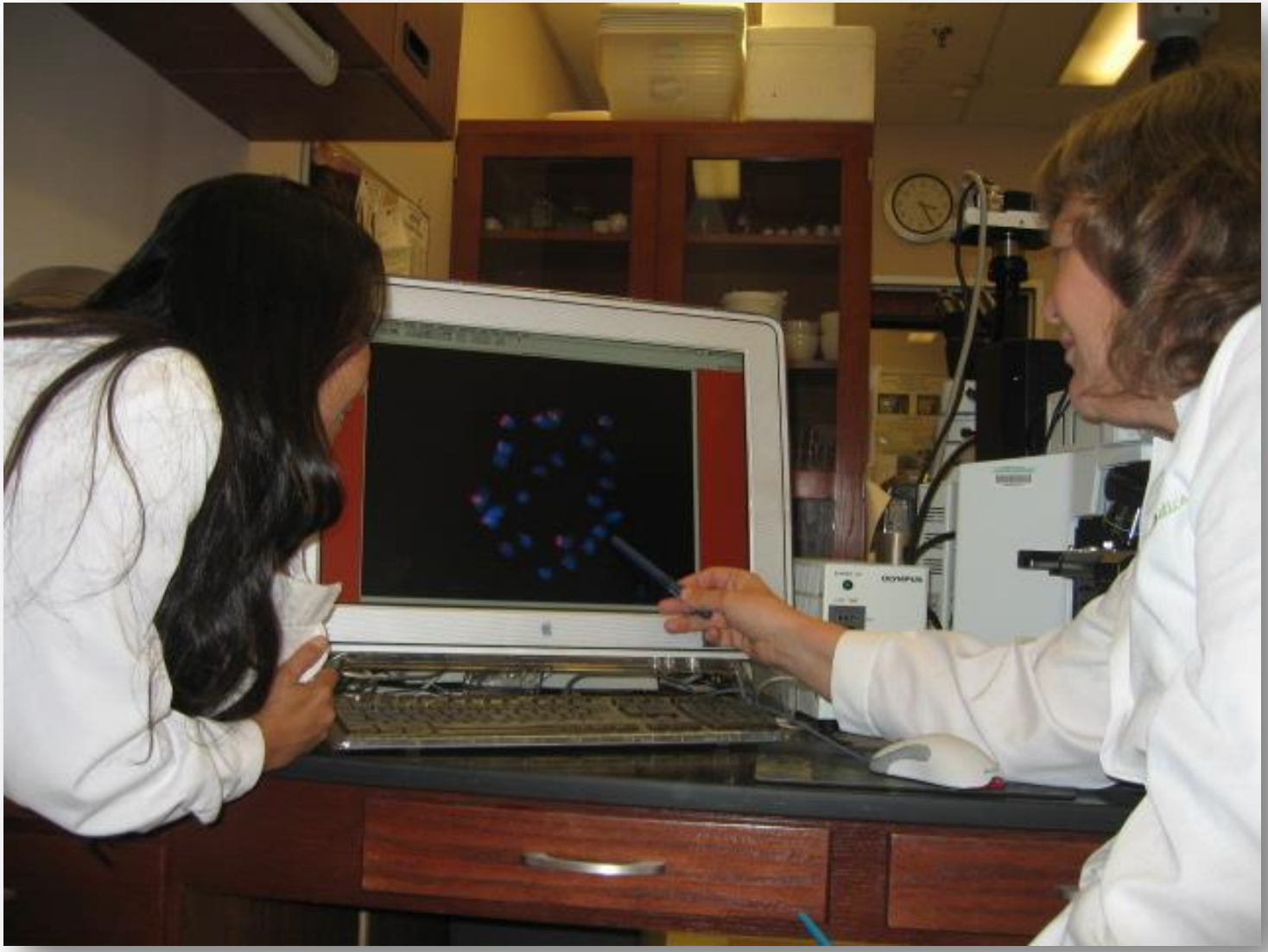
Rice Cultivars Are Evaluated for Tolerance to Salt Using A Hydroponics System



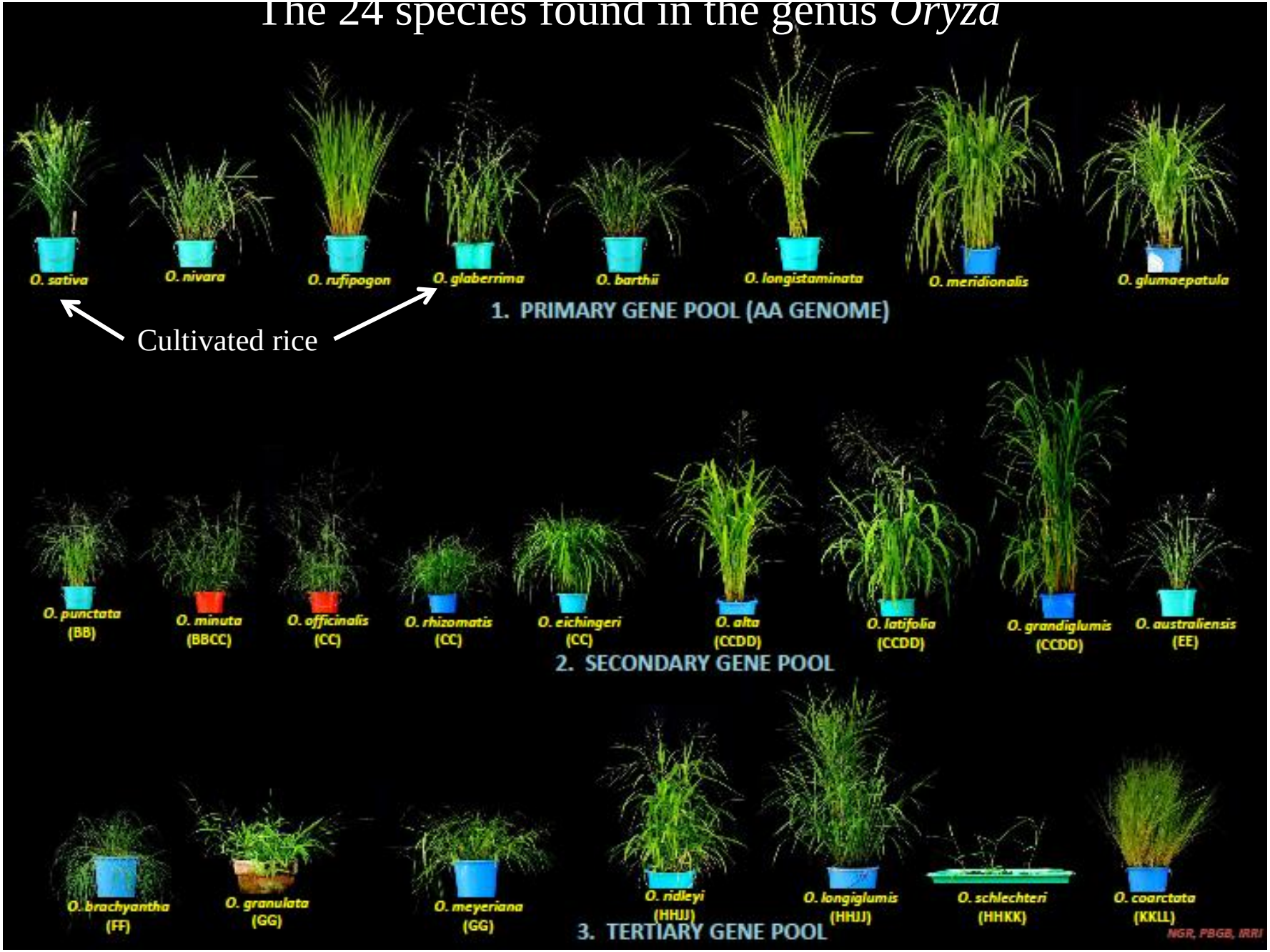
Rice Grain With Chalky, Opaque Areas Will Break Up During Milling



Identifying rice chromosomes as seen by florescence microscopy



The 24 species found in the genus *Oryza*



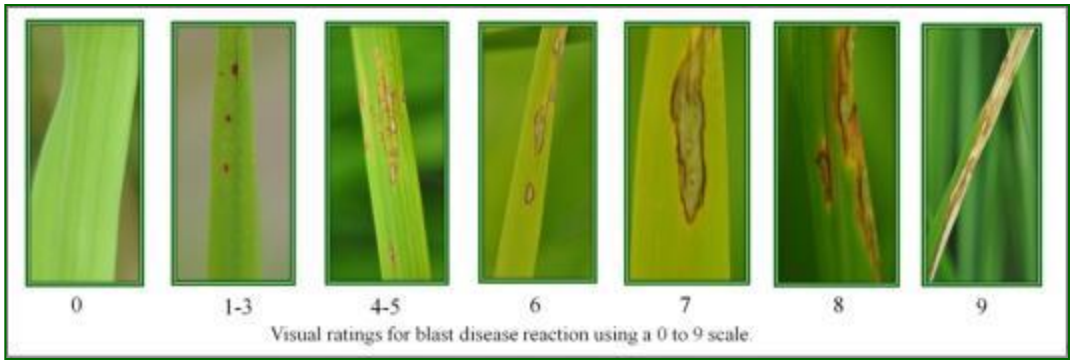
The ancestral rice species, *Oryza nivara* and *Oryza rufipogon*, are the potential source of new (novel) genes for resistance to the most devastating rice diseases, sheath blight and leaf blast.

Evaluating Rice Leaf Blast Disease

Step 1: Prepare blast fungus (spores) to infect the small rice plants

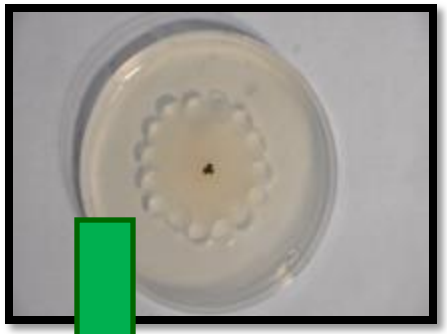
Step 2: Spray blast spores on seedlings with an air brush.

Step 3: Rate the plants for blast disease after 7-10 days using the scale shown below



Visual ratings for blast disease reaction using a 0 to 9 scale

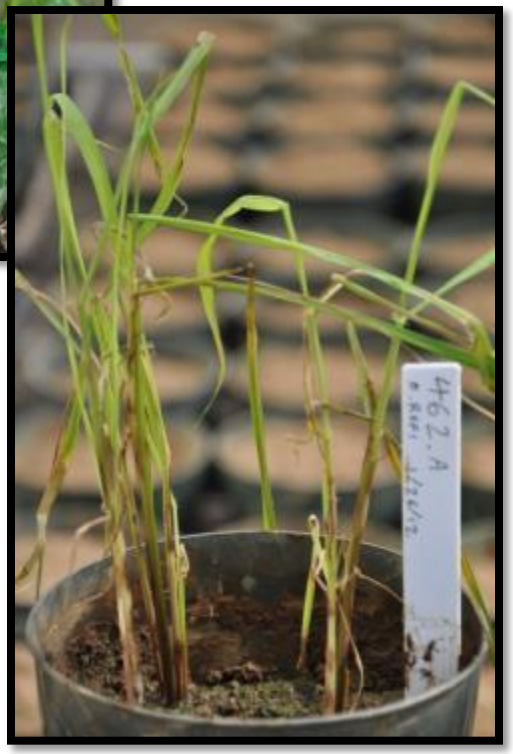
Evaluating Rice Sheath Blight Disease



Sheath blight fungus growing in a Petri dish

Step 1: Inoculate seedlings about two weeks after transplanting to soil

Step 2: Cover seedlings with micro-chamber for 7-10 days so disease develops



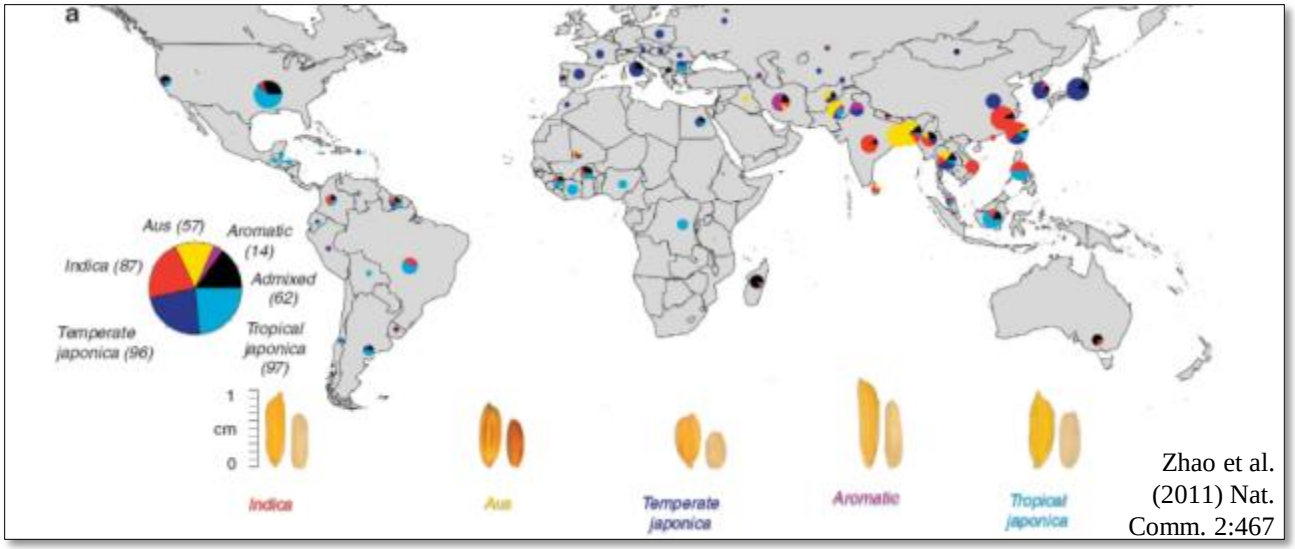
Step 3: Rate sheath blight disease. (This is a susceptible accession.)

Variation in the Estrela x NSF-TV 199 mapping population

Diversity in field plants

Variation in the Rice Diversity Panel 1

The Rice Diversity Panel 1 is composed of over 400 rice varieties from around the world.

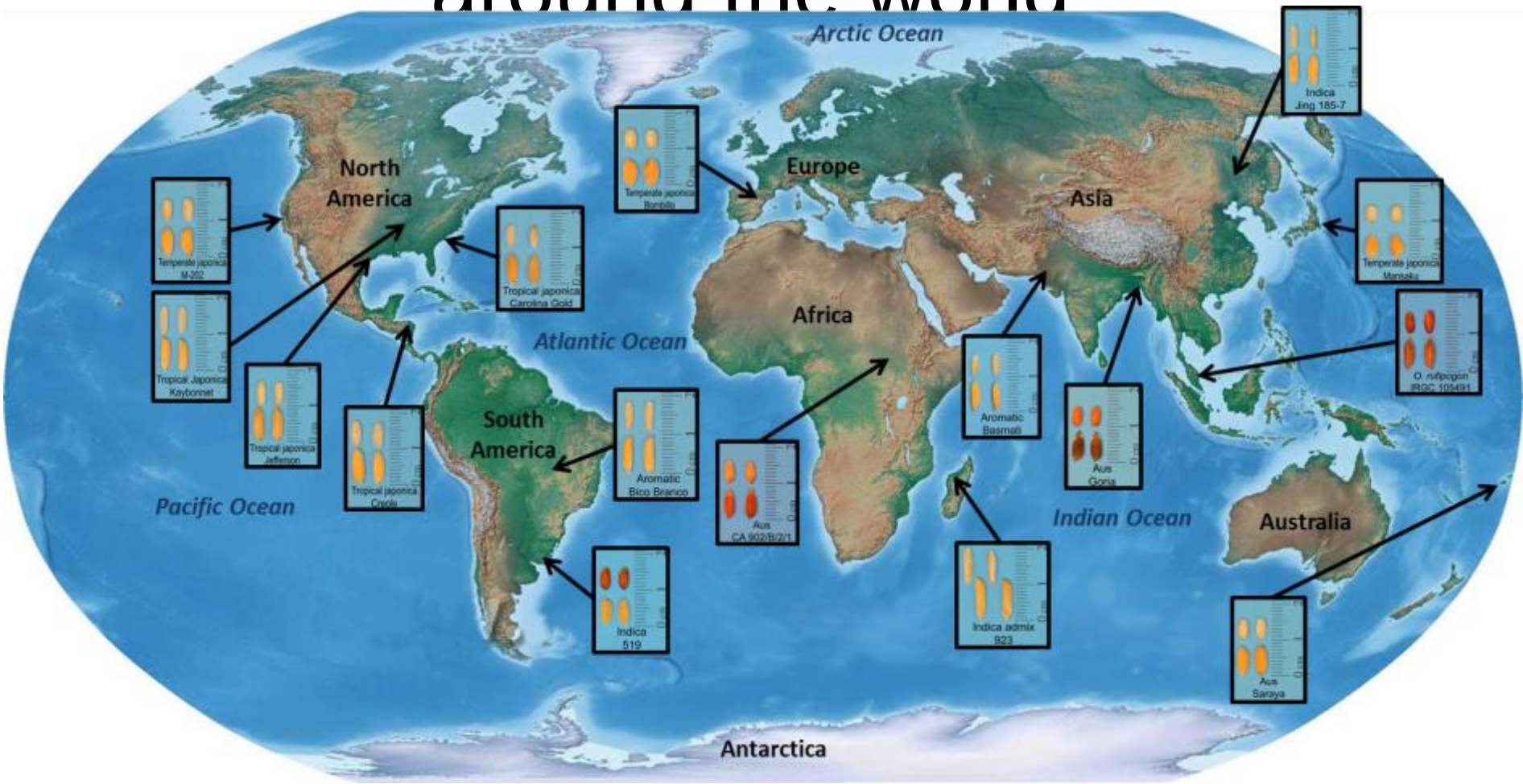


Zhao et al. (2011) Nat. Comm. 2:467

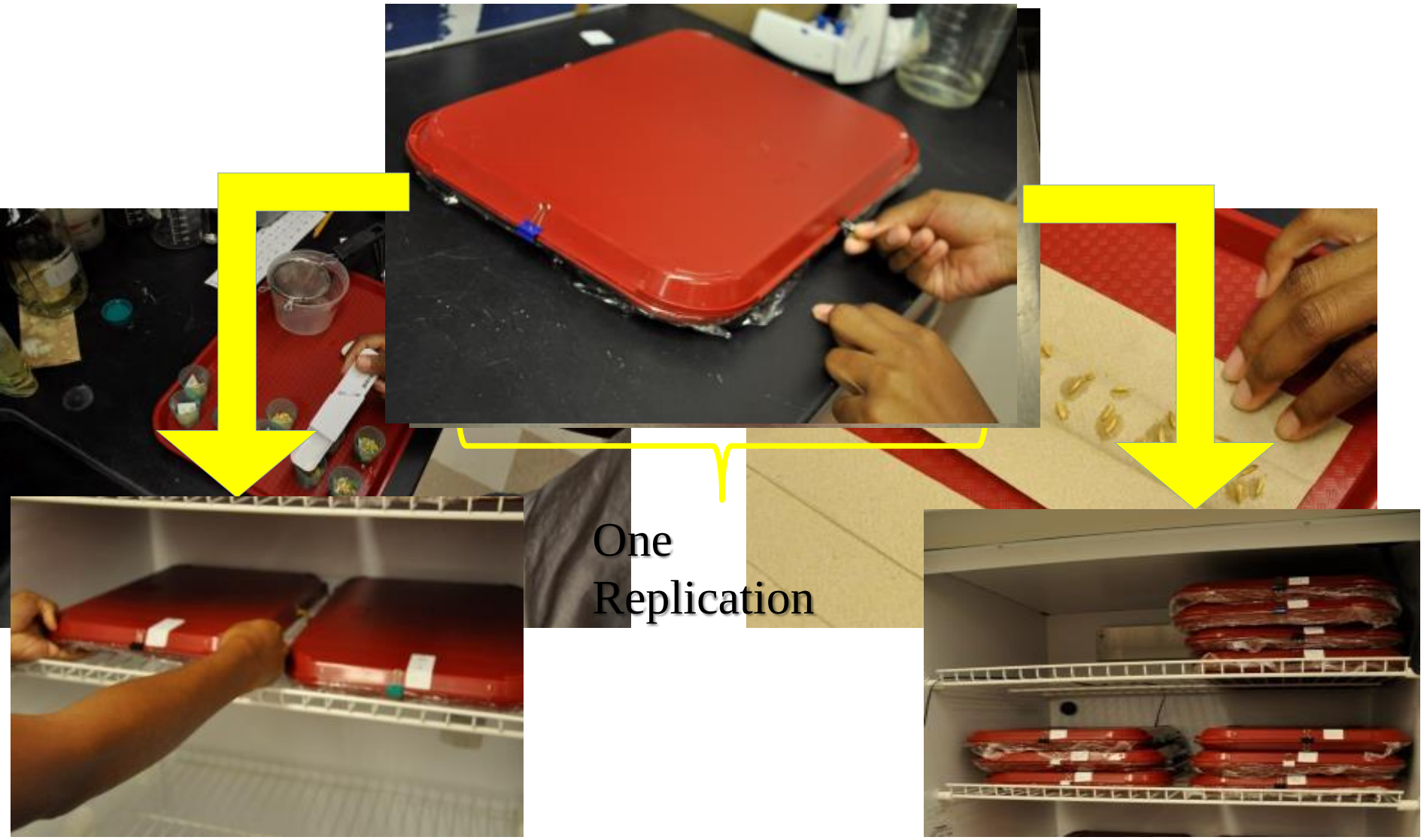
Panicle images of five varieties showing variability in panicle sizes and grain number.

Varieties ARC10376, Basmati 217 and Estrela illustrating the differences in seed.

Variation in rice varieties from around the world



Testing for Cold Tolerance at Germination



Warm condition-5 days

Cold condition-30 days