Rice Breeding and Variety Development

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Breeding trials and activities

• Crosses
• Long grain preliminary yield trial
• Long and medium grain advance yield trial
• Uniform regional rice nursery
• Heat tolerance trial
• Puerto Rico winter nursery
• Establishment of DNA marker laboratory
• Others
  • Arkansas performance trial
  • Observational/head rows
  • Variety trials
Crosses

• Made a total of 214 crosses in 2018
  • 75% long grain
  • 25% medium and aromatic
  • Most long grain have Blast resistance gene
Preliminary yield trials

• Long grain preliminary yield trial
  • F4 or F5 head rows selected from the observational plots in Puerto Rico winter nursery
  • There are 961 entries planted in RCB in two replicates
  • Trial was split into two: PYT1a and PYT1b.
  • PYT1a is composed of 479 breeding lines with 21 checks while PYT1b is composed of 482 breeding lines with 25 checks for a total of 2,017 plots
  • Only data collected is yield.
  • Top 10% will move to 2019 advance yield trial.
Primary objective of selection

Source: Integrated Breeding Platform
Top 50 high yielding long grain breeding lines in PYT1a
Advance yield trial

- Long and medium grain advance yield trial
  - Tested a total of 46 breeding lines and 24 checks
  - 18 foot-long plots with 7 rows ~8 inches apart in a RCB with three replicates for a total of 210 plots
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<th>Entry</th>
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<th>Grain Yield lb/acre</th>
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<th>Plant height cm</th>
<th>Lodged score</th>
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<th>Milling yield</th>
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LSD P=0.05
Means followed by the same letter are not significant different at p-value=0.05
Uniform regional rice nursery (URRN)

- A cooperative testing conducted by the public rice breeding programs in Missouri, Arkansas, Louisiana, Mississippi and Texas, USDA and California.
- All elite lines from each breeding program
- A total of 260 entries - potential releases
- Conducted in each research station using best cultural management
- 18 foot-long plots with 7 rows ~8 inches apart in a RCB with three replicates
- MO has 14 slots
Heat tolerance trial

• Rice can be affected by extreme temperatures
  • Reduction in yield due to lower spikelet fertilities
• Diurnal mean temperatures of rice is at optimum 22 °C and 28 °C night and day. However, rice can maintain its normal development and growth processes at higher temperatures of 27 °C night to 32 °C day
• Development of heat tolerant lines is one of the major strategies to maintain the rice productivity under high temperature conditions
• N22 (Nagina 22) is an upland variety that belong to the “Aus” cultivar and is well-characterized for heat tolerance traits

Objective
• To characterize heat tolerance of N22 and other current US varieties by measuring spikelet fertilities under high temperature controlled conditions during early flowering
Heat tolerance trial
Materials and methods

• A small plastic chamber constructed - dimension of 10ft x 10ft x 5ft (LxWxH)
• A 1000 watt forced air heater was placed inside and controlled by Inkbird C206T 1500W temperature controller
• Temperature maintained at 35°C night and 40°C at day (+-1°C) in a 12-hour period.
• Control - The greenhouse temperature were maintained at 25 °C night and 30 °C day
• 1 plant per pot, completely randomized design with three replicates
• 15 varieties N22, Nipponbare (short grain japonica), M202 (CA medium grain), Titan, Presidio, MM17, Mermentau, CL111, Diamond, Thad, CL151, IR64 (long grain indica), Lakast, CL172, and Wells.
Heat chamber

Force air heater with controller / temperature sensor
Results and discussion

A - Wells control; B - Wells heat-treated
C - N22 control; D - N22 heat-treated
Heat tolerance trial primary panicle

% Fertility

Nipponbare 95% 91%
M202 95% 91%
N22 81% 79%
Titan 79% 74%
Presidio 76% 70%
MM17 75% 70%
Mermentau 77% 66%
CL111 91% 91%
Diamond 90% 84%
Thad 60% 77%
CL151 85% 59%
IR64 50% 39%
Lakast 39% 71%
CL172 25% 77%
Wells 7% 77%

GH control  
Heat
Heat tolerance trial secondary panicle

% Fertility

GH control | Heat

N22 | 99% | 90%
Nipponbare | 94% | 82%
Thad | 91% | 74%
Presidio | 93% | 69%
CL151 | 89% | 68%
Wells | 84% | 60%
MM17 | 78% | 59%
Lakast | 88% | 56%
CL111 | 89% | 45%
M202 | 85% | 45%
IR64 | 82% | 33%
Diamond | 85% | 31%
CL172 | 78% | 18%
Titan | 86% | 9%
Mermentau | 78% | 0%
• PR nursery
  • Joined the agreement with the University of Puerto Rico with other states to use the winter nursery
  • 2019 Harvested 3000+ panicle rows, planted additional 2000+
SEMO DNA marker assisted selection

- Tissue sampling
- DNA extraction
- DNA dispensing
- PCR thermal cycling
- 384 well microplate
- Reagent dispensing
- Fluorescence reading

Source: ebay
DNA Markers for Marker Assisted Selection

- Working markers optimized in SEMO rice lab using KASP method (kompetetive allele specific PCR) captured by means of fluorescence energy resonance transfer (FRET).
- Clearfield S653D
- ALK gene (US medium grain background) for gelatinization temperature
- Amylose (US long grain background) for high or intermediate to low amylose content
- Pita Blast resistance gene
- Piz Blast resistance gene
Thank you.

- Missouri Rice Research and Merchandising Council
- Southeast Missouri State University
- University of Missouri Extension
- MU Fisher Delta Research Center