2012 RICE BREEDING PROGRESS REPORT

P.O. Box 306, Biggs, CA 95917-0306
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OVERVIEW

Kent S. McKenzie

The California Cooperative Rice Research Foundation (CCRRF) is a private nonprofit research foundation [501(c)(5)] and members are California rice growers. The Rice Experiment Station (RES) is owned and operated by CCRRF. RES was established at its present site between Biggs and Richvale, California in 1912 through the cooperative efforts of the Sacramento Valley Grain Association, United States Department of Agriculture (USDA), and University of California (UC). The 478-acre RES facility supports breeding and genetics research, agronomic research and foundation seed production.

The RES scientific professional staff includes a director, director of plant breeding, plant breeders, a plant pathologist and research scientist. Eleven career positions consisting of five plant breeding assistants, one DNA lab technician, a field supervisor, one mechanic and field operator, two maintenance and field operators, and two administrative assistants make up the support staff. Approximately 30 seasonal laborers are employed during crucial planting and harvest times.

RES Rice Breeding Program

The RES Rice Breeding Program encompasses 5 research projects. Three rice breeding projects focus on developing adapted varieties for specific grain and market types and are each under the direction of a plant breeder. The rice pathology project supports the breeding projects through screening and evaluating varieties for disease resistance, rice disease research, and quarantine introduction of rice germplasm for variety improvement. The DNA marker lab provides support to all projects. All projects are involved in cooperative studies with other scientists from the UC, USDA, and industry, including off-station field tests, nurseries, quality research, and biotechnology. All breeding program members cooperatively participate in the preparation, planting, maintenance, and harvest of the research nurseries. The focus of the RES rice breeding program is on developing improved rice varieties to meet the needs of California growers now and into the future.

Organization and Policy

Policy and administration of RES is the responsibility of an 11-member Board of Directors elected by the CCRRF membership. Directors serve a three-year term and represent geographical rice growing areas of California. They are rice growers and serve without compensation. CCRRF works to serve all California rice growers, and its policies generally reflect those of public institutions. CCRRF cooperates with UC and USDA under a formal memorandum of understanding. The UC and California Rice Research Board (CRRB) have liaisons to the Board of Directors. CCRRF scientists cooperate with many national and international public institutions and also with private industry. Organization and policy of CCRRF encourages active grower input and participation in RES research direction.

Research Mission and Funding

The primary mission of CCRRF is the development of improved rice varieties and agronomic management systems for the benefit of the California rice growers. The plant breeding program at RES is designed to develop rice varieties of all grain types and market classes with high and stable grain yields and quality that will sustain the profitability of rice with minimum adverse environmental impact. Important breeding objectives include the incorporation of disease resistance, high milling yield, seedling vigor, cold tolerance, early maturity, semidwarf plant type and lodging resistance into future rice varieties. Improved milling yield, grain appearance, and cooking characteristics relative to consumer preference are major components of the plant breeding program. A secondary and important objective is to address industry research needs including support of UC and USDA research by providing land, resources, and management for genetic, agronomic, weed, insect, disease, and other disciplinary research.

Rice variety development at RES is primarily funded by the CRRB that manages funds received from all California rice producers through California Rice Research Program assessments. The CRRB acts under the authority of the California Department of Food and Agriculture (CDFA). The CRRB finances approximately 80% of the RES annual budget and 20% is derived from the sale of foundation rice seed to seed growers, grants, and revenues from investments. RES does receive some donations from agribusiness and funds from the Rice Research Trust (RRT). The RRT is a tax-exempt trust [501(c)3] established in 1962 to receive tax deductible contributions for support of rice research. RRT has been the primary funding source for capital improvements at RES.

RES Breeding Program is reviewed annually by the Board of Directors, representatives of the UC, and the CRRB. All research is conducted under permits and in compliance with USDA/CDFA regulations and under approved protocols required by the California Rice Certification Act. CCRRF continues to address recommendations from the 2007 Rice Breeding Program Review. This has included a major greenhouse building and renovation, DNA marker facilities and staffing, resource allocation, quality lab, and investigating the potential for japonica hybrid rice for California.

Cooperative Research

Cooperative research is an integral part of rice research at RES involving USDA and UC scientists. Dr. Thomas H. Tai, USDA-ARS Research Geneticist, located at UC Davis (UCD), is working with all project leaders to develop improved breeding and genetics methods for rice variety improvement. Rice quality and genetic research has included studies with USDA scientists Drs. Anna McClung, Bob Fjellstrom, Brian Scheffler, Georgia Eizenga, Zhongli Pan, Rolfe Bryant, and Ming Chen. Dr. Charles F. Shoemaker and his students are pursuing research on rice quality in the Department of Food Science and Technology, UCD and material and support are provided to that effort. Statewide performance testing of advanced experimental lines and varieties was conducted by Mr. Raymond L. Wennig, UCD staff research associate, under the direction of University of California Cooperative Extension Farm

Advisors Dr. Randall G. Mutters (Butte), Dr. Chris Greer (Placer, Sacramento, Sutter, Yuba), Dr. Luis Espino (Glenn, Colusa, Yolo), and Associate Dean and Rice Specialist, Dr. James E. Hill, (UCD). The information developed from this cooperative research is valuable to the RES Rice Breeding Program and the California rice industry. RES values and works to support a well coordinated team effort with these cooperators.

The CCRRF staff, facilities, and equipment also supported agronomic, weed, disease, and insect research of UCD scientists in 2012. Dr. Albert J. Fischer, (professor, Department of Plant Sciences, UCD) and Mr. James Eckert, (UCD staff research associate at RES), conducted UC rice weed research on 18 acres. Drs. Randall Mutters, Dr. Bruce Linquist, Chris Greer, and Luis Espino, are all doing rice research on 18 acres at RES. They are being supported by UCD staff research associate at RES, Mr. John Ray Stogsdill. Dr. Larry D. Godfrey, (extension entomologist) and Mr. Kevin Goding, (staff research associate, Department of Entomology), conducted rice insect research. RES does provide technical input and support to the California Rice Commission (CRC)

CCRRF staff began conducting cooperative research with biotechnology companies in 1996 on transgenic rice for California. This has been a very limited area of research for CCRRF. It has included participants from the private and public sectors. No transgenic materials have been grown at RES since 2001. Future research in this area by RES will depend on California’s needs, market acceptance, regulatory requirements, and the development of research agreements.

Seed Production and Maintenance

The production and maintenance of foundation seed is an important RES activity. The foundation seed program is a cooperative effort with the California Crop Improvement Association to assure availability of pure, weed free and high quality seed for the benefit of the California rice industry. Forty-three improved rice varieties have been released since an accelerated research program began in 1969. Foundation seed of 14 public rice varieties, 1 experimental increase, and basic seed of one Japanese premium quality variety were produced on 170 acres at RES in 2012. Since 1988, CCRRF has protected new varieties under the Plant Variety Protection Act, Title 5 option that requires seed to be sold only as a class of certified seed. Utility patents have also been obtained. This is being done to ensure that California growers are the beneficiary of their research investments as well as assuring that clean, red rice free seed is produced. Although the foundation seed program is self-sustaining and not supported with CRRB funds, foundation seed and certified seed production provides very significant benefits to the whole California rice industry.

CCRRF has followed an aggressive testing program of foundation seed for the presence of the Liberty Link Trait that was discovered at trace levels in Southern US long-grain rice. All results from the initial 2006 USDA tests and annual foundation and basic seed test from 2007 through 2012 by CRC have been non-detect.

The RES web page can be found at http://www.plantsciences.ucdavis.edu/ricestation/.

RICE BREEDING PROGRAM

Virgilio C. Andaya

The Rice Experiment Station marked a milestone as it celebrated its 100th anniversary in 2012. Looking back from its humble beginnings, so many things have been achieved in the past 100 years in terms of increasing rice yields and improving the overall agronomic performance of short, medium and long grain rice varieties. The achievements are indeed significant, but the future presents new breeding challenges. To be viable for the next one hundred years, RES should be able to adapt and change and find ways to do breeding better, faster, and more efficiently.

In 2012, RES underwent significant organizational changes starting with the appointment of Dr. Virgilio C. Andaya as the Director of Plant Breeding (DPB), a position held by the late Dr. Howard Carnahan from 1960 until his retirement in 1988. As the DPB, Dr. Andaya has the responsibility of: 1) providing leadership and oversight duties for the entire Breeding Program at RES, 2) building an effective rice breeding team composed of rice breeders, research scientists, plant pathologist and support personnel, and 3) reviewing and revising breeding goals and objectives for long, medium, and short grain breeding to respond to the needs of the CA rice industry. There were also changes in duties and responsibilities of senior staff, breeding projects and support labs to accommodate personnel turnover and reassignment.

Dr. Kent S. McKenzie briefly took over the leadership of the Medium Grain Calrose Project in 2010 after the retirement of the long-time veteran breeder, Dr. Carl W. Johnson in 2008 and the departure of Dr. Jacob Lage in 2010. Dr. Andaya assumed the position of DPB and leadership of the Medium Grain Project in 2012, as Dr. McKenzie went back as a full-time RES Director with breeding program oversight.

Dr. Stanley Omar Samonte joined the RES in early 2012 to take over the Short Grains and Premium Quality Breeding Project from Dr. Andaya. He was also assigned to oversee the RES data management system and the station's website.

Dr. Farman Jodari continues his leadership of the Long Grain Breeding Project and serves as the liaison to the Southern US Breeding Programs.

Mr. Jeffrey Oster continues to be the station plant pathologist working alongside the breeders in disease resistance screening.

Dr. Cynthia B. Andaya formally took over the leadership of the DNA Marker Lab as well as the Grain Quality Lab in 2012. She is in charge of the fingerprinting and DNA marker-assisted breeding efforts, mapping stem rot resistance, as well as generating mutants and screening them for herbicide resistance.

Staff continues to work to improve rice quality evaluation and selection for all market types. Screening, evaluation, and research in the area of DNA marker technology is progressing at RES.

CALROSE MEDIUM GRAINS

Virgilio C. Andaya

Calrose Breeding Project Overview

Varieties

California's rice industry is mainly driven by medium grain varieties, which are planted on close to 90% of the total rice acreage. There are 8 RES-released Calrose rice varieties still in commercial production, namely, M-104, M-105, M-202, M-205, M-206, M-208, M-401, and M-402. Performance of these varieties serving as checks in the 2012 UCCE Statewide Tests are found in Tables 21 to 26 at the end of this report.

M-104 is a very early-maturing, cold tolerant variety released in 2000 and is the dominant variety in San Joaquin County and in areas too cold for other varieties. In 2011, M-105 was released as an alternative to M-104 in cool areas but it was not as early or as cold-tolerant as its predecessor. However, M-105 has a superior milling yield and stability compared to M-104 and is at par or even better than M-205 or M-206. Reports during the 2012 planting season in Butte County indicate that M-105 is competitive with more popular Calrose varieties and is superior to M-104 in yield and agronomic performance.

M-202, M-205, and M-206 are the most dominant early maturing Calrose varieties planted in California to date. M-202 is an old favorite, and in its prime, comprised almost 70% of the rice acreage. Acreage in recent years of this variety is decreasing due to increased popularity and acceptability of the better yielding, widely adapted variety M-206 released in 2003. M-206 has far superior grain and milling yields, and better cold tolerance. California rice acreage for M-206 is now approaching 50%. Another high-yielding variety but with a more restricted area of adaptation, is M-205. It is later maturing than M-202, is very resistant to lodging, and has superior grain and milling yields. It is mainly adapted in warmer areas of the Sacramento Valley but performs poorly in cooler areas.

A blast-resistant variety, M-208, was released in 2006 in response to the threat the blast pathogen, IG-1, first observed in California in 1996. It carries the *Piz* gene which is effective in conferring resistance to IG-1. However, the blast resistance was short lived, and in the summer of 2010, blast infection was found in M-208 by a new race of the blast pathogen. Without the blast resistance, the future of M-208 is uncertain as it is not superior to other medium grains in terms of yield, adaptation or milling quality. M-401 and M-402 are premium quality medium grains that are planted on limited acreage because of their late maturity.

Breeding Objectives

The breeding goals in the Calrose project have not significantly changed over the years, but the focus and degree of emphasis have changed from time to time. The principal objectives remain to be the development of varieties with high and stable grain yield, high milling yield and excellent grain quality, cold tolerance, and disease resistance.

The most significant yield jump in California rice production happened during the transition from tall varieties to modern varieties with the semi-dwarf trait, M-202 being the most long-lasting and popular semi-dwarf variety.

Yields remained high and stable until the next jump, though not as dramatic, marked by the release of M-205 and M-206. As the yield potential is pushed higher, incremental yield increases are becoming more difficult and significant yield jumps will take a longer time to occur.

California medium grains are known for quality. Grain quality is defined in many ways. Quality can be an attribute of taste, aroma, texture, or appearance of cooked rice. Grain Quality can also be a measure of head rice or milling yield, whiteness, chalkiness, clarity, or shape of the grain. However consumers, millers, or the overall local and international markets define quality, one of the more important Medium Grain Breeding Project's breeding objectives is to develop high quality varieties that adhere to the standard of the Calrose brand.

Resistance to blanking and early seedling cold damage is a big problem and is being addressed by using foreign germplasm as new sources of cold tolerance genes and using refrigerated greenhouses and cold location nurseries for screening.

In the last couple of years, the project concentrated efforts in breeding and pyramiding new sources of blast resistance genes that are stable and take a longer time to breakdown. The basic strategy is to incorporate several blast resistance genes initially in M-206 background via marker-assisted backcrossing and move on with a similar strategy using M-205 and M-105 varieties. Ultimately, most medium grains for release will have blast resistance. With respect to stem rot and aggregate sheath spot, efforts to try to understand the genetics of resistance are gradually making headway.

Special Sub-Projects

The Breeding Program as a whole and the Calrose Breeding Project in particular, is continuously searching and evaluating traits that may add value to rice in California. By generating mutant populations derived from M-205, M-206 and M-401, we isolated interesting mutants that are short, early maturing, and perhaps show tolerance to certain herbicides. Generation of mutants and development of screening protocols is currently handled by Dr. C. Andaya.

Development of herbicide-resistant rice lines is a special project started by Dr. McKenzie for a number of years, working with UC weed scientists for guidance on popular or emerging chemical products and screening methods. Traditional introgression of imidazilinone herbicide resistance (Clearfield®) into M-205, M-206, and other medium grains are still being continued. However, it is not clear if the herbicide will eventually make it to the California market or if the breeding materials will reach quality medium grains standard.

The work on hybrid rice is still in its exploratory stage. Whether hybrid rice is economically feasible in California is still an open question.

Breeding Nursery Highlights

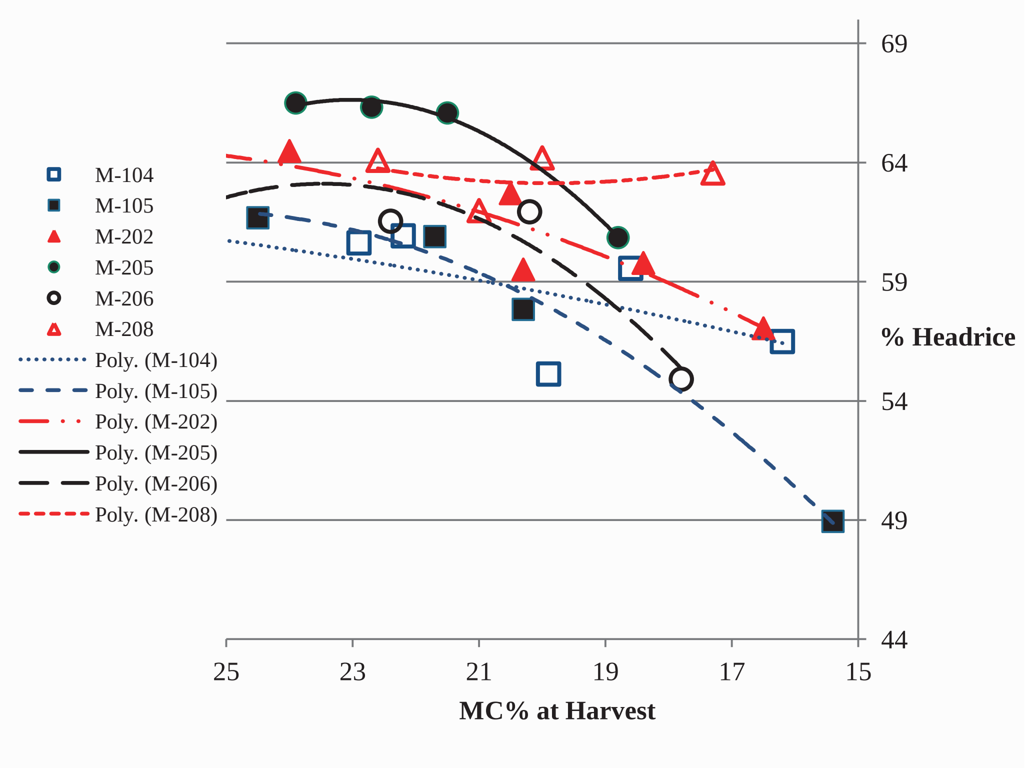
The RES Breeding Program initiated operational changes in managing the breeding nurseries and yield trials at the station. With the purchase of a research combine in 2011 to cut yield plots, plot dimensions were changed from 12' x 15' to 10' x 20'. In the medium and short grain nurseries, the 4' x 6' small plots were changed to 10' x 10' to enable the combine to cut the plots for yield. This change allowed the projects to measure yields in earlier generations, thereby eliminating low yielders and accelerating the promotion of materials for statewide tests. The milling plots, which measured 10’ x 15’ and 4’ x 6’, were centralized in one location at the RES nursery for a more efficient management and cutting by field crews.

Also in use during 2012 planting was a precision fertilizer drill mounted in a GPS-guided tractor to promote uniform fertilizer application, avoiding the yearly problem associated with aerial application. A warming basin was also set up for the yield trials to reduce the effect of low water temperature across the fields, thus reducing field variability. The warming basin may be upgraded to a recirculation system in the future.

Milling Performance

The milling yields, sampled from the centralized milling plot fields, were below average in 2012. The dry down period dragged on for most of the standard varieties, and took about 60 days from heading for kernel moisture content to drop to 20%. Head rice yields started falling at 21-22%, noticeable even to varieties with stable milling yields like M-206 and M-105 (Figure 1). Later maturing varieties performed better in percentage head rice compared to the very early maturing varieties. Possible reasons for the below-average and unusual performance of the varieties may be related to high temperature patterns during the growing period and the arrival of drying winds late in the season.

Figure 1. Percentage of head rice recovery at different harvest moisture levels for six medium grains rice varieties taken from the milling plots at RES in 2012.



Promising Advanced Line

An advanced line designated as 08Y3269 performed very well in the Statewide test in the last three years of yield testing, outperforming M-205 in warmer areas of the Sacramento Valley (Table 1). 08Y3269 is semi-dwarf, smooth, early maturing, regular Calrose rice derived from a cross made in 2004 with M-205 as the immediate parent. Compared to M-205, 08Y3269 registered a 3-year grain yield advantage of 4-5% in warmer areas such as in Butte and Colusa. It heads one to two days earlier, has a slightly larger kernel (Table 2), and similar vigor and height. The area of adaptation is similar to M-205 and therefore limited to warmer areas.

Some of its weaknesses are poor cold tolerance, therefore not adapted in cooler environment, and lower percent head rice.

In 2013, 08Y3269 will be entered in all locations of the Statewide test for further yield evaluation. Strip trials in selected locations and seed increase in headrows for further purification will also be done.

Table 1. Agronomic performance and grain characteristics of 08Y3269 across location and years.

Year	Location	SV‡	Days§	Lodging (%)	Height (cm)	Grain Yield#	% Yield Advantage vs.	
							M-205	M-206
Warm Locations								
2010	Butte	5.0	87	1	94	9380	18	11
	Colusa	5.0	98	2	99	11110	-1	5
	Biggs	4.8	90	0	94	10930	1	-1
	Yuba	5.1	93	3	109	10320	10	0
2011	Butte	5.0	96	1	99	9520	7	12
	Colusa	5.0	96	1	104	10210	5	3
	Biggs	4.8	93	0	102	10870	2	8
	Yuba	5.0	101	1	112	10260	3	1
2012	Butte	4.9	85	16	98	10210	6	11
	Colusa	5.0	92	1	96	10100	11	4
	Biggs	4.6	87	0	93	9870	-6	-1
	Yuba	4.9	96	52	102	9010	2	-2
Mean	08-Y-3269	4.9	93	6	100	10150		
	M-205	4.9	94	5	99	9720		
	M-206	4.9	86	27	103	9770		
Cold Locations								
2012	Biggs	4.8	86	0	97	10360	1	-1
	San Joaquin	5.0	118	1	82	6910	51	-23
	Sutter	4.9	88	3	87	9190	3	-1
	Yolo	5.0	92	89	107	9720	4	-2

‡ SV = seedling vigor score, where 1 = poor and 5 = excellent;
§ Days to 50% heading;
# Paddy rice yield in lb/acre at 14% moisture

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Table 2. Grain characteristics of M-205, M-206, and 08Y3269, from RES in 2012.

Identity	Grain Characteristics†					
	% MC	% Chalk	Length (L)	Width (W)	L/W ratio	Head/ Total
M-205	18.8	21.5	5.82	2.43	2.40	61/69
M-206	20.2	34.2	5.68	2.53	2.25	62/67
08Y3269	21.5	24.9	5.91	2.46	2.41	61/69

† %MC is moisture content at harvest and % chalk, L, and W measured by S-21 Analyzer.

Blast Resistance

In 2005, a backcrossing project was initiated to introgress different blast resistance genes (*Pi* genes) into M-206. Selection of materials for crossing and generation advance were made using DNA markers linked to these genes. Stable M-206 isolines (e.g. M-206+*Pik*^{m}, M-206+*Pi40*), or lines which are genetically identical to M-206 except in a particular gene, in this case *Pi* genes, were field-tested in 4'x6' plots in 2011 and in demonstration plots in 2012.

Agronomic performance and grain characteristics of the M-206 isolines and standard Calrose varieties are presented in Table 3. Compared to M-206, agronomic performance and grain characteristics varied depending on the resistance gene introgressed even after seven or eight backcrosses. Linkage drag, area of chromosome introgression, or agronomic penalties associated with specific resistance genes may account for the differences.

In 2012, four of the isolines were entered in a preliminary group of the Statewide Yield Tests. Test results are presented in Table 4. Compared to M-208, the blast resistant variety that contains the *Piz* gene, all four isolines yielded better than M-208 in all locations. Though yields are not significantly higher than M-205 or that of M-206, these isolines showed promise and any one of them could be a replacement for M-208. Considered as the "first version" of blast-resistant lines that came out of the backcrossing project, these lines are being used in crosses to further improve agronomic performance. Gene pyramids, containing two to four *Pi* genes, were also generated and are moving through the breeding pipeline at an accelerated rate.

All the isolines will be entered in a yield trial at RES to determine the grain yield and other important agronomic and grain characteristics, and possibly be entered in a preliminary group of the Statewide Yield Tests where blast infection is always observed. These studies will guide us in determining the most suitable resistance genes to use in medium grain breeding.

Stem Rot Resistance

Several genes control stem rot resistance. At least seven quantitative trait loci (QTL) were detected as per latest analysis by Dr. C. Andaya. Three of these QTLs were found to be consistent across locations and seasons (See DNA Marker Lab portion). The Medium Grain Project coordinated with RES pathologist Mr. Oster in screening the mapping population for stem rot resistance at the station with the goal of further narrowing down the chromosomal regions of interest.

In conjunction with this, the DNA Marker Lab will continue to screen for additional DNA markers that can be used for stem rot resistance mapping.◆

Table 3. Agronomic and grain characteristics of M-206 isolines containing individual blast resistance genes versus Calrose varieties from RES in 2012.

Designation	Seedling Vigor	Days to Heading	Grain Characteristics†					
			% MC	Head/ Total	%Chalk	Length (L)	Width (W)	L/W ratio
M-104	4.8	75	18.5	57/71	38	5.71	2.45	2.33
M-202	4.4	90	20.7	68/71	28	5.61	2.56	2.19
M-205	4.9	87	19.3	69/71	29	5.88	2.45	2.40
M-206	4.8	82	21.0	70/72	29	5.70	2.50	2.28
M-208	4.8	85	20.2	70/72	31	5.87	2.51	2.33
M-206+*Pik*^{h}	4.8	84	20.2	66/72	31	5.72	2.49	2.29
M-206+*Pik*^{m}	4.8	82	20.8	65/71	28	5.68	2.48	2.29
M-206+*Piz*^{5}	4.8	86	18.7	69/72	34	5.68	2.50	2.27
M-206+*Pi40*	4.8	85	19.4	68/71	32	5.69	2.50	2.28
M-206+*Pib*	4.8	83	17.0	67/71	37	5.78	2.51	2.30
M-206+*Pi9*	4.8	85	18.5	63/69	47	5.49	2.46	2.23
M-206+*Pita*^{2}	4.7	83	20.9	69/72	35	5.79	2.53	2.29
M-206+*Pi33*	4.7	81	19.2	69/73	33	5.52	2.50	2.21

† %MC is moisture content at harvest and % chalk, L, and W measured by S-21 Analyzer.

Table 4. Performance of selected blast isolines and check varieties in 2012 UCCE Statewide Yield Tests.

Designation	Grain Yield#	% MC	Grain Yield by Location (lb/acre)				SV‡	Days§	Lodging (%)	Height (cm)
			Biggs	Butte	Colusa	Yuba				
M-205	9520	22.0	10530	9600	9130	8840	4.9	91	14	97
M-206	9530	20.7	9980	9240	9680	9240	4.9	84	52	104
M-105	9220	19.6	10250	9490	8620	8510	4.9	80	81	104
M-208	8870	21.0	9560	8760	9350	7810	4.9	88	56	104
M-206+*Pik*^{h}	9220	21.8	10450	9170	9010	8250	4.9	85	50	107
M-206+*Piz*^{5}	9550	21.5	10420	9120	10020	8630	4.9	86	51	104
M-206+*Pi40*	9450	20.5	10360	8880	9670	8900	4.9	85	40	104
M-206+*Pib*	9620	20.7	10150	9580	9550	9180	4.9	85	43	102
LSD (.05)	490	1.2	1300	680	910	1070	0.2	1	19	3

‡ SV = seedling vigor score, where 1 = poor and 5 = excellent; § Days to 50% heading;
# Paddy rice yield in lb/acre at 14% moisture

PREMIUM QUALITY AND SHORT GRAINS PROJECT

Stanley Omar PB. Samonte

Introduction

The Premium Quality and Short Grains Project encompasses the improvement of varieties that are of the following types:

- Short grain, conventional (SG)
- Short grain, low amylose (SLA)
- Short grain, waxy (SWX)
- Short grain, premium quality (SPQ)
- Medium grain, premium quality (MPQ), and
- Arborio or bold grain (BG).

All new lines are being bred and selected for improved grain yield (and yield-related traits) and grain quality (milling or cooking), tolerance to cold temperature (reduced delay in maturity and blanking), lodging resistance, very early to early and uniform maturity, and resistance to diseases. In addition, there are specific trait parameters that have to be selected to qualify a line into a specific grain type. The rows and plots in nurseries and yield trials are compared against check varieties, which include S-102 for SG types, Calamylow-201 (CA-201) for SLA's, Calmochi-101 (CM-101) for SWX's, Calhikari-202 (CH-202) and Koshihikari for SPQ's, M-402 and M-401 for MPQ's, and 87Y235 for BG's, and selected lines must show improvements over their respective checks.

In the past two years (2010 and 2011), the estimated average percent of rice acreage in California was about 8.1% for MPQs, 3.5% for SWXs, 2.9% for SPQs, 1.7% for SGs, close to 0% for SLAs, and 0% for BGs (http://www.plantsciences.ucdavis.edu/ricestation/ccrrf_res-v28_030.htm). The first step to increase interest in growing SLA and BG lines would be to develop and have an improved variety of each type ready.

This year, Calhikari-202 (CH-202) was released as a new short grain premium quality variety. Its performance this year, as well as elite lines of the project, are presented in this report. One of the elite lines is short waxy-grain 09Y2141, and it is being proposed for experimental seed increase. Also presented in this report is the progress being made in the different nurseries, yield trials, and activities of this project.

Crossing

Artificial cross-pollination of selected parents was the main method of producing variable populations from which new lines and varieties will be selected and developed. Five hundred seventy-one crosses were made in 2012, consisting of 298 during the spring and 273 during the summer (Table 5).

F_1, F_2, Pedigree, and Winter Nurseries

F_1 seed produced from the crossing work in spring were planted in the Summer F_1 Nursery at RES. Of the 298 F_1 rows planted, 285 were selected for advancement to next year's F_2 nursery. Regarding the 273 F_1s produced during summer, 189 are growing in the Winter F_1 nursery at Kauai, while the remainder is growing in a greenhouse nursery at RES.

F_2 nurseries were established at RES and at San Joaquin County, which serves as a cold tolerance evaluation nursery. At RES, 318 of the 329 F_2 populations evaluated were selected, while at San Joaquin, 159 of the 324 populations evaluated were selected. The pedigree nursery at RES consisted of (excluding checks) 7677 F_3 lines, 3033 F_4s, 1377 F_5s, and 114 F_6s. These were evaluated for the targeted breeding traits resulting in the selection of 1,581 lines from the F_3s and 1259 lines from the F_4 to F_6 group. Some of the traits observed were heading, plant type (whether the leaves and tillers were erect), panicle density, awn, and lodging. Of these, 1116 lines were selected based on grain quality and planted in the 2012-2013 Winter Nursery at Kauai, Hawaii.

Yield Trials

Three levels of yield trials were conducted; 10 x 10 ft plot, 10 x 20 ft preliminary yield (PY), and 10 x 20 ft statewide or multi-location trials. There were 614 10 x 10 plots that were evaluated, consisting of 250 entries replicated once and 140 entries replicated twice. In the PY trials, 824 plots (planted on two dates) consisting of 175 entries were evaluated. In the SW trials, 27 entries were evaluated, consisting of the following:

- MBG – 1 entry
- MPQ – 14 entries + 2 checks
- SG – 5 entries (inc 1 SSR) + 1 check
- SLA – 2 entries + 1 check
- SPQ – 3 entries + 3 checks
- SWX – 2 entries + 1 check

Premium Quality Short Grain and New Variety Calihikari-202

Calhikari-202, which was released early last year (2012), was one of the entries in the Statewide Yield Tests, but this time it served as one of the check varieties. As a new release, its performance in 2012, as well as in recent years is presented here in comparison to CH-201 (released in 1999).

In the Statewide Yield Tests, CH-202 had higher grain yield than CH-201 in 20 out of 31 test environments (6 of 9 in 2010, 8 of 11 in 2011, and 6 of 11 in 2012) for a 3-year average of 8617 lb/A, which was 5% higher than that of CH-201 (8222 lb/acre) (Figure 2). CH-202 had higher yields than CH-201 mostly in RES, Sutter, Yolo, and Yuba test locations. Both varieties had similar seedling vigor, height, and head rice percentage, with CH-202 having an earlier heading and slightly more lodging (Table 6). Milled rice length and width were 4.5 and 2.5 mm for CH-202, respectively, and 4.6 and 2.5 mm, respectively, for both CH-201 and Koshihikari.

Panicle blanking in the cold tolerance tests in the greenhouse in 2012 was 18% for CH-202 and 23% for CH-201.

The agronomic and yield performance of CH-202, as well as check varieties and other SPQ entries, in the test locations in 2012 are shown in Table 7.

Waxy Short Grain

Two SWX lines were evaluated in this year’s statewide tests, 09Y2141 in the advanced group and 11Y2071 in the preliminary group. 09Y2141 had been evaluated in statewide tests since 2010, first as an entry in the early preliminary group (3LB), and then as an entry in both the very early (1LA) and early (3LA) advanced groups in 2011 and 2012, for a total of 19 test environments (or year-location combinations). In comparison to CM-101, 09Y2141 had higher grain yield in all test environments in which it was evaluated. The yield advantage of 09Y2141 over CM-101 ranged from 11 to 46%, for an average of 28% across environments (Table 8). Grain yield (averaged across environments) was 10,081 lb/acre for 09Y2141 versus 7854 lb/acre for CM-101.

Compared to CM-101, 09Y2141 was similar in seedling vigor, taller by about 1.4 cm, it required one more day to reach heading, and it lodged 5.3% more (Table 9). 09Y2141 had higher head rice percentages and larger grain size dimensions than CM-101. Grain length and width were 5.1 and 2.9 mm for 09Y2141, respectively, and 4.9 and 2.6 mm for CM-101, respectively. Blanking, based on the greenhouse cold tolerance tests, was higher in 09Y2141 than in CM-101.

As an elite line and possibly a replacement for CM-101, which was released in 1985, 09Y2141 was initially purified in isolated water-seeded headrows in 2012, and an official notification to propose for its experimental seed increase has been submitted.

The other SWX line evaluated in the statewide tests, 11Y2071 had a 10% higher grain yield than CM-101 (8430 vs. 7692 lb/acre), and its head and total milled rice percentages were 65 and 71%, respectively, compared to CM-101s 64 and 68%.

Conventional Short Grain

The project evaluated five entries in the statewide tests, consisting of 09Y2036 and 08Y2049 in the very early advanced group, 09Y2179 in early advanced group, and 10Y2043 and 11Y2040 in very early preliminary group (Table 10). S-102 (released in 1996) was the check variety upon which these entries were evaluated against. In 2012, both 09Y2036 and 09Y2179 had a 12% grain yield advantage over S-102. 09Y2179 had less lodging and panicle blanking than S-102 and 09Y2036, while 09Y2036 had higher head rice percentage than 09Y2179 (Table 11). 09Y2036 and 09Y2179 had superior performance to S-102 and they are being considered for initial purification in headrows in 2013.

SG 08Y2049, which had stem rot resistance (SRR) ancestry, had 7% higher grain yield than S-102, but it had lower head rice percentage. This line would be useful as a high yielding source of SR resistance.

Short Grain Low Amylose

In 2012, SLA line 09Y2159 was evaluated in the statewide early maturing advanced group, while 11Y2045 was entered in the preliminary group. 09Y2159 produced a 30% yield advantage and had less lodging than CA-201 (Table 12). Head rice and total rice percentages were similar (65 and 72% for 09Y2159 versus 66 and 71% for CA-201, respectively). Because of its superior yield and low lodging when compared to CA-201 (released in 2006), 09Y2159 is being considered for initial purification in headrows in 2013.

Premium Quality Medium Grain

Check varieties for the MPQ grain type are M-401 (released in 1981) and M-402 (released in 1999); they are late and intermediate maturing lines, respectively, and high yielding, especially M-402. In the statewide tests at RES, where all entries and checks were grown, there were 5 entries that had both higher yield (Table 13) and earlier heading than M-402 (97 days). These lines, which were still in the statewide preliminary group, were 11Y2182, 10Y2094, 11Y2183, 10Y2120, and 10Y2081, with number of days to heading ranging from 85 to 90 at RES. Among these, 11Y2183 had the highest head rice at 64%, compared to 65% for M-402. These lines will be evaluated in advanced group of the 2013 Statewide Yield Tests.

Arborio or Bold Grain Rice

Currently, Arborio or bold grain rice types are not being grown in California. RES has not yet released a BG variety, although it has released 87Y235 as a germplasm in 1994. The development of new BG lines is a first step to increase interest in this type of rice. The improvement of the plant type of our BG lines is of particular interest. Grain yield of 10Y2179 entered in the 2012 statewide preliminary group yielded 7665 lb/acre with head rice and total milled rice percentages of 52 and 66%, respectively.◆

Table 5. Number of crosses produced for each grain type group in of 2012.

Grain Type	No. of Crosses		
	Spring 2012	Summer 2012	Total
Short	31	72	103
Short Premium Quality	112	55	167
Short Waxy	38	49	87
Short Low Amylose	19	41	60
Medium Premium Quality	97	45	142
Bold	1	11	12
Total	298	273	571

Figure 2. Grain yield of Calhikari-202 and Calhikari-201 in UCCE Statewide Yield Tests in 2010 through 2012.

Table 6. Trait performance of short premium quality varieties CH-202 and CH-201 in the Statewide Yield Tests in 2010, 2011, and 2012.

Trait	2010		2011		2012		Average	
	CH-202	CH-201	CH-202	CH-201	CH-202	CH-201	CH-202	CH-201
SV †	5.0	5.0	4.8	5.0	4.9	5.0	4.9	5.0
Heading (d)	90	94	92	96	86	90	89	93
Height (cm)	91	91	94	94	90	93	92	93
Lodging (%)	51	23	35	33	74	71	53	42
Head Rice (%)	65	61	67	67	69	69	67	66

† SV = seedling vigor score, where 1=poor and 5=excellent.

Table 7. Agronomic performance (averaged across locations), and grain yield at specific locations and averaged across locations of short grain premium quality lines evaluated in the 2012 Statewide Yield Tests.

Group †	Variety	SV ‡ §	Heading (d) §	Lodging (%) §	Plant Height (cm) §	Grain Yield (lb/acre at 14%)				
						Mean	Loc 1	Loc 2	Loc 3	Loc 4
							RES	*Sutter*	*Yolo*	*San Joaquin*
1LA	CH-202	4.9	89	57	86	9070	9460	9050	9750	8000
1LA	CH-201	5.0	94	49	89	8720	8790	8350	9660	8070
1LB	11Y2059	5.0	87	40	86	8400	8440	8700	9150	7300
							RES	*Butte*	*Colusa*	*Yuba*
3LA	CH-202	4.8	82	91	94	8390	9000	8630	7370	8540
3LA	CH-201	5.0	86	92	97	7570	8680	8080	7430	6080
3LB	09Y2184	4.6	94	1	94	8590	10440	8340	7920	7680
3LB	11Y2049	4.9	87	57	102	7410	9450	7270	7140	5800
							RES	*Glenn*	*Sutter*	
7LA	CH-201	5.0	85	32	91	8820	9180	8000	9280	
7LA	CH-202	4.9	81	33	86	8720	9080	7970	9130	
7LB	KOSH	5.0	94	95	119	5490	5180	6850	4440	

† 1LA=Very early maturity, advanced group; 1LB = Very early maturity, preliminary group; 3LA = early maturity, advanced group; 3LB = early maturity, preliminary group; 7LA = intermediate/late maturity, advanced group; 7LB = intermediate/late maturity, preliminary group

‡ SV = seedling vigor score, where 1=poor and 5=excellent.

§ Averaged across locations

Table 8. Grain yield of 09Y2141 and CM-101 in Statewide Yield Tests in 2010, 2011, and 2012.

Year	Location	SW Trial †	Grain Yield (lb/acre at 14%)		% Yield Advantage over CM-101
			09Y2141	CM-101	
2010	Butte	3LB, 3LA	9370	6770	38
2010	Colusa	3LB, 3LA	12310	9390	31
2010	Yuba	3LB, 3LA	11170	8870	26
2011	RES	1LA	8850	8000	11
2011	RES	3LA	11430	8980	27
2011	RES	3LA	10280	7680	34
2011	Colusa	3LA	8000	6510	23
2011	San Joaquin	1LA	9580	7850	22
2011	Sutter	1LA	9030	7410	22
2011	Yolo	1LA	11580	8320	39
2011	Yuba	3LA	10740	7370	46
2012	RES	1LA	11130	8500	31
2012	RES	3LA	11060	8520	30
2012	Butte	3LA	10050	7190	40
2012	Colusa	3LA	8680	7700	13
2012	San Joaquin	1LA	8890	7880	13
2012	Sutter	1LA	9460	7500	26
2012	Yolo	1LA	10590	7450	42
2012	Yuba	3LA	9350	7360	27
Average			10080	7850	28

†1LA=Very early maturity, advanced group; 3LA = early maturity, advanced group; 3LB = early maturity, preliminary group; In 2010, 09Y2141 was entered in 3LB, while CM-101 as in 3LA

Table 9. Performance of short waxy grain 09-Y-2141 and CM-101 from 2010 to 2012.

Trait	2010		2011		2012		Average	
	09Y2141	CM-101	09Y2141	CM-101	09Y2141	CM-101	09Y2141	CM-101
Seedling Vigor	4.9	5.0	4.9	4.9	4.8	5.0	4.9	5.0
Heading (d)	83	84	92	90	86	83	87.0	85.7
Height (cm)	98	106	106	97	98	95	100.7	99.3
Lodging (%)	57	12	15	34	54	64	42.0	36.7
Head Rice (%)	-	-	65	58	66	64	65.5	61.0
Blanking (%) †	5	1	64	58	39	1	36.0	20.0

† Panicle blanking rating in cold tolerance evaluation in the greenhouse.

Table 10. Agronomic performance (averaged across locations), and grain yield at specific locations and averaged across locations of short grain lines evaluated in the 2012 Statewide Yield Tests.

Group †	Variety	SV ‡ §	Heading (d) §	Lodging (%) §	Plant Height (cm) §	Grain Yield (lb/acre at 14%)				
						Mean	Loc 1	Loc 2	Loc 3	Loc 4
							RES	*Sutter*	*Yolo*	*San Joaquin*
1LA	09Y2036	4.9	89	59	97	9610	10180	9640	9970	8640
1LA	08Y2049	4.1	89	9	86	9240	9430	9400	9350	8800
1LA	S-102	5.0	84	31	91	8610	9370	8470	8400	8180
1LB	10Y2043	4.9	87	38	91	10270	10930	10300	10960	8900
1LB	11Y2040	4.9	84	12	91	9530	9750	10070	9920	8390
							RES	*Butte*	*Colusa*	*Yuba*
3LA	09Y2179	4.9	89	1	102	9270	10280	10190	9650	6960
3LA	S-102	4.9	78	88	99	8290	9500	8220	7460	7970

† 1LA=Very early maturity, advanced group; 1LB=Very early maturity, preliminary group; 3LA=early maturity, advanced group; 3LB=early maturity, preliminary group;

‡ SV = seedling vigor score, where 1=poor and 5=excellent.

§ Averaged across locations

Table 11. Grain quality and dimensions and panicle blanking of short grain lines evaluated in the Statewide Yield Tests at RES in 2012.

Variety	Head Rice (%)	Total Rice (%)	Grain Length (mm)	Grain Width (mm)	Panicle Blanking (%) †
08Y2049	53	67	5.21	2.74	20
09Y2036	65	69	5.28	2.95	17
09Y2179	62	71	5.13	2.83	3
10Y2043	57	63	4.89	2.65	39
11Y2040	64	68	5.06	2.66	6
S-102	62	68	5.34	2.93	20

† Based on cold tolerance evaluation in greenhouse at RES.

Table 12. Agronomic performance (averaged across locations), and grain yield at specific locations and averaged across locations of low amylose short grain lines evaluated in the 2012 Statewide Yield Tests.

Group†	Variety	SV ‡ §	Heading (d) §	Lodging (%) §	Plant Height (cm) §	Grain Yield (lb/acre at 14%)				
						Mean	RES	Butte	Colusa	Yuba
3LA	09Y2159	4.3	89	33	99	8720	9430	8880	8760	7810
3LB	11Y2045	5.0	89	66	104	7990	9950	7500	7380	7140
3LB	CA-201	5.0	83	90	99	6670	7230	7560	6320	5570

† 3LA=early maturity, advanced group; 3LB=early maturity, preliminary group
‡ SV = seedling vigor score, where 1=poor and 5=excellent.
§ Averaged across locations.

Table 13. Agronomic performance (averaged across locations), and grain yield at specific locations and averaged across locations of premium quality medium grain lines evaluated in the 2012 Statewide Yield Tests.

Group†	Entry	SV ‡ §	Heading (d) §	Lodging (%) §	Plant Height (cm) §	Grain Yield at 14%				
						Mean	Loc 1	Loc 2	Loc 3	Loc 4
							RES	*Sutter*	*Yolo*	*San Joaquin*
1LB	11Y2022	5.0	92	23	97	9240	9410	9480	9530	8540
1LB	11Y2023	5.0	93	69	102	8980	9410	9170	8870	8460
1LB	11Y2032	5.0	98	26	99	8490	9810	8670	9000	6490
1LB	11Y2021	5.0	97	21	89	8420	9480	8800	8800	6590
							RES	*Butte*	*Colusa*	*Yuba*
3LB	11Y2182	3.8	94	14	97	9390	10430	9690	8010	9420
3LB	11Y2112	4.9	90	27	99	9160	9740	9320	9430	8140
3LB	10Y2094	4.8	87	50	102	9090	10470	8570	9340	8000
3LB	11Y2192	4.9	85	94	112	8290	9420	8850	7160	7720
							RES	*Glenn*	*Sutter*	
7LA	M-402	5.0	97	2	99	9190	10260	8260	9040	
7LA	09Y2176	5.0	91	9	102	8770	10110	8120	8080	
7LB	11Y2183	5.0	91	12	102	9620	11650	9360	7850	
7LB	09Y2173	5.0	93	34	112	8970	10080	8310	8510	
7LB	10Y2120	4.9	89	16	104	8890	10370	8270	8040	
7LB	M-401	5.0	103	34	107	8620	8630	10030	7200	
7LB	10Y2081	5.0	89	32	102	8500	10610	8360	6540	
7LB	09Y2174	5.0	87	68	107	8470	9410	8280	7720	

† 1LB=Very early maturity, preliminary group; 3LA=early maturity, advanced group; 3LB=early maturity, preliminary group; 7LA=intermediate/late maturity, advanced group; 7LB= intermediate/late maturity, preliminary group
‡ SV = seedling vigor score, where 1=poor and 5=excellent.
§ Averaged across locations.

LONG GRAINS

Farman Jodari

The long-grain breeding project continues its research and breeding efforts to develop superior long grain varieties of four major quality types for California, including 1) Conventional long grain, 2) Jasmine, 3) Basmati, and 4) Aromatic types. Milling and cooking quality improvements of conventional and specialty long grain types remain a major priority objective in this program, followed by resistance to cold induced blanking and other agronomic and disease resistance traits.

Conventional Long Grain

The long-grain rice market in the US is based on quality characteristics of Southern US varieties. Cooking quality of conventional long-grain types are characterized, for the most part, by intermediate amylose content (21 to 23%), intermediate gelatinization temperature (alkali spreading value of 3 to 5), and a moderate viscogram profile. Extensive cooking quality screening and selection efforts in recent years have eliminated the majority of texture softness from the California long-grain breeding material. Consequently, less intense cooking quality screening is required within the conventional long-grain breeding material. The primary focus is currently being directed toward milling yield and cold resistance improvements.

L-206, a conventional long-grain quality variety, was released for commercial production in California in 2006. Cooked grain texture of L-206 is harder than L-204 as indicated by its amylographic profile and therefore compares favorably with Southern US produced long grains. Milling yield of L-206 is 1-2 % lower than L-204. Recent studies, however, indicate that L-206 is significantly more resistant to grain fissuring than L-204, indicating more stable milling yield at lower harvest moisture. Primary advantages of L-206 over L-204 are improved cooking quality, higher grain yield, and earlier maturity.

L-206 is a very early to early maturing semidwarf variety. Average heading date is 1 day earlier than M-206. Plant height is 14 cm shorter than M-206. Lodging potential is significantly lower than M-206, however, due to earlier maturity, plants may lean due to excessive dryness after harvest maturity. Similar to Southern long grain types, L-206 has intermediate amylose and gelatinization temperature types.

Grain yield of L-206 in 2012 multi-location, early and intermediate maturity groups, Statewide Yield Tests averaged 9590 lb/acre (Tables 23 and 25). Average yield for M-205 within the same tests was 9605 lb/acre. Yields of L-206 at colder locations of Yolo and San Joaquin have not been as competitive as medium grain varieties. Based on the results from multiple locations and multiple years, L-206 has shown good yield stability and is adapted to most of the rice growing regions of California except the coldest locations of Yolo and San Joaquin Counties. Average head rice yield of L-206 during 2006–2012 seasons was 62%. Kernel length of L-206 ranged between 7.1 and 7.3 mm.

In 2012, the USA Rice Federation Rice Marketability and Competitiveness Taskforce continued to sponsor a comprehensive study, for the third year, to address quality and marketing issues with US long-grain rice. Nineteen long-grain varieties and hybrids from Southern US as well as L-206 from California were evaluated for market acceptability by 9 Southern milling organizations and USDA rice quality lab. All 19 Southern varieties and hybrids were uniformly grown in 6 locations and 2 seeding dates. Two L-206 samples were provided from RES foundation and increase fields to represent optimal and late planted samples. To maintain uniformity, all samples, a total of 224, were milled and processed by a Louisiana rice mill and provided to evaluating rice mills and USDA quality lab. Two commercial milled samples, considered high package quality, from Thailand and Uruguay were also included in the study. RES participated in the effort by providing image analysis measurements using S-21 Analyzer instrument. Results of evaluations of 2012 crop indicated that L-206 was ranked 1st among all US varieties and hybrids for package quality by the participating rice mills. Evaluation criteria that were used included; bran streaks, chalk, kernel color, uniform length, and overall appearance. Percent chalk content of L-206, as measured by two methods, Russell Marine, and Winseedle, was also lowest, with the exception of commercially milled sample from Thailand.

The long-grain project is currently placing high selection pressure to recombine various quality and agronomic traits, including milling, and cooking qualities, market acceptance, and grain yield. Agronomic and milling characteristics of selected conventional lines with improved quality traits are listed in Table 14. Entries 12Y020, 10Y1008, 11Y1008, and 06Y575 performed well in 2012 statewide tests as compared to standard varieties. Entry 06Y575 is a high amylose/low gelatinization temperature type, with high yield potential, good milling yield, and cold tolerance. This experimental line has shown exceptional yield potential for 4 consecutive years in cooler locations such as San Joaquin as well as the warmer locations like Glenn County. The unique wide adaptability trait of this line is being incorporated to a considerable number of long grain breeding lines. Due to unique quality combination of this line and lack of response for processing uses in California further testing will not continue in 2013. Progenies of 06Y575 crossed to other elite lines that contain intermediate amylose and gel type have been selected and will be included in preliminary yield tests in 2013.

Table 14. Performance of selected conventional long-grain entries as compared with standard varieties in 2012 yield and milling tests.

Entry	Type†	Identity	Yield‡		Head Rice§
			Statewide	RES	(%)
Very Early Statewide					
20	LR	12Y20	9820	10290	65
18	LSR	10Y1008	9350	10370	64
1	L	L-206	9050	10020	62
14	M	M-206	9660	10420	--
Early Statewide					
64	L	11Y1008	10180	11650	62
63	L	09Y1122	9940	11350	62
62	LR	06Y575	9900	10400	62
61	L	L-206	9600	10510	62
74	M	M-206	9530	9980	--
Intermediate Statewide					
130	LSR	12Y130	9370	10740	64
122	LR	06Y575	9950	10980	62
121	L	L-206	9580	11180	62
128	M	M-205	9690	11210	--
Very Early Preliminary					
1045	L	11P631	--	11350	60
1077	L	11Y153	--	10990	63
1001	L	L-206	--	9550	62
Early Preliminary					
1145	L	10P1143	--	10500	63
1081	L	L-206	--	9770	62
Intermediate Preliminary					
1176	L	11P200	--	11490	60
1162	L	L-206	--	10620	62

†L=long grain intermediate amylose type, LR=long grain high amylose type, L=long grain stem rot, and M=medium grain.
‡ Paddy rice yield in lb/acre at 14% moisture.
§Head rice yields are from solid seeded stands for statewide tests and single rows for preliminary yield tests.

Specialty Long Grains

Expanded breeding efforts in specialty long grain area continued in 2012. Specialty types occupy 50% of the long grain nursery and include Jasmine, Basmati, and conventional aromatics such as A-201. Agronomic and quality of selected specialty lines are shown in Tables 15 and 16.

Calmati-202 is a true basmati variety released in 2006. It is an early maturing, semi-dwarf, pubescent, aromatic, elongating long grain. Susceptibility to cold induced blanking is significantly higher than standard varieties and therefore is not adapted to cold locations. Average yield of Calmati-202 in 2012 early and intermediate-late tests were 6820 lb/acre as compared to 9590 for L-206 (Tables 23 to 26).

Grain and cooking qualities of Calmati-202 is considerably closer to imported basmati types than Calmati-201. Due to finer grain shape, the yield potential of Calmati-202 is 10% lower than Calmati-201. Calmati-202 is not intended as a replacement for a higher yielding conventional aromatic variety such as A-201.

Milled rice kernels of Calmati-202 are longer than Calmati-201 and slightly shorter than imported basmati rice available in the US market. Grain width is more slender than Calmati-201, but not as slender as imported basmati rice. Cooked kernel length of Calmati-202 is also slightly longer than Calmati-201. The overall appearance of cooked basmati type rice is an important quality feature among basmati rice consumers. Cohesiveness of the cooked grains as well as grain shape and texture of Calmati-202 are distinguishable improvements over Calmati-201. Cooked rice of Calmati-202 that was aged nearly one year was preferred by taste panelists over Calmati-201. Grain fissuring studies have shown that both Calmati-201 and Calmati-202 are susceptible to fissuring at low harvest moistures (data not shown). Timely harvest and proper handling is recommended to preserve milling as well as cooking qualities of this variety. Due to slender grain shape and pubescent hull and leaf, drying rate of the grain at harvest is significantly faster than standard varieties. Recommended harvest moisture is 19 percent.

Three improved experimental basmati lines, 11Y158, 10Y1199, and 11Y1079 were tested in the 2012 Statewide Yield Tests. Cooking quality evaluations of these lines in earlier generations has shown considerable quality advantages over Calmati-202. 11Y158 is an early maturing, true basmati type, pubescent experimental line that was in the advanced purification stage in 2012. Headrow components from these lines are being evaluated for subtle basmati quality differences such as cooked grain texture. Primary advantages of these lines over Calmati-202 variety include higher cooked kernel elongation, more slender grain shape, and a closer cooked grain texture to imported basmati as shown by RVA profile (Table 16). Aging of this selection by one year has increased its RVA viscosity values as shown in that table. A stronger RVA profile is expected to improve cooked grain texture resulting in more flakey cooked rice as is the case with imported basmati. Average grain yields over 6 statewide locations was 5980 lbs/acre for 11Y158 and 6820 lb/acre for Calmati-202 (Table 16). Primary drawback of 11Y158 is a low milling yield of 36%. This compares with 61% for Calmati-202. Small experiments have been planned for 2013 to identify harvesting and processing procedures that can enhance milling yield and cooking quality. These factors include harvest moisture, drying rate, and milling degree. Based on the current grain and head rice yield estimates, whole grain production per acre of this line can be estimated at 2100 lb/acre. Standard long grain variety L-206, at the same time, with the current level of production can potentially yield 6200 lb/acre of whole grain. The current market price differential between basmati rice and standard long grain is considerably higher than 3 to 1 ratio. Milled samples of 11Y158 from 2012 crop season will be provided to potential marketing organizations for their evaluation.

Efforts continued in 2012 to develop jasmine types through pedigree and mutation breeding. Crosses and backcrosses were made with jasmine type material from various sources including Southern U.S. breeding programs and foreign introductions. The extreme photoperiod sensitivity of the original Thai Jasmine variety, Kao-Dak-Mali 105 (KDM), has been a significant breeding barrier. Pedigree and mutation breeding efforts are generating breeding lines with diverse and unique quality combinations. Primary objective is to incorporate imported jasmine quality into adapted breeding lines.

In 2012, 5 jasmine type selections were tested in the UCCE Statewide Yield Tests and 46 in preliminary yield tests. Breeding objectives for jasmine type quality include low amylose, strong aroma, a high degree of whiteness, and a smooth cooked grain texture.

Efforts in the area of conventional aromatics increased in 2012 due to a need for an A-301 type variety replacement that possessed improved agronomic traits. Three experimental lines, 11Y1049, 11Y1096, and 12Y139 were tested in 2012 statewide tests. Entry 11Y1049 has been selected and is currently being increased as a special breeder seed in Hawaii winter nursery as well as RES greenhouse facility. A putative foundation seed increase is planned for 2013. Additional selections will be tested in 2013.

Milling Quality

Continued improvement in milling yield and milling stability of new long grain varieties to the level of medium grains remains a major objective. Grain characteristics are being evaluated and selected that will lend milling yield stability to long-grain lines under adverse weather conditions and allow a wider harvest window. These may include hull cover protection, grain formation, or physicochemical properties of the grain that result in fissuring resistance. In 2012, all selections in preliminary and advanced yield tests were evaluated in special small or large solid seeded plots to obtain more accurate milling yield evaluation. Advanced lines were evaluated at 6 to 8 different harvest moistures and preliminary entries were tested at two harvest moistures. The goal for long grain is to maintain a minimum of 64% head rice yield in all advancing breeding lines.

Disease Resistance

SR resistance originating from *Oryza rufipogon* continues to be incorporated into an increasing number of high yielding long-grain lines. Twenty-four entries with a range of SR resistance were tested in 2012 Statewide and Preliminary Yield Tests. Performance of a selected number of these lines is shown in UCCE Statewide Yield Tests (Tables 21 to 26). Despite a close linkage in the SR resistance trait with increased chalkiness and cold susceptibility, selections are being obtained that have broken such a linkage and have combined low SR score, low blanking, and high milling yield.

Entry 10Y1008 is a stem rot resistant line that compared favorably with L-206 grain and milling yield in 2012 (Table 21). This line was scored as the most resistant entry in 2012 statewide disease screening tests. Preliminary yield tests in 2012 also showed record yields, within long-grain nursery, from a number of stem rot resistant populations. ◆

Table 15. Performance of selected specialty long-grain entries in 2012 Statewide Yield and RES milling tests.

					Yield†					
Entry	Type	SV	DH	Ht	RES	Butte	Colusa	Yuba	Avg.	HR‡
L206	L	4.6	84	85	10514	9380	9400	9100	9600	62
10Y1059	LJ	4.7	84	97	9902	9520	8380	8370	9040	61
12Y87	LJ	4.7	86	87	9702	7580	7400	8730	8350	57
CT202	LB	4.8	86	90	7986	7910	5340	5570	6700	58
11Y1079	LB	4.9	82	85	7974	7490	6130	7020	7150	42
10Y1199	LB	4.5	92	102	7764	6560	5900	4720	6240	34
11Y158	LB	4.7	86	86	7545	5720	4680	4400	5590	36
A301	LA	3.6	93	84	8637	8200	6580	5700	7280	53
A201	LA	5	89	87	8478	8230	8140	7240	8020	53
11Y1049	LA	4.8	85	95	9991	9040	9260	8210	9130	60

† Grain yield in lb/acre at 14% moisture.

‡ Head rice yields are from solid seeded stands for all entries.

Table 16. Kernel and cooking quality characteristics of 11Y158.

	Milled Kernels†								RVA			
ID	Area	L	W	L/W	100 kwt	Elong ‡	Amylose Content	Gel type	Peak	Hold	Final	Setback
CT202	12.2	7.5	2.0	3.8	2.02	2.11	Int	Int	226	134	257	31
11Y158	9.4	7.1	1.6	4.3	1.44	2.32	Int	Int	137	107	235	98
11Y158 - aged 12 Months						2.33			160	115	293	133
Basmati Import-A	10.6	7.5	1.8	4.2	1.68	2.34	Int	Int	161	128	280	119
Basmati Import-B	10.2	7.2	1.8	4.1	1.54	2.31	Int	Int	121	105	287	166

†Area in mm^2, L=length in mm, W=width in mm, L/W=L/W ratio, and 100 kernel weight in g.

‡ Increase in kernel length from milled rice after cooking.

RICE PATHOLOGY

Jeff Oster

Breeding for disease resistance is a cooperative effort between the plant breeders and plant pathologist. The pathologist produces disease inoculum, conducts a disease nursery, identifies resistant germplasm, and screens statewide and preliminary trial breeding lines and varieties (about 2380 rows) for stem rot resistance in the field. Since 2005, the immediate backcross program involved screening entries for blast, SR and SS. The objective was to transfer resistance genes into an M-206 background for use by the breeders. The backcrossing has been transferred to the breeders, and advancing generations from those crosses have been screened for both SR and SS resistance (550 rows plus greenhouse SS screening). In addition, early generation materials derived from breeder's crosses are cycled through the disease nursery to identify and verify disease resistant lines (about 2200 rows). Intense selection pressure is applied for important agronomic traits because sources of disease resistance have a number of undesirable characteristics. The sources of SR resistance also confer aggregate and bordered sheath spot (SS) resistance. Conversely, the sources of SS resistance also seem to confer SR resistance in some materials.

Stem Rot

Screening for SR resistance in inoculated nurseries and greenhouses usually begins in F_3 for materials provided by the breeders. Resistant germplasm often has low seedling vigor, low tillering, susceptibility to blanking, and late maturity. Only a small percentage of the lines screened show higher levels of SR resistance than current varieties. There were about 5200 rows in the 2012 SR nursery.

This year, 3640 rows in the stem rot nursery were drill seeded. This resulted in less seed drift, establishment of a more uniform stand, and allowed use of higher nitrogen without inducing lodging. Increased nitrogen results in greater disease severity and better screening.

Promising long and short grain resistant lines are emerging, but progress has been slow with the medium grains.

As in the past, some lines (derived from all donor parents) again showed SS resistance equivalent to that found in sheath spot donor parents (see Aggregate Sheath Spot below).

In addition, 2415 BC_3F_3 rows of a population established for fine mapping of SR resistance genes from *Oryza rufipogon* (originally identified in a BC_1 mapping population) were evaluated for SR resistance in the field at two sites at the RES.

Molecular markers would enable selection for disease resistance without having to perform biological screening and the uncertainties of environmental fluctuations that come with it. Such markers would allow early generation identification of resistant seedlings before crossing, thus greatly speeding the breeding process.

Aggregate Sheath Spot

An immediate backcross program was started in 2005 to transfer aggregate sheath spot (SS) resistance genes from Teqing, Jasmine 85, and MCR10277 to M-206 and L-206. Existing segregating populations from various backcrosses are now being advanced in the greenhouse, where sheath spot screening is conducted. In addition, these same materials were grown in the SR field nursery. As in the past, some lines (derived from all three donor parents) again showed SR resistance equivalent to that found in the wild species.

Blast

Rice blast disease in California was identified for the first time in 1996 in Glenn and Colusa Counties. It spread over significantly more acres in 1997, and has reached Sutter (1998), Butte (1999), and Yuba (2000) counties. From 1998 to 2009, blast severity was much lower than in previous years. A few affected fields continue to be found, mostly on the west side of the valley. Severity and extent of affected acres in 2010 was higher than most previous years, and even greater in 2011. Significant blast was also present in RES fields for the first time in 2011. Blast was lower in severity and incidence in 2012, perhaps because of a summer hot spell at the time the disease would normally be spreading. M-104 appears to be more susceptible than other varieties, followed by M-205.

Historically, major resistance genes limit blast symptom expression to small brown flecks at most, but different races of the blast fungus can overcome this resistance within several years after variety release. The first blast resistant variety (M-207, possessing the *Piz* gene) was released in 2005, followed by M-208 (also with *Piz*) in 2006.

IRRI reported development of monogenic lines each containing one major gene for blast resistance. These lines were brought through quarantine and tested to verify their blast resistance to the IG1 race present in California. A backcross program was started in 2005 to introduce these genes into M-206.

Only genes with a wide spectrum of blast resistance in worldwide tests were chosen (*Pib*, *Pik*^{h}, *Pik*^{m}, *Piz*^{5}, *Pi9*, *Pi40*, and *Pita*^{2}). Seven backcrosses were made and screened for blast resistance. Theoretically, 99.6% of genes in this material are from M-206. In 2009, homozygous resistant lines were selected from the F_2 aided by molecular markers. Selections were made from these lines and brown rice has been evaluated for seed traits by the medium grain breeder. Four lines (*Pi40*, *Piz*^{5}, *Pikh*, *Pib* genes) were entered in the early statewide trial in 2012, and they yielded more than M-208, and even as much as M-206.

Blast infection was found in M-208 fields in 2010-12. DNA tests confirmed that infected plants were M-208 and DNA markers indicated the *Piz* resistance gene was present. UC Riverside researchers found that DNA patterns of all fungi isolated from M-208 are similar to each other (genetically closely related, or of the same lineage) and to the IG1 race found in 1996.

A new race has been found which is significantly different from IG1. So, even though all isolates appear to be genetically related, the M-208 isolates can infect rice with *Piz* and *Pik* resistance genes, while IG1 isolates cannot. This virulence pattern is representative of race IB1.

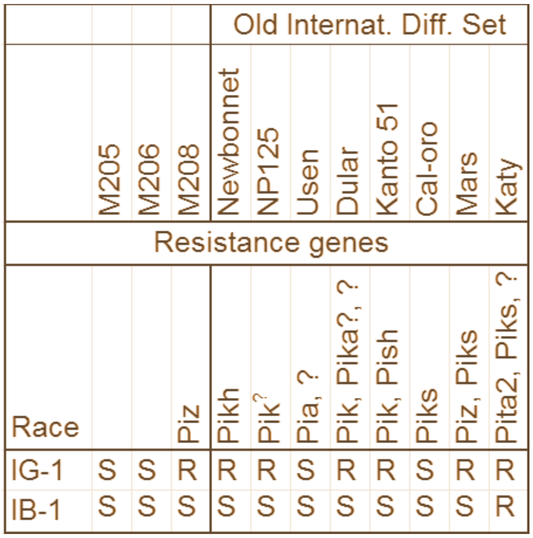
Lines with different blast resistance genes from the M-206 backcross program (below) were screened against the M-208 isolates. Again, lines with *Pik*^{h} and *Piz* genes were susceptible. However, lines with other genes were resistant.The components of M-208 were also tested individually. They are still resistant to IG1, but not IB1. It is too early to judge whether *Piz* resistance has been overcome in an epidemiological sense, since frequency of infection in M-208 fields was about 1 in 5000 to 10,000 plants in 2010-12. The new race may be able to attack scattered M-208 plants (it is virulent), but we do not know if it will severely damage M-208 in the future (will it be reproductively fit?). In California, it may be difficult to determine whether the blast fungus has overcome *Piz* resistance in subsequent years if environmental conditions are not as favorable to disease as in 2010-11.

The project by Dr. C. Andaya to develop molecular marker screening for blast has been successful. The following table summarizes findings from this project.

Marker	Gene
RM224	*Pi1, Pik*^{h}
RM1233	*Pik*^{m}
AP5930F	*Pi2, Piz, Piz*^{5}*, Pi9, Pi40*
RM7102	*Pita*^{2}
RM208	*Pib*
RM331	*Pi33*

Pi40, Pik^{h}*, Pita*^{2}, and *Pi33* genes from the above program have been pyramided into 4 gene lines, and are being advanced for agronomic evaluation. These genes were chosen for their broad spectrum and complementary resistance to blast races. Unfortunately, the new race IB1 can attack *Pikh*, but this was not known when the pyramid was being constructed. At the same time, 2 and 3 gene combinations have been identified. Presence of several genes in a variety should prevent rapid loss of resistance when exposed to natural blast fungus populations.

Several hundred blast single spore IB1 isolates taken from M-208 and typical IG1 isolates will be screened first on the old international differential set of varieties and then on the new IRRI monogenic and NIL lines (which represent a wider variety of blast resistance genes). Monogenic lines have only one blast resistance gene, but may have different genetic backgrounds. NIL (near isogenic lines) have one gene per line and have nearly the same genetic background. NILs are preferable, since they differ from each other only for the blast resistance gene. The following table demonstrates how an IG1 and IB1 race differ from each other on the old differential set (R=resistant, S=susceptible). Farm Advisor Dr. Chris Greer has indicated he would like to have DNA of selected isolates sequenced by UC Davis facilities. Hopefully, the segments of DNA which make IG1 and IB1 races different can be identified. In this way, races could be determined by DNA tests in the same way that blast resistance genes are now identified.



				Old Internat. Diff. Set							
	M205	M206	M208	Newbonnet	NP125	Usen	Dular	Kanto 51	Cal-oro	Mars	Katy
Resistance genes											
Race			Piz	Pikh	Pik$^{?}$	Pia, ?	Pik, Pika?, ?	Pik, Pish	Piks	Piz, Piks	Pita2, Piks, ?
IG-1	S	S	R	R	R	S	R	R	S	R	R
IB-1	S	S	S	S	S	S	S	S	S	S	R

Quarantine Introductions

The building blocks for any breeding program are varieties with traits desirable in commercial production. From time to time, varieties are imported for use in the breeding program. Seed of 14 IRRI NIL lines were brought through quarantine this past year using a special USDA/CDFA permit. This permit allows brown rice to be brought directly to RES for quarantine processing.

All introductions were grown under procedures developed and approved by USDA and CDFA to prevent introduction of exotic pests and rice diseases. This expedited process helps the breeding program and the industry to maintain a competitive edge in the world rice market while preventing the introduction of new pests to California.◆

DNA MARKER LAB

Cynthia Andaya

The DNA Marker Lab performs activities in support of the different breeding programs and spearheads the implementation of special projects. The DNA lab is involved in the following: (1) Mapping Stem Rot Resistance, (2) Pyramiding of Blast Resistance Genes, (3) Marker-Aided Selection for the different grain types (4) Fingerprinting Activities of various materials, (5) Herbicide Resistance Rice Project, and (6) Mutagenesis.

Mapping Stem Rot Resistance

An advanced backcross recombinant inbred line mapping population from the cross 87Y550/M-206*2 was used to map the stem rot resistance from *O. rufipogon*. In 2010, microsatellite markers were screened for polymorphism and 100 markers were found polymorphic and were used for mapping in 2011. Seven more markers were added to the map in 2012. Replicated trials were done at RES in 2010 and at RES and Colusa in 2011. Stem rot scores of the different lines were evaluated by pathologist Jeff Oster and Marker and QTL analyses were done by the DNA Lab. Last year, Resistance QTLs were reported in Chromosomes 4, 6, and 10.

In 2012, the two–year data was further analyzed using a very sensitive method for detecting QTLs with smaller effects. Seven QTLs were identified to contribute to stem rot resistance. QTLs were detected in Chromosomes 1, 2, 3, 4, 5, 6 and 10. Stem rot QTLs (qSR) in Chromosome 3, 6, and 10 were consistent in both years and in two locations (RES and Glenn). These three QTLs account for 40% of the stem rot resistance observed. One QTL in Chromosome 4 (qSR4) detected only in 2010 accounts for 10% of the stem rot resistance. Three QTLs in Chromosomes 1, 2, and 5 were only detected in 2011 and explains 23% of the stem rot resistance observed.

We are actively looking for additional polymorphic markers to narrow down the region of interest. Currently, plant breeder Dr. Virgilio Andaya and pathologist Mr. Jeff Oster are developing a mapping population to expand our population size. Once another mapping population is generated, we will do another round of DNA marker analysis and replicated stem rot evaluation. This is all aimed at finding a tightly linked marker to stem rot resistance that can be used for marker-aided selection by the different breeding program.

Pyramiding of Blast Resistance Genes

Rice blast disease caused by the fungal pathogen *Magnaporthe oryzae* causes considerable damage to rice. Although rice blast is not prevalent in California, it could pose a serious concern. M-208 was released in 2005 and contains a major blast resistance gene *Piz*, but blast symptoms have been observed in some fields.

RES pathologist Jeff Oster initiated a backcrossing program in 2005 to incorporate several blast resistance genes into M-206 background. Last year, we screened 5600 F_2 plants from different crosses for four blast resistance genes using DNA markers (AP5930, RM224, RM331 and RM7102). These materials have resistance genes from 4 blast resistance sources namely: Drew (*Pita2*), C101LAC (*Pi33*), Cocodrie (*Pikh*) and IR65482-4-136-2 (*Pi40*). We have identified 36 plants that contain all 4 blast resistance genes. These plants were grown in the greenhouse in 2012 and were used in medium grain project crosses. These materials were also planted in the field in 2012 for plant breeder evaluation.

Marker-Aided Selection

The main goal of the DNA lab is to help the breeders in their selection process. As such, the DNA lab's time for 2012 was devoted mostly for MAS. This year, we screened 14,400 lines for MG project using the 4 blast resistance markers generating 57,600 data points (Table 17). The markers help identify plants that contain the resistance genes, thereby precluding the laborious blast inoculation tests in the greenhouse.

For the long-grain project, 2300 lines were screened for five grain quality markers. Using the markers: gt-alk, RM 190, and Waxy SNPs Intron1, Exon6, and Exon10, about 11,500 data points were generated. The genotype scores for these markers give the breeder a predicted quality score in terms of gel temperature, amylose type, and viscosity. Though the marker data is not the breeders' ultimate selection criteria, it can assist them in discarding materials that do not conform to their set standard.

To assess the DNA Lab's productivity, the 2-year MAS request is presented (Table 18). The number of lines analyzed by the DNA lab increased from 7672 lines in 2011 to 16,700 lines in 2012. There was a 110% increase in the number of lines analyzed in the lab. In terms of data points, there was a 122% increase in the data points generated from 28,360 in 2011 to 69,100 data points in 2012.

Fingerprinting of various materials

An important component of the DNA lab is to provide research personnel with assistance in variety identity and purity. In 2010, we started building a marker database to fingerprint the California varieties. To date we have 110 markers that we have run against 48 rice varieties (data not shown). We are continuously adding markers to our database because successful fingerprinting depends largely on finding markers that can distinguish one variety from another. Currently, we have a panel of 11 markers that can distinguish the CA medium-grain varieties from each other. We will develop a similar panel for the long-grain and short-grain varieties.

In previous 2 years, fingerprinting activities were done on a small scale dealing mainly with variety identity, determining if plants from blast-infected fields are really the blast resistant variety M-208. A few requests were also received from the MG, SG projects and Foundation Plot Nursery during previous years to determine identity and/or purity of the lines or varieties. This year, we received a considerable amount material for fingerprinting from the different programs (Table 19). For the long-grain program, around 1400 lines were analyzed with 10 markers to determine the purity of the head rows (~14,000 data points) starting September 2012 to December 2012. The MG program requested fingerprinting of 180 mutant lines to determine if they are indeed mutants of M-401. Seven markers were used to fingerprint these mutant materials (~ 1260 data points). The SG program submitted 337 lines for fingerprinting to determine the purity of the headrows using 7 markers (~2359 data points). A rice sample from Arkansas was also fingerprinted in June 2012 to determine if the material bears resemblance to one of the CA varieties and if it is a product of the cross the farmer claimed he made. In summary, the DNA lab analyzed almost 2000 lines and generated 17,620 data points for the year 2012.

Herbicide Resistance

A special project at the RES is to develop rice lines that are resistant or tolerant to various herbicides being used in the rice production system. Putative Prowl mutants identified by lab screening methods in 2010 and planted for seed increase in 2011 were re-tested in the greenhouse in 2012. Greenhouse results indicated that the tolerance/resistance levels of these lines were not as dramatic as was seen in the paper assay. These materials are stored for further testing.

Dr. Cynthia Andaya initiated another round of Prowl selection of M-206 irradiated seeds in the cold greenhouses in 2012. Eighty kilograms of seeds soaked in Prowl overnight were plated in 80 trays containing Prowl solution. The set-up was maintained for 14 days in the greenhouse and scoring and selection were done thereafter. We obtained around 100 lines that were grown in the greenhouse for seeds. This new batch of mutants will be tested using our paper assay before greenhouse and field tests are done. Dr. Kent McKenzie initiated a field selection for Prowl in June 2012. The land adjacent to the railroad was planted with irradiated materials and sprayed with 3X Prowl. However, we were not able to identify any promising mutant line from this experiment. Selection for Prowl resistance will be continued in the lab and/or in the field, as schedule and resources will permit.

EMS Mutagenesis

Another special project at the RES is to generate materials that breeders can use in the Station’s breeding programs. Ethyl methane sulfonate (EMS) mutagenesis is one of the most widely used methods of generating mutations. EMS changes the structure of the guanine bases of the DNA causing it to pair with the wrong base. An alkylated guanine will pair with thymine rather than a cytosine base. This ultimately results in an amino change or deletion. In 2010, we started generating EMS-treated materials for the medium-grain and short-grain projects. This year, Dr. Virgilio Andaya will be reporting one of the products of our early EMS mutagenesis, an M-401 with an early maturity (see MG section).

From January to September 2012, we treated a total of 17 kilograms of M-206 & M-205 seeds with 1.25 to 1.5% of EMS (Table 20). These materials were planted in the 8 benches of greenhouse 5B. Breeders can evaluate the EMS mutant lines this coming planting season. Materials that were not selected by the breeders can be passed on to the DNA Lab for herbicide resistance project.◆

Table 17. Marker-aided selection (MAS) for blast resistance in the medium grain project.

Type	Lines	Materials	Crosses	Month	Data Points
Blast Pyramids	1640	M104, M105, M202, M204, M205, M206, M208	27	May-June 2012	6560
Blast Pyramids	260	M105, M205	2	Sept. 2012	1040
F2's	12500	M104, M105, M202, M204, M205, M206, M208	33	Sept-Nov 2012	50000
Total	14400		62		57600

Table 18. Comparison of marker-aided selection (MAS) work 2011 to 2012.

	2011			2012		
Breeding Program	Lines	Markers	Data Points	Lines	Markers	Data Points
Long Grain	1200	3	3600	2300	5	11500
Medium Grain	5600	4	22400	14400	4	57600
Short Grain	872	6	2360	-	-	-
Total	7672		28360	16700		69100

Table 19. DNA Lab fingerprinting analysis completed in 2012.

Program	Lines	Markers	Data Points
Long Grain	1400	10	14000
Medium Grain	180	7	1260
Short Grain	337	7	2359
Total	1917		17619

Table 20. EMS mutagenesis treatments for 2012.

Variety	Seed Treated (kg)	Treatment	Date
M205 & M206	3	1.5% EMS	January 24, 2012
M206	3	1.5% EMS + 2.0% EMS	July 10, 2012
M206	3	1.5% EMS	July 24, 2012
M206	6	1.5% EMS	August 8, 2012
M205	2	1.5% EMS + 1.25% EMS	September 5, 2012
TOTAL	17		

BREEDING NURSERIES

Seeding of the 2012 breeding nursery began May 15th, and was completed May 23rd. In 2012, 1418 crosses were made at RES for rice improvement, bringing the total number of crosses made since 1969 to 42,550. Crosses made in the early spring were grown during the summer in an F_1 nursery to produce seed for the F_2 generation. Crosses made this past summer were planted in the Hawaii Winter Nursery and/or the greenhouse so the segregating F_2 generations could be grown for selection purposes in 2012, thereby accelerating the breeding process.

The 2012 RES breeding nursery occupied approximately 78 acres. Water-seeded yield tests included 2793 small plots and 2730 large plots. Small seed increase plots, cooking samples and advanced breeding lines were grown on 5 acres. The nursery included about 57,300 water-seeded and 31,600 drill-seeded progeny rows. F_2 populations from 2010 and 2011 crosses were grown in precision drill-seeded plots on 12 acres. An estimated 150,000 panicles were selected from the various F_2 populations in nurseries for further screening and advancement. Selected material is being advanced in the Hawaii Winter Nursery and greenhouse facilities. The remainder will be screened and processed for planting in 2012.

Headrows (1600) of M-104, M-208, Calhikari-202, and 08Y1115 were grown for breeder seed production in 2012. This headrow seed can be used for several years to produce breeder seed because it is stored under low temperature and proper humidity conditions.

The Hawaii Winter Nursery allows the advancement of breeding material and screening for cold tolerance during the winter to hasten variety development. The Hawaii Winter Nursery is a very valuable breeding tool and has been a successful and integral part of the RES Rice Breeding Program since 1970.

Selection and harvest of the 2011-12 winter nursery was completed and seed returned to RES and planted in May. The 2012-13 winter nursery of 9281 rows was planted November 6-7, 2012, and 600 F_1 populations were transplanted to the nursery November 28, 2012. Selection and harvest will occur in April, and seed returned for processing and planting in the 2012 RES breeding nursery.

The San Joaquin Cold Tolerance Nursery was planted in cooperation with two local rice growers. The 7 acre drill-seeded nursery included 6800 rows, and 6 acres of F_2 populations. Stand establishment and weed control was good. Very little blanking was observed in the rows, but blanking occurred in the F_2 populations for selection. The nursery was very delayed due to the cool growing season. An additional yield test was grown in cooperation with UCCE on Twitchell Island near Rio Vista. High levels of blanking, and extreme delays in maturity were observed in entries at that location.

The San Joaquin Cold Tolerance nursery and Hawaii nursery remain an essential part of selecting for resistance to blanking and are used in conjunction with two refrigerated greenhouses at RES. ◆

RES Rice Breeding Program Terminology

1. **Germplasm**. Breeding material used in crossing including varieties, introductions, lines, mutants, and wild species.

2. **Crossing (hybridization)**. The process of selecting parent plants and artificially cross-pollinating them. Backcrossing is crossing again to one of the parents of the original cross.

3. **F_1 generation**. The 1st generation after crossing. F_1 plants (hybrids) are grown from the seed produced by crossing. They are allowed to naturally self-pollinate to produce seed of the F_2 generation or may be used as parents (backcrossing).

4. **F_2 generation**. The 2nd generation after crossing. This is the stage that produces the maximum segregation for the different characteristics of the parents. Spaced plants from each cross are grown in large plantings and individual panicles selected, evaluated for seed quality factors, and planted to produce the F_3 generation.

5. **Progeny rows**. Selected rice lines grown in single rows for selection, generation advance, and purification. This may include lines in the 3rd through the 7th generation after crossing.

6. **Small plots**. Promising lines selected from progeny rows are grown in 4 by 6 ft or 10 by 10 ft plots for further screening, evaluation, and seed increase.

7. **Preliminary Yield Tests**. The best small plot entries are grown in replicated 10 by 20 ft plots at two seeding dates and evaluated for agronomic and quality traits.

8. **Statewide Yield Tests**. Outstanding preliminary yield test entries are grown in yield tests at several on-farm locations by UCCE and also at RES. Information on adaptability, agronomic performance, and quality traits is collected in these tests.

9. **Headrows**. Individual panicles of superior lines are planted in individual rows for purification and seed increase as potential new varieties.

10. **Breeder seed**. Headrow seed of varieties and experimental lines is grown in isolation and carefully inspected to maintain its purity to produce breeder seed. Breeder seed is the pure seed source planted each year to produce foundation seed.

STATEWIDE YIELD TESTS

Agronomic performance and adaptation of advanced selections from the breeding program were determined in multi-location yield tests. These tests are conducted annually in grower fields by University of California Cooperative Extension (UCCE) and also tested at RES. The 2012 Statewide Yield Tests were conducted at seven locations in commercial fields by Mr. Raymond L. Wennig, Dr. Randall G. Mutters, Dr. James E. Hill, Dr. Chris Greer, and Dr. Luis Espino. Advanced selections were tested in one of the three maturity groups: very early, early, or intermediate to late with standard check varieties included for comparison. Each maturity group was subdivided into an advanced and preliminary experiment. The advanced entries and checks had four replications and the preliminary entries had two replications. Plots were combine-size (10 by 20ft) and the experimental designs were randomized complete blocks.

All of these advanced large plot entries were also tested at RES in a randomized complete block design. The large plot seeding dates at RES were May 15-19, and May 22-23, 2012. The plot size was 10 by 20 ft with the center 7 ft combine harvested (140 ft^2).

Water-seeding and conventional management practices were used in these experiments. Bolero UltraMax®, and Stam80df® were applied for weed control and one application of Silencer® was applied for rice water weevil control.

Tables 1 through 6 contain a summary of performance information from the 2012 Statewide Yield Tests. Yields are reported as paddy rice in pounds per acre at 14% moisture. A cold growing season, fall rain, and muddy conditions delayed harvest in the nursery. Experimental yields may be higher than commercial field yields because of the influence of alleys, border effects, levees, roadways, and other environmental factors. Disease scores for stem rot (SR) are averages from the inoculated RES disease nursery. The entries that performed well will be advanced for further testing in 2013. Complete results of the UCCE Statewide Yield Tests can found on the web at http://ucanr.edu/sites/UCRiceProject/Research/Agronomy_Progress_Reports/.

Table 21. Agronomic performance means of very early advanced entries in Statewide Yield Tests at RES and over-location mean yields at San Joaquin, Sutter, Yolo, and RES (4 reps) locations in 2012

Entry Number	Identity	Type †	SV ‡	Days §	Height (cm)	Lodging (%)	SR ¶	--- Grain Yield # --- RES	State
8	09Y2141	SWX	4.8	82	94	11	5.0	11130	10020
17	08Y3310	M	4.8	87	89	1	4.2	10690	9390
3	11Y1005	L	4.8	83	94	3	5.0	10620	9480
14	M206	M	4.8	84	97	1	5.1	10420	9660
15	10Y3286	M	4.9	81	91	1	4.6	10400	9600
16	08Y3269	M	4.8	86	97	1	4.5	10360	9050
11	M104	M	4.9	78	89	16	4.7	10260	9330
13	M205	M	4.9	88	94	1	4.4	10220	8260
9	09Y2036	S	4.7	82	94	68	5.2	10180	9610
12	M202	M	4.9	89	104	8	5.0	10050	8820
1	L206	L	4.8	81	84	1	5.4	10020	9050
2	06Y575	L	4.8	87	102	1	4.8	9520	9210
7	CH-202	SPQ	4.8	83	84	60	4.9	9460	9070
10	08Y2049	SSR	4.9	81	86	3	4.7	9430	9240
5	S102	S	4.9	78	89	53	5.0	9370	8610
6	CH-201	SPQ	5.0	86	89	50	4.8	8790	8720
4	CM-101	SWX	4.9	79	89	45	5.1	8500	7830
Mean			4.8	83	91	19	4.9	9960	9110
LSD(0.05)			0.1	2	5.1	22	0.7	860	300
CV %			1	2	4.3	81	11	6	5

† L= long grain, M = medium grain, S = short grain, SPQ = premium quality short grain, SSR = short grain stem rot, and SWX = short grain waxy.

‡ SV = seedling vigor score, where 1 = poor and 5 = excellent.

§ Days to 50% heading.

¶ SR = stem rot score, where 0 = no damage and 10 = plant killed.

Paddy rice yield in lb/acre at 14% moisture.

Table 22. Agronomic performance means of very early preliminary entries in Statewide Yield Tests at RES and over-location mean yields at San Joaquin, Sutter, Yolo, and RES (2 reps) locations in 2012.

Entry Number	Identity	Type †	SV ‡	Days §	Height (cm)	Lodging (%)	SR ¶	--- Grain Yield # --- RES	State
19	11Y1044	L	4.8	85	97	1	4.9	11560	9730
48	10Y3469	M	4.8	85	91	1	5.0	10970	9660
22	10Y2043	S	4.8	78	89	16	4.4	10930	10270
34	10Y3274	M	4.8	82	99	11	5.5	10420	9780
47	10Y3452	M	4.9	83	102	30	5.3	10420	9760
18	10Y1008	LSR	4.9	84	99	1	3.6	10370	9350
31	10Y3236	M	4.8	78	91	1	5.5	10370	9460
20	12Y20	L	4.9	83	97	1	4.6	10290	9820
45	10Y3395	M	4.8	82	97	1	4.9	10080	9330
49	10Y3558	M	4.9	82	99	6	5.2	10080	9430
35	10Y3276	M	4.8	81	91	1	5.3	10020	9040
46	10Y3437	M	4.9	83	94	6	5.2	10000	8990
37	10Y3292	M	4.9	81	91	1	4.9	9980	9150
30	M105	M	4.9	80	89	1	5.4	9950	9360
43	10Y3332	M	4.9	86	94	1	4.5	9920	9130
28	11Y2032	MPQ	5.0	87	104	1	4.8	9810	8490
32	10Y3237	M	4.7	79	89	1	4.9	9800	9140
40	10Y3387	M	4.9	81	91	1	5.3	9770	9050
44	10Y3394	M	4.8	83	91	1	4.8	9770	9460
25	11Y2040	S	4.9	78	91	1	4.3	9750	9530
42	10Y3318	M	4.9	83	99	6	5.1	9720	9380
36	10Y3287	M	4.9	81	94	1	4.9	9620	8750
50	10Y3566	M	4.8	83	94	1	5.0	9540	9110
51	10Y3706	M	4.8	85	94	1	4.5	9540	8770
23	11Y2021	MPQ	4.9	88	97	1	4.6	9480	8420
41	10Y3428	M	4.9	80	94	6	5.9	9430	8870
26	11Y2022	MPQ	4.8	84	91	1	4.7	9410	9240
24	11Y2023	MPQ	5.0	86	107	85	4.6	9410	8980
38	10Y3326	M	4.8	81	91	1	5.2	9340	9050
39	10Y3362	M	4.8	78	91	1	4.5	9270	9110
33	10Y3241	M	4.8	78	91	45	5.1	9120	8830
27	11Y2059	SPQ	4.9	82	81	1	5.0	8440	8400
29	10Y2179	MBG	4.7	85	91	1	5.0	8290	7750
21	CA201	SLA	5.0	83	86	25	5.9	6050	6760
Mean			4.8	82	94	8	4.9	9730	9100
LSD(0.05)			0.1	2	7.6	18	0.7	1330	460
CV %			1	1	5	120	11	7	5

† L = long grain, LSR = long grain stem rot, M = medium grain, MBG = medium grain big, MPQ = premium quality medium grain, S = short grain, SLA = short grain low amylose, and SPQ = premium quality short grain.

‡ SV = seedling vigor score, where 1 = poor and 5 = excellent.

§ Days to 50% heading.

¶ SR = stem rot score, where 0 = no damage and 10 = plant killed. # Paddy rice yield in lb/acre at 14% moisture, NS = not significant.

Table 23. Agronomic performance means of early advanced entries in Statewide Yield Tests at RES and over-location mean yields at Colusa, Butte, Yuba, and RES (4 reps) locations in 2012.

Entry Number	Identity	Type †	SV ‡	Days §	Height (cm)	Lodging (%)	SR ¶	--- Grain Yield # --- RES	State
64	11Y1008	L	4.7	82	91	1	5.0	11650	10180
63	09Y1122	L	4.7	87	86	1	4.6	11350	9940
69	09Y2141	SWX	4.5	84	99	30	5.4	11060	9790
76	08Y3126	M	4.6	84	99	1	5.0	10690	9770
73	M205	M	4.8	88	94	3	4.2	10530	9520
61	L206	L	4.6	84	84	6	4.8	10510	9600
77	09Y3887	M	4.6	88	97	1	4.6	10470	8860
62	06Y575	L	4.8	87	104	3	4.5	10400	9900
70	09Y2179	S	4.8	89	99	1	4.0	10280	9270
74	M206	M	4.5	84	97	3	4.5	9980	9530
75	08Y3269	M	4.6	87	91	1	4.5	9870	9800
72	M202	M	4.8	87	104	11	4.5	9770	9070
66	S102	S	4.6	80	91	60	5.5	9500	8290
71	09Y2159	SLA	4.2	87	97	44	5.0	9430	8720
68	CH202	SPQ	4.6	82	84	93	5.1	9000	8390
67	CH201	SPQ	5.0	85	89	85	5.3	8680	7570
65	CM101	SWX	4.7	80	89	86	5.2	8520	7690
Mean			4.7	85	94	25	4.8	10100	9170
LSD(0.05)			0.2	1	5.1	17	0.7	1070	360
CV %			3	1	4	48	10	8	6

† L = long grain, M = medium grain, S = short grain, SLA = short grain low amylose, SPQ = premium quality short grain, and SWX = short grain waxy.

‡ SV = seedling vigor score, where 1 = poor and 5 = excellent.

§ Days to 50% heading.

¶ SR = stem rot score, where 0 = no damage and 10 = plant killed.

Paddy rice yield in lb/acre at 14% moisture.

NS = not statistically significant.

Table 24. Agronomic performance means of early preliminary entries in Statewide Yield Tests at RES and over-location mean yields at Colusa, Butte, Yuba, and RES (2 reps) locations in 2012.

Entry Number	Identity	Type †	SV ‡	Days §	Height (cm)	Lodging (%)	SR ¶	--- Grain Yield # --- RES	State
83	11Y1076	L	4.5	83	99	1	4.2	10660	9710
105	09Y3805	M	4.7	87	104	1	3.7	10590	9600
92	11Y1096	LA	4.8	84	99	1	4.0	10480	9180
94	10Y2094	MPQ	4.6	85	97	11	4.3	10470	9090
106	10Y3536	M	4.7	83	102	1	5.1	10470	9140
112	11P498	MB	4.8	84	102	1	4.8	10450	9220
95	09Y2184	SPQ	4.1	86	91	1	4.2	10440	8590
101	11Y2182	MPQ	4.2	90	97	1	4.6	10430	9390
113	11P503	MB	4.7	84	97	6	4.6	10420	9550
82	12Y82	L	4.6	88	84	1	5.0	10390	9420
114	11P507	MB	4.6	84	97	1	5.2	10360	9450
111	10Y3729	M	4.5	87	97	1	4.7	10330	9300
103	M105	M	4.7	79	91	31	5.0	10250	9220
115	11P509	MB	4.6	84	94	6	4.4	10150	9620
104	09Y3517	M	4.6	84	97	1	4.9	10100	9470
91	11Y1049	LA	4.8	85	97	1	3.7	9990	9130
108	10Y3670	M	4.5	85	91	1	4.8	9960	8870
99	11Y2045	SLA	4.8	86	94	13	4.2	9950	7990
81	12Y81	L	5.0	82	102	1	5.0	9940	9270
86	10Y1059	LJ	4.7	84	97	1	3.8	9900	9040
107	10Y3622	M	4.5	84	94	1	5.5	9870	9360
110	10Y3754	M	4.6	85	94	1	4.9	9860	9410
97	11Y2112	MPQ	4.8	85	99	1	4.5	9740	9160
109	10Y3722	M	4.5	84	94	1	5.1	9720	9150
87	12Y87	LJ	4.7	86	86	1	5.2	9700	7600
84	12Y84	L	4.6	83	91	1	4.7	9650	9590
102	M208	M	4.8	85	102	31	5.1	9560	8870
96	11Y2049	SPQ	4.9	87	102	20	5.2	9450	7410
98	11Y2192	MPQ	4.8	85	107	85	5.5	9420	8290
100	11Y2071	SWX	4.5	77	97	40	5.7	9250	8430
80	A301	LA	3.6	93	84	1	5.0	8640	7280
78	A201	LA	5.0	89	86	1	5.4	8480	8020
85	11Y106	LJ	3.7	91	107	1	3.7	8350	6100
79	CT202	LB	4.8	86	89	1	5.2	7990	6700
90	11Y1079	LB	4.9	82	86	1	5.3	7970	7150
89	10Y1199	LB	4.5	92	102	1	5.3	7760	6230
88	11Y158	LB	4.7	86	86	1	4.9	7540	5580
93	CA201	SLA	4.9	83	91	85	6.3	7230	6670
Mean			4.6	85	97	9	4.8	9630	8560
LSD(0.05)			0.2	2	7.6	21	0.7	1300	490
CV %			3	1	4	112	10	7	6

†L = long grain, LA = long grain aromatic, LB = long grain basmati, LJ = long grain jasmine, M = medium grain, M = medium grain blast resistant, MPQ = premium quality medium grain, SLA = short grain low amylose, SPQ = premium quality short grain, and SWX = short grain waxy.

‡ SV = seedling vigor score, where 1 = poor and 5 = excellent.

§ Days to 50% heading.

¶ SR = stem rot score, where 0 = no damage and 10 = plant killed.

Paddy rice yield in lb/acre at 14% moisture.

NS = not statistically significant

Table 25. Agronomic performance means of intermediate to late advanced entries in Statewide Yield Tests at RES and over-location mean yields at Glenn, Sutter, and RES (4 reps) locations in 2012.

Entry Number	Identity	Type †	SV ‡	Days §	Height (cm)	Lodging %	SR ¶	--- Grain Yield # --- RES	State
128	M205	M	4.9	87	97	1	4.5	11210	9690
121	L206	L	4.8	81	84	1	5.6	11180	9580
127	M202	M	5.0	85	107	1	5.4	11090	9480
122	06Y575	L	4.8	85	104	1	4.5	10980	9950
123	M402	MPQ	4.9	93	99	1	4.3	10260	9190
126	09Y2176	MPQ	4.9	91	99	1	5.1	10110	8770
124	CH201	SPQ	4.9	82	94	90	5.1	9180	8820
125	CH202	SPQ	4.8	80	86	90	4.9	9080	8720
Mean			4.9	85	97	23	4.8	10390	9280
LSD(0.05)			0.1	2	5.1		0.7	950	380
CV %			1	1	4		10	6	5

† L = long grain, M = medium grain, MPQ = premium quality medium grain, and SPQ = premium quality short grain.
‡ SV = seedling vigor score, where 1 = poor and 5 = excellent.
§ Days to 50% heading.
¶ SR = stem rot score, where 0 = no damage and 10 = plant killed.
# Paddy rice yield in lb/acre at 14% moisture.

Table 26. Agronomic performance means of intermediate to late preliminary entries in Statewide Yield Tests at RES and over-location mean yields at Glenn, Sutter, and RES (2 reps) locations in 2012.

Entry Number	Identity	Type †	SV ‡	Days §	Height (cm)	Lodging (%)	SR ¶	--- Grain Yield # ---	
								RES	State
148	11Y2183	MPQ	4.9	87	102	1	4.8	11650	9620
154	10Y3690	M	4.9	86	99	1	4.5	11510	9830
131	12Y131	L	4.8	81	99	1	4.4	11430	9750
155	10Y3703	M	4.9	85	104	1	5.0	11390	10050
149	08Y3314	M	4.9	88	102	1	4.4	11360	8930
157	10Y3737	M	4.9	87	102	1	4.9	11350	9500
159	10Y3773	M	4.9	85	97	1	4.3	11290	9400
160	10Y3789	M	4.9	86	104	1	4.9	11160	9620
152	10Y3661	M	4.8	85	94	1	4.6	11140	8870
150	09Y3502	M	4.9	86	107	1	4.7	11110	9370
153	10Y3507	M	4.9	84	102	1	4.3	11030	9420
156	10Y3717	M	4.9	87	107	1	5.3	11020	9460
158	10Y3748	M	4.9	84	104	1	4.6	11010	8980
139	12Y139	LA	4.8	85	91	1	5.1	10870	9180
130	12Y130	LSR	4.8	84	99	1	4.2	10740	9370
132	12Y132	L	4.8	82	104	1	4.7	10650	9130
145	10Y2081	MPQ	4.9	90	102	1	5.1	10610	8500
146	10Y2120	MPQ	4.8	88	102	1	4.8	10370	8890
147	09Y2173	MPQ	4.9	92	109	1	4.8	10080	8970
151	10Y3247	M	4.9	82	97	1	4.8	10070	8360
141	A201	LA	4.9	88	91	1	5.2	9450	8620
144	09Y2174	MPQ	4.9	87	107	85		9410	8470
140	08Y1115	LA	4.8	85	84	1	5.7	9290	7820
135	12Y135	LJ	4.9	91	97	1	5.0	8860	9360
142	M401	MPQ	4.9	101	99	1	4.9	8630	8620
134	11Y106	LJ	4.7	89	117	1	4.1	8320	8010
137	12Y137	LB	4.9	80	102	1	4.9	7840	7060
133	12Y133	LJ	4.9	98	91	1	5.4	7770	8100
138	12Y138	LB	4.9	86	97	1	4.8	7760	7360
129	CT202	LB	4.9	88	84	1	5.2	7150	6940
136	11Y158	LB	4.9	93	86	1	4.9	6710	6370
143	KOSH	SPQ	4.9	92	112	90	6.3	5180	5490
Mean			4.9	87	99	6	4.8	9880	8670
LSD(0.05)			0.1	2	5.1	3	0.7	640	570
CV %			0.9	1	2.3	19.5	10.0	3.2	5.8

† L = long grain, LA = long grain aromatic, LB = long grain basmati, LJ = long grain jasmine, LSR = _____, M = medium grain, MPQ = premium quality medium grain, and SPQ = short grain premium.

‡ SV = seedling vigor score, where 1=poor and 5=excellent.

§ Days to 50% heading.

¶ SR = stem rot score, where 0 = no damage and 10 = plant killed.

Paddy rice yield in lb/acre at 14% moisture.

PRELIMINARY YIELD TESTS

Preliminary Yield Tests are the initial step of replicated large plot testing for experimental lines. The experimental design, plot size, and production practices are identical to the Statewide Yield Tests grown at RES. Two replications are planted at the early and late seeding date. The medium grain preliminary is only a single plot. A summary of the yields of 2012 Preliminary Yield Tests is presented in Table 27. These tests included 959 entries and check varieties.

Results in Table 7 show that yields of the top experimental lines compare well with the check varieties. Agronomic and quality information will be combined with cold tolerance and disease screening information to identify superior entries for further testing and advancement to the 2013 Statewide Yield Tests. ◆

Table 27. Summary of Preliminary Yield Tests at RES in 2012.

Test	Type	Number of Entries	All	Highest	Top 5	Check	Standard Check
			----------Average Yield (lb/acre)†----------				
Very Early							
Short grains	Conventional	5	9150	10260	9150	9370	S-102
	Specialty rice	31	8590	11010	9850	8770	CH-202
Medium grains	Conventional	74	10100	11200	11050	10820	M-105
	Specialty rice	19	8900	10090	9740	9830	M-402
Long grains	Conventional	59	10250	11350	11200	9550	L-206
	Specialty rice	21	8190	10740	10510	8040	A-201
Early							
Short grains	Conventional	1	10030	10030	10030	9180	S-102
	Specialty rice	21	9270	10460	10040	9750	CH-202
Medium grains	Conventional	75	10460	11370	11330	10880	M-206
	Specialty rice	63	9770	11450	10940	9530	M-402
Long grains	Conventional	31	9740	10970	10570	9570	L-206
	Specialty rice	50	7870	11410	10870	6730	A-201
Intermediate-Late							
Short grains	Conventional	1	10460	10460	10460	9720	S-102
	Specialty rice	15	9330	10700	10360	9990	CH-202
Medium grains	Conventional	42	11410	12840	12400	12300	M-205
	Specialty rice	19	10490	12070	11330	9650	M-402
Long grains	Conventional	10	10420	11490	10920	10620	L-206
	Specialty rice	35	8330	11440	11170	7120	CT-202

† Paddy rice yield at 14% moisture

Rice Cultivar Releases

CULTIVAR ‘M-105’

The California Cooperative Rice Research Foundation, Inc. (CCRRF), the University of California Agricultural Experiment Station, and the United States Department of Agriculture, Agricultural Research Service (USDA-ARS), announce the naming and release of a new rice cultivar M-105, April 1, 2011.

M-105 is a very early, semidwarf, California glabrous, Calrose quality medium-grain cultivar that has been evaluated in large plot yield tests since 2005 under the experimental designation 05-Y-471. It is a very early selection from the Rice Experiment Station (RES) 2000 summer greenhouse cross R25878 and has the pedigree S-301/M-204//M-104. The female parent S-301/M-204 (98-Y-242) was later released as M-206, and is currently the predominant medium-grain cultivar in California. M-104 is a very early maturing, cold tolerant, medium-grain rice also released by CCRRF. 05-Y-471 first entered the UC Statewide Rice Yield Testing Program in 2006 and has been tested in both the very and early locations and included replicated strip trial in three locations in 2010. M-105 is the product of pedigree breeding utilizing a Hawaii winter and RES nurseries for generation advance and purification.

Days to heading average about 2 days later or earlier than M-104 and M-206, respectively. Multiple years of agronomic testing showed a comparable yield potential to current Calrose varieties. UC Statewide 2006-10 plot yields in very early tests averaged 9130, 9250, and 9460 lbs/acre for M-104, M-105, and M-206, respectively; and in early tests 9560 and 9610 lbs/acre for M-105 and M-206, respectively. Harvest moisture milling studies have been conducted since 2008 and show the percent head rice yield and milling stability to be superior to M-104 and equivalent to M-206. Milling samples have been provided to several major California rice marketing organizations in 2009 and 2010 and no concerns expressed. Pedigree, physicochemical test, and cooking tests indicate it fits the historical Calrose market type.

M-105 is adapted to all current rice growing areas and may find application for growers seeking an earlier maturing Calrose market type cultivar with good milling and high yield potential in all but the coldest production areas.

Approximately 600 cwt of foundation seed was produced in 2010 at RES. The Certification Technical Committee of the California Crop Improvement Association approved M-105 for certification in California. Application is being made to protect M-105 under the U.S. Plant Variety Protection Act, Title V option, and for utility patents. Breeder and Foundation seed of these cultivars will be maintained by California Cooperative Rice Research Foundation, P.O. Box 306, Biggs, CA 95917-0306.

CULTIVAR 'CALHIKARI-202'

The California Cooperative Rice Research Foundation, Inc. (CCRRF), the University of California Agricultural Experiment Station, and the United States Department of Agriculture, Agricultural Research Service (USDA-ARS), announce the naming and release of a new rice cultivar Calhikari-202, April 1, 2012.

Calhikari-202 is an early, semidwarf, pubescent, premium quality short-grain cultivar. It is a selection from the Rice Experiment Station (RES) 1995 winter greenhouse cross R20885 and has the pedigree Koshihikari*2/S-101//Koshihikari/S-101/3/Hitomebore. The female parent "Koshihikari*2/S-101//Koshihikari/S-101", designated as 05P104, is a sister line of the progenitor of Calhikari-201. Hitomebore is a premium quality Japanese short grain variety.

Calhikari-202 is the product of pedigree breeding utilizing a Hawaii winter and RES nurseries for generation advance and purification. It was evaluated in large plot yield tests since 2005 under the experimental designation 04Y177. Seedling vigor scores, plant height, and lodging averaged 4.8 and 5.0; 35 and 36 inches; and 49 and 33 % for Calhikari-202 and Calhikari-201, respectively. Plot yields from 2008-11 UC Statewide Yield tests 8750 and 8392 lbs/acre for Calhikari-202 and Calhikari-201, respectively. Days to heading average about 3 days earlier than Calhikari-201. Harvest moisture milling studies showed a small head rice advantage over Calhikari-201 and cooking quality evaluations from samples provided to several major rice marketing organizations gave superior scores to Calhikari-202. Calhikari-202 is adapted to the current rice growing areas in California where Calhikari-201 and Koshihikari are being planted.

Approximately 88 cwt of foundation seed was produced in 2011 at RES. The Certification Technical Committee of the California Crop Improvement Association approved Calhikari-202 for certification in California. Application is being made to protect Calhikari-202 under the U.S. Plant Variety Protection Act, Title V option, and for a utility patent. Breeder and Foundation seed of these cultivars will be maintained by California Cooperative Rice Research Foundation, P.O. Box 306, Biggs, CA 95917-0306.