RICE FIELD DAY

Wednesday, August 30, 2023

California Cooperative Rice Research Foundation, Inc.
University of California
United States Department of Agriculture
Cooperating

Rice Experiment Station
P.O. Box 306, Biggs, CA 95917-0306

About the Cover

Photo of participants at the weed science field tour stop during the CCRRF – Rice Research Station Annual Field Day in 2022. Each year the field tours are the highlight of the annual field day. This years' field tour includes 6 stops highlighting research in rice breeding and genetics, agronomy, fertility, entomology, pathology, and weed science.

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Matthew Morgan, Maintenance and Operator
Justin Valencia, Maintenance and Operator

ROXY® RPS Partners

Chad Shelton, Albaugh LLC.
Kent McKenzie, ROXY®RPS consultant

UC Rice Research

J. Ray Stogsdill, Staff Research Associate III
Kevin Goding, Staff Research Associate II
Saul Reyes, Junior Specialist

2023 Rice Field Day Program

7:30 - 8:30 a.m. Registration and Poster Session

8:30 - 9:15 a.m. General Session & CCRRF Business Meeting

Pledge of Allegiance and Welcome
Kim Gallagher, Vice-Chairman, CCRRF

Rice Experiment Station & ROXY® Update
Dustin Harrell, Director, RES

Financial Report
Kyle Niehues, Treasurer, CCRRF

Directors Nomination Committee Report
Dustin Harrell, Director, RES

Rice Research Trust Report
Steven Willey, Chairman, RRT

D. Marlin Brandon Rice Research Fellowship
Dustin Harrell, Director, RES

Rice Yield Contest
Bruce Linquist, Professor, UC-Davis

California Rice Research Board Report
Burt Manuel, Chairman, CRRB

California Rice Industry Award Presentation
Kim Gallagher, Vice Chairman, CCRRF
Kent McKenzie, ROXY®RPS consultant

9:20 - 10:30 a.m. Simultaneous Field Tours (1)
Two tours occur simultaneously and will repeat.

<u>Main Station Tour</u>
Blue & Green Groups to Trucks

<u>Hamilton Road Weed Science Tour</u>
Red and White Groups to Buses

10:30 - 10:45 a.m. Refreshments – Under Carport

10:45 – 11:55 a.m. Simultaneous Field Tours (2)

Main Station Tour
Red & White Groups to Trucks

Hamilton Road Weed Science Tour
Blue and Green Groups to Buses

12:00 a.m.   Luncheon Concludes Program

Lunch will be served under the carport with seating at the tables on the lawns under the canopies.

Continuing Education credit for this 2023 Rice Field Day has been requested from Cal/EPA Department of Pesticide Regulation.

Continuing Education Units (CEU) are available for the CCA, CPAg, CPSS, and CPSC certification programs.

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Disclaimer

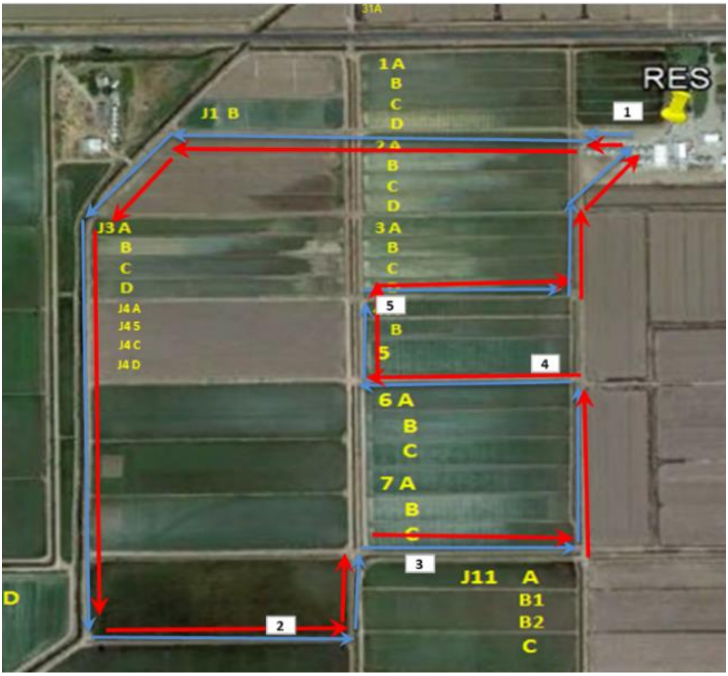
Trade names of some products have been used to simplify information. No endorsement of named products is intended nor is criticism implied of similar products not mentioned.

Hamilton Road Weed Science Tour (1 stop)

1. *Rice Weed Research Program*
   K. Al-Khatib
   University of California – Davis

Main Station Tour Program (5 stops)

1. *Pest Management, Water Grass, and Herbicide Resistance Updates*
   Dr. L. Espino & Dr. W. Brim-DeForest
   University of California Cooperative Extension
2. *Rice Agronomy, Fertility, and Insect Management*
   Dr. B. Linquist & Dr. I. Grettenberger
   University of California – Davis
3. *Medium grain and herbicide tolerant rice breeding*
   Dr. T. DeLeon
   CCRRF Rice Experiment Station
4. *Short Grain Breeding Program & Genome wide selection*
   Dr. F. Maulana
   CCRRF Rice Experiment Station
5. *Long Grain Breeding Program*
   Dr. N. Sharma
   CCRRF Rice Experiment Station



POSTERS AND DEMONSTRATIONS

1. **No-Till Rice Systems as an Alternative to Conventionally Managed Rice**. Mia Godbey, Bruce Linquist, Whitney Brim-DeForest, Luis Espino, and Ray Stogsdill.
2. **Evaluation of Tolerance to Tetflupyrolimet in Common California Rice Varieties**. Matthew A. Lombardi, Michael J. Lynch, and Kassim Al-Khatib.
3. **Efficacy of conventional against rice seed midge.** Sophie Allen, Kevin Goding, Luis Espino, and Ian Grettenberger.
4. **Tadpole shrimp: approaches to management.** Ian Grettenberger, Kevin Goding, Madi Hendrick, Whitney Brim DeForest, and Luis Espino.
5. **Assessing needed application timing and density of mosquitofish (Gambusia affinis) for biological control of tadpole shrimp (Triops longicaudatus).** Madi Hendrick, Kevin Goding, Luis Espino, and Ian Grettenberger.
6. **Guidelines for Bakanae seed treatment**. Luis Espino.
7. **Armyworm monitoring update.** Luis Espino, Troy Clark, and Consuelo Baez-Vega.
8. **Management of rice stem rot**. Luis Espino and Whitney Brim De-Forest.
9. **Preliminary Data on Cover Cropping in Rice Systems in California.** Sara Rosenberg, Michelle Leinfelder-Miles, Cameron Pittelkow, Whitney Brim-DeForest.
10. **Can tadpole shrimp be useful as a weed control tool? Interactions between tadpole shrimp, herbicides, weeds, and rice.** Whitney Brim-DeForest, Luis Espino, Troy Clark, Consuelo Baez-Vega, Taiyu Guan, Ian Grettenberger.
11. **Rice Crop Rotation Calculator: a decision-support tool.** Consuelo Baez Vega, Sara Rosenberg, Ellen Bruno, Chinh Lam, Bobby Tooyserkani, Hannah Zorlu, Tunyalee Martin, Cameron Pittelkow, Whitney Brim-DeForest.
12. **Calhikari-203, A Glabrous High Yielding Premium Quality Short** Grain Rice. Teresa B. De Leon, Omar Samonte, Virgilio Andaya, Kent S. McKenzie, Gretchen Zaunbrecher, and Dustin Harrell.
13. **Multiplex Gene Editing of UGP3 Gene in Rice Confers Oxyfluorfen Herbicide Resistance**. Teresa B. De Leon, Kent S. McKenzie, Virgilio Andaya, Cynthia Andaya, and Dustin Harrell.
14. **M-521 is a Blast Resistant and Herbicide Tolerant Calrose Rice.** Teresa B. De Leon, Kent S. McKenzie, Virgilio Andaya, Cynthia Andaya, Gretchen Zaunbrecher, and Dustin Harrell.

15. **18Y2070, A Lodging-Tolerant High- Yielding Advanced Risotto Rice.** Teresa B. De Leon, Kent S. McKenzie, Gretchen Zaunbrecher, and Dustin Harrell, RES.
16. **Cattail Invasion and Control in California Rice.** Deniz Inci1, Michelle Leinfelder-Miles2, and Kassim Al-Khatib.
17. **Active Water Quality Management.** California Rice Commission.
18. **Conservation Programs on California Riceland.** California Rice Commission.
19. **Rice Helping Salmon**. California Rice Commission.
20. **Communications - CalRiceNews.org.** California Rice Commission
21. **Introduction of aerobic soil conditions to continuous rice enhances soil nitrogen availability.** Zhenglin Zhang, Daniel C. Olk, and Bruce A. Linquist.
22. **High Yielding Low Amylose Short Grain Rice.** F. Maulana, T. DeLeon, N. Sharma, G. Zaunbrecher, and D. Harrell.
23. **Promising Waxy Short Grain Rice.** F. Maulana, T. DeLeon, N. Sharma, G. Zaunbrecher, and D. Harrell.
24. **Late Season Control of Watergrass.** Whitney Brim-DeForest, Troy Clark, Taiyu Guan.

Introduction
By Kim Gallagher

On behalf of the Board of Directors, staff, and UC cooperators, I would like to welcome you to the 2023 Rice Field Day. Field Day is our annual opportunity to highlight the research that is underway at the Rice Experiment Station on behalf of the California Rice Industry. It also serves as the annual business meeting for the grower-owners of the California Cooperative Rice Research Foundation.

The 2023 growing season has been an epic comeback for the California rice industry to say the least. After facing a devasting drought that cut our acreage in half, a remarkably wet winter filled the reservoirs and allowed us to return to a full-size crop. Seeing rice flourish on both sides of the Central Valley has been a welcomed sight.

While 2023 has been a return to normal, we know that investing in the future of our industry is what keeps our industry viable. The work of the Rice Experiment Station continues to advance the development of premium Calrose varieties that are high quality as well as high yielding. The release of M-521, the first herbicide-tolerant rice to be grown in California, has the potential to help growers facing weed herbicide resistance in their fields. Calhikari-203 was also released and is a high-yielding premium quality short grain variety with improved lodging resistance.

The RES Rice breeding program remains focused on its mission and continues to move our industry forward. This has been possible due to the financial support from the California Rice Research Board, the Foundation, and the Rice Research Trust, as well as a committed Rice Experiment Station staff.

The highlight of the day's activities are the field tours where you can hear from the researchers and see the breeding nurseries on the main station as well as weed control research at the Hamilton Road site.

Dr. Frank Maulana will provide an update on the short grain breeding program at the RES.

Dr. Nirmal Sharma will provide an update on the long grain breeding program at the RES.

Dr. Teresa De Leon will provide an update on the medium grain and herbicide tolerant breeding programs at the RES.

Drs. Bruce Linquist and Dr. Ian Grettenberger will provide updates on rice agronomy and insect management research.

Drs. Luis Espino and Whitney Brimm-DeForest will provide updates on pest management, water grass and herbicide resistance.

Dr. Kassim Al-Khatib will provide a walking tour of the weed research nursery at the Hamilton Road site.

The Rice Experiment Station remains committed to the production of clean, weed and disease-free foundation seed for California rice growers. We continue work in cooperation with the Foundation Seed and Certification Services and the California Crop Improvement Association. We are now further strengthening our seed program for all RES varieties by licensing all seed growers of our varieties. The certified seed program is an essential part of maintaining genetic purity in our varieties, ensuring the highest quality seed is available to the industry, and stemming the spread of weedy red rice. The seed program is self-supporting and is not funded by the Rice Research Board.

I would like to acknowledge the many businesses and growers who support Rice Field Day through financial donations, agrochemicals and use of trucks for our tours. This year we have also included equipment displays from several sponsors. This industry support is very important to the success of the field day. The supporters are listed in your program and we thank them again for their assistance.

Lastly, thanks to all of the RES and UC staff that work very hard to make Rice Field Day successful. Thank you for attending Rice Field Day and supporting our research programs. If you have any questions about Field Day or the Rice Experiment Station, please take the opportunity to talk with the Board or the staff. There is a great deal of useful information on display today and I invite you to visit the displays and posters as well as take the field tours.

D. Marlin Brandon Rice Research Fellowship

In 2000, a memorial fellowship was established to provide financial assistance to students pursuing careers in rice production science and technology as a tribute to Dr. D. Marlin Brandon, past Director and Agronomist at the Rice Experiment Station. The California Rice Research Board made a one-time donation to the Rice Research Trust of $52,500 with $2,500 used for the 2000 fellowship. The Rice Research Trust has since contributed an additional $50,000 in 2022 to the fellowship account. Interest from investments on the approximately $100,000 principal is used to provide fellowship grants to the D. Marlin Brandon Rice Scholars. Thirty-three fellowships have been issued from 2000 to 2022.

D. Marlin Brandon Rice Scholars

William Carlson	2000
Nicholas Roncoroni	2001
David P. Cheetham	2002
Jennifer J. Keeling	2002
Kristie J. Pellerin	2003
Michael S. Bosworth	2003
Kristie J. Pellerin	2004
Leslie J. Snyder	2004
Gregory D. Van Dyke	2004
Leslie J. Snyder	2005
Louis G. Boddy	2006
Rebecca S. Bart	2006
Jennifer B. Williams	2007
Mark E. Lundy	2007
Louis G. Boddy	2008
Monika Krupa	2008
Cameron Pittelkow	2009
Charles Joseph Pfyl	2009
Maegen Simmonds	2009
Mark E. Lundy	2010
Cameron Pittelkow	2011
Whitney Brim-DeForest	2011
Matthew Espe	2015
Mathias Marcos	2015
Gabriel T. LaHue	2016
Johnny Campbell	2017
Alex Ceseski	2017
Telha Rehman	2017
Katie Driver	2018
Luke Salvato	2018
Henry Perry	2019
Aaron Becerra-Alvarez	2021
Madison Lee Hendrick	2022

POSTER ABSTRACTS

No-Till Rice Systems as an Alternative to Conventionally Managed Rice
Mia Godbey, Bruce Linquist, Whitney Brim-DeForest, Luis Espino, and Ray Stogsdill.

No-till agriculture is gaining popularity as a conservation management system with potential benefits including decreased soil erosion, improved soil health, reduced production expenses, and sustainable long-term crop yield. Despite its widespread adoption in many agricultural systems, the use of no-till practices in rice cultivation remains limited. Previous studies have reported variable yields, indicating the need for further research to better comprehend the factors that may limit its effectiveness. By conducting additional investigations, we can enhance our understanding of these limiting factors and make informed decisions to improve future management practices in rice farming.

This 2022 study focuses on a modified no-tillage system whereby field preparation is done during the summer when the field is fallow. Here, we are testing the feasibility of directly flooding and planting these fields in the subsequent year without any additional tillage. This approach would allow growers the ability to plant sooner and concurrently reduce expenses associated with tillage practices. In this project, we marked off a 1-acre portion of a field at three on-farm locations – Nicolaus, Robbins, Durham – to determine the feasibility of planting and growing rice in fallowed soils that were tilled and leveled in the previous growing season. This no-till area was compared to an adjacent area that was conventionally tilled. Nitrogen rate trials were set up as well as monitoring areas for weeds and pests.

The most prominent difference between the till and no-till treatments at the beginning of the season was related to stand establishment. The average number of established seedlings ranged between 19.4 and 40 plants per square foot in conventional till, and between 9.8 and 34.8 plants per square foot for no-till. Yield and N response data reveal that both conventional till and no-till demonstrated peak yields at an N rate of 175 lb N/acre at the Nicolaus site. Specifically, yields at 14% moisture reached 11,137 lb/acre and 10,572 lb/acre in conventional till and no-till respectively. At the Robbins site, peak yield reached 9,158 lb/acre at an N rate of 75 lb N/acre for conventional till, and a peak yield of 8,568 lb/acre at N rate 175 lb N/acre. In Durham, the highest conventional till yield was 10,517 lb/acre at 125 lb N/acre in and 11,309 lb/acre at 175 lb N/acre in no-till. Additional initial findings indicate potential differences in weed and pest pressure between the studied systems. While there were very few midge larvae on the Nicolaus and Biggs samples, Robbins samples from the no-till section had more midge larvae than the samples from the conventional section 10 days after flooding. Furthermore, there were very few tadpole shrimp observed. Those that were present were found in the conventional section at the Biggs location. Additionally, there was a higher percentage of stem rot in conventional till than no-till at the Biggs and Nicolaus sites. The only discernable differences in aggregate sheath spot were seen at the Biggs site and the conventionally tilled area showed a higher percentage of this disease than the no-till area. Preliminary weed cover differences were visible at Nicolaus and Robbins sites even with herbicide applications. At 66 DAP, Nicolaus had greater watergrass cover in the tilled area, whereas the no-till area had greater arrowhead and ducksalad cover. At 73 DAP, Robbins had greater watergrass cover in the tilled area, while the no-till area had greater arrowhead cover.

Evaluation of Tolerance to Tetflupyrolimet in Common California Rice Varieties
Matthew A. Lombardi, Michael J. Lynch, and Kassim Al-Khatib.

California rice production has a limited number of herbicides for weed management. There have been several cases of herbicide resistant weeds which further reduce the amount of effective management tools available for growers. Tetflupyrolimet is the active ingredient of a new herbicide from FMC. It is a novel mode of action, dihydroorotae dehydrogenase (DHODH) inhibitor.

The herbicide's crop response in six common California rice varieties (M-105, M-206, M-209, M-211, L-208, and CM-203) was evaluated in small-plot field trials for the 2022 and 2023 seasons. A split-plot design study with three replications was conducted at the Rice Experiment Station in Biggs, California.

Six treatments including a treated control with Shark H20, tetflupyrolimet at two different rates and timings, and a "grower standard" were assessed for rice phytotoxicity at 7, 14, and 28 days after treatment (DAT). Grain yield at 14% moisture were collected. ANOVA was used to analyze data and means were separated using LSD (p=0.05).

All varieties tested showed minimal to no injury (less than 10% injury compared to the control) in tetflupyrolimet treated plots at all rating times. Yields were not significantly different from the grower's standard treatment, ranging from 7,100 to 9,600 lb/ac.

Tetflupyrolimet could be a promising addition to California rice growers' toolboxes by controlling herbicide resistant populations Echinochloa spp. and Leptochloa fusca spp. fasicularis.

Efficacy of Conventional Against Rice Seed Midge
Sophie Allen, Kevin Goding, Luis Espino, and Ian Grettenberger.

Rice seed midge are common pests whose larvae feed primarily on rice seeds and seedlings, resulting in seed death and seedling damage. Midges have especially high damage potential in late-planted fields and cool seasons as the abundant midges have more time to feed on the slow-germinating seeds . In this study, we are evaluating the effectiveness of conventional rice insecticides against midges in the field and in the lab. We tested materials typically used early in the season, including pyrethroid and growth regulator modes of action. In last year’s field trials, rice was seeded into one meter diameter metal rings approximately ten days after the last rice in the area was planted, and treatments were applied the same day as seeding. We conducted substrate sampling after seven days in each ring to evaluate midge populations. We have a similar field study this year testing a wider range of products and concentrations. In the lab, midges were individually tested for resistance to the same products. Results from this study will help inform management of midges as an early-season rice pest.

Tadpole Shrimp: Approaches to Management
Ian Grettenberger, Kevin Goding, Madi Hendrick, Whitney Brim DeForest, and Luis Espino.

Tadpole shrimp are the key invertebrate pest in rice early in the season. Management relies heavily on insecticides, but opportunities remain for taking a more integrated approach to tadpole shrimp management. The timing of applications vary because tadpole shrimp can be difficult to detect when they are small and because they can grow very quickly. Scouting is a key need to better time and use insecticides. Currently, pyrethroids are the most-used mode of action, but additional materials have been employed in some cases. This likely will affect efficacy of some materials. These different timings could be critical for insecticide efficacy. We have been evaluating a number of different insecticides for managing tadpole shrimp. We tested insecticides from multiple modes of action due to the threat of resistance to pyrethroids. In addition, we tested multiple rates and application timings to address the economics of management and different scouting situations. Managing shrimp with multiple modes of action will be critical for preventing insecticide resistance from spreading more broadly. Additional work has been evaluating if biological control may help suppress tadpole shrimp and has been assessing if tadpole shrimp may provide some benefit through weed suppression. As a problematic pest whose management hinges on insecticides, tadpole shrimp could be managed in a more effective and sustainable manner.

Assessing Needed Application Timing and Density of Mosquitofish (Gambusia affinis) for Biological Control of Tadpole Shrimp (Triops longicaudatus)
Madi Hendrick, Kevin Goding, Luis Espino, and Ian Grettenberger.

Tadpole shrimp (Triops longicaudatus; TPS) are the key, early-season pest of rice in California. TPS have desiccation-resistant eggs that begin hatching within 24-48 hours after flooding under the right conditions. Because California rice is planted after the fields are flooded, their biology gives them a unique advantage. By the time rice is planted, many TPS are already large enough to begin damaging the plants. They feed on the weak roots of young rice seedlings, which causes them to float to the surface and results in stand loss. TPS are a severe pest with few control options, and growers are typically limited to chemicals such as pyrethroids to treat. Because there are so few management options, alternative control methods could be vital to managing insecticide resistance. We set up two different field trials testing different densities of mosquitofish (Gambusia affinis), as well as application timing. 100ft^2 rings were built in the fields pre-flooding; fish were added immediately after flooding in the density trial, and at their designated intervals for the timing trial. Trials were conducted in two different fields with known differing TPS densities. The density trial (held in Systems) showed a slight difference between treatments. The application timing trial (in J7) showed differences among treatments, indicating better tadpole shrimp control with earlier applications.

Guidelines for Bakanae Seed Treatment
Luis Espino

Bakanae is a fungal disease found in California in 1999. The pathogen causes excessive seedling elongation, typically killing the plant before it produces a panicle. If a panicle is produced, it does not produce grains. Dying plants produce large amounts of spores that can infest seeds during harvest.

Soaking rice seed in a sodium hypochlorite solution greatly reduces seedling infection. This treatment was widely adopted and was successful in limiting the spread of the disease. However, in recent years, a resurgence of Bakanae has been observed across the rice production area of California. One possible reason for this resurgence is the misapplication of the sodium hypochlorite soaking treatment.

For the sodium hypochlorite treatment to be effective, seed should be soaked for 2 hours using a thoroughly premixed solution by diluting the concentrated sodium hypochlorite product in water to achieve a 3,000 ppm available chlorine solution, then the seed soak solution is drained and replaced with fresh water to continue seed soaking and draining as usual. Alternatively, seed can be soaked in a thoroughly pre-mixed solution by diluting the concentrated sodium hypochlorite product in water to achieve a 1,500 ppm available chlorine solution that is used to soak the seed for the entire seed soak time (no rinse required).

Armyworm Monitoring Update
Luis Espino, Troy Clark, and Consuelo Baez-Vega.

Since the armyworm outbreak of 2015, armyworm adult populations are being monitored using pheromone traps. The traps have shown that there are two armyworm flights, one in late June-early July and another in mid-August. The time when these flights occur coincide with the time when armyworms are observed in causing injury in the field. During 2022, fields monitored with pheromone traps were monitored for larvae presence and defoliation weekly. Results showed that the peak in the number larvae found in the field occurs one to two weeks after the peak in the number of moths was obtained in the traps. The relationship between number of moths and number of larvae was different for each field. In some cases, fields with large number of moths had very low larvae population. Information from pheromone traps can be used to predict when field monitoring should be intensified to avoid defoliation damage.

Management of Rice Stem Rot
Luis Espino and Whitney Brim De-Forest.

Stem rot is a common disease of rice in California. In some fields, the disease can reach high severity, resulting in blanking, lodging, and reduced yields. Research conducted in the past few years has shown that varieties with longer periods of development (M-209, M-211) are more tolerant than shorter season varieties (S-102, CM-101). The fungicide azoxystrobin applied at the late boot to early heading stage can significantly reduce the severity of the disease.

Typically, the decision to use a fungicide to manage stem rot is based on the history of the field. Symptoms of the disease are most visible during drain time, allowing for disease severity determination. Unfortunately, this timing is too late for a fungicide application. Monitoring for stem rot before the fungicide application timing can help growers make a more informed decision weather a fungicide treatment is needed.

During 2022, several fields were monitored for disease development during the late boot stage and at drain time, to determine if there is a relationship between disease incidence and severity at these times. More data is being collected during 2023.

Preliminary Data on Cover Cropping in Rice Systems in California
Sara Rosenberg, Michelle Leinfelder-Miles, Cameron Pittelkow, and Whitney Brim-DeForest.

A rice cover crop trial started last fall (2022) and will continue for the 2023 and 2024 winter seasons. The sites are located at the Rice Experiment Station in Butte County and two grower fields, one in Colusa and one in San Joaquin. The rain this year made it difficult to establish crops at all locations. A variety trial, as well as a larger basin planted with a mix were established at each site, and compared to a control (winter flood). The current report is on the larger basins only, which were planted with a mix of bell beans, purple vetch, rye, and field bean. We harvested biomass, including weed biomass, at the end of the season. Due to high precipitation rates this winter, all three cover crop demonstrations had very low growth. Each site also presented with different weed populations.

San Joaquin site was dominated by grasses, the Butte site was dominated by grasses and sedges, and the Colusa site was dominated by broadleaf weeds. Weed growth outperformed all cover crop species by the end of the cover crop growing season. At the Colusa site, all species (especially rye) showed positive germination rate at the beginning of the growing season but declined after flooding events due to amount of time submerged over the season. Biomass samples were taken before cover crop termination at each site. San Joaquin had the highest overall biomass weight for purple vetch, which did not exceed .4 grams. Colusa had average 20 grams per meter 2 of broadleaf weed dry weight while Biggs site had almost 30 g/ meter 2 dry weight for grass weeds in the control plot. There was no substantial growth of any cover crop this year due to flooding events as described previously. More data will be collected at the end of the year on the difference in yields. Soil sample data as well as carbon and nitrogen content of the weeds and cover crops will also be analyzed.

Can Tadpole Shrimp be Useful as a Weed Control Tool? Interactions Between Tadpole Shrimp, Herbicides, Weeds, and Rice

Whitney Brim-DeForest, Luis Espino, Troy Clark, Consuelo Baez-Vega, Taiyu Guan, and Ian Grettenberger.

In contrast to the rice damage they can cause, tadpole shrimp may actually provide weed management benefits. Our project is also evaluating the capacity of tadpole shrimp to feed on rice weeds. A greenhouse experiment was carried out in at the Rice Experiment Station in Biggs, CA. Field soil which contained both tadpole shrimp eggs and several weed species was utilized, to provide a natural environment in which to understand the interaction between the tadpole shrimp, rice, and weed species, and the effect of herbicides on the predation on rice versus weeds. Field soil was placed into clear plastic tubs (30.1 cm x 42.5 cm x 17.8 cm) at a depth of approximately 1 inch, and then water was applied at a depth of 4 inches above the soil surface. Rice was seeded into the treatments at rate of 150 lb per acre. Weed species present in the soil included two sedges (ricefield bulrush (*Schoenoplectus mucronatis*) and smallflower umbrellasedge (*Cyperus difformis*), several broadleaves (waterhyssop (*Bacopa* spp.) and redstem (Ammania spp.) and no grasses. The experiment consisted of three treatments: Untreated Control, Herbicide (benzobicyclon), and Copper Sulfate. The benzobicyclon and copper sulfate were applied at labeled rates (7.5 lb per acre and 25 lb per acre, respectively). Both were applied day of seeding. The entire experiment was replicated three times over the course of the winter and spring of 2023 (February-March, March-April, and May-June). Each experiment was arranged in a Completely Randomized Design (CRD) with 5 replications the first round, and 6 replications for the second and third rounds. Tadpole shrimp were counted 2-3 times a week over the course of the experiment, and final measurements of tadpole shrimp size were taken at the end of each experiment (approximately 6 weeks after the application of water to the soil). The data is still being analyzed and will be reported in the following report. Weed and rice aboveground biomass (fresh and dry) was measured at the end of the experiment as well. Plants were harvested by cutting stems right at the soil surface. Plants were separated into sedges, broadleaves, grasses, and rice. Fresh weights (g) were recorded immediately after harvest. Plants were allowed to dry to a constant weight, and then dry weights (g) were recorded as well. In the Control treatment, tadpole shrimp were present, as were all weed species and rice. Weed and rice biomass were found to be in the middle of the other two treatments. In the Herbicide treatment, almost no weeds were found at the end of the experiment (due to control by the benzobicyclon) and the rice aboveground biomass was the lowest out of the three treatments. Tadpole shrimp were present in the treatment, as no insecticide was used for shrimp control. In the Copper Sulfate treatment, no tadpole shrimp were found, as all were controlled by the insecticide. The weed and rice biomass were the greatest out of all three of the treatments, both for sedges, and for broadleaves.

Rice Crop Rotation Calculator: A Decision-Support Tool

Consuelo Baez Vega, Sara Rosenberg, Ellen Bruno, Chinh Lam, Bobby Tooyserkani, Hannah Zorlu, Tunyalee Martin, Cameron Pittelkow, and Whitney Brim-DeForest.

Crop rotations have been shown to support agronomic challenges by disrupting pest life cycles, allowing use of pesticide modes of action otherwise not available, and may help long-term soil health functions like improved soil structure. In response to a grower survey conducted regarding crop rotation in California rice, a crop rotation calculator was developed, in collaboration with the University of California Integrated Pest Management (IPM) Team, as an interactive decision support tool to support rice growers in the Sacramento Valley and other interested persons. Funding was supported through the Western IPM Center and USDA NIFA grants. The calculator explores how different production decisions may impact profitability in the year following rice by calculating the short-term profitability of switching from rice to a rotational crop. In 2021, four focus groups were held to evaluate the economic costs and requirements for switching from rice to a rotational crop. Supplementing the focus group outcomes, UCCE cost studies and partial budgets were used to extrapolate prices for relevant cost components for the individual crops. Costs were calculated for each crop ($/acre). The cost-benefit equation, Profit = Revenue - Costs, was used. Equipment, overhead and operating (include fuel and repair) costs were based on UCCE cost assumptions. Overhead costs for equipment were estimated using Capital Recovery to value annual depreciation and interest rate of capital investments. Annual overhead and operating costs were converted to average hourly rates then scaled to $/acre. It’s important to note that values will be different based on grower's average land size and other cost components unaccounted for. The calculator was presented for review, updated to its current form, and officially launched in November 2022.

Calhikari-203, A Glabrous High Yielding Premium Quality Short Grain Rice

Teresa B. De Leon, Omar Samonte, Virgilio Andaya, Kent S. McKenzie, Gretchen Zaunbrecher, and Dustin Harrell.

Calhikari-203 (Oryza sativa L.), a rice cultivar previously known as 17Y2087 was released in January 2023 by the California Cooperative Rice Research Foundation Inc., for premium quality short grain market. Calhikari-203 or CH-203 was developed through pedigree method. It is a semidwarf, early-maturing, non-pubescent, high-yielding premium-quality short grain rice. In the five-year Statewide Yield Tests, Calhikari-203 consistently outyielded Calhikari-202 by 11%. On average, Calhikari-203 yields 9,050 lbs./acre compared to 8,158 lbs./A of Calhikari-202. Calhikari-203 flowers at 89 days, it is cold tolerant, more lodging resistant, and with seedling vigor suitable for organic rice farming. At 18-20% moisture content during harvest, Calhikari-203 had milling yield of 66% head rice, 72% total. Internal and external blind test evaluations of rice marketing companies and some Japanese individuals indicated the grain appearance, cooking, and eating qualities of Calhikari-203 as closely similar to Koshihikari and Calhikari-202 parents, thus supporting its market acceptability.

Multiplex Gene Editing of UGP3 Gene in Rice Confers Oxyfluorfen Herbicide Resistance

Teresa B. De Leon, Kent S. McKenzie, Virgilio Andaya, Cynthia Andaya, and Dustin Harrell.

In 2013 the California Rice Experiment Station started a research study that aimed to develop herbicide resistant rice. An oxyfluorfen resistance trait in EMS-treated rice was discovered and was called ROXY®. Genetic testing indicated that the herbicide tolerance trait was controlled by a single recessive gene mapped in chromosome 5 of rice. Fine mapping and DNA sequence analysis indicated nucleotide deletion in a gene that encodes for a UDP-Glucose Pyrophosphorylase 3 (UGP3). To confirm the genetic modification and herbicide tolerance found in EMS-mutated rice, a CRISPR-Cas9 gene construct containing multiple guide RNAs was designed and used in rice transformation of Calmochi-203. The gene-edited rice was advanced to T2 generation and treated with oxyfluorfen. The treated T2 seedlings of gene-edited Calmochi-203 showed enhanced shoot and root growth under oxyfluorfen treatment consistent with the resistance of ROXY® trait. Gene sequencing of UGP3 target site confirmed several mutations introduced by CRISPR and recovery of herbicide resistant trait.

M-521 is a Blast Resistant and Herbicide Tolerant Calrose Rice
Teresa B. De Leon, Kent S. McKenzie, Virgilio Andaya, Cynthia Andaya, Gretchen Zaunbrecher, and Dustin Harrell.

To help mitigate the growing weed resistance problem in California rice production, the Rice Experiment Station started a research study that aimed to develop herbicide resistant rice. The station used a mutation breeding approach to introduce genetic variants not found in rice germplasm. An oxyfluorfen resistance trait in EMS-treated rice was discovered and was named ROXY®. The trait was successfully introgressed to M-210. The resulting rice variety was named M-521 and was officially released in January 2023. The M-521 is a non-GMO conventional early-maturing medium grain rice, flowers at 88 days, with good seedling vigor, low lodging potential, and high cold tolerance like M-206. M-521 grain yield averaged 8,821 lbs. per acre and had milling yield of 67% headrice, 72% total at 18-20% moisture content during harvest. M-521 contains Rox1.1 allele for oxyfluorfen tolerance and Pi-b gene for blast resistance.

18Y2070, A Lodging-Tolerant High- Yielding Advanced Risotto Rice
Teresa B. De Leon, Kent S. McKenzie, Gretchen Zaunbrecher, and Dustin Harrell.

With pedigree that traced back to Italian rice varieties such as Arborio, Carnaroli, and Faro, an experimental line designated as 18Y2070 was developed to accommodate the niche market for risotto rice cooking. 18Y2070 has the signature bold kernels and white belly typical of risotto rice varieties. Four-year multi-location statewide yield testing indicated the excellent yield potential and favorable agronomic characteristics of 18Y2070 over 89Y235, a released germplasm by the station for Arborio type. Overall, 18Y2070 is a semidwarf, glabrous rice, flowers at 89 days, and lodging resistant. 18Y2070 averaged 8,862 lbs./acre, and had milling yield of 50% head rice, 66% total at 21% harvest moisture content. 18Y2070 is currently in headrow purification and seed increase. With positive external blind evaluations for grain appearance, cooking and eating characteristics of risotto rice, 18Y2070 will be proposed for foundation seed production in 2024 and possible variety release in January 2025.

Cattail Invasion and Control in California Rice
Deniz Inci, Michelle Leinfelder-Miles, and Kassim Al-Khatib.

Cattail is an invasive weed that grows up to 10 feet tall and naturally occurs at ditches, drainage and irrigation canals, lakes, marshes, ponds, rivers, and streams. Unlikely its natural habitat, cattail has recently begun to infest rice fields in California's Sacramento-San Joaquin Delta. Loyant CA is a novel synthetic-auxin-type rice herbicide newly registered in California. This research aimed to study the potential of using Loyant CA for cattail control. Two field research were conducted at McDonald Island of the Delta region during the 2022-2023 growing seasons. Treatments were Loyant CA at 2.66 and 1.33

pint/acre, Loyant CA at 1.33 plus Grandstand CA at 1.0 pint/acre, and Grandstand CA at 1.0 pint/acre use rates. Loyant CA was applied at zero to three feet tall and three to six feet tall plants. Methylated seed oil at 0.5 pint/acre was also added to all treatments. The study was a randomized complete block design with four replicates. Herbicides were applied on 100 square feet plots to a range of cattails from two to three-leaf growth stages up to six-feet-tall growth stages. Visual injuries were rated at 7, 14, 21, 28, and 42 days after treatments (DAT) using a scale where 0 means no injury and 100 means plant kill. All Loyant CA treatments achieved 100% control when cattails were up to three feet. When cattails were three to six feet, the efficacy was 96, 78, 75, and 0% at 42 DAT, respectively. This study showed a significant potential for foliar applications of Loyant CA to control cattail up to three-feet-tall growth stages.

Active Water Quality Management
California Rice Commission

Proactive participation and representation in several regulatory programs and initiatives, with the goal of minimal impact to rice industry members, while continuing to routinely meet regulatory compliance requirements.

Conservation Programs on California Ricelands
California Rice Commission

Outlining a variety of wildlife conservation programs available to growers that aide in providing additional habitat for birds and fish in the Sacramento Valley.

Rice Helping Salmon
California Rice Commission

Phase II of the Pilot Salmon Project with UC Davis and California Trout continues, highlighting the 2023 successes during this multi-year effort to develop a strategy for managing winter-flooded rice fields to aid in salmon recovery efforts.

Communications - CalRiceNews.org
California Rice Commission

Providing industry specific information including regulatory, conservation, and policy related details you need to know, sign up for instant updates at CalRiceNews.org. Utilizing social media, media and the CalRice.org website, the CRC highlights the unique connection planted rice in the Sacramento Valley has with the economy, environment, and ecosystem by showcasing the unparalleled habitat value and biodiversity benefits planted rice provides (California Rice Commission)

Introduction of Aerobic Soil Conditions to Continuous Rice Enhances Soil Nitrogen Availability

Zhenglin Zhang, Daniel C. Olk, and Bruce A. Linquist.

Rice in California represents a sizeable proportion of U.S. harvest. The default growing strategy of yearly monocropping rice without upland rotations or fallows has shown signs of yield gaps in other rice-growing regions in the world likely due to an accumulation of lignin-derived phenols that limit N availability. In this experiment, we investigated the effect of fallow on rice yield. Rice after fallow will be compared to a control of continuous rice to determine differences in yield potential and crop N uptake from soil N and fertilizer N pools. From our N rate trial, we found that differences in yield was the most prominent at low N rates. However, higher N rates reduced yield differences. Through a labeled 15N experiment, we show that rice after fallow has greater soil N availability, resulting in a difference of 16.8 kgN/ha at harvest. On the other hand, fertilizer N availability was similar between the two systems. Through analysis of soils sampled from across the growing region of the Sacramento Valley, we found that continuous rice consistently had greater soil phenol content compared to rice after fallow, providing mechanistic support for stronger N binding and reduced soil N availability. Our results suggest that the fallowing of fields that have been in a prolonged duration of rice production can increase productivity by enhancing soil N uptake.

High Yielding Low Amylose Short Grain Rice

F. Maulana, T. DeLeon, N. Sharma, G. Zaunbrecher, and D. Harrell.

In 2006, the California Cooperative Rice Research Foundation Inc. released the first low amylose short grain, Calamylow-201 (CA-201), developed through mutation breeding for specialty market. However, CA-201 has a low yielding potential, as such there is need to develop an alternative variety to address this limitation. Low amylose rice has been associated with more resistance to staling (loss of freshness) as such it has been used to make frozen rice products. An experimental line,16Y2028, is an improved low amylose short grain rice developed at the Rice Experiment Station through pedigree breeding. It is a very high yielding, semidwarf, early maturing, and cold tolerant rice. From 2019 to 2022 statewide yield tests, 16Y2028 significantly outyielded CA-201 in all test locations. On average, 16Y2028 yielded 9,182 lbs./A compared to 6,858 lbs./A of CA-201, a yield advantage of 34% over CA-201. Its days to 50% heading is at 84 days, it is cold tolerant, and it has good seedling vigor like CA-201. Overall, 16Y2028 had milling yield of 63% head rice,71% total when harvested at 18-20% MC. In addition, its kernels are larger and heavier, while its cooked rice is whiter and slightly more firm than CA-201. Grain quality attributes, including grain appearance, cooking and eating qualities, such as shininess, stickness, mouthfeel and taste of 16Y2028 are similar to CA-201.

Promising Waxy Short Grain Rice
F. Maulana, T. DeLeon, N. Sharma, G. Zaunbrecher, and D. Harrell.

The short grain breeding program at the Rice Experiment Station has developed an improved waxy short grain rice designated as 20Y2124, through pedigree breeding for potential future release. Its agronomic performance during statewide (SW) yield testing showed significant improvement to two commercially grown waxy short grain varieties, Calmochi-101 (CM-101) and Calmochi-203 (CM-203), previously released by the station. It is a very high yielding, semidwarf, and early maturing rice. Across all SW test locations, 20Y2124 had an average grain yield of 9,278 lbs./A compared to 9,010 lbs./A for CM-203 and 7,583 lbs/A for CM-101, representing 3 and 22% yield advantages over CM-203 and CM-101, respectively. It flowered at 85 days like CM-101 and earlier than CM-203, it is more lodging resistant than CM-101 and CM-203 by 10%. The grain milling yield of 20Y2124 was 58% head rice and 70% total when harvested at 18-22% moisture content.

Promising Conventional Short Grain Rice
F. Maulana, T. DeLeon, N. Sharma, G. Zaunbrecher, and D. Harrell.

An experimental line, 20Y2001, is a promising conventional short grain rice developed through pedigree breeding by the California Cooperative Rice Research Foundation Inc. at the Rice Experiment Station. It is a very high yielding, semidwarf, early maturing rice with good seedling vigor. Across two-year statewide yield tests, 20Y2001 significantly outyielded S-102 by 24% and S-202 by 2%. Average grain yield of 20Y2001 was 9,916 lbs./A compared to 7,980 lbs./A for S-102 and 9,726 lbs./A for S-202. It reached days to 50% heading at 84 days after planting, which was 3 days later and earlier than S-102 and S-202, respectively. In addition, it is tolerant to lodging and cold-induced panicle blanking. When harvested at moisture content ranging from 18 to 20%, 20Y2001 had a similar milling grain yield of 60% headrice to S-102 and 1% higher than S-202.

Late Season Control of Watergrass
Whitney Brim-DeForest, Troy Clark, and Taiyu Guan.

For the past several years, late watergrass, barnyardgrass, and now Walter's barnyardgrass have been increasingly difficult to control late in the season, and our options for follow-up foliar applications are limited. Starting in 2022, we have been testing different combinations, both tank mixes and back-to-back applications of currently-registered rice herbicides to determine if there are options other than propanil alone, or propanil followed by propanil. This year, we have trials at 5 locations, including the one at the Rice Experiment Station. Except for the RES, all fields have grasses with various levels of herbicide tolerance or resistance. We are evaluating control, as well as phytotoxicity and yields. Some of the treatments tested include: Propanil + Shark H2O, Regiment followed by Propanil, Propanil + Loyant, Regiment + Loyant, Propanil + Abolish, Regiment + Clincher and a few standards for comparison. Results so far indicate that control may be site and species-specific, but many of these tank mixes look promising.

FIELD TOUR ABSTRACTS

RES Rice Breeding Program

Teresa DeLeon, Frank Maulana, Nirmal Sharma, Gretchen Zaunbrecher and Dustin Harrell

The RES Breeding program has released fifty-eight improved rice varieties since 1969 and it continues its effort in developing excellent rice varieties for all grain types and market classes of rice for California rice growers. The program is divided to medium grains, short grains, and long grains projects. For all grain types, the program aims to develop superior rice varieties with 1) high and stable grain yield potentials, 2) superior milling yield and grain qualities including grain appearance and cooking characteristics relative to market and consumers preference, 3) improved cold tolerance and seedling vigor, 4) early maturity and statewide adaptability, 5) improved straw strength for lodging resistance, 6) blast and stem rot disease resistance, and more recently, 7) herbicide tolerance. The medium grains project includes development of regular and premium Calrose rice. The short grains project includes development of regular short grain (S), premium quality short grain (SPQ), waxy or sweet rice (SWX), low amylose-type (SLA) and short bold grain or Arborio-type rice (SBG). In the long grains, the project includes conventional or regular long grain, aromatic, Jasmine-type, and Basmati-type rice.

Medium Grain Breeding

Teresa B. De Leon

The Medium Grain Breeding Project is focused on development and improvement of grain yield, grain quality, cooking, and eating qualities preferred by the medium grain market. Furthermore, emphasis is given to selecting breeding lines with high seedling vigor, very early to early maturity, with strong straw, cold tolerance, disease and herbicide resistance, and wide adaptation to California-rice growing counties. With water shortage we experienced in the past years, we are actively selecting for water-saving rice without compromising the yield and grain quality of Calrose rice.

The project employs traditional breeding methods and molecular markers at various generations of variety development to speed up trait selection and breeding cycles. We use SSR and SNP DNA markers to select for disease and herbicide resistance, headrow purification, and fingerprinting of advanced promising lines. For selection of cold tolerant rice, the medium grain project actively utilizes the San Joaquin nursery and cold greenhouse. Additionally, we use the Hawaii winter nursery to achieve two cropping seasons within a year for generation advancement, seed increase, and headrow purification.

Variety Performance in 2022 Yield Tests

The MG project evaluates more than 45,000 breeding lines including check varieties every year. Last year, we entered 838 lines in replicated yield trials at RES and 30 advanced lines in the Statewide (SW) Yield Tests. Despite the water shortage we encountered, the medium grains had an average yield of 85 sacks per acre or 8,556 lb/A across the statewide yield tests. The premium Calrose M-211 had the highest yield averaging at 9,071 lb/A followed by M-209 at 8,850 lb/A. Blast-resistant M-210 registered an average yield of 8,569 lb/A. The very early M-105 had an average yield of 8,055 lb/A while the widely grown M-206 had 8,381 lb/A yield.

In the milling yield study last year, data indicated the superior head rice recovery of all medium grain varieties when harvested at moisture content (MC) not lower than 18%. At 20% moisture, medium grain varieties averaged a milling yield of 68% head rice and 71% total. M-105 had the most stable milling yield with 69% head rice at harvest moistures ranging from 15-28%. Both M-206 and M-210 had more than 67% head rice at 18-26% MC. M-209 had slightly lower head rice yield of 65% at 16-26 MC. In contrast, M-211 showed moisture sensitivity during harvest. M-211 flowers a week later than M-206. Therefore, we recommend M-211 field draining a week later than other medium grains to complete its grain maturity. M-211 should be harvested at moisture content not lower than 20% to recover 65% head rice yield.

The 2022 August-September heatwave apparently had affected not only the grain yield but also the grain quality of medium grains. Rice sampled from milling yield plots showed a significant number of chalky kernels. The M-206 showed the highest chalky kernels at 3.2%. The M-211 had 2.6% chalk, M-209 had 2% while the M105 and M-210 had 1.9% chalky kernels.

New Variety Released in 2022

M-521, formerly known as 19Y4000 was released in January 2023. M-521 is genetically an M-210 containing the blast resistant *Pi-b* gene with the addition of herbicide tolerant trait, Roxy. M-521 has high tolerance to oxyfluorfen chemical which is included in the PPO group of herbicides. M-521 was bred conventionally with the aid of marker-assisted selection (MAS) for *Pi-b* and the ROXY trait. M-521 was derived from 2015 summer cross designated as RM3447 = M-210 x 14G9. M-210 was developed by backcrossing a blast donor isoline to M-206 seven times (BC7). M-206 is a high yielding, glabrous, early maturing, Calrose-type medium grain variety released by RES in 2003. M-206 is the most widely grown Calrose variety in California with excellent milling yield and grain quality. 14G9 is an EMS-induced mutant of M-206 containing nucleotide deletion at *UGP3* gene and confers high tolerance to oxyfluorfen herbicide (US Patent 11,180,771 B2 and trademark ROXY®).

Field performance of M-521 is closely similar to M-206 and M-210 in all SW test locations based on the pooled four-year SW Yield Tests. It has a very good seedling vigor, flowers at 87 days, plant height of 96cm, with similar lodging potential and adaptation like M-206 and M-210. The overall grain yield of M-521 across 41 SW yield experiments averaged 8,839 lb/A compared to 8,907 and 8,949 lb/A for M-206 and M-210, respectively.

The milling yield of M-521 is also similar to M-206 and M-210. When harvested at 18-22% MC, M-521 yields 67% head rice, 71% total. The milled grains of M-521 (length = 5.83 mm, width = 2.69 mm) meet the criteria of the Calrose rice market with a slightly longer grain and higher L/W ratio of 2.19. The average apparent amylose and protein content of M-521 is like M-206 and M-210 at 19.26% and 5.96%, respectively. Rice viscosity analysis indicated the low gel type and cooking characteristics of M-521 similar to M-206 and typical of a Calrose type rice. Therefore, milled rice of M-521 grains can be comingled with other Calrose rice varieties currently in production in California.

In panicle blanking test, M-521 had 1.3% blanking in San Joaquin and 34% in cold greenhouse similar to the level of cold tolerance of M-210. For disease resistance, M-521 is moderately susceptible to stem rot infection. M-521 was not tested against blast and aggregate sheath spots. However, with *Pi-b* gene, M-521 is expected to be blast resistant. More details of M-521 are available in a poster presented at RES field day and in 2023 RES Annual Report.

Promising Advanced Lines Under Headrow Purification

For blast-resistant Calrose type, 18Y3018 had a 3-5% yield advantage over M-210. 18Y3018 has *Pi-b* and *Pi-z5* blast resistance genes, and thus, may offer a broader blast resistance than M-210. 18Y3018 has been in the SW yield tests since 2019 with average yield of 9,370 lb/A yield in four years. Like other medium grain varieties, 18Y3018 had lower yield last year compared to previous years. However, 18Y3018 consistently outyielded M-210, averaging 8,836 lb/A compared to 8,569 lb/A of M-210. 18Y3018 showed similar seedling vigor to M-210, flowered at 88 days (5 days later), was more lodging resistant than M-210, was more cold tolerant in San Joaquin, had lower chalky kernel (1% vs 2%), and has higher taste value than M-210 (77 vs 65). Compared to M-210, 18Y3018 had a lower milling yield than M-210 at 20%MC.

In addition to regular, premium, herbicide, and blast resistant Calrose types, the medium grain project started developing a fragrant Calrose. For this type, 20Y4033 was selected promising for possible variety release to compete. In SW yield tests, 20Y4033 had equal or better yield than M-206, flowered one day earlier than M-206, had similar agronomic traits, cold tolerance, had lower chalky kernel, and a higher taste value than M-206.

For specialty rice, we have the 18Y2070 as the most promising line for Arborio type. With average yield of 8,862lb/A, 18Y2070 offers 14 and 100% yield advantage over 89Y235 and Arborio rice, respectively. Furthermore, 18Y2070 gives 50% headrice, 66% total at 21% harvest moisture. The leaves and paddy rice of 18Y2070 are glabrous. It is early maturing, flowers at 90 days, plant height is 100cm, lodging tolerant, and has seedling vigor suitable for organic farming. External blind test evaluations indicated the suitability of 18Y2070 for risotto cooking.

Long Grain Breeding
N. Sharma

The long grain breeding projects include conventional long grain, Jasmine-type, Basmati-type and Aromatic rice. This year a total of 504 crosses were made in spring (239) and summer (265) for long grain project. In 2022, the project evaluated a total of 19,804 breeding lines which included 339 F_1, 514 F_2, 11,810 progeny rows (F_3- F_5), 304 Preliminary Yield Trial, 354 Advanced Yield Trial, 280 Statewide Yield Trial, 1,360 headrows, 2,750 seed maintenance rows and 1,270 cold nursery rows (Greenhouse and San Joaquin).

For long grain yield and agronomic testing, check varieties included in all experiments were L-207 and L-208 for conventional, Calaroma-201 for Jasmine-type, Calmati-202 for Basmati-type and A-202 for Aromatic rice. Based on pooled statewide experiments, L-208 had an average yield of 9,915 lbs./acre, followed by L-207 at 9,481 lbs./acre, Calaroma-201 at 8,752 lbs./acre, A-202 at 8,088 lbs./acre and Calmati-202 at 6,179 lbs./acre.

Long grain varieties had an average milling yield range of 52.2-62.9% head rice and 65.7-70.1% total rice across all harvest moistures. L-207 showed higher average head rice (61.7%) compared to L-208 (60.8%). Calaroma-201 showed the highest average percent head rice which was 62.9. Based on milling yield trends, the long grain check varieties showed highest head rice near at 20% moisture content except Calaroma-201, which showed highest head rice at 18-19% moisture content. L-207 had the most stable grain quality at 15-24% MC. The best milling yields in 2022 were observed when harvested at 20% grain moisture content. The August-September heatwave of 2022 affected the long grain varieties L-208, L-207 and A-202 in terms of chalkiness and showed 4.42%, 5.48% and 6.65% whole chalky kernels, respectively. However, the long grain varieties Calaroma-201 (0.72%) and Calmati-202 (0.42%) showed a very trace amount of chalkiness.

There were ten advanced lines (19Y1018, 19Y1071, 21Y1002, 20Y1008, 20Y1029, 20Y1058, 20Y1080, 20Y1101, 20Y1102 and 20Y1117) in the 2022 statewide yield trial and out of those 3 lines (19Y1018, 20Y1029, 20Y1008) showed promising for future release.

The advanced line 19Y1018 is a regular long grain placed in the statewide trial for the second time. The line was planted in seven locations and out yielded L-208 and L-207 by 1.7% and 5.7%. The average RES and statewide yield of 19Y1018 was 10,013 and 10,123 lbs./acre, while L-208 was 9,877 and 9,953 lbs./acre, as well as L-207 was 9,411 and 9,551 lbs./acre, respectively. The line grew 92 cm tall in, which was similar to L-208 and 7 cm smaller than L-207. 19Y1018 is 2 days and 6 days earlier than L-208 and L-207 in 50% heading. Based on milling yield trends, the line 19Y1018 showed stable head rice performance, which can be harvested from 18-26% moisture content.

20Y1029 is another promising regular long grain planted in four statewide locations for the first time in 2022. The average yield of the line in statewide experiments and RES was 9,916 and 10,221 lbs./acre, respectively. In the RES experiments, the line outperformed L-208 (9,877 lbs./acre) by 3.4%. The line grew 99 cm, which was 8 cm taller than L-208. The line reached 50% heading in 89 days, which was 4 days earlier than L-207.

20Y1008, another 2022 statewide newcomer, is a regular long grain and was planted in seven statewide locations. The line had an average yield of 9,941 lbs./acre in RES and 9,837 lbs./acre in statewide test locations. In the statewide experiments, the line outperformed L-207 (9,551 lbs./acre) by 2.9%. 20Y1020 was 95 cm tall, 4 cm smaller than L-207. The line reached 50% heading in 87 days which was comparable to L-208.

Short Grain Breeding
Frank Maulana

The short grain breeding program at the Rice Experiment Station continues its mandate of developing conventional short grains and specialty types, including premium quality, waxy, low amylose and Arborio short grain rice for the benefit of rice growers in California. During the 2023 field day, the rice experiment station will showcase promising low amylose, waxy and conventional short grain rice. Multi-year statewide yield testing has identified three promising experimental lines designated as 16Y2028, 20Y2124 and 20Y2001 as potential future releases. An experimental line, 16Y2028, is a very high yielding, semidwarf, early maturing, and cold tolerant low amylose short grain rice with 34% yield advantage over Calamylow-201 (CA-201), previously released low amylose variety by the station. 20Y2124 is a very high yielding, semidwarf, and early maturing waxy short grain rice with yield advantage of 3% over Calmochi-203(CM-203) and 22% over Calmochi-101(CM-101). 20Y2001 is a very high yielding, semidwarf, early maturing conventional short grain rice with good seedling vigor which outyielded S-102 by 24% and S-202 by 2% in statewide yield tests.

Calhikari-203 is a new premium quality short grain released in January of 2023. It is a semidwarf, early-maturing, non-pubescent, high-yielding premium-quality short grain variety. In the five-year Statewide Yield Tests, Calhikari-203 consistently outyielded Calhikari-202 by 11%. On average, Calhikari-203 yields 9,050 lbs./acre compared to 8,158 lbs./A of Calhikari-202. Calhikari-203 flowers at 89 days, it is cold tolerant, more lodging resistant, and with seedling vigor suitable for organic rice farming. At 18-20% moisture content during harvest, Calhikari-203 had milling yield of 66% head rice, 72% total. Internal and external blind test evaluations of rice marketing companies and some Japanese individuals indicated the grain appearance, cooking, and eating qualities of Calhikari-203 as closely similar to Koshihikari and Calhikari-202 parents, thus supporting its market acceptability.

Genomic Selection: Improving Rice Breeding Efficiency and Reducing Costs

Pedigree breeding based on phenotypic selection is time-consuming and costly. It takes about 10-12 years to develop and release a new rice variety and it requires a lot of resources. Marker-assisted selection (MAS) is suitable for simple traits, such as amylose content, aroma, blast resistance and herbicide resistance, controlled by a single gene with large effect, but it is less suitable for complex traits, controlled by many small-effect genes, including grain yield and milling quality. Genomic selection (GS), another form of MAS, has shown to overcome this drawback. GS uses prediction model to estimate DNA marker effects from a training population (TP-with genotypes and phenotypes) to predict the performance of the lines that have been genotyped but not phenotyped. GS can reduce breeding cycle by earlier selection of potential parents for crosses with improved chance of obtaining superior lines, reduce phenotyping costs by predicting the performance of lines before field testing and increase genetic gain over time. The objectives of this project are: 1) to develop the TP for GS model training and optimization, and 2) to integrate GS in rice breeding programs at the Rice Experiment Station (RES) to speed up the development of new varieties and reduce expenses. A population of 360 lines, including advanced breeding lines and RES released rice varieties of all grain types, are currently being evaluated for grain yield and quality in the field at RES. In addition, we plan to genotype the population with genome-wide DNA markers for GS model training. Our long-term plan is to integrate GS, as one of the breeding strategies, in RES rice breeding programs to improve overall breeding efficiency.

DNA Marker Laboratory

Gretchen Zaunbrecher

Since its establishment in 2008, The DNA Marker Lab’s primary goal has been to assist the breeders in their selection work using DNA marker technology. MAS has become an essential tool for increasing the efficiency of the breeding program by identifying potential lines that possess superior agronomic traits, allowing the breeder to advance these lines sooner thereby reducing costs and the time needed to eventual variety release. In addition to the MAS work identifying traits such as blast resistance, grain quality, aroma and herbicide tolerance, the DNA lab is responsible for genetic fingerprinting and purity testing of advanced lines for quality assurance of our released varieties. Through the years the DNA lab has played important roles in the genetic mapping and validation of stem rot resistance and oxyfluorfen herbicide tolerance traits in our advanced lines as well as the generation of new mutant populations through traditional irradiation and chemical mutagenic protocols.

The DNA lab is currently verifying over 2,830 F1 entries for true crossing and fingerprinting 4,120 short, medium, long, and specialty advanced lines with 6-12 markers each. Approximately 5,000 lines will be analyzed for the presence of both oxyfluorfen and blast tolerance. Every year off-type field samples that are submitted by our breeders and commercial producers are fingerprinted and identified by the lab. The lab is also developing a Purity Certification Assay for future ROXY® foundation seed which will give producers additional assurance in the quality of their seed. Future projects include the implementation of the new gene modification protocol, CRISPR, to develop rice varieties with valuable traits that will further enhance grain quality, productivity, and overall performance of future varieties.

Hamilton Road Weed Science Tour

Aaron Becerra-Alvarez, Michael Lynch, Saul Reyes, Deniz Inci, Matthew Lombardi and Kassim Al-Khatib.

The UC Rice Weed Research Program at the Rice Experiment Station seeks to assist California rice growers in achieving their weed control and herbicide resistance management goals. This year’s RES Field Day demonstrations focus on new herbicides and technologies that are or will become available to California rice growers in the coming years. The goals are to learn how to integrate these new tools into the water-seeded system and evaluate their efficacy.

The dominant weed species within our field, this year, included late watergrass, early watergrass and barnyardgrass, followed by smallflower umbrella sedge, ricefield bulrush, ducksalad and water hyssop. Bearded sprangletop, redstem and arrowheads were present but with decreased density this year. All weeds present are susceptible to all registered herbicides. Rice cultivar M-209 was air-seeded at 150 lbs/ac on June 1, 2023 onto the field with a four-inch flood. M-209 was hand-seeded for the Zembu® study and ROXY RPS® cultivar hand-seeded at 150 lbs/ac on May 31, 2023. Weed control efficacy presented primarily reflect the visual ratings in percent of the untreated recorded at various intervals after applications. The rice injury is similarly recorded as percent of the untreated across stand reduction, stunting, chlorosis or overall injury at various intervals after applications.

Stop 1: Efficacy of Loyant CA® as a Partner in Season-Long Herbicide Programs

Loyant CA® is a newly registered herbicide for California rice. The active ingredient is florpyrauxifen-benzyl, it is an auxin type herbicide (Group 4). In this study the objective was to evaluate Loyant CA® efficacy as a post-emergence application alongside various herbicides for season-long control. Bolero Ultramax® at 23 lb/ac, Cerano® at 12 lb/ac and Butte® at 9 lb/ac were applied as base treatments in different plots and followed by Loyant CA® at 1.33 pt/ac alone or in mixtures with other available products at the four- to five-leaf stage rice. Loyant CA® was also applied at 1.33 pt/ac alone and as a sequential application within 14 days without a base treatment. Rice injury from Loyant CA® was minimal and insignificant. Loyant CA® alone and as a sequential application provided greater than 95% control over grasses, sedges and broadleaves. As a post-emergence alone and in mixtures after Bolero Ultramax®, Cerano® and Butte®, control of smallflower umbrella sedge, ricefield bulrush, ducksalad and redstem was increased to 100% at 28 DAT. Loyant CA® alone after Cerano® did not provide greater than 50% control of the two-sedge species, but in mixtures with SuperWham CA®, RebelEx CA® and Regiment CA® control was greater than 90%. Loyant CA® is an excellent new mode of action to integrate in season-long herbicide programs to achieve broad-spectrum control of weed species.

Stop 2: Efficacy of Tetflupyrolimet

FMC have developed a dihydroorotate dehydrogenase (DHODH) inhibitor (Group 28), for weed control in rice. Tetflupyrolimet is a novel herbicide mode of action. The objective of this study was to evaluate tetflupyrolimet in a water-seeded system and alongside currently available herbicides in season-long herbicide programs. Tetflupyrolimet was applied at 8.9 lb/ac as a base treatment at day of seeding and followed by other available products and at one- to two-leaf stage rice at 13.4 lb/ac. Rice injury was minimal across treatments. If any injury symptoms, it was caused by the partner herbicides and not tetflupyrolimet. Nearly complete grass control was achieved across all treatments. The partner herbicides provided variable control levels of sedges and broadleaves and are needed layer in the season for a broad-spectrum control program. Tetflupyrolimet provides excellent grass control and minimal rice injury which reiterates previous research results.

Efficacy of Prowl H20® in Herbicide Mixtures at Different Rates

Herbicide-resistant grasses are a major challenge to manage with available herbicides. Pendimethalin has been effective in controlling herbicide-resistant populations in survey studies. Pendimethalin is a Group 3, microtubule inhibiting herbicide. In this study, Prowl H20® was applied at four- to five-leaf stage rice at three rates alone and in herbicide mixtures with currently available products and evaluated for weed control efficacy and rice injury. Prowl H20® alone did not provide control of emerged grasses, however, in mixtures with

SuperWham! CA®, Clincher CA® and Regiment CA® control increased greater than 75%, since the additional herbicides control emerged grasses. The Prowl H20® rates of 2 lbs ai/ac and 4 lbs ai/ac appeared to increase control when compared to the 1 lb ai/ac at 14 DAT, however, in mixtures, the additional herbicides dictated overall visual weed control in the plots with greater than 80% by 24 DAT. Rice injury was minimal across all treatments. Prowl H20® can be a useful tool for water-seeded rice in herbicide mixtures at four- to five-leaf stage rice for control of herbicide-resistant grasses and late-emerging grasses.

Stop 3: Efficacy of Zembu® at Different Application Timings

Zembu® is a new herbicide developed by Nichino America Inc. soon to be available for rice growers. Pyraclonil is the active ingredient which is a protox porphyrinogen (PPO) inhibitor (Group 14). Zembu® weed control efficacy was evaluated after different application timings. The application rate was 14.9 lbs/ac applied three days before seeding on bare ground, three days before seeding on an established four-inch flood, one day before seeding on an established four-inch flood and two days after seeding. All treatments provided excellent control of grasses, broadleaves and smallflower umbrella sedge. Ricefield bulrush control was reduced by 26% at the pre-seeding on bare ground application, while all other timings provided 82% to 96% control. Rice injury symptoms at 14 DAT were greater when timing was two days after seeding and most reduced from the pre-seeding on bare ground application. However, visual rice injury was less than 17% by 21 DAT on all treatments. Timing of Zembu® can affect efficacy and injury levels.

ROXY RPS® Efficacy and Rice Response at Different Rates

ROXY RPS® is a new technology available for California rice growers. ROXY RPS® is an herbicide-tolerant rice cultivar that allows for application of the ALB2023 herbicide, which contains oxyfluorfen as the active ingredient, a PPO-inhibitor (Group 14). ROXY RPS® was evaluated for weed control efficacy and rice injury in season-long herbicide programs. ALB2023 was applied at 1.75 pt/ac and 2.00 pt/ac onto bare ground on May 28, 2023, then followed by Granite SC®, Loyant CA®, Clincher CA® and/or Grandstand CA® at five-leaf stage rice. Rice injury symptoms was evident early on as stunting and visual stand reduction up to 85% at 14 DAT across treatments, however, rice soon recovered to less than 7% at 28 DAT. There was excellent control of grasses, sedges and broadleaves across treatments. No difference in efficacy were observed across the two application rates. This year ROXY RPS® showed exceptional efficacy and increased injury symptoms were evident. ROXY RPS® is a valuable addition for weed management in California rice.

No-till rice production and optimizing management of previously fallowed fields

Bruce Linquist, Zhang Zhenglin, Mia Godbey, Luis Espino and Whitney Brim-DeForest

Over the past decade the amount of fallowed (idled) rice fields in any given year has increased and peaked in 2022 at almost 50% of the rice area. While there are still years where most rice land is planted, in other years we are seeing anywhere from 20 to 50% of rice land being fallowed. Reasons for fallowing rice land are due mostly to drought, but also to late season rains which prevent land preparation and tillage. Leaving land fallow over a growing season can affect nutrient management, weeds, pests and diseases in the following year. This year we are conducting several studies examining how to optimize rice production in fields that were previously fallowed and in looking at options to conserve water.

Nitrogen management in previously fallowed vs continuously flooded rice fields

This is the third year that we are conducting research to find out if N management is different in fields that have been fallowed compared to fields that had rice grown in it the previous year. There are several reasons why N management might be different. First, fallowed fields have less straw as the straw will have had almost one and a half years to decompose. Less straw means less tie up of fertilizer N. Secondly, we know that in fields which are flooded for most of the year, phenols build up. These phenols can tie up nitrogen fertilizer. Keeping the soil aerated for a long period allows for these phenols to break down. Finally, the yield potential may be higher in fallowed fields - necessitating more N fertilizer. In this experiment at the RES, we are looking at six N rates (ranging from 0 to 190 lb N/ac) applied as aqua-NH_3 in basins that were either fallow or had rice in 2022. This research will inform us if we need to apply a different rate or time to fields that were fallow. This is the third year of that study. In 2021 and 2022, we found that in fallowed fields the yield potential was higher and there was more available soil N than in continuous rice fields. We also found more soil phenols in continuous rice fields. In addition, stem rot incidence was higher in continuous rice fields.

No-till water seeding into previously fallowed and worked rice fields

This is not a strict “no-till” system, but rather a system where the tillage and field preparation was done during the summer when the field was fallow. Many growers take the opportunity to till and level the fields when the field is fallow. We are testing to see if it is possible to simply flood and plant these fields in the following year without any further tillage. This would allow growers the ability to plant sooner and also reduce tillage related costs. There may also be some benefits related to weeds and pests, which we are evaluating. In 2022 we evaluated this system at three on-farm locations; this year we are evaluating this at three on-farm locations and at the RES. Results from last year’s study are available in a poster presented at field day and in an abstract in this pamphlet. In general, this system shows promise as yields were comparable between the till and no-till systems. Early season crop establishment is key to success in this system.

No-till drill seeding
Given the increased limitations on water available for rice production, in 2023, we expanded our no-till research to look at drill seeding rice. We no-till drilled seeded into four different seed beds: (1) a seedbed that was fallowed and worked the previous year, (2) a seedbed that had rice in the previous year and the straw was burned, (3) a seedbed that had rice in the previous year and the straw was removed, a seedbed that had rice in the previous year and the straw was chopped and left on the surface. In the seedbeds 2 to 4, the fields were winter flooded. The fields were planted on May 2, flushed on May 4 and drained on May 8. No further irrigation was applied until June 2 when the fields were flooded for a permanent flood. Just before the permanent flood, we applied urea and herbicides (Prowl, Clincher and Propanil). On June 30 we applied Regiment. This is the first time we have examined such systems, we are looking at both fertility and weed management. We are very optimistic about the potential of this system and plan to fine tune it in upcoming years. Ideally, we would like to be able to plant into existing soil moisture which would allow for significant water savings, the potential to plant early, and reduced tillage costs.

Rice Disease and Arthropod Update
Luis Espino, UCCE

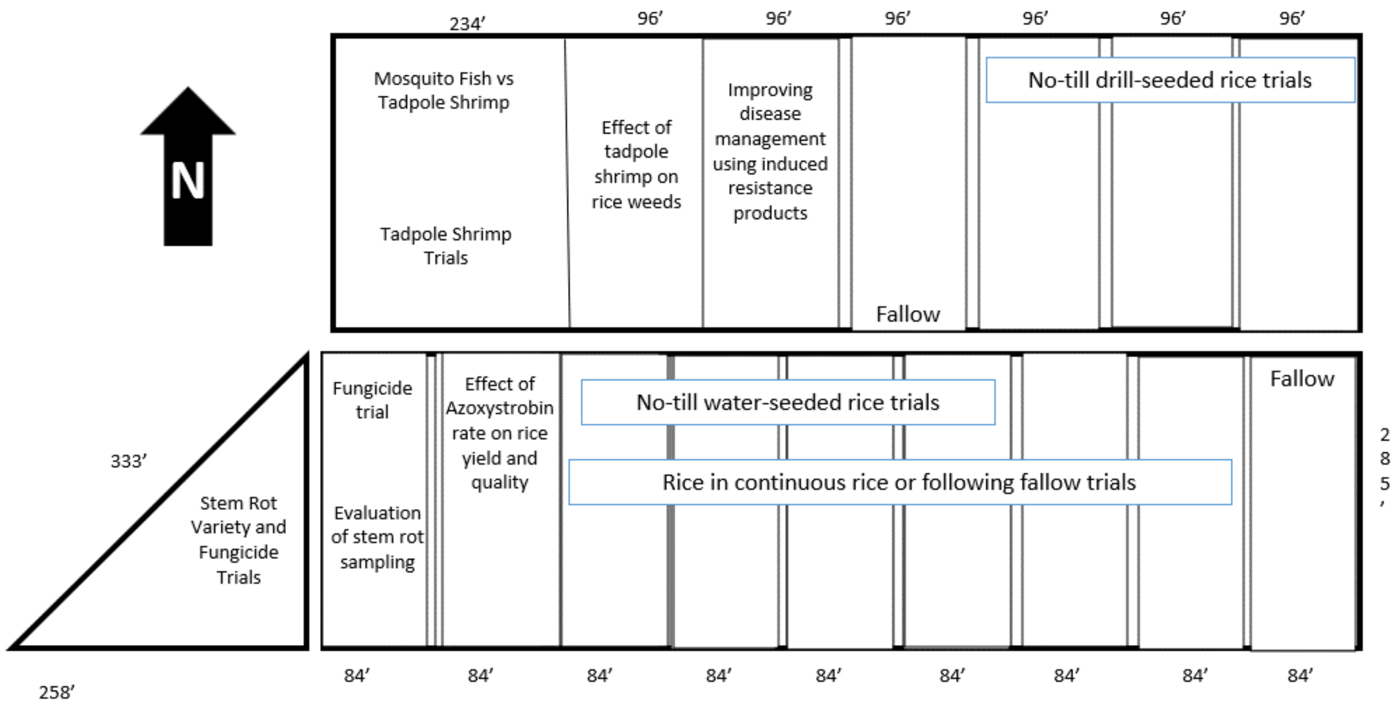
Diseases update - Bakanae seems to be more prevalent this year than in the past. It is unclear why there is a resurgence of this disease. It is possible that in fields with high rates of Bakanae the sodium hypochlorite treatment was not used or it was applied incorrectly. Blast was observed at very low levels in Glenn County.

Arthropods update – Rice seed midge caused problem this spring in several fields. Common insecticides do not seem to work well for this pest. Armyworm moth numbers were the highest since trapping began; however, only some fields had worm population levels that required treatment.

Watergrass and Herbicide Resistance Management Update
Whitney Brim-DeForest

This presentation will cover management of watergrass species in rice, including herbicide resistance management, foliar clean-up herbicide applications, and herbicide resistance prevention.

2023 RES Systems Site Plan



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