Missouri
Rice Research
Update 2011

Southeast Missouri State University

University of Missouri Columbia

University of Missouri Outreach and Extention

Special Report # 01-2011

February 2012

Introduction

This report is a compilation of research projects, demonstration efforts, and additional Missouri rice information. Its purpose is to inform producers, research and extension personnel, industry representatives, agribusiness consultants, farm suppliers, and commodity organizations about rice activities in Missouri. The information is a result of rice research conducted at the Missouri Rice Research Farm and UM Fisher Delta Center Research Farm. The research results were summarized by University of Missouri Fisher Delta Center Experiment Station and Southeast Missouri State University Personnel. The use of trade or company names in this report does not constitute recommendation or endorsement.

A special acknowledgement is extended to the Missouri rice producers, Missouri Rice Research and Merchandising Council, Southeast Missouri State University, the University of Missouri College of Agriculture, Food, and Natural Resources, and the Missouri Commercial Agriculture Extension Program for financial support.

Editors:
Cathy Dickens
Donn Beighley

For further information on Missouri Rice visit these websites:

A SEMO Rice Page on the World Wide Web at
http://www.semo.edu/rice/

A Missouri Rice Page on the World Wide Web at
http://www.ext.missouri.edu/agebb/rice/

A Missouri Rice DD50 Program on the World Wide Web at
http://www.agebb.missouri.edu/rice/ricemodel.htm

Missouri Rice Producers Conference
February 16, 2012
Program

8:00 Registration

8:30 Weed Control with Flood and Pivot – Jim Heiser, MU Delta Center

9:00 Rice Fertility and Drills MU Research – Matt Rhine, MU Delta Center

9:20 Rice Varieties and Insects – Donn Beighley, SEMO Malden

9:40 Japonica Type Rice Opportunities – Won K. Jung, MU Delta Center

10:00 Break

10:15 Irrigation MU Research – Joe Henggeler, MU Delta Center

10:30 SEMO Aquifer and Laws – Michael Aide, SEMO Cape Girardeau

11:00 U.S. Rice Markets – Dennis DeLaughter, Progressive Farm Marketing

11:45 Rice Soils and Fertility – David Dunn, MU Delta Center

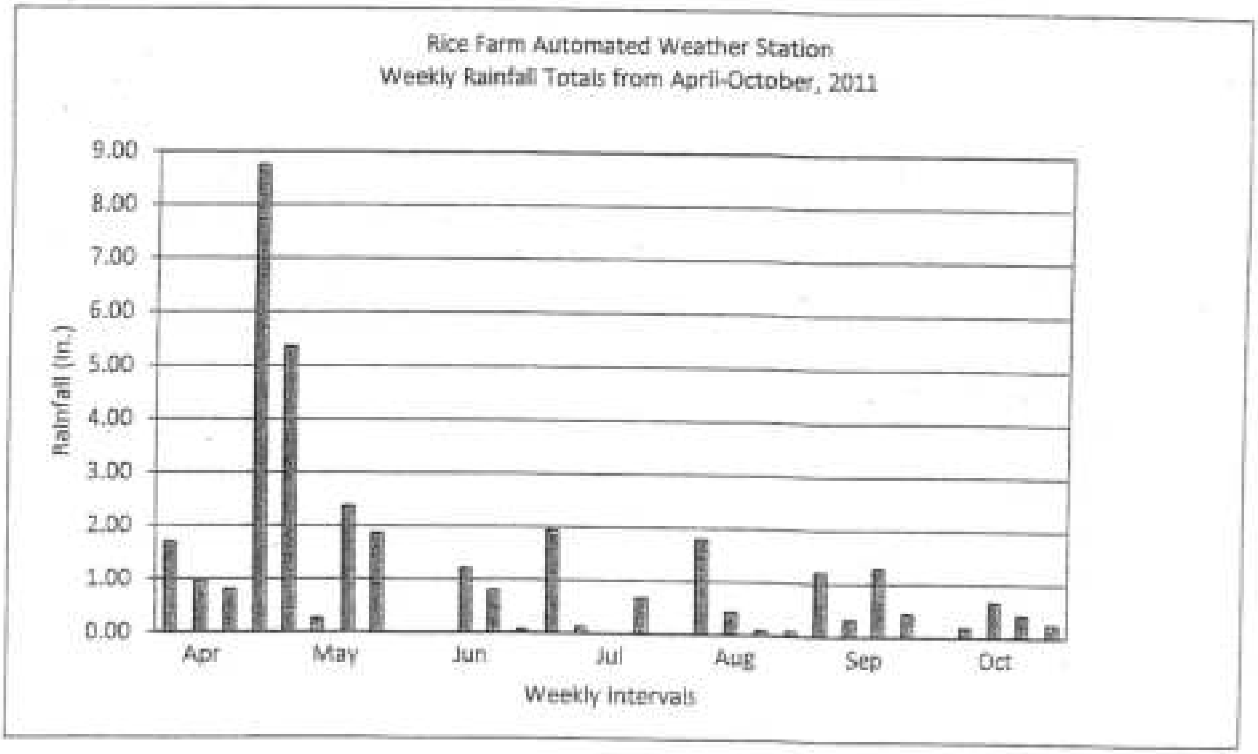
12:00 Lunch - Provided by the Commercial Sponsors

Table of Contents

Data collected and summarized by Pat Guinan
University of Missouri – Columbia, Meterologist
Extension Commercial Agriculture Automated Weather Station
Rice Farm (1 mile east of Glennonville, MO)
Monthly Weather Summary
Year: 2011

Temperature (°F)

	Avg Max.	Avg Min.	Avg	Departure
January	41.4	26.1	33.4	-1.6
February	48.7	31.2	40.3	1.0
March	57.6	41.2	49.5	1.3
April	72.6	52.3	62.5	3.8
May	75.8	57.7	66.6	-1.7
June	92.1	70.5	81.3	4.0
July	93.0	73.6	82.8	2.2
August	89.6	68.8	78.6	-0.6
September	78.7	55.5	66.4	-5.0
October	73.1	46.1	59.0	-0.9
November	59.6	42.6	51.2	2.3
December	50.5	33.9	42.2	4.5
Year	69.4	50.0	59.5	0.8



Rice Variety Reactions to Diseases 2011

Variety	Sheath Blight	Blast	Straighthead	*Bacterial Panicle Blight*	Narrow Brown Leaf Spot	Stem Rot	Kernel Smut	False Smut	Brown Spot	Lodging	Black Sheath Rot
Cheniere	S	S	MS	S	S	S	S	S	R	MR	MS
CL 111	VS	S	S	S	VS	VS	S	S	R	MS	S
CL 131	VS	MS	VS	VS	VS	S	S	S	R	R	S
CL 142 AR	MS		MS	S	S	S	S	S	R	MS	S
CL 151	VS	VS	VS	S	S	S	S	S	R	S-MS	S
CL 152	S	S	S	S	R		VS	S			
CL 162	VS	S		VS	R		S	S	S		
CL 161	VS	S	MS	S	MS	S	S	S	R	MS	S
CL 181 AR	VS	S	MS	S	MS	S	S	S	R	MS	S
CL 261	MS	VS	S	VS	S	VS	MS	MS		MS	MS
Francis	MS	VS	MS	VS	S	S	VS	S	R	MS	MS
JazzMan	MS	S	S	S	S	S	MS	S	R	MS	MS
JES	MS	R	MR	MS	R	VS	MS	MS	R	S	MR
RT CL XL 729	MS	MR	MR	MR	MS	MS	MS	S	R	S-MS	MS
RT CL XL 730	MS	MR	MR	MR	MS	MS	MS	S	R	S-MS	MS
RT CL XL 745	MS	R	R	MR	MS	MS	MS	S	R	S-MS	MS
RT XL 723	MS	R	MR	MR	MS	MS	MS	S	R	MS	MS
RT XP 756	MR	R	MS	MR	MR	S	MS	MS			
RT XP 753	MS	R	MS	MR	MR	S	MS	MS			
RT XP 754	MR	R	MS	MR	MR	S	MS	MS			
Roy J	MS	S	S	S	MR	S	S	S		MR	MS
Taggart	MS		R	MS	MS	S	S	S	R	MS	MS
Templeton	MS	R	S	S	S	MS	S	S	R	MS	MS
Wells	S	S	MS	S	S	VS	S	S	R	MS	MS
Medium Grains											
Jupiter	MS	S	MS	MR	MS	S	MS	MS	R	S-MS	MR
Neptune	MS	MS	VS	S	MS	S	MS	MS	R	MR	MR
Caffey	MS			S	R			MS			

Reaction: R = Resistant; MR = Moderately Resistant; MS = Moderately Susceptible; VS = Very Susceptible

General characteristics of varieties tested in the Arkansas Rice Performance Trials and Arkansas Rice Disease Monitoring Program.

Variety/Hybrid	Year Released & State	Highlights
Caffey	2010 – Louisiana	The new medium grain variety has very good yield potential also has shown excellent milling and grain characteristics. It is approximately two days earlier than Jupiter and Neptune.
Cheniere	2003 – Louisiana	A very short season, semi-dwarf long-grain with good yield potential, less oil in bran than Cocodrie, and improved straighthead tolerance. It has L202 and Jodon cooking type.
CL 111	2008 – BASF, Horizon Ag	An early season, semi-dwarf long grain similar to CL 131. Susceptible to blast, straighthead, and bacterial panicle blight.
CL 131	2005– BASF, Horizon Ag	A midseason, semi-dwarf long-grain similar to CL 161 with shorter plant height, moderately susceptible to blast, very susceptible to straighthead and sheath blight, but improved grain yield potential.
CL 142 AR	2009– BASF, Horizon Ag	A midseason, semi-dwarf long-grain Clearfield similar to Francis with good yield potential, and high tolerance to Newpath herbicide. It is susceptible to blast and bacterial panicle blight, and moderately susceptible to sheath blight and straighthead.
CL 151	2008 – BASF, Horizon Ag	A midseason, semi-dwarf long-grain similar to Cocodrie with good yield potential and high tolerance to Newpath herbicide. It is very susceptible to blast, straighthead, and susceptible to lodging and sheath blight.
CL 152	2010 - BASF, Horizon Ag	
CL 161	2002 – BASF, Horizon Ag	A midseason, semi-dwarf, long-grain similar to Cypress with high tolerance to Newpath herbicide. It is very susceptible to sheath blight, susceptible to blast and moderately susceptible to straighthead.
CL 162	2010 - BASF, Horizon Ag	
CL 181 AR	2009 – BASF, Horizon Ag	A midseason, semi-dwarf, long grain Clearfield with good yield potential and milling quality.
CL 261	2008 - BASF, Horizon Ag	First medium grain release with good yield and excellent milling quality.
XL 723	2003- Rice Tec Hybrid	A short-season long-grain hybrid with excellent yield potential, average milling quality, but resistant to blast and moderately susceptible to sheath blight.
XL 729	2006 – Rice Tec, Inc.	A short-season, long grain with excellent yield potential and moderately susceptible to sheath blight, and moderately resistant to blast.
XL 745	2007– Rice Tec, Inc.	A short-season, long grain with excellent yield potential, moderately susceptible to sheath blight, and moderately resistant to blast, and susceptible to lodging. Reported to have improved tolerance to shattering.
XP 744	2012 – Rice Tec, Inc.	Similar in agronomics features to XL 745, 3-5 days earlier than Cheniere, average milling yield.

Variety/Hybrid	Year Released & State	Highlights
XP 754	2011 – Rice Tec, Inc.	Will make a great companion hybrid with XL 723. Has grain retention improvements over XL 723 and is a longer maturing hybrid by 7 - 10 days later than XL 723.
XP 753	2011 – Rice Tec, Inc.	Has many characteristics similar to XL 723. With grain retention and yield improvements over XL 723. Has standard milling yield, and maturity comparable to XL 723.
XP 756	2011 – Rice Tec, Inc.	Similar yield potential to XL 729, standard milling yield, higher sheath blight tolerance, and maturing 5 - 7 days later than XL 729.
Francis	2002 – Arkansas	A very short season, long-grain with excellent yield potential, susceptible to rice blast and very susceptible to kernel smut. It is the best long grain for high pH and salt soils of NE Arkansas west of Crowley's ridge but should not be stressed for water due to blast concerns.
Jazzman	2009 - Louisiana	A long grain aromatic variety with high yield and good milling quality.
Jazzman 2	2010 - Louisiana	
JES	2009 - Arkansas	A Jasmine type aromatic rice with good yield potential and milling quality.
Jupiter	2005 - Louisiana	A medium grain type with excellent yield potential with superior resistance to Blast and straighthead while exhibiting better tolerance to panicle blight than Bengal. Milling quality is similar to Bengal.
Neptune	2008 - Louisiana	A semi-dwarf medium grain with very high yield potential with good levels of resistance to current Blast races. It has excellent milling quality with a "bold" grain is similar to Bengal.
Taggert	2009 - Arkansas	A late mid-season, long grain variety with excellent yield potential across years with resistance to Brown Spot while moderately susceptible to sheath blight and bacterial panicle blight. It has average milling quality.
Templeton	2009 - Arkansas	A mid-season, long-grain variety with good yield potential, resistant to Blast and Brown Spot while moderately susceptible to sheath blight and bacterial panicle blight. It appears to have average milling quality.
Wells	1999 - Arkansas	A short season, long grain with excellent yield potential, average to good milling quality, large kernel size similar to Lemont, but is susceptible to rice blast. Only moderately susceptible to kernel smut and most other diseases and is the most widely adapted long grain rice in Arkansas.

Plant Sap Test for Foliar N, K, Mn, and Lime on Rice, Soybean and Cotton

Gene Stevens, Jim Heiser, Mathew Rhine,
Kelly Nelson, and David Dunn

Rice, soybean and cotton farmers could benefit from rapid, inexpensive methods to evaluate crop tissue or sap to determine when mid-season foliar nutrient sprays are needed to maximize yields. Horticulture crop growers measure plant sap in tomato, potato, and lettuce as a tool for managing N. Water districts in California publish leaf sap nitrate-nitrogen sufficiency guide sheets for testing fresh sap from broccoli, Brussels sprouts, cabbage, cauliflower, celery, lettuce, spinach, and onions.

The objective of this study is to evaluate field ion-selective electrode meters, colorimeters, and color indicator strip tests on rice, soybean and cotton plants growing on a range of soil test levels and foliar fertilizer N, K, and Mn applications. We hope to develop a fast testing process which works like a diabetic person pricking his finger and testing for blood sugar.

Soil samples were collected from fields at the Fisher Delta Center at Portageville, Rhodes Farm at Clarkton, Greenley Center at Novelty, and Missouri Rice Research Farm at Qulin, Missouri. Rice, soybean and cotton was planted in small plots in fields with soil test levels in the low and medium ranges for potassium and manganese. Cotton was also planted at Clarkton and rice at Qulin to evaluate N quick tests. Fertilizer treatments for K, Mn, and N included an untreated check, recommended dry preplant fertilizer and several timings and sources of foliar fertilizer. Each treatment was replicated five times. Leaves and petioles or basal stems from each soybean cotton or rice plot were collected. Samples were collected at V7, R1, and R1+ 1 week growth stages for soybeans, first square, first square + 1 week, and first bloom for cotton and first tiller, first tiller + 2 weeks and panicle initiation for rice. Sampling was followed by foliar sprays of each nutrient using a CO_2 backpack sprayer. Plots were visually rated for leaf burn at 3, 7, and 14 days after foliar applications. Leaf, petiole and basal stem samples were frozen in plastic bags until they could be processed. A garlic press was used to squeeze leaf, petiole/basal stem sap. Cotton and Rice tissue nitrate-N was measured by Horiba® Cardy nitrate meter, Hach® Colorimeter, and Quant® Nitrate test Strips. Duplicate samples were oven dried and tested in the Delta Center Lab with a nitrate ion-selective electrode. A plot combine and cotton picker were used to mechanically harvest plots. Yield response to foliar spray will be correlated with leaf sap meter readings to determine best growth stages and plant tissue to sample.

Several of the "soluble' potassium fertilizers did not dissolve sufficiently in 15 gallons per acre application volume. To apply the targets amounts, we had to apply more water and spray some plots twice. This would not be practical for farmers. A significant soybean yield increase was found at Novelty and Qulin from applying preplant potash (Table 1). In soybean plots, none of the foliar K treatments produced significant yield increases compared to the untreated check. At Novelty, significant leaf burn occurred with Re-Nforce K. For cotton, most of the K treatments showed no yield increases, but three application of KNO_3 did significantly increase lint yield compared to the check. No significant soybean yield increases were found from Mn soil or foliar fertilizers at Novelty or Clarkton (Table 2). Likewise, N did not increase cotton lint yields at Clarkton (Table 3). This field had been used in winter legume cover crop research in the past and may have N released from organic matter during the year. Both rice N and K tests produced very low yields due to excessive heat and low humidity during pollination. This was further magnified by late harvest and high winds after maturity. Treatment averages for the N test were less than 70 bushels per acre and for the K test, less than 20 bushels per acre. Therefore, no correlation between yield and sap nutrient levels would prove useful. We are currently in the process of making quick test measurements from frozen samples collected during the season and comparing the results to duplicate leaf and petiole samples test at the Delta Center Soil Lab (Figure 1, Table 4). This winter we are growing soybean, cotton and rice in vermiculite pots in the greenhouse with nutrient solutions formulated to create deficiencies in N, P, and K. Toxic levels of Mn and Al are also being studied. Quick tests will be used on these plants.

Table 1. Soybean and cotton yield response to soil and foliar potassium treatments at Novelty, Qulin, and Clarkton, Missouri in 2011.

Trt	Fertilizer	Preplant	V7	R1	R1 + 1 wk	Novelty	Qulin	Clarkton
						soybean		Cotton
		lb K20/a				bu/a		lb lint /a
Check			0	0	0	44 ab†	53 cd	987 b
Soil	Potash	120	0	0	0	47 a	61 a	930 b
Bdcst	Potash	0	0	0	60	45 ab	53 cd	911 b
Foliar	White Sol Potash	0	19	19	19	43 bc	53 cd	1039 b
Foliar	White Sol Potash	0	0	19	19	43 bc	52 cd	1010 b
Foliar	White Sol Potash	0	0	0	19	44 ab	57 abc	949 b
Foliar	KNO3	0	4.62	4.62	4.62	46 ab	55 abc	1217 a
Foliar	KNO3	0	0	4.62	4.62	44 ab	56 abc	970 b
Foliar	KNO3	0	0	0	4.62	43 bc	60 ab	960 b
Foliar	Re-NforceK	0	4.68	4.68	4.68	38 e	54 bc	985 b
Foliar	Re-NforceK	0	0	4.68	4.68	41 cd	48 d	1048 b
Foliar	Re-NforceK	0	0	0	4.68	39 de	52 cd	963 b

†Yields followed by the same letter were not significantly different at the 0.05 level

Table 2. Soybean yield response to soil and foliar manganese treatments at Novelty and Qulin, Missouri in 2011.

Trt	Fertilizer	Preplant	V7	R1	R1+1 wk	Novelty	Clarkton
		------------lb Mn/acre-------				----bu/acre----	
Check		0	0	0	0	43 a†	43 a
Soil	Mn sulfate 6%	4	0	0	0	43 a	40 ab
Foliar	Chelated EDTA Mn	0	0.25	0.25	0.25	43 a	31 cd
Foliar	Chelated EDTA Mn	0	0	0.25	0.25	43 a	40 ab
Foliar	Chelated EDTA Mn	0	0	0.5	0	42 a	32 cd
Foliar	Chelated EDTA Mn + glyphosate	0	0	0.5	0	42 a	28 d
Foliar	Mn sulfate + glyphosate	0	0	0.5	0	44 a	35 bc
Foliar	Gluco Mn + glyphosate	0	0	0.5	0	43 a	39 ab
Foliar	glyphosate alone	0	0	0.5	0	44 a	42 a

†Yields followed by the same letter were not significantly different at the 0.05 level.

Table 3. Cotton yield response to soil and foliar nitrogen treatments at Clarkton, Missouri in 2011.

Treatment	Fertilizer	Preplant	V12	First Blm	Blm +1 wk	Cotton
		----------------lb N/acre----------------				lb lint/acre
Check	----	0	0	0	0	959 a†
med N	soil	40	0	0	0	1120 a
high N	soil	120	0	0	0	994 a
low N foliar	Foliar KNO3	0	4.62	4.62	4.62	1082 a
low N foliar	Foliar KNO3	0	0	4.62	4.62	1070 a
low N foliar	Foliar KNO3	0	0	0	4.62	1106 a
med N foliar	Am nitrate + foliar KNO3	40	4.62	4.62	4.62	1136 a
med N foliar	Am nitrate + foliar KNO3	40	0	4.62	4.62	1032 a
med N foliar	Am nitrate + foliar KNO3	40	0	0	4.62	1122 a

†Yields followed by the same letter were not significantly different at the 0.05 level

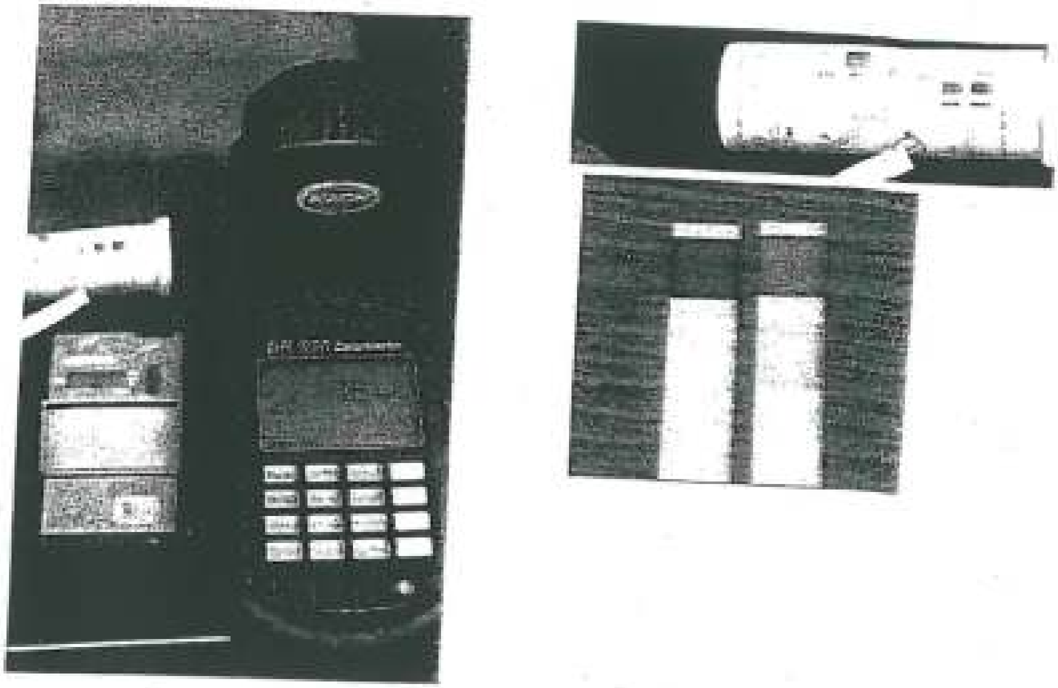


Figure 1. Portable nitrate meter, colorimeter, and nitrate test strips used to measure sap nitrate.

Table 4. Cotton tissue nitrate-N measured by ion selective electrode (ISE) from oven dried and ground leaves and petioles and quick test sap squeezed from frozen green leaves and petioles collected at V7, first bloom, and R1+ 1 week and measure by Horiba® Cardy nitrate meter, Hach® Colorimeter, and Quant® Nitrate test Strips.

Plant N	Plant part	Growth stage	Cardy meter	Hach colorimeter	Quant strip	Soil Lab ISE meter
			sap ppm Nitrate-N			dry sample
0	Leaves	V12	767 a†	760 a	1116 a	44,833 b
120		V12	1366 a	757 a	753 a	103,485 b
0		1st Bloom	1233 a	477 a	146 a	10,055 b
120		1st Bloom	1100 a	263 a	3866 a	22,706 b
0		R1+1week	733 a	453 a	183 a	12,197 b
120		R1+1week	666 a	66 a	440 a	20,848 b
0	Petioles	V12	1233 a	387 a	2586 a	1,809,325 a
120		V12	700 a	223 a	1387 a	2,159,460 a
0		1st Bloom	267 a	73 a	67 a	13,177 b
120		1st Bloom	1133 a	220 a	100 a	443,000 b
0		R1+1week	300 a	240 a	107 a	36,649 b
120		R1+1week	1316 a	433 a	1727 a	545,864 b

†Yields followed by the same letter were not significantly different at the 0.05 level.

Phosphorus and Potassium Availability to Rice in Winter Flooded Soils

Dr. Gene Stevens, Matthew Rhine,
and James Heiser

Rice production in the United States is typically performed on flooded soils. Floods are usually maintained on drill seeded rice from first tiller until near maturity. With the recent oil disaster occurring in the Gulf of Mexico, government incentives were introduced to maintain flooded fields through the winter months to provide food and habitat for waterfowl. Many producers took advantage of these programs, but the implications on nutrient availability are not completely understood at this time. Soils flooded during the winter months can reduce phosphorus availability for the upcoming season. Potassium availability, although not directly affected by flooded soils, can be indirectly affected by reduced potassium uptake due to soil compaction and restricted root growth.

Our goal was to determine the impact that winter flooding may have on the following growing season in terms of phosphorus and potassium availability and uptake. The flooded and non-flooded fields were soil sampled in the spring before planting. Samples were tested for P and K levels and recommendations supplied for each field. Treatments included an untreated check, soil test recommendations, test + 30% K, test + 30% P, and test + 30% P and K on winter flooded and non-flooded soils. All plots were planted into rice and applications of phosphorus and potassium were evaluated for effectiveness. Plots were harvested with a plot combine, plot grain weight measured and corrected to 13% moisture

Results indicated that there was no difference in crop yield when a field was flooded during winter as compared to not being flooded. Results also indicated that the addition of K and P did not significantly increase yields (Table 1). A companion study at the Missouri Rice farm on a non-flooded soil also illustrated that P and K additions were not beneficial. However, these data may be confounded due to very low (< 75 bu/ac) yields resulting from high temperatures and low humidity during pollination and high winds after maturity.

Table 1. Treatment average bushels of rice per acre harvested from winter flooded and non-flooded fields near Jaywye, Mo. when P and K were added at various levels in 2011.

Winter Flood	Fertilizer	Treatment avg. Bu/acre
No	Check	160
	Soil Test Rec'd	159
	ST + 30%K	165
	ST + 30% P	160
	ST + 30% P&K	156
Yes	Check	169
	Soil Test Rec'd	154
	ST + 30%K	168
	ST + 30%P	171
	ST + 30% P&K	164

2011 Effect of Flood Depth Study

**Donn Beighley, Cathy Dickens, Travis Wagner,
Michael Kean and Scott Wheeler**

As rice continues to be produced in southeast Missouri the effects of different rice production practices are tested by the rice researchers as an aid to the Missouri rice producer community. The effect of flood depth study was initiated to see if there were either positive or negative effects when rice is produced at different flood depths. This aspect of rice production is important as energy costs for pumping continue to increase.

Experimental Procedure

Location

Rice plots were established at the Missouri Rice Research Farm near Glennonville, MO. The plots at the Rice Research Farm were planted on 3 June on a continuous rice field. The trial consisted of five permanent flood depths (0, 2, 4, 6, and 8 inches) and four conventional varieties (Jupiter, Francis, Trenasse and Wells) grown at each depth to determine if there were varietal effects due to flood depth. The zero inch flood depth pan was kept moist but not allowed to dry out completely.

All the varieties were evaluated within the same trial. The yield trial was arranged in a randomized complete block design with six replications. Each plot consisted of seven rows, 12 feet long, with a between-row spacing of 7.5 inches.

Plots were planted with an Almaco no-till plot drill. Pre-flood fertilizer was applied at a rate of 180 lb nitrogen for all lines. For primary weed control, 12 oz. Command applied post plant while 2 pts. Prowl, 2 oz. Aim, 78 oz. Permit, 4 qt. Rice Shot and ¾ lb. Facet were applied prior to flooding. There were no insecticides applied. The different flood depths (0, 2, 4, 6, and 8 inches) were maintained throughout the growing season. The zero flood depth was difficult to maintain as there was the problem of backflow from the surrounding field through the drain pipe and the effect of rainfall. The plots were not harvested due to inclement weather. A single row harvested from the plots was weighed and moisture was determined.

Data was recorded for: Emergence date, the number of days to 50% heading, plant height, lodging for each variety in the field. Milling quality was determined at the Rice Lab located at the Crisp Bootheel Education Center located in Malden, MO.

Results

Only agronomic and milling quality data was obtained from the plots in this test in 2011 due to late season weather conditions. See Table 1.

The average plant height for depths two through eight was 38 inches and while the zero depth was 25 inches for plant height.

The percent lodging averaged less than 20 percent in 2011. The range was from no lodging at the zero depth to 25 percent for the eight inch depth. Most all the flood depths that received and held water had more than ten percent lodging.

The average percent total kernel milling quality for the four depths (two to eight inches) was 74% with little difference any depth except at the four inch depth (75%). The average percent whole kernel milling quality was 64%. The six inch depth was 59% while the other four depths averaged 64%. There was some difference between depths for percent whole rice. This differed from 2009 when the whole rice percentage was the same across the water depths.

Summary

The effects of increasing flood depth were observed for plant height, percent lodging, and percent whole rice milling quality. 2011 yields were not harvested due to inclement weather conditions. The zero depth did not produce enough grains for determining milling quality.

When one looks across years the four inch has been the highest yielding depth followed by six inches, eight inches, two inches and zero inches. The value of this information is in the pumping costs from one depth to another and the corresponding yields at those depths. There has been no noticeable difference in disease incidence at the various water depths as one might expect when Blast is prevalent.

The percent whole rice values were similar for all depths except for the six inch depth which was five points less and approximately three percentage points less for both 2009 and 2011.

There was no noticeable difference between the different depths for algae incidence in the alleys or plant disease incidence. There were definitely fewer weeds in the zero flood depth than the other depths. And the incidence of aquatic weeds appeared to greater as the flood depth increased.

Table 1.

Water Depth (In)	# Days to Emerge	Plant Height (In)	Percent Lodging	% Total Rice	% Whole Rice
0	8	25	0	—	—
2	8	37	13	74	64
4	8	37	20	75	64
6	8	41	20	74	59
8	8	40	25	74	64
Avg.	8	36	19	74	63

The 2011 Effect of Planting Date on Rice Varieties

Donn Beighley, Cathy Dickens, Michael Kean,
and Travis Wagner

In southeast Missouri there are fewer numbers of rice varieties grown that meet the needs of Missouri rice producers. These varieties are planted as the weather and the field conditions permit during the period from early April to late June. However, the time of planting may vary from year-to-year based on the planting environment, i.e. the weather. Consequently we attempt to provide as much information possible concerning varietal performance with respect to harvest date, yield, quality and their agronomic traits when planted at different dates between early April and post wheat harvest in mid-June.

Experimental Procedure

Location

Rice plots were established at the Missouri Rice Research Farm near Glennonville, MO on a Crowley silt loam. The plots were planted on: 11 May, 19 May, 1 June, and 16 June. There was also a planting of this test on hipped rows on 1 June. At each planting date there were fifteen varieties that represent the major rice varieties grown in southeast Missouri as well as four experimental varieties. The released varieties were: Francis, Jupiter, RoyJ, Caffey, CL 151, Neptune, Taggart, Templeton, and Wells.

Each planting date was evaluated as a separate trial and all varieties were included at each date. Each test was arranged in a randomized complete block design with four replications. Each plot consisted of seven rows, 12 feet long, with a between-row spacing of 7.5 inches.

Seed of all public varieties were obtained from: Karen Moldenhauer – UA, Stuttgart, AR and Steve Linscombe – LSU, Crowley, LA and Horizon AG.

The drill plots were planted with an Almaco no-till plot drill. For primary weed control, 12 oz. Command was applied post plant while 2 pts. Prowl, 2 oz. Aim, 78 oz. Permit, 4 qt. Rice Shot and ¾ lb. Facet were applied prior to flooding. A pre-flood fertilizer was applied at a rate of 180 lbs N. The flood was maintained throughout the growing season. There were no insecticides applied. A single row was harvested to determine milling quality. Milling quality was determined on two replications of each variety from the 11 May and 19 May planting dates.

Data Recorded

Agronomic notes taken on each plot included: Emergence date, days to 50% percent heading, plant height, lodging and any disease reactions observed as well as measuring yield for each variety. Emergence date was noted as the date when ten plants per square foot were emerged. The days to 50% heading is determined by counting the days from emergence to the presence of 50% of the panicles at least partially emerged from the boot. Height was taken as the average distance in inches from the soil surface to the top of the panicle. Lodging, which indicates the degree of erectness, was scored on a scale of 0 to 100 with 0 indicating all plants in a plot were erect (no lodging) and 100 percent indicating all plants were lodged. Total and head milling yield were determined after milling a sample of each variety in the study.

Results

Yield:

In 2011 only the 11 May was harvested for yield due to inclement harvest weather. The yields ranged from 114 to 191 BU/A while the average yield across varieties was 144 BU/A. When the 11 May individual variety yields were averaged an experimental variety, Mo02115035 (191 BU/A) was followed by Neptune and Mo0318016. Table 2.

Days to Emergence

The number of days from planting to emergence ranged from 12 days at the 11 May planting date to 8 days at the 19 May planting date. Two fewer days (7 days) was required for long grain varieties when compared with the medium grain varieties at the 19 May planting date. Table 1.

Days to 50% Heading

Across planting dates the average number of days to 50% heading ranged from 79 days at 11 May up to 102 days planted 11 May (Table 2). A similar trend was observed within varieties; RoyJ had the longest average days to 50% heading date (102 days) while RU0002146 had the fewest (79 days) (Table 2). There was only a one day difference between the two planting dates with respect to days to 50% heading (Table 1).

Plant Height

When averaged across all varieties the plant height did not change noticeably from one planting date to the second planting date (Table 1). There was a similar trend for the individual varieties. Taggart was the tallest variety (40 inches) while Neptune was the shortest variety (33 inches) when averaged across all planting dates (Table 2).

Percent Lodging

Percent lodging averaged 20 to 30 percent across planting dates for all of the varieties. There was 10% more lodging for the May 19 planting date when compared to the May 11 planting date. (Table 1)

Milling Yield / Quality

The percent whole rice yield values for 2011 were higher at the 11 May date (69%) and significantly lower at the 19 May date (58%). This has been observed in previous year's trials; planting later in the growing season the milling quality values, particularly whole rice percent decreases.

Across varieties RU0202195 (76 / 72) had the highest average milling quality and Wells had the lowest average (75 / 49). The trend appears to be that the medium grain varieties consistently have the highest milling values across all planting dates and this trend has observed in most years.

Summary

Due to a limited amount of data across planting dates it is hard to make comparisons. However it was evident that there were differences between planting dates in the categories of days to emergence, percent lodging, kernel smut, and percent whole rice.

Table 1.

	2011 Planting Date Agronomic Trait Averages							
Planting Date	Days to Emergence	Days to 50% Heading	Plant Height (Inches)	Percent Lodging	Kernel Smut (1 – 5)	Bu / A	Percent Total Rice	Percent Whole Rice
11 May	12	91	43	20	1	144	75	69
19 May	8	90	43	40	2	----	75	58

Table 2.

	2011 Variety Averages Across Two Planting Dates						
Variety	Days to 50% Heading	Plant Height (Inches)	Percent Lodging	Kernel Smut (1 – 5)	Bu / A (1X)	Percent Total Rice	Percent Whole Rice
RoyJ	100	45	30	1	120	72	61
Francis	90	44	30	1	129	75	64
Jupiter	86	41	30	1	132	75	67
Neptune	91	45	30	1	180	76	64
Taggart	98	48	30	1	130	75	60
Templeton	94	45	30	1	114	75	66
Wells	94	43	30	1	136	75	59
Caffey	88	40	30	1	131	76	64
RU0202195	87	43	30	2	137	75	68
Mo0318016	91	42	30	1	161	75	63
RU0002146	80	43	20	1	155	75	62
Mo0215035	85	38	30	1	191	76	61

2011 Missouri Rice Variety Performance Trials

Donn Beighley, Cathy Dickens, Michael Kean, Travis Wagner,
Kelly Tindall, Gene Stevens, David Dunn, Allen Wrather, and Wonko Jung

In 2011 the Missouri Rice Council, University of Missouri-Delta Center and Southeast Missouri State University conducted the Missouri rice variety trials as a cooperative effort. These trials are conducted as a service to Missouri rice producers to provide a reliable, unbiased, up-to-date source of information for comparing rice varieties produced in the southeast Missouri environment.

Experimental Procedure

Rice plots were established at two locations in 2011: the Missouri Rice Research Farm near Glennonville, MO and at the Delta Center Farm at Portageville, MO. The Rice Research Farm yield trial consisted of: drill-seeded plots following soybeans, drill-seeded plots following rice, and water-seeded plots following rice which were planted on 11 May, 3 June and 3 June, respectively on a Crowley silt loam. The plots at the Delta Center were drill seeded on 3 June on a Sharkey clay soil at the Rhone Farm and under the center pivot on a sandy soil on 10 May. The seed planted in the water seeded trial were treated with Apron-Maxim-Zinc for rice water weevils. The trial consisted of 33 public, private, and experimental varieties.

All the varieties were evaluated within the same trial. The yield trial was arranged in a randomized complete block design with four replications. Each plot at the Missouri Rice Farm consisted of seven rows, 12 feet long, with a between-row spacing of 7.5 inches while the plots at the Delta Center were 16 feet long. The water seeded plot size was 12 foot long by 4.4 feet wide.

Seed of all public varieties were obtained from: Karen Moldenhauer / James Gibbons – UA, Stuttgart, AR; Steve Linscombe – LSU, Crowley, LA; Anna McClung – USDA-ARS / Dante Tabien, Beaumont, TX; Dwight Kanter – MSU, Stoneville, MS, and commercial varieties from Horizon Ag.

Plots were planted with an Almaco no-till plot drill. Pre-flood fertilizer was applied at a rate of 180 lb nitrogen. In the water seeded trial 60 lb urea was applied post emergence, 60 lb N applied at panicle initiation and 60 lb N applied 14 days later.

For primary weed control, 12 oz. Command applied post plant, 2 pts. Prowl, 2 oz. Aim, 78 oz. Permit, 4 qt. Rice Shot and ¾ lb. Facet per acre were applied prior to flooding. There were no insecticides applied. The flood was maintained throughout the growing season. The plots at the Rice Research Farm were harvested with an Almaco research plot combine or a Wintersteiger plot combine depending on the field being harvested while Wintersteiger plot combine only was used at the Delta Center. The grain from the plots was weighed and moisture was determined.

Data Recorded

Depending on the location and test was recorded for: emergence date, the number of days to 50% heading, plant height, lodging, and yield for each variety in the field. Milling quality was determined in the laboratory. Emergence date was the date there were ten plants per square foot on the drill-seeded trial and ten plant per square foot emerged from the water surface in the water-seeded trial. The days to 50% heading was determined from the number of days from emergence to the presence of 50% of the panicles at least partially emerged from the boot. Plant height was taken as the average distance in inches from the soil surface to the top of the panicle on the plant. Lodging, which indicates the degree of erectness, was scored on a scale of 0 to 10 with 0 indicating all plants in a plot were erect (no lodging) and 10 indicating all plants were lodged. Yields were adjusted to 12 percent moisture and reported on a bushel per acre basis. Milling quality was determined at the Rice Lab located at the Crisp Bootheel Education Center located in Malden, MO.

RESULTS

Due to inclement weather only three of the 2011 Missouri Rice Variety Trials were harvested; the drill-seeded and water-seeded following rice were not harvested. The harvest yields at the Delta Center drill-seeded test on clay are not presented due the high level of variability between replications within varieties. Kernel smut was the most prevalent disease observed however some damage due to high winds during pollination were also observed.

Yield - Location Averages

The average yields were as follows: conventional drill test (MO Rice Farm) – 131 BU/A and center pivot drill test (UM Delta Center) - 145 BU/A. These yields are lower than previous year's yields for the same trial locations.

Long Grain Type (Table 1 and 2)

Differences among varieties were observed across all trials. The highest yielding line across all trials was CL111 (188 BU/A) followed by RU0202195 and Mo0302006. In the conventional drill-seeded trial at the Missouri Rice Farm Mo0327005 and Rex (162 BU/A) were the highest yielding lines at followed by RU0202195 and Francis. In the center pivot conventional drill-seeded trial at the UM Delta Center CL111 (223 BU/A) was the highest yielding line followed by Mo0202195 and Mo0327005.

The new long grain releases were CL111, CL142, CL152 and CL162 which yielded 165, 134, 111 and 121 BU /A respectively across two locations.

For those varieties tested over multiple years (2010 and 2011) - Rex, Francis, CL181, CL111, and Cheniere along with several of the experimental lines appear to perform well on silt loam soils while Templeton, CL111, CL142, and CL151 yielded well on under a center pivot on a sandy soil type.

Medium Grain Type (Table 1 and 2)

The highest yielding line across all trials was Mo0215035, at 161 BU/A followed by RU0002146 and Caffey. In the Missouri Rice Farm conventional drill-seeded trial Mo0215035 (161 BU/A) was the highest yielding line followed by RU0002146 and Caffey. In the center pivot conventional drill-seeded trial at the UM Delta Center Mo0215035 (198 BU/A) was the highest yielding line followed by RU0002146 and Jupiter.

For those lines tested over multiple years (2010 and 2011) and soil types – RU0002146, Jupiter and Neptune yield in that order at each location.

Aromatic Long Grain Type (Table 1 and 2)

Within the aromatic long grain types across locations Jazzman 2 (125 BU/A) was the highest yielding variety followed by Jazzman and Charleston Gold. In the Missouri Rice Farm conventional drill-seeded trial Jazzman (156 BU/A) was the highest yielding line followed by Jazzman 2 and Charleston Gold. In the center pivot conventional drill-seeded trial at the UM Delta Center Jazzman 2 (168 BU/A) was the highest yielding line followed by Jazzman and Charleston Gold.

Within the aromatic long grains over multiple years Jazzman has significantly higher yields than JES on the silt loam soils. JES's yields on the center pivot are erratic from year to year.

Days to Emergence

In 2011 the number of days from planting to emergence was 12 days for the MO Rice Farm trial. This was comparable to the 11 May date of planting study. However, there was a wider diversity of varieties in the MO Rice Farm trial which may have contributed to the difference in days to emergence.

Days to 50% Heading (Table 1)

Days to 50% heading was taken only at the MO Rice Farm. The number of days ranged from 79 days (RU0002146) to 103 days (RoyJ) with an average was 88 days for the conventional rice trial behind soybeans. RoyJay has required the most days over the last two years (105 day).

Plant Height (Table 1)

The 2011 average plant heights across locations were 41 inches. Individual location plant heights were 43 inches for the MO Rice Farm and 39 inches for the UM Delta Center pivot trial.

Lodging (Table 1)

There was no lodging observed at the UM Delta Center pivot trial while lodging averaged 10% at the MO Rice Farm drill seeded trial.

Milling Quality (Table 1)

Average percent milling quality values across locations was 72 / 67 for percent total rice and percent whole rice, respectively. The MO Rice Farm conventional rice trial average was 71 / 65 and the UM Delta Center pivot average was 74 / 69.

The long grain average was 68 / 62, the medium grain average was 75 / 71, and the aromatic long grain average was 73 / 67.

Rice Disease Data

In 2011 the major disease observed was due to kernel smut, for which ratings were taken at the Rice Farm and are reflected in Table 1.

Summary

In 2011 the rice growing season was shortened as a result of wet field conditions at during the month of April. This appears to have negatively impacted the yield at harvest. The hot conditions during pollination (days to 50% heading) may have also had an impact on yield. As a result the yields were down between 10% and 20 % as compared to previous years. The milling quality was better in 2011 than 2010 on most all the varieties due to cooler temperatures later in the growing season. There was not much disease pressure until late in the season when kernel smut became a factor.

The other agronomic traits were not affected much by the growing season as plant height and lodging did not appear to impact yields.

2011 Rice Variety Trial Agronomic Data

Variety	Grain Type	Days to 50% Heading (1X)	Plant Height (In) (1X)	Percent Lodge (1X)	Kernal SMUT * (1X)		BU / A (2X Avg.)	Lbs / A (2X Avg.)		% Total Rice (2X)	% Whole Rice (2X)
Cheniere	L	90	43	0	2		148	6651		75	71
Francis	L	88	43	0	1		139	6240		75	66
Rex	L	85	45	0	1		144	6495		74	67
Rondo	L	91	42	70	1		101	4542		72	65
RoyJay	L	103	46	10	3		66	2957		72	58
Taggart	L	97	44	0	3		77	3444		74	57
Templeton	L	93	45	0	3		142	6386		74	68
Wells	L	93	44	0	2		145	6543		74	67
Rufipogon	L	93	39	20	1		122	5494		75	52
RU0702085	L	84	43	0	1		149	6696		58	70
RU0202195	L	86	45	0	2		177	7965		75	70
Mo0318016	L	89	45	0	3		162	7306		75	71
Mo0302006	L	86	43	0	2		172	7754		75	71
Mo0327005	L	88	41	0	3		161	7229		75	70
Mo0256872	L	88	44	0	2		160	7215		76	72
Mo0234639	L	90	44	0	2		128	5755		75	67
Mo0237654	L	87	44	0	2		162	7268		75	70
Jazzman	ALR	90	44	0	1		122	5472		73	70
Jazzman 2	ALR	85	39	0	2		144	6480		74	71
JES	ALR	93	34	60	2		55	2477		73	67
Charleston Gold	ALR	88	41	60	1		68	3080		73	62
CL111	L	85	44	0	1		188	8478		74	69
CL142-AR	L	88	50	20	3		158	7098		77	69
CL151	L	86	42	10	2		146	6576		75	70
CL152	L	93	44	0	3		148	6680		74	71
CL181-AR	L	90	41	0	3		164	7364		74	69
CL162	L	85	47	0	2		122	5511		73	68

Caffey	M	87	43	50	1		149	6706		76	72
Jupiter	M	85	40	10	1		148	6640		76	72
Neptune	M	83	47	40	1		113	5104		75	68
RU0002146	M	79	45	20	1		165	7433		76	70
Mo0215035	M	84	41	10	1		180	8078		77	73
CL261	M	84	42	30	1		126	5668		75	73

* Kernel Smut Rating (1-3, very little to severe infestation)

Variety	UM Center Pivot BU/A	MO Rice Farm BU/A	2011 Location Avg. BU/A		2010-2011 UM Center Pivot BU/A	2010-2011 MO Rice Farm BU/A
Cheniere	162	134	148		156	149
Francis	119	159	139		137	167
Rex	127	162	144		145	172
Rondo	124	77	101		135	124
RoyJay	55	76	66		87	135
Taggart	45	108	77		95	141
Templeton	150	134	142		168	140
Wells	144	147	145		125	144
Rufipogon	120	124	122			
RU0702085	144	154	149			
RU0202195	193	161	177		156	167
Mo0318016	170	154	162		157	179
Mo0302006	191	153	172		191	161
Mo0327005	159	162	161			
Mo0256872	190	130	160		177	149
Mo0234639	111	144	128			
Mo0237654	177	146	162		159	159
Jazzman	88	156	122			
Jazzman 2	168	120	144			
JES	58	52	55			
Charleston Gold	77	60	68			
CL111	223	154	188		173	165
CL142-AR	173	142	158		175	155
CL151	188	104	146		172	130
CL152	154	143	148			
CL181-AR	172	155	164		161	162
CL162	121	124	122			
Caffey	164	134	149			
Jupiter	173	122	148		173	149
Neptune	110	116	113		139	145
RU0002146	186	144	165		200	157
Mo0215035	198	161	180			
CL261	156	96	126			

Opportunities of Japonica type rice in Southeast Missouri

Won K. Jung
University of Missouri
Delta Research Center

The average rice yield for past a decade has been reported 140 bushel/acre and 143 bushel/acre for long-grain and medium grain in the state of Missouri. The Missouri long-grain rice yield was 4% and 6.5% less than the rice yield in Arkansas and California. Missouri long-grain rice yield has been a second lowest in the US. The Missouri medium-grain rice yield was more than 20% lower than California medium-grain rice yield. Rice variety has been developed to fit the local environments, such as temperature, precipitation, soil, water, solar radiation, and so on due to the rice plant has been a very sensitive response of plant growth, disease, yield and grain quality. Therefore, it is essential to develop the specific varieties to reach maximum yield and quality under the specific local environment.

The Southeast Missouri area has 60-65 °F of average annual temperature, which is relatively higher than Arkansas area (i.e., over 65 °F) and Louisiana area (i.e., over 70 °F). However Sacramento valley area in California has similar temperature characteristics compare to Southeast Missouri area. Most of rice varieties grown in Missouri are Indica type and have been developed in Louisiana and Arkansas area. These rice varieties maybe need to be more optimized to the Southeast Missouri area for better yield and quality. It's been a potential limiting factor for increasing rice yield in the Southeast Missouri.

Indica type of rice has been identified varieties have been acclimatized in the subtropical area (e.g., India, Thailand, Bangladesh, South China, Philippine etc.). Japonica type of rice varieties have been acclimatized in the temperature area (e.g., Japan, Korea, North China). Generally, Japonica type of rice yield has been higher than Indica type of rice. In the US, Indica type of rice has been predominantly distributed in the Southern states and Japonica type of rice has been predominantly distributed in California. We assume that Japonica type of rice variety is more appropriate in the temperate zone such as California. Therefore, introducing premium quality Japonica type varieties in the Southeast Missouri area have a great potential not only to increase grain yield but also to improve grain quality. It also can be used to breed premium quality rice variety to fit the local environment.

Many Asians consume large amounts of medium-grain rice as their primary staple food. Even the average Asian American consumes 70-100 lbs per year of medium-grain table rice. Gradually, demand around the world for high quality medium-grain rice has increased due to greater interests in healthy diets, food safety and taste preferences. Because of taste preference by consumers, the price of high quality Japonica type medium-grain rice in the grocery store is more than double that of Indica type. Currently, California produces most of the US domestic japonica type medium-grain rice. Increased total medium-grain rice production might be expected to decrease market prices, but a shift in region of production and effects of increased taste preference for Japonica type could allow increased production while maintaining the price benefits of these types.

Taste preference of medium-grain rice is related to factors including genetic characteristics, crop and soil management techniques and post-harvest treatments linked to cooking processes. Quality japonica type medium-grain rice has less than 7% protein in the grain and the starch has less than 20% amylose content. Genetics of the variety is the major factor controlling grain quality. Recent consumer rice taste preference test indicate that "taste" accounted for 73% of the preference and price accounted for only 16%. Production of high quality medium-grain rice may appeals to domestic and abroad market.

In 2011, we evaluated possibility of cultivating Korean Japonica type rice varieties in Missouri. Twenty three Korean Japonica type rice varieties were tested in greenhouse and field. Rice were transplanted and managed under the flooded field. Due to the small amount germplasm seed available to start research, yield data does not represent direct comparison to conventional varieties. Table 1 showed that the preliminary data of Korean Japonica type premium quality grown in Missouri. From the first year's experiment, No significant disease, insect and lodging were observed from the greenhouse and field study in 2011. These are all premium quality variety and have a great potential to breed high quality medium-grain rice variety fit in the Southeast Missouri.

Table 1. Preliminary characteristics of Korean Japonica type rice varieties grown in Missouri.

Variety	Days to 50% heading *	Culm Length inch	Plant height inch	Panicle Number	Panicle length inch	Spikelet number /Panicle	Mature rate %	Yield lbs/acre
Dongjin	117	30.3	38.7	13.9	8.3	116	19	5190
Odae	115	29.3	37.6	14.7	8.3	115	76	3310
Ilpum	119	25.5	34.5	13.1	9.1	177	29	2573
Jinmi	115	28.1	36.2	14.1	8.1	130	79	4137
Chuchung	117	26.4	34.1	14.4	7.7	94	83	2744
Hwasung	115	29.2	37.0	14.7	7.8	110	83	3930
Hwayoung	115	27.7	35.6	13.2	7.9	126	63	4061

* Transplanting

** No lodging, disease and insect influences were observed in the field trial.

Using Nitrogen Stabilizers to Promote Rice Yield

Michael T. Aide and Donn Beighley
Department of Agriculture   Southeast MO State University

January 2012

ABSTRACT

This field trial evaluated Urea and SuperU, comparing the influence of nitrogen stabilizers impregnated in the SuperU product. The goal was to observe if the nitrogen stabilizers limited ammonia volatilization and the conversion of ammonium to nitrate during delayed flood regimes. Within the Urea and SuperU treatments, rice yields were slightly reduced because of the delayed flood regimes; however, the rice yields were not influenced within a delayed flood regime because of nitrogen stabilizers. Urea and SuperU both increase rice yields relative to the untreated check.

Goal

To determine if nitrogen stabilizers permit greater nitrogen recovery by rice at a delayed flood timing regimes of 24 hours, five days and ten days.

Introduction

Nitrogen is a key element in plant nutrition and is vital to the growth and development of rice (*Oryza sativa* L.). Rice root systems are able to uptake nitrogen primarily in two forms: (1) ammonium (NH_4^+) and (2) nitrate (NO_3^-). Rice, being an aquatic plant, shows a preference for ammonium uptake.

The Idealized Nitrogen Cycle for Rice

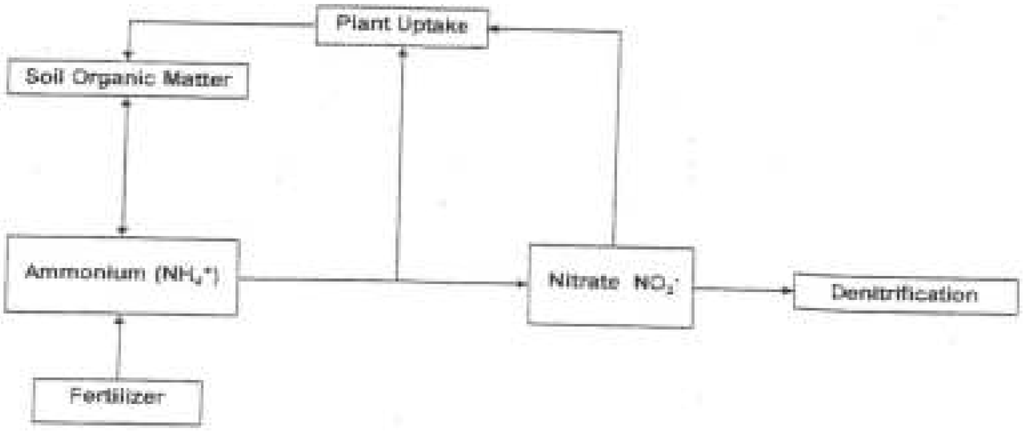


Figure 1. The idealized nitrogen cycle for rice.

Nitrogen mineralization is a general term indicating the microbial decomposition of soil organic matter and the subsequent production of ammonium. Nitrification is a nitrogen pathway involving the microbial-mediated conversion of ammonium (NH_4^+) to nitrate (NO_3^-). The entire nitrification process may be completed within three days if the soil moisture is near 60% of field capacity and the soil temperature approaches 30°C (86ºF).

Denitrification is the anaerobic, microbial reduction of nitrate to N_2, NO or N_2O, which happens mostly during periods of extreme soil wetness. Denitrification is usually presumed to occur in warm, anaerobic (suboxic to anoxic) soil conditions; however, suboxic to anoxic zones may well exist within otherwise oxic soil conditions, especially in heavy-textured soils. Thus, partial water saturation of fine-textured soils may be a source of nitrogen loss. Denitrification is inhibited at soil temperatures greater than 60°C and at or below 4°C.

Urea Hydrolysis and Urease Enzymes

Urea undergoes soil hydrolysis to produce carbon dioxide and ammonia (Fig. 2).

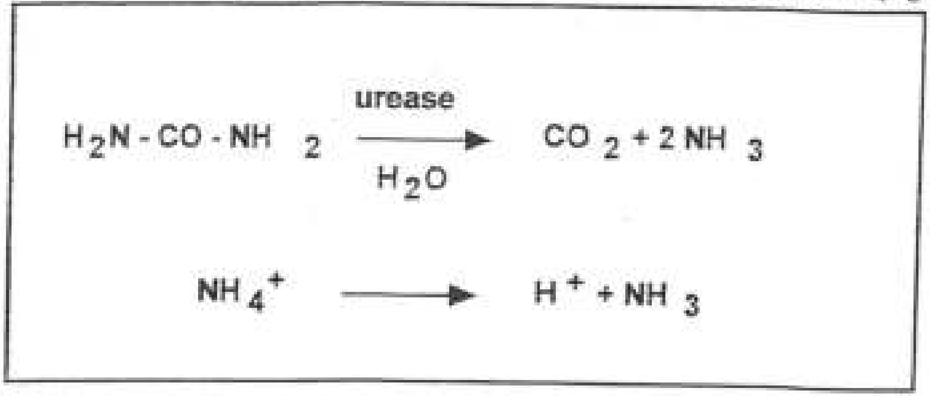


Figure 2. Urea hydrolysis and ammonium as a weak acid.

Urease is a series of naturally-occurring, extracellular enzymes produced by fungi, bacteria and actinomycetes that catalyze urea hydrolysis. The soil concentration of urease is not ready measurable; however, the urease activity is a measurable soil quantity. Soils having greater amounts of soil organic matter and/or litter-residues are likely to possess greater urease activity. The optimum soil temperature for urease activity is 37ºC (99ºF); however, urease activity may be measured as low as 2ºC (Havlin et al., 2005).

Norman et al. (2009) investigated ammonia volatilization rates on dry-seed, delayed-flood rice in Arkansas, noting that urea-NBPT reduced ammonia volatilization rates (2 to 10%), when compared with urea (17-24%). The corresponding reductions in ammonia volatilization correlated with higher rice yields. Griggs et al. (2007) observed ammonia volatilization and nitrogen uptake patterns for conventional and conservation tilled dry-seeded, delayed-flood rice systems in Arkansas. They observed that tillage practices had only a minor influence on ammonia volatilization and that the time interval between urea application and the imposition of flood was critical to minimizing ammonia volatilization.

Experimental Design

A field design having a randomized and replicated block design with (1) nitrogen fertilizer types (control, Urea, SuperU) as the main treatment and (2) timing of the delayed-flood (less than 24 hours, five days and 10 days) as the secondary treatment. The main treatment consisted of 150 lbs N per acre equivalent provided as: (i) Urea, (ii) SuperU, and (iii) untreated check (No nitrogen). Nitrogen was applied at the five-leaf stage to simulate the dry-seeded, delayed-flood rice culture system. SuperU (46-0-0) is an efficient nitrogen fertilizer having the urease inhibitor N-(n-butyl) thiophosphoric triamide, plus dicyandiamide to limit the conversion of ammonium to nitrate.

The rice variety 'Wells' was planted. Separate levee constructions permitted independent water flooding for the 24 hour, 5 day and 10 day delayed-flood program. Tissue testing (N, P, K, Ca, Mg, S, Na, Al, Fe, Mn, Zn, B, and Cu) and plant biomass accumulation were used to assess nutrient uptake patterns at pre-internodal elongation. Total biomass and panicle weight sampling involved randomly selecting 10 plants from each replicate, followed by drying at 70ºC for two days and weighing. Soil samples were collected at planting. Harvest was by plot combine.

Results and Discussion

Mid-season Nutrient Concentrations in Rice Tissue

Prior to internode elongation, rice plant tissue sampling was analyzed for N, P, K, Ca, Mg, S, Na, Fe, Mn, B, Cu and Zn. Rice plant tissue N concentrations were appropriate for rice culture and were statistically equivalent for the Urea, and SuperU treatments, regardless of the flood delay regime (Table 1 and Figure 3). The untreated check (no nitrogen treatments) was N deficient regardless of the flood delay regime.

Phosphorus (P) rice plant tissue concentrations were appropriate for the commercial culture of rice; however, the potassium (K) rice plant tissue concentrations were slightly deficient to moderately deficient for the commercial culture of rice. No statistical P and K rice tissue concentration differences were observed because of N source with or without nitrogen stabilizers (Urea, SuperU, untreated check). Additionally, the flood delay program did not show any statistical differences in the plant tissue P and K concentrations. The rice plant tissue concentrations for Ca, Mg, S, Na, Fe, Mn, B, Cu and Zn were appropriate for the commercial culture of rice and no appreciable differences involving the untreated check, the nitrogen sources or the flood delay program were evident (Tables 1 and 2).

Table 1. Primary and secondary rice tissue concentrations prior to internode elongation

Flood Delay (Days)	N treatment	N	P	K	Mg	Ca	S
		Percent	Percent	Percent	Percent	Percent	Percent
10	control	2.66	0.28	2.35	0.16	0.43	0.18
10	urea	4.57	0.29	1.77	0.27	0.39	0.26
10	superU	3.72	0.29	2.2	0.23	0.4	0.23
5	urea	4.64	0.33	1.98	0.27	0.4	0.26
5	superU	3.4	0.3	2.3	0.22	0.42	0.22
0	urea	4.37	0.35	2.51	0.24	0.32	0.24
0	superU	4.55	0.34	2.48	0.25	0.34	0.26

Table 2. Micronutrient rice tissue concentrations prior to internode elongation

Flood Delay (Days)	N treatment	mg/kg Fe	mg/kg Mn	mg/kg B	mg/kg Cu	mg/kg Zn
10	control	64	742	5	7	26
10	urea	103	530	9	8	33
10	superU	90	771	7	8	31
5	urea	94	583	5	7	33
5	superU	87	711	6	7	29
0	urea	96	721	18	10	39
0	superU	93	652	6	7	34

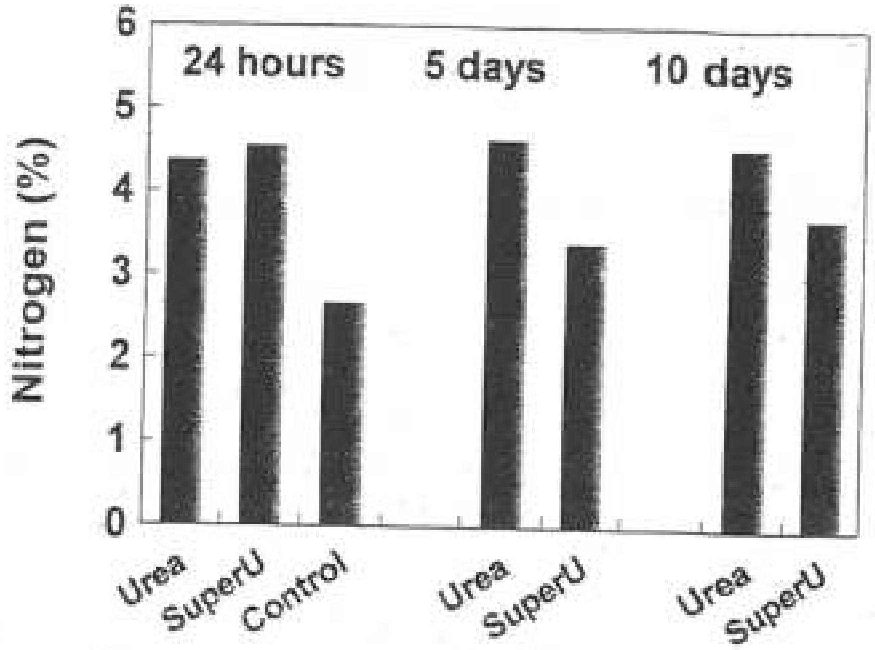


Figure 3. Rice plant tissue nitrogen concentrations just prior to internode elongation (July-2011).

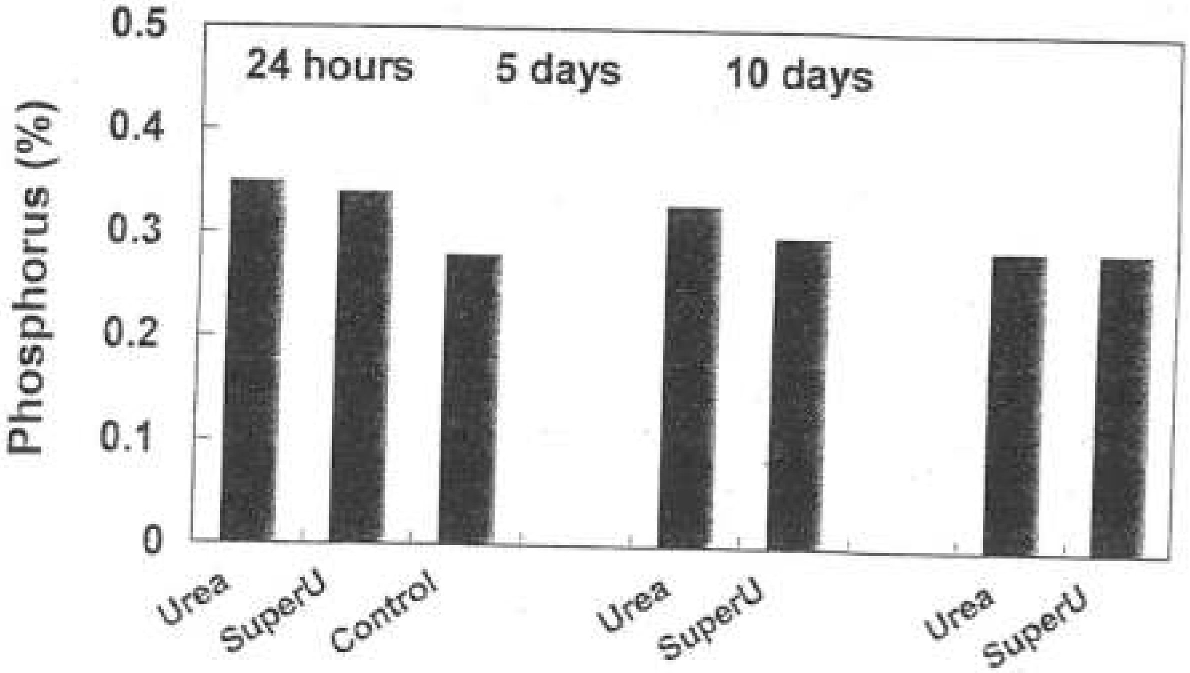


Figure 4. Rice plant tissue phosphorus concentrations just prior to internode elongation (July-2011).

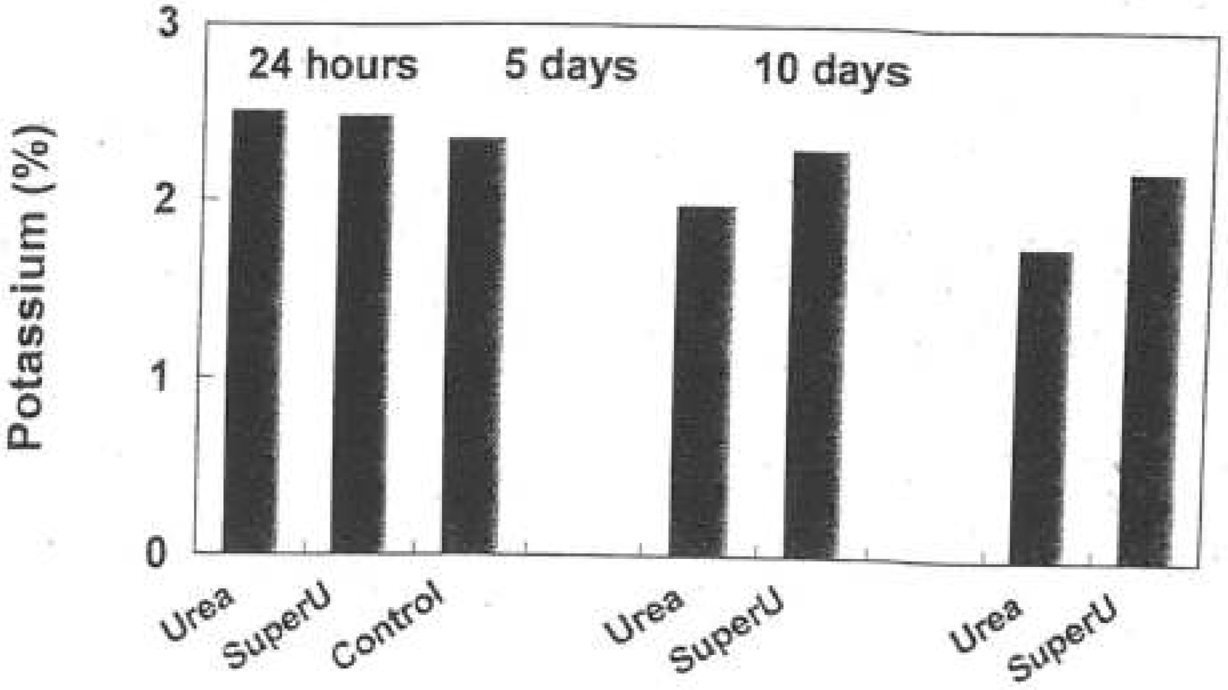


Figure 5. Rice plant tissue potassium concentrations just prior to internode elongation (July-2011).

Soil nitrate and ammonium concentrations on the day of flood.

Soil ammonium and nitrate concentrations just prior to flood were assessed for the 5 and 10 day flood regimes. The ammonium concentration for the untreated check was smaller and the nitrate concentration for the untreated check was greater than for experimental units receiving nitrogen. The ammonium concentration, where Urea was applied, was greater for the 10 day flood delay than the five day flood delay, whereas the nitrate concentrations were approximately equivalent regardless of the flood delay regime. The ammonium concentration, where SuperU was applied, was smaller for the 10 day flood delay than the five day flood delay, whereas the nitrate concentrations were greater for the 10 day flood delay regime. Soil pH was slightly acidic to neutral.

Table 3. Ammonium and nitrate concentrations prior to flood

Flood Delay (Days)	N Treatment	pH	NO3-N	NH4-N
			mg/kg	mg/kg
10	Control	6.3	74.4	12.2
5	Urea	6.6	53.9	32.2
10	Urea	6.6	54.1	62.3
5	SuperU	6.8	28.3	31.6
10	SuperU	6.6	72.6	19

Paddy water nitrate and ammonium concentrations one week flood.

Paddy water concentrations on the day of flood were assessed for the five and ten day flood regimes. Water pH was slightly alkaline (Table 4). Ammonium concentrations increased slightly because of flood delay, whereas nitrate concentrations were consistently small and did not show any evidence of being influenced by the flood delay regime.

Table 4. Water concentrations 1 week after flood

time delay	NH4-N	NO3-N	pH
	mg/kg	mg/kg	
0	0.1	1.3	7.6
5	0.2	1.0	7.7
10	0.3	1.0	7.8

Yield Components

At harvest, plant height was assessed to infer overall plant vigor. Nitrogen application, regardless of the nitrogen source, produced appreciably taller rice plants (data not shown). Within treatments, N sources and the presence of nitrogen stabilizers did not statistically influence plant height. The flood delay regime furthermore did not statistically influence plant height.

Panicle weight is primarily determined by the number of seed per panicle and seed weight. Panicle weights were generally smaller for the five day flood delay than the zero or ten day flood delay, a feature attributed to reduced seed development in the panicles of the five day flood delay (Figures 6,7 and 8). High temperatures at anthesis resulted in the reduced panicle weight.

For the zero day delay flood regime, panicles from the Urea treated plots were larger (heavier) than those from the SuperU treated plots. The five and ten day delay flood regimes did not exhibit panicle weight differences attributed to the presence of nitrogen or nitrogen source (N stabilizers).

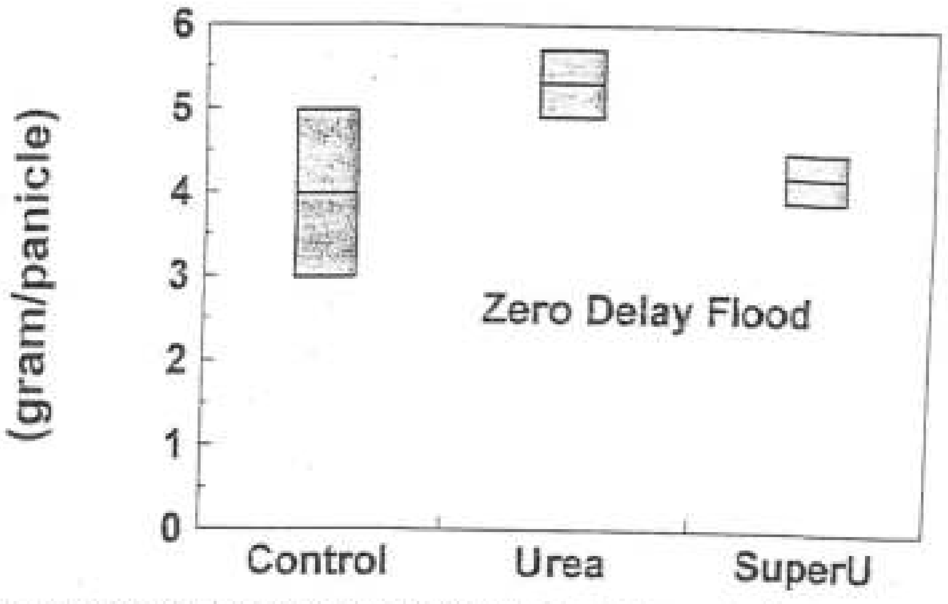


Figure 6. Panicle weight for the zero day flood delay regime. The center line in the box represents the mean, whereas the top and bottom of the box represents the 95% confidence interval.

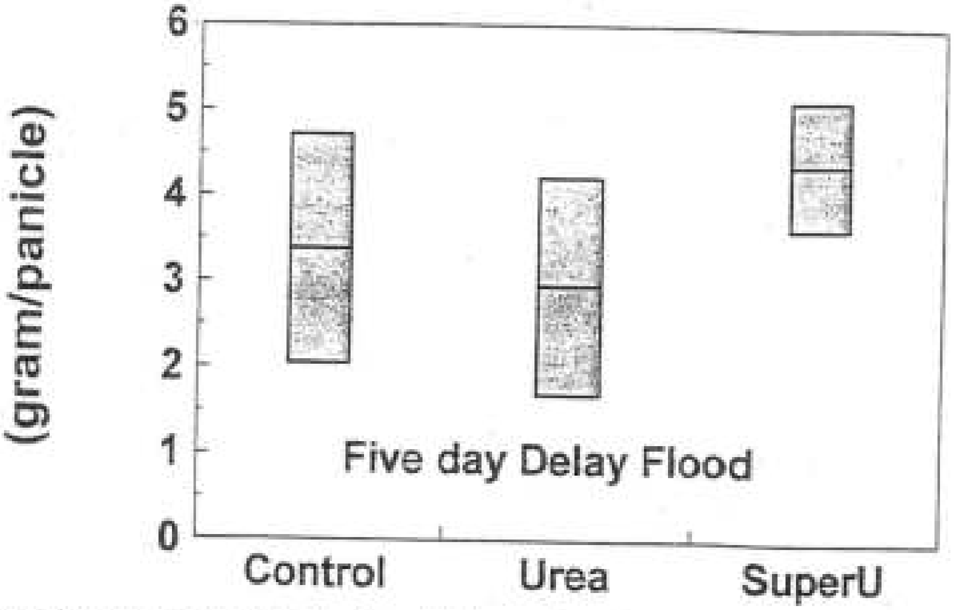


Figure 7. Panicle weight for the five day flood delay regime. The center line in the box represents the mean, whereas the top and bottom of the box represents the 95% confidence interval.

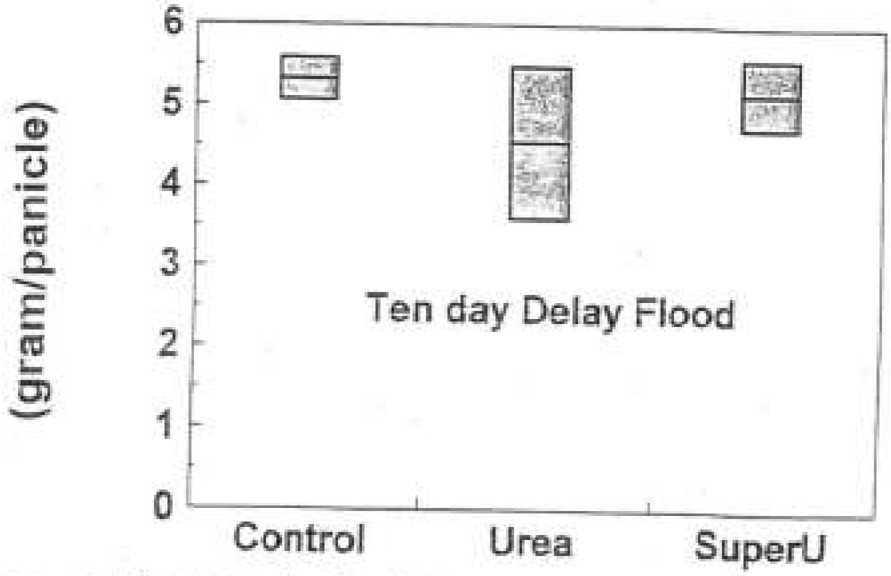


Figure 8. Panicle weight for the ten day flood delay regime. The center line in the box represents the mean, whereas the top and bottom of the box represents the 95% confidence interval.

Days to 50% heading were 92 to 93 days for Urea, 89 to 93 days for SuperU and 82 days for the untreated check. The time differences allowed the five day flood delay regime to experience high temperatures (Figure 9), thus inhibiting pollen viability and seed set. .

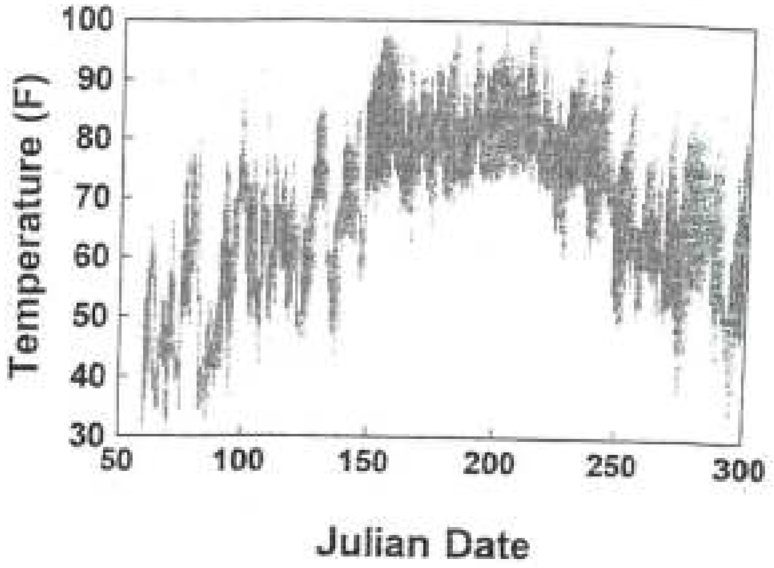


Figure 9. Maximum, average and minimum temperatures during the rice growing season (2011).

Overall harvest yields were typical for the Mid-South region. For each flood delay regime, yields were significantly greater where nitrogen was applied than for the untreated check (Figures 10, 11, 12). For the zero, five and ten day flood delay regimes, Urea and superU were equivalent in promoting yield. The zero delay flood regime had higher yields than the five or ten day flood delay regimes, with the yields of the five and ten day flood delay regimes being equivalent.

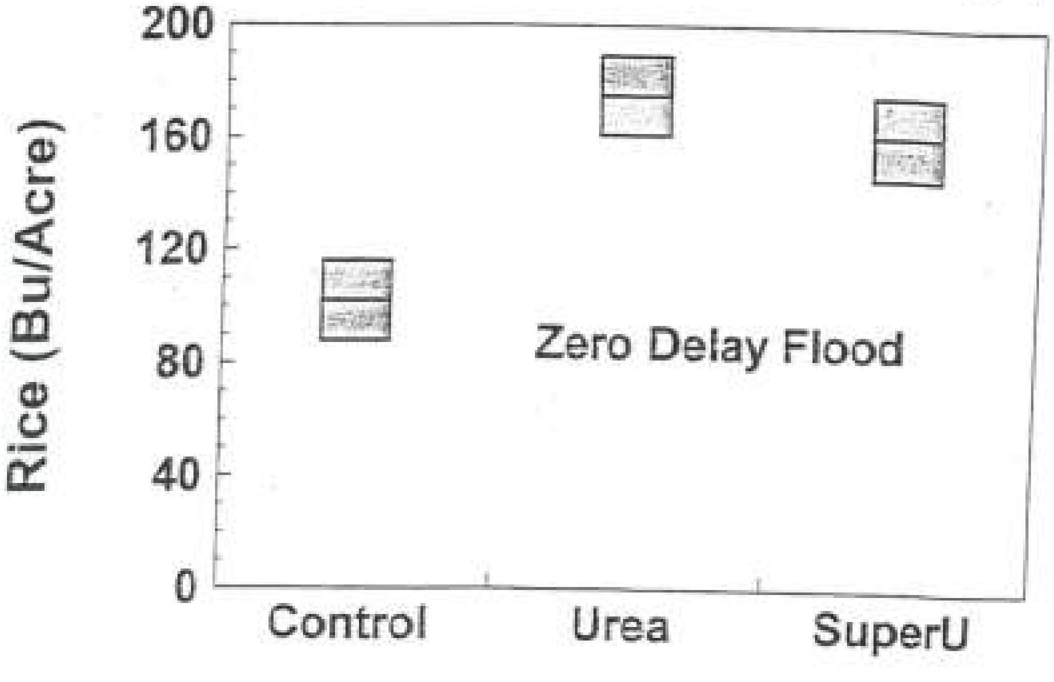


Figure 10. Rice yields for the zero day flood delay regime. The center line in the box represents the mean, whereas the top and bottom of the box represents the 95% confidence interval.

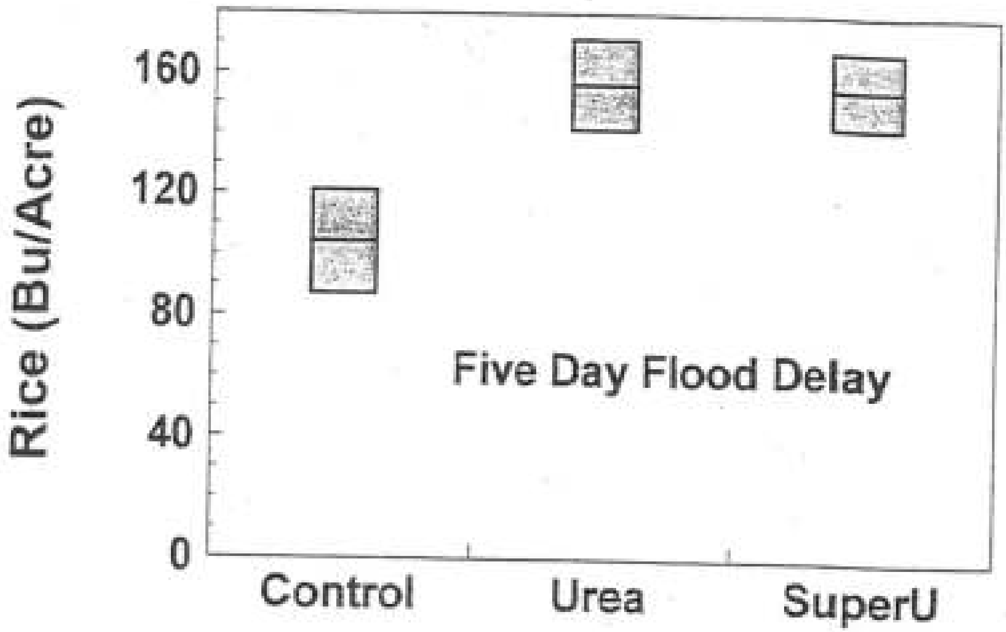


Figure 11. Rice yields for the five day flood delay regime. The center line in the box represents the mean, whereas the top and bottom of the box represents the 95% confidence interval.

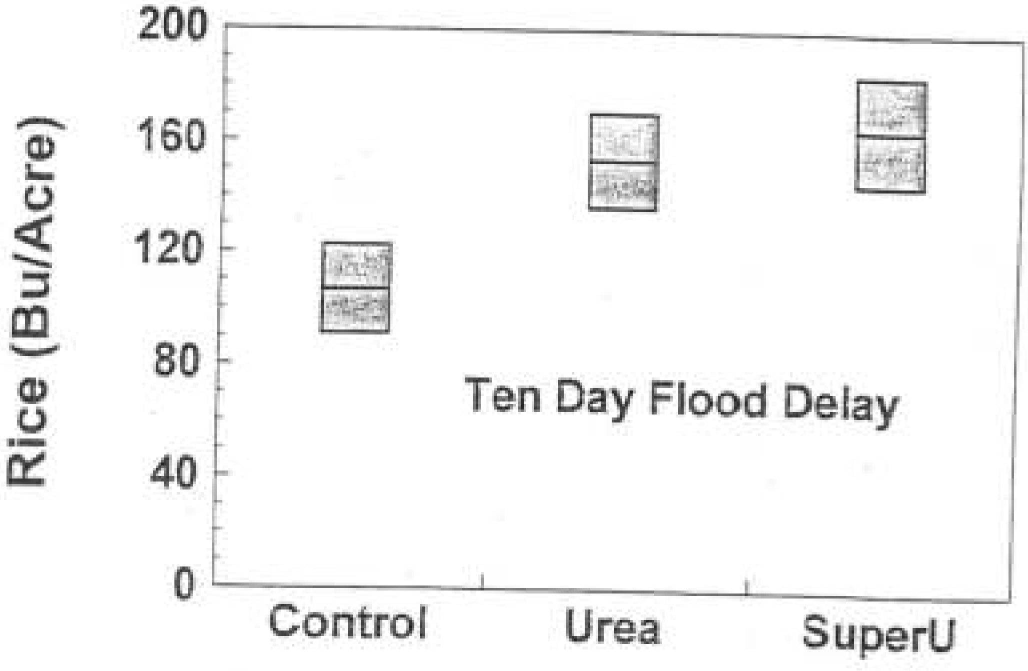


Figure 12. Rice yields for the ten day flood delay regime. The center line in the box represents the mean, whereas the top and bottom of the box represents the 95% confidence interval.

Summary and Observations/Conclusions

Nitrogen stabilizers function to limit the conversion of Urea to ammonia (ammonium). Ammonia is a gas at room temperature and pressure, thus the possibility of gaseous loss of N exists. Slowing the conversion of urea to ammonia allows a greater likelihood that the nitrogen will remain in the Urea form until the flood water is in place, limiting the gaseous loss of ammonia.

In oxic soil environments (not flooded), ammonia will convert to nitrate via the nitrification process. Nitrification inhibitors reduce the conversion of ammonium to nitrate, limiting denitrification once flood waters are in place. Thus, nitrogen stabilizers that limit both (i) the conversion of Urea to ammonium and (ii) the conversion of ammonium to nitrate act to limit the loss of nitrogen, especially if flood waters are not immediately applied after Urea application (Illustration 1).

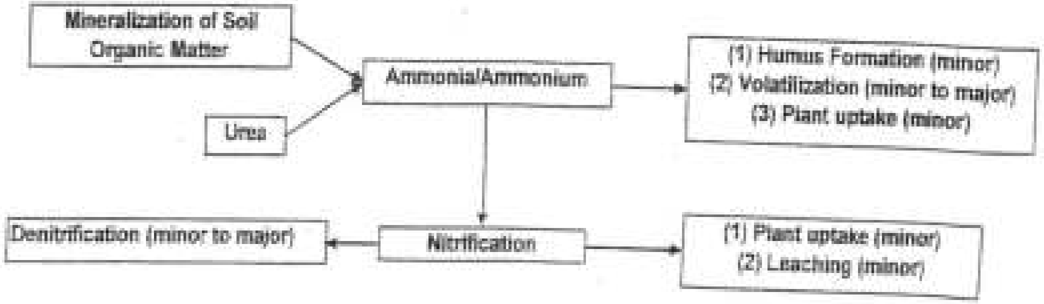


Illustration 1. Idealized rice nitrogen cycle pre-flood to 1 week post flood.

In this study, a five and ten day flood delay was imposed to compare the effects of Urea and SuperU relative to a zero flood delay regime. The yields of Urea and superU were equivalent within a given delay flood regime; however yields were lower in the delayed flood regimes relative to immediate flooding after fertilization. Thus, Urea with nitrogen stabilizers did not influence rice yields relative to urea without nitrogen stabilizers. Rainfall during the flood delay intervals may be reduced the likelihood of ammonia volatilization.

Literature Cited

Griggs, B.R., R.J. Norman, C.E. Wilson, Jr., and N.A. Slaton. 2007. Ammonia volatilization and nitrogen uptake for conventional and conservation tilled dry-seeded, delayed-flood rice. Soil Sci. Soc. Am. J. 71:745-751.

Havlin, J.L., J.D. Beaton, S.L. Tisdale, and W.L. Nelson. 2005. Soil fertility and fertilizers: An introduction to nutrient management. Prentiss Hall, Upper Saddle River, NJ.

Norman, R.J., C.E. Wilson, Jr., N.A. Slaton, B.R. Griggs, J.T. Bushong, and E.E. Gbur. 2009. Nitrogen fertilizer sources and timing before flooding dry-seeded, delayed-flood rice. Soil Sci. Soc. Am. J. 73:2184-2190.