Missouri Rice Research Update 2008

Southeast Missouri State University
University of Missouri-Columbia
University of Missouri Outreach and Extension

Special Report #01-2009

February 2009

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 resulted from contributions of the University of Missouri Agricultural Experiment Station Personnel, and Southeast Missouri State University, United States Department of Agriculture – Wildlife Services. 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 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:
Donn Beighley
Cathy Dickens
Trent Brewer

For further information on Missouri Rice visit these websites:

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 18, 2009
Program

8:30 Growing Rice under a Center Pivot - Dr. Gene Stevens – UMC Delta Center

8:50 P and K Management in Rice with Soil Treating – Mr. David Dunn,

Soil Lab Director – UMC Delta Center

9:20 Flood Tolerant Soybeans – Mr. Scotty Smothers, Research Associate –

UMC Delta Center

9:40 New Bird Repellant Seed Treatment for Rice – Mr. Robert Bird

USDA Wildlife Specialist – UMC Delta

Mid-morning Break

10:20 Insect Update, What's New in Missouri – Dr. Kelly Tindall, Entomoligist -

UMC Delta Center

10:40 Rice Varieties – Dr. Donn Beighley, Rice Breeder –

Southeast Missouri State University

11:00 New 2009 Farm Bill Provisions – Mr. Steve Morrison,

FSA County Executive Director – Stoddard Country

11:30 Rice Policy and Market Update – Me Greg Yielding, Field Representative –

US Rice Producers Association

Lunch

Industry Representatives on hand to answer questions about their products and service

Table of Contents

Rice Variety Reactions to Diseases 2009

Variety	Sheath Blight	Blast	Straighthead	Bacterial Panicle Blight	Narrow Brown Leaf Spot	Stem Rot	Kernel Smut	False Smut	Brown Spot	Lodging	Black Sheath Rot
Catahoula	VS	R	S	S	MR	S	S	S	R	MR	MS
Cheniere	S	S	MS	S	S	S	S	S	R	MR	MS
Cl 131	VS	MS	VS	VS	VS	S	S	S	R	R	S
CL151	VS	VS	VS	S	S	S	S	S	R	S-MS	S
CL161	VS	S	MS	S	MS	S	S	S	R	MS	S
CL171											
CL171AR	VS	S	MS	S	MS	S	S	S	R	MS	S
Cocodrie	S	MS	VS	VS	MS	S	S	S	R	MR	MS
Cybonnet	VS	R	MS	S	MS	S	S	S	R	MR	S
Francis	MS	VS	MS	VS	S	S	VS	S	R	MS	MS
RT CLXL730	MS	MR	MR	MR	MS	MS	MS	S	R	S-MS	MS
RT CLXP745	MS	R		MR	MS	MS	MS	S	R	S-MS	MS
RT XL723	MS	R	MR	MR	MS	MS	MS	S	R	MS	MS
RTCLXL729	MS	MR	MR	MR	MS	MS	MS	S	R	S-MS	MS
Spring	S	MS	VS	S	MS	VS	MS	MS	R	S-MS	MS
Trenasse	VS	S	VS	S	S	S	S	S	R	MS	MS
Wells	S	S	MS	S	S	VS	S	S	R	MS	MS
Medium Grains											
Bengal	MS	S	VS	VS	S	VS	MS	MS	VS	MR	MR
Jupiter	MS	S	MS	MR	MS	S	MS	MS	R	S-MS	MR
Neptune	MS				MS	S	MS	MS		MR	MR

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

Variety	Year Released & State	Highlights
Bengal	1992 – Louisiana	A short season, semi dwarf, medium-grain with good yield potential and milling quality. It has a preferred large grain size.
Catahoula	2008 - Louisiana	A semi-dwarf, long-grain with good yield and milling potential and resistance to blast.
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.
Cocodrie	1997 – Louisiana	A short season semi-dwarf long-grain with good yield potential and milling quality. Susceptible to sheath blight and other diseases. High bran oil content makes it somewhat of a milling concern to certain buyers.
Cybonnet	2004 – Arkansas	A short season, semidwarf long grain with good yield potential and excellent milling quality similar to Cypress. It has blast resistance similar to Katy and moderately susceptible to straighthead. Very susceptible to sheath blight.
Francis	2002 – Arkansas	A very short season, long-grain with excellent yield potential, very susceptible to rice blast and very susceptible to kernel smut.
Jazzman	2009 - Louisiana	A long grain aromatic variety with high yield and good milling quality.
Jess	2009 - Arkansas	A long grain aromatic variety with average yield and average milling quality. Is moderately susceptible to Blast and sheath blight.
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.
Rondo	2009 - USDA	A late, mid-season long grain variety with high yield and average milling quality but has good parboiling characteristics. It is resistant to Blast and Brown Spot while exhibiting moderate resistance to sheath blight and Narrow Brown Leaf Spot.
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.
Trenasse	2005 - Louisiana	A very short season, long grain with excellent yield potential. It is very susceptible to sheath blight, straighthead, and susceptible to blast.
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.

Variety	Year Released & State	Highlights
Arize 1003	2008 – Bayer Cropscience	A mid-season, long-grain hybrid with good yield potential and is moderately resistant to sheath blight.
CL 131	2005 – 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 151	2008 – 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 161	2002 – 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 171 AR	2006 - Horizon Ag	A midseason, semi-dwarf, long-grain similar to Wells with high tolerance to Newpath herbicide. It is susceptible to sheath blight, moderately susceptible to blast and straighthead. Yield is similar to CL 161.
CL 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.
CL XL 730	2005– Rice Tec, Inc.	A short-season, long grain with excellent yield potential and moderately susceptible to sheath blight, and moderately resistant to blast. Somewhat susceptible to lodging under extreme conditions.
CL 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.
CL XP 746	2008 – Rice Tec, Inc.	A short-season, long grain with excellent yield potential and high tolerance to Newpath herbicide, moderately susceptible to sheath blight, and moderately resistant to blast. Reported to have improved tolerance to shattering.
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.

Nitrogen Fertilization for Sprinkler Irrigated Rice

Gene Stevens, Jim Heiser, Matt Rhine,
and David Dunn
University of Missouri-Delta Center

Two challenges to pivot irrigated rice are nitrogen management and weed control. In 1988 and 1989, research at the Delta Center conducted by Steve Hefner and Paul Tracy showed fluctuating aerobic/anaerobic soil conditions inherent with a furrow-irrigated rice system may facilitate increased N losses. Soil and plant N concentrations indicated that the most efficient N application for furrow-irrigated rice occurred when the majority of N was applied 4 weeks after panicle differentiation.

A study was begun in 2008 to compare rice production with sprinkler irrigation to flood irrigation with different nitrogen fertilization programs. The objective is to reduce water use with sprinkler irrigated rice without using more nitrogen fertilizer or pesticides and produce equivalent or greater yields to flood irrigated rice. The research is partially funded by the Parks, Soils and Water Sales Tax and is administered by the Soil and Water Conservation Program in the Dept of Natural Resources. Valmont Industries, Inc. and Mid-Valley Irrigation donated the center pivot uses in the project.

Results from the first year of sprinkler irrigated rice research at the University of Missouri Delta Center indicate a water usage savings of 28% compared to the traditional flooding of rice fields. This comparison was made using a side inlet flooding system which has been shown to be up to 60% more efficient than the conventional cascade method of flooding. Additionally, grain yields from several sprinkler irrigated plots compared favorably and in many situations surpassed the grain yields with the same nitrogen treatments applied to the flooded study. During the course of these studies, many other production challenges were face. It has been our goal to meet these challenges with a systems approach as an alternative to developing entire studies to determine what may or may not work. Some of these challenges include selection of cultivars that may be better suited to this system, weed control programs and seeding rate adjustments. These studies have been and will continue to be conducted to determine if water, nitrogen and pesticide usage can be decreased with the use of sprinkler irrigation while producing equivalent or higher yield than in a flooded rice production system.

Application of treatments

Tests areas where sprinkler irrigation was to be used were planted on May 6, 2008 at the UM Delta Center Marsh Farm. The dry urea/flooded rice study used as a comparison was planted on May 23, 2008 at the UM Delta Center Lee Farm. First tiller nitrogen treatments for the sprinkler irrigated rice were applied on June 6 for both the dry urea and fertigation UAN studies. Flooded rice received the same treatments on June 23. The first fertigation treatment was applied in a split application on June 24 and July 1 due to a diluted solution being inadvertently used. The error was discovered and corrected. The subsequent fertigation treatments were applied with the correct rates on July 9, 16, 29 and August 13.
Midseason and late boot urea nitrogen treatments were applied on July 28 and August 13 for the pivot irrigated study, and on July 29 and August 15 for the flooded urea study.

Data Collection

SigmaScan photographic analysis and the yardstick method were used to determine nitrogen levels in the plants during the season. SigmaScan is a computer program that utilizes digital images and counts the number of green pixels present. Lower numbers of green pixels indicate a nitrogen deficiency, while higher numbers indicate a healthy plant canopy. A picture of each plot was taken, analyzed and averaged by treatment. The yardstick method has been used to determine a rice crops midseason nitrogen needs. By placing a yardstick between the rows of rice and counting the numbers on the yardstick not obscured by the plants leaves, an estimate of nitrogen needed can be made. Generally, the more numbers that are showing on a yardstick, the greater the rice yield response that can be expected from applying midseason nitrogen. SigmaScan photographs and yardstick readings were taken on July 30 and 23 for the dry urea/ pivot irrigated study, on July 29 and 27 for the fertigation study and on August 6 for the dry urea/flooded rice study. Grain from the pivot irrigated tests was harvested on August 24 and 25, and the flooded test was harvested on October 6. Subsamples from all plots were collected at harvest for milling quality analysis.

Results

Yield data from all three tests tended to be lower than expected due to shattering (grain falling off the plant) and lodging (plants falling over) as a result of heavy winds sustained from the remnants of Hurricane Ike on September 14. An estimate of these losses is presented in Table 1. Yields from the pivot irrigated/dry urea study had higher yields than the same nitrogen treatments applied to flooded rice for all three varieties/hybrids. Fertigation treatments yielded higher than the flooded dry urea for both the Clearfield variety and hybrid but not the conventional variety 'Cybonnet' (Figure 1) when 180 lb total N was applied.

The Clearfield hybrid also had higher yields in the fertigation study compared to the same hybrid in the dry urea/pivot irrigated study. At the 135 lb N/acre total rate, fertigation treatments with 50% of total nitrogen applied at the first tiller as dry urea yielded substantially higher than treatments with only 25% total nitrogen applied first tiller except when applied to the RiceTec CLXL730 hybrid (Figure 1). The yields for these treatments were higher than for the other varieties at the same fertility level, and were similar with 168 bu/ac for the 50% first tiller treatment and 175 bu/ac when only 25% of the nitrogen was applied at first tiller. The remaining nitrogen was applied in five fertigation treatments at 10 and 15% per application respectively. Timing had less affect on rice yields at the 180 lb N/acre rate of application (Figure 2).

Water usage (Figure 3) was lower for the pivot irrigated rice study as compared to the flooded study. Approximately 23 inches of water were applied to the sprinkler irrigated study area. The flooded test received approximately 32 inches of water throughout the growing season. This represents a decrease of 28 percent.

Yardstick measurements and SigmaScan readings were made on all plots to verify nitrogen use and plant health. In most cases the yardstick measurements and SigmaScan analysis correlated well with crop yields and reflected the nitrogen rate applied. Some examples are shown in Table 2. However, this was not always the case as weeds present in the plot, and therefore in the analyzed photographs, would increase the percentage of green pixels counted by the SigmaScan software. This seemed to be more common in the flooded test as algae and difficult to control aquatic weeds may have been present.

Other management practices which may need to be altered when growing rice with pivot irrigation include weed control programs and seeding rates. Flooding rice not only irrigates the crop but contributes 40-60% of the weed control. As a consequence, more herbicide applications may need to be made. Some conventional herbicide programs which may be useful with this production system are shown in Table 3. In addition, many "add-on" herbicides were helpful for pigweed control including penoxsulam (Grasp), bentazon/acifluorfen (Storm), carfentrazone (Aim), and triclopyr (Grandstand). The use of the Clearfield, herbicide resistant rice system may have little value in this system unless red rice becomes a problem. This system utilizes the herbicides NewPath (imazethapyr) and Beyond (imazamox) herbicides from the Acetolactase Synthase (ALS) family of herbicides. The main weed problem we faced in these studies was Palmer Amaranth. In many areas, this weed is resistant to ALS herbicides.

The low seeding rates of hybrids may also need to be increased when used in this system. The reduced number of rice plants in a given area took longer to close canopy. As a result weeds had more time to emerge and compete with the rice plants. We believe that a higher seeding rate may reduce this early season competition and allow for fewer herbicide applications later in the season.

Conclusion

In areas where quality and quantity of irrigation water are not suitable for the common cultural flooding method of rice production, it is reasonable to speculate that a pivot irrigation system could be used. Our studies have indicated that grain yields comparable to the flooding method are achievable and can even be surpassed with a center pivot sprinkler irrigation system. Not only would this system be suitable for areas where rice production is not practiced because of the topography and soil types not being conducive to flooding, but may be useful for producers in rice production already as a way to conserve water, and consequentially reduce fuel usage.

Nitrogen losses have been shown to be increased in furrow irrigated due to the soil fluctuating between anaerobic and aerobic states. These studies indicate that a fertigation system provides the best method of supplying the crops nitrogen requirements. Additionally, the amount of urea applied at the first tiller stage may be critical. When 50% of the total nitrogen was applied at this stage, 2 of the 3 varieties/hybrids yielded much higher than when only 25% was applied. This higher amount of N applied early in the season may allow fro a healthier more competitive crop. The remaining nitrogen is applied more or less as needed for the next 5 weeks. In this way we can limit the amount of N loss because there is little or no excess in the soil. In other words, we only apply what the crop can use.

Dry urea fertilization with this system was also shown to be effective, however not at the levels realized with the fertigation system. The probable cause for this is nitrogen loss due to volatilization and runoff. Urea is used for flooded rice production but only if the crop is going to be flooded soon or is already flooded. The pellets of urea convert from dissolved ammonia to ammonia gas when not incorporated into the soil. The nitrogen is then lost to the atmosphere. When the soil is flooded the ammonia gas is held by the flood water and reaches equilibrium with the soil and is still plant available. With this system, irrigating the crop may only cause more volatilization. As well, increasing the amount of irrigation with this system may lead to runoff of the urea because there are no structures such as levees to retain the water as there

Varietal selection may be more important with this system also. Diseases such as blast are known to be more destructive when the rice plants are under water stress. Varieties and hybrids with higher levels of resistance to this and other diseases should be selected to insure that yield losses are kept to a minimum.

The first year of these studies offered a great deal of insight into the benefits of using this system and also some of the obstacles which must be overcome. While we were able to produce equivalent yields with less water and nitrogen, it appears that our pesticide usage may actually be increased with this system.

Additional research will reveal the best programs to reduce this input and should also help to increase crop yield further.

Table 1.

Shattered kernel counts and yield loss estimates of three rice cultivars at the University of Missouri-Lee Farm on Sharkey clay flood irrigated.

Cultivar	Kernels/ft^2	Yield loss bushels/ acre†
Cybonnet	51	3
CL171	285	14
CLXL730	532	32

† Calculated from tables in the Arkansas Rice Production Handbook (Univ Ark Coop Ext Service Bull. MP192).

Table 2.

Yardstick and SigmaScan readings for plots planted to Clearfield 171AR and receiving 135 lb total nitrogen per acre on pivot irrigated rice and flood irrigated check. Results were similar for Cybonnet and RiceTec CLXL730.

Method	Yardstick numbers showing	Green Pixels
Dry urea	18	85%
Fertigation	14	95%
Flood urea Sharkey clay check	14	98%

Table 3.

Conventional herbicide programs, weed control ratings and cost per acre for pivot irrigated rice study. Ratings based on 0=no control, 100=complete weed control.

Program	Pigweed	Carpetweed	Morning glory	Cost/acre
	--------------	% control	----------------	
Prowl fb Stam (2)	97	100	100	$40.89
Command fb Stam (2)	94	100	100	$45.16
Command fb Stam + Facet (2)	100	100	100	$69.66

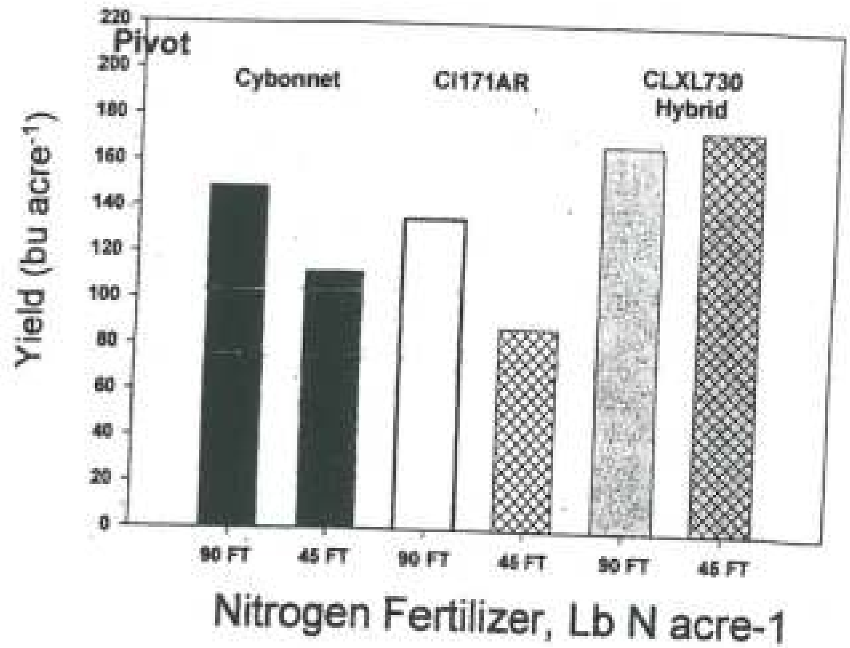


Figure 1.

Rice yields of rice cultivars and hybrid supplied with 135 lb total N/acre split between dry and fertigation with 90 or 45 lb dry urea applied at first tiller (FT) on a Tiptonville silt loam and irrigated with center pivot system. Plots that received 90 and 45 lbs N per acre at first tiller were fertigated with five 9 lbs N/application and 18 lbs N/application, respectively, in 7 day intervals.

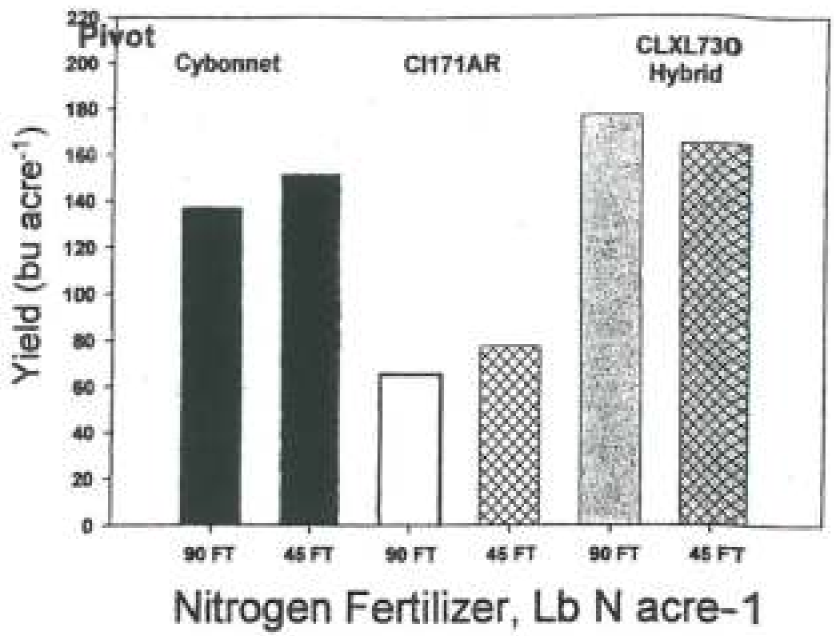


Figure 2.

Rice yields of three cultivars supplied with 180 lb total N/acre split between dry and fertigation with 90 or 45 lb dry urea applied at first tiller (FT) on a Tiptonville silt loam and irrigated with center pivot system. Plots that received 90 and 45 lbs N per acre at first tiller were fertigated with five 14 lbs N/application and 20 lbs N/application, respectively, in 7 day intervals.

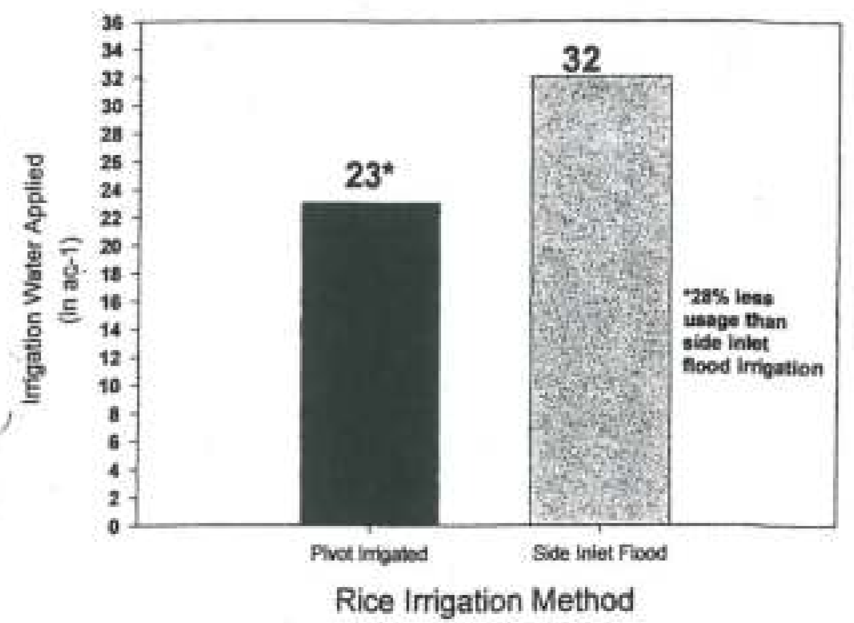


Figure 3.

Irrigation applied with center pivot irrigation and side-inlet flooding on rice.

University of Missouri Soil Test Recommendations for Rice Production

Gene Stevens and David Dunn

Introduction

Most of the Current University of Missouri soil test recommendations has been adopted from Arkansas. During the past 10 years a team of scientists including Dr Gene Stevens, Dr Michael Aide, Dr Paul Tracy, and David Dunn have carried out field evaluations of these recommendations. These evaluations are continuing today thanks to support from the Missouri Rice Research and Merchandising Council.

pH and soil acidity

In Missouri soil acidity is measured on the basis of Salt pH (pH_s). The pH_s indicates the need to apply lime. The lime requirement is measured by the Woodruff Buffer method. Missouri lime recommendations are given in lbs. of Effective Neutralizing Material (ENM) per acre. ENM is an estimate of how much soil acidity the lime will neutralize in a 3 year period.

Currently the University of Missouri does not recommend liming before rice is grown. Liming is necessary to maximize soybean yields in the rice-soybean rotation. Last year soybean yields were increased 25% when 1 ton/a of lime was applied before soybeans were planted at the Missouri Rice Research Farm.

Nitrogen (N)

Currently the University of Missouri recommendations for nitrogen are variety specific. These recommendations are posted on the Ag Electronic Bulletin Board at http:\\agebb.missouri.edu\rice. Table 1 gives the nitrogen recommendations for 4 popular varieties.

Table 1.

Nitrogen recommendations for 4 popular rice varieties.

Variety	Total N	Preflood	Mid-season
Bengal	135	75	30+30
Cocodrie	150	90	30+30
Francis	150	90	30+30
Wells	150	90	30+30

Phosphorus (P)

Phosphorus recommendations are based on a target level of 30 lbs P/a. A rice crop will remove .30 lb of P_2O_5 per bu per acre. To account for this loss a crop removal factor is included for soils testing between 30 and 55 lb P/a. Recommendations are given in lbs of P_2O_5 per acre.

Potassium (K)

In 2003 the University of Missouri Missouri changed the target level for K fertilization. The new target level reflects recent research in Missouri. These new recommendations also reflect the higher yield potential of the rice varieties grown in Missouri. Potassium recommendations are based on a target level of 125 + 5X CEC. For silt-loam soils this is about 200 lbs K/a. For gumbo soils this number is about 225 lbs K/a. Rice yields drop off quickly when a soil tests below these levels. For low testing soils a factor for building the soil up to maximum productive levels is included in the fertilizer recommendation added in. The current recommendation package allows the producer to choose how quickly to build up the soil K levels. A rice crop removes 0.2 lb K_2O per bushel per acre. A crop removal factor is included to account for this. Recommendations are given in lbs of K_2O per acre.

Additives for Increasing Nitrogen Efficiency in Rice

David Dunn and Gene Stevens
University of Missouri-Delta Center

Introduction

Rice needs supplemental nitrogen fertilizer additions to achieve maximum yields. In the standard dry seeded, delayed flood rice production system, the bulk of the nitrogen is supplied as urea. Then a permanent flood is immediately established. However, in real farm situations the establishment of the permanent flood can be delayed for several days. During the time period between fertilizer application and flood establishment the applied urea is subject to losses by several pathways. These include volatilization of urea and conversion of urea to nitrate followed by subsequent leaching and denitrification. Several products are commercially available to control these losses. This study compares several products in their ability to achieve rice yields in a dry seeded, delayed flood production system.

Methods and Materials

In 2008 this evaluation was conducted at two locations representing the two major soil types used for rice production in Missouri. The soil types were: Sharkey clay soil, University of Missouri-Delta Center, Portageville, MO and Crowley silt loam, Missouri Rice Research Farm, Qulin, Missouri. At each location a small plot evaluation with a randomized complete block design employing four replications was conducted. Rice was cultivated using the standard methods of P and K fertilization, water management, and weed & insect control for dry-seeded, delayed flood rice in Southeast Missouri. At the clay soil location four pre-plant N rates (35, 70, 105, and 140 lbs N/a) were compared to an untreated check. At the silt loam soil location three pre-plant N rates (70, 105, and 140 lbs N/a) were compared to an untreated check. No additional N was applied. At both locations the following products: urea, urea + Agrotain®(Agrotain, International, St Louis, MO) urea + NSN (NurtiSphere-N™, Specialty Fertilizer Products, Belton, MO), and urea + Upgrade® (Atlantic-Pacific Agriculture Company, Marvell, AR). The following rates were used for each additive: Agrotain®. 5 qt/ ton urea, NSN 0.25%, and Upgrade® 3 qt/ ton urea. At each location the N fertilizers were applied 7 days prior to flood establishment. SPAD 502 chlorophyll meter, plant height, Arkansas plant area board, and Missouri yardstick readings were collected from each plot at midseason (data not presented). At seasons end each plot was harvested and the resulting rice yield was measured.

Results

Yield results for the clay soil location are given in Table 1, for the silt loam soil location in Table 2. At the clay soil location the 105 lbs N as urea produced the greatest yields when averaged for all products. At the silt loam soil location the 140 lbs N rate produced the greatest yields when averaged for all products. At both locations urea produced the lowest yields when averaged for all N rates. At the clay soil location when yield results were averaged for all N rates the urea + NSN treatments produced the numerically greatest yields. At the silt loam soil location when yield results were averaged for all N rates the urea + Agrotain® treatments produced the numerically greatest yield.

Conclusions

The yield results from the clay soil location indicate that this soil was capable of supplying more nitrogen to the rice crop than is usually possible. The environmental conditions found in 2008 may or may not be typical for Southeast Missouri. More study is needed before definitive conclusions are drawn. Rice producers should exercise caution before extending these results in to future years.

Acknowledgement

This research was made possible by the generous and continuing support of the Missouri Rice Research and Merchandising Council, Specialty Fertilizer Products, Belton, MO, and Atlantic-Pacific Agriculture Company, Marvell, AR. Use of trade or product names is for identification purposes only and does not constitute an endorsement or recommendation by the University of Missouri.

Table 1.

Average rice yields for N treatments for a clay soil located at the University of Missouri-Delta Center, Portageville, MO, 2008

N rate	Urea	Urea + Agrotain® 5 qt/ton	NSN 0.25%	Upgrade® 3 qt/ton	Average for all products
0			118		
35	163	168	181	162	167
70	171	177	193	167	180
105	186	190	191	189	188
140	177	188	183	189	180
Average for N rates	174	181	187	177	

Table 2.

Average rice yields for N treatments for a silt loam soil located at the Missouri Rice Research Farm, Qulin, MO, 2008

N rate	Urea	Urea + Agrotain® 5 qt/ton	NSN 0.25%	Upgrade® 3 qt/ton	Average for all products
0	106				
70	127	144	135	137	137
105	133	147	138	139	139
140	139	151	148	146	146
Average for N rates	133	147	140	141	

Comparison of Commercially Available foliar N & K Products for Rice Production

David Dunn

Introduction

Foliar feeding of rice represents an opportunity for producers to correct nutrient deficiencies during the growing season. In a previous evaluation it was demonstrated that foliar solutions of KNO_3 could be used to increase grain yields and decrease lodging in *Baldo* rice. In a 2006 study funded by the Helena Chemical Company, foliar N & K treatments increased yields at a trial location where soil test K was below optimum levels for rice production. In that evaluation adding foliar K solutions at mid season added 5 bu of grain at harvest. Currently several commercial foliar N & K products are being marketed for rice production in Missouri. These products have not been compared "head to head" or against generic chemicals in Missouri rice growing conditions.

This study investigates the yield effect of commercially available and generic of foliar N & K products in Missouri rice production.

Methods and Materials

Rice field plots were established in 2008 on a Crowley silt loam soil located at the Missouri Rice Research Farm at Qulin, MO. The initial soil test P and K levels at this location was 23 lbs/a, and 181 lbs/a respectively. The University of Missouri recommended rates for P and K were: 60 lbs P_20_5 and 30 lbs K_2O. The experimental design was a randomized complete block four replications. In this evaluation rice was cultivated under the standard methods for producing rice in a dry seeded delayed flood production system in Missouri. Supplemental nitrogen was applied to all plots as urea at the rate of 150 lbs/N at pre-flood. No additional nitrogen was supplied at midseason. At seasons end each plot was harvested and grain yield determined.

Three commercially available foliar products were compared to a solution of KNO_3. A treatment consisting of 30 lbs K_2O as granular murate of potash applied pre-plant was also evaluated. These commercial products were CoRoN® 10-0-10-0.5B (The Helena Chemical Company, Collierville, TN), Trisert K® 5-0-20-15S (Tessenderlo Kerley Inc., Phoenix, AZ), and Mic-Ro-Pac® 11-8-5 (Atlantic-Pacific Agriculture Company, Marvell, AR). These products were applied at a rate of two gallons per acre of product diluted with water for a total application rate of 10 gallons of solution per acre. An additional foliar treatment consisting of two gallons per acre of Mic-Ro-Pac® and 1 ½ pint per acre of Hook® (Atlantic-Pacific Agriculture Company, Marvell, AR) was also compared. A solution of KNO_3 was prepared from reagent chemicals. The strength of this solution was chosen to match the average K contribution of the three commercial products, 2.3 lb k/a). All of these treatments were applied at inter-node elongation with a CO_2 back pack sprayer.

Results and Discussion

The yield results for 2008 from this experiment are presented as Table 1. The untreated check produced the lowest yields of all treatments. This indicates that low soil fertility conditions may have been limiting rice yields. The pre-plant P & K increased yields relative to the untreated check but produced yields that were less than the average of all foliar treatments. The greatest yields were obtained with the Mic-Ro-Pac® 11-8-5 + Hook® treatment.

Acknowledgement

This research was made possible by the generous and continuing support of the Missouri Rice Research and Merchandising Council and Atlantic-Pacific Agriculture Company, Marvell, AR. Materials used in this evaluation were also provided by The Helena Chemical Company, Collierville, TN and UAP Mid South, Portageville, MO. Use of trade or product names is for identification purposes only and does not constitute an endorsement or recommendation by the University of Missouri.

Table 1.
Average rice grain yields for foliar and pre-plant fertilizer treatments Qulin, MO 2008.

Product	Rate	lb NPK /a	Yield (bu/a)
Check	0	0	156
CoRoN® 10-0-10-0.5B	2 gal/a	2 lb N 0 lb P 2 lb K	164
Trisert K® 5-0-20-15S	2 gal/a	1 lb N 0 lb P 4 lb K	165
Mic-Ro-Pac® 11-8-5	2 gal/a	2.2 lb N 1.6 lb P 1 lb K	161
Mic-Ro-Pac® 11-8-5 + Hook®	2 gal/a + 1 ½ pint/a	2.2 lb N 1.6 lb P 1 lb K	168
Reagent KNO_3	6 lb/a	0.8 lb N 0 lb P 2.3 lb K	167
Pre-plant P & K	60 lb P 30 lb K	60 lb P 30 lb K	163

The Economics of Liming for a Rice-Soybean Rotation

David Dunn

Introduction

Rotating rice with soybeans is a common practice in Southeast Missouri. These crops have different soil pH requirements with soybeans requiring a higher pH than rice to achieve maximum yields. Current University of Missouri soil test recommendations for lime treat rice and soybeans as separate crops. The standard recommendation is to lime before soybeans but not before rice. Soybeans like a higher pH than rice. Micronutrients, like zinc and boron, become less available as the pH goes up. Zinc is critical for rice production. Zinc deficient rice is not able to withstand flooded conditions and will die when the flood is applied. A rice crop that has been recently limed should be monitored closely for zinc deficiency, here the rice is an abnormal bronze color, is limp and floats on the water. The rice will die unless the flood is pulled. At this stage foliar zinc and additional nitrogen may be required.

This study investigates the economics of lime and P & K fertilizer applications in the rice-soybean rotation.

Methods and Materials

Rice and soybean field plots were established in 2007 on a Crowley silt loam soil located at the Missouri Rice Research Farm at Qulin, MO. The initial soil $pH_{(s)}$ at this location was 5.1, the P level was 23 lbs/a, and the K level was 181 lbs/a. The recommended limestone rate for both rice and soybeans was 1 ½ tons/a. For rice 70 lbs P_20_5 & 30 lbs K_2O was recommended, for soybeans 80 lbs P_20_5 & 120 lbs K_2O was recommended. The experimental design was a split plot with crop as the main plot and fertilizer treatment as the sub plot. Four replications were employed. Two rates of aglime (0 & 1 ½ ton/a) and one rate of pelletized lime (200 lb/a) were evaluated. Two rates of P & K (0 & 100% of the recommended rate) were evaluated. These rates were based on the individual recommendations for each crop.

Each plot was harvested and grain yield determined. Net returns to producers were calculated based on grain prices of soybeans @ $10.00/bu, and rice @ $5.00/bu. Input costs for 2008 were based on lime @ $25.00/ton, pelletized lime @ $110.00/ton, P @ $1.05/lb, and K @ $0.60/lb

Results and Discussion

The average grain yields and net returns to producers for lime and fertilizer treatments for 2008 are presented in Tables 1, 2, & 3. When averaged for all fertilizer treatments, the 1.6 ton/a lime rate produced the greatest rice yields. When averaged for all lime treatments, the 70-30 rate of P & K produced the greatest yields for rice. When averaged for all fertilizer treatments, the 1.6 ton/a lime rate produced the greatest soybean yields. When averaged for all lime treatments, the 80-120 rate of P & K produced the greatest yields for soybean. For both rice and soybeans the 200 lb/a pelletized lime treatment increased yields relative to the no lime treatment. When averaged for all fertilizer treatments, the 1.6 ton lime treatment produced the greatest returns to producers for rice. When averaged for all lime treatments, the 0 rate of P & K produced the greatest returns to producers for rice. When averaged for all fertilizer treatments, the 1.6 ton/a lime rate produced the greatest returns to producers for soybeans. When averaged for all lime treatments, the 0 rate of P & K produced the greatest returns to producers for soybeans. For both rice and soybeans additions of P & K increased yields, but the increased yields were not great enough to compensate for higher fertilizer costs experienced in 2008.

Acknowledgement

This research was made possible by the generous and continuing support of the Missouri Rice Research and Merchandising Council.

Table 1.

Average grain yields, input costs, gross and net returns for lime and fertilizer treatments for rice and soybeans, Qulin, MO in 2008.

2008 Rice							
#	P+K (lb/a)	Lime (t/a)	2008 Yield (bu/a)	2008 Gross return* ($/a)	2008 Input costs** ($/a)	2008 Net returns ($/a)	2-year net returns ($/a)
1	0	0	135	$675	$0	$675	$1380
2	0	0.4	151	$755	$0	$755	$1451
3	0	0.8	142	$710	$0	$710	$1436
4	0	1.2	133	$665	$0	$665	$1337
5	0	1.6	154	$770	$0	$770	$1453
6	0	200 lb pel	149	$745	$11	$734	$1433
7	70-30	0.4	151	$755	$92	$664	$1331
8	70-30	0.8	154	$770	$92	$679	$1427
9	70-30	1.2	169	$845	$92	$754	$1452
10	70-30	1.6	177	$885	$92	$794	$1493
11	70-30	200 lb pel	160	$800	$103	$698	$1444

2008 Soybeans							
#	P+K (lb/a)	Lime (t/a)	2008 Yield (bu/a)	2008 Gross return* ($/a)	2008 Input costs** ($/a)	2008 Net returns ($/a)	2-year net returns ($/a)
1	0	0	27	$270	$0	$270	$630
2	0	0.4	39	$390	$0	$390	$761
3	0	0.8	43	$430	$0	$430	$801
4	0	1.2	41	$410	$0	$410	$792
5	0	1.6	39	$390	$0	$390	$773
6	0	200 lb pel	41	$410	$11	$399	$778
7	80-120	0.4	38	$380	$156	$224	$613
8	80-120	0.8	44	$440	$156	$284	$693
9	80-120	1.2	57	$570	$156	$414	$754
10	80-120	1.6	68	$680	$156	$524	$915
11	80-120	200 lb pel	47	$465	$167	$298	$675

*Based on rice @ $5.00/bu and soybeans @ $10.00/bu

**Based on lime @ $25.00/ton, pelletized lime @ $110.00/ton, P @ $1.05/ lb P_2O_5 and K @ $0.60/ lb K_2O.

Table 2.

Average rice and soybean yields and net returns for fertilizer treatments averaged for all lime rates, Qulin, MO in 2008.

P&K treatment	Rice				Soybeans		
	2008 Yield (bu/a)	2008 Net returns ($/a)	2-year Net returns ($/a)		2008 Yield (bu/a)	2008 Net returns ($/a)	2-year Net returns ($/a)
No P & K	145.8	$727	$1422		40.6	$404	$781
+ P & K	162.2	$717	$1429		50.7	$349	$730

Table 3.

Average Rice and soybean yields and net returns for lime treatments averaged for all fertilizer rates, Qulin, MO in 2008.

Lime	Rice				Soybeans		
	2008 Yield (bu/a)	2008 Net returns ($/a)	2-year Net returns ($/a)		2008 Yield (bu/a)	2008 Net returns ($/a)	2-year Net returns ($/a)
0	135	$675	$1380		27	$270	$630
0.4 t	151	$666	$1391		39	$307	$687
0.8 t	148	$695	$1431		44	$357	$747
1.2 t	151	$710	$1395		49	$412	$773
1.6 t	166	$782	$1473		54	$457	$844
200 lb pel	155	$716	$1439		43	$349	$644

Rice Insect Research

Kelly Tindall UMC Delta Center

Update on Rice Water Weevil Research

The rice water weevil is the most important early season insect pest of rice in Missouri. Adults of this insect begin emerging from overwintering sites in early June in Missouri and fly to rice fields, where they feed on young rice leaves. This form of injury is not economically important except under unusually heavy infestations. Eggs are laid when standing water is present in a field that is infested with adults. This condition is usually met immediately after a permanent flood is applied to a field. Young rice is preferred for oviposition. After emerging from eggs, larvae feed under water on rice roots and pass through four larval instars and a pupal stage in approximately 30 days. Removal of root tissue results in decreases in above-ground growth and tillering of rice plants in the vegetative stage, and in reductions in panicle densities and grain weights at harvest. Research conducted in Louisiana indicates that one rice water weevil larvae on a young rice plant can result in a yield loss of approximately 0.4% to 1.0%.

Data were collected in 2008 in attempt to gather distribution data for Missouri. Table 1 presents data from 10 locations in Southeast Missouri. The average number of larvae ranged from 2.8-25 larvae per core. The average number of all samples was 12-15 larvae per core. Based on information form Louisiana; 1 larva/core = 0.4%-1% yield losses), the average yield loss would be 4.8-15%. However, the highest infestation rate for an individual field was 25 larvae per core which would cause an estimated 10-25% yield loss.

Table 1. Average number of rice water weevil larvae per core from 10 locations in southeast Missouri, 2008.

Site No.	3WAF		4WAF		5WAF	
	Ave. No	Range	Ave. No	Range	Ave. No	Range
1	14.0	0-26	10.3	2-29		
2	7.1	1-20	14.8	1-22		
3	23.4	6-45	14.7	3-27		
4	7.8	3-15	20.2	6-48		
5.	2.8	0-13	6.0	0-28		
6	11.5	0-22	9.65	0-23		
7	7.3	0-20	11.9	0-31	10.6	4-16
8	8.8	0-22	19.1	6-68	11.4	3-22
9	15.2	1-32	25.2	14-34	8.1	0-23
10	25.0	7-55	22.0	5-50	8.0	3-49

Dermacor™ X-100 seed treatment has been evaluated for efficacy against the rice water weevil in Missouri for two years (2007-2008). In 2007, efficacy data was good; however, yield data compromised due to black bird damage. Studies from 2008 consist of 15 trials (Figure 1). From these studies, control averaged 71% with nearly 50% of the trials having 75% control or better (Figure 1a). Only one test had a comparison of Karate® to Dermacor™ X-100, and Dermacor™ X-100 preformed slightly better than Karate®. Furthermore, throughout the southern US rice belt, efficacy has ranged from very good to excellent; in some cases, level of control (reduction in densities of weevil larvae) was >90%. As expected with good control, in 11 of the 15 trials, yields increased from 4.5-18.5% (Figure 1b). The average increase was 8%, but as high as 18.5%. There were four data points that ranges -1.9-0.5%; it is unclear why there was a slight yield loss or increase in yield for these trials. There could have been management issues that negated the benefit of using Dermacor™ X-100. Furthermore, similar results with Dermacor™ X-100 have been obtained in trials conducted in Arkansas, Louisiana, Mississippi, and Texas.

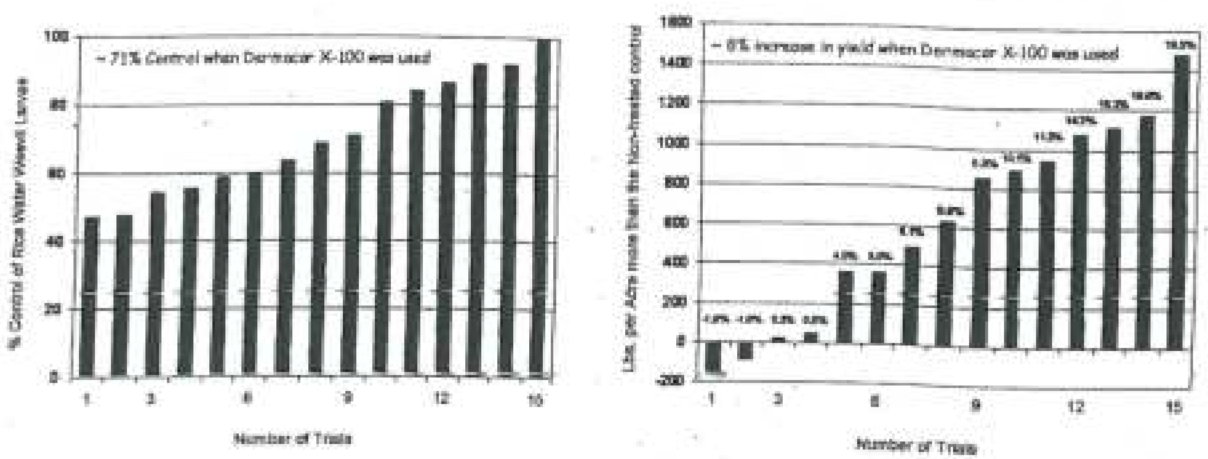


Figure 1. Summary of percent control of rice water weevil larvae (a) and the percent increase of yield (b) from 15 trials evaluating of Dermacor™ X-100 in Southeast Missouri in 2008.

Tadpole Shrimp in Missouri

In June of 2007, a single specimen was brought to the Delta Research Center in Portageville, for identification. The specimen was collected from a rice field near Bakerville. I mentioned this at the rice meeting and asked for people to get in touch with me if they encountered tadpole shrimp. In late May 2008, I received a call about a 40 acre field of water-seeded hybrid rice that had not emerged, located near Catron. The water was drained from the field and hundreds of thousands of tadpole shrimp were congregated in the remaining puddles. There was not a single viable seed found. The field had to be replanted. Another call was received in June about a field north and west of Catron in Stoddard County that was infested with tadpole shrimp.

Conversations with growers and consultants yielded additional data about the extent of the infestations. At least 4000 acres had tadpole shrimp present and of those infested, approximately 2000 acres were economically impacted. Infestations also caused approximately 100 acres to be replanted.

Hybrid varieties are planted at a lower seeding rate (30 lbs/A) than conventional varieties (100 lbs/A). Fields with hybrid varieties are more susceptible to damage. Plants are not more susceptible to tadpole shrimp damage, but the low seeding rate makes the losses more apparent than in a higher seeding rate. Loosing 10% of a stand planted at 30 lbs/A is more detrimental than loosing 10% of a stand planted at 100 lbs/A

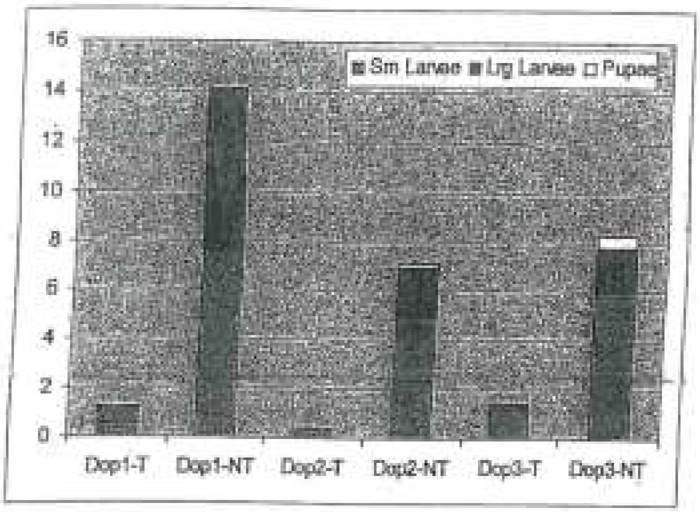
Tadpole shrimp are pests in California; however, they have not been previously documented to occur in rice production systems outside California. In California, water-seeding is the primary method of planting. Water-seeded systems that have problems with tadpole shrimp because eggs hatch once fields are flooded. Last spring, the Southeast region was wet and really set the stage for problems, which may mean in the future, wet springs may present similar problems for water seeded farmers. Immatures initially are filter feeders until they are large enough to feed on plant material. The smaller the plant when tadpole shrimp begin to feed on rice, the more damage is likely to occur; however, when rice plants emerge from the water surface, they can usually tolerate tadpole shrimp feeding. Drill-seeded and dry-seeded rice plants are large enough when fields are flooded; therefore, tadpole shrimp are not considered pests in dry-seeded systems.

When rice is no longer vulnerable to the tadpole shrimp, the tadpole shrimp can be a mosquito control agent and a weed control agent eating and/or uprooting weed seedlings. We still do not know the extent of the distribution in Missouri, but we know that it will only be a problem for water-seeded systems AND it may even be beneficial to farmers in drill-seeded systems and once plants have broken the surface in water seeded systems.

The Effects of Planting Date on Rice Water Weevil Counts

Kelly Tindall and Donn H. Beighley

When sampled three weeks after permanent flood was applied data from core samples showed that the early planted rice had more rice water weevil damage to it compared to the other planting dates three weeks after flood (Fig. X). However the effect is not seen four weeks after flood. It is likely that weevils are emerging at the time of flood of the early planted rice and the early planted rice represents only a small percentage of the rice available at the time. Therefore, rice water weevils are concentrated in the early planted rice. However, when rice is planted at the later planting dates, more acres of rice are available and, therefore, rice water weevils are more spread out over the rice acreage. Additionally, as rice is planted later, it is younger and more attractive to rice water weevils and egg lay continues over a longer time period than the earlier planted rice because it loses the attractiveness to weevils over time. If this above hypothesis remains true, the effect of planting date on rice water weevil will be different than that of other states that recommend planting early to avoid rice water weevil injury. More data is needed to confirm this.



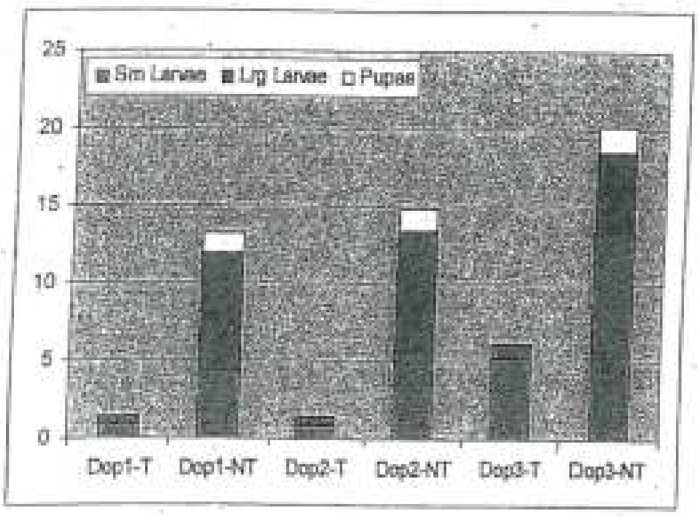


Figure X. Number of rice water weevil per core collected from treated (T) and non-treated (NT) plots from a date of planting (DOP) study three (top) and four weeks (bottom) after flood. DOP1 = Apr 16; DOP2 = May 1; DOP3 = June 5

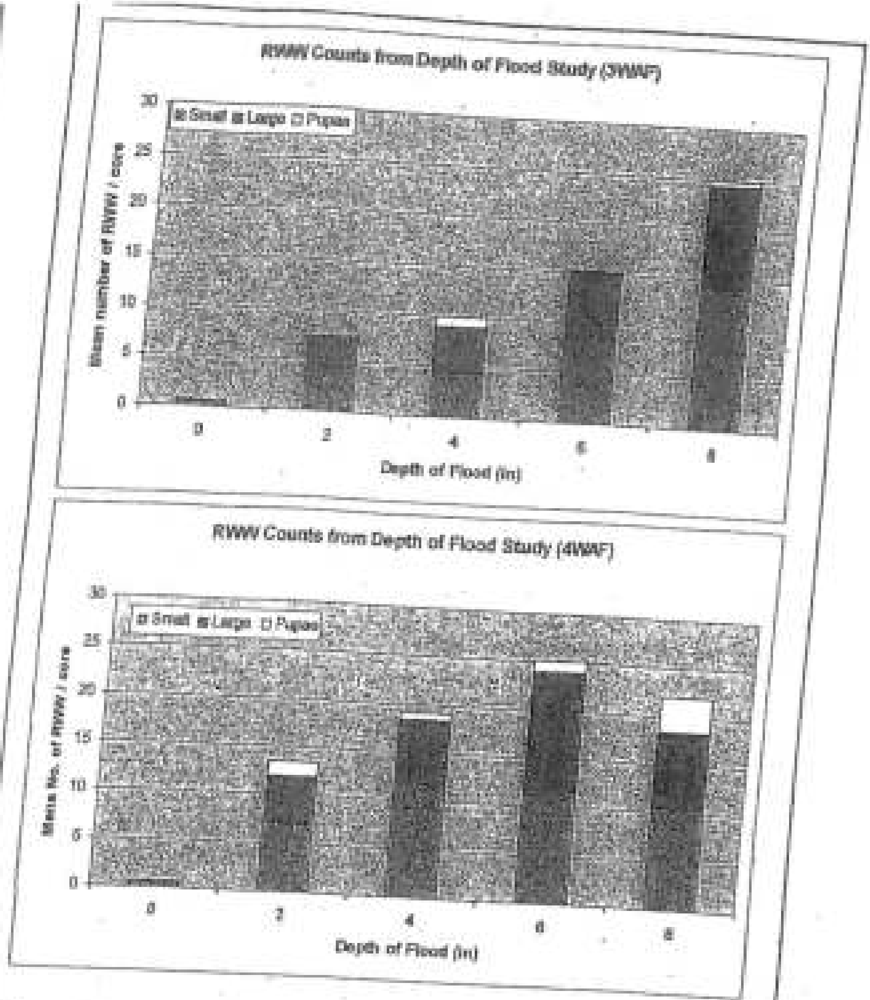


Figure X. Number of rice water weevil per core collected from a depth of flood study. Flood depths were 0, 2, 4, 6, 8 inches.

Vhile there were no significant differences, there is a trend to see fewer numbers of rice water weevil ırvae from plots with a shallow flood (Fig. X). This suggests some injury by rice water weevil may ; avoided by managing the depth of you flood. However, this practice may be problematic in keeping shallow flood because of evaporation. More work is need to determine how long a shallow flood ust be maintained to receive maximum benefit.

When sampled three weeks after permanent flood was applied data from core samples showed that the early planted rice had more rice water weevil damage to it compared to the other planting dates three weeks after flood (Fig. X). However the effect is not seen four weeks after flood. It is likely that weevils are emerging at the time of flood of the early planted rice and the early planted rice represents only a small percentage of the rice available at the time. Therefore, rice water weevils are concentrated in the early planted rice. However, when rice is planted at the later planting dates, more acres of rice are available and, therefore, rice water weevils are more spread out over the rice acreage. Additionally, as rice is planted later, it is younger and more attractive to rice water weevils and egg laying continues over a longer time period than the earlier planted rice because it looses it attractiveness to weevils over time. If this above hypothesis remains true, the effect of planting date on rice water weevil will be different than that of other states that recommend planting early to avoid rice water weevil injury. More data is needed to confirm this.

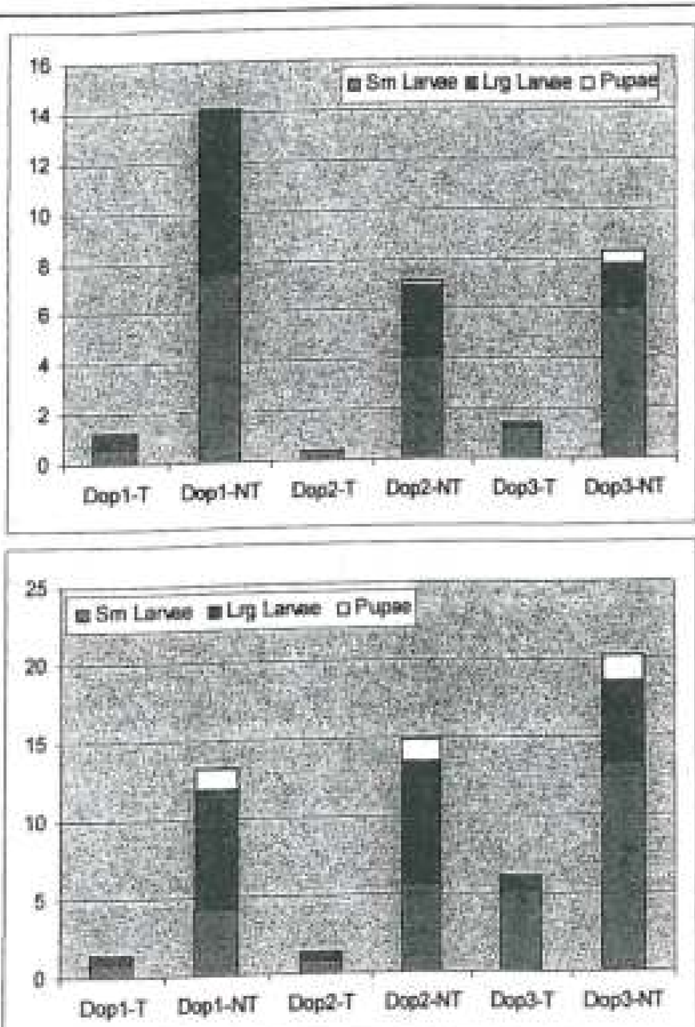


Figure X. Number of rice water weevil per core collected from treated (T) and non-treated (NT) plots from a date of planting (DOP) study three (top) and four weeks (bottom) after flood. DOP1 = Apr 16; DOP2 = May 1; DOP3 = June 5

2008 Missouri Rice Variety Performance Trials

Donn Beighley, Cathy Dickens, Randy Dickens,
Janet Dickens, Kelly Tindall,
Gene Stevens, David Dunn and Allen Wrather

In 2008 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 grown in the southeast Missouri environment.

Experimental Procedure

Location

Rice plots were established at two locations in 2008: 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 16 April, 6 May and 6 May, respectively on a Crowley silt loam. The plots at the Delta Center were drill seeded on 23 May on a Sharkey clay. The seed planted in the water seeded trial were treated with Apron-Maxim-Zinc for rice water weevils. The trial consisted of 24 public, private, and experimental varieties.

Field Plot Design

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 consisted of seven rows, 12 feet long, with a between-row spacing of 7.5 inches. The water seeded plot size was 12 foot long by 4.4 feet wide.

Entries

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

Plot Management

Plots were planted with an Almaco no-till plot drill. Pre-flood fertilizer was applied at a rate of 180 lb nitrogen. No adjustments in rates were made to meet specific requirements of individual varieties. 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 while Kincaid plot combine was used at the Delta Center. The grain from the plots was weighed and moisture was determined.

Data Recorded

Data 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

The Missouri Rice Variety Trials resulted in optimum yields for three of the four management practices they were tested under; while the yields in the conventional drill trial at the MO Rice Farm were low due to yield limiting plant stands as a result of cool early season growing conditions and some shattering due to high winds just prior to harvest. There were no diseases observed and no other problems were seen during the growing season.

Yield (Table 1, 2 and 3) Location Averages

The yields averaged 114, 174 and 199 Bu/A respectively for the conventional drill test (MO Rice Farm), continuous rice drill test (MO Rice Farm) and conventional drill test (UM Delta Center) while the water-seeded test (MO Rice Farm) averaged 138 Bu/A. The Delta Center yields were higher than expected as the plot area was not on newly cut ground and it was hard to maintain a consistent flood throughout the growing season. The water-seeded trial yields were higher than expected in light of higher lodging than observed in previous years.

Long Grain Type (Table 1)

Differences among varieties were observed across all trials. The top yielding line across all trials was RU0202195 followed by Cybonnet, Trenasse, and Cocodrie. In the conventional drill-seeded trial at the Missouri Rice Farm RU0603075 was the top yielding lines at 158 Bu /A followed by Cybonnet, Bowman and CL171-AR. In the conventional drill-seeded trial at the UM Delta Center Trenasse was the top yielding line at 225 Bu /A followed by RU0202195, Cheniere, and Cocodrie. In the continuous rice drill-seeded trial at the Missouri Rice Farm RT XL723 topped the test at 219 Bu/A followed by Cybonnet, RU0202195, and Cocodrie. The top yielding line in the water-seeded trial was RU0603075 at 176 Bu /A followed by CL171-AR, CL131, CL151 and RT XL723.

The only new long grain release was Catahoula which yielded 145 Bu /A across four locations.

Medium Grain Type (Table 1)

The top yielding line across all trials was Neptune, a new medium grain release, at 174 Bu/A followed by RU0002146, Jupiter and Bengal. Jupiter was the top line in the Missouri Rice Farm conventional drill-seeded trial (140 Bu/A). Neptune was the top line in the UM Delta Center conventional drill-seeded trial (240 Bu/A), Missouri Rice Farm water-seeded trial (159 Bu/A) and continuous rice drill-seeded trial (192 Bu/A).

Multiple Years (Table 2)

When comparing long grain varieties across 2007 - 2008 those drill-seeded varieties that yielded well were RU0202195, Trenasse and Wells followed by Cocodrie and RT XL723. Across multiple years, 2003 to 2008, Wells and Francis have been the best yielding varieties.

RU0002146 was the best medium grain variety in 2006 – 2008 in the drill-seeded trials and RU9902028 does yield significantly more than Bengal over years.

Days to Emergence (Table 3).

In 2008 the difference in number of days from planting to emergence between continuous rice water-seeded (9 days) and continuous rice drill-seeded emergence (23 days) was 14 days. Twenty three days were required for the MO Rice Farm trial to emerge while the Delta Center trial required nine days to emerge.

The Days to 50% Heading (Table 3).

Days to 50% heading was taken in all of the trials. The water-seeded trial required nine days fewer than the conventional drill-seeded trial, the continuous rice trial, and Delta Center drill-seeded trial. In the water-seeded trial the average number of days to 50% heading was 78 days and 87 days was the average for the other trials. The range of the difference between the different trials was 16 days. The average number of days to 50% heading observed for the varieties in the combined trials ranged from 72 days for Spring to 95 days for RU0603075.

Plant Height (Table 3)

The 2006 average plant heights were 37 inches for the MO Rice Farm, UM Delta Center drill-seeded trials and water-seeded trial and 41 inches for the continuous rice trial.

Lodging (Table 3)

Lodging averaged 60% in the MO Rice Farm trial, 20% in the continuous rice trial, 10% in the Delta Center trial and 70% in the water-seeded trial across all varieties.

Milling Quality (Table 1 and 3)

Average percent milling quality values across all trials was 73/66. The continuous rice trial had the lowest overall milling quality values at 73/64 and the UM Delta Center trial had the highest at 72/68. The MO Rice Farm averaged 73/65. In 2008 the differences between the three locations for percent total rice were small (1%) but larger (4%) for percent whole rice. The percent head yield scores in the ranged from 53 to 72, much higher than observed in previous years. The highest consistency across the different trials was observed in the medium grain types particularly the variety, Neptune, which had the same overall value as Jupiter and RU0002146. Francis had the lowest milling quality values across the different trials.

The higher milling quality values may have been the result of moderately cool drying conditions from September through the end of harvest.

Rice Disease Data

No significant disease symptoms were observed in 2008.

2008 Effect of Planting Date on Rice Varieties

Donn Beighley, Cathy Dickens,
Randy Dickens, Janet Dickens and Bruce Beck

In southeast Missouri there are a narrowing number 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. So 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 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: 16 April (mid-April), 1 May (early May), 21 May (late May), 5 June (mid to late June) and 16 June (late June). At each planting date there were six varieties that represent the major rice varieties grown in southeast Missouri as well as four experimental varieties. These varieties were: Catahoula, Francis, Jupiter, Neptune, Trenasse, and Wells.

Field Plot Design

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.

Entries

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

Plot Management

The drill plots were planted with an Almaco no-till plot drill. For primary weed control, 12 oz. Command was applied post plant, 4 qt. Duet and ¾ lbs. Facet herbicides 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 each planting date.

Data Recorded

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[1]. 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 2008 when the variety yields were averaged for each planting date it was observed that the late May planting date had the highest overall yields at 174 Bu/ A. It was followed by the mid-April (117 Bu/A), early May (115 Bu/A), and mid-June (114 Bu/A) Table 1. In three out of the four previous years the early April planting date resulted in the highest overall yields. However since we were unable to plant the early April date in 2008 we did not have this data. The trend has been observed that yields are lower at the mid-April planting date than either the early April or early May planting dates.

Across all planting dates Francis and Wells were the highest yielding long grain types (126 and 125 Bu/A, respectively) while Jupiter was the highest yielding medium grain type (145 Bu/A). Table 2.

When comparing variety differences at each planting date across years, Jupiter was the top yielding variety in mid- April (142 Bu/A), late May (189 Bu/A) and early June (127 Bu/A) Table 3.

Days to Emergence

The number of days from planting to emergence ranged from 24 days at mid- April to 6 days at the early June planting date. 15 fewer days, on average are required for days from planting to emergence when comparing mid April (24 day average) to mid June date (6 day average).

Neptune and Trenasse continue to have an emergence date that is about one day later than the average of the varieties at all planting dates.

Days to 50% Heading

The average number of days to 50% heading ranged from 79 days at early May up to 87 days at mid-April (Table 1). A similar trend was observed within varieties. Catahoula had the longest average period between emergence and 50% heading date (91 days) and Trenasse had the fewest (77 days) (Table 2).

Plant Height

When averaged across all varieties the plant height did not change noticeably mid- April to the later planted dates. Table 1. There was a similar trend for the individual varieties. Wells was the tallest varieties (42 inches) while Neptune was the shortest varieties (35 inches) when averaged across all planting dates.

Lodging

Lodging was not observed in any of the varieties in 2008.

Milling Yield / Quality

The percent head yield values for 2008 were noticeably higher than previous years and the percent total yield was about the same as observed in previous years. This may have been a result of the slow drying conditions that occurred due to the cooler than normal late season temperatures.

The highest overall milling quality was from the early May date (75/70) and the lowest was the mid-April date (71/65). Table 1.

Across varieties Neptune (76/72) had the highest average milling quality and Wells had the lowest average (75/61). The trend appears to be that the medium grain varieties consistently have the highest milling values across all planting dates and this trend is observed in most years. Table 2.

Summary

The results of the 2008 date of planting yield trials indicates that the late May planting did result in higher yields than later planting dates and that the mid-June yields were the lowest observed of all the planting dates.

The results of the milling quality analysis indicated that the early May date had the best values but there were no major differences trends observed between the early planting dates.

Table 1. 2008 Planting Date Agronomic Trait Averages

Planting Date	Bushels / Acre	Days to 50% Heading	Plant Height (IN)	Percent Lodging	Stand Count	% Total Yield	% Whole Yield
Mid April	117	87	39	7	14	71	65
Early May	115	79	38	6	14	75	70
Late May	174	83	42	2	30	76	69
Mid June	114	82	39	1	---	75	67

Table 2. 2008 Variety Averages Across Four Planting Dates

Variety	Bushels / Acre	Days to 50% Heading	Plant Height (IN)	Percent Lodging	Stand Count	% Total Yield	% Whole Yield
Catahoula	121	87	37	82	15	77	67
Francis	126	85	41	84	26	74	63
Jupiter	145	82	38	88	16	76	71
Neptune	134	83	35	84	21	76	72
Trenasse	117	77	42	79	15	74	65
Wells	125	85	43	84	23	75	61

Table 3. Grain Yield (Bu/A) over Planting Dates and Multiple Years

Variety	Mid-April		Early May		Late May		Mid-June	
	2008	2007 - 2008	2008	2007 - 2008	2008	2007 - 2008	2008	2007 - 2008
Francis	111	158	110	170	182	183	100	96
Jupiter	142	183	122	167	189	190	127	160
Trenasse	88	141	105	144	152	172	122	141
Wells	97	152	104	145	187	190	111	126
Average	110	159	110	157	178	184	115	131

2008 Effect of Flood Depth Study

Donn Beighley, Cathy Dickens,
Randy Dickens, Janet Dickens and Scott Wheeler

As rice production continues to increase in southeast Missouri the effects of different rice production practices are being 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. Within this trial we were able to evaluate the effect of flood depth on rice water weevil populations. 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 6 May on a continuous rice field. The trial consisted of four conventional varieties (Bengal, Francis, Trenasse and Wells) to determine if there were varietal effects due to flood depth.

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, 3 qt. Stam and ½ lb. Facet herbicides 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 harvested with a research plot combine. The grain 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, and yield 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

The average yield of the flood depth study at the MO Rice Farm was 191 Bu/A with the zero inch depth having the highest yield (204 Bu/A) followed by six inches, two inches, four inches and eight inches, respectively. There was not much difference in yield from zero to six inches but at the eight inch depth the yields dropped off by an average of 43 Bu/A. Table 1.

Across the different flood depths Wells had the highest yields (199 Bu/A) while Trenasse and Bengal had the lowest (187 Bu/A). Trenasse was the one variety that steadily decreased in yield as the flood depth increased.

There was a three day difference in number of days to 50% heading between the different flood depths. The average for zero inch flood was 82 days while the other depths averaged 79 days.

The average plant height was 41 inches and there as only a one to two inch difference between flood depths for plant height.

The percent lodging averaged less than 20 percent although there was a slight increase in lodging as flood depth increased.

The average percent whole kernel milling quality was 64 percent with little difference between the zero and six inch depth but the eight inch depth averaged a slight improvement to 66 percent.

Summary

The main effect of increasing flood depth was observed to on the final yield although small effects were observed for days to 50% heading and percent whole rice milling quality. Preliminary indications are that yields are highest at the zero flood depth and do not decrease appreciably until the flood depth approaches eight inches at which time yields did decrease by an average of 43 Bu/A.

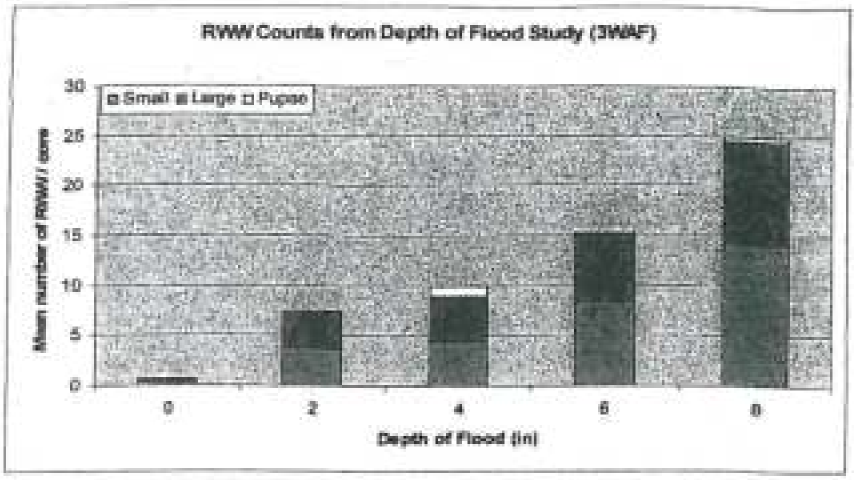
One noticeable difference between the zero flood depth and the other depths was the higher incidence of algae / scum in the alleys. There were definitely fewer weeds in the zero flood depth than the other depths. And the incidence of aquatic weeds appeared to greater as the flood depth increased.

Table 1.

2008 Effect of Flood Depth Study - Agronomic Data						
Flood Depth (Inches)	Bu/A	Days to 50% Heading	Plant Height (In)	Percent Lodging	% Total	% Whole
0" Flood Depth	204	82	41	10	74	64
2" Flood Depth	198	79	40	20	73	63
4" Flood Depth	197	79	41	20	75	63
6" Flood Depth	199	79	41	20	74	64
8" Flood Depth	156	79	42	30	75	66
Average	191	80	41	20	74	64

The Effect of Flood Depth on Rice Water Weevil Counts

Donn H. Beighley and Kelly Tindall



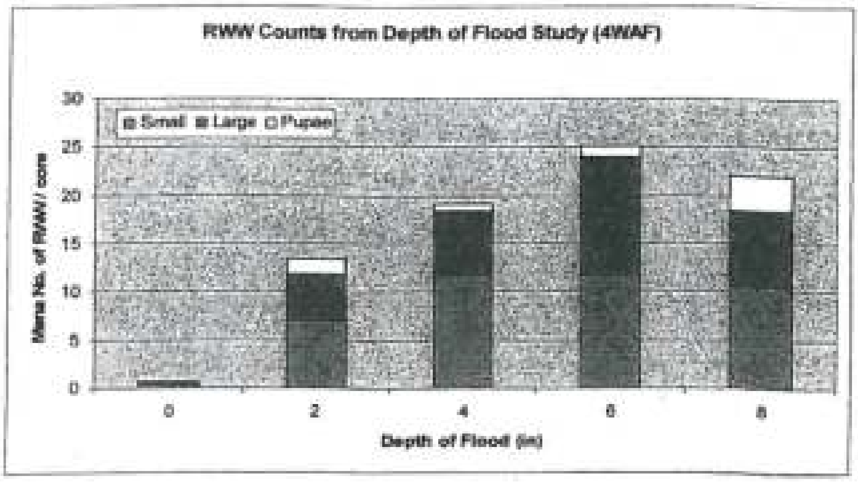


Figure X. Number of rice water weevil per core collected from a depth of flood study. Flood depths were 0, 2, 4, 6, 8 inches.

While there were no significant differences, there is a trend to see fewer numbers of rice water weevil larvae from plots with a shallow flood (Fig. X). This suggests some injury by rice water weevil may be avoided by managing the depth of the flood. However, this practice may be problematic in keeping a shallow flood because of evaporation. More research is needed to determine how long a shallow flood must be maintained to receive maximum benefit.

2008 Bayer Performance Trials

Donn Beighley, Cathy Dickens,
Randy Dickens, and Janet Dickens

As rice production continues to increase in southeast Missouri new varieties are continually being tested by the rice breeding community. The Bayer yield trials were conducted as a service to Missouri rice producers to provide a reliable, unbiased, up-to-date source of information for comparing private and public rice varieties grown in the Southeast Missouri growing environment.

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 16 April on a soybean rotation field and in the continuous rice field on 8 May. The trial consisted of one Bayer hybrid rice line, and three conventional lines.

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 120 lb nitrogen for the Bayer line and 180 lb nitrogen for the Horizon AG lines. A pre-boot application of 60 lb N was made to the Bayer lines. For primary weed control, 12 oz. Command applied post plant, 3 qt. Stam and ½ lb. Facet herbicides were applied prior to flooding. There were no insecticides applied. The flood was maintained throughout the growing season. The plots at both locations were harvested with a research plot combine. The grain 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, and yield 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

The average yield of the Bayer trial at the MO Rice Farm was 139 Bu/A with Arize 1003 leading the conventional management trial with 178 Bu/A and the continuous rice trial was 188 Bu/A with Wells leading the trial with 211 Bu/A.. The conventional trial check lines averaged 126 Bu/A while the continuous rice trial check lines averaged 194 Bu/A.. Table 1 and 2.

The milling quality values for percent head yield ranged from 60% to 72% with an average of 64%. The days to 50% heading ranged from was at 80 days (Jupiter) to 99 days for Arize 1003 with the test average of the trial 88 days. The percent lodging was 80% in the conventional trial and 20% in the continuous rice trial. The plant height of the lines ranged from 33 to 42 inches with an average of 39 inches. There was no disease observed during the growing season.

The new Bayer Agroscience hybrid, Arize 1003, displayed promise in its ability to tiller exceptionally well, yield well across locations and have acceptable milling quality. Its limitation is in the lateness with respect to days to 50% heading. Table 3.

Table 1.

2008 Bayer Yield Trial Agronomic Traits - Rice - Fallow Rotation						
Variety	Bu/A	Days to 50% Heading	Plant Height	Lodging	Total %	Whole %
Arize1003	178	99	37	9	73	60
Francis	118	90	40	9	74	61
Wells	105	91	37	8	74	61
Jupiter	154	86	33	5	76	69
Average	139	92	36	8	74	62

Table 2.

2008 Bayer Yield Trial Agronomic Traits - Continuous Rice Rotation						
Variety	Bu/A	Days to 50% Heading	Plant Height	Lodging	Total %	Whole %
Arize1003	170	90	43	3	73	60
Francis	188	83	41	2	74	66
Wells	211	84	41	2	76	66
Jupiter	182	80	39	1	76	72
Average	188	84	41	2	75	66

Table 3.

2008 Across Location Yields			
Variety	RF	CR	2008 Avg
Arize1003	178	170	174
Francis	118	188	153
Wells	105	211	158
Jupiter	154	182	168

Introduction

Continuous rice production in Missouri is a popular rotation system because of the higher production costs of other crops or inability to rotate particular fields. Producer experiences indicate that yields decrease after the first year of rice production when followed by rice in the same field. The cause of the yield decrease is not known nor what management practices can be taken to maintain yields for fields in continuous rice. Because continuous rice production is a practice already being used throughout southeastern Missouri, we seek to document the practice and propose possible yield protecting solutions through a multiple year research project.

Objective

The objective of this project was to determine the effect of rice diseases, insects, and soil fertility in continuous rice production in Missouri and to propose yield protecting solution to improve yields, milling quality and agronomic traits. An emphasis was placed on soil fertility.

MATERIALS AND METHODS

Drill-seeded, delayed flood continuous rice and soybean-rice rotation studies were conducted at the Missouri Rice Research Farm in fields that have been in continuous rice for four years and also previously planted to soybeans. Each plot consisted of seven rows of the rice variety 'Wells' planted in 12 foot long plots having seven-inch row spacing. A randomized complete block design consisting of three nitrogen rates (i)120, (ii) 150, (iii) 180 lbs N/acre as urea pre-flood and two rates of phosphorus-potassium (i) 0, and (ii) 66 lbs P_2O_5 and K_2O/acre using (4-24-24) were applied preflood. A post plant application of Command and an early post emergence herbicide (Stam and Facet) treatment was applied for weed control.

The physiology study consisted of estimating total nutrient uptake and plant biomass, which was performed by measuring nutrient concentrations at internode elongation and at harvest. Plant biomass was performed by weighing individual plants. Plot analysis will include estimates of (i) the date and extent of emergence, (ii) the degree of tillering, (iii) the date of panicle initiation and 50% heading, (iv) biomass accumulation, (v) nutrient accumulation based on plant tissue testing and biomass accumulation, (vi) and carbon partitioning in seed, (vii) plant height and lodging, and (viii) yield and milling quality. Seed weight per panicle (seed weight / head) was estimated by counting the number of seed per panicle and weighting the weed. Ten replicated per plot were performed

RESULTS AND DISCUSSION

Yield Components and Yields

Seed weights / panicle in the rice after soybeans trial were greater for the 150 and 180 lbs of N/acre treatments than the 120 lbs of N/acre treatment. Within the N treatments, no significant differences were observed because of P and K additions.

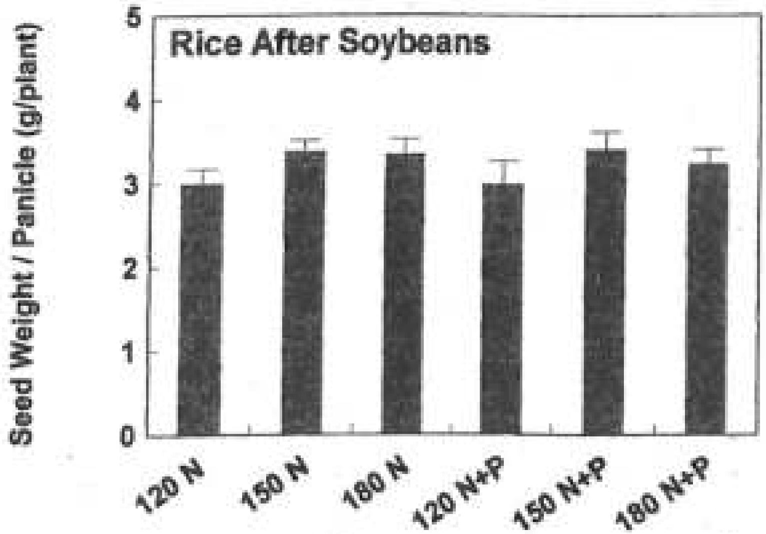


Figure 1. Seed weight / panicle for rice after soybeans

In general, seed weights / panicle were greater in the rice after rice trial than the rice after soybean trial. Seed weights / panicle in the rice after rice trial were not significantly different because of nitrogen treatments. Within a nitrogen treatment, P and K additions promoted greater seed weights / panicle for the 120 and 150 lbs N/acre treatments, whereas P and K treatments reduced seed weights / panicle at the 180 lbs N/acre treatment.

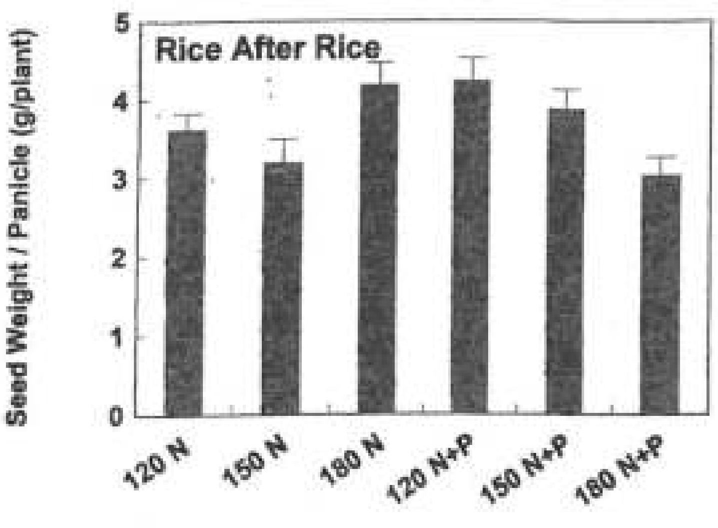


Figure 2. Seed weight / panicle for rice after rice

Yields of (i) rice after soybeans and (i) rice after rice were compared. The yields of rice after rice were greater than the yields of rice after soybeans. Low yields in the rice after soybeans are partially attributed to wind damage caused by remnants of Hurricane Ike that passed through southeast Missouri in September. Lodging and seed dislocation (shattering) occurred primarily in the rice after soybean treatment; however, both crop rotation treatments suffered some lodging and shattering. Rice yields were not significantly influenced by P and K additions, regardless of N treatments or the previous crop.

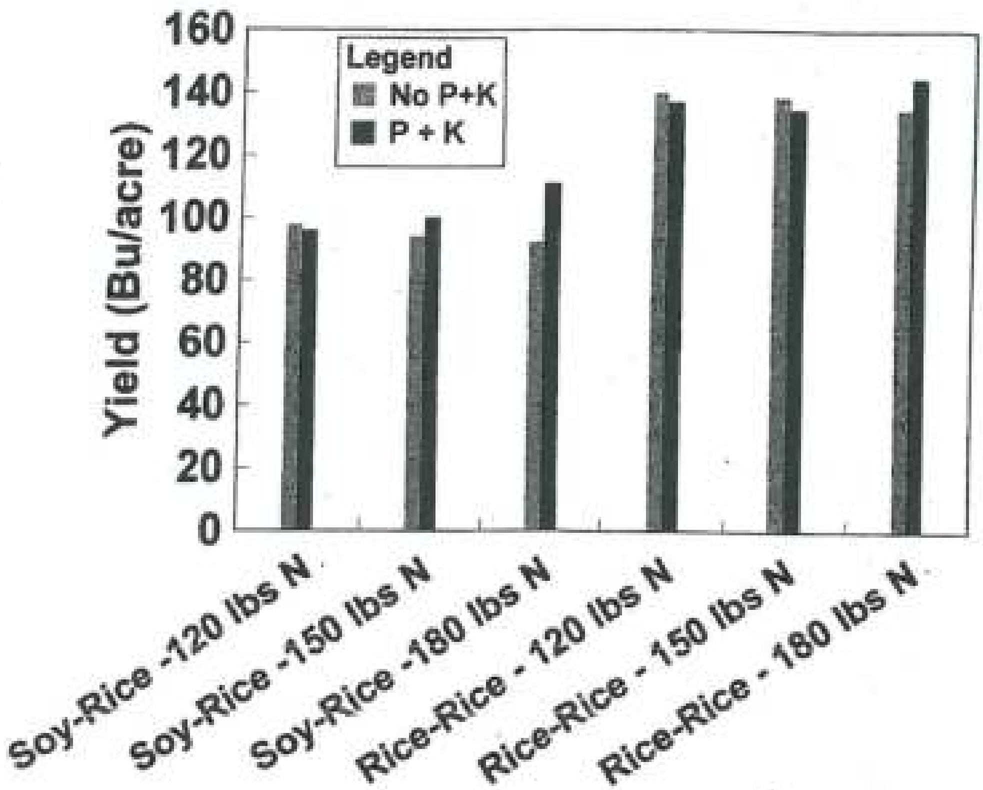


Figure 3. Rice yields for rice after soybeans and rice after rice.

Nutrient Uptake Patterns

Plant Tissue Analysis Prior to Internode Elongation

Plant tissue analysis just prior to internode elongation shows appropriate N, S, P, K, Mg, Ca, Fe, Mn, Cu, Zn and B concentrations for rice after soybeans (Table 1a) and appropriate P, K, Mg, Ca, Fe, Mn, Cu, Zn and B concentrations for rice after rice (Table 1b). Sulfur was slightly deficient and N showed slightly deficient concentrations at the 150 and 180 lbs N/acre rates in rice after rice. Smaller N concentrations at the higher N rates resulted in slightly greater biomass accumulations, which effectively diluted the N concentrations.

Potassium plant tissue concentrations were slightly greater because of P+K additions, but the differences were largely not significant. Phosphorus plant tissue concentrations were not significantly different because of P+K additions. In general, the plant tissue concentrations of S, Mg, Ca, Fe, Mn, Cu, Zn and B were not significantly different because of P+K additions.

Plant Tissue Analysis and plant Biomass Accumulations at Harvest

Plant tissue concentrations and the mean biomass accumulations for vegetation (stem (culm), leaves, and peduncle) and seed for (i) rice after soybeans and (ii) rice after rice are shown in Table 2. Nitrogen, P, K, Mg, Ca, Na, Fe, Mn, B, Cu, and Zn concentrations show dramatic differences between the vegetation and seed compartments, with the seed compartment showing greater concentrations of N, P, Fe, and Cu. Conversely, the vegetation shows greater concentrations of K, Mg, Ca, Na, B, and Zn. Sulfur concentrations were rather evenly distributed between the seed and vegetation.

Rice following soybeans showed greater N, Mg, Ca, Na, and Cu vegetation concentrations, whereas rice following rice showed greater P, K, and Mn vegetation concentrations. Seed concentrations showed that rice after soybeans had greater Mn and Zn concentrations, whereas all of the other nutrients showed no significant differences. The influences of P +K additions were largely not significantly different, especially for the seed component.

The ratio of N/K is significantly greater for rice following soybeans than rice following rice. A large N/K ratio is frequently associated with lodging, which corresponds with the lodging observed in the rice following soybean treatment.

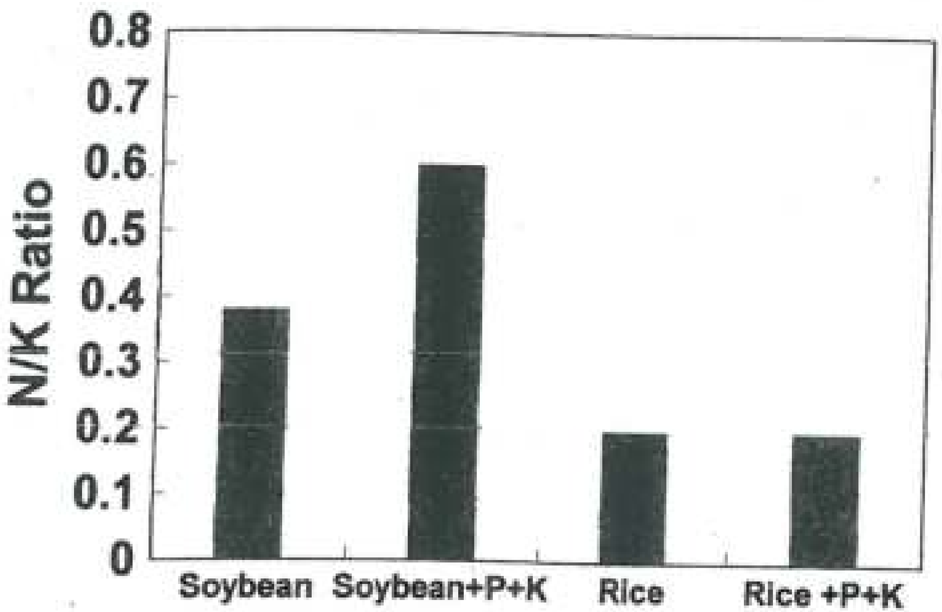


Figure 4. Nitrogen to potassium ratios for rice after soybeans and rice after rice.

Vegetative plant biomass was slightly greater for rice following soybeans than rice following rice, whereas total seed weight was slightly greater for rice following rice than rice following soybeans. The ratio of vegetation to seed weight was substantially greater for rice following soybeans.

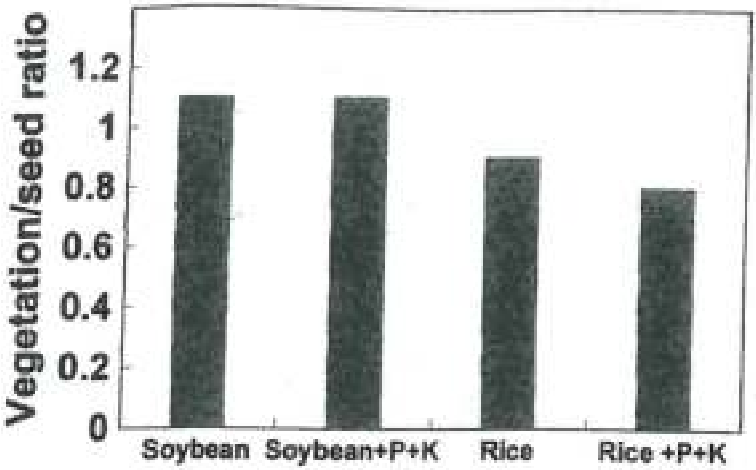


Figure 5. Vegetation weight to seed weight ratios for rice after soybeans and rice after rice.

The total nutrient mass was estimated on a per acre basis, illustrating that the straw residue is an important reservoir for selected plant nutrients (Table 3), especially potassium. Corresponding with the total nutrient uptake on an acre basis, the percent of each nutrient associated with the seed compartment, relative to the total nutrient uptake, is displayed in Table 4. Nitrogen, P, S, Fe, and Cu are preferentially accumulated in the seed and these nutrients are removed from the field during harvest.

Soil Phosphorus Differences

Soil analysis of selected plots demonstrated no significant differences in the Bray1-P soil analysis because of P and K additions.

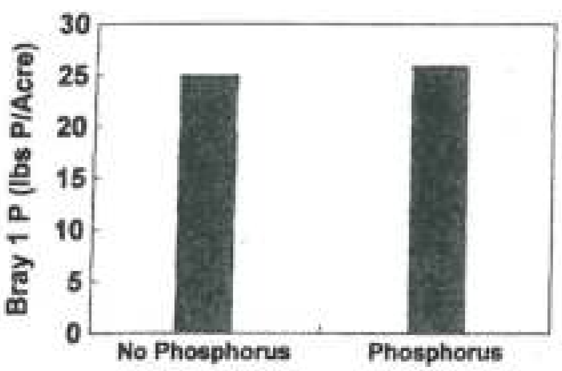


Figure 6. Bray1-P mean values comparing P+K additions.

CONCLUSIONS

The yields of rice were greater after a crop rotation involving continuous rice rather than soybeans. Unfortunately, lodging and seed shattering resulting from strong winds affected the yield results.

Nitrogen rates did not consistently influence rice yields and the low rate of 120 lbs N / acre appears acceptable.

Total nutrient uptake in the vegetation and seed shows how plant essential nutrients are partitioned in the rice plant. Potassium was shown to be substantially partitioned in the rice straw, illustrating the importance of residue decomposition for maintaining soil fertility.

REFERENCES

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.

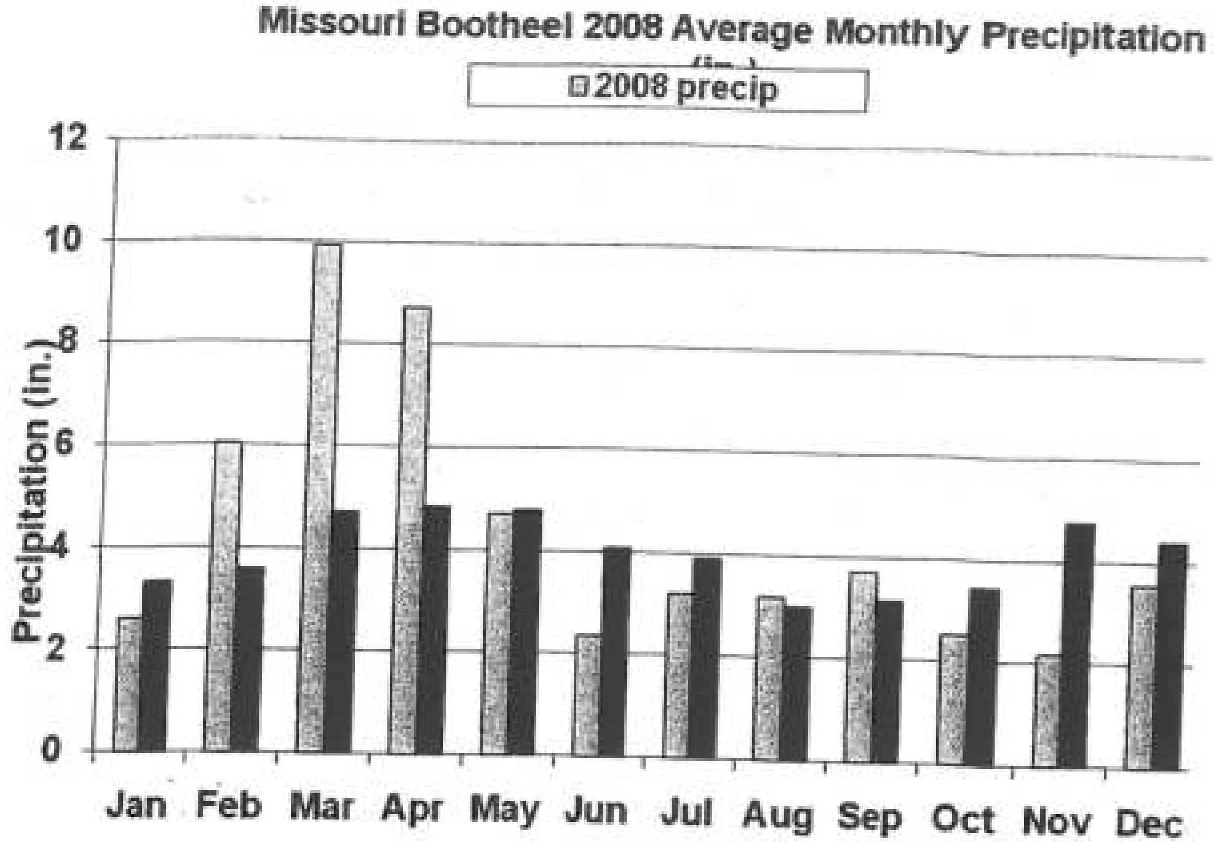
Table 1.

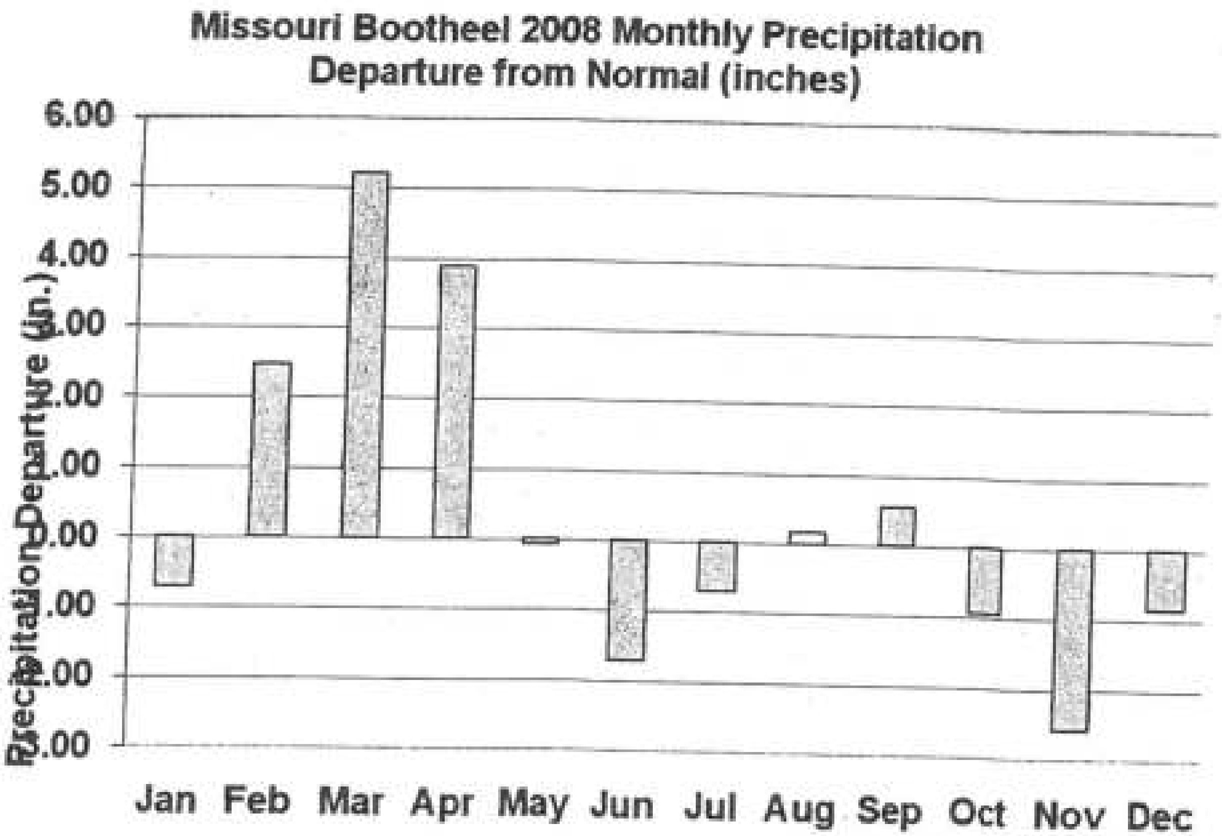
2008 Rice Variety Yield and Milling Quality Average									
	Bushels Per Acre					% Total Rice / % Whole Rice			
Variety	MO Rice Farm	Continuous Rice	Water-Seeded	UM Delta Center		MO Rice Farm	Continuous Rice	Water-Seeded	UM Delta Center
Bowman	135	134	146	166					
Catahoula	110	191	144	133		72/53	69/54	72/62	71/61
Cocodrie	111	198	122	217		77/66	74/62	76/67	75/67
Cheniere	103	138	132	218		75/65	74/65	74/68	74/69
CL131	108	185	158	168		75/63	74/64	75/64	75/68
CL151	121	169	157	187		77/67	74/64	75/69	76/72
CL161	122	152	149	151		75/66	72/60	74/66	69/68
CL171-AR	125	150	170	149		76/66	72/59	74/68	73/66
Cybonnet	135	215	144	166		76/67	75/64	75/68	73/67
Francis	118	172	115	212		74/64	75/65	74/68	74/67
Spring	58	141	113	174		72/58	73/62	74/65	71/64
Trenasse	119	178	127	225		74/69	74/66	74/66	73/66
Wells	93	177	139	188		72/60	72/60	73/64	72/61
RT XL723	91	219	150	145		74/58	74/59	74/63	73/62
RU0001108	110	177	142	202		73/57	74/60	74/64	74/67
RU0202195	113	205	143	223		75/63	73/62	75/65	72/67
RU0603075	158	195	176	197		72/63	73/65	75/68	74/70
						71/60	71/61	70/63	66/60
Jupiter	140	181	126	224					
Neptune	105	192	159	240		75/72	74/68	74/71	75/72
RU0002146	134	189	141	220		74/71	75/70	76/72	75/72
RU9902028	112	136	127	197		77/71	75/69	75/70	73/70
						75/70	74/71	75/69	77/74

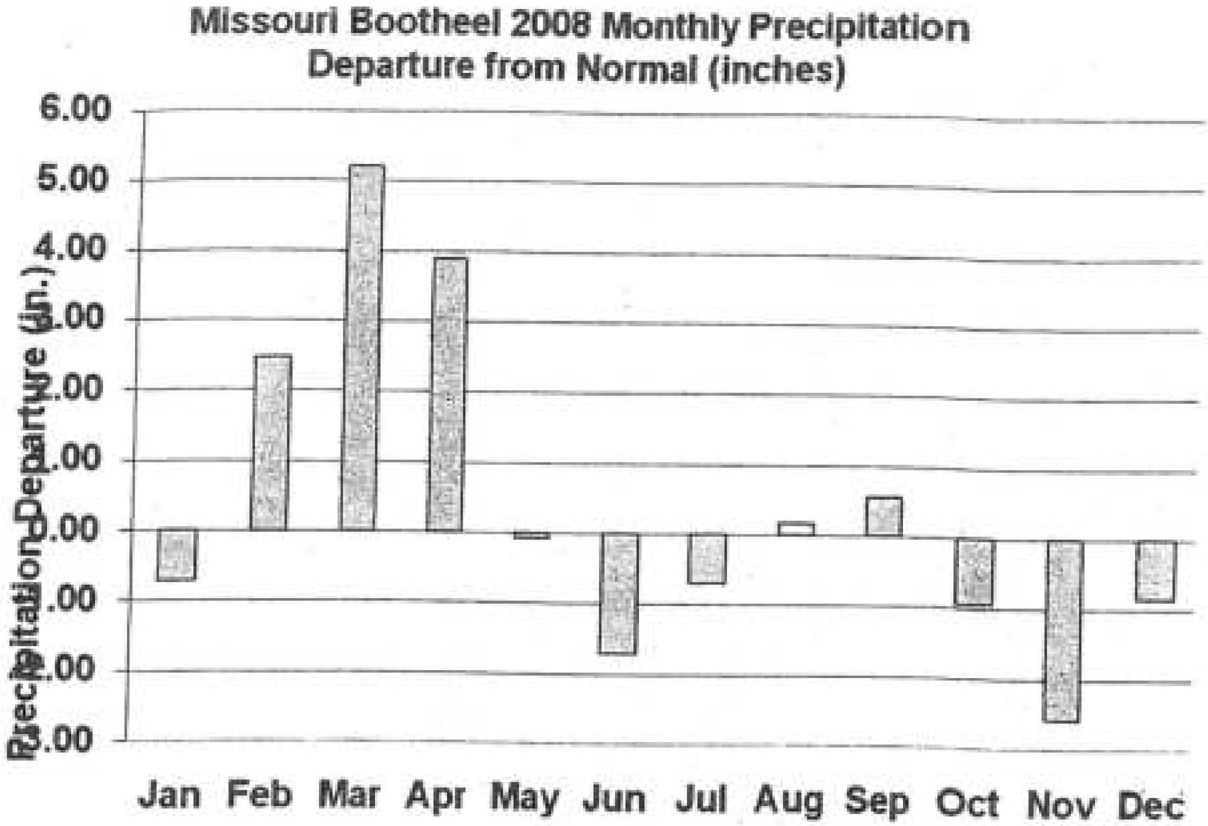
Table 3.

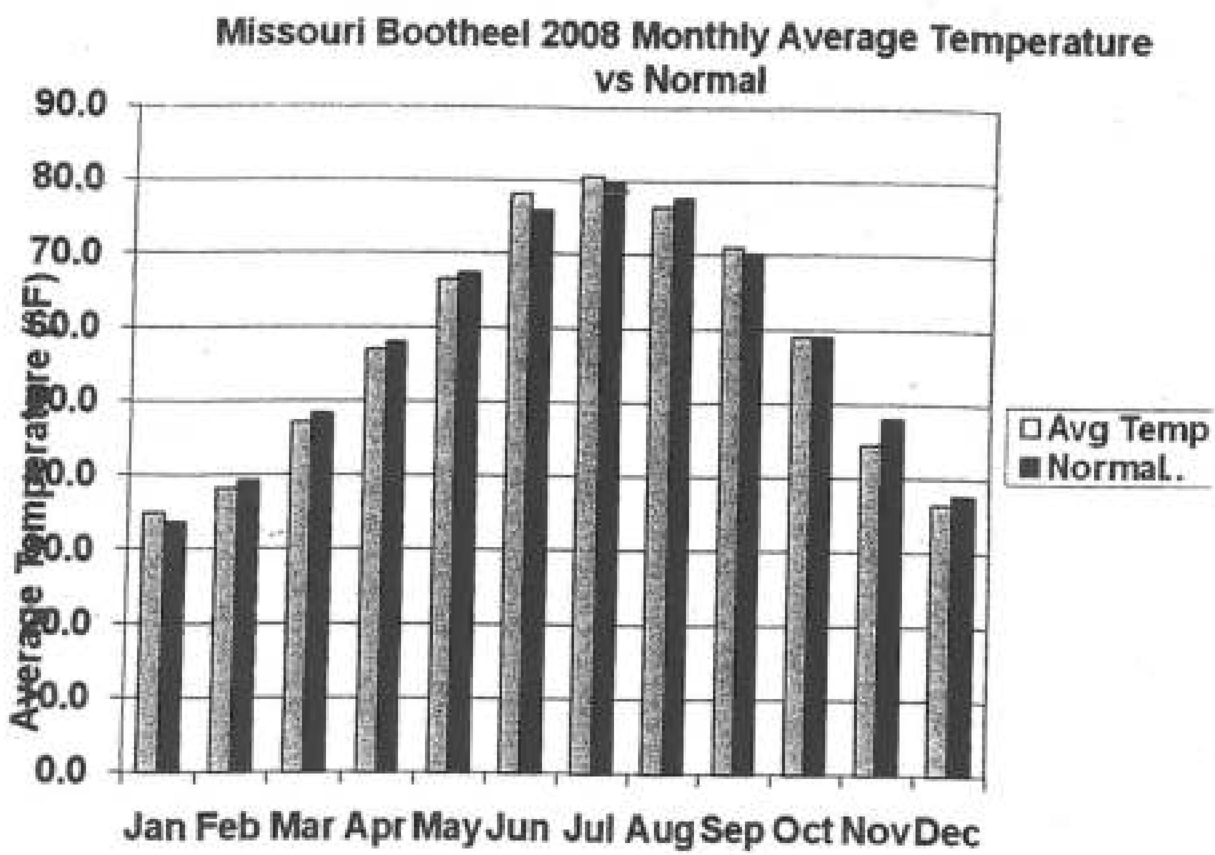
2008 Rice Variety Agronomic Data - Averaged Across Locations

Variety	Grain Type	Days to 50% Heading	Plant Height (IN)	Percent Lodging	Bushals / Acre	% Total Yield	% Whole Yield
Bowman	L	87	38	2	145	71	58
Catahoula	L	84	39	3	145	76	65
Cocodrie	L	84	42	3	162	66	67
Cheniere	L	84	36	5	148	74	64
CL131	L	84	36	3	154	75	68
CL151	L	82	39	4	158	73	65
CL161	L	89	39	4	144	74	65
CL171-AR	L	86	39	3	148	75	66
Cybonnet	L	84	39	4	165	74	66
Francis	L	84	40	5	154	73	62
Spring	L	76	40	5	122	74	67
Trenasse	L	77	40	5	162	72	61
Wells	L	86	41	5	149	74	60
RT XL723	L	81	42	3	151	74	62
RU0001108	L	82	41	5	158	74	64
RU0202195	L	82	37	3	171	74	66
RU0603075	L	91	40	3	181	70	61
Jupiter	M	82	37	4	168	74	71
Neptune	M	85	36	3	174	75	71
RU0002146	M	79	40	5	171	75	70
RU9902028	M	80	40	5	143	75	71


Missouri Bootheel 2008 Average Monthly Precipitation (in.)
2008 precip
Precipitation (in.)
12
10
8
6
4
2
0
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec


Missouri Bootheel 2008 Monthly Precipitation
Departure from Normal (inches)
Precipitation Departure (in.)
6.00
5.00
4.00
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec


Missouri Bootheel 2008 Monthly Precipitation
Departure from Normal (inches)
Precipitation Departure (in.)
6.00
5.00
4.00
3.00
2.00
1.00
0.00
-1.00
-2.00
-3.00
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec


Missouri Bootheel 2008 Monthly Average Temperature
vs Normal
Average Temperature (ºF)
90.0
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0.0
Avg Temp
Normal
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

Bootheel 2008 Weather Summary
Climate Division 6

Month	Total Precip (in.)	Normal (1971-2000)	Precip. Dept (in.)
Jan	2.61	3.33	-0.72
Feb	6.05	3.59	2.46
Mar	9.94	4.73	5.21
Apr	8.73	4.84	3.89
May	4.72	4.80	-0.08
Jun	2.36	4.08	-1.72
Jul	3.21	3.91	-0.70
Aug	3.19	3.02	0.17
Sep	3.72	3.16	0.56
Oct	2.53	3.46	-0.93
Nov	2.19	4.77	-2.58
Dec	3.57	4.42	-0.85
Ann	**52.82**	**48.11**	**4.71**

Month	Average Temp (°F)	Normal (1971-2000)	Temp Dept. (°F)
Jan	35.0	33.8	1.2
Feb	38.3	39.3	-1.0
Mar	47.2	48.4	-1.2
Apr	57.0	58.0	-1.0
May	66.5	67.4	-0.9
Jun	78.3	76.0	2.3
Jul	80.8	80.1	0.7
Aug	76.6	77.8	-1.2
Sep	71.1	70.3	0.8
Oct	59.0	59.0	0.0
Nov	44.6	48.0	-3.4
Dec	36.5	37.8	-1.3
Ann	**57.6**	**58.0**	**-0.4**