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:
Cathy Dickens
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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
March 3, 2010
Program

8:30 Rice Weed Control - Dr. Ford Baldwin, Practical Weed Consultants, LLC

9:15 Rice Insecticide Seed Treatments - Dr. Kelly Tindall, Entomologist, UMC - Delta Center

9:30 N-ST*R (Nitrogen Soil Test for Rice) – Dr. Richard Norman, Soil Scientist, U of A

10:00 Introduction of the New Rice Agronomist Dr. Won Kys Jung, UMC – Delta Center

10:10 Mid-morning Break

10:30 Growing Rice under a Center Pivot – Dr. Gene Stevens, Soil Scientist, UMC – Delta Center

10:45 Rice Varieties – Dr. Donn Beighley, Rice Breeder, Southeast Missouri State University

11:00 New Fertilizer Technologies – David Dunn, Soil Lab Director, UMC Delta Center

11:15 Bootheel Nutrient Management Committee – Scott Crumpecker, Bootheel RC and D Coordinator

11:30 Rice Market and Outlook – Dwight Roberts, President and CEO, US Rice Producers Association
Greg Yielding, Field Representative

12:00 Lunch - Provided by the Commercial Sponsors

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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
Arize QM1003	MR	R	VS	MR	MR	MR	MS	MS	MR	S	MR
Catahoula	VS	R	MS	S	MR	S	S	S	R	MR	MS
Cheniere	S	S	MS	S	S	S	S	S	R	MR	MS
CL111	VS	S	S	S	VS	VS	S	S	R	MS	S
CL131	VS	MS	VS	VS	VS	S	S	S	R	R	S
CL142	MS		MS	S	S	S	S	S	R	MS	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
CL171AR	VS	S	MS	S	MS	S	S	S	R	MS	S
CL181	VS	S	MS	VS	S	VS	S	S	R	MR	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
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 XL729	MS	MR	MR	MR	MS	MS	MS	S	R	S-MS	MS
RT CL XL730	MS	MR	MR	MR	MS	MS	MS	S	R	S-MS	MS
RT CL XL745	MS	R		MR	MS	MS	MS	S	R	S-MS	MS
RT XL723	MS	R	MR	MR	MS	MS	MS	S	R	MS	MS
Spring	S	MS	VS	S	MS	VS	MS	MS	R	S-MS	MS
Taggert	MS		R	MS	MS	S	S	S	R	MS	MS
Templeton	MS	R	S	S	S	MS	S	S	R	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	VS	S	MS	S	MS	MS	R	MR	MR

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

Data prepared by R.D. Cartwright, F.N.Lee Both of Plant Pathology

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

Variety/Hybrid	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.
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.
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 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 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 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 171 AR	2006 - BASF, 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 181 AR	2009 – BASF, Horizon Ag	A midseason, semi-dwarf, long grain Clearfield with good yield potential and milling quality.
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.

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, 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.
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.
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.
Spring	Experimental – Arkansas	A very short season, long grain with good yield potential under ideal conditions. It is susceptible to sheath blight, very susceptible to stem rot, prone to lodging and has variable rice blast resistance. It is one of the earliest maturing long-grain rice lines.
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.
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.

Rice Insecticide Seed Treatments

Dr. Kelly Tindall, Entomologist,
UMC Delta Center

There are several insects that can impact rice early season, including rice water weevil, grape colaspis, and rice seedling midge which feed on seeds and/or roots of young seedlings. These insects were effectively controlled by the seed treatment Icon in the late 1990's. Since the loss of Icon, control of rice water weevil and seedling midge was accomplished by the use of pyrethroid applications, but there were no effective means of control of grape colaspis. DuPont and Syngenta have been developing seed treatments for rice in recent years. Dermacor X-100 (DuPont) was available in 2008 and 2009 under a Section 18 in Missouri and other mid-southern rice producing states and a full label is expected soon. Cruiser (Syngenta) was available in Arkansas in 2009 under a Section 18; however, Cruiser has a full label for rice in mid-southern rice producing states for 2010. This report will review performance of the two products and results from multiple trials in Missouri, Arkansas and Mississippi.

Dermacor X-100 is effective at reducing damage from rice water weevil and armyworms, and it offers at least suppression of stem borers. In a summary of 80 trials conducted in Missouri, Arkansas and Mississippi, Dermacor had a 69% likelihood of having a positive net return (Figure 1). Yield increases ranged from -11 bu/A to 33 bu/A, and the average yield increase of was 8.9 bu/A.

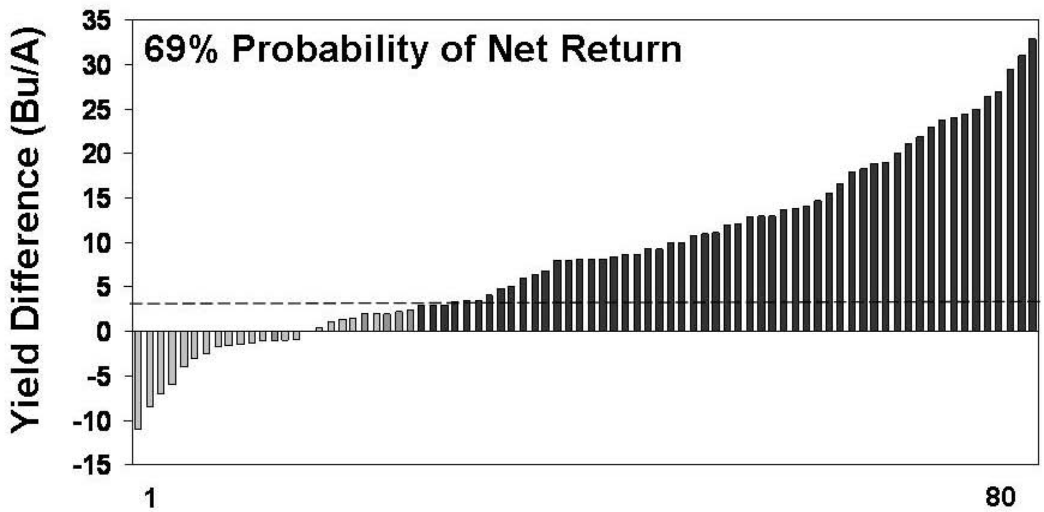

Figure 1. Performance of Dermacor X-100 on rice in 80 trials conducted between 2007-2009 in Arkansas, Missouri, and Mississippi. Dotted line denotes cost of product in bu/A. Figure developed by J. Gore, MSU.

Cruiser is effective at reducing damage from grape colaspis, rice water weevil and chinch bugs. In a summary of 60 trials conducted in Missouri, Arkansas and Mississippi, Cruiser had a 75% likelihood of having a positive net return (Figure 2). Yield increases ranged from -12 bu/A to 23 bu/A, and the average yield increase was 5.5 bu/A.

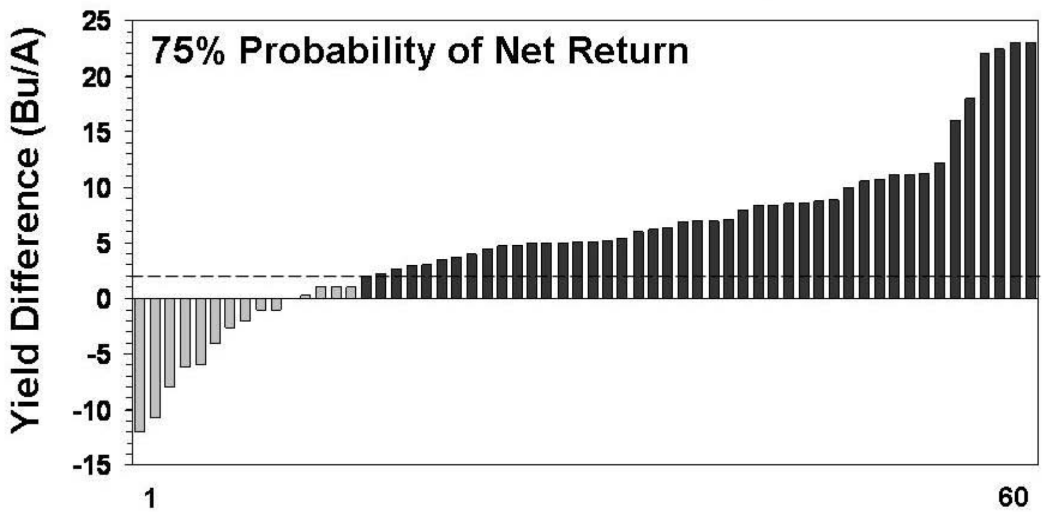

Figure 2. Performance of Cruiser on rice in 60 trials conducted between 2007-2009 in Arkansas, Missouri, and Mississippi. Dotted line denotes cost of product in bu/A. Figure developed by J. Gore, MSU.

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 these products in their ability to achieve rice yields in a dry seeded, delayed flood production system.

Methods and Materials

In 2008 and 2009 this evaluation was conducted on a Crowley silt loam soil located at the Missouri Rice Research Farm, Qulin, Missouri. Each year 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.

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.

In 2008 the N fertilizers were applied 7 days prior to flood establishment. In 2009 the N was applied 10 days before flood establishment. This year an additional treatment set was evaluated, 70, 105, and 140 lbs N/a, of urea applied one day before flood establishment. At season’s end each plot was harvested and the resulting rice yield was measured.

Results

Yield results from 2008 clay are given in Table 1, results for 2009 are given in Table 2 and the 2-year average yields are given in Table 3. For both years of the study and the two-year average the 140 lbs N rate produced the greatest yields when averaged for all products. For both years urea 10 days per-flood produced the lowest yields when averaged for all N rates. In 2008 when yield results were averaged for all N rates the urea + Agrotain® treatments produced the numerically greatest yields. In 2009 when yield results were averaged for all N rates the urea + NSN treatments produced the numerically greatest yield.

The environmental conditions found in 2008 and 2009 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 in bu/a for N treatments for a silt loam soil located at the Missouri Rice Research Farm, Qulin, MO, 2008

N rate	Urea 10 day pre-flood	Urea + Agrotain 10 day pre-flood	Urea + NSN 10 day pre-flood	Urea + Upgrade 10 day pre-flood	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	

Table 2. Average rice yields in bu/a for N treatments for a silt loam soil located at the Missouri Rice Research Farm, Qulin, MO, 2009

N Rate	Urea 1 day pre-flood	Urea 10 day pre-flood	Urea + Agrotain 10 day pre-flood	Urea + NSN 10 day pre-flood	Urea + Upgrade 10 day pre-flood	Average all products
0	102					
70	126	127	135	151	133	134
105	157	138	160	162	142	152
140	173	159	165	165	163	165
Average for N rates	152	141	153	159	146	

Table 3. Two-year average rice yields in bu/a for N treatments for a silt loam soil located at the Missouri Rice Research Farm, Qulin, MO, 2008 and 2009

N rate	Urea 10 day pre-flood	Urea + Agrotain 10 day pre-flood	Urea + NSN 10 day pre-flood	Urea + Upgrade 10 day pre-flood	Average for all products
0	104				
70	127	139.5	143	135	136
105	135.5	153.5	150	140.5	145
140	149	158	156.5	154.5	155
Average for N rates	137	150	150	143	

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 have 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 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.

The 2009 Effect of Planting Date on Rice Varieties

Donn Beighley, Cathy Dickens, and Trent Brewer

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: 7 April (early-April), 23 April (late April to early May), and 1 June (late May to early 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, Cheniere, CL111, CL151, CL171, Francis, Jupiter, Neptune, Taggart, Templeton, 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 and Horizon AG.

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 2009 when the variety yields were averaged for each planting date it was observed that the late April planting date had the highest overall yields at 190 Bu/ A. It was followed by the early-April (174 Bu/A), and and early-June (127 Bu/A) Table 1. In 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 2009 we did not have this data.

Across all planting dates Francis and Taggart were the highest yielding long grain types (182 and 182 Bu/A, respectively) while Neptune was the highest yielding medium grain type (195 Bu/A). Table 2.

When comparing variety differences at each planting date across years, Francis was the top yielding variety in early, Jupiter and Catahoula for late- April (174 Bu/A), while Wells was the top yielding in early June (135 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 two to three day later than the average of the varieties at all planting dates.

Days to 50% Heading

Across planting dates the average number of days to 50% heading ranged from 82 days at early June up to 98 days at early to mid-April (Table 1). A similar trend was observed within varieties. Taggart had the longest average period between emergence and 50% heading date (101 days) and Trenasse had the fewest (76 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. Taggart was the tallest varieties (46 inches) while Cheniere was the shortest varieties (37 inches) when averaged across all planting dates.

Lodging

Lodging was not observed in any of the varieties in 2009.

Milling Yield / Quality

The percent head yield values for 2009 were higher at the early April date and lower at the later planting dates as compared to previous years. The percent total yield was noticeably higher at the early date and about the same as observed in previous years at the other dates. 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 April date (77/69) and the lowest was the early June date (75/61). Table 1.

Across varieties Neptune (77/71) had the highest average milling quality and Wells had the lowest average (75/56). 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 2009 date of planting yield trials indicates that the late April planting did result in higher yields than later planting dates and that the early-June yields were the lowest observed of all the planting dates.

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

Table 1.

2009 Planting Date Agronomic Trait Averages

Planting Date	Days to Emergence	Days to 50% Heading	Plant Height (Inches)	Percent Lodging	Bu/A	% Whole Rice	% Head Rice
Early April	25	98	41	1	203	77	69
Late April	13	96	41	0	215	77	67
Early June	5	82	40	1	130	75	61

Table 2.

2009 Variety Averages Across Three Planting Dates

Variety	Days to 50% Heading	Plant Height (Inches)	Percent Lodging	Bu/A	% Whole Rice	% Head Rice
Catahoula	94	38	0	177	78	70
Cheniere	93	37	0	175	77	64
CL111	90	42	0	178	77	66
CL151	92	40	1	177	76	68
CL171	93	41	1	174	76	67
Francis	91	43	1	177	76	64
Taggart	96	46	0	195	75	56
Templeton	94	43	0	198	76	65
Trenasse	87	40	1	193	74	61
Wells	92	43	1	188	77	60
Jupiter	91	40	1	177	74	69
Neptune	92	38	0	191	77	71
	92	41	1	183	76	66

Table 3.

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

	Early April			Late April			Early June		
Variety	**2009**	**2008 - 2009**	**2007 - 2009**	**2009**	**2008 - 2009**	**2007 - 2009**	**2009**	**2008 - 2009**	**2007 - 2009**
Catahoula	205	158		214	161		111	111	
Francis	210	160	175	201	155	180	120	110	162
Trenasse	215	151	166	225	165	171	137	129	160
Wells	209	153	171	217	160	169	139	125	173
Jupiter	188	165	185	208	165	181	136	131	172
Neptune	203	166		221	185		147	126	
	205	159		214	165		132	122	

2009 Effect of Flood Depth Study

Donn Beighley, Cathy Dickens,
Trent Brewer 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 June 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 140 Bu/A with the four and six inch depth having the highest yield (152 Bu/A) followed by eight inches, zero inches, two inches, respectively. There was not much difference in yield from two to six inches but at the eight inch depth the yields dropped off by an average of 14 Bu/A. The zero inch depth was an average of 18 Bu/A less than the eight inch and 40 Bu/A less than the two to six inch depth. Table 1.

Across the different flood depths Catahoula had the highest yields (149 Bu/A) while Wells had the lowest (136 Bu/A). Trenasse was the most uniform across all depths except zero inches.

There was a three day difference in number of days (82 to 85 days) to 50% heading between the different flood depths.

The average plant height was 40 inches and there as only a one to two inch difference between flood depths for plant height for depths two to six inches.

The percent lodging averaged less than 10 percent although there was a slight increase in lodging as flood depth increased.

The average percent whole kernel milling quality was 72 percent with little difference any depth. There was not much difference between depths for percent head rice except the slight decrease at the eight inch depth.

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. 2009 preliminary indications are that yields are highest at the four and six inch 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.						
2009 Effect of Flood Depth Study - Agronomic Data						
Flood Depth (Inches)	**Bu/A**	**Days to 50% Heading**	**Plant Height (inches)**	**Percent Lodging**	**% Total Rice**	**% Head Rice**
0"	110	84	34	0	72	58
2"	150	84	39	0	72	58
4"	152	83	40	0	73	58
6"	152	85	40	0	73	59
8"	138	82	37	0	72	56
Average	140	84	38	0	72	58

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.

2009 Missouri Rice Variety Performance Trials

Donn Beighley, Cathy Dickens, Trent Brewer, Kelly Tindall,
Gene Stevens, David Dunn and Allen Wrather

In 2009 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 2009: 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 23 April, 3 June and 5 June, respectively on a Crowley silt loam.

The plots at the Delta Center were drill seeded on 1 June on a Sharkey clay and under the center pivot area on 19 May. The seed planted in the water seeded trial were treated with Apron-Maxim-Zinc for rice water weevils. The trial consisted of 30 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 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.

Entries

Seed of all public varieties were obtained from: Karen Moldenhauer / James Gibbons / Chris Deren– UA, Stuttgart, AR; Steve Linscombe – LSU, Crowley, LA; Anna McClung – USDA-ARS / Dante Tabien, Beaumont, TX; Dwight Kanter – MSU, Stoneville, MS, Bayer, 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. Adjustments in rates were made to meet specific requirements of individual varieties only of the Bayer line. 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

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 four of the five management practices they were tested under; while the yields in the water-seeded trial at the MO Rice Farm were low. Kernel smut was the only disease observed and no other problems were seen during the growing season.

Yield (Table 1) Location Averages

The yields averaged 173 Bu/A for the conventional drill test (MO Rice Farm), 141 Bu/A continuous rice drill test (MO Rice Farm), 175 Bu/A conventional drill test (UM Delta Center), and 159 Bu/A for the center pivot drill test while the water-seeded test (MO Rice Farm) averaged 48 Bu/A. The water-seeded trial yields were lower than expected in light of the later planting date of previous years.

Long Grain Type (Table 1)

Differences among varieties were observed across all trials. The top yielding line across all trials was CFX111 followed by Taggart, Francis, and Cocodrie. In the conventional drill-seeded trial at the Missouri Rice Farm Taggart was the top yielding lines at 211 Bu /A followed by RU0202195, CFX111, and Templeton. In the conventional drill-seeded trial at the UM Delta Center Mo0204044 was the top yielding line at 209 Bu /A followed by Mo0210055, Cocodrie, and Wells. In the continuous rice drill-seeded trial at the Missouri Rice Farm Cocodrie topped the test at 186 Bu/A followed by Rondo, Wells, CFX111. The top yielding line in the water-seeded trial was by Mo0204074 at 63 Bu /A followed by Mo0204034, CFX111, and CL151. The center pivot variety was Francis at 216 Bu/A followed by Taggart, Trenasse, and Cheniere.

The new long grain releases were Taggart and Templeton which yielded 159 and 147 Bu /A across five locations.

<u>Medium Grain Type (Table 1)</u>

The top yielding line across all trials was RU0002146, an experimental medium grain, at 161 Bu/A followed by Neptune, Jupiter and Bengal. Neptune was the top line in the Missouri Rice Farm conventional drill-seeded trial (211 Bu/A), RU0002146 was the UM Delta Center conventional drill-seeded trial (205 Bu/A) and the continuous rice drill-seeded trial (168 Bu/A) . Neptune was the top line in the Missouri Rice Farm water-seeded trial (63 Bu/A) while Jupiter was the top line in the Center Pivot trial (184 Bu/A).

<u>Multiple Years (Table 2)</u>

When comparing long grain varieties across 2007 - 2009 those drill-seeded varieties that yielded well were RU0202195, Trenasse and Wells followed by Cocodrie and RT XL723. Across multiple years, 2003 to 2009, Wells and Francis have been the best yielding varieties. RU0002146 was the best medium grain variety in 2006 – 2009 in the drill-seeded trials and RU9902028 does yield significantly more than Bengal over years.

<u>Days to Emergence</u> (Table 3).

In 2009 the number of days from planting to emergence for the continuous rice water-seeded (11 days) and continuous rice drill-seeded emergence (10 days). Fourteen days were required for the MO Rice Farm trial to emerge.

<u>The Days to 50% Heading</u> (Table 3).

Days to 50% heading was taken in only the MO Rice Farm trials. In the water-seeded trial the average number of days to 50% heading was 66 days, 84 days for the continuous rice trial and 95 days for the conventional rice trial behind soybeans. 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 74 days for Trenasse to 94 days for Arize1003.

<u>Plant Height</u> (Table 3)

The 2009 average plant heights across locations were 36 inches. Individual location plant heights were 39 inches for the MO Rice Farm, 37 inches for the continuous rice trial, 32 inches for the center pivot trial, and 38 inches for the UM Delta Center drill-seeded trial.

<u>Lodging</u> (Table 3)

Lodging averaged no lodging to 10% in all the trials across all varieties.

<u>Milling Quality</u> (Table 1 and 3)

Average percent milling quality values across all trials was 70/57. The continuous rice trial had the lowest overall milling quality values at 68/47 and the conventional rice trial had the highest at 74/66. The other averages were UM Delta Center (71/52), center Pivot (75/61) and water-seeded averaged 64/58. In 2009 the differences between the five locations for percent total rice were smaller than that of the difference between the percent whole rice.

<u>Rice Disease Data</u>

No significant disease symptoms were observed in 2009.

Table 1.

Variety	Bu/A 5x	50% 3x	PH 4x	Ldg	Smut 5x	Whole 5x	Head 5x
Catahoula	129	82	35	0	1	75	65
Cheniere	142	84	34	0	1	72	56
CFX111	159	80	35	0	1	72	59
CL151	135	81	37	0	1	73	60
CL171-AR	129	83	36	0	1	73	61
Cocodrie	151	81	35	0	1	74	62
Cybonnet	147	81	35	0	1	74	64
Francis	157	80	41	0	1	72	56
Jazzman	138	81	39	0	0	71	59
JES	113	82	33	0	0	69	52
Jupiter	137	82	36	0	0	73	59
Neptune	151	83	34	0	0	67	55
Arize1003	120	94	39	0	1	66	41
Spring	98	***	36	0	0	59	48
Rhondo	142	88	36	0	1	67	48
Taggart	159	86	42	0	0	71	50
Templeton	147	83	38	0	1	74	59
Trenasse	149	74	36	0	0	73	58
Wells	151	82	40	0	1	73	52
RU0002146	161	78	39	0	0	75	57
RU0202195	150	79	36	0	1	74	63
Mo0204044	139	76	35	0	1	75	61
Mo0204080	135	76	35	0	1	74	62
Mo0204074	151	79	36	0	1	74	61
Mo0204034	144	78	35	0	1	74	63
Mo0210055	138	79	32	0	1	74	62
Cypress	120	80	40	0	0	65	49
Bengal	126	84	38	0	1	59	56
Catahoula - D	130	84	35	0	1	60	52
Catahoula-MA	123	85	35	0	1	61	53
Tst Mn	139	79	36	0	1	70	57
Chk Mn	140	78	37	0	1	71	56
Exptal Mn	145	78	35	0	1	74	61

Table 2.

	09	09	09	09	09		09
Variety	**Mn Bu/A**	**Mn Bu/A**	**Mn Bu/A**	**Mn Bu/A**	**Mn Bu/A**		
	CP	**DC**	**WS**	**CR**	**RF**		**5 Loc**
Spring	128	149	22	66	127		98
JES	127	135	60	109	131		113
Arize1003	138	160	56	133	112		120
Cypress	131	159	25	134	151		120
Catahoula-MA	122	166	0	146	182		123
Bengal	168	159	28	114	160		126
CL171-AR	135	160	57	153	141		129
Catahoula	141	155	47	124	181		129
Catahoula - D	142	160	0	159	186		130
CL151	144	178	60	137	155		135
Mo0204080	144	191	55	127	160		135
Jupiter	188	157	42	114	186		137
Mo0210055	156	201	49	98	186		138
Jazzman	170	167	56	133	166		138
Mo0204044	162	209	46	113	164		139
Rhondo	161	157	45	177	170		142
Cheniere	185	165	49	134	179		142
Mo0204034	138	196	63	150	170		144
Cybonnet	184	173	55	162	161		147
Templeton	168	174	58	144	190		147
Trenasse	186	196	53	135	173		149
RU0202195	163	164	49	172	203		150
Wells	142	197	56	177	182		151
Neptune	169	203	63	108	211		151
Mo0204074	168	186	63	150	187		151
Cocodrie	141	198	59	186	171		151
Francis	216	165	50	163	189		157
Taggart	197	168	59	159	211		159
CFX111	177	190	63	173	193		159
RU0002146	173	205	58	168	202		161
Tst Mn	159	175	48	141	173		139
Chk Mn	163	171	53	141	170		140
Exptal Mn	158	193	55	140	182		145

Nitrogen and P+K fertilization in Rice in 2010

Michael Aide and Donn Beighley
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Objective:

The objective of this project was to determine the effect of soil fertility in rice production in Missouri and to propose solutions to improve yields, milling quality and agronomic traits, with a particular emphasis on nitrogen.

MATERIALS AND METHODS

Drill-seeded, delayed flood soybean-rice rotation studies were conducted at the Missouri Rice Research Farm in fields that have been 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 four nitrogen rates (i) 0, (ii) 120, (iii) 150 and (iv) 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 twenty individual plants per plot. Plot analysis included 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 seed. Ten replicated per plot were performed.

RESULTS AND DISCUSSION

Plant Tissue Analysis (i) Prior to Internode Elongation, (ii) Anthesis and (iii) Harvest

Prior to internode elongation, rice tissues were analyzed for N, P, K, Ca, Mg, S, Na, Fe, Mn, B, Cu and Zn (Table 1). Nitrogen and K were slightly deficient at each level of applied nitrogen, including 180 lbs N / acre. Sulfur plant tissue concentrations suggest mild deficiency, whereas Mn suggested surplus. The plant tissue concentrations of P, Mg, Ca, Fe, B, Cu and Zn are considered normal.

Plant tissue concentrations involving differences attributed to the P and K fertilization treatments were not significantly different for all of the nutrients, except sodium. Phosphorus and potassium fertilization suppressed Na uptake, suggesting that K effectively limits Na uptake. The untreated check (zero applied nitrogen) showed reduced Mg uptake and enhanced Ca uptake. Most likely, nitrogen assists the uptake of Mg (synergistic effect), whereas nitrogen promoted biomass accumulation that provided the appearance of an enhanced Ca uptake in the untreated check (dilution effect).

At anthesis, plant tissue concentrations demonstrated smaller concentrations of N, K and S when compared to the plant nutrient concentrations at internode elongation, features attributed to rapid early season nutrient uptake and subsequent biomass production (Table 2). Plant tissue concentrations involving differences attributed to the P and K fertilization treatments were not significantly different for the tested nutrients. The untreated check (zero applied nitrogen) showed enhanced Mg and Na uptake relative to the treatments receiving applied nitrogen fertilizer.

At harvest, plant tissue concentrations demonstrated substantially smaller concentrations of N, P and S, whereas K, Mg, Na, Fe, Mn, B, Cu and Zn demonstrated generally larger concentrations when compared to the plant nutrient concentrations at anthesis (Table 3). The plant tissue concentration reductions involving N, P and S may be attributed to rapid biomass production and nutrient partitioning into the developed seed, whereas plant tissue concentration increases involving K, Mg, Na, Fe, Mn, B, Cu and Zn may be attributed to their not being preferentially partitioned into the seed. Interestingly, the seed nutrient concentrations show considerable quantities of N and P, whereas the vegetation maintained greater concentrations of Na, Mn, B and Zn.

Plant Tissue Analysis and Plant Biomass Accumulations at Harvest

Plant tissue nutrient concentrations at harvest were interfaced with biomass accumulation to produce estimates of the nutrient uptake partitioned between seed and vegetation (leaves and culm). Root mass was not considered. Table 4 lists the nutrient partitioning estimates and Figures 1 to 8 display these values for treatments not receiving supplemental P+K for N, P, K, Ca, S, Na, Fe and Mn with applied nitrogen as the independent variable. Nitrogen, P, S, Fe and Mn were largely partitioned into the seed, whereas K, Ca, Na and Mn were not concentrated in the vegetations. Given that the seed is removed from the field and that the vegetation is returned to the soil, harvest removal rates are particularly important for N, P and S.

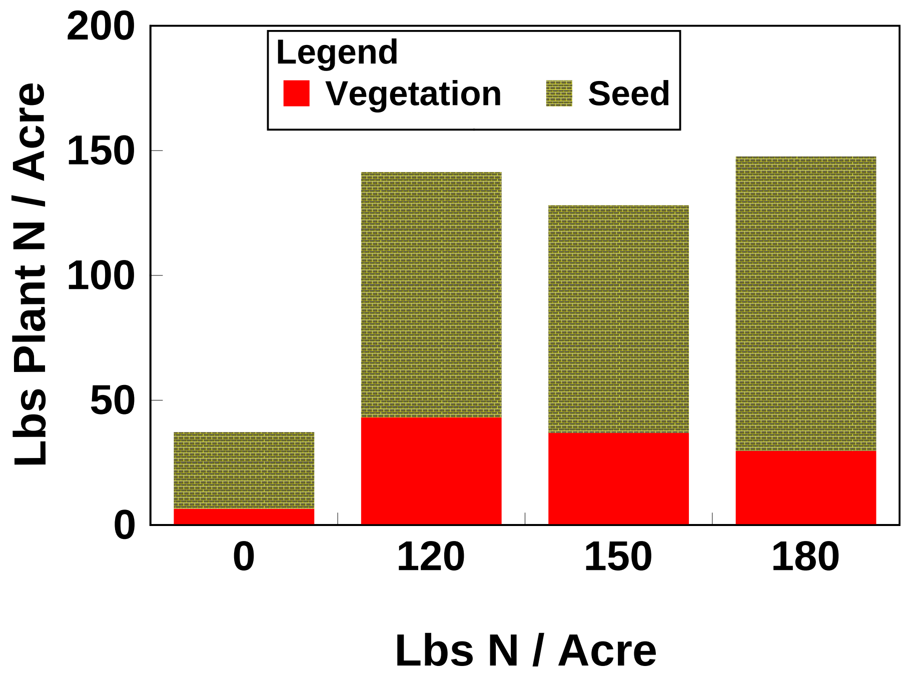


Figure 1. Nutrient uptake by plant yield component (nitrogen)

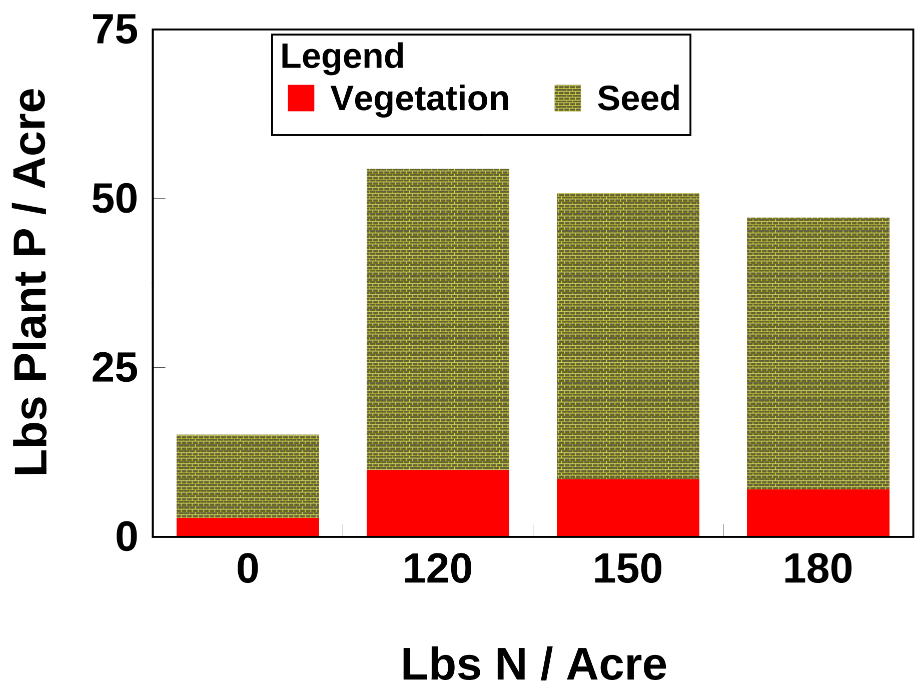


Figure 2. Nutrient uptake by plant yield component (phosphorus)

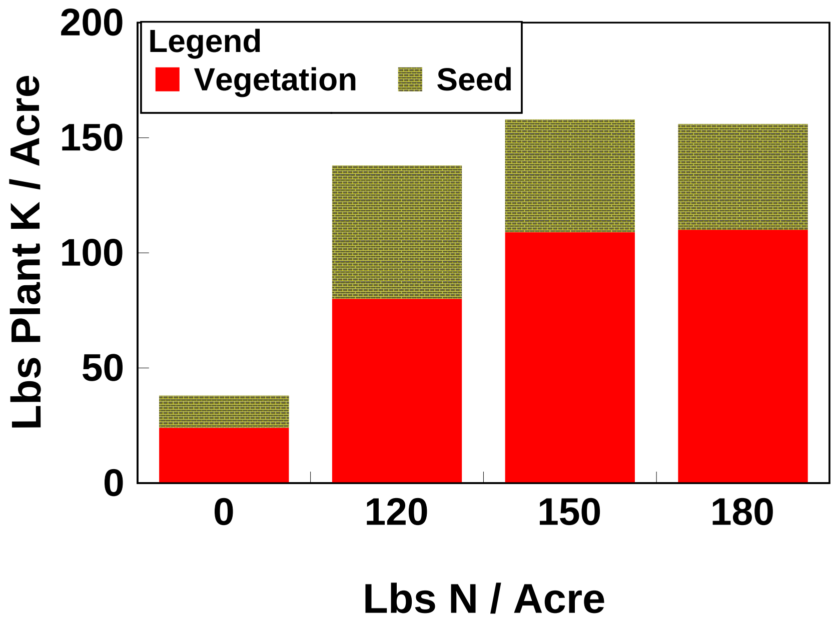


Figure 3. Nutrient uptake by plant yield component (potassium)

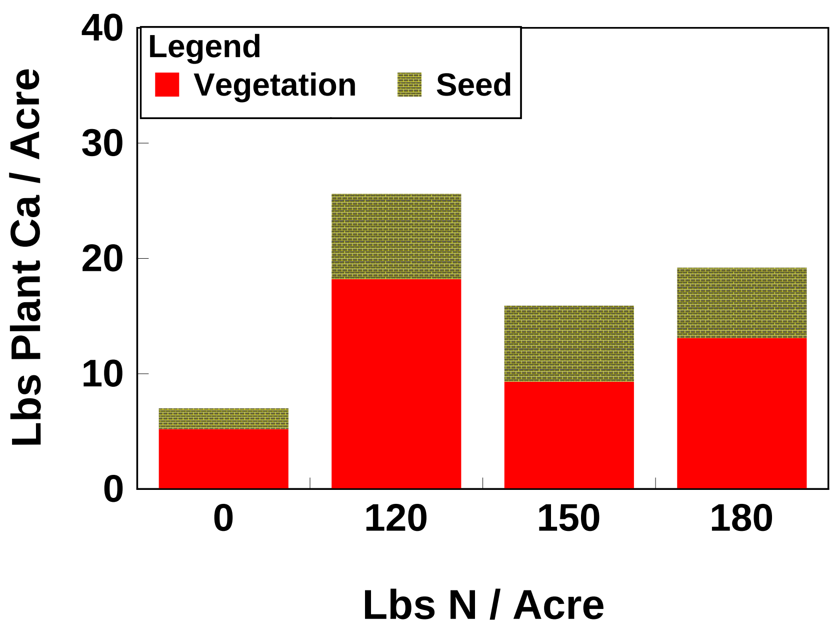


Figure 4. Nutrient uptake by plant yield component (calcium)

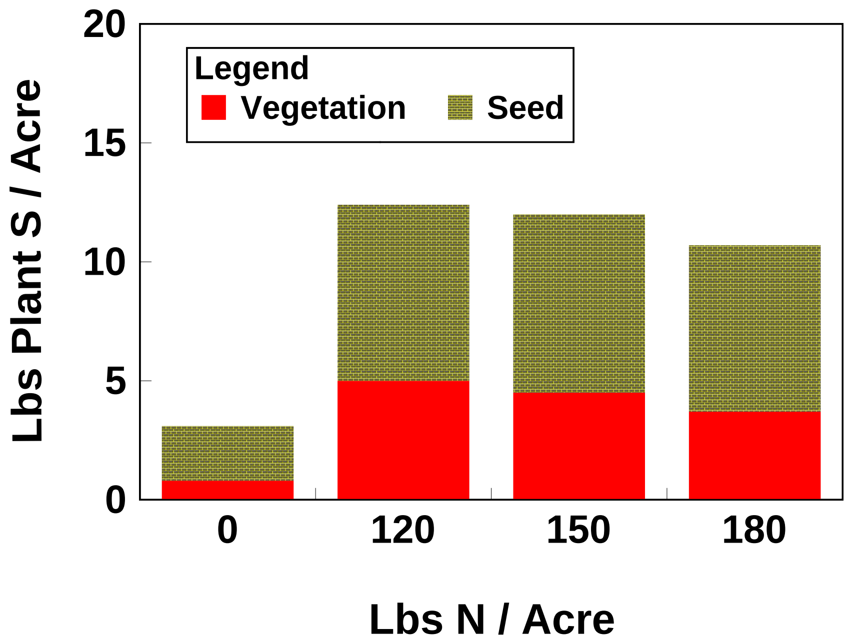


Figure 5. Nutrient uptake by plant yield component (sulfur)

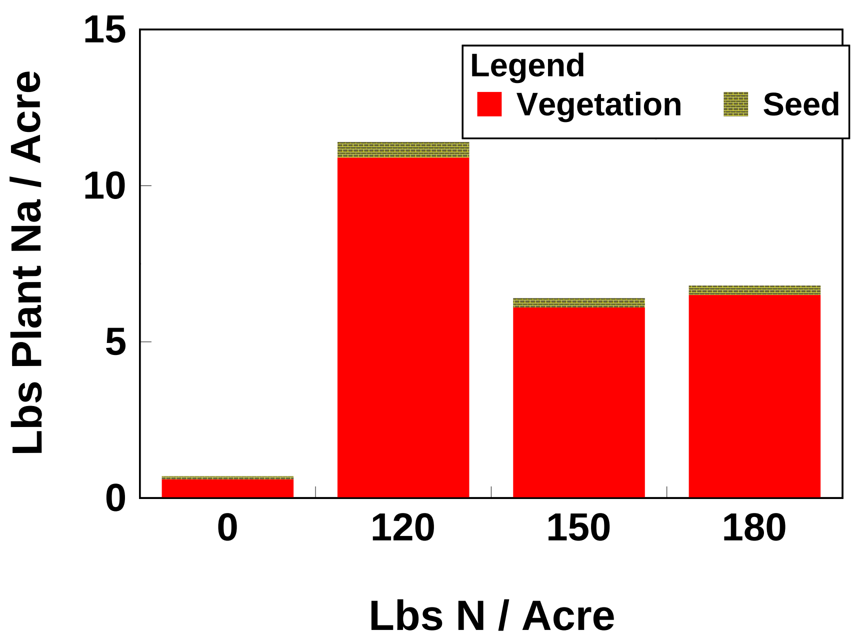


Figure 6. Nutrient uptake by plant yield component (sodium)

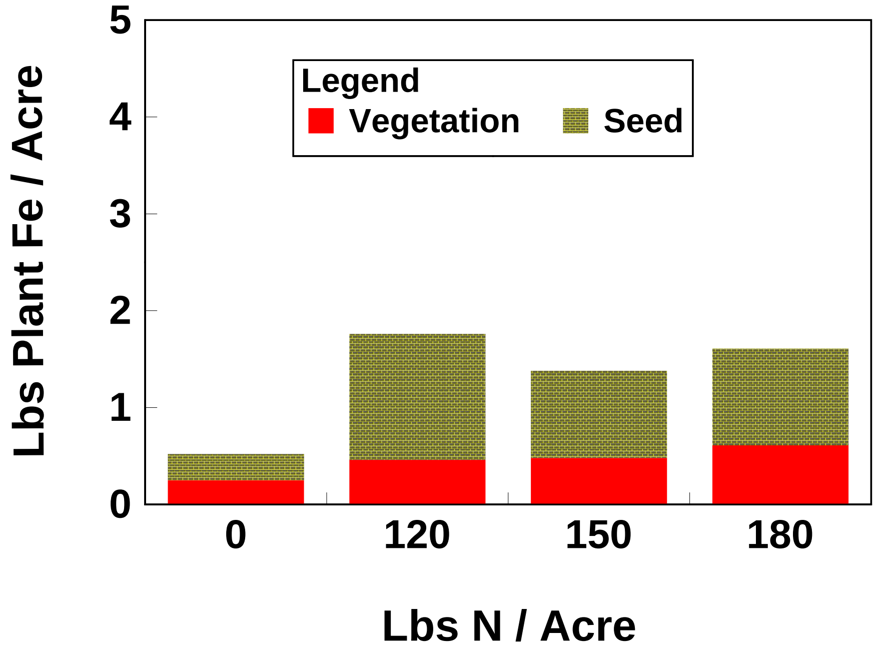


Figure 7. Nutrient uptake by plant yield component (iron)

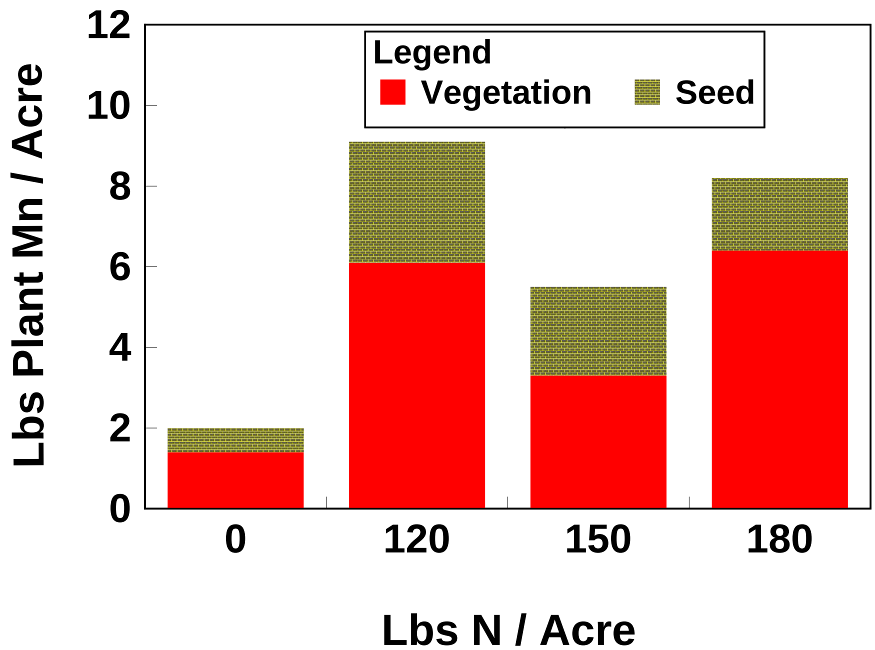


Figure 8. Nutrient uptake by plant yield component (manganese)

Yield Components and Yields

Seed size did not vary because of any treatment. The number of seed per panicle was greatest at the 120 lbs N/acre treatment, with the untreated check and the 150 and 180 lbs N / acre treatments having significantly smaller panicles. The lack of nitrogen for spikelet development in the untreated check and excessive tillering at the higher N rates may be casual factors. The number of seed per panicle did not show differences because of the P+K treatments. The ratio of the weight of the grain to the total plant mass was generally greater than 50% and differences attributed to the applied nitrogen treatment of the P+K treatment were largely non-significant.

Table 5. Yield components for 'Wells'

Nitrogen	Statistic	Seed/Panicle	Grain/Total	Seed/Panicle	Grain/Total
lbs N/acre		No P+K	No P+K	P+K	P+K
			percent		percent
0	mean	209	59	188	54
	standard dev.	72	3	83	7
120	mean	291	55	225	52
	standard dev.	82	6	54	9
150	mean	197	57	206	49
	standard dev.	89	17	67	2
180	mean	169	52	165	49
	standard dev.	30	6	51	2

Yields were dramatically different between the untreated check and the applied nitrogen treatments. The treatments involving P+K were largely non-significant.

Table 6. Yield			
		Bu/Acre	Bu/Acre
Nitrogen	Statistic	No P+K	P+K
lbs N / acre			
0	mean	63	66
	standard dev.	18	25
120	mean	206	216
	standard dev.	22	33
150	mean	209	199
	standard dev.	20	19
180	mean	194	190
	standard dev.	23	40

CONCLUSIONS

(1) Nitrogen applied at 120 lbs of N / acre is the optimum nitrogen rate.
(2) If soil test levels are adequate, supplemental P+K treatment does not provide a yield advantage.
(3) Nutrient harvest removal rates are greatest for N, P and S.

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. Plant tissue concentrations at internode elongation

Nitrogen lbs N / acre	Treatment P and K	N Percent	P Percent	K Percent	Mg Percent	Ca Percent	S Percent	Na Percent	Fe mg/kg	Mn mg/kg	B mg/kg	Cu mg/kg	Zn mg/kg
0	None	2.6	0.34	2.5	0.15	0.54	0.19	0.006	71	812	8	8	23
	Rate 1	2.6	0.34	2.5	0.17	0.59	0.19	0.006	71	889	6	7	21
120	None	2.6	0.37	3	0.22	0.29	0.18	0.124	76	833	7	6	35
	Rate 1	2.5	0.34	2.9	0.2	0.32	0.19	0.05	78	807	8	6	29
150	None	1.7	0.37	2.6	0.21	0.3	0.14	0.15	64	703	7	5	32
	Rate 1	2.5	0.33	2.8	0.2	0.28	0.17	0.097	149	729	7	6	32
180	None	2.6	0.42	2.2	0.23	0.3	0.19	0.37	98	757	7	5	41
	Rate 1	1.9	0.33	2.3	0.24	0.36	0.15	0.211	66	785	6	5	28

Rate 1 is 66 lbs (4-24-24)/acre

Typical values: N (3 to 4%), K (3 to 4%), P (0.25 to 0.30%), Mg (0.1to 0.4%), Ca (0.2 to 1.0%), S (0.25 to 1.0%), Fe (50 to 250 mg/kg=ppm), Mn (20 to 500 mg/kg), B (10 to 20 mg/kg), Cu (5 to 20 mg/kg) and Zn (25 to 150 mg/kg) after Havlin et al. (2005).

Table 2. Plant tissue nutrient concentrations post anthesis.

Nitrogen	Treatment	N	P	K	Mg	Ca	S	Na	Fe	Mn	B	Cu	Zn
lbs N/acre	P and K	--------------------------Percent----------------------							----------------mg/kg-----------------				
0	None	1.40	0.39	2.01	0.23	0.31	0.13	0.10	79	912	8.6	5.1	40
	Standard Dev.	0.25	0.04	0.12	0.04	0.05	0.02	0.12	16	190	0.9	0.6	10
0	Rate1	1.52	0.40	2.25	0.22	0.31	0.15	0.04	77	835	9.5	5.5	36
	Standard Dev.	0.44	0.07	0.23	0.04	0.07	0.03	0.06	17	202	2.2	1.2	8
120	None	2.16	0.29	2.31	0.13	0.29	0.15	0.005	56	456	8.0	5.0	25
	Standard Dev.	1.16	0.04	0.15	0.04	0.07	0.06	0.002	16	164	0.0	4.4	6
120	Rate1	1.83	0.32	2.24	0.16	0.35	0.14	0.004	50	571	7.0	4.7	28
	Standard Dev.	0.17	0.02	0.02	0.01	0.09	0.01	0.001	3	51	1.0	0.6	2
150	None	1.73	0.32	2.03	0.16	0.36	0.14	0.005	52	776	8.0	4.7	28
	Standard Dev.	0.42	0.03	0.2	0.01	0.03	0.02	0.002	8	222	1.0	0.58	4
150	Rate1	1.71	0.34	2.12	0.16	0.34	0.13	0.005	55	660	7.7	4.3	28
	Standard Dev.	0.14	0.04	0.11	0.01	0.04	0.01	0.002	9	93	2.1	0.6	1
180	None	1.94	0.36	2.11	0.19	0.37	0.15	0.024	69	729	9.0	5.0	43
	Standard Dev.	0.54	0.06	0.08	0.05	0.09	0.03	0.001	25	95	2.7	1.0	26
180	Rate1	1.92	0.37	2.32	0.18	0.36	0.15	0.013	63	786	8.7	5.0	32
	Standard Dev.	0.82	0.06	0.45	0.04	0.07	0.04	0.004	22	156	3.8	1.7	5

Table 3. Mean plant tissue nutrient concentrations at harvest.

Nitrogen	Treatment	N	P	K	Mg	Ca	S	Na	Fe	Mn	B	Cu	Zn
lbs N/acre	P and K	---------------------------Percent-----------------------							----------------mg/kg-----------------				
						Mean Vegetation							
0	None	0.56	0.24	2.10	0.16	0.45	0.07	0.05	216	1207	15	11	63
	Rate1	0.54	0.23	2.08	0.16	0.38	0.06	0.05	155	840	22	11	50
120	None	1.04	0.24	1.94	0.28	0.44	0.12	0.26	112	1473	16	7	32
	Rate1	0.91	0.2	3.15	0.23	0.25	0.14	0.21	137	1146	19	11	39
150	None	0.91	0.21	2.68	0.20	0.23	0.11	0.15	119	822	31	17	37
	Rate1	0.79	0.22	2.30	0.24	0.36	0.09	0.35	132	1601	8	2	47
180	None	0.72	0.17	2.66	0.19	0.32	0.09	0.16	148	1551	12	5	52
	Rate1	0.58	0.19	3.08	0.21	0.28	0.12	0.14	173	1383	7	7	294
						Mean Seed							
	Mean	1.08	0.43	0.50	0.19	0.06	0.08	0.004	96	219	6.2	4.2	28
	Standard Dev.	0.2	0.06	0.1	0.03	0.02	0.01	0.002	29	66	1.5	0.8	10

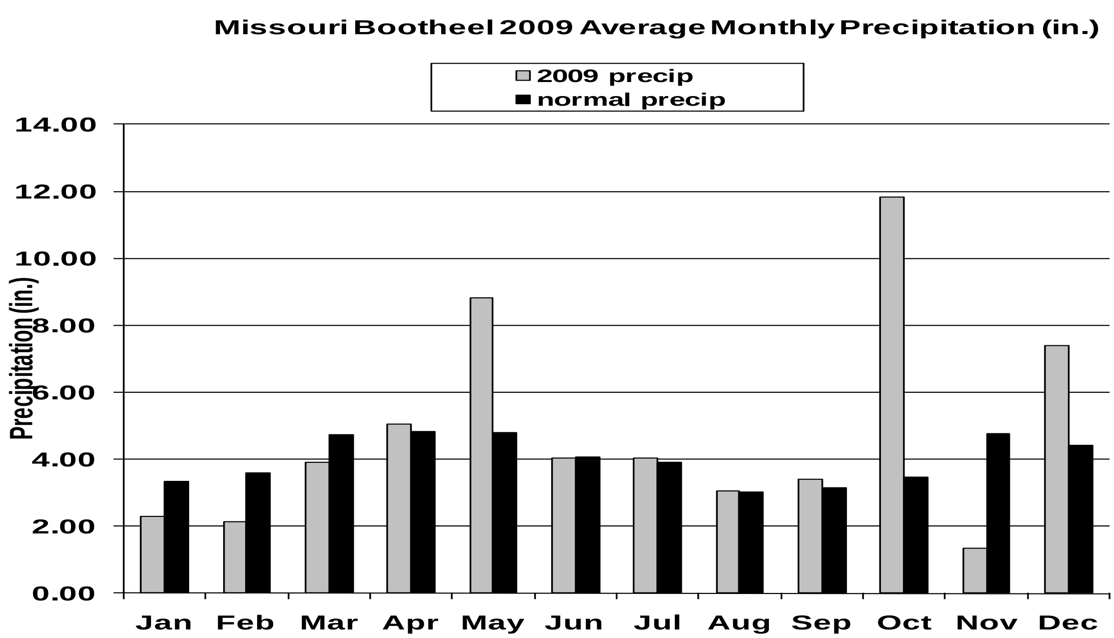
Table 4. Mean plant tissue uptake per acre.

Nitrogen	Treatment	N	P	K	Mg	Ca	S	Na	Fe	Mn	B	Cu	Zn
lbs N/acre	P and K	----------						lbs/acre					----------
						Mean Vegetation							
0	None	6.5	2.8	24	1.9	5.2	0.8	0.6	0.25	1.4	0.02	0.01	0.07
	Rate1	7.5	3.2	29	2.2	5.2	0.9	0.7	0.21	1.2	0.03	0.02	0.07
120	None	43.1	9.9	80	11.6	18.2	5.0	10.9	0.46	6.1	0.07	0.03	0.13
	Rate1	42.6	9.4	147	10.8	11.7	6.6	10.0	0.64	5.4	0.09	0.05	0.18
150	None	36.9	8.5	109	8.1	9.3	4.5	6.1	0.48	3.3	0.13	0.07	0.15
	Rate1	36.1	10.0	105	11.0	16.4	4.1	15.8	0.60	7.3	0.04	0.01	0.21
180	None	29.7	7.0	110	7.8	13.1	3.7	6.5	0.61	6.4	0.05	0.02	0.21
	Rate1	25.1	8.2	134	9.1	12.1	5.2	6.2	0.80	6.0	0.03	0.03	1.27
						Mean Seed							
0	None	30.7	12.3	14	5.3	1.8	2.3	0.1	0.27	0.6	0.02	0.01	0.08
	Rate1	32.1	12.9	14.8	5.6	1.9	2.4	0.12	0.27	0.7	0.02	0.01	0.1
120	None	98.3	44.5	57.5	20.4	7.4	7.4	0.5	1.3	3.0	0.1	0.03	0.3
	Rate1	94.3	36.9	37.9	14.6	3.9	6.8	0.2	0.6	1.7	0.05	0.04	0.24
150	None	91.2	42.3	49	19	6.6	7.5	0.3	0.9	2.2	0.05	0.05	0.3
	Rate1	85.9	31.3	33.1	12.5	3.6	8.1	0.2	0.5	1.1	0.04	0.04	0.26
180	None	118	40.2	45.4	17.5	6.1	7.0	0.3	1.0	1.8	0.05	0.03	0.30
	Rate1	100	41.0	47.9	18.0	6.8	7.7	0.5	1.0	2.1	0.07	0.04	0.25

Bootheel 2009 Weather Summary
Climate Division6

Month	Total Precip (in.)	Normal (1971-2000)	Precip. Dept (in.)
Jan	2.30	3.33	-1.03
Feb	2.14	3.59	-1.45
Mar	3.91	4.73	-0.82
Apr	5.06	4.84	0.22
May	8.83	4.80	4.03
Jun	4.03	4.08	-0.05
Jul	4.04	3.91	0.13
Aug	3.07	3.02	0.05
Sep	3.42	3.16	0.26
Oct	11.84	3.46	8.38
Nov	1.35	4.77	-3.42
Dec	7.40	4.42	2.98
Ann	**57.39**	**48.11**	**9.28**

Month	Average Temp (°F)	Normal (1971-2000)	Temp Dept. (°F)
Jan	33.1	33.8	-0.7
Feb	42.1	39.3	2.8
Mar	50.7	48.4	2.3
Apr	58.0	58.0	0.0
May	67.3	67.4	-0.1
Jun	78.9	76.0	2.9
Jul	76.3	80.1	-3.8
Aug	75.3	77.8	-2.5
Sep	71.0	70.3	0.7
Oct	55.0	59.0	-4.0
Nov	52.8	48.0	4.8
Dec	35.9	37.8	-1.9
Ann	**58.0**	**58.0**	**0.0**



Extension Commercial Agriculture Automated Weather Station
Rice Farm (1 mile east of Glennonville, MO)
Monthly Weather Summary
Year: 2009

	Temperature (°F)								Precipitation (In.)	
	Avg Max.	Avg Min.	Avg	Departure	Days ≥90°	Days ≥100°	Days ≤32°	Days ≤0°	Total	Departure
January	42.5	25.3	33.7	0.4	0	0	27	0	2.03	-1.00
February	51.8	34.3	42.7	4.4	0	0	14	0	2.68	-0.51
March	61.2	41.8	51.4	4.0	0	0	6	0	2.59	-2.14
April	68.5	48.4	58.2	0.2	0	0	0	0	5.77	1.16
May	76.8	58.7	67.8	0.1	0	0	0	0	7.54	3.02
June	89.7	68.5	79.0	2.4	16	0	0	0	2.67	-1.08
July	85.4	67.2	76.3	-4.3	6	0	0	0	4.88	1.19
August	85.5	65.0	74.9	-3.3	5	0	0	0	2.26	-0.21
September	81.3	61.9	70.8	0.0	0	0	0	0	2.19	-0.91
October	65.3	47.1	55.8	-3.6	0	0	0	0	11.84	8.38
November	63.5	42.4	52.3	4.4	0	0	1	0	1.56	-2.85
December	43.4	29.9	36.2	-1.2	0	0	23	0	7.29	3.12
Year	67.9	49.3	58.3	0.3	27	0	71	0	53.30	6.91