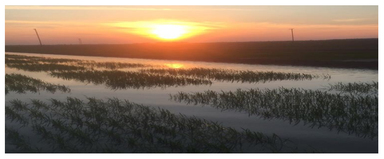

Effect of Delaying the Flood and Preflood Nitrogen Application on Rice Nitrogen Uptake and Yield

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Summary Statement: Preliminary results indicate near maximal rice grain yields (± 5% of maximum) can be produced when preflood-N and flooding are done from about 380 to 730 DD10 units.

Introduction

- Urea-N is utilized best when applied to a dry soil surface which reduces NH_3 volatilization (Photo 1). Rice can recover up to 75% of applied urea-N using a delayed-flood system when the urea is applied to dry soil and incorporated with the flood (Wilson et al., 1989).
- The 4-to 5-leaf stage [190 – 310 degree days (DD10) units] is the 'optimal' time for preflood-N application (Photo 2). Untimely rainfall can create moist field conditions that are not ideal for applying preflood-N.
- Urea-N application onto moist soil is not recommended and farmers are encouraged to delay urea-N application until the soil is dry. Research by Norman et al. (1992) showed delaying preflood-N and flood application up to 3 weeks beyond the 5-leaf stage
  - delayed rice heading and maturity
  - had no significant effect on grain yield
  - total-N uptake was similar over time
  - fertilizer-N uptake increased over time
  - native soil-N uptake decreased slightly over time
  - no information on effect of delaying past 3 weeks

Objective and Hypothesis

- Our objective was to determine the effect of delaying (beyond 3 weeks) preflood-N fertilizer and flooding application beyond the 5-leaf stage on rice growth, N uptake, grain yield, and selected yield components of rice grown on silt loam soils;
- Based on previous research we hypothesized that there would be no yield reduction when preflood-N and flood application were delayed 21 days beyond the current Arkansas recommended application time but further delays would cause irreversible yield loss.

Materials and Methods

- Two field experiments conducted in 2015
  - Calhoun silt loam, planted on April 8 at the Pine Tree Research Station (PTRS).
  - Dewitt silt loam, planted on April 30 at the Rice Research and Extension Center (RREC).
  - Roy J rice cultivar
- NBPT-treated urea rates
  - 0, 45, 90, 135, 180 kg N ha^{-1}
- Preflood-N application times (Table 1)
  - PTRS (6 flood times) & RREC (5 flood times)
- Measurements taken
  - Aboveground biomass at early heading for N uptake
  - Grain yield
- Statistical analysis
  - RCB, split-plot design with 4 replicates
    - Subplot: 5 urea-N rates
  - Replicate data regressed across DD10s accumulated at each preflood fertilizer-N application time.
  - Model allowed for linear and quadratic terms of flood times while the coefficients were allowed to depend on urea-N rate.

Table 1. Degree day (DD10) accumulations and dates of urea-N application for two field sites in 2015.

	PTRS		RREC	
Timing	DD10s	Date	DD10s	Date
3-lf	321	5/23	--	--
5-lf	464	6/04	252	5/28
5-lf + 7 d	523	6/08	339	6/04
5-lf + 14 d	680	6/17	456	6/11
5-lf + 21 d	778	6/23	556	6/17
5-lf + 28 d	911	7/01	696	6/25

Table 2. Regression coefficients for aboveground-N uptake as affected by N rate and application time.

Location	N rate (kg N ha^{-1})	Intercept	Linear coefficient	Quadratic coefficient
PTRS	0	-57	0.316	-0.000175
	90	23	0.316	-0.000175
	135	52	0.316	-0.000175
	180	73	0.316	-0.000175
RREC	0	26	0.222	-0.000257
	45	59	0.222	-0.000257
	90	87	0.222	-0.000257
	135	127	0.222	-0.000257
	kg N ha^{-1} = intercept + Linear(x) + Quadratic(x^2)			

Photo 1. Research plots showing urea applied to a dry soil before flooding.

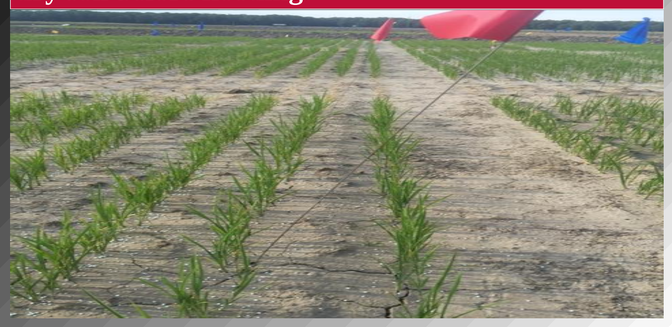


Table 3. Regression coefficients for grain yield as affected by N rate and application time.

Location	N rate (kg N ha^{-1})	Intercept	Linear coefficient	Quadratic coefficient
PTRS	0	-2241	21.49	-0.0157
	45	-798	21.93	-0.0157
	90	1354	20.89	-0.0157
	135	3890	18.03	-0.0157
	180	4427	17.44	-0.0157
RREC	0	863	20.08	-0.0210
	45	4321	11.84	-0.0126
	90	5875	8.62	-0.0085
	135	7450	8.17	-0.0081
	180	7233	9.82	-0.0091
	kg ha^{-1} = intercept + Linear(x) + Quadratic(x^2)			

Photo 2. Example of DD10 (DD50) predictions for rice development and management.

University of Arkansas Cooperative Extension Service
Rice DD50 Report

Tyler Richmond
1366 West Altheimer Drive
fayetteville, AR 72704

May 29, 2015 10:43
County: St_Francis
Variety: Roy J

Field: flood time trial MJC (1 acres) Field # 4
Emergence date: 4/19 DD50 weather zone: 6

**** Predicted dates for timing specific management practices in rice ****

Beginning and Optimum Tillering: Apply Early/Preflood N.....	5/11 - 5/20
Final recommended time to apply preflood N if early N delayed...	6/ 3
Rice Water Weevil Alert:	5/20 - 5/30
High risk of infestation, at flood scout first 7 days for leaf scars.	
Roy J is rated susceptible for straighthead.	
Have soil dried between.....	6/ 4 - 6/19
Begin checking for beginning of internode elongation.....	6/16
Predicted 1/2 inch internode elongation:.....	6/23
Apply 1st midseason N split between:.....	6/17 - 6/23
(May apply all midseason N as a single application)	
(Optional) Apply 2nd midseason N between:.....	6/23 - 6/30
Scout for sheath blight symptoms*.....	6/16 - 7/19
(Roy J is rated moderately susceptible for sheath blight.)	
Boot N Application	Not recommended
Apply Tilt for kernel smut prevention*.....	7/ 7 - 7/19
Roy J rated very susceptible for kernel smut; treatment recommended.	
Critical scouting time for blast symptoms*.....	6/16 - 7/25
(Roy J is rated susceptible for blast.)	
1st critical stage (approximate) for fungicide application*...	7/17
2nd critical stage (approximate) for fungicide application*...	7/25
* See explanation for disease control measures in MP192	
Scout for rice stink bug between:.....	7/24 - 8/27
Predicted date for 50% Heading:.....	7/23
Draining field	8/17
Approximate time of 20% grain moisture:.....	8/27

Herbicide Application Information

Apply Ricestar Between:.....	5/ 2 - 6/16
Apply Regiment Between:.....	5/ 7 - 6/16
Apply AIM or Grandstand - R between.....	5/ 7 - 6/23
Apply Blazer+Propanil tank-mix between:.....	5/ 7 - 6/16
Apply Londax between:.....	5/ 2 - 6/29
Apply Blazer or Lockdown for coffeebean/NJV control.....	6/ 7 - 7/ 9
Propanil application cut-off date.....	6/16
Recommended Beyond application cut-off date	Not recommended
Apply Phenoxy (2,4 - D) between:.....	6/11 - 6/23
Recommended Grasp application cut-off date.....	6/29
Recommended Permit application cut-off date.....	7/11

Produced through the joint efforts of the Agricultural Experiment Station and the UA CES using weather data supplied by the Southern Regional Climate Center - LSU.

Fig. 1. Aboveground-N uptake as affected by N rate and application time at the PTRS.

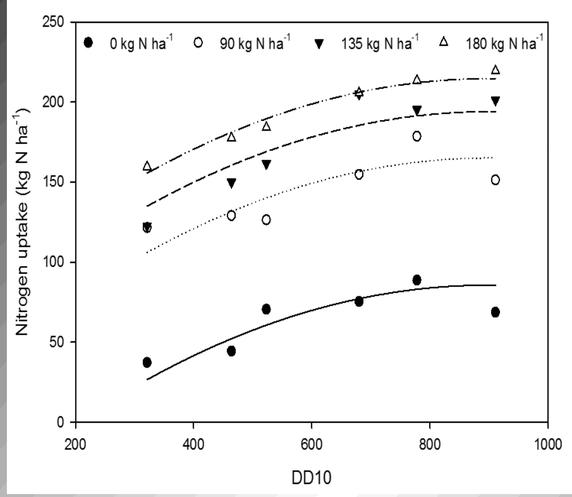


Fig. 2. Aboveground-N uptake as affected by N rate and application time at the RREC.

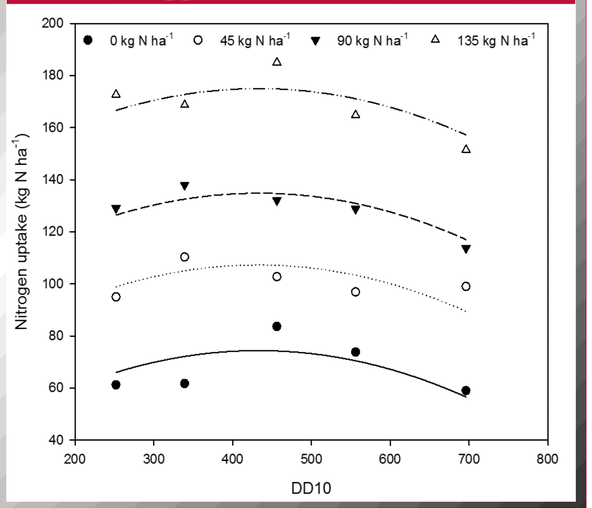


Fig. 3. Grain yield as affected by N rate and application time at the PTRS.

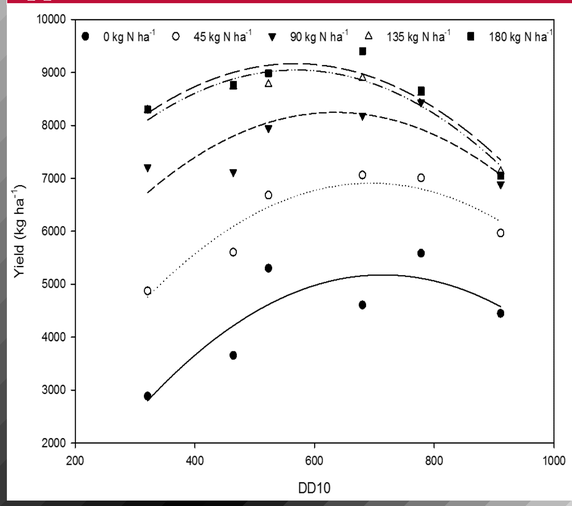
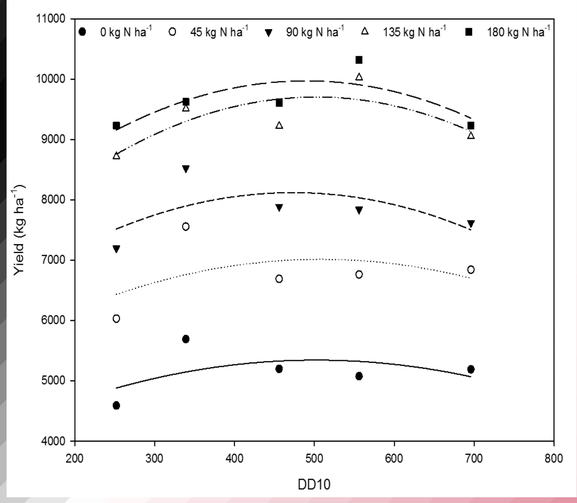


Fig. 4. Grain yield as affected by N rate and application time at the RREC.



Results

Aboveground-N Content at the PTRS

- N uptake increased nonlinearly as DD10 units increased, depended on N rate, and peaked at 896 DD10 units (Table 2 & Fig. 1).
- The increase in aboveground-N content was due to greater uptake of soil-N as flood time was delayed. The aboveground-N content of rice receiving no fertilizer-N nearly doubled across the flood times.

Aboveground-N content at the RREC

- N uptake across flood times was nonlinear (Table 2 & Fig. 2) and peaked at 377 DD10 units. Although total-N uptake changed across time the variation ranged from 157 to 175 kg N ha^{-1} within the range of fertilization dates (Table 1).
- The dramatic increase in soil-N uptake measured at the PTRS (Fig. 1) was not observed at the RREC (Fig. 2).

Grain yield

- At both sites, grain yield was a nonlinear response to fertilization and flood time that depended on preflood-N rate (Table 3).
- At the PTRS, the cumulative DD10 that produced peak yield for each N rate decreased as N rate increased (Fig. 3). Maximal yield was produced at 555 (180 kg N ha^{-1}) to 684 (0 kg N ha^{-1}) DD10 units.
- At the RREC, the cumulative DD10 that produced peak yield for each N rate increased as N rate increased (Fig. 4). Maximal yield was produced at 478 (0 kg N ha^{-1}) to 540 (180 kg N ha^{-1}) DD10 units.

Other observations (data not shown)

- Delaying N and flood timing decreased tiller number but individual panicles produced a greater number of seeds and maturity was delayed.

Practical Application

- Research with the Roy J rice cultivar suggests that fertilizer-N recovery efficiency is not affected by delaying fertilization and flooding beyond the 5-leaf stage (within the scope of this study).
- Yields ±5% of maximum were produced when fertilization and flooding were performed from 380 to 730 DD10 units with the peak at about 550 DD10s.
- Results for other cultivars (not shown) at each site showed yield patterns similar to that described for Roy J, but additional site-years are needed to confirm the consistency of response under different annual growth conditions and soil-N availabilities.
- Growers should follow current recommendations until guidelines are updated with results from this project.

Literature Cited

- Norman, R.J., R.S. Helms, and B.R. Wells. 1992. Influence of delaying flood and preflood nitrogen application on dry-seeded rice. Fert. Res. J. 32:55-59.
- Wilson, C.E., Jr., C.C., R.J. Norman, and B.R. Wells. 1989. Seasonal uptake patterns of fertilizer N effect in split-application to rice. Soil Sci. Soc. Am. J. 53:1884-1889.

Acknowledgements

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ARKANSAS RICE CHECK-OFF

UofA DIVISION OF AGRICULTURE RESEARCH & EXTENSION University of Arkansas System