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Optimum Preflood Nitrogen Applications in Rice

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Nitrogen (N) fertilizer represents the largest single-item input cost for most rice producers. Costs associated with N fertilization vary based on N-STaR, Nitrogen Soil Test for Rice, soil test value, soil texture and cultivar planted. Effective management of fertilizer N, especially preflood-N, is essential for maximizing rice grain yields, rice milling yields and overall profitability. Modern rice cultivars have shorter vegetative growth periods than cultivars that were grown commercially more than 20 years ago.

Proper N nutrition from the preflood-N application is responsible for setting two of the three primary yield components in rice: panicle number (tiller number) and spikes per panicle. The short statured, stiff-strawed cultivars that are commonly produced in Arkansas do not respond to midseason-N fertilization to the extent that previous taller, long-season cultivars did. The use of field-specific N rates from N-STaR and applying a urease inhibitor that contains N- (n-butyl) thiophosphoric triamide, NBPT, to urea that will be applied preflood to reduce ammonia loss makes the use of a single optimum preflood-N rate feasible for stiff-strawed, pureline cultivars in fields that meet the management requirements. The University of Arkansas System Division of Agriculture recommendations for hybrids already use an optimum preflood-N rate to set the yield potential, because the boot-N application serves to decrease lodging.

Optimum Preflood-N Using Standard N Rates

Prior to the development of N-STaR, producers relied solely on results from the Cultivar x N Fertilizer Rate trials and individual field experience to determine the proper N rate to maximize rice grain yield based on cultivar, soil texture and previous crop. Research has consistently shown that a single optimum preflood-N rate can produce similar or greater rice yields than the traditional 2-way split application method. The implementation of a single optimum preflood-N application over a 2-way split N-management strategy will maximize grain yield and milling yields using 20 pounds N less per acre and eliminate the application cost for the midseason-N split. To better illustrate this point, Table 1 provides the optimum preflood-N rates and 2-way split N rates for commonly produced rice cultivars in Arkansas.

TABLE 1. Recommended N rates and distribution for comparing the optimum preflood and traditional 2-way split applications for commonly grown cultivars in Arkansas.

Cultivars	Optimum Preflood N Rate	Rates and Distribution for 2-way Split		
		2-way Split Total N Rate	Preflood N Rate	Midseason N Rate
	lb N / acre			
CL151	100	120	75	45
Della-2, Jazzman-2, Roy J	115	135	90	45
CL111, CL153, CL163, CL172, CL272, Diamond, Jupiter, LaKast, PVL01, Titan, Wells	130	150	105	45

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For producers who use N rates other than the standard 2-way split N recommendation for a given cultivar there is a simple approach to determining the optimum preflood-N rate using the total-N rate applied. The 2-way split application method for pureline cultivars recommends 45 pounds N/acre applied at midseason with the remainder applied as preflood-N. A producer can calculate the optimum preflood-N rate by simply adding 25 pounds N/acre to the 2-way split preflood-N rate and not apply any fertilizer N at midseason. For example, the 2-way split application method for Diamond recommends a total of 150 pounds N/acre with 105 pounds N/acre applied preflood and 45 pounds N/acre applied at midseason. The optimum preflood method N rate would be 130 pounds N/acre by adding 25 pounds N/acre to the 2-way split preflood rate (105 pounds N/acre).

Optimum Preflood-N Using N-STaR

Since the implementation of N-STaR for determining field-specific N rates for rice, there have been several instances where the yield-maximizing N rate was less than 90 pounds N/acre total. In cases where N-STaR recommends less than 90 pounds N/acre, producers have been encouraged to consider using an optimum preflood-N strategy rather than having either the preflood-N application or the midseason-N application be less than 45 pounds N/acre. Current N-STaR reports provide N rate recommendations for the optimum preflood and 2-way split application methods (Figure 2). During the validation of N-STaR for silt loam soils, the 2-way split application was compared to the optimum preflood-N recommendation. The results presented in Table 2 highlight some of this research and indicate that even with low N rates (<90 pounds N/acre), the implementation of an optimum preflood-N strategy not only maximized rice yields, also resulted in additional N savings. The N-STaR recommendation for site three suggested 95 pounds N/acre in a 2-way split application and rice yielded 195 bushels/acre. The optimum preflood N-STaR recommendation for this same field was 75 pounds N/acre and produced an average yield of 198 bushels/acre. These results indicate that using the optimum preflood-N rate in conjunction with N-STaR for all N rates can result in maximal rice yields while significantly reducing N inputs.

Requirements for the Effective Use of Optimum Preflood-N Application Strategy

Preflood-N is the primary factor influencing grain and milling yield in the majority of rice fields in Arkansas; therefore, effective N management is critical for producing maximum rice yields where either an optimum preflood or 2-way split application method is used. Rice yield potential is largely determined prior to midseason, so it is crucial that preflood-N be managed properly to eliminate the potential for N losses prior to rice plant uptake and utilization of fertilizer N. Mismanagement of preflood-N can result in significant yield losses due to the loss of flood after N application or not maintaining a continuous flood for three weeks following preflood-N application. The following factors should be taken into consideration prior to implementing an optimum preflood-N strategy:

1) The field is not a sandy (permeable) soil, but a silt-loam or clayey-textured soil.
2) The field can be flooded in five to seven days.
3) The preflood urea is treated with a recommended urease inhibitor that includes NBPT or ammonium sulfate is used as the N source.
4) A two to four inch flood can be maintained for a minimum of three weeks following the preflood-N application.
5) The preflood-N fertilizer rate must be applied uniformly across the field – no streaking.

If these criteria cannot be met, then rice yield and uptake of fertilizer N may be compromised (e.g., greater fertilizer N loss), and a 2-way split application strategy should be used. Large preflood-N rates can be difficult to apply uniformly, and streaking can cause significant yield loss (Table 3). The best way to avoid streaking optimum preflood-N rates is to use an aerial applicator who understands how to operate the aircraft when applying large rates of fertilizer in a single application or double flying (using one-half the desired application rate and flying at one-half the optimum swath width for that application rate). Fields and situations that permit the implementation of optimum preflood-N can allow producers to save significantly on costs associated

TABLE 2. Rice grain yields obtained during N-STaR validation comparing optimum preflood-N rates to traditional 2-way split applications in conjunction with the N-STaR field-specific N rate.

Trial Location	OPTIMUM PREFLOOD-N MANAGEMENT		2-WAY SPLIT N MANAGEMENT	
	Total N Rate	Rice Yield	Total N Rate	Rice Yield
	lb N/acre	bu/acre	lb N/acre	bu/acre
Site 1	55 pf†	195	75 (45 pf +30 ms)	193
Site 2	60 pf	165	80 (40 pf +40 ms)	160
Site 3	75 pf	198	95 (50 pf +45 ms)	195
Site 4	110 pf	202	130 (85 pf +45 ms)	204

† pf and ms refer to preflood and midseason-N application timings, respectively.

TABLE 3. Influence of non-uniform N distribution (streaking) on rice grain yield. When preflood-N applications are not evenly distributed it leads to yield losses that can be associated with 1) increased disease and lodging in areas of over fertilization and 2) yield reduction in areas of under fertilization.

PREFLOOD-N % DISTRIBUTION	ACTUAL N LBS/ACRE DISTRIBUTION	GRAIN YIELD
% : %	lbs N : lbs N	bu/acre
100 : 100	75 : 75	170
125 : 75	94 : 56	161
150 : 50	113 : 37	160
175 : 25	131 : 19	146
200 : 0	150 : 0	139

Source: Helms et al. (1987). Arkansas Farm Research 36(2):9.

with N fertilizer application and possibly costs associated with disease and lodging. Optimum preflood-N rates are well-suited for precision leveled fields, especially zero-grade fields where flood establishment can be accomplished in less than three days. As with any new technology, we encourage producers to try the optimum preflood-N strategy on one or two fields that they feel comfortable will meet the requirements for its effective use. Optimum preflood-N management has several advantages over the 2-way split including reduced total-N rates, reduced application costs, high rice grain yield potential and high milling yield potential. With recent development of the GreenSeeker™ Response Index, RI, producers have the opportunity to quantitatively determine if the optimum preflood-N rate was sufficient and allow additional N applications to be made (i.e., midseason-N) if needed with no reduction in yield or milling potential.

To determine midseason-N needs using the GreenSeeker, readings should be taken after Green Ring AND no earlier than three weeks following pre-flood-N incorporation. Please refer to the Rice Management Guide or the MP192 Rice Production Handbook, for further guidance on establishing reference plots and the effective use of the GreenSeeker RI for determining midseason-N needs. Implementing an effective optimum preflood-N management strategy will help producers save money on input costs, thereby increasing the long-term sustainability and competitiveness of Arkansas rice production.

Figure 1. Comparison of preflood-N rates to the 2-way split timing. Maximal rice yields can be achieved with a lower total N rate compared to the 2-way split application.

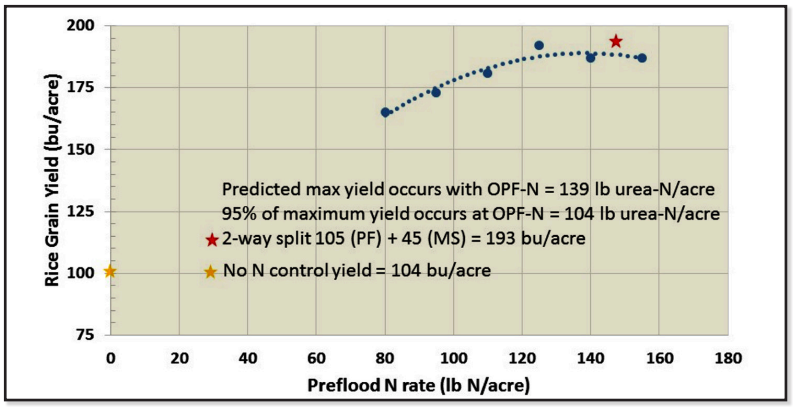
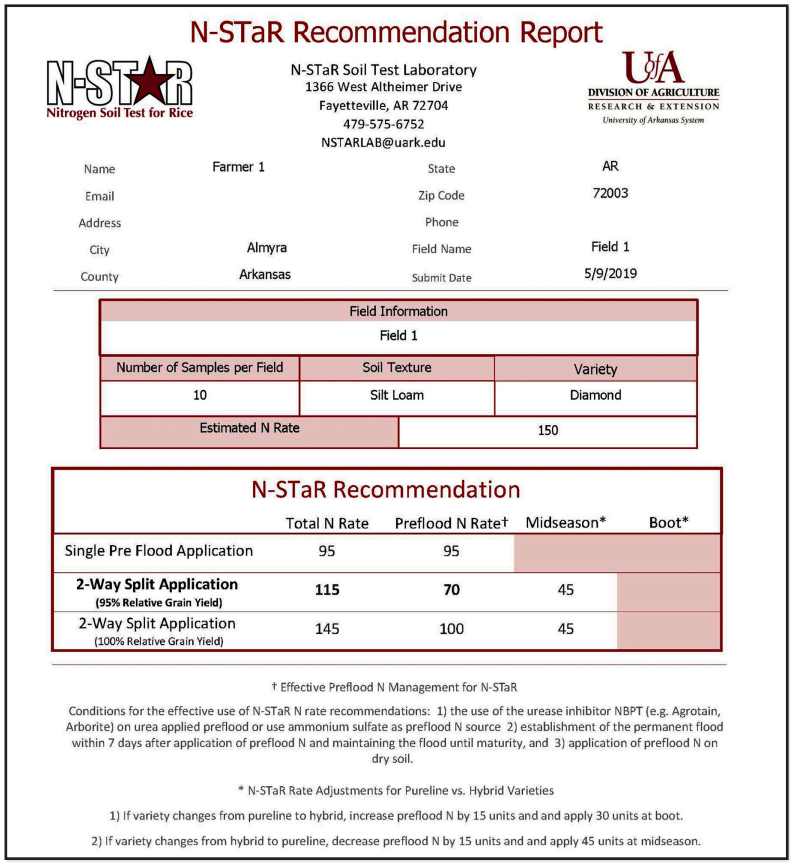


Figure 2. Example N-STaR Report.



N-STaR Recommendation Report

N-STAR Nitrogen Soil Test for Rice

N-STaR Soil Test Laboratory
1366 West Altheimer Drive
Fayetteville, AR 72704
479-575-6752
NSTARLAB@uark.edu

U of A Division of Agriculture Research & Extension, University of Arkansas System

Name	Farmer 1	State	AR
Email		Zip Code	72003
Address		Phone	
City	Almyra	Field Name	Field 1
County	Arkansas	Submit Date	5/9/2019

Field Information		
Field 1		
Number of Samples per Field	Soil Texture	Variety
10	Silt Loam	Diamond
Estimated N Rate	150	

N-STaR Recommendation

	Total N Rate	Preflood N Rate†	Midseason*	Boot*
Single Pre Flood Application	95	95		
2-Way Split Application (95% Relative Grain Yield)	**115**	**70**	45	
2-Way Split Application (100% Relative Grain Yield)	145	100	45	

† Effective Preflood N Management for N-STaR

Conditions for the effective use of N-STaR N rate recommendations: 1) the use of the urease inhibitor NBPT (e.g. Agrotain, Arborite) on urea applied preflood or use ammonium sulfate as preflood N source 2) establishment of the permanent flood within 7 days after application of preflood N and maintaining the flood until maturity, and 3) application of preflood N on dry soil.

* N-STaR Rate Adjustments for Pureline vs. Hybrid Varieties

1) If variety changes from pureline to hybrid, increase preflood N by 15 units and and apply 30 units at boot.

2) If variety changes from hybrid to pureline, decrease preflood N by 15 units and and apply 45 units at midseason.

No endorsement is implied or discrimination intended for firms or references included or excluded from this list.

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