Fertilizer Nitrogen Management in Drill-Seeded, Stale Seedbed Rice

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Abstract

Conservation tillage practices are being adapted to rice production systems in Louisiana. This relatively new concept in rice is raising questions concerning nitrogen (N) fertilizer management and whether current recommendations in conventional systems are adequate for stale seedbed systems. A study was conducted on a Crowley silt loam soil (fine, montmorillonitic, thermic Typic Albaqualf) to determine if N behaves differently in conventional and stale seedbeds. Four rice varieties were drill-seeded each year into conventional and stale seedbeds and fertilized with 90, 120, 150, and 180 lb N/A prior to permanent flood establishment. The 150-lb N rate was also applied in a two-way split consisting of 100 lb N preflood (PF) and 50 lb N at midseason. A significant interaction occurred between varieties and tillage for days to 50% heading each year. Maturity of Lacassine and Cypress was decreased in the stale seedbed in 1993 and was increased in 1994. The other varieties were not affected.

A significant N-by-tillage interaction occurred in 1994 for plant heights. The plant heights increased as N increased in the conventional seedbed only. The plant height of Bengal responded to increasing N in the stale seedbed. There was no yield response to N in 1993. A significant variety-by-N interaction occurred for yield in 1994. Jodon yields increased as N increased to 150 lb/A. There was no response to increasing N by the other varieties. A significant variety-by-tillage interaction occurred each year. In 1993, yields of all varieties except Lacassine were reduced in the stale seedbed. In 1994, the yield of Lacassine was significantly reduced and that of Jodon increased in the stale bed while yield of Bengal was not affected by tillage. Tillage effect was not significant either year, and there was no interaction between tillage and N. These results indicate that current recommended rates of N for these varieties are appropriate for use in stale seedbed, drill-seeded systems.

Introduction

Concern about agriculture's impact on the environment has led to adoption of cultural practices that conserve soil, water, and nutrients. Stale seedbed cropping systems have become very popular in the United States. These innovative techniques are being adapted for use in many rice-producing areas, especially in Louisiana where surface waters are being affected by rice field effluent (Feagley et al., 1992; Feagley et al., 1993). Recommended agronomic practices established in conventionally tilled rice are being examined to determine if these practices need to be modified to better address the needs of stale seedbed cultural systems. Nitrogen management in drill-seeded rice is well established in the southern U.S. In Louisiana, all or most of the required N is applied PF at the 4-leaf growth stage (LSU Agricultural Center, 1987). Conventional seedbeds are very mellow and permeable to the floodwater at this time. Permanent flood establishment provides adequate incorporation of surface-applied N below the soil-water interface. Nitrogen is stabilized in the NH_4^+ form below the thin, oxidized layer and remains available to the developing rice.

Most stale seedbeds are more compacted prior to permanently flooding and downward mobility of N could be compromised. The presence of decomposing preplant vegetation could also influence the availability and utilization of surface-applied N. The objectives of this study were to (1) evaluate the performance of different rice varieties in conventional and stale seedbeds and (2) determine if there is a differential response to N when rice is grown in conventional and stale seedbed cultures.

Materials and Methods

A tillage-by-variety-by-N experiment was conducted at the South Unit of the Rice Research Station, Crowley, LA, in 1993-94. Fertilizer (0 N-40 P_2O_5-40 K_2O was incorporated in the fall preceding each year of the experiment, and all land preparation required to establish a finished seedbed was also performed. The following spring, preplant vegetation was terminated with glyphosate (1.0 lb ai/A + 0.25% surfactant) 5 and 23 days preplant in 1993 and 1994, respectively. Conventionally tilled seedbeds were prepared within 3 to 5 days

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of planting. Lacassine, Cypress, Bengal, and Maybelle were seeded at 100 lb/A to a shallow depth in 7- by 25-foot plots (12 drill rows with 7-inch spacing) in 1993. Jodon was substituted for Maybelle in 1994. The experiment was periodically flushed to provide adequate moisture and to encourage stand development. Urea-N was applied at rates of 90, 120, 150, and 180 lb/A at the 4-leaf stage. The 150 lb/A rate was also applied in a two-way split consisting of 100 lb/A PF and 50 lb/A at midseason. Maturity (measured in days to 50% heading), plant height, and grain yield were determined.

The experiment was analyzed as a randomized complete block with a split plot arrangement of treatments and four replications. Tillage was assigned to the main plot and a factorial arrangement of varieties and N rates to the subplots. Results will be discussed by year since varieties were not consistent with respect to year.

Results and Discussion

Tillage had no influence on days to 50% heading in 1993

Table 1. Influence of tillage and N rate on performance and grain yield of drill-seeded rice varieties. Rice Research Station, South Unit, Crowley, LA. 1993.

Varietv	N[1] rate	Days to 50% heading Conv	Days to 50% heading No-till	Plant height Conv	Plant height No-till	Grain yield at 12% moisture Conv	Grain yield at 12% moisture No-till
				(cm)		(lb/A)	
Lacassine	90	93	88	89	86	6,314	6,759
Lacassine	120	93	88	87	89	6,562	6,799
Lacassine	150	93	90	89	92	6,886	6,694
Lacassine	100|50	92	89	88	84	6,728	6,503
Lacassine	180	92	91	94	90	6,980	6,686
Cypress	90	91	89	91	90	7,614	7,107
Cypress	120	92	88	94	89	8,161	7,367
Cypress	150	94	90	97	93	7,586	7,365
Cypress	100|50	94	90	93	91	7,392	7,064
Cypress	180	94	90	94	94	7,437	7,191
Bengal	90	87	87	89	85	8,129	7,731
Bengal	120	87	86	90	85	8,258	8,143
Bengal	150	87	87	88	87	8,392	8,205
Bengal	100|50	88	87	89	86	8,392	7,992
Bengal	180	88	87	93	88	8,333	7,910
Maybelle	90	79	80	100	95	7,284	6,124
Maybelle	120	79	79	97	99	7,124	6,547
Maybelle	150	81	79	102	99	7,465	6,650
Maybelle	100150	80	78	97	99	7,462	6,609
Maybelle	180	80	80	100	96	7,713	6,648
Tillage (T) mean		88	86	93	91	7.511	7,105
C.V., %		1.84		4.26		7.27	
LSD (0.05):[2]							
Tillage		ns		1		ns	
Nitrogen (N) mean							
90		87		91		7,133	
120		87		91		7,370	
150		88		93		7,405	
100150		88		94		7,362	
180		88		91		7,268	
LSD (0.05):		i		2		ns	
Variety (V) mean							
Lacassine		91		89		6,691	
Cypress		91		93		7,428	
Bengal		87		88		8,148	
Maybelle		80		99		6,963	
LSD (0.05):		1		2		235	
Main effect interactions[z]							
V x N		ns		ns		ns	
V x T		*		ns		*	
N x T		ns		ns		ns	
V x N x T		ns		ns		ns	

[1] Two-way application of 150 lb N/A applied as 100 lb preflood and 50 lb at panicle initiation.
[2] *Denotes significance at P = 0.05; ns = nonsignificant.

(Table 1). Higher N resulted in a modest increase in days to 50% heading. Bengal and Maybelle matured 4 and 11 days earlier than Lacassine and Cypress, respectively. A significant variety-by-tillage interaction resulted in decreased days to 50% heading for Lacassine and Cypress when planted in a stale seedbed. Tillage had no effect on maturity of Bengal and Maybelle. Plant heights of all varieties increased with increasing N, and Cypress and Maybelle were significantly taller than Lacassine and Bengal. There was no varietal response to N but yield potential of the varieties was significantly different, and yields were in the order of Bengal > Cypress > Maybelle > Lacassine. The interaction between varieties and tillage was significant, with all varieties except Lacassine yielding lower in the stale seedbed. Tillage had no effect on Lacassine yield, but yield was significantly lower than the other varieties. Results from 1994 are presented in Table 2. Maturity response due to tillage, variety, and fertilizer was similar to that measured in 1993. Tillage had no effect and increasing rate of N had a small influence. Maturity of varieties over all tillage and N rates was significantly

Table 2. Influence of tillage and N rate on performance and grain yield of drill-seeded rice varieties. Rice Research Station, South Unit, Crowley, LA. 1994.

Variety	N[1] rate	Days to 50% heading		Plant height		Grain yield at 12% moisture	
		Conv	No-till	Conv	No-till	Conv	No-till
				----------- (cm) -----------		----------- (lb/A) -----------	
Lacassine	90	88	91	92	86	7,284	5,976
Lacassine	120	89	92	93	85	7,187	6,239
Lacassine	150	90	92	92	93	7,145	6,280
Lacassine	100150	89	90	88	86	6,866	6,393
Lacassine	180	90	93	94	87	7,381	6,584
Cypress	90	85	86	94	91	7,929	7,616
Cypress	120	85	87	96	90	8,122	7,501
Cypress	150	88	89	95	92	7,921	7,524
Cypress	100150	85	86	96	92	7,974	7,754
Cypress	180	87	88	97	95	7,821	7,863
Bengal	90	82	82	93	87	7,339	7,073
Bengal	120	83	83	94	89	7,421	6,945
Bengal	150	84	84	92	92	7,493	7,475
Bengal	100150	82	82	91	89	7,259	7,066
Bengal	180	84	84	96	91	7,302	7,401
Jodon	90	83	83	92	90	5,744	6,273
Jodon	120	84	84	96	89	7,165	6,729
Jodon	150	84	84	98	92	7,521	7,485
Jodon	100150	83	85	93	92	5,781	6,466
Jodon	180	84	84	98	95	7,058	8,105
Tillage (T) mean		86	86	94	90	7.286	7,037
C.V., %		1.51		3.51		8.69	
LSD (0.05):[2]							
Tillage		ns		2		ns	
Nitrogen (N) mean							
90		85		91		6,904	
120		86		92		7,164	
150		87		93		7,355	
100150		86		91		6,945	
180		87		94		7,439	
LSD (0.05):		1		2		308	
Variety (V) mean							
Lacassine		90		90		6,733	
Cypress		87		94		7,802	
Bengal		83		92		7,277	
Jodon		84		94		6,833	
LSD (0.05):		1		1		276	
Main effect interactions[2]							
V x N		ns		ns		*	
V x T		*		ns		*	
N x T		ns		*		ns	
V x N x T		ns		ns		ns	

[1] Two-way application of 150 lb N/A applied as 100 lb preflood and 50 lb at panicle initiation.
[2] * Denotes significance at P = 0.05; ns = nonsignificant.

different. Delayed maturity of Lacassine, probably caused by poor stand establishment, caused a significant variety-by-tillage interaction. Tillage had no influence on the other varieties. Cypress and Jodon were significantly taller than Lacassine and Bengal. The interaction between N and tillage was significant for plant height. The plant height of Jodon increased with increasing N in both seedbeds, Bengal and Lacassine plant heights were increased in the stale seedbed, and tillage had no effect on plant height of Cypress. The interactions between varieties and N and varieties and tillage were also significant for yield. Jodon responded to increasing N up to 150lb/A, and yield was decreased significantly at the highest rate of N. There was no yield response to increasing N for the other varieties. At the 150 lb/A rate of N, there was no difference in response to applying this amount in a single or two-way split application for any variety. The yield of Bengal was not affected by tillage method, and yield of Cypress was only slightly reduced in the stale seedbed. Yield of Jodon was decreased in the conventional seedbed and was probably due to straighthead, a physiological disorder. Straighthead was not as severe in the stale seedbed. A significant yield reduction occurred with Lacassine in the stale seedbed. Slow seedling growth and poor stand establishment contributed to the lower yield.

Summary

This experiment was conducted to evaluate the performance of rice varieties grown in conventional and stale seedbeds and to determine if N management should be tailored to the tillage system. Significant differences in maturity, plant height, and grain yield among varieties are typical of variety-by-N experiments. Variety-by-tillage interactions each year also indicate the potential for some varieties to be better suited for stale seedbed production. Since there was no interaction between N and tillage either year, there is no evidence to support a change in N management. Recommendations previously established in conventional tillage systems are also appropriate for use in stale seedbeds.

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Literature Review

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