Stand Establishment in Water-Seeded, Minimum-Till Rice as Influenced by Water Management and Preplant Vegetation Control

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Abstract: Water seeding is the predominant cultural practice for establishing rice in Louisiana. While the majority of water-seeded rice is cultured in conventional tillage systems, minimum-till is gaining in popularity. Inadequate stand establishment in water-seeded, minimum-till systems can result in delayed maturity and reduced yields and is one factor that limits continued expansion of this new cultural practice. A study was conducted in 1994-1995 to evaluate the effects of water management and preplant vegetation on stand establishment of six rice varieties in a minimum-till system. Water management strategies included 1) pinpoint flooding with a 4-day postplant drainage interval, 2) delayed pinpoint flooding with a 10-day postplant drainage interval, and 3) delayed flooding with a 20-day postplant drainage interval. Preplant vegetation was manipulated by 1) no herbicide termination, 2) herbicide termination, and 3) herbicide termination plus rolling of preplant residue. Seedbeds were prepared in November prior to planting each year and allowed to revegetate with native weeds. Stand density of rice was influenced by water management in 1995 and increased with a 20-day postplant drainage period. Maturity was delayed for some varieties each year with a 4-day postplant drainage period. Water management influenced grain yield of all varieties in 1994.

Yields of Bengal and Jodon increased as the postplant drainage period increased to 20 days. Cypress. Lacassine, and Jackson yields were highest with a 10-day postplant drainage. Kaybonnet yield was decreased with a 10-day drainage. Preplant vegetation management influenced stand densities and grain yields in 1994. Densities and yields were both reduced when no herbicide was used to terminate preplant vegetation. Neither water management nor preplant vegetation management affected grain yields in 1995. Cypress, Jodon. and Kaybonnet significantly outyielded Lacassine and Jackson. Yield of Bengal was significantly higher than that of Jackson, lower than Jodon and Cypress, and similar to Lacassine and Kaybonnet. Water management and preplant vegetation management can influence the growth and yield of rice in water-seeded, minimum-till systems. Differential varietal response also needs to be considered.

Introduction

Approximately 85% of the rice produced in southwest Louisiana is water seeded. A considerable portion of this total is grown in systems where most of the tillage is performed under flooded conditions and is referred to as "mudding in." A result of this cultural practice is the release of floodwater after planting that contains significant amounts of solids and nutrients that negatively impact the water quality of receiving streams (Cormier, et al.. 1990). Alternative planting practices have been evaluated in an attempt to identify management practices that mitigate the problems associated with mudding in (Feagley et al., 1992: Bollich and Feagley, 1994). No-till and minimum-till rice planting practices have been shown to significantly improve the quality of rice field effluent being released into receiving streams. From a commercial production aspect, these practices have also been found to be feasible alternatives to mudding in.

Adequate stand establishment is critical in water-seeded rice and has been a particular concern in the no-till systems. Poor stand establishment can result in delayed maturity and decreased grain yields. These problems have been observed in commercial fields and were documented in earlier studies (Bollich, 1992; Bollich and Feagley, 1994).

The main objective of this study was to determine which management practices might influence stand establishment in a water-seeded, minimum-till system. Specific objectives included 1) a comparison of three water management strategies, 2) a comparison of three methods to manage preplant vegetation, and 3) an evaluation of six rice varieties.

Materials and Methods

A factorial experiment was conducted at the South Unit of the Rice Research Station, Crowley, LA, in 1994-95. Variables included rice variety, water management, and preplant vegetation management. Fertilizer (0-40-40) was incorporated in November preceding each year of the experiment. All land preparation required to establish a finished seedbed was also performed at this time. Three methods of preplant vegetation management included (1) no herbicide termination, (2) herbicide termination, and (3) herbicide termination plus rolling of preplant vegetation. Glyphosate (1.0 lb ai/A + 0.25% surfactant 13 days preplant) and paraquat (0.66 lb ai/A + 0.25% surfactant 5 days preplant) were used to terminate vegetation in 1994 and 1995, respectively, in those treatments receiving a herbicide. Preplant vegetation was rolled down 1 day after herbicide application in Treatment 3.

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A shallow flood was established 1 day prior to seeding pregerminated Cypress, Bengal, Jodon, Lacassine, Kaybonnet, and Jackson rice varieties at a rate of 150 lb/A. Three methods of water management included (1) pinpoint flooding with a 4-day postplant drainage, (2) delayed pinpoint flooding with a 10-day postplant drainage, and (3) delayed flooding with a 20-day postplant drainage. The 10- and 20-day delayed flooding treatments were flush irrigated as needed unless rainfall provided enough moisture to encourage seedling development and stand establishment. The pinpoint flood and 10-day delayed flooding treatments were drained for 2 days on Day 18 postplant. A nitrogen application of 90 lb/A was applied to the soil surface of all water management treatments. A permanent flood was established 20 days postplant.

Agronomic input practices (midseason N application and weed, insect, and disease control) were applied as required according to current recommendations (LSU Agricultural Center, 1987). Stand densities were recorded approximately 3 weeks after seeding. Maturity (days to 50% heading), plant height, and grain yield were determined.

The experiment was analyzed as a randomized complete block with a split-split plot arrangement of treatments and three replications. Water management was assigned to main plots, vegetation management to subplots, and varieties to sub-subplots. Results will be discussed by year.

Results

Plant height was not affected by water management or preplant vegetation management either year. Differences were due only to varieties (data not shown). Water management had little effect on stand density in 1994 (Table 1). There was a tendency to increase the number of plants with postplant drainage periods of 10 and 20 days, but due to variability in stand counts, the increase in stand density was not significant ($P<0.08$). Preplant vegetation management had a significant effect on stand density. Density was increased when vegetation was terminated with a herbicide. Rolling the preplant vegetation after herbicide termination had no influence on stand density. Stand densities were significantly different among the six varieties, with Kaybonnet establishing the highest plant population. Cypress, Jodon, and Jackson were similar in stand densities. Bengal and Lacassine stand densities were significantly lower than those of the other varieties.

An interaction occurred between water management and varieties (Table 1) for days to *50%* heading. Figure 1 shows a graphic representation of relative varietal differences. Maturity was significantly delayed by 3.7, and 4 days when the postplant drainage period was only 4 days for Cypress, Lacassine, and Jackson, respectively. Maturity was delayed by 2 days for Bengal, Jodon, and Kaybonnet. There appeared to be little difference in maturity between the 10-and 20-day drainage period for any of the varieties. Preplant vegetation management significantly affected maturity by delaying days to 50% heading by 3 days when no herbicide was used for termination, but by only 1 day when vegetation was rolled after herbicide application.

Grain yield was significantly reduced when no herbicide was used to terminate preplant vegetation (Table 1). Yields were similar between the herbicide termination and termination plus rolling treatments. A significant water management by variety interaction occurred for grain yield (Table 1). A graphic representation is shown in Figure 2. Grain yields of Bengal and Jodon increased as the postplant drainage period increased. Yields of Cypress, Lacassine, and Jackson were highest with a 10-day postplant drainage period. Kaybonnet yield was decreased with a 10-day drainage period.

Water management significantly influenced stand densities in 1995 (Table 2). Stand densities were highest with a 20-day postplant drainage period. There was no difference between the 4- and 10-day drainage periods. Stands were lowest for Jodon and Jackson and highest for Lacassine and Cypress. Preplant vegetation management had no effect on stand densities.

A variety by water management interaction occurred for days to 50% heading (Table 2). A graphic representation of relative varietal differences is shown in Figure 3. Maturity was delayed for Cypress, Jackson, and Lacassine as the postplant drainage period decreased. Water management appeared to have little influence on the maturity of Bengal, Jodon, and Kaybonnet.

Grain yields were not affected by water management or preplant vegetation management in 1995 Yield differences were due only to variety. Cypress, Jodon, and Kaybonnet yields were above 7500 lb/A. Yields of Lacassine and Jackson were significantly lower than those of the other varieties. Yield of Bengal was significantly higher than that of Jackson, but lower than yields of Cypress and Jodon.

Discussion

Poor stand establishment is often a serious liability in water-seeded, minimum-till rice production. Stand reductions usually delay maturity and can lead to reduced grain yields. Water management significantly affected stand densities in this study only in 1995. There was a tendency for stand densities to be reduced with a 4-day postplant drainage period in 1994. Maturity of some varieties was delayed each year, indicating that even when stand densities are not reduced, early flooding still negatively impacts plant growth. Earliness in maturity is extremely important in southwest Louisiana because ratoon cropping is very common. Delays in main crop maturity further increase the risks associated with this practice.

Varieties responded differentially to water management treatments in 1994. Yields of Bengal and Jodon increased as the postplant drainage period increased to 20 days. Yields of Cypress, Lacassine, and Jackson were highest with a 10-day drainage period. A longer drainage had no effect on these varieties. Yield of Kaybonnet was slightly reduced with a 10-day drainage and were higher with a 4- and 20-day drainage.

Table 1. Effect of preplant vegetation management, water management, and varieties on stand establishment in wator-seeded rice. Rice Research Station, South Unit, Crowley. LA. 1994.

Variety	Preplant vegetation management	Water management[1] Stand density PP	DP	DP	Mean	Days to 50% heading PP	DP	DF	Mean	Grain yield at 12% moisture PP	DP	DF	Mean
		----(plants/ft²)---								----------(lb/A)----------			
Cypress	No burndown	15	16	15	15	91	85	85	87	6484	7685	6929	7033
Cypress	Burndown	16	22	29	22	85	86	85	85	7217	7613	7616	7482
Cypress	Burndown + Grooving	17	25	31	24	90	84	84	86	7261	7597	7608	7489
Bengal	No burndown	11	13	11	11	86	84	83	84	6012	6081	6870	6321
Bengal	Burndown	15	14	20	16	84	82	81	82	6675	7161	7517	7118
Bengal	Burndown + Grooving	11	22	18	17	86	83	82	83	6157	6521	7136	6605
Jodon	No burndown	12	11	13	12	84	83	81	83	6143	6311	6996	6483
Jodon	Burndown	13	19	32	22	83	79	80	81	6579	8017	8172	7589
Jodon	Burndown + Grooving	17	28	32	26	82	80	78	80	6872	7668	8152	7564
Lacassine	No burndown	6	11	7	8	97	91	88	92	4692	5662	5807	5387
Lacassine	Burndown	11	23	17	17	92	85	86	88	5462	6740	6361	6188
Lacassine	Burndown + Grooving	9	20	25	18	93	86	87	88	6014	6339	6943	6432
Kaybonnat	No burndown	33	21	17	24	86	83	85	85	8094	7148	7913	7718
Kaybonnet	Burndown	21	36	39	32	85	82	81	83	8092	8287	8794	8391
Kaybonnat	Burndown + Grooving	30	36	42	36	84	83	81	82	7882	7757	8256	7965
Jackson	No burndown	11	19	18	16	88	81	81	83	5181	7248	6788	6406
Jackson	Burndown	12	21	25	19	83	81	80	81	6636	7235	6973	6948
Jackson	Burndown + Grooving	17	22	28	22	84	81	80	82	5893	7132	6955	6660
Water management (WM) mean		15	21	23		87	83	83		6519	7122	7321	
C.V., %			27.54				2.11				8.66		
LSD (0.05):[2]													
Water management			ns				3				ns		
Preplant vegetation management (PVM) mean													
No burndown			14				86				6558		
Burndown			21				83				7286		
Burndown + grooving			24				84				7119		
LSD (0.05):[2]			5				1				276		
Variety (V) mean													
Cypress			21				86				7334		
Bengal			15				83				6681		
Jodon			20				81				7212		
Lacassine			14				89				6002		
Kaybonnet			31				83				8025		
Jackson			19				82				6671		
LSD (0.05):			3				1				327		
Main effect interactions'													
WM x PVM			ns				ns				ns*		
WM x V			ns				*						
PVM x V			ns				ns				ns		
WM x PVM x V			ns				ns				ns		

[1] PP = pinpoint flood; DP = delayed pinpoint flood; DF = delayed flood.
[2] * denotes significance at P = 0.05; ns =nonsignificant.

Table 2. Effect preplant vegetation management, water management, and varieties *on* stand establishment in water-seeded rice. Rice Research Station, South Unit, Crowley, LA. 1995.

Variety	Preplant vegetation management	Water management[1]											
		Stand density				Days to 50% heading				Grain yield at 12% moisture			
		PP	DP	DF	Mean	PP	DP	DF	Mean	PP	DP	DF	Mean
		----(plants/ft²)---								----------(lb/A)----------			
Cypress	No burndown	15	16	15	15	91	a5	a5	a7	6484	7685	6929	7033
Cypress	No burndown	13	13	17	14	90	a7	87	88	7556	7958	8345	7953
Cypress	Burndown	18	17	20	18	89	87	87	87	7489	7857	8128	7825
Cypress	Burndm + Grooving	13	11	18	14	a9	89	86	88	7077	7686	8322	7695
Bengal	No burndown	10	11	14	12	86	a5	a4	85	6529	7105	7917	7184
Bengal	Burndown	14	9	15	13	a4	85	a4	85	7326	6550	7625	7167
Bengal	Burndm + Grooving	12	11	15	13	a4	a4	a4	a4	7484	7132	8064	7560
Jodon	No burndown	9	10	14	11	a5	84	a2	84	6949	6978	8390	7439
Jodon	Burndown	a	10	14	11	a5	a4	82	84	7769	7019	a593	7794
Jodon	Burndm + Grooving	11	9	9	10	a4	a4	82	83	7632	7413	8076	7707
Lacassine	No burndown	15	17	19	17	a7	86	*84*	86	7058	6781	7333	7057
Lacassine	Burndown	12	15	18	15	88	86	84	86	7185	6647	7492	7108
Lacassine	Burndown + Grooving	12	15	17	15	89	85	84	86	6845	6806	7712	7121
Kaybonnet	No burndown	12	11	17	13	88	88	a4	a7	7332	7048	7801	7394
Kaybonnet	Burndown	16	13	20	17	87	88	a5	a7	7560	7230	7913	7568
Kaybonnet	Burndm + Grooving	10	9	17	12	a7	88	a5	87	7009	7528	8483	7673
Jackson	No burndown	8	9	16	11	88	86	83	85	6020	6684	7520	6741
Jackson	Burndown	7	8	13	9	87	a5	a3	a5	6931	6911	7733	7192
Jackson	Burndown + Grooving	6	13	12	10	a7	85	a3	85	6755	6839	7634	7076
Water management (WM) mean		11	12	16		a7	86	a4		7139	7121	7949	
C.V., %			25.78				1.57				6.11		
LSD (0.05):[1]													
Water management				1				1				ns	
Preplant vegetation management (PVM) mean													
No burndown				13				86				7295	
Burndown				14				86				7442	
Burndown + grooving				12				86				7472	
LSD (0.05):				ns				ns				ns	
Variety (V) mean													
Cypress				16				åå				7824	
Bengal				12				a4				7303	
Jodon				10				83				7647	
Lacassine				16				86				7095	
Kaybonnet				14				a7				7545	
Jackson				10				85				7003	
LSD *(0.05)*:				2				1				245	
Main effect interactions													
WM x PVM				ns				ns				ns	
m x v				ns				•				ns	
PVM x V				ns				ns				ns	
WM x PVM x V				ns				ns				ns	

[1] PP = pinpoint flood; DP = delayed pinpoint flood (10 day); DF = delayed flood (20 day).
[2] • denotes significance at P = 0.05; ns =nonsignificant.

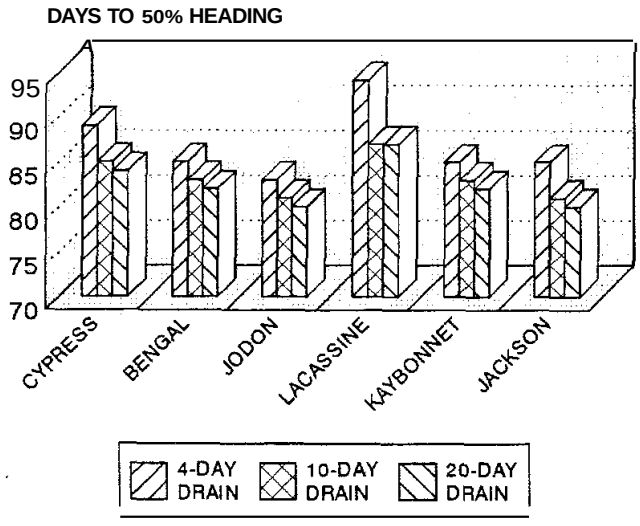

Figure 1. Maturity response of six varieties to postplant drainage time in minimum-till, water-seeded rice. 1994.

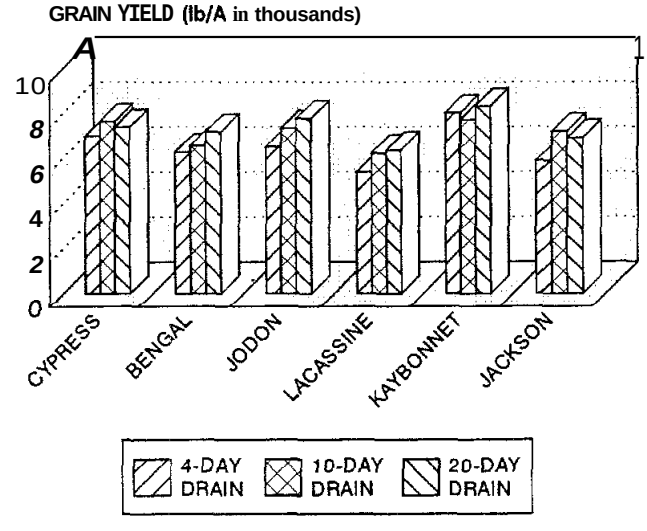

Figure 2. Yield response of six varieties to postplant drainage time in minimum-till, water-seeded rice. 1994.

Vegetation management influenced yields only in 1994. Preplant vegetation was excessive and yields were decreased when no preplant herbicide was applied. Vegetation was less dense in 1995, stand densities were not affected, and yields were similar.

Lacassine and Jackson were the lowest yielding varieties each year, while Cypress, Jodon, and Kaybonnet yielded significantly higher. Varietal responses such as these are very common in conventional seedbeds, indicating differences in genetic potential (Bollich, et al., 1993; Bollich, et al., 1994). These differences seem to be exacerbated in minimum-till seedbeds.

Results of this experiment indicate that management de-

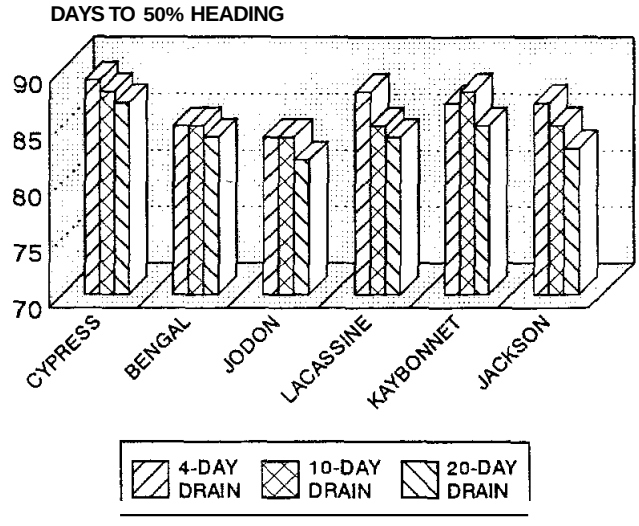

Figure 3. Maturity response of six varieties to postplant drainage time in minimum-till, water-seeded rice. 1995.

cisions concerning variety selection, water management, and preplant vegetation management may all play a role in rice performance in minimum-till seedbeds. Depending on year and environmental conditions, these factors could affect performance singly or in combination with each other.

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