Timing for Irrigation Termination on Silt Loam Rice Soils

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ABSTRACT

Irrigation is critical for successful rice (Oryza sativa, L.) production in the Mid-South. The majority of rice in Arkansas is produced in a dry-seeded, delayed-flood system with the flood normally established at the 4- to 5-leaf growth stage, or about 6 weeks after seeding. The flood is then maintained through physiological maturity. A small amount of interest in early irrigation termination has been expressed to prevent rutting fields during harvest. Previous research suggests that it is safe to drain the flood 14 d after 50% heading. Because of recently emerged questions concerning the applicability of this research for currently produced cultivars, a study was initiated to determine the effects of early irrigation termination on grain yield and milling quality of four widely grown cultivars. Four cultivars (‘Bengal’, ‘Cocodrie’, ‘Medark’, and ‘Wells’) were grown at two locations in 2004 and one location in 2005 following normal production practices, except the time for irrigation termination. The flood was drained either 14, 21, 28, or 35 days after 50% heading. Results suggest that draining 14 days after 50% heading was too early for the soils evaluated. Soil moisture declined to near permanent wilting point with 14 days after draining and yields were subsequently reduced. While clay soils need further evaluation, draining silt loam soils prior to the recommended 25 to 28 days after 50% heading may result in reduced grain yield.

INTRODUCTION

Irrigation is critical for successful rice production in the Mid-South. While a significant amount of rainfall is normal for this region, the majority does not usually occur
during the rice growing season in sufficient amounts to provide optimal production. The majority of rice in Arkansas is produced in a dry-seeded, delayed-flood system with the flood normally established at the 4- to 5-leaf growth stage, or about 6 weeks after seeding. The flood is then maintained through physiological maturity.

Current recommendations for terminating irrigation suggest maintaining the flood until 25 to 28 d after 50% heading to prevent reduction in grain yield and milling quality (Slaton, 2001). This corresponds to physiological maturity for most of the kernels on the panicle. A small amount of interest in early irrigation termination has been expressed to prevent rutting fields during harvest. Previous research (Counce et al., 1990) suggests that it is safe to drain the flood 14 d after 50% heading. In spite of this research, other scientists, county extension agents, and producers have been reluctant to adopt the practice of early irrigation termination. This research only evaluated a single cultivar and substantial rainfall occurred after the early draining treatment was implemented (Counce et al., 1990). Because of recently emerged questions concerning the applicability of this research for currently produced cultivars, a study was initiated to determine the effects of early irrigation termination on grain yield and milling quality of four widely grown cultivars.

**PROCEDURES**

Field studies were implemented at the University of Arkansas Rice Research and Extension Center (RREC) on a DeWitt silt loam (fine, smectitic, thermic Typic Albaqualfs) during 2004 and 2005 and at the Pine Tree Branch Experiment station (PTBS) on a Calloway silt loam (fine, smectitic, thermic Glossaquic Natraudalfs) during 2004. Two medium-grain rice cultivars (‘Bengal’ and ‘Medark’) and two long-grain rice cultivars (‘Wells’ and ‘Cocodrie’) were seeded into 9-row plots that were 16-ft. long with 7-in. row-spacing. Plots were managed according to normal recommended production practices. Nitrogen fertilizer was applied at a rate of 120 lb N/acre as urea at the 4- to 5-leaf growth stage immediately prior to establishing the permanent flood. The flood was maintained until time for the irrigation treatments to be imposed. The plots were drained at 14, 21, 28, or 35 days after 50% heading (DAH). Volumetric soil moisture contents were determined every 2 days after flood removal until harvest.

Rice was harvested from 12 ft of the center four rows when rice grain moisture fell between 15 to 20% moisture. The rice was threshed with a plot combine and grain yield determinations were made by measuring weight and moisture of the harvested grain. Yields were corrected to 12% moisture content. Rice grain was then dried to 12% moisture content at a temperature of 60°C.

The experiment was arranged in a 2-factor factorial, randomized complete block design with four replications. Main effects included cultivar (four) and time of draining (four levels). Analysis of variance procedures were conducted with the PROC GLM procedure in SAS. Mean separations were conducted with Fisher’s protected Least Significant Difference at $\alpha =0.05$. 


RESULTS AND DISCUSSION

Grain yields at both locations were reduced by as much as 10% when the flood was removed 14 or 21 days after 50% heading (DAH) (Fig. 1). Optimal yields were obtained when the flood was not removed until 28 DAH. This corresponds to current University of Arkansas recommendations for long-grain cultivars. However, the optimal drain timing for the medium-grain cultivars evaluated was also 28 DAH. This is confirmed by the lack of a significant interaction between cultivar and drain timing. This response suggests that the optimal drain timing was similar for both the long- and medium-grain cultivars. This is 7 days earlier than the current recommendation for medium-grain cultivars. Therefore it appears that slightly earlier draining than currently recommended may be possible without risk for these new medium-grain cultivars.

Dry weather combined with early draining resulted in drought stress to the point of reduced yields during 2004 (Fig. 2) and 2005 (Fig. 3). After the flood was removed for the 14 DAH treatment, volumetric soil moisture declined from >0.4 (40%, saturation) to near 0.15 m$^3$/m$^3$, or 15% during both 2004 and 2005. This corresponds to permanent wilting point for these silt loam soils. Rainfall during the time between the 14 DAH and 28 DAH treatments totaled 1.60 in. at RREC during 2004, 3.60 in. at PTBS during 2004, and 0.71 in. during 2005 at RREC. However, most of this rainfall occurred within 2 days after implementing the 14-day drain treatment. Rainfall was also received at 28 to 30 DAH during 2005. Less severe yield reductions were observed at PTBS during 2004 than at RREC and are probably due to rainfall maintaining soil moisture above field capacity for an additional week (Figs. 1 and 2).

The current studies were conducted on silt loam soils with rather shallow top soils. Clay soils in eastern Arkansas typically do not dry as quickly as the silt and sandy loam soils. The water-holding capacity of clay soils is greater than silt loam soils and thus should pose less risk from drought during the maturation stage. Proposed research in 2006 and 2007 will attempt to ascertain the risk of early irrigation termination on clay soils.

Economic analyses indicated that the greatest tenant returns above variable costs were typically associated with the recommended drain timing (Fig. 4). Draining 14 DAH reduced net returns from $30 to $100/acre compared to draining 28 DAH. While irrigation costs are reduced with early draining, yields are reduced such that the reduction in total revenue exceeds the reduction in pumping costs. Even in 2005 when pumping costs were much greater, early draining resulted in $22/acre less return. Extending the flood to 35 days resulted in additional costs only at the RREC during 2004.

SIGNIFICANCE OF FINDINGS

The results from this study suggest that early irrigation termination may be detrimental to rice yields, particularly when little or no rainfall occurs after draining (Fig. 1). The current study has focused on silt loam soils. Clay soils typically require longer time to become dry enough to hurt rice and should pose less risk from early draining. Future work is planned for 2006 and 2007 to evaluate these effects on clay soils. However, silt
loam soils typically become drought-stressed more easily and should remain flooded until 28 d after 50% heading. It is possible that with sufficient rainfall after draining, that early draining may be safely done on silt loam soils. However, since the weather is seldom accurately predicted, the risk of yield loss should be considered.

The preliminary results suggest that medium-grain cultivars may potentially be drained earlier than currently recommended. The current recommendations are based on the bigger kernel size of medium-grains and the associated time required to reach maturity and subsequent dry-down. More research is needed to evaluate the effects of early draining on different rice cultivars and grain types.

**LITERATURE CITED**


![Graph](image-url)  
Fig. 1. Influence of time for irrigation termination on grain yields of rice at the Pine Tree Branch Experiment Station (PTBS) during 2004 and the Rice Research and Extension Center (RREC) during 2004 and 2005. (LSD(0.05) = 10.3 (PTBS, ’04); 10.5 (RREC, ’04); and 14.9 (RREC, ’05)
Fig. 2. Volumetric soil moisture content following irrigation termination 14 days after 50% heading at the Rice Research and Extension Center (RREC) and the Pine Tree Branch Experiment Station (PTBS) during 2004.
Fig. 3. Volumetric soil moisture content following irrigation termination 14 days after 50% heading at the Rice Research and Extension Center (RREC) during 2005.

Fig. 4. Tenant returns above variable costs (RAVC) associated with draining 14, 21, 28, and 35 days after 50% heading at the Pine Tree Branch Experiment Station (PTBS) in 2004 and the Rice Research and Extension Center (RREC) in 2004 and 2005.