

Scheduling of Furrow Irrigation Initiation on Soybean Yield and Net Returns

P.B. Francis,* C.R. Stark, Jr., C.G. Henry, L. Espinoza, M. Ismanov, S. Hayes, and L. Earnest

Abstract

The majority of soybeans (*Glycine max* L. Merr.) grown in alluvial soils of the Mid-South USA are irrigated. The impact of delayed irrigation initiation of 0, 5, 10, and 15 days on soybean growth, yield, and economic returns was investigated for three seasons on two contrasting soils located 1,000-ft distance apart: silt loam and silty clay. Scheduling was determined using the Arkansas Scheduler, a deficit-driven program. On the silt loam soil, cultivars representing maturity groups (MG) 3, 4, and 5 were planted in 2007, 2009, and 2010. In 2007, delays of 15 days were omitted on the silt loam soil due to rain. On the silty clay, MG 4 was planted in 2008 and MG 5 in 2009 and 2010. Delays of 15 days reduced seed yields and net returns in 2 of 3 years on the silt loam for MG 3 and 4 cultivars but not for MG 5. On the silty clay, a 15-day delay reduced yields in all three seasons but had no effect on net returns. Irrigation initiation delays reduced plant heights and canopy cover at both sites and all seasons, especially for 15-day delays. Delays in irrigation initiation of 15 days increased risk for early maturing indeterminate cultivars more than later-maturing determinate cultivars in the silt loam soil and for all cultivars in the silty clay. However, delaying irrigation initiation by as much as 10 days for determinate cultivars can potentially reduce irrigation costs without sacrificing yield and net returns.

Soybeans (*Glycine max* L. Merr) are the most common crop species grown on alluvial soils of the Mid-South USA. Increasingly, more of the production fields are irrigated using alluvial aquifer groundwater, and in most regions, unfortunately, the withdrawal of alluvial aquifer groundwater is occurring at unsustainable levels (Czarnecki et al., 2002). A critical groundwater shortage with devastating effects on the economic vitality of the region may result unless more sustainable methods of irrigation management occur. Irrigation of crops generally increases yield, improves yield uniformity, and reduces economic risk for the producer (Wesley et al., 1991). Efficient scheduling of irrigation events necessitates re-supply of soil moisture prior to crop extraction capabilities that would result in irreversible yield losses. Several methods of scheduling irrigation have been used such as deficit irrigation, simulation models (Cahoon et al., 1990; Payero et al., 2005), weather data-driven estimates of potential evapotranspiration (Ortega-Farias et al., 2004), soil moisture sensors (Leib et al., 2003; Bryant et al., 2017), atmometers (Gleason et al., 2013), and canopy temperature monitoring (Stockle and Dugas, 1992; Bockhold et al., 2011).

Crop Management



Core Ideas

- Irrigation delays reduced yield and profit for indeterminate soybean on loamy soils.
- Irrigation delays did not affect a determinate cultivar on a loamy soil.
- A 2-week irrigation initiation delay can reduce yield on a cracking clay soil.
- Delays in irrigation initiation will reduce plant heights and canopy cover.

P.B. Francis, C.R. Stark, Univ. of Arkansas at Monticello, College of Forestry, Agriculture and Natural Resources, Monticello, AR; C.G. Henry, Univ. of Arkansas Rice Research and Extension Center, Stuttgart, AR; L. Espinoza, Univ. of Arkansas, Division of Agriculture, Little Rock, AR; M. Ismanov, Univ. of Arkansas Division of Agriculture, Stuttgart, AR; S. Hayes, L. Earnest, Univ. of Arkansas Division of Agriculture, Rohwer, AR. *Corresponding author (francis@uamont.edu).

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Abbreviations: MG; maturity group; ANOVA; analysis of variance.

Conversions: For unit conversions relevant to this article, see Table A.

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Table A. Useful conversions.

To convert Column 1 to Column 2, multiply by	Column 1 Suggested Unit	Column 2 SI Unit
0.405	acre	hectare, ha
0.454	pound, lb	kilogram, kg
67.19	60-lb bushel per acre, bu/acre	kilogram per hectare, kg/ha
0.304	foot, ft	meter, m
2.54	inch	centimeter, cm (10 ⁻² m)

For soybeans, crop moisture demand fluctuates with growth stage and canopy cover (Brun et al., 1972; Klocke et al., 1989). Simulation models generally calculate actual crop moisture use (ETa) as a function of potential evapotranspiration (ETp) multiplied by a growth stage–related crop coefficient (Kc). Values of Kc for soybeans can be variable (Payero and Irmak, 2013) and are highest during reproductive growth. Factors influencing the moisture use of soybeans include the weather, soil moisture supply, cultivar, tillage, row spacing, and stress (Mason et al., 1982; Foroud et al., 1993; Patil et al., 2000; Garcia y Garcia et al., 2010; Arora et al., 2011; Odhiambo and Irmak, 2012).

Moisture stress in early vegetative growth of soybeans may not reduce yields to any extent, provided sufficient moisture is available during critical reproductive growth (Garcia y Garcia et al., 2010). Rainfall dynamics and readily available soil moisture storage during the season can influence crop yield reductions that may occur during early crop growth. Improvements on irrigation efficiency in the region are needed (Kebede et al., 2014). If the first irrigation event can be delayed without sacrificing yield and economic returns, provided that irrigation management continues through at least R5 growth (Heatherly and Spurlock, 1993), then irrigation input costs will be reduced and significant reductions in groundwater consumption will occur. Therefore, the objectives of this study were to investigate the impact of delaying the first irrigation event on soybean growth, yield, and economic returns for furrow-irrigated soybeans in the Mid-South.

Site Descriptions and Experimental Designs

Research occurred at the University of Arkansas Southeast Branch Experiment Station located near Rohwer, AR (33°48'01.50 N, 91°16'20.00 W; elevation of 144 ft). The Arkansas Irrigation Scheduler program (Cahoon et. al., 1990) determined

Table 1. Precipitation (inches) summary at the study sites, 2007–2010 growing seasons, Rohwer, AR.

Year	May	June	July	Aug.	Total
2007	3.94	5.20	5.16	0.24	14.54
2008	4.17	3.50	1.61	9.17	18.45
2009	11.42	1.93	6.65	2.12	22.12
2010	1.81	2.52	3.78	5.31	13.42
30-yr avg.	5.08	3.74	3.62	2.44	14.88

irrigation events. The program recommends a 2.5-inch deficit for silt loam soils without a pan and a 2.0-inch deficit for clayey soils. The initiation delays were defined as the number of rain-free days past the first target threshold. Rainfall occurring past the target threshold was factored into the deficit budget. Days past the initial irrigation continued after the predicted crop moisture loss equaled or exceeded rainfall.

In 2007, cultivars Morsoy 3993(MG 3.9), Armor 47G7 (MG 4.7), and DK 5567 (MG 5.5) were established in a McGehee silt loam (fine-silty, mixed, thermic Aeric Ochraqualfs) to study planned delays of the first irrigation of 0, 5, 10, and 15 days. Emergence date was 21 May 2007, and the experimental design was a randomized complete block with a split-plot treatment arrangement and three replications. Main plot treatments were MG, and sub-plot treatment was irrigation. Sub-plots were five, 19-inch wide row strips approximately 400 ft long. An 8-ft alley between strips with a small berm was constructed to contain the furrow irrigation treatments. Frequent rains in June 2007 (Table 1) only allowed for delay treatments of 0, 5, and 10 days in 2007 because the 15-day delay timing was not attained prior to R4. Therefore, the 15-day delay treatment was omitted in 2007. Significant yield reductions due to moisture stress from R3 to R5 can occur (Foroud et al., 1993; Kimak et al., 2008), and the initial irrigation event is usually applied prior to R4 by farmers in the region. Early-season moisture deficits for the three MGs were identical, so the first irrigation event treatments were applied on 18 June 2007 for the 0-day delay, 23 June 2007 for the 5-day delay, and 28 June 2007 for the 10-day delay for all MGs. The 0-day delay treatments received six irrigation events, the 5-day delay five irrigation events, and the 10-day delay treatments four irrigation events for all MGs. Irrigation scheduling was terminated at the R 6.5 growth stage (Fehr and Caviness, 1977). A 25-ft-long section of the interior three rows beginning 100 ft from the irrigation pipe was harvested for grain yield.

In 2008, the study on the McGehee silt loam site was abandoned after three plantings due to unacceptable stands of less than 40,500 seedlings/acre that occurred due to ponded soil conditions and poor seed vigor. An acceptable stand of ‘PION 94M7’ (MG 4.7) was established on a Sharkey silty clay (very-fine, smectic, thermic Chromic Epiaquerts), located approximately 1,000 ft from the silt loam site, on 21 May 2008. Due to field limitations, only one MG was planted on the silty clay soil. The experimental design was a randomized complete block arrangement of irrigation treatments with

four replications. Subplots were 10 rows, 19-inch width and approximately 800-ft length, separated by an 8-ft-wide alley with a small berm to contain the irrigation treatments. A target moisture deficit of 2 inches was used on the silty clay site. Final seed yield was determined from the interior three rows in 300-ft strips, beginning 100 ft from the irrigation manifold, using a combine and weigh wagon. Initial irrigation events occurred on 14 June 2008 for the 0-day delay treatment, 15 July 2008 for the 5-day delay treatment, and 22 July 2008 for the 10-day delay treatment. The 15-day delay treatment was scheduled for initial irrigation on 27 July 2008; however, the area received 2.0 in rainfall on that date and the crop was at R2 growth stage. Therefore, the rainfall was considered a substitute for the 15-day delay treatment.

In 2009, cultivars Armor 39K4 (MG 3.9), HBK 4727 (MG 4.7), and HBK 5525 (MG 5.5) were planted on the McGehee silt loam. An acceptable stand of all MGs was established 15 June 2009 after two re-plantings due to extremely wet weather in May (Table 1). On the silty clay site, HBK 5525 (MG 5.5) was planted on 10 June 2009, and the experimental design, instrumentation, and field layout were the same as in 2008. At both sites, yield was determined from the harvest of the interior three rows in 200-ft strips, beginning 100 ft from the irrigation manifold. Initial irrigations on the McGehee silt loam occurred on 2 July 2009 for the 0-day delay treatment, 7 July 2009 for the 5-day delay treatment, 13 July 2009 for the 10-day treatment, and 20 July 2009 for the 15-day delay treatment. On the Sharkey silty clay, initial irrigations were applied on 7 July 2009 for the 0-day delay treatment, 12 July 2009 for the 5-day delay treatment, and 22 July 2009 for the 10-day delay treatment. The 15-day delay treatment was scheduled for 28 July 2009, but 3.6 inches of rainfall accumulated between 27 and 31 July 2009 in the area, and we considered this an irrigation substitute for the 15-day delay treatment since the crop was at R2 growth.

In 2010, cultivars PION 93Y92 (MG 3.9), HBK 4727 (MG 4.7), and HBK 5525 (MG 5.5) were established on 2 June 2010 on the McGehee silt loam. Initial irrigations were applied on 22 June 2010 for the 0-day delay, 28 June 2010 for the 5-day delay, 16 July 2010 for the 10-day delay, and 23 July 2010 for the 15-day delay treatments. On the Sharkey silty clay, HBK 5525 was established on 2 June 2010, and initial irrigations were applied on the same days as the silt loam site.

Plant Characteristics and Economic Data Collected

Plant population, plant height, and visual estimate of percent canopy cover (5% increments) were measured between R1 and R5 growth in 2008–2010. Measurements were from the interior three rows of each experimental unit in a 32-ft length at mid-field. Plant population was determined from counting plants on adjacent rows of a 10-ft-length section of row middle. Plant heights were recorded as the average of three representative plants and measured from soil level to the tip of the apical meristem. In 2010, nodal yield

component data were measured at R7 growth (physiological maturity) for the 0- and 15-day delay treatments from 10 representative plants selected at random locations within the area that plant heights were measured. The number of pods, seeds, and seeds per pod as well as the dry weight of seeds and seeds + pods were recorded. Yield components were dried in a forced-air oven at 140°F prior to weighing. Net return estimates were calculated each season using the respective annual budget spreadsheets for the soil texture class (silt loam or silty clay/clay) for furrow-irrigated soybeans published by the University of Arkansas Cooperative Extension Service. Average fixed cost estimates, actual direct costs, and market-value estimates based on average Arkansas prices for each site-year-experimental unit yields were used as input values in the spreadsheet.

Statistical Methods

Each site was analyzed separately since the experimental design was different and initially evaluated for independence and year effects using the MIXED procedure in SAS (Littell et al., 2006). On the silt loam site, data were analyzed using a linear mixed model for a split-plot design (Gbur et al., 2012). Cultivar and irrigation treatment were considered fixed variables, and block and block*cultivar random variables. The Kenward-Rogers adjustment to the degrees of freedom and compound symmetry covariance structure were used in the models. Data from the silty clay soil were analyzed using the MIXED procedure in SAS (Littell et al., 2006) with irrigation treatment as a fixed variable and replication as a random variable. Where significant, treatment means were compared using Tukey test ($\alpha \leq 0.05$). Nodal data in 2010 were analyzed using PROC GLIMMIX with nodal position treated as repeated measures. For each variable and MG, tests for best covariate structure were conducted (Gbur et al., 2012). The best covariate structures for each variable were found to be identical for all MGs. The first-order autoregressive structure had the best fit for all counted nodal data, such as number of pods, and the heterogeneous Toeplitz (2) structure was identified as the best covariant structure for all weighed nodal data, for example, weight of seeds. Using the appropriate covariate structure, ANOVAs of the data were then conducted.

Maturity Group Responses on McGehee Silt Loam

In 2007, a 10-day delay in irrigation initiation reduced yield and net returns for the MG 4 cultivar on the McGehee silt loam (Table 2) and tended to lower yield and net return for the MG 3 cultivar, but not significantly. Delays in irrigation initiation appeared to have little influence on seed yield and net returns for the MG 5 cultivar. In 2009, yield and net returns were reduced for a 15-day irrigation initiation delay for the MG 3 and a 10-day delay for the MG 4 cultivar. As observed in 2007, delays in initial irrigation did not appear to influence yield or net returns for the MG 5 cultivar in 2009. Seed yield and net returns were reduced by a 15-day delay in irrigation initiation for the MG 3 cultivar in the

Table 2. Emergence date (ED), date of first irrigation (DFI), growth stage of first irrigation (GSFI), yield, and net returns in relation to irrigation initiation delays (Delay) for three soybean maturity groups (MG), McGehee silt loam, Rohwer, AR, 2007, 2009, and 2010.

Year	ED	Delay	DFI	Total irrigations	MG 3	MG 3		MG 4		MG 5	
					GSFI	Yield	Net return	Yield	Net return	Yield	Net return
						bu/ac	\$/ac	bu/ac	\$/ac	bu/ac	\$/ac
2007	21 May	0	14 June	5	R1	71.3a†	341.64a	74.2a	366.37a	68.9a	320.68a
		5	4 July	4	R2	67.5a	313.47a	67.3ab	312.00ab	70.2a	337.05a
		10	25 July	3	R4	65.6a	302.99a	61.9b	270.56b	69.7a	337.87a
2009	1 June	0	2 July	5	V5	62.5a	283.82a	80.8a	456.94a	60.6a	265.97a
		5	7 July	4	V6	62.6a	289.89a	76.9ab	420.09ab	61.9a	283.82a
		10	13 July	3	R1	58.6a	259.09a	68.8b	351.46b	63.1a	299.88a
		15	21 July	2	R2	45.5b	145.11b	55.4c	235.51c	58.0a	286.60a
2010	2 June	0	22 June	5	V6	64.5a	492.48a	56.3a	400.76a	42.4a	244.43a
		5	28 June	4	R1	53.6b	374.56b	52.1a	359.00a	39.0a	211.27a
		10	16 July	3	R3	58.4ab	434.66ab	52.6a	369.32a	38.4a	210.18a
		15	23 July	2	R4	51.3b	360.80b	50.1a	347.21a	36.2a	190.64a

†Column means within MG and year followed by the same letter are not significantly different at the 0.05 level of probability.

2010 season. However, delaying irrigation did not significantly influence seed yield or net returns for the MG 4 and MG 5 cultivars in 2010.

Overall, a 15-day delay in irrigation initiation on the McGehee silt loam soil reduced yield and net returns for the MG 3 and MG 4 cultivars in two of three seasons. Yield and net return for the MG 5 cultivar were not significantly influenced by delays in initial irrigation in any of the three seasons. Crop phenology may explain the differences in sensitivity to early-season moisture stress (Torrior et al., 2014). The MG 3 and MG 4 cultivars have indeterminate growth, whereas the MG 5 cultivars have determinate growth. The indeterminate cultivars reach R1 (beginning flower) around V6 to V7 growth, but R1 growth is not achieved by the MG 5 cultivars until V16 or greater. Soybean yields tend to be impacted by moisture stress greater during reproductive pod set (R3 to R4) and seed fill growth (R5 to R6) more than at other growth stages (Specht et al., 1989; Sweeney et al., 2003). In the Mid-South region, irrigated soybeans planted on 20 May reach R3 growth (beginning pod set) in approximately 52 days after planting (DAP) for a MG 3.9 cultivar, 61 DAP for a MG 4.9 cultivar, and 71 DAP for a MG 5.9 cultivar (Zhang et al., 2005). The need for sufficient crop moisture supply during sensitive growth stages for high yields and net returns may occur earlier for early maturing indeterminate cultivars. Differences in root depth and distribution, nodulation and symbiotic N-fixation, and flower abortion among MGs may have influenced resistance to early-season moisture stress. Our data revealed that delaying irrigation at the beginning of the season increases risks for lower yields and net returns for earlier maturing indeterminate cultivars than for later-maturing determinate cultivars on the McGehee silt loam soil. Additionally, the data reveal that a 5-day delay in irrigation initiation for early maturing indeterminate cultivars on silt loam soils without a restrictive pan can potentially eliminate one irrigation without reducing

yields and net returns. For later-maturing determinate cultivars, a 15-day delay can potentially reduce up to three irrigations with no significant reductions in yield and net returns. Eliminating unnecessary irrigations conserves vital groundwater resources.

Delay Effects on a Silty Clay Soil

Soil water characteristics may also interact with delays in the initial irrigation on soybean performance. The initial irrigation is earlier on soils with less readily available water storage capacity. On the Sharkey silty clay, a 15-day delay in irrigation initiation of the MG 4 (2008) and MG 5 (2009 and 2010) reduced yield in all three seasons, but a 15-day delay on the silt loam soil did not reduce yield for the MG 5 (2007, 2009, and 2010). However, net returns were not affected in the three seasons on the silty clay and for the MG 5 on the silt loam soil (Table 3). The differences in responses of net returns when yield differences occurred on the clayey soil compared with the loamy soil are most likely due to different variable and fixed inputs costs used in the calculations that reflect average costs of production for full-season soybeans in Arkansas for each year and soil. This data suggests that a 10-day delay in irrigation initiation on the silty clay soil can potentially save two irrigations without sacrificing yield or net returns. Retention of plant-available water of alluvial soils in the southern USA tends to be less on clayey soils than for loamy soils (Lund, 1958), which may impose greater stress on determinate soybeans during pre-bloom growth. Additionally, the Sharkey silty clay is a “cracking” clay soil in the Vertisol order with large, dense, wedge-shaped aggregates in the sub-soil within 24 inches of the surface. We have observed soybean roots growing around these dense aggregates in thick root webs, potentially reducing the volume of soil available to the crop for water extraction and thereby imposing greater risk for moisture stress at any growth stage.

Table 3. Emergence date (ED), date of first irrigation (DFI), growth stage of first irrigation (GSFI), yield, and net returns in relation to irrigation initiation delays (Delay), Sharkey silty clay, Rohwer, AR, 2008–2010.

ED	Delay	DFI	Total irrigations	GSFI	Yield†	Net return
	days				bu/ac	\$/ac
2008						
28 May	0	10 July	4	R2	56.7a	362.20a
	5	15 July	3	R2	55.9ab	358.96a
	10	21 July	2	R3	55.8ab	363.82a
	15	27 July‡	1	R3	55.4b	364.23a
2009						
15 June	0	7 July	6	V6	54.5a	247.27a
	5	12 July	5	V8	50.4ab	215.70a
	10	14 Aug.	4	R3	41.8ab	142.45a
	15	19 Aug.	2	R3	40.8b	144.88a
2010						
6 June	0	23 June	5	V4	55.7ab	392.55a
	5	23 July	4	R2	54.5ab	384.06a
	10	2 Aug.	3	R3	57.6a	424.52a
	15	6 Aug.	2	R3	52.4b	371.51a

†Column means within year followed by the same letter are not significantly different at the 0.05 level of probability.

‡A 2.0-inch rain received 27 July 2008 served as a substitute for the scheduled irrigation.

Delay Influence on Plant Characteristics

A 15-day irrigation initiation delay did not affect measured yield components (pod number, seed number, and seed weight) in 2010 within MGs compared with no delay on the McGehee silt loam (Table 4). On the Sharkey silty clay soil, no differences between 0- and 15-day irrigation initiation delay on pod number or seed number were observed (Table 5), but seed weight was less for the 15-day delay treatment at the 0.10 level of probability ($\text{Prob} > F = 0.083$). Moisture stress imposed by the 15-day delay in 2010 on the silty clay occurred from R2 to R3 growth (Table 3). Moisture stress during R2 to R3 growth reduces pod numbers whereas moisture stress during seed fill (R5) reduces seed weight (Desclaux et al., 2000). Our findings indicate that

Table 4. Nodal analysis of reproductive dry matter in relation to irrigation delays in 2010 for three soybean maturity groups (MG), McGehee silt loam soil, Rohwer, AR. Values are average for 10 representative plants.

MG	Delay	No. pods	No. seeds	Total wt. seeds
	days			oz
3	0	42.9	100.4	0.50
	15	45.6	105.1	0.51
	Prob > F	0.497	0.640	0.864
4	0	41.4	98.5	0.44
	15	43.3	110.8	0.45
	Prob > F	0.679	0.236	0.772
5	0	58.6	113.0	0.45
	15	55.2	112.4	0.45
	Prob > F	0.725	0.973	0.925

Table 5. Nodal analysis of reproductive dry matter in relation to irrigation delays for 2010, Sharkey silty clay soil, Rohwer, AR. Values are average for 10 representative plants.

Delay	No. pods	No. seeds	Total wt. seeds
days			oz
0	59.2	123.1	0.49
15	52.4	104.7	0.41
Prob > F	0.256	0.176	0.083

other physiological factors stimulated by moisture stress during flowering and early pod set may be influencing source/sink processes during seed fill, or insufficient sample size was collected. More research to identify physiological responses to moisture stress during reproductive growth for soybeans grown on cracking clay soils is needed.

With regard to canopy characteristics from flowering to pod set, delays in irrigation initiation reduced plant height and canopy cover for all three seasons and cultivars on the McGehee silt loam (Table 6) and in 2008 and 2009 on the Sharkey silty clay soil (Table 7). Shorter plants have been associated with vegetative moisture stress for determinate

Table 6. Canopy characteristics at early reproductive growth in relation to irrigation initiation delays (Delay) for three soybean maturity groups (MG), McGehee silt loam, Rohwer, AR, 2009, 2010.

Year	Delay	Total irrigations	MG 3		MG 4		MG 5	
			Plant height	Canopy cover	Plant height	Canopy cover	Plant height	Canopy cover
			inches	%	inches	%	inches	%
2009	0	5	28.4a†	100a	25.9a	97a	29.8a	100a
	5	4	25.2b	100a	24.1a	95a	24.9b	97ab
	10	3	22.9b	95ab	19.9b	88b	21.2bc	92b
	15	2	23.8b	92b	20.6b	88b	22.4c	92b
2010	0	5	46.3a	97a	44.2a	90a	35.0a	98a
	5	4	37.3b	80b	37.0b	73b	31.1ab	83b
	10	3	38.5b	–	37.9b	–	31.1ab	–
	15	2	37.0b	85b	36.5b	82c	27.0b	82b

†Column means within MG and year followed by the same letter are not significantly different at the 0.05 level of probability.

Table 7. Canopy characteristics at early reproductive growth in relation to irrigation initiation delays (Delay), Sharkey silty clay, Rohwer, AR, 2009–2010.

Year	Total irrigations	Delay	Plant height	Canopy cover
		days	inches	%
2008	0	4	28.1a†	93a
	5	3	28.5a	90a
	10	2	26.4ab	89a
	15	1	24.7b	80b
2009	0	6	25.2a	95a
	5	5	24.6ab	78c
	10	4	24.2ab	83bc
	15	2	22.8b	89ab
2010	0	5	30.4a	100a
	5	4	29.9a	100a
	10	3	29.8a	100a
	15	2	29.6a	100a

†Column means within MG and year followed by the same letter are not significantly different at the 0.05 level of probability.

cultivars (Desclaux et al., 2000). Full canopy cover during reproductive growth of soybeans maximizes interception of photosynthetically active radiation by the crop and increases the potential for optimum yields (Ball et al., 2000; Board, 2004). Our data reveals that moisture stress imposed from initial irrigation delays of 10 days or more can influence later canopy growth needed for optimum yields.

Impacts of Delaying Irrigation Initiation

Shorter-maturing, indeterminate soybean cultivars grown in a full-season production system in the Mid-South are sensitive to delays in initial irrigation for optimization of crop yield and net returns on a silt loam soil. Longer-maturing determinate cultivars were less sensitive to irrigation delays on a silt loam soil. For more clayey soils, irrigation initiation delays of 15 days reduced seed yield in each of two seasons for a determinate MG 5 cultivar. Therefore, growers should be more diligent with irrigation management of determinate cultivars on clayey soils. Irrigation delays of 10 days reduced the seasonal number of irrigation events by two in all sites and years. From a water conservation perspective, delaying the first irrigation application by 10 days may potentially reduce water use by up to 40% without sacrificing yield or net returns for determinate cultivars in a full-season production system. In the Mid-South, three soybean production systems exist: early season, full season, and double crop (usually following wheat). Soil moisture, climate, and pest pressure during critical reproductive growth can vary tremendously among the three production systems. There is a need for additional studies to identify the effects of irrigation management with regard to specific soybean production systems in contrasting soils. The research can lead to more profitable soybean production management and efficient use of limited water resources.

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