

SOYBEAN YIELD RESPONSE TO DRAINAGE AND SUBIRRIGATION OF A CLAYPAN SOIL IN NORTHEAST MISSOURI

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Although agricultural drainage is a familiar system, using drainage as part of an integrated water management system (IWMS) is a relatively new concept that improves water quality and sustains agricultural viability (Fausey et al., 1995; Fisher et al., 1999; Allred et al., 2003; Drury et al., 1996, 2009). Subsurface drainage water from agricultural lands with properly installed IWMS can contribute to the quantity and quality of water in receiving streams. An IWMS uses subsurface drainage to remove excess water in the spring and fall for critical field operations, regulate water flow (managed drainage), and add water to the field through subirrigation (Belcher and D'Itri, 1995; Skaggs, 1999; Frankenberger et al., 2006). Drainage plus subirrigation provides water to the crop through the use of water level control structures, usually requires narrower drain spacings, and can be an efficient method of delivering water to the crop (Belcher and D'Itri, 1995; Brown et al., 1997; Skaggs, 1999). In a high-yield soybean production system, DSI with tile lines on 20 ft spacings increase soybean yields 24 bu/acre compared to a nonirrigated control on soils with a fragipan 14 to 30 inches deep in Ohio (Cooper et al., 1992). In narrow rows (7 inches), long-term soybean yields using DSI reached 80 bu/acre in the 1980s (Cooper et al., 1991). From November to May, upland, flat claypan soils commonly have a seasonal perched water table caused by an impermeable underlying argillic clay layer that restricts internal drainage. During summer, these soils quickly dry out and drought can devastate crop production. Previous research has evaluated the effects of drainage systems on response of corn (Walker et al., 1982; Sipp et al., 1986; Nelson et al., 2009), soybean (Walker et al., 1982; Sipp et al., 1984), and alfalfa (Rausch et al., 1990), but no studies to date have evaluated DSI as part of an IWMS on soybean response in a claypan soil. Simulation research for a Cisne silt loam (claypan soil in southern Illinois) called for a 20 ft drain tile spacing for DSI with good surface drainage, and 16 ft spacing when with poor surface drainage (Mostaghimi et al., 1985). However, research has neither verified these recommendations in the field, nor evaluated the effect of drain tile spacing on soybean response.

Since shallow drain tile depths and narrow spacings are recommended for claypan soils, field research from 2003–2006 was conducted to evaluate the effects of drainage (DO) and DSI on planting date and the effects of DO and DSI at 20 and 40 ft spacings on soybean yield compared to non-drained (ND) and non-drained delayed planting (NDDP) controls on claypan soils. Soybean were planted up to 17 d earlier with DO or DSI systems. Plant populations were reduced 29 to 52% in the non-drained control due to poor drainage in 3 of the 4 yr (data not presented). Grain yield (Table 1), water applied through the DSI system, and water level depth were similar at a 20 or 40 ft drain tile spacings (data not presented). Average yield increase with DSI at 20 and 40 ft spacings was 12 to 29% (6–14 bu/acre) while DO at the same spacings increased yield 9 to 22% (4–11 bu/acre) compared to ND or NDDP controls (Table 1). In a dry year (2005), drainage plus subirrigation increased yield up to 18 bu/acre compared to DO. Plant population variability at harvest was lower with the DO or DSI systems compared to ND or NDDP controls (data not presented). Yield variability over the 4 yr was lower with DSI

compared with DO or ND controls (Table 1), which was affected by the spring–summer precipitation regimes and is important to farmers for a more predictable soybean marketing strategy.

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Table 1. Grain yield for drain tile spacings and drainage water management systems from 2003 to 2006. The spring-summer precipitation regimes are in parentheses.

Drain tile spacing (ft)	2003 (wet-mod.)		2004 (wet-wet)		2005 (dry-dry)		2006 (mod.-mod.)		Average yield	
	DO [†]	DSI	DO	DSI	DO	DSI	DO	DSI	DO	DSI
Non-drained	40.3	42.2	56.8	45.3	38.0	38.3	62.1	52.3 ± 12.6 [§]	47.0 ± 10.6 [†]	
20 ft spacing	48.5	46.5	70.9	71.9	45.8	58.4	64.8	57.5 ± 12.3	60.5 ± 10.8	
40 ft spacing	48.2	47.3	72.1	68.7	40.6	51.1	66.3	56.8 ± 14.9	58.4 ± 10.7	
LSD (<i>P</i> = 0.05)	----- 3.9 -----	----- 9.2 -----	----- 7.9 -----	----- 2.1 ----						

[†]Abbreviations: Drainage only, DO; DSI, Drainage plus subirrigated; LSD, Least Significant Difference; mod., moderate; NS, Non-Significant.

[‡]Non-drained delayed-planting control.

[§]Standard deviation.

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