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# Small Differences in Planting Dates Affect Soybean Performance

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## ABSTRACT

Drought stress reduces yield of traditional May and June plantings of nonirrigated soybean in the midsouthern U.S. The Early Soybean Production System (ESPS) has been developed to avoid drought effects. Field experiments using conventional and glyphosate-resistant Maturity Group (MG) IV soybean varieties were conducted on Sharkey clay (very-fine, smectitic, thermic chromic Epiaquert) near Stoneville, Mississippi (lat. 33°26'N), in 1999 and 2000 at two sites located approximately 2 miles apart. Planting dates at Site 1 were April 23, 1999, and April 20, 2000, whereas planting dates at Site 2 were May 3, 1999, and April 27, 2000. The objective was to determine effects of small differences in early planting dates represented by the two sites each year on agronomic performance of and net returns from soybean grown without irrigation. Even though the difference in planting dates was only 10 days in 1999 and 7 days in 2000, some significant differences in agronomic and economic outcomes were evident. Plants at Site 2 (later planting date) were taller, but weight of individual seed from Site 2 was significantly lower. Seed yield and net return were significantly greater from Site 1 (earlier planting date) in both years. These results may provide some impetus to plant as early in the intended April 1 to 30 timeframe as possible when using the ESPS.

## INTRODUCTION

Traditional soybean production in the midsouthern U.S. typically has involved planting in May and later. Moisture deficit resulting from decreasing rainfall and increasing evaporative demand typically increases from April through September at Stoneville, Mississippi (lat. 33°26'N) (Boykin et al., 1995). This moisture deficit is detrimental to soybean varieties used in the traditional production system because they are in reproductive stages during the latter part of the growing season when moisture deficits are greatest. Thus, they are susceptible to yield limitations imposed by drought stress and concurrent high temperatures. Results from research with this traditional system reveal that May and June sowings of soybean varieties represent a risky enterprise without irrigation (Heatherly and Spurlock, 1999).

An apparent remedy for this problem is to modify production practices so that greater yield and net return can be achieved. Recent reports (Boquet, 1998; Bowers, 1995; Heatherly and Spurlock, 1999) indicate that the ESPS (Bowers, 1995; Heatherly and Bowers, 1998) has merit for improving the yield and profit potential of soybean in the midsouthern U.S. Seeding early-maturing varieties in April so that their critical reproductive development coincides with periods of adequate soil moisture and greater rainfall would partially avoid drought.

A majority of the soybean acreage in the midsouthern U.S. is not irrigated. The objective of this report is to compare the agronomic performance of and economic return from nonirrigated ESPS plantings at two sites with small differences in planting date being the only perceived difference.

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# Materials and Methods

Field studies were conducted in 1999 and 2000 on Sharkey clay on or near the Delta Research and Extension Center in Stoneville, Mississippi. Each year, two separate nonirrigated experiments were conducted to encompass two dates of planting of two MG IV soybean varieties. Sites [referred to as Site 1 (earlier planting date) and Site 2 (later planting date)] for the separate experiments were approximately 2 miles apart. Soil series at both sites were identical, weather patterns were nearly identical, experiments were conducted with identical inputs, and past experience indicated that both sites were different only in their location.

**Table 1. Average daily maximum air temperatures (Max. T) and total rainfall amounts (Rain) for indicated months during 1999 and 2000, and 30-year normals at Stoneville, Mississippi.**

| Month | 1999 | | | 2000 | | | 30-year normals[1] | |
|---|---|---|---|---|---|---|---|---|
| | Max. T | Rain | | Max. T | Rain | | | |
| | Site 2 | Site 1 | Site 2 | Site 2 | Site 1 | Site 2 | Max. T | Rain |
| | *°F* | *in* | *in* | *°F* | *in* | *in* | *°F* | *in* |
| April | 78 | 6.1 | 6.3 | 72 | 9.8 | 11.0 | 74 | 5.4 |
| May | 84 | 6.0 | 5.7 | 85 | 5.8 | 6.9 | 82 | 5.0 |
| June | 89 | 2.3 | 2.8 | 90 | 5.6 | 6.1 | 90 | 3.7 |
| July | 93 | 1.3 | 1.0 | 94 | 0.5 | 0.6 | 91 | 3.7 |
| August | 96 | 0.2 | 0.2 | 98 | 0.0 | 0.0 | 90 | 2.3 |

[1]Boykin, D.L., R.R. Carle, C.D. Ranney, and R. Shanklin. 1995. Weather Data Summary for 1964-1993, Stoneville, Mississippi. Mississippi Agricultural and Forestry Experiment Station Technical Bulletin 201. Mississippi State University.

All seedbed preparation was conducted in the fall preceding each growing season; it included tillage 15 to 18 inches deep using a curved-shank chisel plow with tines spaced 40 inches apart, followed by soil surface smoothing with a disk harrow and spring-tooth cultivator. All tillage operations were started immediately following harvest of soybean when soil was dry at both sites. Plantings were made into a stale seedbed [untilled prior to planting in the spring (Heatherly, 1998)] following application of glyphosate to kill weed vegetation. Both sites had been cropped to soybean the preceding 5 years. All experiments were conducted in a complete block design with the two varieties randomized within each of four replicates at each site.

Dates of planting were April 23 (Site 1) and May 3 (Site 2) in 1999, and April 20 (Site 1) and April 27 (Site 2) in 2000. Varieties were MG IV conventional (CONV) AP 4880 and glyphosate-tolerant (GT) SG 468 in 1999, and MG IV CONV AP 4882 (half-sibling of AP 4880) and MG IV GT SG 498 (half-sibling of SG 468) in 2000. Row spacing was 20 inches, and seeding rate was four to five seed per foot of row. Plots were 85 feet long at Site 1 and 100 feet long at Site 2. All plots were 13.4 feet (eight rows) wide. Seed were treated prior to planting with mefenoxam fungicide as a precaution against *Pythium* spp. After planting, weeds at each site were managed identically with postemergent herbicides broadcast applied at labeled rates with recommended adjuvants and in recommended tank mixes. At both sites each year, combinations of bentazon, acifluorfen, and sethoxydim or clethodim were applied to CONV varieties, while glyphosate was applied to GT varieties. In all cases, weeds were managed so that weed competition was not a factor limiting crop production. Temperature data in Table 1 were collected about 2 miles from Site 1 and about 1/2 mile from Site 2, whereas rainfall data were collected about 1 mile from Site 1 and about 1/2 mile from Site 2.

All production inputs within each year were recorded for all experiments. Estimates of costs and returns were developed for each annual cycle of each experimental unit using the Mississippi State Budget Generator (Spurlock and Laughlin, 1992). Total specified expenses were calculated using actual inputs for each year of the experiment and included all direct and fixed costs, but they excluded costs for land, management, and general farm overhead, which were assumed to be the same for all treatment combinations. Direct expenses included costs for pesticides, seed, and labor; costs for fuel, repair, and maintenance of machinery; cost of hauling harvested seed; and interest on operating capital. Fixed expenses were ownership costs for tractors, self-propelled harvesters, implements, and sprayers. Costs of variable inputs and machinery were based on prices paid by Mississippi farmers each year; i.e., machinery costs varied with year. Cost estimates of field operations were based on using 16-row equipment. Machinery ownership cost was estimated by computing the annual capital recovery charge for each machine and applying its per-acre rate to each field operation. Income from each experimental unit was calculated by multiplying the USDA loan rate for Mississippi of $5.35 per bushel of harvested seed by the experimental yield. Net returns above total specified expenses were determined for each experimental unit each year.

Soybean plant height at maturity was recorded for each plot just prior to harvest to determine the possible effect of planting date on plant stature. A field combine modified for small plots was used to harvest the entire length of the four center rows of each plot. Soybean seed from both sites were harvested between late August and mid-September of each year. Weights of two random 100-seed samples per plot were recorded, and these weights and yield data were adjusted to 13% moisture content.

Analysis of variance [PROC MIXED (SAS Institute, 1996)] was used to evaluate the significance of effects on plant height, seed weight, seed yield, and net returns. Year, site, and variety were treated as fixed effects. When year significantly interacted with site and/or variety, results from separate-year analyses are discussed. Otherwise, results of across-years analyses are used.

## Results and Discussion

Average monthly maximum air temperatures and monthly rainfall amounts during the 1999 and 2000 growing seasons at Stoneville, along with 30-year average monthly maximum air temperatures and monthly rainfall (Boykin et al., 1995), are presented in Table 1. Both growing seasons had near-normal temperatures and near-normal or above-normal rainfall from April through June. Most of the June 1999 rainfall at both sites occurred during the last week of the month. Severe deviation from normal weather during the conduct of this research was similar at both sites and occurred during July and August of both years, when average monthly temperatures were slightly to greatly above normal, and rainfall was negligible at both sites.

**Table 2. Dates of reproductive development stages of MG IV soybean varieties planted at two sites near Stoneville, Mississippi, 1999 and 2000.**

| Planting date | Variety | Reproductive stage[1] | | | | |
|---|---|---|---|---|---|---|
| | | R1 | R3 | R5 | R6 | R8 |
| April 23, 1999 | AP 4880 | June 3 | June 18 | July 8 | Aug. 13 | Aug. 23 |
| | SG 468 | June 3 | June 18 | July 8 | Aug. 13 | Aug. 23 |
| May 3, 1999 | AP 4880 | June 7 | June 25 | July 19 | —[2] | —[3] |
| | SG 468 | June 7 | June 25 | July 19 | —[2] | —[3] |
| April 20, 2000 | AP 4882 | May 26 | June 20 | July 7 | Aug. 7 | Aug. 24 |
| | SG 498 | May 26 | June 23 | July 10 | Aug. 11 | Aug. 30 |
| April 27, 2000 | AP 4882 | June 1 | June 26 | July 15 | —[2] | —[3] |
| | SG 498 | June 1 | July 3 | July 21 | —[2] | —[3] |

[1]R1 = beginning bloom; R3 = beginning pod; R5 = beginning seed; R6 = full seed; and R8 = mature.
[2]Full seed never reached because of drought.
[3]Premature death because of drought.

The severe drought conditions during July and August coincided with the R5 [beginning seed (Fehr and Caviness, 1977)] through R6 (full seed) period of both varieties (Table 2). The effect of the severe July-through-August weather would be expected to be more profound on seed development of varieties at Site 2 (later planting date) because their R5 occurred later than that for varieties at Site 1 (earlier planting date) each year.

Plants of both varieties at Site 2 were taller than those at Site 1 in both years, but the differences were significant only in 1999 (Table 3). In both years, weight of individual seed of both varieties from Site 1 was greater than weight of seed of both varieties from Site 2. Seed yield of the two varieties from Site 1 was 183% and 154% greater in 1999 and 125% and 118% greater in 2000, even though planting date difference was only 10 days in 1999 and 7 days in 2000. As mentioned earlier, developing seed at Site 2 would have been affected more by drought stress because of the later R5 of varieties at this site. The large differences in yield between the two sites each year resulted in large differences in net returns (Table 3). In fact, net returns from Site 2 were negative each year.

The differences in agronomic and economic performance between the two sites were significant. Year and

**Table 3. MG IV soybean mature plant height, seed weight, seed yield, and net return, 1999 and 2000.**

| Variety type[1] | 1999 | | | | | 2000 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Site 1[2] | Site 2[3] | Diff. | P | SE | Site 1 | Site 2 | Diff. | P | SE |
| **Plant height (in)** | | | | | | | | | | |
| GT | 33 | 41 | -8 | <0.01 | 1 | 28 | 31 | -3 | 0.15 | 2 |
| CONV | 27 | 39 | -12 | <0.01 | 1 | 31 | 33 | -2 | 0.24 | 2 |
| | | | 4 | <0.01 | 1 | | | -1 | 0.67 | 1 |
| **Seed weight (mg/seed)** | | | | | | | | | | |
| GT | 125 | 102 | 23 | <0.01 | 6 | 119 | 101 | 18 | 0.02 | 6 |
| CONV | 104 | 90 | 14 | 0.05 | 6 | 112 | 95 | 17 | 0.02 | 6 |
| | | | 9 | 0.32 | 8 | | | 1 | 0.95 | 8 |
| **Seed yield (bu/A)** | | | | | | | | | | |
| GT | 32.8 | 11.6 | 21.2 | <0.01 | 5.7 | 32.1 | 14.3 | 17.8 | 0.01 | 5.7 |
| CONV | 30.5 | 12.0 | 18.5 | <0.01 | 5.7 | 36.7 | 16.8 | 19.9 | <0.01 | 5.7 |
| | | | 2.7 | 0.56 | 4.6 | | | -2.1 | 0.66 | 4.6 |
| **Net return ($/A)[4]** | | | | | | | | | | |
| GT | 56 | -55 | 111 | <0.01 | 30 | 36 | -32 | 68 | <0.05 | 30 |
| CONV | 22 | -50 | 72 | <0.04 | 30 | 32 | -35 | 67 | <0.05 | 30 |
| | | | 38 | 0.14 | 24 | | | 1 | 0.97 | 24 |

[1]GT = glyphosate tolerant; CONV = conventional.
[2]Site 1 date of planting = April 23, 1999, and April 20, 2000.
[3]Site 2 date of planting = May 3, 1999, and April 27, 2000.
[4]Excludes costs for land, management, and general farm overhead.

variety did not significantly interact with the measured differences between sites; thus, the differences were consistent. Experimental conduct was the same at each site each year. No detectable differences in pest pressure or growth parameters occurred between the two sites, and familiarity with the two sites resulting from many years of past research lead to the expectation that soybean grown on both sites should perform similarly when receiving similar inputs. Therefore, in the opinion of the investigators, the large difference in seed yield and net returns between the two sites is attributed to the small difference in the planting dates. Averaged across both years and varieties, the difference in yield between Site 1 and Site 2 is 19.3 bushels per acre ($P < 0.01$; SE = 4.9 bushels per acre), and the difference in net return between Site 1 and Site 2 is $80 per acre ($P < 0.03$; SE = $25 per acre). These results indicate that the ESPS should provide best results if planting is as early as possible in the intended timeframe of April 1 to 30.

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