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Row Spacing, Plant Populations, and Cultivar Effects on Soybean Production Along the Texas Gulf Coast

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Abstract

Three soybean (*Glycine max* L.) cultivars were compared when planted in twin rows (two rows spaced 4 to 6 inches apart on a single bed with 38-inch centers) to soybean produced in single rows on a bed (spaced 38 inches apart) at three seeding rates of 6, 10, and 15 seeds/planted ft at two locations along the Texas Gulf Coast in 2003 and 2004. Soybean yield averaged over cultivars and seeding rates resulted in the twin-row system out-producing the single-row system at two of the four site-years. Soybean yield did not increase as the seeding rate increased with either row spacing. When only seed costs were considered, the twin-row system planted at 6 seeds/ft had the highest net return at three of the four site-years.

Introduction

Soybean producers are continually searching for methods that will help increase yields, reduce costs, or a combination of the two. The use of twin-row systems have resulted in yield increases over a single row system in several crops including corn (*Zea mays* L.), cotton (*Gossypium hirsutum* L.), and peanut (*Arachis hypogaea* L.) (1,5,10,12,15). Several studies have demonstrated the benefit of decreased row spacing on early season canopy development (6,7,11,17,18). In peanuts, Jaaffar and Gardner (13) reported that narrow and twin-row patterns had greater ground cover, leaf area indices, canopy light interception, crop growth rates, and ultimately higher pod yields when compared to a conventional row pattern.

Seedlings in close proximity to each other express phytochrome-mediated responses by developing narrow leaves, long stems, and less massive roots (14). Planting a crop in a pattern that reduces the spacing of plants within and between rows can increase plant biomass and leaf area index (3). Work in the late 1980s showed that reduced row spacing increased the total interception of photosynthetic active radiation by the corn canopy and redistributed the radiation toward the top of the canopy (16). Reduced row spacing are also thought to increase weed control by increasing the competitiveness of a crop with weeds and by reducing light transmission to the soil surface (19). Teasdale (19) showed that reduced row spacing and increased corn populations decreased weed growth in the absence of herbicides and shortened the time of canopy closure by one week.

Twin-row systems have been compared in soybean (*Glycine max* L.) with mixed results. Graterol et al. (9) reported that soybean planted in the twin-row system had no yield advantage over the conventional single-row system in a year with yield-limiting conditions. However, in a year with no yield-limiting conditions, the twin-row planting systems offered yield advantages over a single-row planting system. Other studies have reported on the use of narrow row spacing in soybean. Maturity group V to VII determinate soybean grown in narrow rows (generally 50 cm or less) produced higher yield than soybean grown in wide row spacing in the southern US (4,8,20).

Little use of twin-row soybean production has occurred along the Texas Gulf Coast soybean production area. This study was designed to increase the knowledge about twin-row soybean production for this area. The two objectives were: (i) evaluate a mid-group-IV soybean cultivar and an early group V cultivar produced in twin-rows compared to conventional 38-inch rows, and (ii) compare both row spacings when planted at the rate of 6, 10, and 15 seeds per planted foot.

Field Procedures

Soybean was planted near El Campo and Pt. Lavaca, TX on 24 March 2003 and on 29 March, 2004 near Pt. Lavaca and 21 April 2004 near El Campo. Different planting dates in 2004 occurred due to wet conditions at the El Campo location during the latter part of March. The experimental design for each year was a factorial arrangement using a randomized complete block with three replications at each location. Factors were row spacing (2), seeding rates (3), and soybean cultivars (2). Soybean cultivars used in 2003 at both locations were HBK 5101 and DP 4446 while in 2004 the cultivars at El Campo were HBK 5123 and Pioneer 94M90 and the cultivars at Pt. Lavaca were HBK 5101 and DP 4724.

Boundary (*S*-metolachlor plus metribuzin) was applied preemergence at 1.0 qt/acre for weed control. Select (clethodim) was used postemergence at 10 oz/acre to control any annual grass escapes while Blazer (acifluorfen) was used at 1.5 pt/acre to control any broadleaf weed escapes. Weeds were treated when less than 6 inches tall and all postemergence herbicide treatments included Agridex added at the rate of 0.25% v/v.

Each twin-row plot had two sets of twin rows (two rows spaced 4 to 6 inches apart on a single bed spaced on 38-inch centers) that were planted with a Monosem vacuum planter (Monosem ATI Inc., Leneka, KS) equipped with precision seed meters. Conventional planted soybeans were planted in the middle of the raised bed also spaced on 38-inch centers. Two trips were made through each plot to plant the twin-rows since planters were off-set from the row center while conventionally planted soybeans were centered directly over the row. Plots were planted at a rate of 6 (82,700 seeds/acre), 10 (137,400 seeds/acre), and 15 (206,100 seeds/acre) seed per planted foot; therefore the twin-row actually had 12 (165,400 seeds/acre), 20 (274,800 seeds/acre), and 30 (412,200 seeds/acre) seed planted per linear foot. Seedling emergence counts were taken approximately six weeks after planting. Pod height measurements (mean difference from the ground to the first node on the main stem with the pod attached) were taken in 2003 but not 2004. Lowest pod were measured prior to harvest. Five plants per plot were measured and an average recorded. Harvesting was accomplished mechanically with a small plot combine and plot yields adjusted to 13% moisture.

Net returns were based on seed costs only and did not include land preparation, herbicide, or insecticide costs. Seed costs were calculated based on calls to local seed representatives. Seed costs were based on a cost of $35.00 per bag at 150,000 seeds per bag count while the soybean price was calculated at $5.88/bu based on the close of the market on 21 February, 2006.

Data were analyzed using PROC GLM with SAS (SAS Institute, Inc., Cary, NC) and a model statement appropriate for a factorial design. Treatments means were separated by Fisher's protected least significant difference test at $P = 0.05$. Data for the two years were analyzed separately due to changes in soybean varieties.

Yearly Rainfall

In 2003 at El Campo, below average rainfall was received for March through May with average to above average rainfall for June through July, while in 2004 rainfall was above average for all months except March and July (Table 1). At Pt. Lavaca, in 2003, very little rainfall was received in April, May, and August with below average rainfall for June and July. In 2004, only April resulted in above average rainfall while the other months were extremely dry (Table 1).

Table 1. Rainfall amounts at the two locations in 2003 and 2004.

Month	Rainfall amounts (inches)					
	El Campo			Pt. Lavaca		
	2003	2004	20-year avg	2003	2004	20-year avg
March	1.31	2.56	3.18	2.06	1.04	2.08
April	0.34	4.62	3.30	0.26	6.78	2.93
May	0.16	6.64	4.70	0.28	1.26	4.95
June	5.11	12.66	4.98	3.47	0.02	4.77
July	6.90	0.31	3.27	1.65	0	3.03
August	0.94	3.89	1.04	0.36	0.65	5.37

Plant Populations

Row spacing interacted with seeding rate for each year at both locations. Plant populations increased when seeding rates were increased from six to ten seeds/ft but a decrease in plant populations was noted when the seeding rate was increased from ten to fifteen seeds/ft at both the twin and 38-inch row spacings (Table 2). Other research has shown that optimal plant populations vary from 12,000 to 202,000 plants per acre (4,8). The optimal soybean plant population can vary by as much as 100% across years, even when the same cultivar is grown in the same location (20). This variability can be explained by environmental conditions, with the optimal plant populations increasing under adverse conditions (20).

Table 2. Soybean plant populations (plants/planted foot) as influenced by row spacing and seeding rates in 2003 and 2004 at El Campo and Pt. Lavaca.

Seeding rate (seeds/ft)	Row spacing	El Campo	Pt. Lavaca	El Campo	Pt. Lavaca
		2003		2004	
6	38-inch	5.4	5.2	5.6	4.8
	Twin	11.1	9.8	11.3	8.6
10	38-inch	8.7	9.1	7.7	5.7
	Twin	17.1	16.5	16.8	14.1
15	38-inch	7.1	7.4	6.7	5.5
	Twin	14.8	14.2	14.1	10.7
$LSD_{0.05}$		1.2	1.8	1.0	2.0

Row Spacing Effects on Pod Height.

Lowest pod height was significantly higher in twin rows than single rows for HBK 5101 and DP 4446 at El Campo in 2003 while at the Pt. Lavaca location no response was seen to the twin-row effect with either variety (Table 3). No response to pod height was seen with seeding rate (*data not shown*). Bowers et al. (2) reported that soybean plant and pod heights were generally greater in the twin rows than in the single row planting system; however, in general, row spacing had no measurable effect on pod height.

Table 3. Soybean pod height (lowest pod height) response to twin- versus single-row plantings in 2003.

Variety	Row spacing	El Campo	Pt. Lavaca
		Pod height (inch)	
HBK 5101	Twin	5.6	3.6
HBK 5101	38-inch	3.2	3.3
DP 4446	Twin	3.5	2.3
DP 4446	38-inch	2.5	2.1
$LSD_{0.05}$		1.0	0.7

Soybean Yield

Row spacing by variety response was noted for three of the four site years, with the only exception being Pt. Lavaca in 2003 (Table 4). HBK 5101, Pioneer 94M90, and DP 4724 all had a positive yield response to the twin-row system while HBK 5123 had a negative yield response to the twin-row spacing. Yields were not different for DP 4446 with either system at the two locations. Bowers et al. (2) reported significant yield differences due to row spacing in 3 of 4 years. In 2 of those years, yield was greater from the twin-row system while in one year the reverse was true. They also reported that late-season rainfall also affected yield response to row spacing. In their study the twin-row system produced a yield advantage in the 2 years receiving the most late-season rainfall. Graterol et al. (9) reported that twin-row planting systems yielded more than single-row systems only in environments without yield limitations. Rainfall near El Campo in 2003 was below average for March through May but above average for June and July. At Pt. Lavaca in 2004 all months except April had below-average rainfall (Table 1). Rainfall during late fall of 2003 and winter of 2004 can be characterized as above average (*data not shown*); therefore, sub-soil moisture was present at Pt. Lavaca to help maintain plant growth and development.

Table 4. Soybean yield averaged across seeding rate as influenced by variety and twin- versus single row plantings.

Row spacing	El Campo 2003		Pt. Lavaca 2003		El Campo 2004		Pt. Lavaca 2004	
	Cultivar							
	HBK5101	DP4446	HBK5101	DP4446	HBK5123	94M90	HBK5101	DP4724
	Soybean yield (bu/acre)							
Twin rows	31.8	31.4	19.7	21.2	37.9	59.2	56.1	43.8
38-inch rows	26.4	30.0	18.1	19.9	47.3	54.0	43.2	35.3
$LSD_{0.05}$	4.2		NS		4.5		4.1	

Partial Net Dollar Returns

Partial net returns were greatest with 6 seeds/ft either planted in the twin-row or 38-inch row system (Table 5). At El Campo in 2003 and Pt. Lavaca in 2004, the twin-row system planted at 6 seeds/ft resulted in the highest partial net return while at Pt. Lavaca in 2003 and El Campo in 2004, the 38-inch row system at 6 seeds/ft produced the highest returns. The 10 seeds/ft rate was intermediate in partial net return with both the twin- and 38-inch row system. The 15 seeds/ft rate planted in the twin-row produced the lowest partial net return in 2 of 4 site years.

Table 5. Partial net returns for row spacing and seeding rate effects on yield based on seed costs only.

Row spacing	**Seeding rate** (no. per planted ft)	**Returns** ($/acre)[x]			
		2003		2004	
		El Campo	**Pt. Lavaca**	**El Campo**	**Pt. Lavaca**
Twin	6	151.33	72.69	250.80	259.53
	10	117.77	61.34	237.03	227.23
	15	89.73	28.48	265.58	195.37
38-inch	6	146.71	87.99	289.99	194.14
	10	129.93	76.06	264.29	186.58
	15	121.74	72.08	260.02	212.88
$LSD_{0.05}$		17.64	15.35	29.99	67.58

[x] Seed costs were calculated based on a cost of $35.00 per bag at 150,000 seed per bag count while soybean price was calculated at $5.88/bu.

When seeding rates were compared, at a planting rate of 6 seeds/ft, only at the El Campo location in 2004 was there a significant increase in net returns with either system. The single row 38-inch system had almost a $40/acre return over the twin-row system. At 10 seeds/ft, no difference in net returns were noted between the two systems while at a seeding rate of 15 seeds/ft, both locations in 2003 showed a net increase with the 38-inch spacing over the twin-row system. No differences were noted in 2004 at either location with a seeding rate of 15 seeds/ft (Table 5).

Partial net returns were not different between the two systems at a lower seeding rate in three of four site-years. As seeding rates increased, the 38-inch system had a higher partial net return than the twin-row system in 2003 but not 2004. However, if a twin-row system is to be used, seeding rates should be no greater than 6 seeds/planted ft to avoid a substantial increase in seed cost and a reduction in net returns in most years.

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