Hindawi Publishing Corporation
International Journal of Agronomy
Volume 2014, Article ID 252563, 7 pages
http://dx.doi.org/10.1155/2014/252563

Research Article

Response of Soybean to Early-Season Planting Dates along the Upper Texas Gulf Coast

W. James Grichar[1] and Stephen P. Biles[2]

[1] *Texas A&M AgriLife Research, 10345 State Hwy 44, Corpus Christi, TX 78406, USA*
[2] *Texas A&M AgriLife Extension Service, Port Lavaca, TX 77979, USA*

Correspondence should be addressed to W. James Grichar; w-grichar@tamu.edu

Received 29 May 2014; Accepted 4 August 2014; Published 14 August 2014

Academic Editor: David Clay

Soybeans (*Glycine max* L.) can be planted along the upper Texas Gulf Coast from mid-March through May to take advantage of early season rains and to complete harvest before hurricane season and fall rains become a problem. However, in the Calhoun County area (28.5° north latitude), these planting dates have resulted in below average yields and reasons for these yield reductions are not clear. To determine if earlier planting dates could be an option to eliminate the low yields, field studies were conducted from 2005 through 2010 in Calhoun County, Texas, to determine soybean cultivar response to planting dates which ranged from mid-February through the last of April. Typically, soil temperatures in this area are above 18°C in mid-February and depending on weather patterns may not fall much lower during any time in the early portion of the growing season. The greatest yield was obtained with the mid-February and mid-March planting dates compared with early- or late-April planting dates. Typically, as planting date was delayed, the interval between planting and harvest decreased.

1. Introduction

Soybeans (*Glycine max* L.) are grown along the upper Texas Gulf Coast and this area has become the largest soybean production area in the state. Most of the soybeans are planted from mid-March through May and are categorized as early soybean production system plantings (ESPS). Production components such as planting date and variety can be manipulated to counter the effects of various environmental factors on soybean development and yielded [1–5]. The rationale for planting early is to avoid the high temperature of July and August and to take advantage of late spring and early summer rains for maximum flowering, seed set, and seed filling [4, 6]. Stress can reduce soybean yield by reducing the number of pods seeds and seed mass [7, 8]. Both determinate and indeterminate soybean cultivars have reduced growth rates under drought stress and resume normal growth rates when such stress is removed [8]. This may be an important growth attribute to consider if producers expect considerable soil moisture deficits due to short, intermittent droughts during the growing season [5].

The effect of planting date on soybean yield can vary substantially from year to year depending on variations in environmental conditions, principally rainfall amounts and distribution [9]. Soybean planted along the upper Texas Gulf Coast in late March through April can yield over 1400 kg/ha when timely rainfall is received during the growing season [10]. Soybeans planted during early April through early May in the Calhoun County area of Texas have yielded less than 1000 kg/ha and although the plants develop normally, the pods in many instances do not contain any soybean. Stink bugs including the green (*Nezara viridula*) or brown (*Euchistus heros*) stink bug has been mentioned as a source of the problem (M. O. Way, personal communication) and insecticide applications add to production costs. Calhoun County is located along the upper Texas Gulf Coast and since this area borders the coastal area of the Gulf of Mexico, it was thought that an extremely early planting date could take

advantage of the early-season rainfall and the threat of stink bugs can be less of an issue since they typically move into soybeans after grain sorghum (*Sorghum bicolor* L. Moench) has matured and has been harvested which is usually in early July through August.

Therefore, the objectives of this research were to identify the components of soybean production encompassing cultivar and planting date that could increase soybean yield in Calhoun County depending on moisture conditions without stink bug as one of the limiting factors. This information will aid producers in adapting earlier planting dates that will improve soybean yield and reduce the chance of yield reductions.

2. Materials and Methods

2.1. Field Locations and Soil Types. Field experiments were conducted in 2005 through 2010 on a soybean grower's farm at two locations in Calhoun County in the Texas soybean production area along the upper Texas Gulf Coast. Studies in 2005 through 2008 were conducted in the southwestern area of the county (28.5°N, 96.7°W) and from 2009 through 2010 in the north-central area (28.6°N, 96.8°W) of the county. These two areas are about 30 to 40 km apart. Soil type at the southwestern area of the county was a Houston Black clay (fine, smectitic, thermic Udic Haplustert) with 1% organic matter and a pH of 7.4 to 7.7 while the soil type in the north-central area was also a Houston Black clay with <1% organic matter and a pH of 7.3 to 7.8. Since soybean is a legume and can produce its own nitrogen, no nitrogen fertilizer was applied by the grower; however, phosphorus and potassium were applied as needed according to Texas Cooperative Extension recommendations for soybean.

2.2. Weed Control. Plots were maintained weed-free throughout the growing season using a preemergence application of either a premix of *S*-metolachlor plus metribuzin (Boundary, Syngenta Crop Protection, Greensboro, NC 27419-0135) at the rate of 1.12 kg ai/ha or pendimethalin (Prowl H_2O, BASF Corp., Florham Park, NJ 07932) plus imazethapyr (Pursuit, BASF Corp., Florham Park, NJ 07932) at 1.06 kg ai/ha plus 0.07 kg ai/ha, respectively, depending on location. Grass and broadleaf weed escapes were controlled with postemergence applications of clethodim (Select, Valent USA Corp., Walnut Creek, CA 94596-8025) at 0.21 kg ai/ha and acifluorfen (Blazer, BASF Corp., Research Triangle Park, NC 27709) at 0.84 kg ai/ha or lactofen (Cobra, Valent USA Corp., Walnut Creek, CA 94596-8025) at 0.22 kg ai/ha, respectively. Postemergence herbicide applications included the surfactant, Agridex (Helena Chemical Co., 6075 Poplar Ave., Memphis, TN 38119), at the rate of 0.25% v/v. The number of postemergence herbicide applications varied from year to year depending on weed emergence problems. Since not all of the cultivars evaluated were glyphosate tolerant, no attempt was made to use glyphosate in the study due to drift issues. Effects from glyphosate drift could easily be severe enough to invalidate the experimental results if not avoided. Drift problems with glyphosate that are severe enough to cause substantial yield losses are sometimes very difficult to detect [10].

2.3. Soybean Cultivars. Cultivars (late Group IV through late Group V's) selected for the study were those that had shown promise in previous studies or had been produced well in other soybean producing regions of Texas or surrounding states (Table 1). However, difficulty in obtaining the cultivars from the seed companies for the extremely early planting dates limited the cultivars selected and prevented many of the same cultivars from being used in each year of the study. For ease of reporting these cultivars will be referred to by maturity group. Soybean seed was planted on slightly raised seedbed (except in 2010) with a vacuum planter (Monosem ATI, Inc., Lenexa, KS) to provide a uniform seeding rate of 33 seed/m (55,847 seeds/ha) on a pair of rows with 97 cm centers.

2.4. Planting Dates. Planting dates, approximately three weeks apart, were used each year with the first planting date around the 15th of February depending on weather conditions (Table 2). The March and early-April planting dates in 2007 were delayed due to above normal rainfall which was received during the normal March to early-April planting window and which prevented entry into fields (Table 3). In 2009, the 2nd planting was delayed due to extremely dry conditions while plantings were delayed in 2010 due to extremely wet conditions which persisted throughout the early part of the growing season and prevented entry into the field (Table 3). Also, these plantings in 2010 were on flat ground without beds since land preparation could not be completed during the fall of 2009 due to the extremely wet conditions. Later plantings in April were attempted but poor stands developed due to plantings on flat ground which remained extremely wet because of heavy rains in April. Due to poor stands, it was felt that the data from the April plantings would not give accurate results. For ease of reporting, the planting dates will be referred to as February 20, March 15, April 5, and April 25. All planting dates were within 3 to 5 days of the above dates with few exceptions (Table 2).

2.5. Plant Stands and Plant Height at Maturity. Plant stand counts were not taken in 2005; however, stand counts were taken approximately 6 weeks after soybean were planted in all other years. Plant height was measured in 2008 through 2010 approximately 3 to 4 weeks prior to harvest with measurements taken from ground level to the tip of the plant growth terminal. Five plants per plot were measured and an average was recorded.

2.6. Determining Cultivar Maturity and Harvesting. Physiological maturity of soybean seed occurs when the accumulation of dry weight ceases [11]. This stage first occurs when the pod turns yellow or has completely lost its green color. With favorable drying weather, the soybeans lose moisture quickly [11]. For all cultivars, paraquat at 0.28 kg/ha was applied when at least 70% of the seed pods had reached a mature brown color or when the seed moisture was 25%

Table 1: Soybean cultivars used in each year[a].

Maturity group	2005	2006	2007	2008	2009	2010
4.6	Garst 4612RR	—	—	—	—	—
4.8	—	—	DP 4888RR	—	—	PR4807RR
4.9	—	—	—	S49-W6RR	S49-W6RR	CR4998RR
5.0	—	—	—	HBK 5025	HBK 5025	HBK 5025
5.1	HBK 5123RR	HBK 5123RR	HBK 5123RR	HBK 5123RR	HBK 5123RR	S51-T8RR
5.4	—	DP 5414RR	—	HBK 5425RR	HBK 5425RR	HBK 5425RR
5.9	—	—	HBK 5941	—	HBK 5941	HBK 5941

[a]Soybean cultivar abbreviations: DP, Delta and Pine Land; HBK, Hornbeck Seed Co.; S, Syngenta Seed Co.; PR, Progeny Seed Co.; and CR, Croplan Genetics.

Table 2: Planting dates in each year in Calhoun County.

2005	2006	2007	2008	2009	2010
Feb. 22	Feb. 22	Feb. 21	Feb. 20	Feb. 10	March 15
March 14	March 14	March 26	March 12	March 25	March 29
April 5	April 5	April 16	April 2	April 6	
April 26	April 26	April 30	April 23	April 21	

Table 3: Monthly rainfall and 40-year average in Calhoun County.

Month	2005	2006	2007	2008	2009	2010	Average
				mm			
February	50.8	18.8	8.9	38.1	6.6	81.5	61.1
March	163.1	19.8	168.4	27.4	65.8	40.1	80.7
April	13.7	3.6	68.1	42.7	136.6	129.3	83.8
May	108.5	168.4	152.1	9.4	65.2	120.4	119.4
June	26.4	123.7	82.0	31.0	10.7	155.7	126.5
July	120.1	220.5	444.8	131.5	17.8	247.4	83.8
August	29.7	18.5	147.1	72.9	49.8	29.2	89.2
Total	512.3	573.3	1067.6	353.0	352.5	803.6	644.5

or less [12]. These guidelines were adopted from the US Gramoxone Inteon label [12] and used on all cultivars. Within 3 to 5 days when seed moisture was approximately 12%, plots were harvested with a small plot combine. At the 3- to 5-day interval, additional cultivars were checked for color and moisture content and, if at the desired level, sprayed with paraquat.

2.7. Stink Bug Control. Typically, soybean producers along the upper Texas Gulf Coast make 2 to 3 insecticide applications during the growing season depending on stink bug numbers (authors' personal observations). These growers treat soybean as a secondary crop and are typically not willing to spend the money or the time and the effort to fully control these insects. In our studies we tried to duplicate this practice and normally made the first insecticide application when stink bug numbers reached the threshold values. This was followed by a second insecticide application two to four weeks later.

2.8. Experimental Design and Data Analysis. The treatment design was a factorial arrangement using a randomized complete block design with a planting date and soybean maturity group (cultivars) as factors. To reduce harvesting difficulties when using a small plot combine, it was decided to keep all of the plots for one planting date physically together and cultivars randomized within planting dates. Because the experimental areas were quite uniform in their surface drainage and soil type, we felt that the effect of physical field location would be small compared with the planting date and cultivar effect. Replicates were separated by 1.7 m while planting dates were separated by 6.4 m. Each cultivar was replicated three times within each planting date with a soybean cultivar plot size of 2 rows (97 cm centers) by 9.1 m long. An analysis of variance was performed using the ANOVA procedure for SAS [13] to evaluate the significance of planting date and soybean cultivar on soybean plant stands, plant height, and yield. The Fisher's Protected LSD at the 0.05 level of probability was used for separation of mean differences. Since environmental conditions were different at each location and soybean cultivars varied from year to year due to availability, data are presented separately by years.

3. Results and Discussion

3.1. Soybean Plant Stands as Influenced by Early Plantings. There was a maturity group (cultivar) by planting date interaction for each year; therefore, data are presented by maturity group and planting date. In 2006, with the 5.1 maturity group soybean, the April 5 planting date resulted in the lowest number of emerged plants/m while, with the 5.4 maturity group, all planting dates resulted in lower plant counts than the February 20 planting (Table 4). In 2007, all maturity group soybeans resulted in lower plant stands when planted on February 20 while in 2008 similar trends were noted with lower stand counts with earlier planting. In 2009, all maturity group soybeans, with the exception of 5.1 maturity group, had lower stand counts with the earliest planting date. In 2010, no difference in emergence between planting dates was noted for the 4.9 and 5.4 maturity group. The 4.8 and 5.0 maturity group soybean had greater emergence at the March 15 planting date while the 5.1 and 5.9 maturity group soybean had greater number of emergence at the later planting date.

Soil temperatures (Table 5) were above 18°C at all planting dates. The ideal soil temperature for soybean germination and emergence is 25°C at the 5 cm depth [11]. However, soybean can easily germinate at soil temperatures of 10°C and it is not unusual for emergence to take 3 weeks at these

Table 4: Plants counts of soybean cultivars at different planting dates.

Plant date	2006		2007			2008			
	Maturity group								
	5.1	5.4	4.8	5.1	5.9	4.9	5.0	5.1	5.4
	Plants/m								
Feb. 20	23.9	28.9	31.5	25.9	29.8	21.3	17.9	19.7	20.4
Mar. 15	21.3	23.0	33.1	28.5	31.8	24.3	27.7	27.3	23.9
Apr. 5	18.4	22.3	34.4	33.1	33.1	25.6	26.4	22.6	17.9
Apr. 25	20.2	21.6	33.8	28.9	32.5	27.7	28.1	26.0	19.2
LSD (0.05)	3.9			2.3				6.9	

Plant date	2009					2010				
	Maturity group									
	4.9	5.0	5.1	5.4	5.9	4.8	4.9	5.0	5.1	5.4	5.9
	Plants/m										
Feb. 20	15.5	27.2	24.9	21.6	28.5	—	—	—	—	—	—
Mar. 15	23.9	30.8	24.6	27.2	31.8	22.6	18.7	20.0	23.3	18.4	16.1
Apr. 5	22.8	28.4	24.3	27.5	30.8	13.4	17.7	11.5	28.8	19.0	20.7
Apr. 25	23.1	29.1	23.8	26.8	31.5	—	—	—	—	—	—
LSD (0.05)			2.3					3.6			

Table 5: Soil temperature (°C) at the 2.5 cm depth at planting in Calhoun County.

2005		2006		2007		2008		2009		2010	
Date	Temp.	Date	Temp.	Date	Temp.	Date	Temp.	Date	Temp.	Date	Temp.
Feb. 22	22.4	Feb 22	19.5	Feb 21	19.3	Feb 20	17.8	Mar 17	19.2	—	—
March 14	19.0	March 14	21.3	March 26	22.7	March 12	22.9	Mar 25	23.0	Mar 15	21.0
April 5	22.7	April 5	25.8	April 16	20.4	April 2	24.7	Apr 6	20.5	Mar 29	19.9
April 26	23.4	April 26	26.6	April 30	24.4	April 23	26.5	Apr 21	24.5	—	—

low temperatures [11]. Other studies have reported that early plantings may delay and decrease seedling emergence if the soil is cold and wet at planting [9], resulting in plant populations that are below the threshold for maximum yield [14].

3.2. Soybean Plant Height as Influenced by Planting Date and Maturity Group. Since there was a maturity group (cultivar) by planting date interaction, data are presented by maturity group and cultivar for each planting date. Typically, plant height increased when planting date was delayed from February until mid-March (Table 6). However, delaying planting date from mid-March until April did not always translate to an increase in plant height. In 2008, the February planting date resulted in shorter plant height than the mid-March or April planting date for the maturity group 5.0 and 5.1 soybean; however the 4.9 and 5.4 maturity group soybean did not show a growth response for the February to March planting date. Rainfall events for February through June were below normal with above normal rainfall for July (Table 3).

In 2009, differences were found between the February and mid-March planting date for all maturity groups and mid-March and the 5th of April for all maturity groups with the exception of the 5.4 maturity group. For the late April planting date, the 4.9 maturity group soybean produced a lower plant height than the April 5th planting. No other plant height differences were noted between the April plantings. Although above normal rainfall was observed in April, the rainfall was below normal throughout the growing season (Table 3).

In 2010, plant height increased when planting was delayed with the 4.9 and 5.1 maturity group soybean; however, no other differences were noted. Rainfall for May through July was above normal and may have accounted for some of the increased plant height as planting date was delayed. Previous research has shown a reduction in plant height and node numbers as planting date was delayed [15, 16]. However, these studies were based on May through July plantings and are expected considering photoperiod effect [15]. Since the plantings in this study were early in the season, a response to photoperiod is not unexpected.

3.3. Soybean Yield as Influenced by Planting Date and Maturity Group. There was a maturity group (cultivar) by planting date interaction for each year; therefore, data are presented separately by maturity group and planting date. Generally, the mid-February and March planting dates produced the highest yield with the exception of 2005 and 2010 (Table 7). In 2005, the above normal rainfall in March may have accounted for yields with the April 5 planting that were not seen in 2006 through 2008. The 4.6 maturity group soybean produced the greatest yield when planted in February while the 5.1 soybean yielded the highest when planted mid-March.

Table 6: Plant height response of soybean cultivars to different planting dates.

Plant date	2008				2009					2010					
	Maturity group														
	4.9	5.0	5.1	5.4	4.9	5.0	5.1	5.4	5.9	4.8	4.9	5.0	5.1	5.4	5.9
	cm														
Feb. 20	36.3	37.3	35.1	32.5	38.1	53.3	54.1	54.1	65.3	—	—	—	—	—	—
March 15	39.9	48.3	45.0	37.3	50.8	61.7	75.4	71.1	75.4	39.8	41.9	80.5	35.6	65.3	85.6
April 5	45.4	49.5	46.2	39.4	69.3	75.4	66.0	70.4	88.1	45.2	62.3	76.7	60.9	67.8	85.6
April 25	44.6	51.1	47.5	39.4	55.9	72.3	65.6	70.1	84.3	—	—	—	—	—	—
LSD (0.05)	5.1				4.1					9.7					

Table 7: Yield response of soybean cultivars to different planting dates.

Plant date	2005		2006		2007			2008			
	Maturity group										
	4.6	5.1	5.1	5.4	4.8	5.1	5.9	4.9	5.0	5.1	5.4
	Kg/ha										
Feb. 20	1628	1197	464	706	1600	1971	2374	861	962	665	894
Mar. 15	955	1789	894	901	1015	2501	2064	464	424	256	296
Apr. 5	1137	1137	0	0	0	0	0	0	0	0	0
Apr. 25	565	0	0	0	0	0	0	0	0	0	0
LSD (0.05)	289		154		665			87			

Plant date	2009					2010					
	Maturity group										
	4.9	5.0	5.1	5.4	5.9	4.8	4.9	5.0	5.1	5.4	5.9
	Kg/ha										
Feb. 20	1621	2186	1782	1930	1843	—	—	—	—	—	—
Mar. 15	1406	1547	1204	1439	1311	2492	1897	3524	2145	2643	3605
Apr. 5	773	232	410	336	491	2314	2885	3840	2603	3148	4008
Apr. 25	27	0	0	0	0	—	—	—	—	—	—
LSD (0.05)	81					504					

In 2006, yields were poor with the February and March planting dates and no yield was produced when soybeans were planted in April. Rainfall was below normal for the February through April time period but was normal or above normal for May through July (Table 3). In 2007, soybean yields were at least 1600 kg/ha for all maturity groups soybeans planted in February or March with the exception of the 4.8 maturity group soybean planted mid-March which yielded less than 1100 kg/ha. No yield was obtained with the April plantings. In 2008, similar trends as seen in 2006 were noted due to the extremely dry conditions during the growing season (Table 3).

In 2009, soybean planted in February or March produced yields which ranged from 1200 to over 2100 kg/ha regardless of maturity group while soybean planted on the first of April yielded 232 to 773 kg/ha (Table 7). The 5.0 maturity group soybean produced the greatest yield at either the February or March planting dates. Overall, 2009 was extremely dry but a major rain event in April greatly helped improve the yields. In 2010, extremely wet condition persisted throughout the early portion of the growing season. Soybean yields with either the March or April planting dates were the greatest with the 5.0 and 5.9 maturity group soybean. No differences in soybean yield were noted between planting dates with the exception of 4.9 maturity group soybean which produced a greater yield when planted on the first part of April compared with a March planting date.

3.4. Number of Days from Plant to Harvest. Generally, the later the planting date, the shorter the interval between soybean planting and harvest [10]. However, in the year with above average rainfall, trends toward a greater number of days from planting to harvest were noted. This is important in that the longer the plant is exposed to the elements, whether it is an increasing chance of a hurricane or an increase in green or brown stink bug populations, the greater the chance of yield loss is [10].

In 2005, the planting to harvest interval varied across planting dates and maturity groups and was not consistent (Table 8). In 2006, the time interval between planting and harvest did become shorter by 8 days as planting was delayed from February to March. In 2007, the interval between plant date and harvest date was longer for the March planted soybean than in 2006 and this was due to the above average

Table 8: Days from planting to harvest according to planting dates.

Plant date	2005		2006		2007			2008			
	Maturity group										
	4.6	5.1	5.1	5.4	4.8	5.1	5.9	4.9	5.0	5.1	5.4
	Days										
Feb. 20	121	133	133	121	105	112	126	119	119	119	119
Mar. 15	113	119	121	113	128	134	128	110	110	110	110
Apr. 5	91	139	0	0	0	0	0	0	0	0	0
Apr. 25	117	0	0	0	0	0	0	0	0	0	0
Plant date	2009					2010					
	Maturity group										
	4.9	5.0	5.1	5.4	5.9	4.8	4.9	5.0	5.1	5.4	5.9
	Days										
Feb. 20	148	148	148	148	148	—	—	—	—	—	—
Mar. 15	105	105	105	105	105	135	135	140	135	147	155
Apr. 5	93	93	112	112	112	147	147	141	141	147	147
Apr. 25	97	0	0	0	0	—	—	—	—	—	—

rainfall during the growing season (Table 3) and below normal temperatures (data not shown). These weather conditions slowed plant growth and therefore extended the growing season [7, 10].

When the soybean plant reaches beginning maturity, warm weather does not hasten maturity unless it causes water deficit stress and maturity is more strongly influenced by photoperiod [11].

In 2008, the interval between planting and harvest for the March planting date was reduced from 2006 to 2007 due to the dry, hot conditions [10, 11]. All soybeans planted in February were harvested 119 days after planting while those planted in March were harvested 110 days after planting (Table 8). In 2009, the planting and harvest interval decreased from the February planting while in 2010 little or no difference was noted.

Heatherly [2] reported that, near Stoneville, MS, cultivars planted before 16 April took an average of 5 days longer to reach R1 (beginning bloom) than did cultivars planted after 16 April to 1 May. When cultivars were planted from May through June, the number of days to R1 decreased as planting date was delayed. Heatherly [2] concluded that the reproductive period of later-maturing cultivars would occur later in the season when stored soil moisture has been reduced, probability of rainfall is lower, and air temperatures are higher.

4. Conclusion

Planting soybean in February to mid-March is an option for soybean growers in the Calhoun County (28.5°N latitude) area of the upper Texas Gulf Coast. Soybean planted in early April produced over 1100 kg/ha in two out of six years while in the other years little or no yield was obtained with this planting date. When planting date was delayed until late April, no soybean yields were produced. Also, the length of time from planting until harvest is an issue for producers who are concerned with stink bug population increases after grain sorghum harvest and the increased chance of hurricanes as the season progresses.

Under less than optimum growing conditions due to dry conditions, the early plantings in February took advantage of available soil moisture and produced yields of at least 1000 kg/ha. In contrast, Heitholt et al. [17] reported that a mid-March planting date was not desirable for North Texas (33°N latitude) due to stand loss and poor seedling growth associated with cold and wet weather conditions. They concluded that waiting until mid-May to plant soybeans in that region was less successful than planting in April. Bowers [1] also reported on similar work in North Texas and found that, in general, April plantings outyielded May plantings across all twelve cultivars. The use of maturity group V cultivars resulted in fruiting during hot, dry conditions normally found in July and August while the early maturing types fruited during June when soil moisture was adequate and temperatures were not as severe [1].

Another advantage to early planting is that, in 2007, when Asian soybean rust (*Phakopsora pachyrhizi*) was found in many soybean fields along the upper Texas Gulf Coast in early to mid-July, the soybean in the earlier planted plots had already been harvested and out of the field before this disease became an issue.

Conflict of Interests

The authors declare that there is no conflict of interests regarding the publication of this paper.

Acknowledgments

The authors thank Kevin Brewer, Dwayne Drozd, Bill Klesel, and A. J. Jaks for their technical assistance in this research. This research was supported with grants from the Texas Soybean Board.

References

[1] G. R. Bowers, "An early soybean production system for drought avoidance," *Journal of Production Agriculture*, vol. 8, no. 1, pp. 112–119, 1995.

[2] L. G. Heatherly, "Yield and germinability of seed from irrigated and nonirrigated early- and late-planted MG IV and V soybean," *Crop Science*, vol. 36, no. 4, pp. 1000–1006, 1996.

[3] L. G. Heatherly, "Soybean development in the midsouthern USA related to date of planting and maturity classification," *Crop Management*, 2005.

[4] L. G. Heatherly, "Midsouthern USA soybean yield affected by maturity group and planting date," *Crop Management*, vol. 4, no. 1, 2005.

[5] M. P. Popp, T. C. Keisling, R. W. McNew, L. R. Oliver, C. R. Dillon, and D. M. Wallace, "Planting date, cultivar, and tillage system effects on dryland soybean production," *Agronomy Journal*, vol. 94, no. 1, pp. 81–88, 2002.

[6] M. V. Kane, C. C. Steele, and L. J. Grabau, "Early-maturing soybean cropping system: I. Yield responses to planting date," *Agronomy Journal*, vol. 89, no. 3, pp. 454–458, 1997.

[7] D. A. Ashley and W. J. Ethridge, "Irrigation effect on vegetative and reproductive development of three soybean cultivars," *Agronomy Journal*, vol. 70, pp. 467–471, 1978.

[8] J. E. Beurlein, "Yield of indeterminate and determinate semidwarf soybean for several planting dates, row spacings, and seeding rates," *Journal of Production Agriculture*, vol. 1, pp. 300–303, 1988.

[9] D. B. Egli and P. L. Cornelius, "A regional analysis of the response of soybean yield to planting date," *Agronomy Journal*, vol. 101, no. 2, pp. 330–335, 2009.

[10] W. J. Grichar, J. D. Janak, and P. McGuill, "Texas Gulf Coast soybean yield affected by soybean variety and planting date," *Crop Management*, 2008.

[11] P. Pedersen, *Soybean Growth and Development*, Extension PM 1945, Iowa State University Press, 2009.

[12] Anonymous, "Gramoxone inteon product information," Syngenta Crop Protection, 2011, http://www.syngentacropprotection.com.

[13] SAS Institute, *SAS/STAT User's Guide: Statistics. Version 9.1*, SAS Institute, Cary, NC, USA, 2007.

[14] C. D. Lee, D. B. Egli, and D. M. TeKrony, "Soybean response to plant population at early and late planting dates in the Mid-South," *Agronomy Journal*, vol. 100, no. 4, pp. 971–976, 2008.

[15] A. Q. Parvez, F. P. Gardner, and K. J. Boote, "Determinate- and indeterminate-type soybean cultivar responses to pattern, density, and planting date," *Crop Science*, vol. 29, pp. 150–157, 1989.

[16] J. E. Board and J. R. Settimi, "Photoperiod simulation and branch development in soybean," *Agronomy Journal*, vol. 78, pp. 995–1002, 1986.

[17] J. J. Heitholt, J. B. Farr, and R. L. Sutton, "Risk management in north Texas soybean: mid-March soybean plantings uncertain; maturity group IV cultivars reliable," *Crop Management*, vol. 4, no. 1, 2005.