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Soybean Development in the Midsouthern USA Related to Date of Planting and Maturity Classification

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Abstract

Soybean (*Glycine max*) is planted from late March through June in the midsouthern USA. Different developmental patterns that result from this range in planting dates will affect management decisions. Irrigated field studies were conducted at Stoneville, MS (33°26'N) from 1979 through 2003 to determine effect of late March through June planting dates on developmental patterns of maturity group (MG) IV through MG VI soybean. In all plantings, time from planting to beginning bloom (R1) increased as MG increased from IV to VI. Time from R1 to full seed (R6; pod cavity filled) was sometimes but not always different among the MGs, and differences were always ≤ 7 days. The major difference in the length of growing season among cultivars of different MGs occured before reproductive development began regardless of planting date. Thus, performance of soybean cultivars of disparate MGs should not be affected by differences in time between stages of reproductive development, but rather by when the stages occur.

Introduction

Soybean is a major crop in the midsouthern USA, and is grown on approximately 8 million acres in the region (9). There are two major systems of production based on planting dates: (i) late March through late April plantings which are categorized as early soybean production system plantings (ESPS; 2,5); and (ii) early May and later plantings which comprise the conventional soybean production system (CSPS; 5,6), to include doublecropped plantings behind winter wheat (*Triticum aestivum* L.) (11). In 2003, the midsouthern states of Arkansas, Louisiana, and Mississippi had 36%, 28%, and 36% of the soybean crop planted in the before-1 May, 1 May-to-1 June, and after-31 May periods, respectively (9).

Knowledge of the developmental pattern of soybean is necessary so that inputs timed to reproductive stages, and marketing of an early crop to ensure maximum commodity price, can occur. The objective of this report is to present developmental patterns of MG IV, V, and VI soybean cultivars in the midsouthern USA as related to planting date.

Field Studies Over 25 Years Using MGs IV, V, and VI

Myriad irrigated studies were conducted on Sharkey clay soil (very-fine, smectitic, thermic Chromic Epiaquert) on or near the Delta Research and Extension Center at Stoneville, MS (33°26'N) from 1979 through 2003. Cultivars of MG IV were used from 1989 through 2003, MG V cultivars were used from 1979 through 2003, and MG VI cultivars were used from 1979 through 1992 (Table 1). The maturity group designations are those provided by the originator of each cultivar. Cultivars were constantly deleted and added as new releases became available. The utilization of MGs during the 25-year period reflects a shift in production systems.

Table 1. Soybean maturity groups and years each used, and cultivars in each maturity group grown in long-term soybean evaluation studies at Stoneville, MS.

MG IV cultivars used from 1989 through 2003	**MG V cultivars used from 1979 through 2003**	**MG VI cultivars used from 1979 through 1992**
RA 452	Bedford	Tracy
D&PL DP3478	D&PL DP345	Tracy-M
Asgrow AG4701	D&PL DP105	Centennial
Dixie 478	Asgrow AG5980	Sharkey
Delta King DK4875	Pioneer P9592	Leflore
Asgrow AG4922	D&PL DP415	Asgrow AG6785
Hartz H4994RR	Hartz H5164	Young
Asgrow AG4601RR	Hutcheson	Pioneer P9691
AgriPro AP4880	Asgrow AG5979	Pioneer P9641
Pioneer P9492RR	Pioneer P9501	Hartz H6686
D&PL DP4750RR	D&PL DP3589	
Delta King DK4762RR	NorthKing NKS59-60	
Sure Grow SG468RR	Pioneer P9511	
D&PL DP4690RR	D&PL DP3588	
Asgrow AG4702RR	Hyperformer HY574	
AgriPro AP4882	Hartz H5545	
D&PL DP4748S	Delta King DK5961RR	
Sure Grow SG498RR	D&PL DP5806RR	
Asgrow AG4403RR	Pioneer P9594	
Hornbeck HBK4891	D&PL DP5354	
Delta King DK4868RR	D&PL DP5644RR	
MFA Morsoy RT4809RR	Asgrow AG5701RR	
Hornbeck HBK4820RR		

All experiments were conducted in a randomized complete block design with four replicates. Plantings prior to 1980 (MG V and VI cultivars) were made in wide rows (40 inches), plantings from 1980 through 1987 (MG V and VI cultivars) were made in both wide and narrow (20 inches) rows, plantings from 1988 through 1990 (MG IV, V, and VI cultivars) were made in wide and narrow rows, plantings from 1991 through 1998 (MG IV and V cultivars) were made in wide and narrow rows, and plantings after 1998 (MG IV and V cultivars) were made in narrow rows. Only MG V and VI cultivars were planted in wide rows during the periods when they were used. It is assumed that row spacing had no effect on time of occurrence of growth stages. Seeding rates were within the range necessary for optimum production (7). All weed control was done with recommended preemergent and/or postemergent herbicides, plus cultivation in wide-row plantings. Irrigation was started each year at or near R1 and was continued until R6. Irrigation water was applied by the furrow method through gated pipe whenever soil water potential at the 12-inch depth, as measured by tensiometers, decreased to about -50 centibars. Insect pests were controlled when necessary with recommended insecticides.

For data analyses, five planting date sets were designated: (i) before 16 April; (ii) 16 April to 1 May; (iii) 1 to 16 May; (iv) 16 May to 1 June; and (v) after 31 May. The two data sets with April planting dates (ESPS) contain only MG IV and V cultivars, whereas the data sets with May and June planting dates (CSPS) contain cultivars from all three MGs. This assignment of MGs to the planting date sets is supported by the results of Bowers (2). Dates of R1, beginning pod (R3), beginning seed (R5), R6, and maturity (R8) were recorded by the same person during the 25-year period according to Fehr and Caviness (4).

Data used in all analyses were derived from averaging across replicates in each year/planting date/cultivar combination. Analysis of variance (SAS PROC MIXED; 10) was performed on all of the data sets. Planting dates were divided into the aforementioned five planting date sets, and were further grouped into ESPS (plantings before 1 May) and CSPS (plantings after 30 April) categories. The treatment structure consisted of cultivar and date-of-planting effects. Cultivars were classified into three MGs as described above. Within the ESPS and CSPS categories, date-of-planting within planting date set, MG, and the MG × planting date interaction were treated as fixed effects of interest. Years and cultivars within MG were random components for error, and the residual error was the interaction of years and cultivars. Mean comparisons were based on LSD values at $P \leq 0.05$.

Development of Soybean Cultivars: MG and Planting Date

April (ESPS) plantings. Cultivars in plantings before 16 April took an average 5 days longer to reach R1 than did cultivars in plantings made from 16 April to 1 May (Table 2). Time between R1 and R6 was not affected by planting date in April, and planting date in April had no or little effect on time between R stages from R1 to R6. Planting in the latter half versus the first half of April increased time from R6 to R8 by an average of 5 days, and increased growing season length (planting to R8) by an average of 11 days.

As expected, MG IV cultivars reached R1 earlier than MG V cultivars (average of 42 versus 59 days) (Table 2). The average length of the R1 to R6 period for MG IV cultivars (69 days) was 7 days less than that of MG V cultivars (76 days) in plantings before 16 April, but a 3-day difference in time between R1 and R6 of MG IV and MG V cultivars was not significant in the 16 April-to-1 May plantings. Time between R1 and R3 was greater for MG V than for MG IV cultivars in both planting date sets. Time between R3 and R5 of MG IV cultivars was a significant 3 days longer than that of MG V cultivars, whereas the average length of the R5 to R6 period of MG V cultivars was 3 days longer than that of MG IV cultivars. Average length of the R6 to R8 period was 4 days longer for MG IV than for MG V cultivars. This may be associated with indeterminacy (MG IV) versus determinacy (MG V). Average length of the planting to R1 period for MG V cultivars was 17 days longer than for MG IV cultivars, while the average length of the growing season (planting to R8) was 19 days longer for MG V (157 days) than for MG IV (138 days) cultivars. Thus, the majority of the reason for the longer growing season of MG V cultivars was their longer vegetative period.

Table 2. Days from planting to R1, days between R stages, and days from planting to maturity by planting date set and maturity group within early soybean production system (ESPS) plantings grown at Stoneville, MS, 1976-2003.

Planting date set	Maturity group IV	Maturity group V	Avg.[x]
	Days from planting to R1		
Before 16 April	45	61	53 a[y]
16 Apr. to 1 May	39	56	48 b
Avg.	42 b	59 a	--
	Days from R1 to R6		
Before 16 April	69 c[z]	76 a	
16 Apr. to 1 May	71 bc	74 ab	
	Days from R1 to R3		
Before 16 April	18 c[z]	26 a	
16 Apr. to 1 May	22 b	25 a	
	Days from R3 to R5		
Before 16 April	20	17	18 a
16 Apr. to 1 May	18	16	17 a
Avg.	19 a	16 b	--
	Days from R5 to R6		
Before 16 April	30	32	31 a
16 Apr. to 1 May	30	33	32 a
Avg.	30 b	33 a	--
	Days from R6 to R8		
Before 16 April	28	23	26 a
16 Apr. to 1 May	22	19	21 b
Avg.	25 a	21 b	--
	Days from planting to R8		
Before 16 April	143	163	153 a
16 Apr. to 1 May	134	151	142 b
Avg.	138 b	157 a	--

[x] Cells in this column are blank when the MG x planting date set interaction is significant and comparison of main effect means is not valid.

[y] Average values within a row or column of a variable that are followed by the same letter are not significantly different at $P \leq 0.05$.

[z] Significant MG × planting date set interaction. Values followed by the same letter are not significantly different at $P \leq 0.05$.

May and later (CSPS) plantings. Time between planting and R1 increased with increasing MG and decreased with later planting (Table 3). Time from planting to R1 of MG IV cultivars was less affected by planting date than were planting to R1 times of MG V and MG VI cultivars. Time from planting to R1 of MG IV cultivars ranged from 36 to 40 days, whereas time from planting to R1 of MG V and MG VI cultivars ranged from 47 to 55 days and from 55 to 64 days, respectively.

Table 3. Days from planting to R1, days between R stages, and days from planting to maturity by planting date set and maturity group within conventional soybean production system (CSPS) plantings grown at Stoneville, MS, 1976-2003.

Planting date set	Maturity group IV	Maturity group V	Maturity group VI	Avg.[x]
	Days from planting to R1			
1 to 16 May	40 aC[y]	55 aB	64 aA	
16 May to 1 June	39 aC	52 bB	60 bA	
After 31 May	36 bC	47 cB	55 cA	
	Days from R1 to R6			
1 to 16 May	64 aB	64 aB	71 aA	
16 May to 1 June	60 bA	61 bA	63 bA	
After 31 May	52 cA	51 cA	54 cA	
	Days from R1 to R3			
1 to 16 May	22 aB	22 aB	30 aA	
16 May to 1 June	23 aAB	21 aB	25 bA	
After 31 May	17 bAB	14 bB	19 cA	
	Days from R3 to R5			
1 to 16 May	18 aA	15 aB	13 aC	
16 May to 1 June	14 bAB	15 aA	12 aB	
After 31 May	15 bA	13 bAB	12 aB	
	Days from R5 to R6			
1 to 16 May	23	27	28	26 a[z]
16 May to 1 June	21	25	26	24 b
After 31 May	21	23	24	23 b
	22 b	25 a	26 a	
	Days from R6 to R8			
1 to 16 May	22 aAB	19 aB	24 aA	
16 May to 1 June	21 aA	16 bB	17 bB	
After 31 May	11 bB	18 abA	18 bA	
	Days from planting to R8			
1 to 16 May	127 aC	139 aB	152 aA	
16 May to 1 June	121 bC	129 bB	136 bA	
After 31 May	98 cB	117 cA	120 cA	

[x] Cells in this column are blank when the MG × planting date set interaction is significant and comparison of main effect means is not valid.

[y] Significant MG × planting date set interaction. Values within a column of a variable that are followed by the same lowercase letter are not significantly different. Values withing a row of a variable that are followed by the same uppercase letter are not significantly different at $P \leq 0.05$.

[z] Average values within a row or column of a variable that are followed by the same letter are not significantly different at $P \leq 0.05$.

In the 1 May-to-16 May planting date set, MG IV and MG V cultivars had equal lengths of time (64 days) between R1 and R6, whereas MG VI cultivars averaged 71 days between R1 and R6 (Table 3). In the 16 May-to-1 June and after-31 May planting date sets, cultivars of all MGs had statistically similar average number of days between R1 and R6. Cultivars of all MGs had significant declines in days between R1 and R6 as planting date became later. This was mostly attributable to shortened time between R1 and R3 with later planting.

Time from R1 to R3 was greater for MG VI than for MG IV and MG V cultivars in all planting date sets, and number of days from R1 to R3 for cultivars of all MGs declined significantly when plantings were made after May (Table 3). Time from R3 to R5 was generally less for MG VI than for MG IV and MG V cultivars in all planting date sets. Time from R3 to R5 for MG IV and MG V cultivars generally declined with later planting, but declines were small and sometimes not significant. The average length of the R5 to R6 period of MG IV cultivars (22 days) was significantly less than that for MG V (25 days) and MG VI (26 days) cultivars. Average time between R5 and R6 declined slightly but significantly when planting occurred after 15 May. When planting occurred in May, time between R6 and R8 of MG IV cultivars was equal to or greater than that of MG V and MG VI cultivars, whereas MG V and MG VI cultivars had more time between R6 and R8 than did MG IV cultivars when planting occurred after 31 May.

Days from planting to R8 of cultivars in all three MGs declined significantly across the three planting date sets (Table 3). The decline in days from planting to R1 as planting date for all cultivars became later was disproportionately low compared to the decline in days from planting to R8 with later planting. Thus, the shortened growing season with delayed planting in the CSPS is primarily a result of a shortened time between R1 and R8. This is similar to results from the above ESPS plantings. Time from planting to R8 was greatest for MG VI compared to MG IV and MG V cultivars in May plantings, and for MG V and VI cultivars in plantings made after 31 May. The decline in days between planting and R8 for MG IV cultivars that were planted after May was disproportionately high compared to that of after-May plantings of MG V and VI cultivars.

Discussion and Conclusions

The majority of the difference in the length of growing season (planting to R8) among cultivars of the different MGs was in the days from planting to R1 rather than in days from R1 to R8. The greatest difference in average length of the R1 to R6 period for MG IV and MG V cultivars was 7 days or less, while the average difference in days from planting to R1 ranged from 13 to 17 days in plantings made before 1 June. This finding is important in predicting capability for canopy development and subsequent shading before R1. Thus, performance of cultivars of the disparate MGs should not be affected by differences in time between reproductive stages. Rather, the reproductive period of later-maturing cultivars will occur later in the season when stored soil moisture has been reduced, probability of rainfall is lower, and air temperatures are higher (3). Planting late-maturing cultivars results in later reproductive development and increases the risk of detrimental late-season effects on grain yield from insect pests and drought (1,8), and also provides opportunity for late-season foliar and seed disease development.

Knowledge of the number of days between reproductive stages can be important to producers who time inputs to a particular stage. Once a stage preceding a critical stage for an input is reached, plans can be made for the correct timing of inputs if the time of the next phase can be estimated. This knowledge can enhance planning inputs such as irrigation because knowing the length of the period when such an input will be required (e.g., from R3 to R6) can prevent allotting too little or too much time and resources for the operation. For inputs that may be required at two reproductive stages (e.g., R3 and R5 fungicide applications), knowing the time between these stages will aid in the planning of timely re-application of the input. Prediction of maturity allows scheduling harvest in relation to that of other crops such as corn (*Zea mays* L.) and rice (*Oryza sative* L.), and/or securing custom harvest resources. Maturity prediction is also important in the midsouthern USA because a price bonus for August delivery is available some years.

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