No. 1343 Information Sheet August 2004

Exploring the Feasibility of Growing Maturity Group III Soybeans in Mississippi

Lingxiao Zhang

ABSTRACT

An early-soybean (*Glycine max*. [L]) production system involving early planting of early-maturing soybean varieties has become popular in the Midsouth in recent years. However, limited information is available on the yield potential and other agronomic traits for maturity groups (MG) earlier than IV in the Midsouth. The objectives of this study were to determine the yield potential and optimum planting time and to exam other agronomic traits of MG III soybeans grown in Mississippi and the Midsouth. Results from this study indicated that the average time to maturity was significantly shorter in MG III varieties than in MG IV and V varieties when planted in late April and early May. Yield components of MG III soybeans did not reach its full potential to produce high yields in early plantings, such as March and early April. Plant height, number of main stem nodes per plant, position of first fertile node, number of pods per plant, and seed weight of early-planted MG III soybean were all lower than late-April- and early-May-planted soybeans. Yields of MG III soybeans were very low in the early March planting. However, when MG III soybeans were planted between late April and early May, the average yields were not significantly different from those of MG IV and MG V. This study showed that MG III soybeans should be planted in late April to early May to reach their full potential of vegetative growth in order to get the maximum reproduction growth later.

INTRODUCTION

Until the late 1980s, soybeans were planted in June in the Midsouth using MG VI or VII varieties. Recent studies have shown that soybeans planted in May or even April, using MG V and IV varieties can produce high seed yields in these regions (Bowers, 1995; Kane et al, 1997; May et al., 1989; White et al., 1999). The suggested reason is that early-maturing soybeans planted early could be harvested early, thereby avoiding mid-season drought stress that often occurs in the Midsouth (DowElanco, 1992; Heatherly and Hodges, 1999; Sweeney et al., 1995). However, for some multicrop growers, particularly soybean-rice farmers, the planting and harvest periods for these crops often overlap. For example, in Mississippi, rice is usually planted in early to mid-April and harvested in early September at the same period early-maturity soybeans (such as MG IV) are planted and harvested. For this reason, many rice-soybean farmers have given up growing MG IV soybeans. To solve this problem and to help growers obtain maximum soybean yields, it was necessary to explore alternative production methods.

Several studies conducted in the Midsouth using MG III soybeans planted and harvested early produced satisfactory yields (Boote, 1981, Bowers, 1995; Kane and Grabau, 1992; Savoy et al., 1992). However, the results of these studies were based on a limited number of varieties and the physiological principles of the early production systems were not discussed in detail.

The objectives of this study were (1) to assess the physiological and phenological characteristics of early soybean varieties planted on different dates; (2) to evaluate yield and yield components; (3) to discuss the mechanisms that may be involved in growing early soybeans in the Midsouth; and (4) to provide practical production methods and recommendations for growing early-maturity soybean varieties in Mississippi.

Lingxiao Zhang is an associate research professor at the Delta Research and Extension Center in Stoneville, Mississippi. For more information, contact Dr. Zhang by email at lzhang@drec.msstate.edu; telephone, (662) 686-3215; or fax, (662) 686-7336 This information sheet was published by the MSU Office of Agricultural Communications, a unit of the Division of Agriculture Forestry and Veterinary Medicine.

Experiment Station
Vance H. Watson, Director
Mississippi Agricultural & Forestry Experiment Station
J. Charles Lee, President • Mississippi State University • Vance H. Watson, Vice President

Materials and Methods

Soybean Variety and Maturity Groups

The experiments were conducted on a mixed loam soil at the Delta Research and Extension Center at Stoneville, Mississippi, in 1998 and 1999, using 15 MG III soybean varieties. Most of these varieties are from states north of Mississippi, such as Missouri, Tennessee, and Illinois. Two varieties, 'HBK4600' (MG IV) and Hutcheson (MG V), were also included as checks. 'HBK4600' was one of the top-yielding varieties in the 1997 Mississippi Soybean Variety Trial (Askew et al., 1997). 'Hutcheson' was one of the most popular MG V varieties used in Mississippi until 1997. In 1999, 'AP4800,' the top-yielding variety in the 1998 Mississippi Soybean Variety Trial (White et al., 1999), was used instead of 'HBK4600' as the MG IV check.

Experimental Design

In 1998, two adjacent fields, separated by a buffer zone, were used – one irrigated and the other not irrigated. Soybeans were planted on March 13, April 2, April 23, and May 14. Within each planting date, varieties were arranged in a randomized complete block design with four replications. Seeding rate was six seeds per foot. Each plot consisted of four rows, 30 feet (9.14 m) long with 20 inches (0.51 m) between rows. Due to shortage of seeds, nonirrigated plots were not planted on May 14. Only one row of each variety was planted on each plot on this date in the irrigated field. Thus, yield of May 14 plantings was not determined. Experimental design was similar for the first three plantings on irrigated and nonirrigated fields in 1998. In 1999, soybeans were planted only on May 14 in an irrigated field using similar experimental design as that in 1998.

Data Collection and Calculation

Phenological data and yield components of each variety were recorded only for irrigated field. Phenological development (growth stage) data were recorded once a week starting after planting, using the guidelines developed by Fehr and Caviness (1977). Ten plants from each plot were randomly selected to examine the parameters of yield components, such as plant height, number of nodes, pods per plant, node position of the first fertile node, and height of the first fertile node. For yield at maturity, four 20-foot (6.1 m) rows from each plot were harvested for seed yield and yield per acre was calculated late. Seed weight was determined by randomly selecting and weighing 300 seeds per sample plot. Data were analyzed using ANOVA procedures of SAS (SAS Institute Inc., 1989), and where significant differences were detected, Fisher's protected LSD was used to separate the means.

Results and Discussion

Phenological Development

Across planting dates, the average flowering dates of MG III varieties were only three to six days earlier than those of the MG IV variety, but they were 13 to 23 days earlier at maturity compared with those of the MG V variety (Figure 1).

Time from emergence (VE) to R1 for MG III and MG IV varieties across four planting dates were all less than 40 days, with some even less than 30 days (Figure 1). Average seed maturity time (R8) for MG III soybeans was 2-3 weeks earlier than that of the MG IV check variety (Figure 1), indicating that the MG III varieties have relatively short seed filling period. In dry seasons (low rainfall) and no irrigation, MG III soybeans may avoid severe drought stress that often occurred in the late MG soybeans. However, with adequate rainfall or irrigation and when other environmental conditions are favorable for soybean growth, early planting of MG III soybeans may be a disadvantage, particularly if cool temperatures slowed vegetative growth. Thus, the plants may not have the advantage of the seed filling period necessary for producing bigger and heavier seeds. Only small differences occurred between the March and early April plantings of MG V soybeans. Thus, the March 13 planting only extended the growth period and had no advantage for MG V soybeans in terms of early harvest.

The reasons for differences in phenology were probably due to the effect of temperature, photoperiod, and associated interactions. Temperatures during the early growing season were low and thus slowed seedling growth and development, generally resulting in a longer plant growth period. On the other hand, soybeans planted early (before mid-April) grew under short day-length, which triggered earlier flowering and more rapid reproductive growth. Different MG soybeans responded differently to these effects due to the differences in flowering and maturity period. After growing through the longest day-lengths of the year, 2 weeks before and after June 21, MG III and IV soybeans used a similar number of days to complete seed-filling (Figure 1). Therefore, the period from R6-R8 was less affected by photoperiod. The MG V soybeans reached seed filling stage relatively late compared with MG III and IV. The long day-lengths prolonged the growth and development of MG V (Johnson et al., 1960), resulting in a longer growth period.

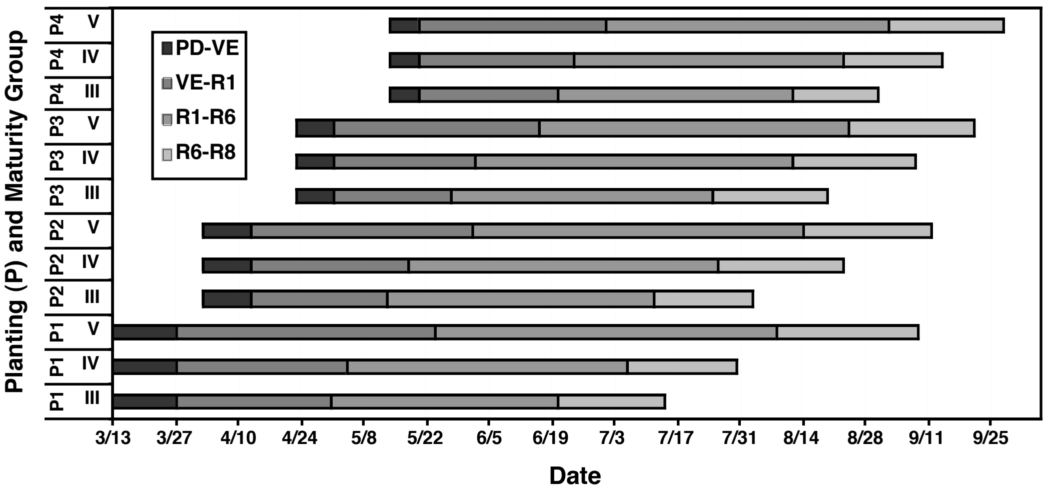

Figure 1. Comparisons of soybean phenological events among MG III, MG IV, and MG V soybeans for an irrigated field by calendar day.

Legend notation:

PD – Time of planting
VE – Time of emergence
R1 – Time of flowering
R6 – Time seed filling to the maximum
R8 – Time of maturity.

Yield components

Many factors affect final soybean seed yield. Plant height, an indication of leaf area, is one of the most important of these factors. Plantings before mid-April resulted in significantly shorter plants compared with the later plantings (Table 1), due to early flowering induced by the short photoperiods in April and early May. The number of main stem nodes was less affected by planting date in most varieties (Table 1), indicating that the process of internode elongation was more sensitive to short photoperiods than the process of initiation of new leaves (or nodes). Final areas per leaf must have been similarly affected.

Most of the early-maturity soybean varieties had an indeterminate growth habit allowing vegetative growth after flowering. Indeterminate soybean plants also fill pods set from the bottom of the stem up. Seeds from the bottom position in this case usually weigh more than those on the topmost part of the stem. The average total number of fertile nodes of MG III varieties in early plantings was not significantly different from that of late plantings (data not shown); however, the average position of the first fertile nodes (above ground height) was significantly lower for early plantings than for late plantings (Table 1). Field observation indicated that pods close to the ground were associate with harvest losses of 15% to 20% in some early-planted MG III plots. The position of the first fertile node is important in order to minimize harvest loses. Pod numbers per plant were greater in the late April planting compared with March or early-April plantings (Table 1). However, average seed weights were higher in early-planted soybeans (Table 1). The low pod number produced by the early-planting treatments may have been compensated by the production of bigger seeds compared with the late April planting possibly due to low number of seeds per pod. This is likely due to the influence of low temperature, shorter photoperiod, or a combination of other factors.

Table 1. Yield components of MG III (average of 15 varieties), MG IV, and MG V soybeans for different planting dates under nonirrigated (NI) and irrigated (I) conditions, Stoneville, MS, 1998.

Planting time	MG III avg.[1]		MG IV avg.		MG V avg.	
	NI	I	NI	I	NI	I
			Final plant height (cm)			
March	37.6	39.7	40.3	44.9	50.6	54.2
Early April	47.4	53.6	54.1	59.4	43.3	49.3
Late April	61.3	61.9	63.0	64.1	46.9	48.9
May [2]	–	100.8	–	118.0	–	95.0
LSD	6.3	8.1	7.5	9.2	5.5	7.9
			Number of main-stem nodes			
March	12.2	12.8	15.0	14.8	13.7	14.1
Early April	13.6	13.6	14.6	13.8	13.9	14.7
Late April	14.7	14.6	15.2	15.2	11.4	11.7
May [2]	–	18.0	–	18.4	–	15.7
LSD	1.8	1.7	0.8	1.4	1.2	1.1
			Position of the first fertile node (height from ground, cm)			
March	7.8	7.6	8.9	8.1	16.8	16.0
Early April	8.9	8.3	11.2	11.7	17.5	16.3
Late April	9.5	9.5	13.0	14.5	–	–
May [2]	–	13.2	–	–	–	–
LSD	0.8	1.1	0.9	1.5	1.2	0.7
			Pod number per plant			
March	23.5	28.4	36.6	45.1	40.5	50.4
Early April	34.8	40.4	31.5	32.8	41	42.3
Late April	39.2	46.7	39.4	40.5	51.9	59.4
May [2]	–	36.2	–	58.7	–	56.7
LSD	4.6	4.8	4.9	6.1	6.5	7.8
			100-seed weight (g)			
March	16.5	16.6	14.5	14.6	11.8	11.9
Early April	14.1	15.9	14.3	13.6	10.9	12.2
Late April	12.8	12.8	13.7	14.1	11.7	13.1
May [2]	–	12.0	–	15.7	–	12.6
LSD	0.7	0.6	0.6	0.7	0.5	0.6

[1]Average of 15 varieties.
[2]Data based on one-row plot and may be used as reference only.

Yield

The yield potential of MG III varieties can be affected by many factors. In the 1998 studies, it was clear that planting dates were a major factor in controlling yields. MG III varieties planted in March did not produce acceptable yields in both irrigated and nonirrigated fields. The yields for all MG III varieties planted on March 13, 1998, were only 21.7 bu/A (1,458 kg/ha) for nonirrigated fields and 25.5 bu/A (1,713 kg/ha) for irrigated fields, which was a yield difference of only 17%. In the early April planting, the yield for the irrigated fields was 48.8 bu/A (3,279 kg/ha), which was 74% higher than the yield on the nonirrigated field at 27.8 bu/A (1,882 kg/ha). However, the average yields of most MG III varieties were significantly lower than those of MG IV and V varieties (Table 2). Unlike the early-April plantings, the average yields of the late April planting of MG III varieties for both irrigated and nonirrigated fields were similar and were not significantly different from the average yields of the MG IV and V varieties (Table 2). Some individual MG III varieties in both irrigated and nonirrigated fields produced higher yields than the average yields of MG IV-V checks. The nonsignificant average yield difference between irrigated and nonirrigated MG III varieties in the late-April planting in 1998 could be due to favorable rainfall at the test location in early July, during the period of pod filling.

Table 2. Yield (bu/A) of MG III, IV, and V soybean varieties from three planting dates under nonirrigated (NI) and irrigated (I) conditions, Stoneville, MS, 1998.

Variety	MG	Planted 3/7		Planted 4/2		Planted 4/23		Mean
		NI	I	NI	I	NI	I	
Hutcheson	V	49.3	47.7	41.4	50.7	53.7	58.6	50.2
HBK 4600	IV	42.2	39.2	50.2	70.6	61.7	56.5	53.4
AP3702 RR	III	27.5	27.5	33.8	48.4	53.9	54.5	40.9
AP3880	III	17.0	22.6	27.2	44.7	52.3	52.9	36.1
AP3802 RR	III	15.6	23.4	32.6	53.7	48.8	58.9	38.8
B 93-09056	III	26.2	25.7	27.9	51.2	58.1	53.9	40.5
Fillmore	III	–	–	21.7	44.1	45.3	55.3	41.6
Kennedy	III	–	–	23.8	46.9	45.2	52.7	42.2
Kennedy RR	III	–	–	24.0	45.6	54.2	56.0	45.0
Macon	III	13.7	23.7	20.6	37.0	60.9	60.0	36.0
Madison	III	–	–	30.1	50.8	56.1	61.0	49.5
Maverick	III	15.7	20.6	14.9	38.7	43.4	46.2	29.9
McKinley	III	–	–	31.1	50.8	54.8	56.0	48.2
Saline	III	27.3	28.7	34.4	58.1	61.4	59.2	44.9
Washington RR	III	–	–	30.5	60.3	50.7	47.9	47.4
William-82	III	30.6	31.8	31.9	52.4	55.0	54.8	42.8
Williams	III	–	–	32.8	47.9	46.2	41.8	42.2
MG III average		21.7	25.5	27.8	48.7	52.4	54.1	41.7
Total average		26.5	29.1	29.9	50.1	53.0	54.5	
LSD		8.8	7.6	5.9	5.5	6.1	6.6	

The 1999 study involved only one planting date – May 14. The average yield of MG III varieties was 58.8 bu/A (3,951 kg/ha) and was not statistically different from the mean yield for the checks (the average of MG IV and V) at 62 bu/A (4,166 kg/ha) (Table 3). This indicates that if the right MG III varieties could be selected and could be planted within an optimum time window, such as late April to early May, their yields could be comparable to other high-yielding maturity groups and at the same time mature early enough for early harvest, a factor which may be important for many growers.

Table 3. Yield (bu/A) of MG III, IV, and V soybean varieties planted on clay-loam soil, Stoneville, MS, May 14, 1999.

Variety	MG	Yield
Hutcheson	V	59.5
AP 4880	IV	64.4
A 3469	III	64.9
A 3904STS	III	58.2
AG3901RR	III	57.4
AG3701RR	III	65.3
CX 339c	III	54.1
CX 364c	III	59.6
CX367cRR	III	61.1
CX 393c	III	62.1
Eisenhower	III	58.1
ES 3901	III	53.1
KS 3904	III	50.1
McKinley	III	56.8
PhoenixRR	III	62.4
Saline	III	56.8
Truman	III	61.2
MG III average		58.8
Total Average		59.1
LSD		4.5

There were two major reasons for obtaining higher yields in late April 1998 and early May 1999 plantings:

(1) Optimum photoperiod: From early May to late June, photoperiods are close to the longest one on June 21. When MG III varieties were planted late April and early May, vegetative growth stage of MG III varieties coincided with long day-length and this delayed flowering, resulting in extended vegetative growth. By flowering time, the plants had adequate vegetative reserves for later reproductive growth. The extended vegetative growth also resulted in better plant canopy closure and increased the interception of solar radiation, which might contribute to later reproductive growth.

(2) Indeterminate behavior: Most MG III varieties used in this experiment had indeterminate growth habit, allowing for further vegetative growth after flowering. Therefore, total main stem node numbers and total nodes with pods in MG III varieties were similar to those of the MG IV and MG V checks (Table1). The period from the first flower (R1) to pod setting (R3) in MG III varieties planted in late April and early May lasted for about 3 weeks, compared with about 10 days for the March planting, indicating a longer vegetative growth period for these plantings.

Summary

Based on the yields and agronomic traits in 1998 and 1999 studies, it is suggested that it is feasible to grow MG III varieties in Mississippi. The critical issue is planting time. It should be clearly recognized that MG III varieties planted in March and early April resulted in early flowering, shorter plant height, lower flowering position of mature pods on the main stem, fewer pods per plant, and the expected early maturity, all of which contributed to low yield. On the other hand, within the optimum planting time window, acceptable yields were obtained for those MG III varieties, and the average yields were not much less than those of MG IV and MG V, even in irrigated fields. Meanwhile, there was the advantage of drought avoidance on nonirrigated fields, as well as the possibility for early harvest.

This study also indicated that planting MG III varieties in the right time was more efficient than planting MG IV and MG V varieties early to avoid midseason drought stress in summer. However, questions still remain about growing MG III soybeans successfully in Mississippi. First, which varieties possess the best agronomical traits and yield potential? Second, how early is not too early to plant MG III soybeans? Third, what row spacing and population is the best for growing early soybeans? Fourth, would the year-to-year variation in environment, such as timing and severity of droughts, result in the acceptable yields reported here? More studies are needed to address these questions. A good soybean production model based upon the fundamental, genetic, physiological, and environmental interactions involved might lead to a faster answer to the questions.

Acknowledgement

I appreciate John Hesketh and Steve Kyei-Boehan for their help in technical review for this manuscript. I also would like to thank Ling Su, Will Marlow, and Ruifang Wang for their assistance. This study was sponsored by the Mississippi Soybean Promotion Board.

Literature Cited

Askew, J.A., Blaine, D. Ingram, R. Ivy, W. Marlow, D. Shaw, A. Smith, C. Watson, B. White, and M. Young. 1997. Soybean Variety Trials 1997. Info. Bull. 328. Mississippi Agricultural and Forestry Experiment Station, Mississippi State University.

Boote, K.J. 1981. Response of soybeans in different maturity groups to March plantings in southern USA. *Agron. J.* 73:854-859.

Bowers, G.R. 1995. An early soybean production system for drought avoidance. *J. Prod. Agric.* 8:112-119.

DowElanco. 1992. *The early soybean production system: A risk management tool in the southeastern United States*. DowElanco, Indianapolis, IN.

Fehr, W.R., and C.E. Caviness. 1977. Stages of soybean development. Iowa State Univ. Agric. Exp. Sta. Spec. Rep. 80.

Heatherly, L., and H. Hodges. 1999. *Soybean Production in the Midsouth*. CRC Press.

Johnson, H.W., H.A. Brothwick, and R.C. Leffel. 1960. Effects of photoperiod and time of planting on rate development of soybeans in various stages of life cycle. *Bot. Gaz.* 122:77-95.

Kane, M.V., and L.J. Grabau. 1992. Early planted, early maturing soybean cropping system: growth development and yield. *Agron. J.* 84:769-773.

Kane, M.V., Steele, and L.J. Grabau. 1997. Early-maturing soybean cropping system: II Growth and development responses to environmental conditions. *Agron. J.* 89:459-464.

May, M.L., C.E. Caviness, and I.L. Eldridge. 1989. Soybean response to early planting in northeast Arkansas. *Ark Farm. Press* 38 (4):5.

SAS Institute Inc. 1989. *SAS/STAT software: Usage and Reference.* Version 6, First Edition, SAS Institute Inc., Cary, NC.

Savoy, B.R., J.T. Cothren, and C.R. Shumway. 1992. Early-season production system utilizing indeterminate soybean. *Agron. J.* 84:394-398.

Sweeney, D.W., G.V. Granade, and R.O. Burrto, Jr. 1995. Early and traditionally maturing soybean varieties grown in two planting systems. *J. Prod. Agric.* 8:373-379.

White, B., A. Blaine, D. Ingram, R. Ivy, W. Marlow, A. Smith, C. Watson, M. Young, and L.X. Zhang. 1999. Soybean Variety Trials 1998. Info. Bull. 346. Mississippi Agricultural and Forestry Experiment Station, Mississippi State University.

Mississippi State UNIVERSITY

Printed on Recycled Paper

Mention of a trademark or proprietary product does not constitute a guarantee or warranty of the product by the Mississippi Agricultural and Forestry Experiment Station and does not imply its approval to the exclusion of other products that also may be suitable.