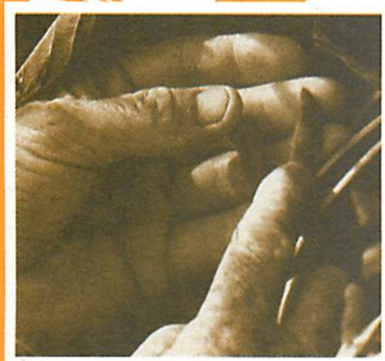
Early Soybean Production System Handbook



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September 1998

Early Soybean Production System Handbook

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Research leading to the development of this *Early Soybean Production System Handbook* was supported in part by the Soybean Checkoff. This handbook is published under the auspices of United Soybean Board Project #6009, entitled “Improving efficiencies of the early soybean production system in the Midsouth.” The United Soybean Board and the editors and contributors to the *ESPS Handbook* acknowledge the financial support and encouragement provided by the Arkansas Soybean Promotion Board, the Louisiana Soybean and Grain Research and Promotion Board, the Mississippi Soybean Promotion Board, and the Texas Soybean Promotion Board for research and education programs leading to the current USB project responsible for this publication. It was published by the Office of Agricultural Communications, a unit of the Division of Agriculture, Forestry, and Veterinary Medicine at Mississippi State University.

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Key words: average soybean yield, weather, rainfall, temperature, freeze, frost, moisture deficit, yield, maturity group, early-maturing varieties, nonirrigated, irrigated, row spacing, canopy development, disease management, insect management, economic threshold, seed treatment, weed management, desiccant, harvest, shattering, seed quality, germination, stale seedbed.

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Introduction

Conventional Production Systems

The conventional soybean production system -- which involves planting Maturity Group (MG) V, VI, VII, and VIII varieties in May and June in the midsouthern U.S. -- has resulted in low and static yields for much of the past 27 years (Table 1). Commonly grown varieties in these maturity groups are in high-water-demanding reproductive stages from mid-July through mid-September, when drought and high temperatures usually occur in this region (Table 2). Thus, they are most susceptible to the yield-limiting stress caused by drought and heat.

Typically, decreasing rainfall and increasing evaporation make moisture deficits more severe from April through August at Stoneville, Mississippi (33°26'N), and Bossier City, Louisiana (32°25'N), (Table 3). Similarly, March through July is a particularly dry and hot period at Temple, Texas (31°08'N), and Port Comfort, Texas (28°39'N), (Table 4). Low soybean yields for 1970-1993 in Mississippi were significantly and negatively correlated with high total pan evaporation and high total moisture deficit (rainfall minus pan evaporation) in July and August. Moisture deficits increased drought stress, creating conditions especially detrimental to the soybean varieties usually planted in the conventional production system. For example, Pioneer Brand 9592 (MG V) was planted on May 27, began setting pods on August 5, and began filling seeds on August 19 (Table 2). Tracy-M (MG VI) was planted on May 12, began setting pods on August 11, and began filling seeds on August 23. Braxton (MG VII) was planted on May 12, began setting pods on August 16, and began filling seeds on August 28. Thus, planting MG V-VII varieties in May and June resulted in podset and seedfill during periods when moisture deficits and subsequent drought stress are usually the most pronounced.

Data from research with irrigated and nonirrigated soybean at Stoneville from 1979-1990 show that planting MG V, VI, and VII varieties in May and June was a high-risk enterprise in those years (Table 5). In many years, nonirrigated yields were generally below 20 bushels per acre and only infrequently exceeded 25 bushels per acre. Though irrigated soybean acreage was much more productive than nonirrigated acreage in dry years, irrigation still resulted in only relatively modest yields (around 45 bushels per acre). Also, up to seven furrow irrigations of 2.5 to 3 inches each were required to attain the highest irrigated yields in the driest years. Irrigated yields ranged from 29.7 bushels per acre (Bedford planted on May 8, 1980) to 54.3 bushels per acre (Asgrow A5980 planted on May 25, 1988), but few irrigated yields exceeded 50 bushels per acre. The frequency of low yields from nonirrigated plantings confirms the low yield plateau shown for states in the midsouthern U.S. in Table 1.

Table 1. Soybean-planted acres in Mississippi, and average yield in Mississippi and Louisiana, 1971-1997.[1]

Period	Mississippi planting dates[2]			Avg. MS	Avg. LA
	4/30-5/3	5/15-5/20	6/5-6/10	yield	yield
	%	*%*	*%*	*bu/A*	*bu/A*
1971-80	2	20	63	21.5	24.6
1981-91	3	20	55	22.0	23.5
1992	2	26	59	34.0	32.8
1993	1	5	33	22.0	21.6
1994	24	59	89	31.0	29.1
1995	20	48	78	21.0	22.4
1996	29	76	95	31.0	33.0
1997	23	62	82	31.0	29.0

[1]Sources: *(1, 2, 3, 4, 5, 6, 7)*.
[2]This is the percentage of total Mississippi soybean acres planted by these dates.

Rationale for the Early Soybean Production System

Apparent remedies for problems associated with late-maturing soybean varieties include modifying dryland production practices or providing irrigation during the more severe drought periods. Crop water deficits in the midsouthern U.S. usually begin to develop in June and continue into September (Tables 3-4). Planting early-maturing varieties in April so that their critical reproductive development coincides with periods of adequate soil moisture and more prevalent rainfall appears to have merit. This early soybean production system (ESPS) is the key to drought avoidance.

DP 3478, a MG IV variety with a Relative Maturity (RM) of 4.7, was planted on April 18 at Stoneville and began blooming on May 29, or 41 days after planting (DAP) (Table 2). Pioneer Brand 9501

Table 2. Dates and days after planting of developmental stages for MG IV, V, VI, and VII of irrigated soybean varieties when planted at indicated times at Stoneville, MS.

Variety (MG)	Planting date	Soybean reproductive stage: Begin. bloom	Begin. podset	Begin. seed	Full seed[1]	Maturity[1]
DP 3478 (IV)	Apr. 18	May 29 (41)[2]	June 19	July 10	Aug. 10 (114)	Sep. 11 (146)
	May 9	June 12 (34)	June 30	July 28	Aug. 24 (107)	Sep. 18 (132)
P 9501 (IV)	Apr. 18	June 5 (48)	June 22	July 14	Aug. 21 (125)	Sep. 15 (150)
	May 9	June 19 (41)	July 10	Aug. 4	Aug. 28 (111)	Sept. 18 (132)
	May 27	July 5 (39)	July 22	Aug. 10	Sep. 7 (103)	Sep. 28 (124)
RA 452 (IV)	Apr. 18	June 12 (55)	June 30	July 24	Aug. 24 (128)	Sep. 15 (150)
	May 9	June 26 (48)	July 24	Aug. 10	Sep. 1 (115)	Sep. 22 (136)
	May 27	July 12 (46)	July 27	Aug. 14	Sep. 4 (100)	Sep. 18 (114)
A 5979 (V)	Apr. 18	June 19 (62)	July 3	July 28	Aug. 28 (132)	Sep. 18 (153)
	May 9	June 30 (52)	July 17	Aug. 7	Sep. 5 (119)	Sep. 27 (141)
	May 27	July 14 (48)	July 30	Aug. 14	Sep. 8 (104)	Sep. 25 (121)
P 9592 (V)	Apr. 18	June 19 (62)	July 17	July 31	Sep. 5 (140)	Sep. 22 (157)
	May 9	June 30 (52)	July 28	Aug. 14	Sep. 15 (129)	Oct. 2 (146)
	May 27	July 16 (50)	Aug. 5	Aug. 19	Sep. 14 (110)	Oct. 5 (131)
Tracy M (VI)	May 12	July 14 (63)	Aug. 11	Aug. 23	Sep. 12 (123)	Oct. 7 (148)
	June 4	July 29 (55)	Aug. 20	Sep. 1	Sep. 17 (105)	
	July 8	Aug. 17 (40)	Aug. 31	Sep. 10	Sep. 23 (77)	
Braxton (VII)	May 12	July 25 (74)	Aug. 16	Aug. 28	Sep. 16 (127)	Oct. 15 (156)
	June 4	Aug. 1 (58)	Aug. 22	Sep. 7	Sep. 24 (112)	
	July 8	Aug. 23 (46)	Sep. 2	Sep. 14	Sep. 30 (84)	

[1]Full seed stage may not be reached, and maturity may occur earlier for nonirrigated soybean.
[2]Days after planting (DAP) are presented in parentheses.

Table 3. Summary of average temperature, rainfall, and pan evaporation for growing season months, Stoneville, MS (33°26'N), 1964-1993, and Bossier City, LA (32°25'N), 1978-1997.[1]

Month	Stoneville Air temp. Max.	Stoneville Air temp. Min.	Stoneville Rain	Stoneville Evap.	Stoneville Diff.	Bossier City Air temp. Max.	Bossier City Air temp. Min.	Bossier City Rain	Bossier City Evap.	Bossier City Diff.
	°F	*°F*	*in*	*in*	*in*	*°F*	*°F*	*in*	*in*	*in*
April	74	53	5.4	6.1	-0.7	76	52	4.7	5.5	-0.8
May	82	62	5.0	7.7	-2.7	84	62	5.1	6.6	-1.5
June	90	69	3.7	8.5	-4.8	90	69	5.1	7.5	-2.4
July	91	72	3.7	8.2	-4.5	94	80	3.9	8.1	-4.2
August	90	70	2.3	7.3	-5.0	94	71	3.1	7.5	-4.5
September	85	63	3.4	5.8	-2.4	89	63	2.7	5.8	-3.1

[1]Source: Stoneville *(10)*; Bossier City – Caldwell, W.D.

(MG IV, RM 5.1) was also planted on April 18 at Stoneville, and it began blooming on June 5 (48 DAP). Both varieties began setting pods in mid-June and began filling seeds in mid-July. Full seed stage was reached on August 10 by DP 3478 and on August 21 by Pioneer Brand 9501. Asgrow A5979 (MG V) was planted on April 18 and started blooming on June 19 (62 DAP), setting pods July 3, and filling seeds on July 28. It reached full seed stage on August 28. Obviously, planting in April allows these early-maturing varieties to undergo reproductive development earlier in the year, when rainfall is usually more prevalent and soil moisture is not depleted. Thus, the effective length of the drought period is usually reduced, and many of its detrimental effects are avoided.

Table 4. Summary of average temperature, rainfall, and pan evaporation for growing season months at two Texas locations.[1]

Month	Temple (31°08'N), 1964-1996					Port Comfort (28°39'N), 1957-1996				
	Air temp.		Rain	Evap.	Diff.	Air temp.		Rain	Evap.	Diff.
	Max.	Min.				Max.	Min.			
	°F	°F	in	in	in	°F	°F	in	in	in
Mar.	70	46	2.5	5.4	-2.9	74	53	2.0	5.2	-3.2
Apr.	78	55	2.8	6.6	-3.8	80	61	2.9	6.3	-3.4
May	84	63	5.1	7.3	-2.2	85	68	4.2	7.8	-3.6
June	91	69	3.8	8.9	-6.1	91	73	5.2	9.3	-4.1
July	95	73	1.7	10.7	-9.0	94	75	3.3	10.3	-7.0
Aug.	96	73	2.3	9.9	-7.6	94	74	3.7	9.5	-5.8
Sep.	89	67	3.7	7.1	-3.4	89	70	5.9	7.1	-1.2

[1]Source: Bowers, G. (Beaumont, Texas).

Table 5. Yield of nonirrigated and irrigated conventional production system soybean, and number of irrigations applied at Stoneville, MS, 1979-1990.[1]

Year	Date of planting	Variety	Yield Nonirrigated	Yield Irrigated	No.[2]
			bu/A	bu/A	
1979	June 13	Bedford	40.9	39.7	2
		Tracy	50.1	50.2	2
		Bragg	47.1	53.4	1
1980	May 8	Bedford	10.9	29.7	6
		Tracy	17.1	41.8	7
		Bragg	19.6	52.9	7
1981	May 13	Bedford	14.6	41.3	3
		Bragg	15.3	48.7	4
1982	May 12	Bedford	14.5	33.4	3
		Braxton	15.0	40.4	4
1984	May 14	Braxton	20.2	52.0	5
1985	May 2	Braxton	23.8	42.8	6
1986	May 15	Braxton	1.5	38.6	7
1986	June 3	Sharkey	5.6	43.9	3
1987	May 11	Sharkey	10.5	40.0	3
1988	May 16	Sharkey	33.9	39.8	3
1987	June 8	A5980	13.6	38.9	4
1987	May 6	Leflore	16.4	43.2	6
1988	May 25	A 5980	39.3	54.3	4
		Leflore	32.9	45.9	4
1989	May 8	A 5980	39.8	41.2	2
		Leflore	26.5	32.0	2
1990	May 2	A 5980	19.0	44.3	6
		Leflore	15.9	49.5	6

[1]Sources: Heatherly et al. *(14, 15, 18, 19, 20, 21).*
[2]Number of furrow or flood irrigations applied to irrigated soybean.

Perceived Constraints for ESPS

Freeze/frost possibilities are useful for assessing potential early planting dates for soybean. The data in Table 6 give the probabilities of freeze/frost at Stoneville, Mississippi (33°26'N), and Temple, Texas (31°08'N), for selected dates. Producers at these latitudes can generally expect frost at 36°F, a light freeze at 32°F, and a moderate freeze at 28°F. Stoneville has only a 20% chance of frost on April 8 and a 10% chance of frost on April 13. Temple has only a 10% chance of frost on April 10. There is only a 10% chance of a light freeze (32°F) by March 25 at Temple and by April 3 at Stoneville. Thus, April planting of soybean at the Stoneville and Temple latitudes is a low-risk proposition from an early-season temperature standpoint. At Jackson, Tennessee (35°37'N), there is a 50% chance that a freeze will occur after April 6, and a 10% chance that one will occur after about April 15 *(6)*. Thus, even at this more northerly latitude, April planting can safely occur from an air temperature standpoint. Another important factor with early planting is that soybean planted in early April may require up to 14 days or more to emerge, so chance of cold-induced injury to emerged seedlings is further reduced when emergence vs. planting date is considered.

Days suitable for field work dictate the acreage that can be planted using the ESPS. According to Spurlock et al. *(30)*, there is an 80% chance of having at least 7.5 days suitable for field work in Mississippi from April 9 to May 1. Actual days suitable for planting may be greater since soils can be too wet for conventional tillage and still be planted using a stale seedbed system. Thus, the minimum acreage that can be planted between April 9 and May 1 in 8 out of 10 years will be a farmer's daily planting rate times 7.5 or more days. If a farmer using two planters can plant and apply preemergent herbicides at the rate of 250 acres per day, more than 1,800 soybean acres can be planted in April in 8 out of 10 years. This example suggests that it is possible to plant a sizeable acreage in most years in the region using the ESPS, especially when no-till or stale seedbeds are used.

Another possible negative aspect of early-planted soybean is that their harvest likely will conflict with rice harvest and may coincide with corn harvest. Thus, competition for limited harvest equipment may occur in farm operations with a mix of these crops. This conflict can be troublesome since all three crops should be harvested as soon as they mature. One method of overcoming this dilemma is to have one crop -- preferably soybean -- custom-harvested. Costs for this service will be about $20-25 per acre, which is similar to the cost of about $26 per acre for combine ownership and farmer harvesting listed in the latest Mississippi State University soybean budgets *(29)*.

Finally, growers harvesting from ESPS fields should determine if adequate storage is available for soybean with respect to late August or early September harvest. In certain areas, either temporary storage or arrangements for adequate transportation to terminal elevators should be assured before harvest.

Table 6. Probability of freeze/frost occurring after a spring date based on minimum air temperatures, Stoneville, MS (33°26'N), 1964-1993, and Temple, TX (31°08'N), 1951-1980.[1]

Prob.	Stoneville[2]			Prob.	Temple[2]		
level	28°F	32°F	36°F	level	28°F	32°F	36°F
.35	Mar. 4	Mar. 19	Apr. 2	.40	Feb. 25	Mar. 11	Mar. 26
.20	Mar. 13	Mar. 27	Apr. 8	.30	Mar. 2	Mar. 14	Mar. 30
.10	Mar. 22	Apr. 3	Apr. 13	.20	Mar. 8	Mar. 19	Apr. 3
.05	Mar. 29	Apr. 9	Apr. 18	.10	Mar. 17	Mar. 25	Apr. 10
.01	Apr. 13	Apr. 21	Apr. 27				

[1]Source: Stoneville *(10)*; Temple – Bowers, G. (Beaumont, Texas).
[2]Spring date threshold temperatures.

ESPS Results

Recent reports suggest that the ESPS does have merit for improving the yield potential of midsouthern U.S. soybean acres. Bowers *(11)* conducted 3 years (1986-1988) of nonirrigated studies at two northeast Texas locations [Blossom (33°33'N) and Hooks (33°38'N) -- Table 7]. Two facts are obvious from this report: (1) Early-maturing varieties planted in April yielded more than conventional varieties planted in May; and (2) Early-maturing varieties planted in May yielded as much as or more than conventional varieties planted in May. Results from studies conducted in Arkansas in 1987 and published by Regan *(26)* corroborate Bowers' findings.

Heatherly conducted irrigated and nonirrigated studies at Stoneville on Sharkey clay in 1992 and 1994-1997 (Tables 8-9). Following are six main conclusions from these studies, along with related information concerning other states:

(1) Irrigated April plantings of all MG IV and V soybean varieties always yielded more than nonirrigated April plantings. However, this finding may not hold true for ESPS plantings made on the alluvial silt loam soils of northeast Arkansas.

(2) April-planted, nonirrigated MG V varieties yielded at least as much as MG IV varieties planted in April and not irrigated. This result was also reported from research conducted in St. Francis County, Arkansas, and near Bossier City, Louisiana. In northern Arkansas, nonirrigated MG IV varieties tend to slightly outyield MG V varieties in April plantings (Table 10).

(3) April-planted MG V varieties that were properly irrigated yielded at least as much as MG IV varieties that were planted in April and irrigated. In northern Arkansas, April plantings of MG IV varieties that were irrigated tended to slightly outyield irrigated MG V varieties (Table 10).

(4) May-planted, nonirrigated MG IV varieties will often yield as much as MG V varieties planted in May and not irrigated. This was not true with

Table 7. Yield of MG III through VII soybean varieties planted in April and May at Blossom and Hooks, TX, 1986-88.[1]

Planting date[2]	Variety (MG)	Year 1986	1987	1988
		bu/A	*bu/A*	*bu/A*
Blossom				
April	Williams 82 (III)	44.0	42.3	22.6
	Crawford (IV)	25.6	26.6	34.5
	Forrest (V)	7.9	17.5	37.6
	Leflore (VI)	4.3	7.8	23.3
	Bragg (VII)	3.2	5.3	16.1
May	Williams 82	15.0	13.8	--
	Crawford	14.3	14.1	--
	Forrest	12.9	12.8	--
	Leflore	10.7	4.3	--
	Bragg	3.8	2.2	--
Hooks				
April	Williams 82	54.7	24.0	35.6
	Crawford	48.2	31.5	47.9
	Forrest	36.8	11.3	46.8
	Leflore	42.6	6.6	40.5
	Bragg	27.5	11.2	38.0
May	Williams 82	36.0	25.2	--
	Crawford	32.0	10.8	--
	Forrest	43.8	8.1	--
	Leflore	36.5	15.9	--
	Bragg	28.5	20.6	--

[1]Source: *(11)*.
[2]Planting dates at Blossom: April 16 and May 15, 1986; April 17 and May 12, 1987; April 22 and May 6, 1988. Planting dates at Hooks: April 17 and May 14, 1986; April 15 and May 11, 1987; April 21 and May 7, 1988.

nonirrigated MG IV varieties planted on shallow silt loam soils in Arkansas (Table 10).

(5) MG IV varieties that were planted in early May and irrigated almost always yielded as much as MG V varieties planted at the same time and irrigated.

(6) Net returns from irrigated and nonirrigated April plantings were always greater than those from May plantings.

In short, MG IV and V soybean varieties planted in April and grown with or without irrigation will produce greater yields and net returns compared with irrigated and nonirrigated May plantings in most years. These conclusions should be valid across northeastern Texas, northern Louisiana, and other Mississippi locations. They also are consistent with conclusions from other experiments not reported here.

The risk of planting early-maturing soybean varieties after April does not appear to be any higher than using the conventional system (Table 5) on irrigated and nonirrigated soils. Results of several studies (Tables 7-9, 11) indicate that yields from May plantings of MG III and IV soybean varieties were almost always as high as those from May plantings of later varieties *(11, 17, 25, 26)*. Thus, the planting window for the ESPS appears to extend to mid-May; however, most available information indicates that yield and economic potential from April plantings are higher than those from later plantings.

Table 8. Seed yield and net returns from nonirrigated April and May soybean plantings at Stoneville, MS, in 1992 and 1994-97.

Year	Variety	Seed yield (bu/A)			Net returns ($/A)		
		Planting date[1]		Avg.	Planting date		Avg.
		Early	Late		Early	Late	
1992	RA 452	42.3 b[2]	32.4 cd	37.4	101 b	42 d	72
	Pioneer 9501	36.9 c	29.8 de	33.3	71 c	28 e	50
	Pioneer 9592	56.4 a	34.9 c	45.6	178 a	56 cd	117
	A 5979	52.9 a	33.2 cd	43.1	159 a	47 cde	103
	Avg.	47.1	32.6		127	43	
1994	RA 452	39.4	32.1	35.8 a	25	-10	8 a
	DP 3499	31.2	27.8	29.5 b	-23	-32	-28 b
	Pioneer 9592	37.1	33.0	35.0 a	15	- 4	6 a
	A 5979	38.6	33.7	36.2 a	22	0	11 a
	Avg.	36.6 a	31.6 b		10 a	-12 b	
1995	RA 452	25.2 b	17.7 d	21.5	8 b	-46 d	-19
	DP 3478	36.9 a	25.2 b	31.1	81 a	2 b	42
	DP 3589	21.3 c	20.9 c	21.1	-18 c	-26 c	-22
	A 5979	25.9 b	20.8 c	23.4	12 b	-26 c	- 7
	Avg.	27.3	21.2		20	-24	
1996	D 478	30.6	30.2	30.4 d	84	69	76 d
	DP 3478	32.3	29.0	30.7 d	95	60	78 d
	Pioneer 9501	33.0	34.7	33.8 c	100	100	100 c
	HY 574	45.9	43.7	44.8 ab	191	162	176 a
	DP 3588	42.8	42.2	42.5 b	158	149	154 b
	Hutcheson	45.2	45.2	45.2 a	190	177	183 a
	Avg.	38.3 a	37.5 a		136 a	119 b	
1997	D 478	28.8	28.4	28.6 bc	107	81	94 c
	DP 3478	30.0	30.4	30.2 b	115	93	104 bc
	A 4922	25.5	27.8	26.6 c	81	75	78 d
	HY 574	30.4	28.6	29.5 b	99	81	90 cd
	DP 3588	34.5	31.5	33.0 a	126	100	113 b
	Hutcheson	36.0	33.3	34.7 a	143	119	131 a
	Avg.	30.9 a	30.1 a		112 a	92 b	

[1]April 15 and May 27, 1992; April 21 and May 13, 1994; April 18 and May 9, 1995; April 30 and May 15, 1996; April 9 and May 12, 1997.
[2]Means within year followed by the same letter are not significantly different (P= 0.05). Where letters follow individual values, a significant interaction occurred using pooled errors; where letters follow planting date and variety averages, no significant interaction occurred.

Table 9. Seed yield and net returns from irrigated April and May soybean plantings at Stoneville, MS, in 1992 and 1994-97.

Year	Variety	Seed yield (bu/A)			Net returns ($/A)		
		Planting date[1]		Avg.	Planting date		Avg.
		Early	Late		Early	Late	
1992	RA 452	62.2	45.2	53.7 a[2]	194	111	153 a
	Pioneer 9501	61.9	45.0	53.4 a	193	110	151 a
	Pioneer 9592	61.2	43.2	52.2 a	189	100	145 a
	A 5979	64.2	43.7	53.9 a	205	103	154 a
	Avg.	62.4 a	44.3 b		195 a	106 b	
1994	RA 452	50.0 ab	48.3 bc	49.1	62 bc	42 de	52
	DP 3499	46.4 c	41.2 d	43.8	44 de	4 f	24
	Pioneer 9592	53.0 a	45.7 c	49.3	80 a	30 e	55
	A 5979	51.2 ab	50.1 ab	50.6	70 ab	53 cd	62
	Avg.	50.2	46.3		64	32	
1995	RA 452	57.0	53.7	55.4 a	166	131	148 a
	DP 3478	56.4	53.9	55.2 a	162	135	148 a
	DP 3589	54.7	56.1	55.4 a	148	146	147 a
	A 5979	57.2	57.8	57.5 a	164	157	161 a
	Avg.	56.3 a	55.4 a		160 a	142 b	
1996	D 478	57.7 b	58.7 ab	58.2	249 b	227 b	238
	DP 3478	57.1 b	52.3 c	54.7	243 b	181 c	212
	DP 3588	58.5 ab	50.0 c	54.3	248 b	164 c	206
	Hutcheson	62.5 a	61.2 ab	61.8	282 a	248 b	265
	Avg.	58.9	55.5		256	205	
1997	D 478	57.9 ab	55.8 ab	56.9	250 ab	203 bc	226
	DP 3478	62.6 a	61.8 ab	62.2	283 a	242 ab	263
	DP 3588	46.8 c	56.3 ab	51.6	134 d	202 bc	168
	Hutcheson	53.9 bc	63.1 a	58.5	188 c	254 ab	221
	Avg.	55.3	59.2		214	225	

[1]April 15 and May 27, 1992; April 21 and May 13, 1994; April 18 and May 9, 1995; April 30 and May 15, 1996; April 9 and May 12, 1997.
[2]Means within year followed by the same letter are not significantly different (P=0.05). Where letters follow individual values, a significant interaction occurred using pooled errors; where letters follow planting date and variety averages, no significant interaction occurred.

Table 10. Average yield of irrigated and nonirrigated MG IV, MG V, and MG VI soybean varieties in Arkansas.[1]

Planting date	MG IV	MG V	MG VI
	bu/A	*bu/A*	*bu/A*
Nonirrigated[2]			
April 24-30	27.7	26.4	27.0
May 15-18	23.8	27.2	28.0
July 1-7	19.0	25.2	26.0
Irrigated[3]			
April 24-30	58.9	56.6	54.0
May 15-18	54.0	50.9	52.8
July 1-7	31.5	37.8	39.4

[1]Source: Ashlock, Malone, Sills, and Haynes, unpublished data.
[2]Grown without irrigation on Calloway silt loam soil at Marianna, AR (34°46'N), 1995 and 1996.
[3]Grown with irrigation on Calhoun silt loam soil at Colt, AR (35°07'N), 1995, 1996, and 1997.

Table 11. Yield of soybean as affected by maturity group and planting date in Arkansas, 1987.[1]

Variety	Planting date	
	April 7-20	May 12-14
	bu/A	*bu/A*
Hempstead County[2]		
MG III & IV	26.8	20.0
MG V & later	15.2	7.9
Lafayette County[2]		
MG III & IV	26.4	9.7
MG V & later	15.2	20.3
Keiser[2]		
MG III & IV	46.4	47.6
MG V & later	45.3	34.2

[1]Source: *(26)*.
[2]Each value is the average of six varieties.

Management Considerations for ESPS

Combination of ESPS and Stale Seedbed

Early planting is the key component in the ESPS concept. The stale seedbed planting system is the best choice to ensure this early-planting component, especially on the millions of acres of clay soils in the Midsouth. Primary tillage during the fall followed by use of a burndown herbicide prior to or at planting provides a favorable environment for planting early. Tillage to destroy weeds and incorporate herbicides prior to planting is discouraged since it will dry the topsoil and possibly delay planting until after the next rain. Thus, the combination of the stale seedbed planting system and the ESPS is synergistic. In other words, the ESPS is a way of ensuring maximum benefit from early planting allowed by the stale seedbed system, and the stale seedbed system is a dependable method of ensuring that the ESPS can be used on the maximum acres in most seasons.

Row Spacing

Narrow Rows. Early-maturing varieties planted in the ESPS may respond favorably to narrow-row culture. At Bossier City, Louisiana, reducing row spacing from 40 inches to 10 inches increased average yield by 8-10 bushels per acre of MG III and IV soybean varieties during 1988, 1990, and 1991 (Table 12). Arkansas studies in 1993 and 1994 also show that row spacings of 10-20 inches appear superior to wide rows in dryland, early (April) plantings.

In a 1997 study at Stoneville, Mississippi, MG IV Dixie 478 (planted April 8 on clay soil and irrigated) averaged 64.2 bushels per acre when grown in 20-inch rows, but only 38.6 bushels per acre when grown in 40-inch rows. Nonirrigated Dixie 478 soybean planted on the same date averaged 25.6 bushels per acre when grown in 20-inch rows, compared with 21.4 bushels per acre from 40-inch rows.

G.R. Bowers (unpublished data) grew MG III and IV varieties in 16- and 32-inch-wide rows at three Texas locations from 1984 through 1988 (Table 13). In three of five April plantings, yields were greater from soybean grown in the 16-inch-wide rows. Two conclusions can be drawn from these studies: (1) row spacing does not matter in low-yield (less than 25 bushels per acre) environments; and (2) 16-inch-wide rows yielded more than 32-inch-wide rows in higher yielding environments.

Savoy et al. *(27)* planted Williams 82 in 14- and 40-inch rows at College Station, Texas (30°35'N), on April 20 in 1988 and 1989 (Table 14). They measured small, nonsignificant differences in yield between the two row spacings. However, the trend was toward higher yields from the narrow rows. Results from this and the related studies suggest that yield of irrigated and nonirrigated early-maturing varieties planted in April will benefit from narrow-row culture under certain conditions.

Table 12. Yield of early-maturing soybean varieties when planted in April in two row spacings at Bossier City, LA.[1]

Variety (MG)	Row spacing	
	10 inches	40 inches
	bu/A	*bu/A*
1988		
Williams 82 (III)	35.2	26.3
AgriPro 4321 (IV)	54.2	41.6
Crawford (IV)	53.6	48.4
P 9442 (IV)	56.7	42.0
1990		
Williams 82	27.1	19.0
Crawford	40.2	32.1
P 9442	26.3	22.4
RA 452 (IV)	38.6	24.8
1991		
Williams 82	35.2	26.3
AgriPro 4321	54.2	41.6
Crawford	53.6	48.4
P 9442	56.7	42.0

[1]Source: Rabb and Ryan, unpublished; *(24)* and *(25)*.

Growth Habit. Other factors also point to the conclusion that early plantings will benefit from narrow-row culture. Some MG V determinate varieties planted early may be short (18-24 inches) at maturity *(17)*. Reduced height due to early planting is greatest with determinate varieties, and this may result in an incomplete canopy in wide rows. It is also generally accepted that early-maturing MG III and IV

Table 13. Average yield of MG III and IV soybean varieties planted in two row spacings at Blossom, Corpus Christi, and Port Lavaca, TX, 1984-1988.[1]							
Row spacing	Planting date and location						
	5/17/84[2] Port Lavaca	4/19/85[3] Corpus Christi	5/9/85[4] Blossom	4/24/86[5] Corpus Christi	4/25/86[6] Port Lavaca	4/22/87[4] Blossom	4/22/88[4] Blossom
	bu/A	*bu/A*	*bu/A*	*bu/A*	*bu/A*	*bu/A*	*bu/A*
16 inches	23.7	34.8	16.5	17.7	13.0	32.9	32.4
32 inches	22.1	26.3	13.3	18.7	15.9	19.1	25.5
Prob.	0.53	0.02	0.15	0.60	0.14	0.03	0.07

[1]Source: Bowers, unpublished data.
[2]Varieties planted at Port Lavaca (28°36') in 1984: JMS 4982, Lawrence, RA 450, and Williams 79.
[3]Varieties planted at Corpus Christi (27°47') in 1985: JMS 4982, Lawrence, RA 450, and Williams 79.
[4]Varieties planted at Blossom (33°33'N) in 1985, 1987, and 1988: Crawford, Franklin, JMS 4982, Pioneer 4880, and Union.
[5]Varieties planted at Corpus Christi in 1986: Crawford, Egyptian, Pioneer 9471, Sparks, and Union.
[6]Varieties planted at Port Lavaca in 1986: Crawford, Egyptian, JMS 4982, Pioneer 9471, Sparks, and Union.

indeterminate soybean varieties produce a much narrower plant type or structure than do MG V and later determinate types. This narrow plant growth habit is more suited to narrow rows.

Weed Infestations. Maturity will commence in August if early-maturing varieties are planted early, causing leaves to begin shedding and the canopy to begin opening. Moist soil from rainfall or irrigation, combined with high temperatures during this time may promote a flush of weeds. These late-season weed infestations can interfere with harvest and contaminate harvested seed if not controlled. Narrow-row culture promotes earlier and more complete canopy closure at the beginning of the growing season and later opening of the canopy at the end of the season. These benefits may help impede late-season weed infestations.

Use of Beds. A bed may be desirable if soybean is planted in April on soils such as the flat alluvial clays of the Mississippi Delta, which have poor surface and internal drainage. If a disk hipper is used for bed forming, row spacing must be 30 inches or wider because individual row beds cannot be effectively formed, maintained, and planted in narrower rows. If producers want to use narrow row planting on beds, they must construct wide beds capable of supporting several rows per bed. Recent equipment developments *(13)* allow this to be done, and a management system of narrow rows planted on beds is now possible.

Plant Stature. Tall-statured varieties (30-36 inches) that branch the entire length of the stalk are adapted to wide rows because they will usually form a complete canopy. Varieties with these traits fall into MG V and later maturity. When used in the ESPS, most of the MG IV soybean varieties presently available are short-statured (24 inches or less), branch only at the lower nodes, and possess a narrow, upright profile. They will form an incomplete canopy in wide rows, will usually yield less, and will be the most likely to have late-season weed infestations. Thus, using wide rows in ESPS plantings will preclude selection of many MG IV varieties.

Table 14. Effects on yield of irrigation and row spacing in early-planted soybean at College Station, TX, 1988-1989.[1,2]				
Irrigation	Row spacing			
	1988		1989	
	14 in.	40 in.	14 in.	40 in.
	bu/A	*bu/A*	*bu/A*	*bu/A*
I	56.9	53.4	65.7	62.0
NI	50.2	50.4	65.4	60.4

[1]Source: *(27)*.
[2]Williams 82 soybean planted on April 20, irrigated (I) and nonirrigated (NI).

Disease Management

Weather Effects. In ESPS plantings, seeds germinate and seedlings emerge when soils are cool and wet. Soil temperatures below 60°F reduce the rates of germination and seedling growth, giving soil-borne pathogens a longer time to infect soybean seedlings. Weather summaries for Stoneville *(10)* show that average minimum air temperature in April is 53°F, average minimum 2-inch soil temperature is 58°F, and average rainfall is 5.4 inches. For May, average minimum air temperature at Stoneville is 62°F, average minimum 2-inch soil temperature is 67°F, and average rainfall is 5 inches. Thus, the cooler air and soil temperatures in April are more ideal for seedling diseases caused by *Pythium* spp., *Phytophthora sojae*, *Rhizoctonia solani*, and *Fusarium* spp. These diseases reduce stands and may affect the vigor of surviving plants.

Cultural Practices. Damage to germinating seedlings is usually worse in wet spots in the field. Therefore, planting on beds may reduce seedling diseases by reducing the time in which soil around germinating seeds is saturated. Seedling diseases caused by *Rhizoctonia solani* may be more severe in fields previously cropped with rice, especially if there is a large amount of crop residue left on the soil surface. Tillage systems that either bury the debris or push the debris away from emerging seedlings may be helpful in reducing damage from this disease.

Seed Selection. The importance of high-quality, disease-free seed, or fungicide-treated seed is greater for early-planted soybean. Seedling diseases caused by *Pythium* spp. or *Phytophthora sojae* can be controlled by seed treatments containing the fungicide Apron XL (mefenoxam), which cost only $1 to $2 per acre. Seedling diseases caused by *P. sojae* can be controlled with resistant varieties. In Arkansas, tests conducted with 21 MG IV varieties found that 9 were susceptible, 6 were field-tolerant, and 6 were resistant *to P. sojae* (Table 15). To control seedling diseases caused by *R. solani* or *Fusarium* spp., use seed treatments containing captan or carboxin alone or in combination with thiram or PCNB.

Other Diseases. The effect of ESPS on other diseases varies, and some diseases may be avoided by planting early. However, rainy weather may delay planting until conditions are more favorable for development of these diseases, so growers should be cautious and not depend on early planting alone to protect against them.

Table 15. Numbers of 28 MG IV soybean varieties in different disease reaction categories.[1]

Disease	Susceptible	Moderate/ tolerant	Resistant
Phytophthora root rot[2]	9	8	9
Frogeye leaf spot	9	11	3
Stem canker	1	7	15
Sudden death syndrome	3	13	2
Soybean cyst nematode[3]	11	4	9
Rootknot nematode	11	2	1

[1]Source: *(12)*.
[2]Resistance ratings are based on greenhouse hypocotyl assay with Race 3. Tolerance ratings are based on field observations.
[3]Varieties listed as resistant or moderate are resistant or moderately resistant to some but not all races of the nematode.

Stem canker has seldom been observed in ESPS plantings, which may be due in part to the high level of resistance in MG IV soybean varieties. However, there are some susceptible MG IV varieties (Table 15), and conditions for infection are more favorable in early plantings. Screenings of varieties for stem canker in Arkansas show that about 20% of MG IV varieties are rated either susceptible or moderately susceptible to this disease. Fortunately, stem canker manifests itself after yield potential has been established in MG IV varieties, but the best practice is to plant moderately resistant or resistant varieties in ESPS plantings in fields known to have problems with this disease.

Frogeye leaf spot may be a problem in fields when prolonged dew periods occur. This disease can be controlled with resistant varieties (Table 15) or with an application of a systemic fungicide such as benomyl or thiophanate-methyl at beginning podset. Sudden death syndrome (SDS) can occur in early-planted soybean, but the effect on yield is not known. Growers may consider planting SDS-resistant varieties (Table 15) if the field has a history of this disease. Charcoal rot is generally not a problem in ESPS plantings due to abundant rainfall in the spring and early summer. However, an early drought or a delay in planting could result in increased levels of this disease. Irrigation and reduced plant populations to avoid drought stress are the only control options for charcoal rot. Brown spot may be more severe in ESPS than in later plantings and can result in defoliation of lower leaves. The effect of this disease on yield appears to be slight, and there are no recommended control measures.

Root-knot nematode and soybean cyst nematode have been reported in early-planted soybean, but the level of yield loss may vary considerably depending on various factors *(22)*. Both nematode genera can cause greater damage in coarse-textured, sandy soils. Since ESPS fields are often located on coarse-textured soils that allow early planting, they may be susceptible to nematode damage. The cool soil temperatures at planting may suppress nematode activity at the beginning of the season, and the short maturation period for these varieties may limit nematode population increases. These factors could result in less severe losses than those seen in longer-season varieties. However, losses to nematodes could be severe in ESPS fields if planting is delayed or if unusually warm weather occurs in the spring. While severe nematode injury can result in visible, above-ground symptoms, nematodes generally cause significant losses without such obvious symptoms. The only sure way of detecting nematode problems is to examine the soil. If nematodes are present, growers should consider either not planting soybean or planting resistant or moderately resistant varieties (Table 15).

Effects of Irrigation

Early-planted, early-maturing varieties respond favorably to supplemental irrigation in years with drought stress *(16)*. Results from 5 years of research at Stoneville, Mississippi, show that both April- and May-planted MG IV and V soybean varieties yielded an average of about 21 bushels per acre more when irrigated (Tables 8-9). Yields of April-planted, irrigated MG IV and V varieties (Table 9) were higher than yields of May-planted, irrigated MG V, VI, and VII varieties examined in previous studies (Table 5). Fewer irrigations were needed for the ESPS plantings in dry years at Stoneville. Thus, irrigation of these plantings resulted in higher yields with less irrigation water, significantly increasing water conservation. Savoy et al. *(27)* measured no significant yield effect from irrigating April-planted Williams 82 at College Station, Texas, in 1988 and 1989 (Table 14). However, their nonirrigated yields averaged 50.3 (1988) and 62.9 (1989) bushels per acre, which indicated almost no drought stress at that location.

Weed Management

No reports indicate differences between weed control measures for ESPS plantings and those required for conventional production systems. Three points should be considered in weed management for ESPS plantings:

(1) ESPS plantings will be made sufficiently early in the season so that one burndown herbicide application may be sufficient to control emerged weeds. The 1998 stale seedbed budget *(29)* for conventional soybean plantings in Mississippi includes two burndown herbicide applications -- one in February and one in May. This split burndown application has its advantages for May and later plantings. The first burndown can use a lower herbicide rate because weeds will be small. The second can also use a relatively low rate since it will be applied to kill only weeds that have emerged since the first burndown application. Using the ESPS, it is possible that the first application can be delayed until the April planting date. However, this application might require a higher herbicide rate since weeds may be larger. Another option is to use the February burndown application, followed by a tank-mix of a burndown herbicide and preemergent herbicides during the April planting operation.

(2) ESPS plantings should be made in narrow rows, which may preclude effective cultivation of middles for weed control after soybean emergence. If so, all weed control will be done with broadcast application of herbicides, which will greatly increase the importance of weed species identification, herbicide selection, and application timing.

(3) Recently completed research at Stoneville, Mississippi, showed that a preemergent broadleaf herbicide alone was sufficient for highest net returns from nonirrigated ESPS soybean grown in narrow rows (no cultivation) on clay soil. Lowered net returns resulted when plots were treated with postemergent broadleaf herbicides alone or in combination with preemergent broadleaf herbicides. Maximum net returns were achieved with weed control expenditures of $25 or less in dryland plantings (low-yield potential). In irrigated ESPS plantings of a MG IV soybean variety, the highest net returns and lowest weed control costs were recorded when plots were treated with

postemergent grass herbicides combined with either preemergent or postemergent broadleaf herbicides.

Roundup Ready Varieties. Use of Roundup Ready® varieties in ESPS plantings is increasing. Two years of research at Stoneville focused on weed management in irrigated and nonirrigated ESPS plantings of Roundup Ready® varieties on clay soil. Results showed that it is not necessary to apply a conventional preemergent herbicide in addition to postemergent applications of Roundup. Maximum yields and greater net returns were attained when researchers used only post-applied Roundup. This total POST weed management system with Roundup assumes that no delays occur in early-season weed control.

Preharvest Desiccants. Soybean is an annual plant that matures at the end of its reproductive cycle each year. Therefore, soybean grown in conventional systems (MG V and later varieties planted in May or later) will not require application of preharvest desiccants to affect maturity. In ESPS plantings, however, weeds or soybean plants with green leaves may be present in an amount that could reduce grain quality and impair harvest efficiency (slow ground speed, frequent stopping, and machine choking). Under these conditions, the use of a desiccant may be warranted. On the other hand, it is important to point out that applying a desiccant before harvest may not prevent grain from being contaminated by foreign matter (seed from mature weeds and dry, desiccated plant material not removed during threshing).

Application of a desiccant at harvest is a poor substitute for proper early-season weed control. However, it is possible for late-season weed infestations to cover the soybean canopy completely in ESPS fields at harvest, even when early-season weed control was excellent. April-planted, early-maturing varieties will mature during August and early September, which means they could have an earlier open canopy. This early canopy opening allows sunlight to reach the soil surface, possibly resulting in increased weed growth by harvest time in late August to mid-September. For example, a mid- to late-April planting of an RM 4.7 variety will reach full seed stage in early August, begin to mature in mid-August, and reach full maturity in late August or early September. In contrast, a May 15-planted MG V variety will reach full seed stage in early to mid-September and full maturity in late September.

The possibility of late-season weed infestations highlights the importance of current research examining the use of a preharvest desiccant in ESPS plantings done in April. Until definitive research has produced results sufficient for making recommendations about the use of a preharvest desiccant, several factors should be considered:

(1) Desiccants will not be needed if weeds present at maturity do not reduce harvest efficiency. Such weeds include those that emerge late in the growing season and are still small at harvest, as will be the case in most nonirrigated plantings. Small-statured annual grasses, small-stemmed perennial vines such as redvine, small-statured and small-stemmed broadleafs such as teaweed also will not interfere with harvest.

(2) Desiccants will not be needed if the weeds present at harvest have not produced mature seeds that will contaminate the grain.

(3) Desiccants will not be needed if they cannot be applied sufficiently ahead of harvest to satisfy label requirements (usually 7 days between desiccant application and harvest). Desiccants also must be applied in time to ensure that weeds are dry at harvest.

(4) Desiccants will not be needed if the weed vegetation cut by the combine during harvest is returned to the field with the soybean residue, so that no foreign matter enters the grain sample.

(5) Desiccants will not be needed if row spacing and variety selection were compatible and an effective herbicide program was in place. Row spacing should be sufficiently narrow to allow the selected variety to form a canopy.

(6) It is economical to control only those weed infestations that will create enough foreign matter contamination in harvested grain to cause dockage.

(7) Effective control of early-season weeds will result in fewer significant weed infestations late in the season when the soybean canopy opens at maturity. Late-emerging weeds may be of much less significance at harvest, compared with those that are present beneath the soybean canopy during the growing season.

(8) Pre-harvest desiccants will not speed the process of soybean seed drying, so they should not be used to hasten a reduction in seed moisture content.

Preliminary findings in Arkansas, Louisiana, Mississippi, and Texas show that in many cases it was not necessary or was not cost effective to apply preharvest desiccants on ESPS fields. An acceptable general rule regarding the use of a preharvest desiccant in an ESPS planting is to anticipate the need for its application in short-statured MG IV varieties that have been irrigated or that receive abnormally high rain in August.

Insect Management

Use of the ESPS should allow soybean producers to avoid late-season foliage-feeding insect infestations, according to research conducted in Arkansas, Louisiana, Mississippi, and Texas. Mississippi soybean budgets *(29)* list a planned August insecticide application to conventional crops planted in May and June. The 1998 ESPS budget does not list this application, because early plantings of early-maturing varieties will be nearing maturity when outbreaks of foliage-feeding insects usually occur. The maturing foliage of these varieties will not be susceptible to significant damage from foliage-feeding insects.

At Stoneville, Mississippi (33°26'N), foliage-feeding pest populations were extremely low in 1996 and 1997 ESPS plantings (Table 16). No insecticide applications have been required in ESPS plantings at Stoneville in 2 years of sampling. Similarly, northeastern Texas soybean producers required almost no insecticide usage in ESPS plantings, since caterpillars, stink bugs, and bean leaf beetles generally do not become an economic threat to early-planted, early-maturing soybean in that region.

Caterpillar Pests. Data from the Texas Gulf Coast also support the notion of reduced insecticide usage in ESPS fields for control of foliage-feeding pests. Economic threshold (ET) is the point at which insect damage becomes economically significant. Lepidoptera (caterpillar) defoliators -- such as velvetbean caterpillars, green cloverworms, and soybean loopers -- usually reach ET levels in conventional soybean production systems during mid- to late September in this region of Texas. In general, ESPS soybean are harvested before Lepidoptera defoliators reach ET populations along the Texas coast. Thus, ESPS producers in this area can safely eliminate the insecticide applications required to control caterpillar pests in conventional soybean production.

Recent studies conducted in Louisiana further illustrate the benefits of planting early to avoid lepidopterous foliage-feeding insects late in the

Table 16. Peak population levels and dates of peak populations for selected insects on indicated soybean varieties at Stoneville, MS, in 1996-1997.

Variety[1] Date planted	Irr.[2]	Peak population levels and date of peak populations[3]													
		TCAH		BLB		SGSB		BSB		SL		VBC		PRED	
		No.	Date	No.	Date	No.	Date	No.	Date	No.	Date	No.	Date	No.	Date
1997															
MG IV..... 4/9	NI	4	8/6	4	7/15	0	NA	0	NA	0	NA	0	NA	3	6/26
	I	5	7/15	4	8/6	0	NA	0	NA	0	NA	0	NA	2	6/26
MG V 4/9	NI	6	7/15	5	7/15	0	NA	0	NA	0	NA	0	NA	2	6/26
	I	5	7/15	4	8/6	0	NA	0	NA	0	NA	0	NA	1	7/9
MG IV.... 5/12	NI	8	7/15	12	7/15	0	NA	2	8/27	0	NA	0	NA	2	7/22
	I	5	7/22	7	8/6	0	NA	0	NA	0	NA	0	NA	2	7/22
MG V 5/12	NI	7	8/18	9	8/27	0	NA	0	NA	0	NA	0	NA	3	7/22
	I	4	7/15	3	8/6	0	NA	0	NA	0	NA	0	NA	1	7/22
1996															
MG IV.... 4/30	NI	17	8/19	27	6/24	0	NA	0	NA	0	NA	0	NA	4	6/17
	I	8	8/19	15	7/26	0	NA	0	NA	0	NA	0	NA	6	6/17
MG V 4/30	NI	15	9/10	25	9/3	0	NA	0	NA	0	NA	0	NA	5	6/17
	I	6	9/10	18	9/3	0	NA	0	NA	0	NA	0	NA	4	6/17
MG IV.... 5/12	NI	18	8/19	25	7/26	0	NA	0	NA	0	NA	0	NA	3	6/17
	I	13	8/19	20	7/26	0	NA	0	NA	0	NA	0	NA	6	6/17
MG V 5/12	NI	15	9/10	70[4]	9/3	0	NA	0	NA	0	NA	0	NA	4	6/17
	I	3	9/10	25	9/3	0	NA	0	NA	0	NA	0	NA	5	6/17

[1]MG IV varieties were DP 3478 and Dixie 478; MG V varieties were DP 3588 and Hutcheson.
[2]Irrigation treatments: NI = nonirrigated and I = irrigated. All row spacings were 20 inches.
[3]Number of insects per 25 sweeps. Insects listed are the three-cornered alfalfa hopper (TCAH), bean leaf beetle (BLB), southern green stink bug (SGSB), brown stink bug (BSB), soybean looper (SL), velvetbean caterpillar (VBC), and total insect predators and spiders (PRED).
[4]Population levels exceeded economic threshold levels.

growing season. MG IV varieties planted in April were ready to harvest in late August and did not require insecticides for control of these pests. However, in three of four sites [Bossier City (32°25'N), Alexandria (31°19'N), St. Gabriel (30°17'N), and Crowley (30°11'N)], caterpillar pests reached high population densities in soybean planted during the normal planting period (May 1- May 15) (Table 17). In 1996 at Bossier City, DP 3478 and Hutcheson planted on May 8 required applications of insecticide on August 26 to control soybean loopers. At Alexandria, Hutcheson and Asgrow A6961 planted May 16 received insecticides on August 22 for soybean looper control. Plants were between beginning seed and full seed when insecticides were applied. The cost of this treatment ranged from $6.80 to $7.75 per acre per application.

Table 17. Peak population levels and dates of peak populations for selected insects on indicated soybean varieties at indicated Louisiana locations, 1996-1997.[1]

Variety	Date planted	Peak population levels and date of peak populations[2]													
		TCAH		BLB		SGSB		BSB		SL		VBC		PRED	
		No.	Date	No.	Date	No.	Date	No.	Date	No.	Date	No.	Date	No.	Date
Bossier City (1997)															
DP 3478	5/12	11	8/4	0	NA	10	8/9	0	NA	7	8/9	0	NA	14	8/4
Hutcheson	6/3	9	7/28	0	NA	2	8/9	0	NA	4	8/9	0	NA	12	7/28
Alexandria (1997)															
DP 3478	4/17	10	5/27	29	7/10	17[3]	7/16	2	8/20	2	8/20	0	NA	12	5/27
DP 3478	4/17	--	NA	--	NA	10[3]	7/23	--	NA	--	NA	--	NA	--	NA
Hutcheson	4/17	11	7/23	13	7/2	11[3]	8/6	2	9/3	8	9/3	0	NA	9	6/17
DP 3478	5/12	11	7/16	23	8/6	20[3]	8/6	2	8/28	12	8/28	0	NA	6	7/2
Hutcheson	5/12	15	9/10	13	8/6	15[3]	8/20	3	9/10	15	9/10	1	9/10	7	7/29
Hutcheson	5/12	--	NA	--	NA	12[3]	8/28	--	NA	--	NA	--	NA	--	NA
A 6961	5/12	21	10/1	25	8/20	7	9/17	10[3]	9/17	15	9/17	5	9/10	8	7/2
Crowley (1997)															
DP 3478	5/7	9	8/13	2	8/6	3	8/6	14[3]	8/13	2	8/13	1	8/6	9	7/10
P 9592	5/7	12	8/13	4	8/20	2	8/20	12[3]	8/28	1	8/20	1	9/3	9	7/10
A 6961	5/7	9	8/6	3	8/28	6	9/17	13[3]	9/17	1	10/1	6	9/17	7	7/10
St. Gabriel (1997)															
DP 3478	4/23	3	7/16	0	NA	9[3]	7/16	2	8/20	9	8/6	0	NA	7	6/20
DP 3478	4/23	--	NA	--	NA	17[3]	8/6	--	NA	--	NA	--	NA	--	NA
P 9592	6/5	8	8/13	0	NA	39[3]	9/10	4	9/10	3	9/24	14	8/28	5	7/23
A 6961	6/5	5	8/6	0	NA	32[3]	9/10	3	9/10	3	10/1	16	8/28	5	8/13
Bossier City (1996)															
DP 3478	5/7	21	7/29	3	7/29	23[3]	8/26	24[3]	8/26	47[3]	8/28	--	NA	7	7/15
Hutcheson	5/7	24	8/18	2	8/12	16[3]	8/12	18[3]	8/12	24[3]	8/26	--	NA	8	8/12
Alexandria (1996)															
DP 3478	4/19	25	7/23	26	7/9	1	7/23	5	7/23	2	8/13	--	NA	20	6/4
Hutcheson	5/16	23	7/23	11	7/23	1	9/11	5	9/11	69[3]	8/22	--	NA	6	6/25
A 6961	5/16	19	7/23	69[3]	9/3	22[3]	10/1	31[3]	9/25	58[3]	8/22	--	NA	7	6/18
Crowley (1996)															
DP 3456	4/24	5	7/16	0	NA	2	7/16	2	7/30	0	NA	0	NA	18	7/9
P 9592	5/15	5	7/16	0	NA	8	9/3	10[3]	9/3	0	NA	0	NA	13	7/9
A 6961	5/15	6	7/30	0	NA	87[3]	10/1	99[3]	10/1	2	9/11	12	9/11	16	7/16
St. Gabriel (1996)															
DP 3478	4/22	4	7/17	2	7/24	5	8/8	7	8/8	0	NA	0	NA	32	6/25
P 9592	5/21	6	7/2	0	NA	9[3]	9/4	11[3]	9/4	7	9/4	7	9/4	12	6/25
A 6961	5/21	7	7/2	4	9/12	13[3]	9/12	22[3]	9/12	8	8/30	29	9/12	14	8/8

[1]Double entries for the same variety indicate two insecticide applications. All row spacings were 30-38 inches.
[2]Number of insects per 25 sweeps. Insects listed are the three-cornered alfalfa hopper (TCAH), bean leaf beetle (BLB), southern green stink bug (SGSB), brown stink bug (BSB), soybean looper (SL), velvetbean caterpillar (VBC), and total insect predators and spiders (PRED).
[3]Population levels exceeded the economic threshold and were treated with insecticide.

Velvetbean caterpillars did not exceed the ET at St. Gabriel in 1996, but populations reached approximately half ET on September 12 on Asgrow A6961 planted May 21. Plants were between beginning seed and full seed stages when velvetbean caterpillar populations reached their highest levels. Boyd et al. *(9)* observed that the velvetbean caterpillar reached peak population levels in early September on MG V soybean, but it was barely detectable on MG IV varieties.

Stink Bugs. Infestation and subsequent seed damage by phytophagus (plant-eating) stink bugs in ESPS plantings is a concern in some areas. ESPS will result in an abundance of suitable hosts for stink bugs, because pods will be available earlier in the season when populations of this pest reach their highest levels. Most data suggest that stink bug management will be necessary on ESPS fields in parts of Texas and Louisiana. However, this management should not be more than that required for conventional plantings of conventional varieties.

At Beaumont, Texas (30°04'N), stink bugs are typically a problem in the ESPS. Stink bugs -- particularly the green stink bug and the southern green stink bug -- generally become a problem on conventional soybean plantings in late September in the Texas Gulf Coast area. However, stink bugs in this region often reach ET levels during the reproductive stages of ESPS crops in July and August, usually requiring insecticide application. ESPS plantings in this area should be inspected frequently for stink bugs since adults are highly mobile and can invade fields quickly and repeatedly.

Data from Louisiana in 1996 and 1997 *(9)* indicated that MG IV varieties were more heavily infested with stink bugs than were MG V varieties. However, only the later-maturing varieties in 1996 required insecticide management of stink bugs. In 1996, colonization of the MG IV varieties was late and populations did not build to treatment levels before they moved to colonize the later varieties. In southern Louisiana, MG IV varieties required more insecticide applications.

At Louisiana locations, early-planted MG IV and V varieties were attacked by southern green stink bugs earlier in the season than were the later-planted varieties (Table 17). ESPS plantings at Bossier City have required insecticide applications in 3 of the last 7 years to control the southern green stink bug. In 1996 at Bossier City, southern green stink bug densities exceeded ET twice between August 9 and August 26 on DP 3478 and Hutcheson planted May 7. In 1997 at Alexandria, these same varieties were planted April 17, and southern green stink bug populations exceeded ET twice between July 16 and August 6, thus requiring insecticide application. Hutcheson planted on May 12 at Alexandria required treatment twice between August 20 and August 28, while DP 3478 planted on May 12 required only one insecticide application. At St. Gabriel, a May 21, 1996, planting had southern green stink bug densities that exceeded ET levels on Pioneer Brand 9592, Asgrow A6961, and Pioneer Brand 9761 varieties. However, ET densities were not exceeded in April 22-planted MG IV varieties at St. Gabriel. At the recommended insecticide rates for stink bug control, applications between September 4 and 10 on these varieties cost between $1.70 and $4.50 per acre per application for organophosphate and pyrethroid insecticides, respectively.

The brown stink bug in Louisiana reached its greatest population level later in the season than did the southern green stink bug. The brown stink bug was primarily a problem on MG V, VI, and VII varieties planted on conventional planting dates (Table 17). In 1996 at Alexandria, brown stink bug populations exceeded the ET in Asgrow A6961 on September 18 when the plants were at the full seed stage. At Crowley in 1996, the brown stink bug required insecticide for control in Pioneer Brand 9592 and Asgrow A6961 between September 11 and 18. In 1997 at Crowley, brown stink bugs exceeded the ET in DP 3478 on August 13, in Pioneer Brand 9592 on August 28, and in Asgrow A6961 on September 17.

Bean Leaf Beetle. Adoption of the ESPS may require increased management of the bean leaf beetle at some Louisiana locations. In recent studies, the bean leaf beetle displayed two distinct peaks of population density, one early and one late in the season. Later generations of this species reach a higher population level than the earlier generation. Also, the later generations have the potential to be especially harmful because adults feed on developing pods. In 1996 at Alexandria, Asgrow A6961 planted May 16 (conventional planting) required insecticide treatment on September 9 to control the insect. In 1997 at Alexandria, the beetle reached its highest population levels on May 27, when April 17-planted DP 3478 had five trifoliolate leaves (Table 17).

Conversely, ESPS plantings at Stoneville did not require treatment for bean leaf beetles even though populations reached peak levels on June 24 on April 30-planted DP 3478 and Dixie 478 that had 11 or 12 trifoliolate leaves (Table 16). In a conventional May 15 planting of Hutcheson, beetle numbers exceeded ET on September 3 when plants were at the full seed stage, and required treatment.

Farming operations that include both ESPS and traditional production systems should involve scouting for the bean leaf beetle in later plantings to detect densities that may require management. In general, bean leaf beetle populations tend to increase with each succeeding generation during the season. Therefore, populations may not exceed ET densities in early-planted, early-maturing varieties. However, the abundant food source provided by these varieties for beetles emerging from overwintering habitats in early spring may increase the survival of the beetles. This survival advantage can lead to bean leaf beetle populations that become an economic threat in later-planted, later-maturing varieties in late season.

Banded Cucumber Beetle. The banded cucumber beetle was found primarily at the St. Gabriel location in southern Louisiana. Generally, a single peak in population density occurred around early to mid-July when insect densities in early-planted, early-maturing varieties were approximately one-half those in the later-planted varieties. In July 1997, banded cucumber beetle density in DP 3478 planted April 23 was 10-11 beetles per 25 sweeps, while density in Pioneer Brand 9592 and Asgrow A6961 planted June 5 was 20-25 beetles per 25 sweeps. These levels were below the ET.

Three-Cornered Alfalfa Hopper. Sampling should be conducted at latitudes south of about 33°N to monitor early-season populations of the three-cornered alfalfa hopper. This pest has the potential to cause feeding damage on early-emerging plants in ESPS production. Three-cornered alfalfa hoppers required late-season management at Louisiana locations in 1996 (Table 17). At Alexandria, these pests reached peak densities on July 23 when soybean ranged from full seed (MG IV) to full bloom (MG VI). Densities were highest on the MG IV soybean leading up to this date. Insecticides at rates similar to those used on bean leaf beetle and stink bugs are recommended for three-cornered alfalfa hopper control.

At Stoneville, Mississippi, higher populations of the three-cornered alfalfa hopper and bean leaf beetle were found on nonirrigated soybean, regardless of planting date or maturity group in 1996 (Table 16). Populations were similar on nonirrigated and irrigated soybean until August 19, when nonirrigated soybean planted April 30 were between beginning seed (Deltapine 3588 and Hutcheson) and full seed (DP 3478 and Dixie 478). From August 19 until harvest, nonirrigated soybean had average populations of 16 hoppers per 25 sweeps, while irrigated soybean averaged 6 hoppers per 25 sweeps. During that same period, bean leaf beetles averaged 34 adults per 25 sweeps on nonirrigated soybean and 15 adults per 25 sweeps on irrigated soybean. All these densities were below the ET.

Beneficial Insects. Some evidence has been found that early-planted, early-maturing soybean serve as a haven for beneficial insect predators early in the season. Only predators were sampled in a Louisiana study (Table 17). In 1996, the most abundant predator was the bigeyed bug; at St. Gabriel, populations were highest between June 18 and June 25. Populations were much higher on DP 3478 planted on April 22 (19-20 bigeyed bugs per 25 sweeps) than on later-maturing varieties planted on conventional planting dates (2-4 bigeyed bugs per 25 sweeps). DP 3478 was at full pod size when bigeyed bug population densities peaked, and Pioneer Brand 9592, Pioneer Brand 9761, and Asgrow A6961 had five to six trifoliolate leaves. In 1996 at Bossier City, bigeyed bug populations in a May 7 planting peaked on July 15, and were higher on DP 3478 (10 bigeyed bugs per 25 sweeps) than on Hutcheson (2-4 bigeyed bugs per 25 sweeps). In 1997, the bigeyed bug was not as prevalent. At Alexandria, April 17-planted DP 3478 had a total of 11-12 predators of all types per 25 sweeps on May 28 and August 13.

Advantages of Using the ESPS

Traditionally, full-season (MG V-VIII) soybean varieties have been planted during May-June and harvested in October and November. Rains frequently delay harvest, and wet soils result in harvesting inefficiencies and rutting of fields, especially during November. From 1971 through 1991, only 16% of the Mississippi soybean crop had been harvested by October 10, and less than 50% of the crop had been harvested by October 30 *(1, 2, 3, 4)*. Plantings of MG IV and V varieties made in April to early May mature and reach harvest seed moisture content between mid-August and the end of September, resulting in earlier harvest. This early harvesting and marketing sometimes results in a higher price received.

Harvest was relatively early when significant acres of soybean were planted by the first week in May in Mississippi (Table 1). Large portions of the Mississippi crop were harvested by the first week in October: 40% in 1994; 46% in 1995; 31% in 1996; and 47% in 1997. This earlier harvest when soil is dry allows effective fall subsoiling, resulting in greater yields from nonirrigated soybean planted the following year *(31)*. This finding was confirmed in subsequent studies at Stoneville on Tunica clay. The key to this subsoiling response from ESPS plantings is that the subsoiling must be done in the fall when soil is dry. Subsoiling wet soil at any time, or subsoiling sites that are to be irrigated, will provide no return to the subsoiling. Earlier harvest and fall land preparation also eliminate some weeds before they reach maturity. They also ensure that the next year's crop can be planted early because the seedbed can be prepared (subsoiling, smoothing, bedding, etc.) in the fall when soil is dry and allowed to settle to a stale condition by planting time.

The ESPS is a perfect match for rotation with early-planted crops such as corn and rice because early harvest of the soybean allows land preparation in the fall for next year's grain crop. These grain crops can then be planted on time the following spring on a flat stale seedbed (rice) or on stale beds (corn) created following tillage the preceding fall. Early soybean harvest also allows effective land preparation before fall-planted grain or cover crops.

Potential ESPS Problems and Solutions

Pod Shattering

One potential problem with early-planted, early-maturing soybean varieties in the Midsouth is shattering, when pods open and release seeds before harvest. Shattering is related to the very rapid drying of pods and seeds during August or early September, the hottest, least humid time of the year. The only sure way of avoiding this loss is to harvest as soon as the seed moisture is appropriate. According to Spurlock et al. *(30)*, weather and soil moisture conditions during the anticipated harvest time (August 15 to September 30) allow an 80% chance of at least 29 of the 47 days being suitable for field work in Mississippi. Thus, timely harvest of ESPS plantings can be accomplished during this period because of the high probability of days suitable for harvesting.

Seed Quality

Poor seed quality (low germination, discoloration, shriveling, etc.) of harvested seed is a major production problem in MG III and IV soybean varieties grown in the Midsouth. Factors affecting seed quality include planting date, foliar fungicide application, irrigation, harvest timing, and location (north or south) within the region. The importance of these factors varies from year to year, depending on disease history of the field and on maximum temperature, fog, rainfall, and other weather factors during and after seed maturation.

Seed Germination. Mayhew and Caviness *(23)* grew four MG III and four MG IV April-planted soybean varieties under nonirrigated conditions in 1989 and 1990 in Arkansas (34 to 36°N). Average seed germination for MG III and IV varieties was 28% and 42%, respectively (Table 18). A strong relationship was seen between reduced germination rates and increased rates of infection with *Phomopsis longicolla*, the primary cause of phomopsis seed decay. MG V varieties were not included in this study, so it is impossible to say that seed of early plantings of only early-maturing varieties are susceptible to low germination.

Similarly, 1995 and 1996 studies at Stoneville, Mississippi, showed that elevated levels of infection with *Diaporthe phaseolorum* var. *sojae* (primary cause of pod and stem blight) were significantly related to low germination of seed from irrigated ESPS plantings. With seed from nonirrigated ESPS plantings, this relationship was present only in 1996, when August rainfall was almost 5 inches. Heatherly *(16, 17)* measured significantly higher germination of harvested seed from some ESPS MG IV and V varieties that were irrigated at Stoneville (Tables 19-20), but this improvement was not always sufficient to impart acceptable (more than 80%) levels of germination. Heatherly *(17)* made three other relevant findings: (1) harvested seed of early-planted MG V soybean varieties may also be low in germination; (2) harvested seed of early-planted MG IV varieties were not always low in germination; and (3) planting MG IV and V varieties in May and irrigating will usually ensure seed with the highest germination percentage (Table 20).

Seed produced in the 1993 and 1994 Texas ESPS Variety Trials conducted at Cooper (33°23'N) and De Kalb (33°32'N) were tested for germination by G.R. Bowers (unpublished data). Large differences in germination of seed produced in the same environment were measured (Table 21). For example, seed of Asgrow A3935 and A4415 produced at Cooper in 1993 had 91% and 16% germination, respectively. Seed of Asgrow A4539 produced at Cooper in 1994 had 37% germination, while seed of TN4-86 had 98% germination. Location and year also affected germina-

Table 18. Germination of harvested seed from MG III and IV soybean varieties planted in April in Arkansas, 1989-1990.[1]

Variety	1989[2]	1990[3]
	%	%
MG III		
Williams 82	23	39
A 3966	18	28
Pella 86	22	22
S42-30	38	34
MG IV		
HY 401	37	49
Competitor	29	50
Crawford	40	50
Coker 614	40	43

[1]Source: *(23)*.
[2]Planted April 6-11 at three locations in 1989.
[3]Planted April 11-25 at three locations in 1990.

Table 19. Germination of harvested seed from nonirrigated and irrigated MG IV soybean at Stoneville, MS, 1990-1991.[1]

Variety	Irrigation[2]	Germination[3]	
		1990	1991
		%	%
Avery	NI	15	--
	I	34	--
Crawford	NI	44	67
	I	44	85
FFR 464	NI	44	--
	I	72	--
RA 452	NI	--	62
	I	--	89

[1]Source: *(16)*.
[2]NI = nonirrigated; I = irrigated.
[3]Planting dates: April 25, 1990, and May 16, 1991.

Table 20. Germination of harvested seed from nonirrigated and irrigated MG IV and V soybean planted on two dates at Stoneville, MS, 1992-1995.[1]

Variety (MG)	Planting date[2]			
	Early		Late	
	NI	I	NI	I
	%	%	%	%
1992				
RA 452 (IV)	70	68	91	91
P 9501 (IV)	14	36	84	82
P 9592 (V)	73	68	98	98
A 5979 (V)	69	77	93	98
1993				
RA 452	82	--	92	96
DP 3499 (IV)	93	--	88	98
P 9592	93	--	92	97
A 5979	92	--	91	98
1994				
RA 452	95	90	97	96
DP 3499	89	94	92	97
P 9592	94	91	96	98
A 5979	89	89	96	96
1995				
RA 452	38	77	33	94
DP 3478	72	24	71	59
DP 3589	85	93	81	96
A 5979	58	95	72	95

[1]Source: *(17)*.
[2]NI = nonirrigated; I = irrigated. Planting dates were April 15 and May 27, 1992; April 29 and June 3, 1993 (NI), and May 21, 1993 (I); April 21 and May 13, 1994; April 18 and May 9, 1995.

tion. Seed of Asgrow A3935 produced at Cooper and De Kalb in 1993 germinated 91% and 30%, respectively. Seed of Asgrow A4415 produced at Cooper in 1993 and 1994 germinated 16% and 81%, respectively. On the other hand, seed of Dekalb CX404 produced in the 1993 Cooper environment germinated 91%, while seed produced at Cooper the following year germinated 37%. Varieties with excellent germination rates were identified; seed of Buckshot 44 and Patriot from all environments germinated at least 90%.

Fungicide Application and Harvest Timing. In 1989 and 1990, the effect of foliar fungicide application and harvest timing on quality of harvested seed of MG III Williams 82 and MG IV Crawford was measured at Hope, Arkansas (33°40'N) (J. Rupe, T. Kirkpatrick, and M. May, unpublished data). Crops were planted in mid-April, and benomyl was applied at a half pound of active ingredient per acre on one of two treatment schedules: (1) once at both beginning podset and beginning seed; or (2) once at full seed alone. Harvest either was prompt (as soon as the seed reached harvest maturity) or delayed until 2 weeks after harvest maturity. Rainfall was more abundant in July and August of 1989 than in 1990, when irrigation was required (Table 22).

Prompt harvest in the Arkansas study resulted in generally higher yields from Williams 82 in both years, suggesting that some shattering occurred when harvest was delayed (Table 23). Foliar fungicide treatments increased yields from the prompt harvest of Williams 82 and from the delayed harvest of Crawford in 1989, but did not affect yield of either variety in 1990. Frogeye leaf spot was present in 1989 and may have been controlled by the fungicide.

Germination of harvested seed of both varieties was very poor in 1989 and was not increased by most foliar fungicide applications (Table 24). Delaying harvest resulted in dramatically reduced germination in both years. In 1990, germination of seed of both varieties was much higher, but levels were not high enough for quality planting seed. Delayed harvest resulted in

Table 21. Germination of harvested seed from April-planted dryland soybean trials at two NE Texas locations, 1993-1994.[1]

Variety	Cooper 1993	Cooper 1994	De Kalb 1993	De Kalb 1994
	%	%	%	%
Asgrow A3935	91	48	30	54
Asgrow A4415	16	81	20	68
Asgrow A4539	57	37	71	94
Asgrow A4715	71	98	81	98
Avery	93	91	88	86
Buckshot 44	90	91	90	99
Chesapeake	91	97	66	98
Dekalb CX404	91	37	41	87
Delsoy 4900	90	89	97	99
Lynks 5415	90	29	30	81
Manokin	95	90	88	99
Novartis S46–44	37	86	69	67
Patriot	90	93	90	96
Pioneer 9451	88	22	35	75
Stewart SB4510	98	90	70	91
TN4–86	58	98	70	94

[1]Source: Bowers, unpublished data.

Table 22. Monthly rainfall at two Arkansas locations, 1989-1991.

Month	Hope (33°40'N) 1989	Hope (33°40'N) 1990	Keiser (35°40'N) 1990	Keiser (35°40'N) 1991
	in	*in*	*in*	*in*
March	9.4	10.7	7.3	2.9
April	1.7	6.6	6.1	11.8
May	8.5	6.2	4.9	7.2
June	5.5	4.7	4.4	4.0
July	10.9	2.0	2.0	1.9
August	7.9	2.5	1.3	3.0
September	2.0	3.0	3.1	3.0

Table 23. Effect of foliar fungicide treatments on yields of two April-planted soybean varieties with prompt or delayed harvest at Hope, AR, 1989-1990.[1]

Fungicide treatment[2,3]	Williams 82 Prompt	Williams 82 Delayed[4]	Crawford Prompt	Crawford Delayed[4]
	bu/A	*bu/A*	*bu/A*	*bu/A*
1989				
None	34.2	35.9	36.2	29.1
R6	46.3	38.7	36.4	33.2
R3+R5	44.1	37.2	36.2	40.8
		$LSD_{0.05} = 7.9$		
1990				
None	36.9	30.3	32.3	32.4
R6	35.5	34.0	30.9	31.3
R3+R5	37.2	33.7	28.2	29.1
		$LSD_{0.05} = 3.0$		

[1]Source: Rupe, Kirkpatrick, and May, unpublished data.
[2]R6 = full seed; R3 = beginning pod; and R5 = beginning seed.
[3]Benomyl was applied in one of two treatments: 0.5 lb ai/acre with a backpack sprayer as a single application at the full seed stage (R6); or a 0.5 lb ai/acre application at both beginning pod (R3) and beginning seed (R5) stages.
[4]Harvest delayed for 2 weeks.

reduced germination and greater infection with *P. longicolla* in both years. The higher germination of 1990 seed was associated with lower rainfall in July and August (Table 22). Fungicide applications at either harvest time decreased seed infection. Poor seed germination was due in part to infection by *P. longicolla*, but it probably was also due to physiological problems associated with high temperatures during seed formation and maturation *(28)*.

Similar studies were conducted at Stoneville, Mississippi, in 1994 and 1995 (Heatherly, unpublished data). Foliar applications of benomyl fungicide (half pound active ingredient per acre) at beginning seed did not improve germination percentage or yield of seed from ESPS plantings.

Delayed Planting. In northern Arkansas, seed quality was improved by a delay in planting. In 1990 and 1991, Williams 82 and Crawford were planted in an irrigated test at Keiser (35°40'N) on two dates each year (Table 25) (J. Rupe, T. Kirkpatrick, and M. May, unpublished data). Germination of seed harvested at this location was much higher than that of the seed harvested in southern Arkansas (Table 24). Germination of seed harvested from June 8 and June 21, 1990, plantings of Williams 82 was 73% and 89%, respectively. For Crawford, germination of seed was 92% from a June 8 planting and 91% from a June 21 planting. Germination of all 1991 seed was 90% or greater (Table 25). Seed infection by *P. longicolla* was low in 1990 and nonexistent in 1991. Yields in 1990 were slightly higher from the June 8 planting, and both varieties produced about the same yields with or without a fungicide applied at full seed -- 39.3 bushels per acre from fungicide-treated crops, compared with 40.8 bushels per acre from untreated crops. In 1991, only Crawford's yield was affected by planting date, and fungicide treatment did not affect yield or seed infection by *P. longicolla*. Both the delay in planting and the northern location in Arkansas seem important in producing high-quality seed of early-maturing varieties.

These results agree with the results of Mayhew and Caviness *(23)*, who reported that seed infection by *P. longicolla* was lower and germination was higher in seed produced at Fayetteville, Arkansas (36°03'N), compared with Hope. Similarly, germination was higher in MG IV than in MG III varieties. Cooler temperatures in the northern sections of the region during maturation of seed of early-planted, early-maturing varieties are presumed to be associated with the higher quality seed produced in the northern sections.

Location. Results from these Arkansas studies suggest that in the southern part of that state, it is unlikely that high-quality seed can be produced when

Table 24. Effect of foliar fungicide treatment on germination of harvested seed and *Phomopsis longicolla* infection of two April-planted soybean varieties with prompt or delayed harvest at Hope, AR, 1989-1990.[1]

Fungicide treatment[2,3]	Germination: Prompt	Germination: Delayed[4]	*P. longicolla*: Prompt	*P. longicolla*: Delayed[4]
	%	%	%	%
Williams 82 (1989)				
None	12	0	17	70
R6	18	0	6	49
R3+R5	19	0	12	60
	$LSD_{0.05}$ within harvest = 10		*$LSD_{0.05}$ within harvest = 12*	
	$LSD_{0.05}$ between harvests = 11		*$LSD_{0.05}$ between harvests = 12*	
Williams 82 (1990)				
None	64	18	18	44
R6	68	36	9	23
R3+R5	54	23	4	15
	$LSD_{0.05}$ within harvest = 3		*$LSD_{0.05}$ within harvest = 11*	
	$LSD_{0.05}$ between harvests = 3		*$LSD_{0.05}$ between harvests = 19*	
Crawford (1989)				
None	5	0	40	88
R6	1	0	25	64
R3+R5	0	0	22	48
	$LSD_{0.05}$ within harvest = 10		*$LSD_{0.05}$ within harvest = 12*	
	$LSD_{0.05}$ between harvests = 11		*$LSD_{0.05}$ between harvests = 12*	
Crawford (1990)				
None	68	29	12	20
R6	64	28	4	7
R3+R5	62	44	3	6
	$LSD_{0.05}$ within harvest = 3		*$LSD_{0.05}$ within harvest = 11*	
	$LSD_{0.05}$ between harvests = 3		*$LSD_{0.05}$ between harvests = 19*	

[1]Source: Rupe, Kirkpatrick, and May, unpublished data.
[2]R6 = full seed; R3 = beginning pod; and R5 = beginning seed.
[3]Benomyl was applied in one of two treatments: 0.5 lb ai/acre with a backpack sprayer as a single application at the full seed stage (R6); or a 0.5 lb ai/acre application at both beginning pod (R3) and beginning seed (R5) stages.
[4]Harvest delayed for 2 weeks.

Table 25. Effect of planting date on yield, germination of harvested seed, and *Phomopsis longicolla* infection of two soybean varieties at Keiser, AR, 1990-1991.[1]

Planting date	Yield		Germination		*P. longicolla*	
	Williams 82	Crawford	Williams 82	Crawford	Williams 82	Crawford
	bu/A	*bu/A*	*%*	*%*	*%*	*%*
1990						
June 8	43.0	42.0	73	92	11	1
June 21	38.0	37.2	89	91	0	1
	$LSD_{0.05}$ = NS		*$LSD_{0.05}$ within variety = 4*		*$LSD_{0.05}$ within variety = 2*	
			$LSD_{0.05}$ across variety = 5		*$LSD_{0.05}$ across variety = 2*	
1991						
May 23	43.4	44.8	90	95	0	0
June 18	42.5	38.6	97	95	0	0
	$LSD_{0.05}$ = 3.5		*$LSD_{0.05}$ =3*		*$LSD_{0.05}$ = NS*	

[1]Source: Rupe, Kirkpatrick, and May, unpublished data.

MG III and IV soybean are planted early, even when foliar-applied fungicides are used. This is especially true when harvest is delayed. Delays in planting do not appear to improve seed quality consistently enough for reliable seed production of MG III and IV varieties in southern Arkansas and in central and southern Mississippi. If plantings for seed are delayed into May and June, yields will be significantly lower than yields from April plantings that are irrigated.

Production of high-quality seed of early-maturing varieties requires that soybean be grown at northern locations of the Midsouth, that foliar fungicides be applied in years with high rainfall during seed maturation, and that irrigation be applied to produce highest yields. Producers must realize that seed quality will vary greatly from year to year and location to location. As a result, control measures may not always be effective when conditions strongly favor poor seed quality. The conclusions drawn from current knowledge are that farmers should not save seed harvested from ESPS plantings for future plantings, and that only certified seed grown in locations with environments known to produce quality, germinable seeds should be used.

Genetic Variation. Little is known about genetic variation in early-maturing soybean varieties for seed quality traits. In a recent 2-year study conducted at Stoneville, maturity date was positively and significantly correlated with germination; that is, later-maturing lines generally had higher germination. A very small percentage of seed lots harvested from early-maturing lines had commercially acceptable germinations (more than 80%) in both years. Certain breeding populations showed better seed quality, thus suggesting that there is genetic variation in soybean for this trait. Timing of major weather events in relation to seed development and date of maturity are the most important factors that determine germination quality of seed. *Phomopsis* resistance is a likely component contributing to improved seed quality, but other resistance factors may also contribute. Identifying these other genetic factors and incorporating them into breeding programs will enhance the feasibility of the ESPS for southern seedsmen.

Visual Assessment. Several studies have used visual ratings (1 = very good; 5 = very poor) of harvested seed as an index of quality of seed harvested from early-planted, early-maturing soybean varieties. These ratings are usually based on the percentage of shriveled seed, seed discoloration, etc. However, these ratings have never been related to dockage or reduced value of marketed seed. Germinability of soybean seeds usually cannot be predicted or assessed by visual appearance of seeds. Seeds harvested from ESPS plantings often have a favorable appearance, but a very low germination percentage. For example, seed of Asgrow A4415 and Avery produced at Cooper, Texas, in 1993 both had visual seed quality scores of 3.5, but germination of Asgrow A4415 seed was 16% compared to 93% for Avery seed. Seed of Asgrow A3935 produced in the same environment had a visual score of 2.2 and germination of 91%, while seed of Asgrow A4539 had a score of 2.3 and germination of 57%. Thus, visual ratings of seed quality are of little value in assessing germination quality of seed from ESPS plantings.

Summary of Present Knowledge

(1) In the Midsouth, planting early-maturing (MG III, IV, and V) soybean varieties in April generally results in maximum irrigated and nonirrigated yields and net returns.

(2) Weather conditions in April allow a significant acreage of ESPS plantings in the region.

(3) ESPS plantings should be made in narrow rows (less than 20 inches) to assure highest yield and maximum canopy development.

(4) Damage from late-season, foliage-feeding insect infestations will likely be avoided by ESPS plantings at more northerly locations and minimized at more southerly locations in the midsouthern states.

(5) Germinability of seed harvested from ESPS plantings made in April and early May in the Midsouth may be low. Although this problem can be overcome to some extent by planting later in the season (May-June) and irrigating, yield from these later plantings will be lower. Seed from ESPS plantings made in April and early May in the midsouthern U.S. should not be saved for planting a subsequent crop.

(6) ESPS plantings will be harvested earlier than conventional soybean production system plantings, and they may result in a higher price if marketed when harvested.

(7) ESPS plantings respond significantly to irrigation on soils that are droughty, but less irrigation water will be required than for conventional soybean production systems.

(8) A preemergent broadleaf herbicide alone will usually be sufficient for highest net returns from nonirrigated ESPS plantings grown in narrow rows (no cultivation) on clay soil. Using only postemergence broadleaf herbicides or a combination of pre- and postemergence broadleaf herbicides may result in lowered net returns.

(9) In irrigated plantings (narrow rows, no cultivation), a combination of preemergent broadleaf and postemergent grass herbicides will usually result in highest net returns.

(10) Preharvest desiccants will not hasten soybean maturity, but may be needed to kill weeds and speed drying of green soybean plants before harvest of irrigated plantings.

(11) Most of the days between August 15 and September 30 are suitable for harvesting ESPS plantings, and this should allow timely harvest to avoid losses from shattering.

(12) Stink bug management in ESPS plantings in the southern portions of the region will be as critical as in conventional plantings.

Summary of Unknowns

(1) Are there disease susceptibilities unique to the ESPS fields?

(2) What is the advantage of determinancy or indeterminancy for ESPS plantings, and what is the optimum canopy structure for ESPS plantings?

(3) What are the causes of poor germinability of seed harvested from ESPS plantings?

(4) Will the discolored and/or shriveled seed harvested from ESPS plantings affect marketed grain price?

(5) How early can ESPS be planted, and what is the earliest maturity group that can be planted?

(6) Can shattering and seed quality be genetically improved?

(7) What is the variety within maturity group agronomic response to the April planting date? It is not known if varieties within a maturity group will respond the same and/or produce acceptable yield, plant height, and other agronomic qualities in response to varying planting dates.

Acknowledgments

We thank the following for resources and assistance provided in the preparation of this handbook: Stan Spurlock, Mississippi State University (MSU) Department of Agricultural Economics; Debbie Boykin, USDA-ARS, Stoneville, Mississippi; Michael May, United Soybean Board, St. Louis, Missouri; and Robyn Hearn, MSU Office of Agricultural Communications. We are also grateful to Owen Taylor of Brandon, Mississippi, for freely putting the ESPS Handbook on his website (http://www.agfax.com/early.htm).

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Appendix Tables

Appendix Table 1. Latitudes for selected locations in the midsouthern U.S.

City	State	Latitude
Alexandria	Louisiana	31°19'N
Beaumont	Texas	30°04'N
Blossom	Texas	33°33'N
Bossier City	Louisiana	32°25'N
College Station	Texas	30°35'N
Colt (PTES)	Arkansas	35°07'N
Cooper	Texas	33°23'N
Corpus Christi	Texas	27°47'N
Crowley	Louisiana	30°11'N
De Kalb	Texas	33°32'N
Fayetteville	Arkansas	36°03'N
Hope	Arkansas	33°40'N
Hooks	Texas	33°38'N
Jackson	Tennessee	35°37'N
Keiser	Arkansas	35°40'N
Marianna (CBES)	Arkansas	34°46'N
Port Comfort	Texas	28°39'N
Port Lavaca	Texas	28°36'N
St. Gabriel	Louisiana	30°17'N
Stoneville	Miss.	33°26'N
Temple	Texas	31°08'N

Appendix Table 2. Scientific names for insects discussed in text.

Common name of insect	Scientific name
Banded cucumber beetle	*Diabrotica balteata* Leconte
Bean leaf beetle	*Cerotoma trifurcata* (Forster)
Bigeyed bugs	*Geocoris punctipes*
Brown stink bug	*Euschistus servus* (Say)
Colaspis beetles	*Colaspis* spp.
Green cloverworm	*Plathypena scabra* (F.)
Green stink bug	*Acrosternum hilare* (Say)
Southern green stink bug	*Nezara viridula* (L.)
Soybean looper	*Pseudoplusia includens* (Walker)
Three-cornered alfalfa hopper	*Spissistilus festinus* (Say)
Velvetbean caterpillar	*Anticarsia gemmatalis* Hubner

Appendix Table 3. Abbreviations used in text.

Phrase or Term	Abbreviation
Days After Planting	DAP
Early Soybean Production System	ESPS
Economic Threshold	ET
Maturity Group	MG
Relative Maturity	RM

USB 6009-091998-11000

Published by the Office of Agricultural Communications, Mississippi State University