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MAFES
Mississippi Agricultural & Forestry Experiment Station • George M. Hopper, Director
Mississippi State University • Mark E. Keenum, President • Gregory A. Bohach, Vice President

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Normie Buehring
North Mississippi Research and Extension Center
Mississippi State University

Jeff Gore
Delta Research and Extension Center
Mississippi State University

Don Cook
Delta Research and Extension Center
Mississippi State University

Angus Catchot
Department of Biochemistry, Molecular Biology, Entomology, and Plant Pathology
Mississippi State University

Mark Harrison
North Mississippi Research and Extension Center
Mississippi State University

Andy Taylor
North Mississippi Research and Extension Center
Mississippi State University

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ABSTRACT

Very limited information is available regarding soybean maturity group (MG) response to insecticide seed treatments and planting dates. The objective of this study was to evaluate the response of selected Roundup Ready MG III, IV, and V varieties planted during three periods to a fungicide seed treatment [mefenoxam + fluidioxonil (ApronMaxx RTA)] and an insecticide-fungicide seed treatment [ApronMaxx RTA + thiamethoxam (Cruiser 5SF)]. Studies were planted in three 4-week planting intervals starting early to mid-April through early to mid-June at three locations (Verona, Starkville, and Stoneville).

Although injury levels from bean leaf beetle [*Ceratoma trifurcate* (Förster)] defoliation and thrips spp. (*Thysanoptera: Thripidae*) were very low at all three locations, the April planting experienced more injury at the V1 or V3 growth stages than May or June plantings at all locations. ApronMaxx + Cruiser, averaged over years, resulted in less defoliation and thrips injury than ApronMaxx at V1 and V3 with little or no differences between maturity groups for all locations.

Even though bean leaf beetles and thrips injury levels were low, ApronMaxx + Cruiser had 1.8 bushels per acre more yield than ApronMaxx in low-yield environments (20 to 30 bushels per acre, Starkville); 3.3 bushels per acre more in medium-yield environments (40 to 50 bushels per acre, Verona); and 2.1 bushels per acre more in high-yield environments (60 to 75 bushels per acre, Stoneville). Averaged over years, locations, and soybean maturity groups, the ApronMaxx + Cruiser yield was 2.4 bushels per acre more than ApronMaxx.

The average returns above the insecticide seed treatment cost ($13 per acre) were $6, $11, and $16 per acre more than the fungicide seed treatment alone at soybean market grain prices of $8, $10, and $12 per bushel, respectively. Even in a low-yield environment, the yield increase of 1.8 bushels per acre resulted in a positive return with market price as low as $8 per bushel.

These data indicated that for maximum yield, April planting of early and late MG IV varieties in north Mississippi (nonirrigated) and especially in the Mississippi Delta (irrigated) is the most successful. In the Delta, when planted in April, early and late MG V varieties' yields were equivalent to the early and late MG IV varieties. MG V varieties had 15 bushels per acre less yield when planted in May and 40 bushels less when planted in June. All maturity groups in the Delta yielded 20 to 41 bushels per acre less when planted in June compared with April or May. June plantings in north Mississippi resulted in the lowest yield for all planting dates, with the exception of the late MG V variety.

Late MG V varieties are suited for April, May, or June planting in north Mississippi. The MG III varieties are best suited for May plantings in both locations. These data also indicated selection of productive varieties with different maturity groups in combination with different planting dates can maintain high yields, help manage for more timely harvest, and improve farm equipment efficiencies and profits.

Soybean Maturity Group Yield and Economic Response to Insecticide Seed Treatments and Planting Dates

INTRODUCTION

Neonicotinoid insecticide/fungicide seed treatments for soybean, *Glycine max* (L.) Merr., for protection against soilborne pathogens and insects were first commercialized in 2005 (Harrington 2008; Kampelman 2009). Most of the insecticide seed treatment research on soybeans has been conducted in the Midwestern, Northern, and Northeastern United States for control of soybean aphid, *Aphis glycines* Matsumura (Cox and Cherney 2011; McCornack and Ragsdale 2006; Johnson et al. 2008; Johnson et al. 2009; and Magalhaes et al. 2009). Most studies reported seed treatments reduced aphid densities, but yield responses were inconsistent (Bradshaw et al. 2008; Cox et al. 2008; Cox and Cherney, 2011; Magalhaes et al. 2009). Others reported seed treatments did not protect against yield loss from soybean aphid infestations (McCornack and Ragsdale 2006; Johnson et al. 2008).

Bean leaf beetle not only causes economic damage to soybeans by feeding on leaves, stems, and pods (Smelser and Pedigo 1992a; Pedigo and Zeiss 1996), but also by transmitting Bean Pod Mottle virus (*Comoviridae*) (BPMV) (Giesler et al. 2002). Bradshaw et al. (2008) reported that insecticide seed treatments may provide more reliable protection by helping control overwintering bean leaf beetles and managing the spread of BPMV, especially when used in conjunction with a foliar insecticide application targeting the first generation. This system also resulted in a yield increase.

In the Midsouth, seed treatments target at a wide variety of pests, including bean leaf beetle, grape colaspis [*Colaspis brunnea* (F.)], three-cornered alfalfa hopper [S*pissistilus festinus* (Say)], and thrips (Davis et al. 2009, 2010). Several neonicotinoid insecticide seed treatments are labeled for use in soybeans. These insecticide compounds are taken up by the roots and distributed systemically throughout the plant. They act as a nicotinic acetycholine receptor antagonist against sucking and chewing insects (e.g., thrips and bean leaf beetle, respectively) and have long-lasting residual activity (Maienfisch et al. 2001).

There is a large disparity in seed treatment adoption rates among Eastern U.S. growers with wide adoption rates in the Midsouth (e.g., 15% of acres were planted with a seed treatment in Alabama; 65%, Arkansas; 80%, Louisiana; 75%, Mississippi; and 45%, Tennessee) (Musser et al. 2011). These rates are in contrast to lower adoption rates in the Southeast/mid-Atlantic region (e.g., 0% in North Carolina and 10% in Virginia) (Musser et al. 2011).

Despite their widespread use in the Midsouth soybean production, very little data has been published regarding the impact of insecticidal seed treatments on early-season insect control and yield. Reisig et al. (2012) reported that thiamethoxam (Cruiser®) was more effective than imdacloprid (Guacho®) in reducing adult thrips densities at 5 weeks after planting. Although neonicotinoid insecticides reduced thrip populations, there was no positive yield response in Virginia or North Carolina (Reisig et al. 2012).

Experiments were conducted at three locations in Mississippi during 2008–10 to determine the impact of insecticide seed treatments on grain yield, economic returns, and thrips injury and bean leaf beetle leaf defoliation for soybean varieties representing selected maturity groups planted during three periods.

Objectives

(1) Evaluate the growth and yield response of selected MG III, early (E) MG IV, late (L) MG IV, E MG V, and L MG V varieties to an insecticide-fungicide seed treatment with 4-week planting intervals from mid-April to mid-June at three locations.

(2) Determine if soybean maturity group in combination with insecticide-fungicide seed treatment and planting date influence early-season insect control and yield.

(3) Determine the optimum planting dates for soybean maturity groups.

MATERIALS AND METHODS

The 3-year (2008–10) study was conducted at Verona, Starkville, and Stoneville, Mississippi. The maturity group varieties selected for these studies were MG III (Asgrow AG 3906), E MG IV (Asgrow AG 4403), L MG IV (Pioneer 94B73), E MG V (Delta King DK 5068), and L MG V (Deltapine DP 5634). Because AG 3906 (MG III) and DP 5634 (L MG V) seed were not available in 2010, AG 3803 (MG III) and DK 5606 (L MG V) were used as replacements.

Seeds were treated with either the fungicide mefenoxam + fluidioxonil (ApronMaxx RTA®, Syngenta Crop Protection, Greensboro, North Carolina) or the fungicide–insecticide mixture mefenoxam + fluidioxonil + thiamethoxam (ApronMaxx RTA® + Cruiser® 5FS, Syngenta Crop Protection, Greensboro, North Carolina). The ApronMaxx RTA rate was 2.5 ounces per 100 pounds of seed. The Cruiser 5FS rate was 1.28 ounces per 100 pounds of seed.

Fifty pounds of seed were placed in a small concrete mixer. Cruiser and ApronMaxx liquid concentrations were added in small increments with a syringe during the mixing process until all liquid had been applied. The mixing process continued until the seeds were dry. The treated seeds were planted early to mid-April, early to mid-May, and early to mid-June with 140,000 seeds per acre in narrow rows at Verona (16-inch rows) and Stoneville (18-inch) and wide rows at Starkville (38-inch). Plot lengths were 30 feet. There were four replications. The only location that received supplemental irrigations during the growing season was Stoneville.

The experimental design was a split-split plot with planting date as the main plot, variety representing maturity group as the subplot, and seed treatment as the sub-subplot treatment with four replications. Data were subjected to ANOVA using PROC GLMMIX (SAS Institute 2008) procedure for each location. Locations were analyzed separately to represent environments with different yield potentials. Random effects were years and replications nested within years (Blouin et al. 2011).

Plots were rated for thrips injury (0–5 rating scale) and bean leaf beetle defoliation (0–100%) at V1 (unifoliate leaf) and V3 (second trifoliate leaf) growth stages. The thrips injury rating scale was 0 for no injury and 5 for severe injuries (leaf crinkling and stunted plants). Plots also were scouted for Asian Rust and stinkbugs, and appropriate pesticides were applied to the entire study as needed.

Maturity dates and plant height at maturity were recorded. Plots were harvested with a plot combine 5 to 10 days after plants had reached maturity (95% pods were brown). Seed weights and moisture were determined, and plot yields were converted to bushels per acre at 13% seed moisture. Returns above the cost of the insecticide seed treatment cost ($13 per acre) were determined by subtracting the ApronMaxx seed treatment yield from the ApronMaxx + Cruiser yield. These yields were multiplied by grain market prices of $8, $10 or $12 per bushel. The insecticide seed treatment cost of $13 per acre was then subtracted from these sums.

RESULTS AND DISCUSSION

Verona

The mean monthly minimum air temperatures and monthly rainfall for 2008, 2009, and 2010 were highly variable (Table 1). The 2008 departure from the mean (DFM) minimum air temperatures for April, May, June, and July were -2°, -2°, -3°, and -4° F below the 27-year (1987–2013) average, respectively. The 2009 DFM minimum air temperatures for April, May, June, and July were -2°, +2°, +1°, and -2° F, respectively. In contrast, the 2010 DFM minimum air temperatures for April, May, June, and July were 0°, +2°, +5°, and +3° F, respectively. The April, May, June, and July 2008 rainfall was 116%, 127%, 10%, and 49% of the 27-year (1987–2013) average, respectively. The April, May,

Table 1. Monthly rainfall and monthly mean minimum air temperature (2008–10), Verona, Mississippi.						
Month	**Mean min. °F**	**Min. air temp. °F (1987–2013)**	**DFM**[1]	**Rainfall**		
				Inches	**(1987–2013)**	**Pct. monthly**
2008						
April	48	50	-2	5.64	4.88	116
May	58	60	-2	6.96	5.47	127
June	64	67	-3	0.46	4.56	10
July	66	70	-4	2.21	4.51	49
2009						
April	48	50	-2	3.09	4.88	63
May	62	60	+2	11.49	5.47	210
June	68	67	+1	2.10	4.56	46
July	68	70	-2	5.77	4.51	128
2010						
April	50	50	0	2.05	4.88	42
May	62	60	+2	10.66	5.47	195
June	72	67	+5	4.16	4.56	91
July	73	70	+3	7.75	4.51	172

[1]DFM means departure (+/-) from the historical monthly mean minimum air temperature.

June, and July 2009 rainfall was 63%, 210%, 46%, and 128% of the 27-year average, respectively. The April, May, June, and July 2010 rainfall was 42%, 195%, 91%, and 172% of the 27-year average, respectively.

There was no interaction effect of maturity group by planting date by seed treatment on defoliation at V1 or V3. But there was an interaction of planting date by seed treatment for defoliation at these growth stages. Early-season soybean leaf defoliation was less than 10% with no visible thrips injury. The April plantings had higher defoliation than the May or June plantings (Table 2). At the V1 stage, ApronMaxx had higher defoliation than the ApronMaxx + Cruiser with the April and May planting; at the V3 stage, ApronMaxx had higher defoliation with the April and June planting. No differences were observed among the seed treatments for defoliation at V3 for the May planting or at V1 for the June planting.

There also was an interaction of maturity group by planting date for defoliation (Table 3). Varieties from all maturity groups had higher defoliation when planted in April than when planted in May or June. With the April and May plantings, there was no difference in defoliation among soybean maturity groups. However, with the June planting, the L MG IV variety had lower defoliation than the L MG V.

Plant height at maturity was higher with ApronMaxx + Cruiser (35 inches) than ApronMaxx (33 inches). Yield was also higher with ApronMaxx + Cruiser (50.3 bushels per acre) than ApronMaxx (47 bushels per acre) (Table 4). These results are in contrast with North Carolina and Virginia data (Reisig et al. 2012), which indicated no yield response to insecticide seed treatments.

There also was an interaction of planting date by maturity group for plant height at maturity and yield

Table 2. Soybean defoliation at V1 and V3 as influenced by planting date and seed treatment, averaged over soybean variety maturity groups, Verona, Mississippi.						
Seed treatment	**Planting date**					
	V1 pct. defoliation			**V3 pct. defoliation**		
	April	**May**	**June**	**April**	**May**	**June**
ApronMaxx	5.0 A[1] a[2]	2.1 B a	1.1 B a	6.8 A a	2.6 B a	1.6 B a
ApronMaxx + Cruiser	2.2 A b	1.4 B b	1.0 B a	5.3 A b	2.3 B a	1.3 B b

[1]Within V1 or V3 across planting dates, within seed treatment, numbers with the same uppercase letters are not significantly different at the 5% probability level.
[2]Within a column, numbers with same lower case letters are not significantly different at the 5% probability level.

Table 3. Soybean defoliation at V1 as influenced by soybean maturity groups and planting dates, averaged over seed treatment, Verona, Mississippi.			
Soybean maturity group	**Pct. defoliation by planting date**		
	April	**May**	**June**
MG III	3.3 A[1] a[2]	1.9 B a	1.0 B ab
MG Early IV	3.6 A a	1.8 B a	1.0 B ab
MG Late IV	4.3 A a	1.8 B a	0.8 B b
MG Early V	3.1 A a	1.8 B a	1.1 B ab
MG Late V	3.6 A a	1.5 B a	1.3 B a

[1]Within maturity group, across planting dates, numbers with the same upper case letters are not significantly different at the 5% probability level.
[2]Within a column, numbers with the same lower case letters are not significantly different at the 5% probability level.

(Table 5). Varieties from all maturity groups planted in May or June—except the E MG V variety—had greater plant height than those planted in April. The E MG V variety planted in April, May, and June, as well as the L MG V variety planted in June, were taller at maturity than all the other varieties planted in April, May, or June. The MG III variety was shorter than the other varieties across all planting dates.

Although varieties representing the various maturity groups generally were shorter when planted in April than those planted in May, yields for most varieties were higher when planted in April or May than when planted in June (Table 5). However, the MG III variety had higher yields when planted in May. The E MG IV variety had similar yields when planted in April or May. However, yields were lower when planted in June. There were no differences in yield among planting dates for the L MG IV variety. The E MG V variety yielded more when planted in April. There were no differences in yield for the L MG V variety planted in April or May, but yields for this variety were lower when it was planted in June. Regardless of planting date, the L MG V variety produced higher yields than varieties representing the other maturity groups.

These results are in agreement with a study conducted by Egli and Cornelius (2009), who reported yield potential declined rapidly with plantings after June 7 in the upper South (Arkansas, Missouri, and Tennessee). Bruns (2011) also reported that, in the Mississippi Delta, soybean yield declined as much as

Table 4. Seed treatment effect on yield and plant height at maturity, averaged over planting dates and soybean maturity groups, Verona, Mississippi.		
Seed treatment	**Yield**	**Mature plant height**
	bu/A	*in*
ApronMaxx	47.0 b[1]	33 b
ApronMaxx + Cruiser	50.3 a	35 a

[1]Within a column, numbers followed by the same letters are not significantly different at the 5% probability level.

Table 5. Plant height at maturity and yield as influenced by soybean maturity groups and planting dates, averaged over seed treatment, Verona, Mississippi.						
Soybean maturity group	**Mature height by planting date**			**Yield by planting date**		
	April	**May**	**June**	**April**	**May**	**June**
	in	*in*	*in*	*bu/A*	*bu/A*	*bu/A*
MG III	24 B[1]d[2]	32 A d	31 A d	35.6 B d	46.1 A c	40.5 AB d
MG Early IV	30 B b	38 A b	35 A c	50.5 A b	49.1 A bc	42.8 B cd
MG Late IV	29 B bc	37 A bc	35 A c	45.8 A c	49.1 A bc	46.8 A b
MG Early V	35 B a	41 A a	37 AB b	54.2 A b	49.8 B b	44.0 C c
MG Late V	28 B c	36 A c	39 A a	60.2 A a	62.8 A a	52.4 B a

[1]Within maturity group, across planting dates, numbers followed by the same upper case letters are not significantly different at the 5% probability level.
[2]Within a column, numbers with the same lower case letters are not significantly different at the 5% probability level.

Table 6. Soybean maturity averaged over planting dates and years (2008–10), Verona, Mississippi.					
Mean planting date	Maturity date by soybean maturity group				
	MG III	MG Early IV	MG Late IV	MG Early V	MG Late V
April 18	August 30	September 4	September 4	September 15	September 26
May 20	September 16	September 21	September 21	September 29	October 7
June 13	October 3	October 3	October 3	October 14	October 15

40% when planting was delayed from mid-April until late May or June.

Table 6 illustrates the average maturity dates for varieties representing the maturity groups included in this study for the different plantings (3-year, 2008–10 average). This information is presented so growers can design a farm plan using yield, soybean maturity group, planting date, and maturity date statistics not only to maintain high yields, but also to manage for a timely and efficient harvest.

Starkville

The DFM monthly minimum air temperature and rainfall for April, May, June, and July during 2008, 2009, and 2010 were variable (Table 7). The 2008 monthly DFM minimum air temperatures for April, May, June, and July were 0°, +1°, +2°, and -1° F compared with the 43-year average (1971–2013), respectively. The 2009 DFM minimum air temperatures for April, May, June, and July were +1°, +2°, +2°, and -3° F, respectively. In 2010, the DFM for April, May, June, and July were +3°, +6°, +7°, and +4° F, respectively.

Rainfall for 2008 was 144%, 106%, 79%, and 51% of the 43-year (1971–2013) monthly average for April, May, June, and July, respectively. Rainfall for 2009 was 70%, 225%, 97%, and 113% of the 43-year average for April, May, June, and July. Rainfall for 2010 was 78%, 134%, 60%, and 67% of the 43-year average for April, May, June, and July.

There was an interaction of planting date by seed treatment for defoliation at V1 and yield (Table 8). Although overall defoliation was less than 5%, higher levels of defoliation were observed in April plantings than in May or June plantings, regardless of seed treatment. April-planted ApronMaxx had higher defoliation levels than ApronMaxx + Cruiser. There were no differences in defoliation among seed treatments for the May or June plantings, which had defoliation ranging from 1% to 1.1%. No thrips injury was observed during the 3 years of the study.

Table 7. Monthly rainfall and minimum air temperature (2008–10), Starkville, Mississippi.						
Month	Mean min. °F	Min. air temp. °F (1971–2013)	DFM[1]	Rainfall		
				Inches	(1971–2013)	Pct. monthly
2008						
April	50	50	0	7.87	5.46	144
May	61	60	+1	5.09	4.78	106
June	69	67	+2	3.31	4.20	79
July	70	71	-1	2.31	4.51	51
2009						
April	51	50	+1	3.82	5.46	70
May	62	60	+2	10.77	4.78	225
June	69	67	+2	4.08	4.20	97
July	68	71	-3	5.10	4.51	113
2010						
April	53	50	+3	4.25	5.46	78
May	66	60	+6	6.40	4.78	134
June	74	67	+7	2.52	4.20	60
July	75	71	+4	3.04	4.51	67

[1]DFM means departure (+/-) from the historical monthly mean minimum air temperature.

Table 8. Yield and soybean defoliation at V1 as influenced by planting date and seed treatment, averaged over soybean maturity groups, Starkville, Mississippi.				
Seed treatment	**Yield**	**Defoliation by planting date**		
		April	**May**	**June**
	bu/A	%	%	%
ApronMaxx	26.5 b[1]	3.1 A[2] a	1.1 B a	1.1 B a
ApronMaxx + Cruiser	28.3 a	1.7 A b	1.0 B a	1.0 B a

[1]Numbers within a column with the same lower case letters are not significantly different at the 5% probability level.
[2]Within a seed treatment, across planting dates, numbers with the same upper case letters are not significantly different at the 5% probability level.

Table 9. Soybean maturity group yield response to planting dates, averaged over seed treatments, Starkville, Mississippi.			
Soybean maturity group	**Yield by planting date**		
	April	**May**	**June**
	bu/A	*bu/A*	*bu/A*
MG III	32.1 A[1] a[2]	29.6 A a	20.8 B a
MG Early IV	32.8 A a	30.4 A a	18.9 B a
MG Late IV	42.9 A a	31.7 B a	21.1 C a
MG Early V	30.5 A b	24.3 B b	15.2 C b
MG Late V	42.0 A a	19.5 B c	18.7 B a

[1]Within a maturity group, across planting dates, numbers with the same upper case letters are not significantly different at the 5% probability level.
[2]Within a column, numbers with the same lower case letters are not significantly different at the 5% probability level.

There were no significant interactions that included seed treatment or yield. Plots treated with ApronMaxx + Cruiser (28.3 bushels per acre) produced higher yields than plots treated with ApronMaxx alone (26.5 bushels per acre) (Table 8). The positive yield response to an insecticide seed treatment is in contrast to what was reported in North Carolina and Virginia (Reisig et al. 2012). The lower yields observed at Starkville compared with the other locations were due to below-average rainfall during the growing seasons, especially in 2008 and 2010.

There was an interaction of soybean maturity group by planting date for yield (Table 9). Except for the MG III and E MG IV varieties, all maturity group varieties had higher yields with the April planting than both May and June plantings. The MG III and E MG IV April and May plantings were equal but higher than the June planting. April-planted yields for the L MG IV and L MG V varieties were 42.9 and 42 bushels per acre, respectively, which were higher than the May or June plantings. There were no yield differences between the MG III, E MG IV, L MG IV, or L MG V varieties planted in April, but their yields were higher than the E MG V variety planted in April. When planted in May, the MG III, E MG IV, and L MG IV varieties showed no differences in yield, but they yielded more than E MG V and L MG V. Yields of all varieties planted during June ranged from 15.2 to 21.1 bushels per acre, which was lower than April plantings. When planted in June, all varieties produced higher yields than the E MG V variety. These results agree with reports by Bruns (2011) and Egli and Cornelius (2009), which indicated lower yield with May and June plantings compared with April planting.

Stoneville

The 2008 DFM minimum air temperature from the 43-year (1971–2013) monthly average were -1°, 0°, 0°, and 0° F for April, May, June, and July, respectively (Table 10). The 2009 DFM was -1°, +1°, +1°, and -2° F for April, May, June, and July, respectively. The 2010 DFM was +1°, +3°, +4°, and +3° F for April, May, June, and July, respectively.

The 2008 rainfall for April, May, June, and July was 159%, 134%, 11%, and 43%, respectively, of the 43-year (1971–2013) monthly average. April, May, June, and July 2009 rainfall was 59%, 263%, 7%, and 229% of the 43-year average, respectively. April, May, June, and July 2010 rainfall was 47%, 103%, 34%, and 49% of the 43-year average, respectively.

Table 10. Monthly rainfall and monthly mean minimum air temperature (2008–10), Stoneville, Mississippi.						
Month	Mean min. °F	Min. air temp. °F (1971–2013)	DFM[1]	Rainfall		
				Inches	(1971–2013)	Pct. monthly
2008						
April	52	53	-1	7.98	5.03	159
May	62	62	0	6.89	5.14	134
June	70	70	0	0.42	3.70	11
July	72	72	0	1.64	3.82	43
2009						
April	52	53	-1	2.97	5.03	59
May	63	62	+1	13.51	5.14	263
June	71	70	+1	0.27	3.70	7
July	70	72	-2	8.74	3.82	229
2010						
April	54	53	+1	2.38	5.03	47
May	65	62	+3	5.28	5.14	103
June	74	70	+4	1.24	3.70	34
July	75	72	+3	1.89	3.82	49

[1]DFM means departure (+/-) from the historical monthly mean minimum air temperature.

There was an interaction of soybean maturity group by planting date for thrips injury at V1 and V3 soybean growth stages (Table 11). However, thrips injury at V1 and V3 did not exceed a rating of 2 (Table 12). ApronMaxx + Cruiser had less thrips injury than ApronMaxx.

There were no interactions among factors for defoliation at V1 or V3. May-planted soybeans had less defoliation compared with April or June plantings (Table 13).

There was an interaction of maturity group by planting date for plant height at maturity (Table 14). April- and May-planted E MG V variety plant height at maturity was 34 and 46 inches, respectively, which was greater than all other varieties within the respective planting dates. Regardless of planting date, plant height for the MG III variety was less than all other varieties. Plant height for May-planted MG III and L MG V varieties were similar but lower than the other varieties. All May-planted varieties were taller than those planted in April or June, except the L MG V. All April-planted varieties were shorter than those planted in May or June. ApronMaxx + Cruiser had greater plant height at maturity than ApronMaxx (Table 12).

There was an interaction of maturity by planting date for yield (Table 14). Yields ranged from 38.3 to 81.1 bushels per acre. April and May plantings indicated no yield differences among the MG III, E MG IV, and L MG IV varieties. The MG E V and L V varieties had higher yields when planted in April. Regardless of variety, yields for June plantings were lower than April and May plantings. Within the April planting, yield for the MG III variety was 65 bushels per acre, which was

Table 11. Thrips injury at V1 and V3 as influenced by soybean maturity group and planting date, averaged over seed treatment, Stoneville, Mississippi.						
Soybean maturity group	V1 thrips injury by planting date[1]			V3 thrips injury by planting date[1]		
	April	May	June	April	May	June
MG III	1.0 A[2] a[3]	1.3 A a	1.3 A a	1.0 B a	1.7 A a	1.1 B a
MG Early IV	1.0 A a	1.4 A a	1.1 A ab	1.1 A a	1.4 A a	1.2 A a
MG Late IV	0.9 A a	1.1 A a	1.1 A ab	1.1 B a	1.6 A a	1.0 B ab
MG Early V	1.0 A a	1.4 A a	1.1 A ab	1.1 B a	1.5 A a	1.1 B a
MG Late V	1.1 A a	1.2 A a	0.9 A b	1.2 A a	1.3 A a	0.9 A b

[1]Thrips injury was rated on a scale of 0–5: 0 = no injury; 5 = severe injury.
[2]Within maturity group across planting dates, numbers with the same upper case letters are not significantly different at the 5% probability level.
[3]Within a column, numbers with the same lower case letters are not significantly different at the 5% probability level.

Table 12. Seed treatment effect on thrips injury at V1 and V3, defoliation at V3, plant height at maturity and yield, averaged over planting dates and soybean maturity groups, Stoneville, Mississippi.				
Seed treatment	**Thrips injury (V1)[1]**	**Thrips injury (V3)[1]**	**Mature plant height[2]**	**Yield**
			in	*bu/A*
ApronMaxx	1.4 a[3]	1.6 a	34 b	61.9 b
ApronMaxx + Cruiser	0.8 b	0.9 b	35 a	64.0 a

[1]Thrips injury was rated on a scale of 0–5: 0 = no injury; 5 = severe injury.
[2]Averaged over 2 years (2009–10).
[3]Within a column, numbers with the same lower case letters are not significantly different at the 5% probability level.

Table 13. Soybean defoliation at V1 and V3 growth stages, averaged over seed treatment and maturity group, Stoneville, Mississippi.		
Planting date	**Defoliation at V1**	**Defoliation at V3**
April	1.40 a[1]	1.20 b
May	0.60 b	0.05 c
June	1.50 a	1.60 a

[1]Within a column, numbers with the same lower case letters are not significantly different at the 5% probability level.

lower than all of the other varieties. When planted in May, the E MG IV variety had the highest yield (75.2 bushels per acre) of all the varieties. May plantings of the MG III and L MG IV varieties produced higher yields than L MG V. When planted in June, the L MG V variety produced lower yields than all other varieties. There was no yield advantage in delaying soybean planting until late May or early June in the Delta.

These results are similar to those of Egli and Cornelius (2009) and Bruns (2011), who reported that delaying planting from April until late May or June resulted in lower yields. Early soybean production with early-maturing MG III, IV, and V in irrigated and nonirrigated environments resulted in maximum returns (Heatherly et al. 1988). ApronMaxx + Cruiser yield of 64 bushels per acre was 2.1 bushels per acre more than ApronMaxx (Table 12). The positive yield response to an insecticide seed treatment is in contrast to the findings reported in North Carolina and Virginia (Reisig et al. 2012).

The average (2008–10) maturity date for varieties representing the soybean maturity groups included in this study ranged from August 26 for mid-April plantings of the MG III variety to October 17 for June plantings of the L MG V variety (Table 15). These data indicated soybean farmers could expect high yields with maturity dates from late August through mid- to late September with MG III, MG IV, and MG V varieties planted in mid-April, as well as MG III, MG E IV, and MG L IV varieties planted mid-May. This plan would not only maintain high yields, but also extend the harvest season and maximize the potential acreage harvestable with one combine.

Table 14. Yield as influenced by soybean maturity group and planting dates, averaged over seed treatment, Stoneville, Mississippi.						
Soybean maturity group	**Mature height by planting date**			**Yield by planting date**		
	April	**May**	**June**	**April**	**May**	**June**
	in	*in*	*in*	*bu/A*	*bu/A*	*bu/A*
MG III	24 C[1] c[2]	35 A c	31 B b	65.0 A b	68.8 A bc	45.5 B a
MG Early IV	30 C b	42 A b	36 B a	77.4 A a	75.2 A a	45.8 B a
MG Late IV	30 C b	42 A b	35 B a	76.8 A a	71.5 A b	44.8 B a
MG Early V	34 C a	46 A a	36 B a	81.1 A a	67.0 B cd	42.6 C a
MG Late V	30 B b	35 A c	36 A a	79.5 A a	65.1 B d	38.3 C b

[1]Within maturity group, across planting dates, within variety maturity group, numbers with the same upper case letters are not significantly different at the 5% probability level.
[2]Within a planting date column, numbers with the same lower case letters are not significantly different at the 5% probability level.

Table 15. Soybean maturity dates, averaged over years (2009–10), Stoneville, Mississippi.					
Mean planting date[1]	Maturity date by soybean maturity group				
	MG III	MG Early IV	MG Late IV	MG Early V	MG Late V
April 17	August 26	August 31	September 3	September 14	September 20
May 16	September 14	September 13	September 13	September 30	October 1
June 18	October 1	October 2	October 1	October 7	October 17

[1]Three-year (2009–10) average planting date.

Overall Findings

The ApronMaxx + Cruiser seed treatment across low (Starkville), medium (Verona), and high (Stoneville) yield environments resulted in yield increases ranging from 1.8 to 3.3 bushels per acre when compared with ApronMaxx alone (Table 16). With a cost of $13 per acre for the insecticide seed treatment and given soybean grain market prices of $8, $10, or $12 per bushel, the returns above the cost of the insecticide seed treatment ranged from $1.40 per acre for the 1.8-bushel yield increase at the $8 market price up to $26.60 per acre for the 3.3-bushel increase at the $12 market price (Table 17).

The average yield increase across locations was 2.4 bushels per acre. Based on that yield, the returns above the insecticide seed treatment cost ($13 per acre) was $6.30 per acre at the $8-per-bushel soybean market price; $11.00 per acre at the $10 market price; and $15.80 per acre at the $12 market price.

Table 16. Soybean yield response to seed treatments, averaged over soybean maturity groups, planting dates, Verona, Stoneville, and Starkville, Mississippi.				
Seed treatment	Verona	Starkville	Stoneville	Average
	bu/A	*bu/A*	*bu/A*	*bu/A*
ApronMaxx	47.0 b[1]	26.5 b	61.9 b	45.1
ApronMaxx + Cruiser	50.3 a	28.3 a	64.0 a	47.5

[1]Within a column, numbers with the same letters are not significantly different at the 5% probability level.

Table 17. Apron + Cruiser seed treatment yield increase and returns above Cruiser seed treatment cost at a selected soybean market price.				
Soybean market price ($/bu)	Yield increase after Apron + Cruiser treatment			
	Verona 3.3 bu/A	Starkville 1.8 bu/A	Stoneville 2.1 bu/A	Avg. 2.4 bu/A
	$/A	*$/A*	*$/A*	*$/A*
8	13.40 [1]	1.40	3.80	6.30
10	20.00	5.00	8.00	11.00
12	26.60	8.60	12.20	15.80

[1]These figures show returns above an Apron + Cruiser treatment cost of $13 per acre.

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