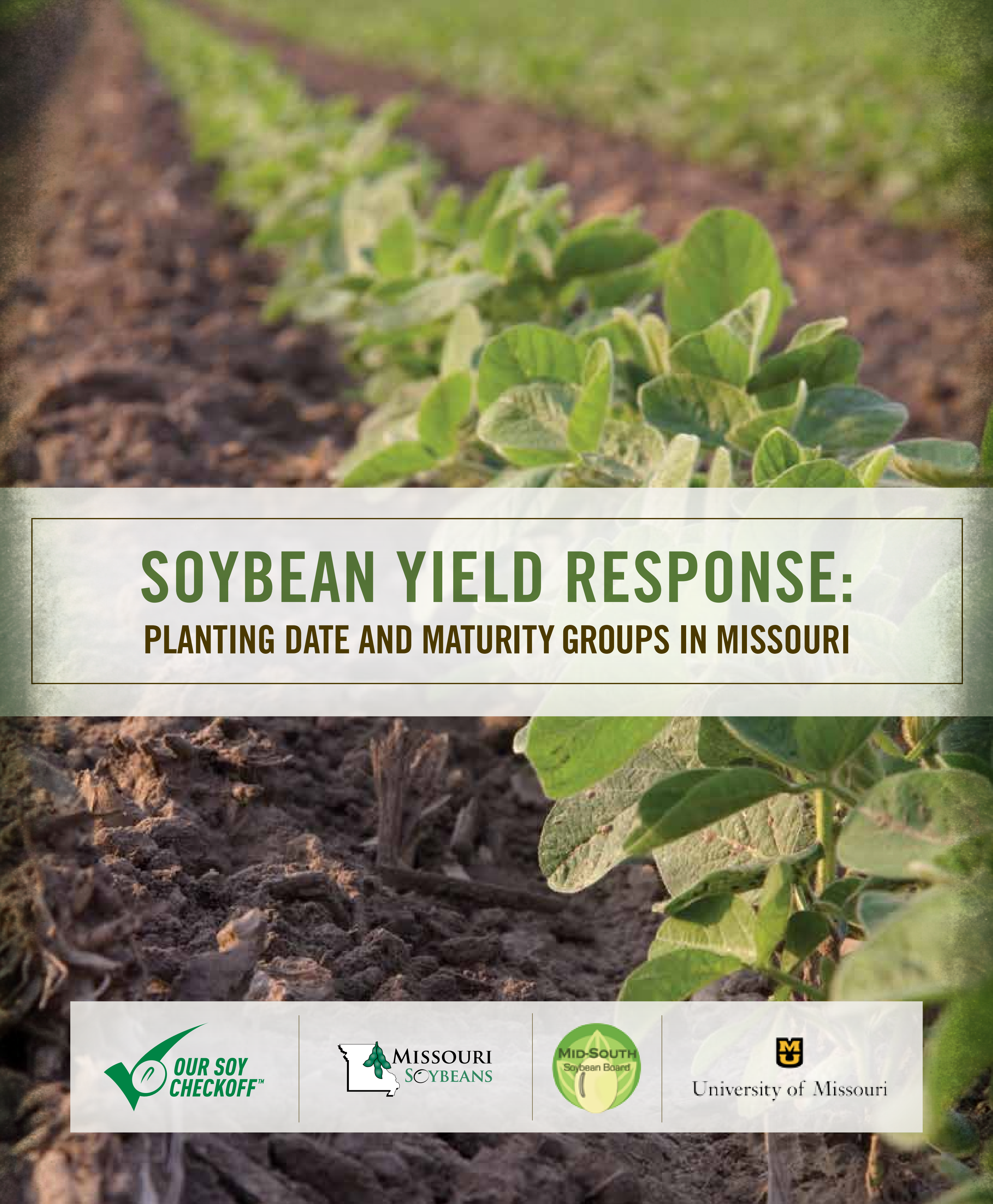

SOYBEAN YIELD RESPONSE:

PLANTING DATE AND MATURITY GROUPS IN MISSOURI

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MID-SOUTH Soybean Board
University of Missouri

Farmers growing soybeans in the Mid-South region often face similar issues as their counterparts across state lines. For this reason, the Mid-South Soybean Board (MSSB) funds research projects that address soybean-production questions and challenges to benefit farmers across the region. The volunteer farmer-leaders who serve on MSSB invest checkoff dollars in ongoing research and extension programs designed to address soybean-production challenges and provide information to increase farmer profitability. Use the information in this publication to help you achieve success during the 2017 planting season and beyond.

Montse Salmerón, Larry C. Purcell, Felix B. Fritschi, Grover Shannon, Earl D. Vories, and William J. Wiebold

PLANTING DATE AND MATURITY GROUP REGIONAL PROJECT

The data presented in this report are part of a regional project jointly funded by United Soybean Board (USB) and the Mid-South Soybean Board (MSSB). The study evaluated the effect of planting date and soybean maturity group (MG) choices on the yield, economics and seed quality of soybeans grown under fully irrigated conditions. Experiments were conducted from 2012 to 2014 at a total of 10 locations (Figure 1) with four planting dates and four soybean cultivars in each of the MGs, from 3 to 6. Data from the Portageville and Columbia, Missouri locations are the focus of this report.

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Figure 1: Planting date and maturity group regional project field experiments were conducted in ten different locations in the Mid-South. Results from Columbia and Portageville, MO (highlighted on map) are summarized in this report.

BACKGROUND

Planting date is one of the main factors affecting soybean yield. The environmental conditions in the U.S. Mid-South, combined with irrigated management, can allow for a wide planting window from late March to early July, and using cultivars from MG 3 to 6. However, selection of optimum planting dates for a location and/or MG cultivar can be a crucial component for achieving yields close to the potential for a given environment.

Optimum planting dates that maximized yield over the 10 locations in the regional experiment ranged from March 22 to May 17 depending on the location and MG (Salmerón et al., 2016). In a previous review of planting date studies under rainfed conditions, yields started to decrease with planting dates after June 7 in the upper Mid-South (AR, KY, MO and TN) and after May 27 for the deep Mid-South (AL, FL, GA, LA, MS, SC) (Egli and Cornelius, 2009). Our results indicated that planting-date recommendations for soybean production in Missouri under fully irrigated conditions may be different than those obtained under rainfed conditions and from common planting date recommendations.

Although yields tend to be higher with relatively early plantings, planting dates after the optimum are common when double-cropping and in years when excessive rainfall delays the start of field preparation and planting in spring. When planting date was delayed from mid-May to early June across the regional study, yield dropped by between 0.09 percent and 1.69 percent per day (Salmerón et al., 2016). Under this scenario, the choice of MG can be critical to minimize the yield reduction associated with later planting dates. Similarly, for very early planting dates, the choice of MG can be important, since relatively early soybean MG 3 and MG 4 cultivars could have a shortened growing season, reduced light interception, and a lower yield potential compared with cultivars in later soybean MGs (Salmerón et al., 2015). Therefore, selecting the best MG for a given planting date and location helps farmers maximize yield potential under each set of environmental conditions.

SPECIFIC RECOMMENDATIONS FOR MISSOURI

Specific recommendations for two locations in Missouri (Portageville and Columbia) within our large regional study can provide more useful information. A detailed analysis of the yield response to planting date was conducted over three years in Portageville and two years in Columbia to identify the most appropriate MG choice for a given planting date at each location. These relationships were used to estimate the optimum planting windows to maximize yield, as well as relative yields by MG for selected planting dates.

APPROACH: EXPERIMENTS AND ANALYSIS

Field experiments were conducted at Columbia (92.3° W 38.9° N) during 2013 and 2014 and at Portageville (89.7° W 36.4° N) from 2012-2014 (Figure 1). Treatments consisted of four different planting dates and four cultivars within MGs 3-6. Planting dates ranged from April 2 to June 20 at Portageville, and from April 22 to June 27 at Columbia. Seeding rate was 142,000 seeds per acre with a 30-inch row spacing. The experiment was furrow irrigated in Portageville

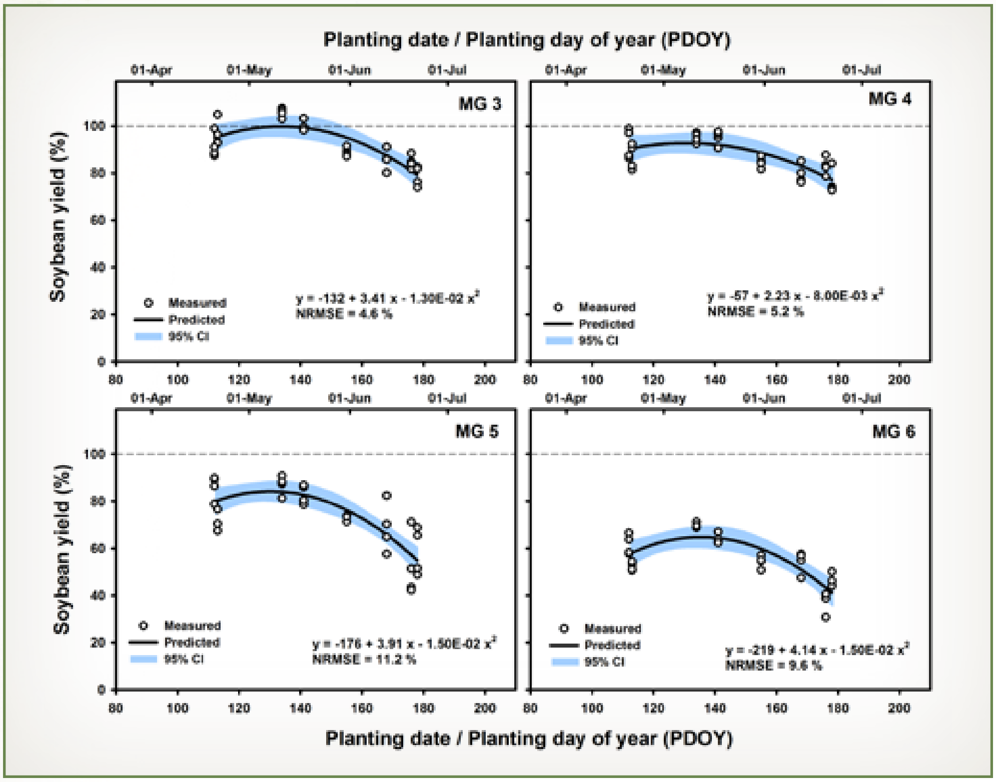

Figure 2: Soybean relative yield versus planting date by MG from a 2-yr study at Columbia, MO. The open symbols indicate observed data, the solid line shows the estimated relative yield over a wide range of planting dates for each MG (equation provided in the figure), and the blue shaded area represents the 95 percent confidence interval in the prediction of the relative yield model. The normalized root mean square error (NRMSE) is provided as a measure of the goodness of the model fit, with lower values indicating less dispersion of the observed data from the estimated model fit.

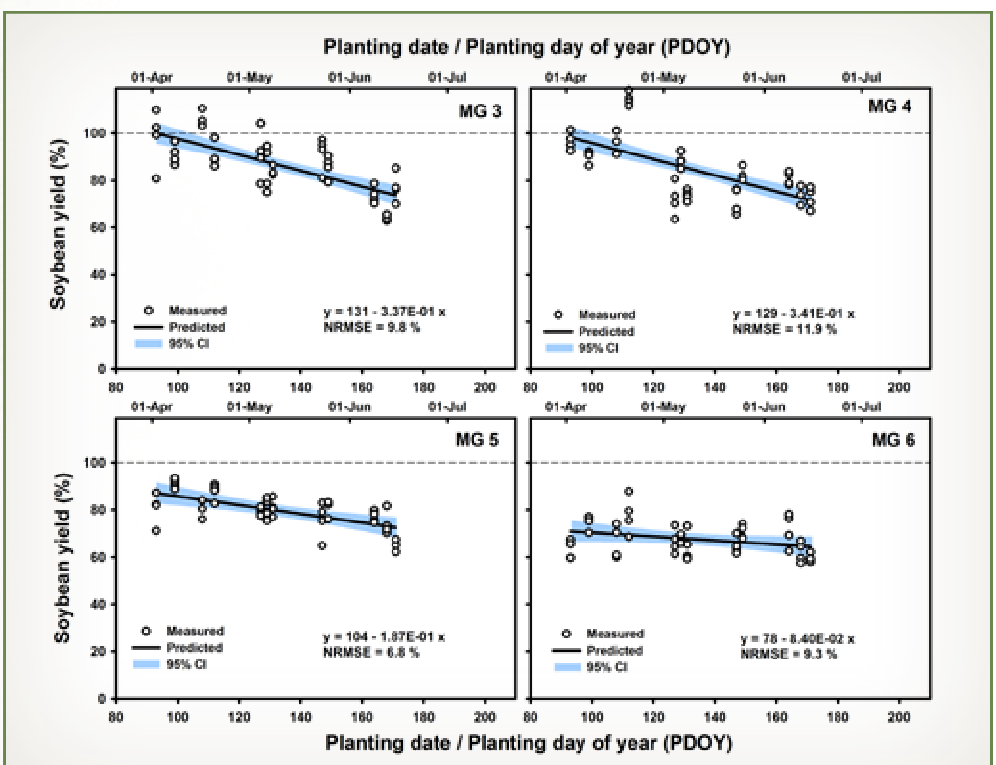

Figure 2 (continuation): Soybean relative yield versus planting date by MG from a 3-yr study at Portageville, MO. The open symbols indicate observed data, the solid line shows the estimated relative yield over a wide range of planting dates for each MG (equation provided in the figure), and the blue shaded area represents the 95 percent confidence interval in the prediction of the relative yield model. The normalized root mean square error (NRMSE) is provided as a measure of the goodness of the model fit, with lower values indicating less dispersion of the observed data from the estimated model fit.

and irrigated using a lateral-move system in Columbia according to the Missouri Irrigation Scheduling Program.

Yields were converted to a relative-yield basis to remove year and location effects so that results could be compared across years and locations (Figure 2). Therefore, a relative yield of 100 percent indicates the highest possible yield for a location and year, and yields lower than 100 percent represent yields proportionally less than the highest-yielding MG at that location. The relationship between relative yield and planting date was studied with a quadratic or linear model, depending on the location and MG. Figure 2 shows the models obtained, describing the relationship between relative yields and planting date for each location and MG. More detailed information about the experimental design and statistical analysis can be found in publications by Salmerón et al. that are listed in the reference section.

OPTIMUM PLANTING DATES BY MG

The optimum planting dates can be defined as those that would allow yield to reach the maximum relative value for a location and MG combination. A range of optimum planting dates or 'optimum planting window' was calculated according to the relationships obtained in Figure 2 to reach at least 95 percent of the maximum relative yield for each location and MG treatment. In Figure 3, the length of the different colored bars indicates the optimum planting window for the respective MGs. The position of the bars on the vertical axis indicates the relative yield of the different MGs when planted during the optimum planting window.

- **COLUMBIA**
  At this location, MG 3 cultivars had an optimum planting window that spanned from the last week of April to early June, achieving the highest yields relative to the other MGs (relative yield of 100 percent). MG 4 cultivars had an optimum planting window similar to MG 3 cultivars, but relative yields were 7 percent less than MG 3 cultivars. The optimum planting window for MG 5 cultivars also started at the last week of April but ended earlier in late May, with a maximum yield that was 16 percent less than the maximum-yielding MG. Finally, MG 6 cultivars had a narrower planting window from late April to late May, with a relative yield of only 65 percent.

- **PORTAGEVILLE**
  The optimum planting window for all MGs started earlier than the more northern location at Columbia. MG 3 and 4 cultivars had relatively early and narrow optimum planting windows from early to mid-April to achieve their yield potential (relative yields of 100 and 98 percent for MG 3 and 4, respectively). MG 5 cultivars planted at Portageville had an optimum planting window from early to late April with relative yields of 87 percent. MG 6 cultivars had the widest planting window at Portageville, form early April to mid-May, but only achieved a relative yield of 71 percent compared with the maximum-yielding MG.

RATE OF YIELD DECLINE WITH DELAY IN PLANTING DATES

When planting date is delayed after the optimum planting window, there is a yield reduction related to a shortening of the growing season, reduced radiation interception and

Location	MG	Max Relative yield†	Yield decline (percent day^{-1})	Estimated percent relative yield for different PD†					
				Apr 1	Apr 15	May 1	May 15	Jun 1	Jun 15
Columbia	3	100	0.14	-	-	97 a	100 a	97 a	89 a
	4	93	0.19	-	-	91 a	92 b	89 a	84 a
	5	84	0.56	-	-	82 b	84 c	79 b	68 b
	6	65	0.38	-	-	62 c	66 d	62 c	53 c
Portageville	3	100	0.30	101 a	96 a	91 a	86 a	80 a	75 a
	4	98	0.32	99 a	94 a	89 a	84 a	78 a	73 a
	5	87	0.22	87 b	85 b	82 b	79 b	76 a	73 a
	6	71	0.09	71 c	70 c	69 c	67 c	66 b	65 b

†Same letters within a location and planting date (PD) column indicate similar yields at the earliest planting date at the location.

Table 1: Maximum relative yield (percent), rate of yield decline with delay in planting date (percent per day of delay), and estimated relative yield (percent) with different planting dates for each soybean maturity group (MG) at each location. Data summarized from a 3-year planting-date study at Portageville, and 2-yr study at Columbia, MO. The highlighted areas in the table indicate the MG choice(s) that would give the highest yield within a planting date and location.

less-than-optimum environmental conditions. The rate of yield decline was calculated for each MG when delaying planting date from May 17 to June 2 and according to the relationships obtained in Figure 2. The rate of yield decline was expressed as a percent reduction in maximum relative yield per day of delay in planting *(Table 1)*.

- **COLUMBIA**
  The rates of yield decline when delaying planting date after May 17 were similar for MG 3 and 4 cultivars (0.14 and 0.19 percent per day, or 0.10 and 0.14 bushel per acre per day in absolute yield values, for MG 3 and 4 cultivars, respectively). With later soybean maturities, the rate of yield decline increased to 0.56 percent per day in MG 5 (0.40 bushel per acre per day) and to 0.38 percent per day in MG 6 cultivars (0.27 bushel per acre per day) when planting date was delayed at Columbia.

- **PORTAGEVILLE**
  The rate of yield decline for MG 3 and 4 cultivars when planting after May 17 was similar, averaging 0.31 percent per day (0.19 bushel per acre per day). For MG 5 cultivars, the yield decline associated with late planting dates was estimated at 0.22 percent per day (0.13 bushel per acre per day). MG 6 cultivars had a yield decline of only 0.09 percent per day (0.05 bushel per acre per day) but maximum relative yield for this MG was already low.

BEST MG CHOICES TO MAXIMIZE YIELD AT DIFFERENT PLANTING DATES

While MG 3 cultivars reached the highest yields on average, yields of MG 4 and 5 cultivars were not statistically different from those of MG 3 depending on the location and planting date, allowing for a wide range of MG management options. The yield ranking of the different MG choices at different planting dates could be helpful to identify MG recommendations that would attain similar yields to those of MG 3 cultivars. Table 1 summarizes the estimated relative yield for different planting dates in two-week intervals.

- **COLUMBIA**
  Yields of MG 3 and 4 cultivars were similar when planted from May 1 to June 15, with the exception of plantings close to the optimum planting date in mid-May, when maximum yield was attained by MG

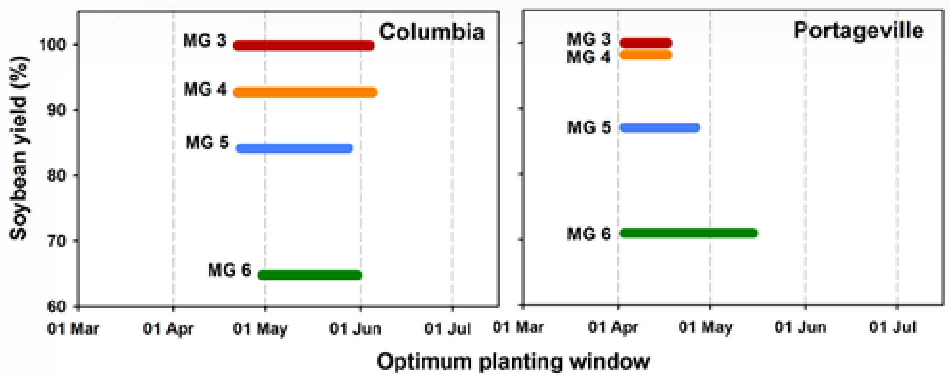

Figure 3: Optimum planting window by maturity group (MG) at Columbia and Portageville, MO. For both locations, MG 3 cultivars had the highest relative yield at the optimum planting dates, and other MGs had relative yields similar or below those of MG 3 cultivars at the optimum planting dates.

3 cultivars. Overall, yields of MG 4 cultivars were 6-8 percent lower than those of MG 3 cultivars across all planting dates. MG 5 and 6 cultivars had significantly lower yields compared with earlier maturities at all planting dates in Columbia from May 1 to June 15.

- **PORTAGEVILLE**
  Yields of MG 3 and 4 cultivars were similar at all planting dates, ranging from April 1 to June 15. Yields of MG 4 cultivars were on average only 2- 3 percent lower than those of MG 3 cultivars across all planting dates studied. For planting dates in April and May, MG 5 cultivars had relative yields 14 to 8 percent lower, respectively, than those of the maximum-yielding MG 3 cultivars. However, for planting dates in June, yields of MG 5 cultivars were only 3- 5 percent lower than those of MG 3 cultivars, with this difference not being statistically significant. MG 6 cultivars had relative yields lower than those of the maximum-yielding MG at all planting dates, with yield reductions ranging from 30 percent on April 1 to 13 percent on June 15.

CONCLUSIONS

The results obtained from the two northernmost locations within our Mid-South regional study indicated that maximum yields are achieved by MG 3 cultivars at the two locations in Missouri. However, yields of MG 4 cultivars followed close behind (2 to 8 percent lower than those of MG 3 cultivars) and were not statistically different in all cases except for planting dates in mid-May at Columbia. MG 5 cultivars planted in June at Portageville can provide similar yields to those of MG 3 cultivars, but would lead to yield reductions when planted earlier or when planted at Columbia. MG 6 cultivars were a poor choice at both locations and for all planting dates, leading to significant yield reductions.

- The optimum planting window to attain maximum yields at Columbia was constant across MG cultivars and started in mid-April (MG 3 to 5) and late April (MG 6) and ended in early June (MG 3 and 4) and late May (MG 5 and 6). At Portageville, optimum planting windows were earlier in general compared with Columbia, starting at the beginning of April and ending in mid-April (MG 3 and 4), late April (MG 5) and mid-May (MG 6).
- When planting date was delayed after May 17 in MG 3 to 6 cultivars, yields declined at variable rates ranging from 0.9 to 0.56 percent per day (or 0.05 to 0.40 bushel per acre per day in absolute yield values).
- The estimated relative yields provided in Table 1 are useful to compare MG yields at different planting dates at both locations. When relative yields are similar among MG cultivars, short-season cultivars could offer an incentive by reducing irrigation costs, avoiding late-season stress (insect and disease pressure) and benefiting from earlier harvest dates and higher market prices.


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