IOWA STATE UNIVERSITY
University Extension

# Soybean Replant DECISIONS

**SOYBEAN REPLANT DECISIONS** *should be based on accurate stand count and interacting factors, including yield potential of the existing stand, planting date, maturity group, and the true cost of replanting. Unfortunately, producers tend to make replant decisions based on quick visual estimations that often underestimate the existing plant population. Seedlings are usually in an early-vegetative growth stage with only a few leaves when early stand counts are made. Narrow row widths exaggerate the impression of a low stand level because there are larger within-row spaces between plants.*

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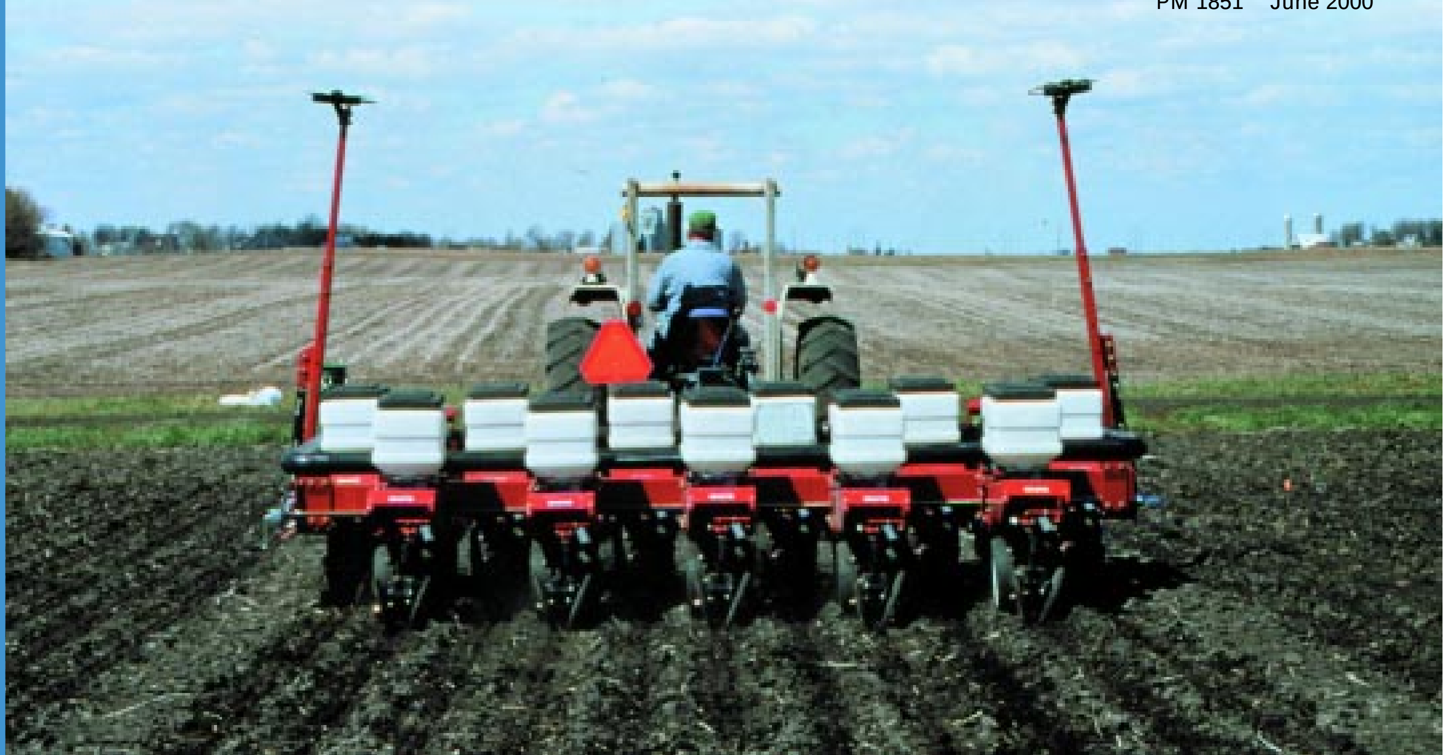


*Hail damaged soybeans.*

**Planting into a poor seedbed, use of poor quality seed, inaccurate planter adjustment, planting "too fast," soil crusting, soil moisture extremes, and envrionment-induced plant injury—pesticide drift, insects or disease pathogens, frost, and hail—contribute to inadequate soybean stands.**

## Causes of Stand Reduction

MANY FACTORS CONTRIBUTE TO INADEQUATE soybean stands, including planting into a poor seedbed, use of poor quality seed, inaccurate planter adjustment, planting "too fast," soil crusting, soil moisture extremes, and environment-induced plant injury (pesticide drift, insects or disease pathogens, frost, and hail). Taking steps to identify and correct the cause of a poor quality stand where possible prevents repeating the problem in a replanted stand.

In most situations, stand reduction occurs in two forms: not uniform across the field, or gaps within the row. Stand reductions are frequently patchy in their distribution. Examples of nonuniform stand reduction include poorly drained drowned-out areas, sandy areas with insufficient moisture, compacted high-traffic field areas, and field boundaries injured by pesticide drift. Size and location of the poor stand area must be considered before replanting. Consider, for example, a drowned-out area of less than one acre isolated in the middle of a field. Time required to replant the area (and potential damage to the existing crop incurred as a result of driving equipment to the isolated area) may not be worth the return gained by replanting.

Gaps of less than 2 feet in diameter can be compensated for by adjacent soybean plants, which fill in the gaps by developing branches. These branches develop pods and seed that compensate for seed production lost by the reduced stand. Gaps greater than 2 feet in diameter usually contribute to reduced yield.

**TABLE 1**

**Percentage of full-yield potential for soybeans, as influenced by plant density established and stand reduction 2 to 4 weeks after planting.**

| | Plants per foot of row | | |
|---|---|---|---|
| Stand reduction (%) | 8 | 6 | 4 |
| | Percent of yield potential | | |
| 0 (full stand) | 100 | 97 | 95 |
| 10 | 98 | 96 | 93 |
| 20 | 96 | 93 | 91 |
| 30 | 93 | 90 | 88 |
| 40 | 89 | 86 | 83 |
| 50 | 84 | 81 | 78 |
| 60 | 78 | 75 | 73 |

The reduction in stand was achieved by random placement of 12-inch gaps within 30-inch rows and the "plants/foot of row" were without gaps or skips.

Source: University of Illinois.

# Relationship between Yield and Plant Stand

SEVERAL UNIVERSITY RESEARCH STUDIES have evaluated the yield potential of soybean stands. Results indicate that stand levels can vary widely without significant yield loss. A study conducted by University of Illinois researchers is summarized in Table 1.

Established stands of 8, 6, and 4 plants per foot in 30-inch rows equal approximately 140,000, 105,000, and 70,000 plants per acre (PPA), respectively. "Full stand" established populations ranging from 70,000 to 140,000 PPA differed in "full-yield potential" by only 5 percent. These results suggest that soybeans compensate for low stands, producing yields that differ only slightly across a wide range of planted populations. The data suggest that yield potential decreases by 2 to 6 percent for each 10 percent decrease in stand (up to 60 percent stand reduction). Stands of 8 plants/foot had 2 to 3 percent greater yield than stands of 6 plants/foot, and stands of 8 plants/foot had 5 to 6 percent greater yield than stands of 4 plants/foot.

Differences in yield potential (Table 1) between 4 plants/foot established at planting versus 4 plants/foot resulting from 50 percent stand reduction emphasize the importance of both stand reduction timing and stand uniformity on yield potential. Researchers consider a stand of 8 plants/foot optimum (100 percent of yield potential).

Results from the University of Minnesota indicate that timing of stand reduction also is important. The study evaluated the effects of stand reduction at different growth stages on yield and is summarized in Table 2.

Reducing soybean plant density at the VC and V3 stages resulted in similar yield responses, except that VC stand reduction to 50,000 PPA produced yields higher than the same population at V3. Yield responses to stand reductions at the V6 stage of development were lower than VC and V3 when the plant densities were less than 100,000 PPA. Yield compensation by the remaining plants was less at the V6 stage when the populations were less than 100,000 PPA. Soybean stands of 75,000 PPA with 1-foot gaps produced similar yields to those with uniform stands at the same population. However, 2-foot gaps in the row at the same population resulted in a greater yield reduction. These studies indicate that soybean stands may be reduced early in the growing season without significant yield loss. Stand reduction occurring during late vegetative stages may result in greater yield loss.

**TABLE 2**

**Effect of plant density at three stages of development on soybean yield.**

| | Thinning stage | | |
|---|---|---|---|
| Plant density | VC[a] | V3 | V6 |
| Plants/acre | | Bushels/acre[b] | |
| 150,000 (no thinning) | 45.1 | 45.5 | 45.3 |
| 125,000 | 44.8 | 46.0 | 45.0 |
| 100,000 | 45.1 | 48.1 | 44.0 |
| 75,000 | 44.2 | 44.7 | 41.4 |
| 50,000 | 41.6 | 38.5 | 33.3 |
| 1-ft gaps[c] (75,000) | 43.6 | 43.8 | 40.2 |
| 2-ft gaps (75,000) | 41.5 | 41.3 | 38.8 |

[a] VC, cotyledon stage; V3, third node stage; and V6, sixth node stage.
[b] LSD (0.05) = 2.1 bushels/acre difference between any two means.
[c] 1- and 2-foot within row gaps were applied 2–4 weeks after planting

Source: University of Minnesota.

## Estimating Plant Stands

**Wait several days after soybeans have emerged or are damaged by hail, chemicals, or other causes and count only live plants when determining stand levels.**

UNDERSTANDING HOW TO ACCURATELY estimate soybean plant population is an important component of replant decisions. Wait several days after soybeans have emerged or are damaged by hail, chemicals, or other causes and count only live plants when determining stand levels. If the plants are damaged by hail or chemicals, healthy soybean plants should start regrowth within a few days after being damaged. Loss of soybean leaf tissue is less serious than stem damage and will have little effect on yield, provided some leaf tissue remains on the plant. Soybean plants severed below the cotyledons by hail or mechanical damage have no potential for regrowth and should be considered dead. Bruised plants may not survive damage, depending on the severity of the bruise and the presence of disease organisms. Monitor weather conditions closely for several days after stands are damaged. A period of sunny, warm weather should allow a greater percentage of damaged plants to recover and survive. A prolonged period of cool, damp conditions after

*Evaluating soybean population.*

*Hula-hoop use for stand counts.*

**TABLE 3**

**Plant density for common row widths based on the average number of plants/foot of row.**

| | Plants per acre | | | | | | |
|---|---|---|---|---|---|---|---|
| Plants/foot of row | Row width (inches) | | | | | | |
| | 38 | 36 | 30 | 20 | 15 | 10 | 7 |
| 1 | 13,800 | 14,500 | 17,400 | 26,100 | 34,800 | 52,300 | 74,700 |
| 2 | 27,500 | 29,000 | 34,800 | 52,300 | 69,700 | 104,500 | 149,300 |
| 3 | 41,300 | 43,600 | 52,300 | 78,400 | 104,500 | 156,800 | 224,000 |
| 4 | 55,000 | 58,100 | 69,700 | 104,500 | 139,400 | 209,100 | 298,700 |
| 5 | 68,800 | 72,600 | 87,100 | 130,700 | 174,200 | 261,400 | 373,400 |
| 6 | 82,500 | 87,100 | 104,500 | 156,800 | 209,100 | 313,600 | |
| 7 | 96,300 | 101,600 | 122,000 | 183,000 | 243,900 | | |
| 8 | 110,000 | 116,200 | 139,400 | 209,100 | 278,800 | | |
| 9 | 123,800 | 130,700 | 156,800 | 235,200 | 313,600 | | |
| 10 | 137,600 | 145,200 | 174,200 | 261,400 | | | |
| 11 | 151,300 | 159,700 | 191,700 | 287,500 | | | |
| 12 | 165,100 | 174,200 | 209,100 | 313,600 | | | |
| 13 | 178,800 | 188,800 | 226,500 | | | | |
| 14 | 192,600 | 203,300 | 243,900 | | | | |
| 15 | 206,300 | 217,800 | 261,400 | | | | |

plants are damaged, however, restricts plant regrowth and allows disease organisms to thrive. If hail has caused the stand reduction, a trained hail-adjusting professional should be consulted for accurate yield loss estimates.

When estimating the number of plants remaining in a reduced stand, randomly sample several areas of the field. Within-row gaps should be included in random samples for stand counts. Do not restrict plant stand estimates to only the best- or worst-appearing areas. Make at least 10 random stand counts in areas where the stand is reasonably uniform. With a tape measure, mark off the appropriate row length representing 1/1000th of an acre for the desired row width. Record the average stand counts as plants per foot of row.

The length of row needed to represent 1/1000th of an acre varies by soybean row width as follows:

38-inch row width = 13 feet, 9 inches
36-inch row width = 14 feet, 6 inches
30-inch row width = 17 feet, 5 inches
20-inch row width = 26 feet, 2 inches
15-inch row width = 34 feet, 10 inches
10-inch row width = 52 feet, 3 inches
7-inch row width = 74 feet, 9 inches

Use Table 3 to determine the field's estimated plant density. Plant density also can be estimated by counting plants per square yard or plants inside a circle of a known area. The hula-hoop method can be used to rapidly count plants, especially in narrow row widths. Toss or roll the hoop into the area to be counted and allow it to fall at random, then count plants inside the circle. Average at least 10 samples for a reliable estimate of plant density. Table 4 provides information to determine plants per acre if plant counts are based on plants per square yard (9 $ft^2$) or plants inside a circle.

**TABLE 4**

**Plant density per square yard and circle measurements based on number of plants counted per square yard or circle.**

| | Plants per acre | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Plants counted | Square yard | Circle measuresments (inside diameter in inches) | | | | | | | | |
| | | 38 | 37 | 36 | 35 | 34 | 33 | 32 | 31 | 30 |
| 10 | 48,000 | 55,000 | 58,000 | 62,000 | 65,000 | 69,000 | 73,000 | 78,000 | 83,000 | 89,000 |
| 12 | 58,000 | 66,000 | 70,000 | 74,000 | 78,000 | 83,000 | 88,000 | 94,000 | 100,000 | 107,000 |
| 14 | 68,000 | 77,000 | 82,000 | 86,000 | 91,000 | 97,000 | 103,000 | 109,000 | 116,000 | 124,000 |
| 16 | 77,000 | 89,000 | 93,000 | 99,000 | 104,000 | 110,000 | 117,000 | 125,000 | 133,000 | 142,000 |
| 18 | 87,000 | 100,000 | 105,000 | 111,000 | 117,000 | 125,000 | 133,000 | 140,000 | 150,000 | 160,000 |
| 20 | 97,000 | 111,000 | 117,000 | 123,000 | 130,000 | 138,000 | 147,000 | 156,000 | 166,000 | 178,000 |
| 22 | 106,000 | 122,000 | 128,000 | 136,000 | 143,000 | 152,000 | 161,000 | 172,000 | 183,000 | 196,000 |
| 24 | 116,000 | 133,000 | 140,000 | 148,000 | 157,000 | 166,000 | 176,000 | 187,000 | 200,000 | 213,000 |
| 26 | 126,000 | 144,000 | 152,000 | 160,000 | 170,000 | 179,000 | 191,000 | 203,000 | 216,000 | 231,000 |
| 28 | 136,000 | 155,000 | 163,000 | 173,000 | 183,000 | 193,000 | 205,000 | 218,000 | 233,000 | 249,000 |
| 30 | 145,000 | 166,000 | 175,000 | 185,000 | 196,000 | 207,000 | 220,000 | 234,000 | 250,000 | 266,000 |
| 32 | 155,000 | 177,000 | 187,000 | 197,000 | 209,000 | 221,000 | 235,000 | 250,000 | 266,000 | 284,000 |
| 34 | 165,000 | 188,000 | 199,000 | 209,000 | 222,000 | 235,000 | 250,000 | 265,000 | 283,000 | 302,000 |
| 36 | 174,000 | 199,000 | 210,000 | 222,000 | 235,000 | 249,000 | 264,000 | 281,000 | 300,000 | |
| 38 | 184,000 | 210,000 | 222,000 | 234,000 | 248,000 | 263,000 | 279,000 | 297,000 | | |
| 40 | 193,000 | 221,000 | 234,000 | 247,000 | 261,000 | 277,000 | 294,000 | | | |
| 42 | 203,000 | 232,000 | 245,000 | 259,000 | 274,000 | 290,000 | | | | |
| 44 | 213,000 | 243,000 | 257,000 | 271,000 | 287,000 | 304,000 | | | | |
| 46 | 223,000 | 255,000 | 269,000 | 284,000 | 300,000 | | | | | |
| 48 | 232,000 | 266,000 | 280,000 | 296,000 | | | | | | |
| 50 | 242,000 | 277,000 | 292,000 | | | | | | | |
| 52 | 252,000 | 288,000 | 304,000 | | | | | | | |
| 54 | 261,000 | 299,000 | | | | | | | | |

Example: 24 plants counted inside a 34-inch circle = 166,000 plants/acre.

# Replant Decisions

Yield results suggest that planting dates through mid-May provide the best chance of attaining maximum soybean yield potential. Delaying planting until early June (or later), resulted in consistent, significant loss of soybean yield potential at all locations.

PRODUCERS EVALUATING A REDUCED soybean stand may be tempted to replant directly into the stand and thicken existing stand levels. This "quick fix" is not recommended. Replanting into the existing stand results in nonuniform plant sizes causing uneven competition for light, moisture, and nutrients. Smaller plants suffer due to the competition from larger adjacent plants and may actually act as weeds competing with larger plants.

After the producer determines 1) the cause of soybean stand loss, 2) the uniformity and estimated plants per acre of the remaining stand, and 3) the yield potential of the remaining stand, he or she can make an informed soybean replant decision. Current and forecasted weather conditions, estimated date of replanting, the real costs of replanting, yield potential of a replanted field, and opportunity cost of time spent replanting, also need to be considered. Real costs include input costs (e.g., seed, fuel, pesticides), equipment depreciation, interest on a loan to replant, risk of yield loss due to early fall frost damage on late-planted soybeans, and labor costs. Economically, a soybean stand of 73,000 (or more) healthy, uniformly spaced plants per acre in early June or later is probably worth keeping, according to research results from the University of Minnesota and the University of Illinois.

If a reduced stand is saved, weed control must be a greater priority. Reduced soybean stands allow additional light to reach the soil surface and more weeds to compete with the soybean plants. Monitor the field closely and use appropriate management practices to minimize the impact of weed competition on yield.

If the decision is made to replant, consider planting the crop in intermediate (10–20 inches) or narrow (less than 10 inches) row widths, and use a

**TABLE 5**

**Effect of planting date on soybean yield in Iowa (1995 to 1997).**

| Planting date | Northern Iowa | Central Iowa | Southern Iowa |
|---|---|---|---|
| | Relative yield (percent of potential yield) | | |
| Late April | 100* | 96* | 98* |
| Early May | 96* | 100* | 100* |
| Mid-May | 99* | 96* | 98* |
| Early June | 81 | 93 | 89 |
| Mid-June | 61 | 59 | 82 |
| Early July | 33 | 45 | 47 |

* Not statistically different from 100 percent.

seeding rate 10–20 percent higher than normal. These management strategies are recommended because late-planted soybeans remain shorter and have fewer pods and seeds per plant than earlier-planted soybeans of the same variety. Late-planted wide-row (30 inches or more) soybeans probably will not close the canopy between the rows, allowing sunlight to reach the soil surface. Failure to achieve canopy closure limits photosynthesis and promotes weed growth and competition. Use of narrower rows and slightly higher seeding rates increase plant growth efficiency of late-planted soybeans, resulting in more pods per acre and reduced weed competition.

## Consider Date of Planting

Soybean planting date studies provide useful yield loss potential information. Studies at Iowa State University evaluated dates of planting at five locations (two in northern Iowa, one in central Iowa, and two in southern Iowa) from 1995 to 1997. Results are summarized in Table 5.

Yield results suggest that planting dates through mid-May provide the best chance of attaining maximum soybean yield potential. Soybeans planted from late April through mid-May yielded similarly at all locations. Two conclusions can be drawn from these results: 1) soybeans respond favorably to early-planting dates (i.e., if soil conditions are fit for planting and weather is favorable for early soybean growth), and 2) the potential risk of stand-reducing late-spring frost is offset by the opportunity to capture maximum soybean yield potential, particularly if early-season growing conditions are favorable.

Planting dates from late April through mid-May produced similar yields. Delaying planting until early June (or later), however, resulted in consistent, significant loss of soybean yield potential at all locations. Yield loss potential was most obvious in northern Iowa, where soybeans planted in early June yielded nearly 20 percent less than those planted in late April. Further planting delays until mid-June resulted in yield losses of 40 percent or more in northern and central Iowa. These results suggest that producers replanting in early July should expect to capture only 33 to 50 percent of the yield potential available when planting before mid-May.

## Consider Soybean Maturity Group

In planting date studies, Iowa State University researchers evaluated six varieties with a range of maturity groups (MG) adapted for each testing location. Varieties ranged in MG from 1.4 to 2.5 planted at northern Iowa sites, 1.9 to 3.2 in central Iowa, and 2.2 to 4.1 in southern Iowa. Varieties tested at each location represent MG extremes of early and late maturity to answer producer questions about switching to earlier MG varieties with planting delays. Conclusions about the yield response interaction of MG with planting date follow:

- In northern Iowa, the highest yields were most consistently produced using full-season (2.5 MG) varieties planted from late April to late June.
- All varieties yielded similarly on planting dates through late June in central Iowa; however, very full-season varieties (3.2 MG) may not mature before frost occurs in the fall when planting is delayed until early July.
- In southern Iowa, full-season varieties tended to yield best on planting dates through early July. However, when planting was delayed until mid-July, varieties ranging in maturity from 2.2 to 2.9 yielded highest.

Producers should plant their original soybean variety selection unless planting is delayed beyond late June in northern and central Iowa and beyond early July in southern Iowa.

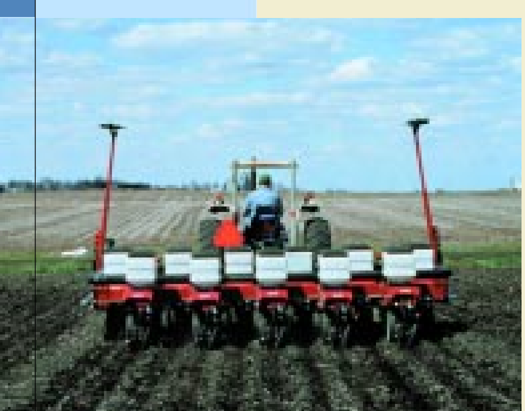
**TABLE 6**

**Interaction between planting date and maturity group on physiological maturity date, days from VE to R8, and relative yield for soybeans grown in Iowa, 1997.**

| Planting dates | Maturity group 2.2 | | | 2.5 | | | 2.9 | | |
|---|---|---|---|---|---|---|---|---|---|
| | Date[a] | Days[b] | Relative[c] | Date | Days | Relative | Date | Days | Relative |
| | | | Yield (%) | | | Yield (%) | | | Yield (%) |
| Late April | 9/30 | 137~ | 100 | 9/17 | 132 | 100 | 9/25 | 131 | 100 |
| Mid-May | 10/3 | 134 | 96 | 9/21 | 118 | 91 | 9/25 | 126 | 88 |
| Early June | 10/5 | 116 | 91 | 9/26 | 107 | 72 | 10/1 | 111 | 75 |
| Late June | 10/14 | 108 | 67 | 10/2 | 99 | 61 | 10/6 | 103 | 54 |
| Early/mid-July | 10/14 | 104 | 61 | 10/15 | 95 | 38 | 10/15 | 99 | 40 |

[a] Harvest date (month/day).
[b] Days between growth stages VE to R8.
[c] Relative yield = percent of potential yield for the average of six varieties.

Producers are frequently concerned about late maturity of full-season varieties planted in mid-June or later. Soybean yield potential and seed quality may be negatively affected if frost damages the soybean crop before the plants reach the R7 (beginning maturity) developmental stage. Data concerning planting date's effect on maturity date, days from emergence to maturity, and relative yield potential of three varieties are summarized in Table 6. The varieties profiled in Table 6 are representative of the MG designation and were evaluated in the region of Iowa where that MG is considered a full-season variety (i.e., MG 2.2 was evaluated in northern Iowa, MG 2.5 in central Iowa, and MG 3.2 in southern Iowa). Late-April planting resulted in 1) longest VE to R8 (emergence date to full-maturity date) period, 2) earliest maturity dates, and 3) greatest relative yield for all three varieties. The VE to R8 period was reduced by 33 (MG 2.2), 37 (MG 2.5), and 32 (MG 3.2) days when planting was delayed from late April until July. Late April-planted soybeans required 20–25 days to emerge, whereas those planted in July emerged within 3–8 days of planting. Days between VE and R1 (beginning flower) stages varied for each variety, with longer VE-R1 periods associated with earlier planting dates. Similarly, earlier planting dates were associated with longer reproductive growth periods (R1 to R8) for all varieties. The positive yield response of soybeans to early planting dates is due to extended vegetative and reproductive growth periods. An 8 to 10 week difference in planting date is reduced to a 2 to 4 week difference in physiological maturity. Day length and temperature are environmental factors responsible for this compression in the growing season associated with delayed planting. Varieties of the same maturity group may not respond the same in different environments.



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## Summary

IF PRODUCERS CAN ACCURATELY ESTIMATE a surviving stand they must evaluate the economics of replanting. Consider the yield potential of late-planted soybeans, along with costs associated with late planting. Final stands of at least 73,000 PPA consistently yielded more than 90 percent of optimum. Soybeans planted after mid-June probably have few options for replanting, but the producer can estimate the yield potential of the crop by determining the surviving stand and use the tables in this bulletin. Soybeans compensate for low stands and produce yields that differ only slightly across a wide range of populations. A soybean stand with the potential to yield 90 percent or more of optimum should be saved and not replanted because the costs associated with replanting probably are greater than the return from replanting.

The important issues for the producer to consider are 1) yield of the surviving stand versus yield of a replanted stand, and 2) cost of replanting versus losses resulting from surviving stand. If the decision is made to replant, consider planting the crop in intermediate- or narrow-row widths. Changing the variety to an earlier maturity may not be necessary unless the planting date is delayed until late June or early July. Soybeans planted in mid-June or later flower sooner than normal and do not develop to the same height as soybeans of the same variety planted earlier. Shorter plants may not close the canopy as rapidly as normal, and plants may not be able to use the available radiation and moisture efficiently to maximize yield.