PB 1912-D

TENNESSEE SOYBEAN PRODUCTION HANDBOOK

CHAPTER 4:
Soybean Production

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This chapter highlights some of the important production decisions related to soybean agronomy. Because certain areas are greatly influenced by multiple factors, some duplication or overlap in discussion was necessary.

FIELD SELECTION

Soybeans can grow on a wide range of soil types, which makes the crop suited to both productive and more marginal ground. Higher yields are possible when soybeans are planted on moderately deep to deep soils with the ability to supply adequate moisture to the crop, especially during July and August when water stress is more likely to occur. Medium-textured (silt loam) soils are better for soybean yield than coarse-textured (sandy) soils. Certain varieties are better suited to fine-textured (silty clay loam) soils. Managing compaction and improving soil drainage are two ways a field can be made more productive for soybean.

SEED QUALITY

Seed quality is an indicator of a soybean seed's ability to germinate successfully under average field conditions and involves **germination percentage** as well as **vigor** of the seed. By law, soybean seed sold in Tennessee must meet genetic purity standards and have a germination percentage or "germ" of at least 75 percent. Seed companies monitor seed vigor prior to sale; however, vigor information is not required on the seed tag. Seed beans grown with good management practices under good weather conditions and harvested with properly adjusted equipment typically produce excellent germ and vigor seed. Nevertheless, due to differences in seed production environments, seed lots of the same variety may vary in quality (germ and/or vigor). Storing soybeans at too high moisture and temperature can also affect seed quality.

Plant seed of 80 percent or greater germination and adjust planting rate for variety and seed lot. Seed germ percentage may vary by seed lot; therefore, farmers should check seed tag information when determining planting rate if switching to different seed lots of the same variety. For example, if the desired planting rate of a variety is 130,000 seeds/acre, the seed drop rate should be 137,000 seeds/acre for a seed lot with 95 percent germination (130,000/0.95), but 163,000 seeds/acre for a seed lot with 80 percent germination (130,000/0.80). Overplanting high germ seed wastes money and creates conditions for overcrowding on wide rows. Under-planting low germ seed might result in suboptimal stands and delay canopy development and weed suppression.

Seed vigor is an indicator of the ability of seed to produce an adequate stand when field conditions are adverse. Good seed vigor is critical when planting soybeans very early (greater likelihood of wet, cold soils) or as double crop beans (high temperature soils more likely). Two tests that are indicators of soybean seed vigor are "accelerated aging" and "cold germination." **Accelerated aging** testing involves placing seed in high humidity and high temperature (130 to 139 F) conditions prior to providing optimal seed germination conditions. **Cold germination testing** includes placing a seed sample into wet and cold (40 to 50 F) conditions for several days prior to optimal seed germination conditions. Seed with high vigor would be more likely to germinate and produce an adequate stand under extreme environments. Because growing, harvest and storage conditions impact vigor, it is sometimes possible to have stand differences between different seed lots of the same variety with similar germ percentages, resulting in differences in performance. Seed testing labs such as Mississippi State Seed testing lab[1] can test soybean seed quality and offer different types of vigor testing.

VARIETY SELECTION

Over 10 companies market soybean seed in Tennessee. **By planting different genetics of different maturity groups (MG) it is possible to stagger timing of reproductive development and spread harvest risk with planting date.** A soybean variety is the "best" fit for a field because it is the right maturity group for desired planting date, has good yield potential, possesses necessary herbicide resistance traits and disease tolerance, and has other characteristics that may offset field yield limiting factors.

There are 10 U.S. soybean maturity groups, ranging from MG 00 to MG 8. Varieties within a MG are bred to reach

[1] See Mississippi Department of Agriculture & Commerce. "State Seed Testing Lab."

physiological maturity before frost in specific photoperiod latitudes or zones within the U.S. (***Figure 4-1***). Varieties in MG 00 through 4 are primarily indeterminate growth types, early MG 5 varieties may be indeterminate or determinate growth types and late MG 5 through MG 8 are mostly determinate growth types.

Maturity group adaptation has changed considerably in the Mid-South and Southern states. In the early 2000s, experimentation with the Early Soybean Production System (ESPS) encouraged farmers to incorporate early maturity soybeans on more acres. Tennessee fields traditionally planted to determinate MG 5 varieties shifted more and more towards earliness and indeterminate growth habit varieties, and this change has increased yield in Tennessee since the mid-2000s.

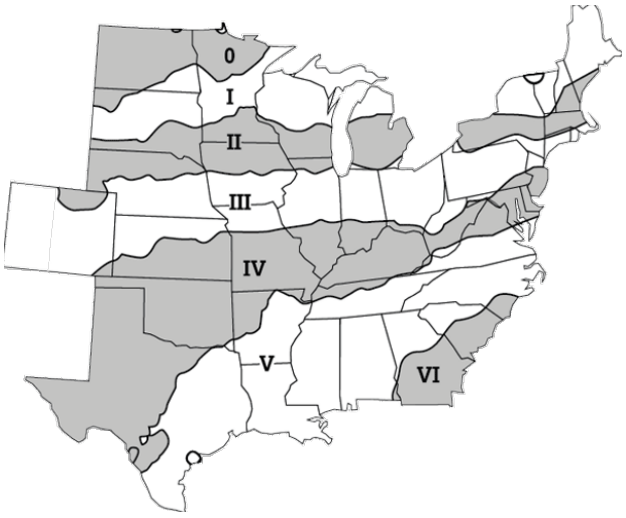


Fig. 4-1. *Adaptation zones of soybean maturity groups in the U.S. Source: Mourtzinis and Conley, 2017.*

Maturity Group and Variety Selection

By planting varieties of more than one MG, a farmer incorporates diverse yield genetics onto the farm. Currently, about 70 percent of varieties planted in Tennessee are MG 4 beans, with remaining acres planted to varieties that are MG 5 or MG 3. Late maturity varieties tend to out yield very early maturity varieties. An exception to this would be MG 4 varieties, which are widely adapted in Tennessee because they produce comparable or superior yields to MG 5 varieties and will harvest earlier. There is a strong interaction between maturity group and planting date with respect to yield, based on dryland planting date x maturity group research conducted between 2017 and 2021 (Figure 4-2). Test areas received adequate to excellent seasonal rainfall. Maturity group 5 varieties yielded highest when planted early, and there was a linear (steeper) yield decline as planting was delayed during May compared to MG 3 or 4 varieties. In June, MG 4 and 5 varieties yielded similarly and outyielded MG 3 varieties (***Figure 4-2***).

Maturity group 4 varieties are suited to early (April) planting and sustain good yields when planted during May and June. **Maturity group 5** varieties are particularly suited to very early April planting and June or double crop planting under dryland conditions. **Maturity group 3** varieties perform well when planted in late April or early May and have a fit as an earlier harvest option when placed on good productive soils.

Fig. 4-2. *Yield response of maturity group to planting date 2017-2020 in Milan, TN. Source: A. McClure, unpublished data, 2020.*

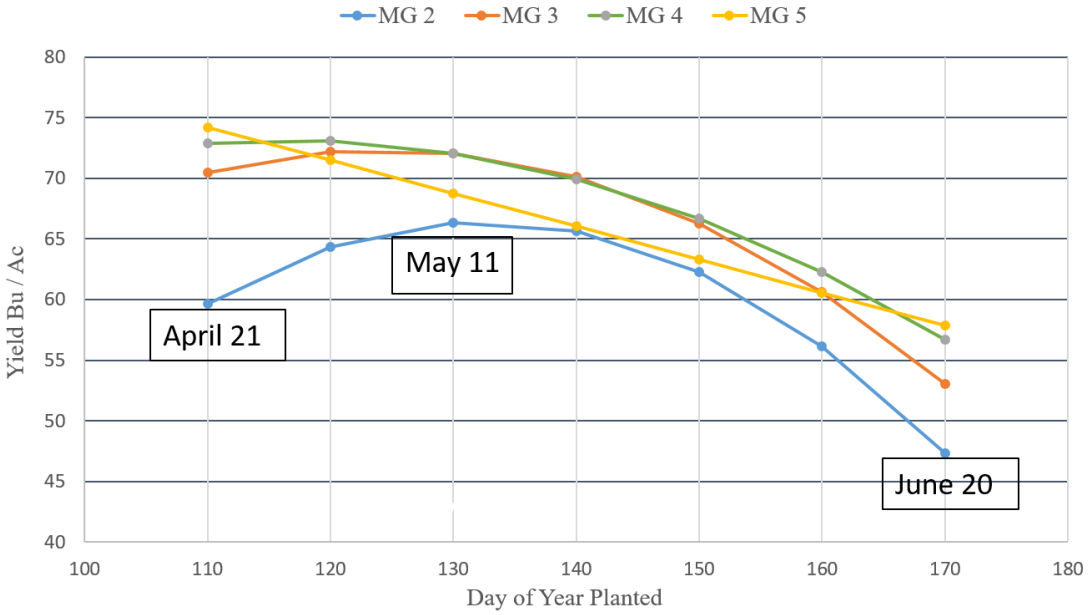


Table 4-1. *Irrigated maturity group x planting date relative yield, Milan, TN, 2014-2015. Source: McClure, et al., Soybean Yield Response: Planting Date and Maturity Groups in Tennessee, 2016.*

SOYBEAN MG	YIELD DECLINE PER DAY PLANTING DELAY	IRRIGATED PLANTING DATE				
		April 22	May 1	May 15	June 1	June 15
	(Bu/ac)	(Percent of maximum yield[1])				
3	0.14	96 a	94 a	90 a	86 a	83 ab
4	0.15	100 a	98 a	94 a	90 a	86 a
5	0.37	99 a	96 a	91 a	85 a	80 bc
6	--	80 b	79 b	78 b	77 b	76 c

[1]Maximum yield is with MG 4 planted in April. All other MG planting dates are expressed as a percent of maximum yield.

Under irrigation most MG perform well, regardless of planting date (***Table 4-1***); therefore, the desired harvest date might drive MG choice. Yield decline with delay in planting is greater for irrigated MG 5 varieties than MG 3 varieties, making MG 3 an early harvest alternative to MG 5 varieties as an irrigated double crop option planted after wheat (***Table 4-1***).

Yield Data and Variety Selection

Select a variety that is high yielding, with yield stability across multiple locations and years. Data from both university and industry seed performance trials across multiple years gives a truer indication of a variety's performance. Each year, soybean varieties are evaluated by the University of Tennessee variety testing group[2] and results are available online. Variety trials are organized by MG and herbicide technology trait, and side-by-side yield evaluations are conducted as small plot–replicated AgResearch and Education Center (OVT) trials and in large strip trials located on producer farms in the county standard testing (CST) program.

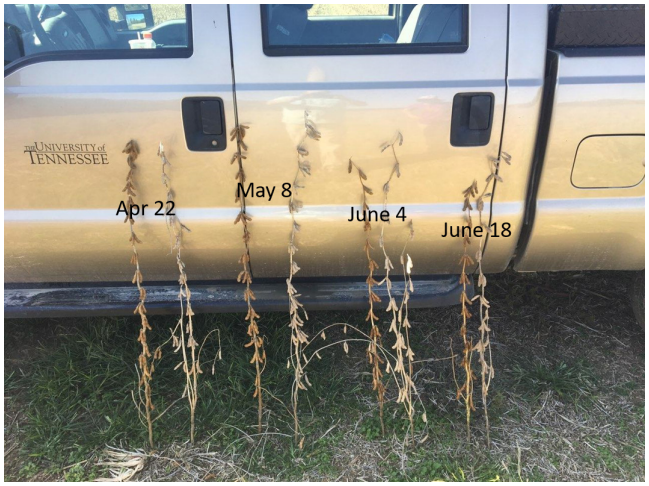
To select a variety using university yield data, consider desired MG and herbicide traits, then focus on varieties in the "A" group that have a good consistency or performance score. A variety is included in the elite or "A" group when it yields statistically similar to the highest yielding varieties in the dataset. A consistency percentage (number locations with above average yield shown as percentage) indicates how often a variety yielded above the average of each location in which it was tested. For example, an "A" group variety with a consistency score of 75 percent means that this variety yielded above the average yield at 75 percent of the testing sites. An "A" group variety with a high consistency score should perform well across environments and might be a good choice for the farm.

Yield Limiting factors and Variety Selection

Use traits and characteristics of a good yielding variety to help offset yield limiting factors of a field. Disease and weed management are discussed in other chapters of this publication, but the disease resistance of a variety and herbicide resistance traits are extremely critical to variety selection. Varieties must contain tolerance to specific herbicides in order for products to be used for weed management.[3] Pay attention to the disease history of each field and match it to a variety with some tolerance to those diseases. This is especially important when managing diseases for which there is no effective fungicide control, such as Sudden Death Syndrome, Phythopthora and Southern Stem canker. A variety with Phythopthora resistance and tolerance to wet conditions may be better suited in a field with poor drainage.

Lodging data are also collected during yield evaluations, and these scores can guide selection of varieties that stand well in "strong" or high fertility ground that is prone to lodging. Soybeans planted in early to mid-May tend to be taller than any other planting date in Tennessee (***Figure 4-3***), so it makes sense to plant a variety with a

Fig. 4-3. *Side-by-side height comparison of two soybean varieties planted in April, May and June at Milan, TN, in 2021. Early May planted soybeans tend to be taller than other planting dates due to more main stem nodes and taller internodes. Source: A. McClure, 2021.*



[2]See UT Crops. "Variety Trials."

[3]See V. Sykes, et al. "Tennessee Row Crop Trait Cheat Sheet."

good lodging score. Lodging can also be managed by reducing planting rate, especially in wide rows. A variety that performs well across soils might be a good fit in a field with a wide range of soil textures. Some varieties shatter more than others, which might be worth considering in fields where harvest is delayed or where early maturity varieties will be defoliated with a harvest aid.

Final Thought on Variety Selection

Buying seed of the same MG from different companies is not a guarantee that unique genetics are being planted. Tennessee does not currently require disclosure of breeder or variety code information on seed tags, but other states such as Arkansas publish a yearly cross reference list[4] of varieties with similar genetics that may be useful.

PLANTING DATE

Planting soybeans in April or early May with favorable soil conditions can produce plants with more main stem nodes and pods per plant and optimal soybean yield. In reality, only a small percentage of Tennessee soybean acres get planted in April as producers focus on planting corn. Soybean planting may be delayed during an extended wet spring or where soybeans become a replacement crop behind failed corn or cotton. About a quarter of bean acres are planted in June or early July following wheat harvest. Full coverage crop insurance is available for soybeans planted until June 15. Full season soybeans are those planted from early April through May. Double crop soybeans are planted in June as soon as grain is harvested to minimize yield reduction with further delays in planting.

Soil temperature, moisture and short-term weather forecast actually determine when the planter should go to the field. Ideally, early planting should begin when April or early May soil temperatures are between 50 and 60 F, with adequate but not excessive soil moisture to promote seed germination, and a seven-day forecast predicts soil temperatures at or above 50 F. Optimal germination and more uniform emergence occur at soil temperatures of 60 F or greater. Soybeans may emerge in 10 to 14 days when soils are cool and in as little as 4 days at soil temperatures above 80 F.

When planting in April or early May, the risk of a late spring freeze and cold wet soil conditions are of primary concern. Planting into cold and wet soils slows germination and emergence, resulting in weaker plants that are more susceptible to disease. For West Tennessee, the last spring frost typically occurs by about April 10 and by about mid-April at lower elevations in North Central and South Central, TN (***Table 4-2***). Avoid planting within 48 hours of a cold front, particularly ahead of a rain. Chilling injury during the first 24 to 48 hours of water uptake by seed can occur when soil temperatures fall below 40 F and may reduce stand enough to warrant a replant. Planting high vigor fungicide–treated seed may help offset negative fluctuations in soil temperature and improve emergence and stand with early planting.

Table 4-2. *Date of the last spring freeze (32 F or less) in Tennessee based on data from 1991-2020 Climate Normals from NOAA. Source: National Centers for Environmental Information.*

TENNESSEE LOCATION	30% PROBABILITY DATE OF LAST SPRING FREEZE *(32 degrees F or less)*
NORTHWEST TN	
Milan	April 11
Martin	April 10
Union City	April 10
SOUTHWEST TN	
Bolivar	April 9
Ripley	April 2
Savannah	April 6
NORTH CENTRAL TN	
Clarksville	April 10
Crossville	April 24
Springfield	April 16
SOUTH CENTRAL TN	
Murfreesboro	April 15
Pulaski	April 20
Winchester	April 14
EAST TN	
Knoxville	April 19
Lenoir City	April 12
Elizabethton	April 27

PLANTING RATE AND REPLANTING

Planting rate varies with planting date, seed quality and even planting equipment. **A final stand at harvest of about 100,000 plants per acre produces similar yields for full season beans.** With adequate moisture, soybean plants can produce similar yields at reduced populations by setting more pods per plant, more seeds per pod or producing larger seed.

[4] See University of Arkansas Cooperative Extension Service. "Cross Reference Guide for Common Soybean Varieties – 2022."

Table 4-3. *Soybean seeding rates for full season and double crop soybean at different seed germination percentages and assumed stand loss rates. Table data partially adapted from Soybean Production in Kentucky article, University of Kentucky Cooperative Extension Service, AGR-130. Source: Knott and Lee, 2017.*

ASSUMED STAND LOSS [1]	YIELD DECLINE PER DAY PLANTING DELAY				IRRIGATED PLANTING DATE			
	Standard Germination (%) from seed tag							
	80%	85%	90%	95%	80%	85%	90%	95%
	Seeding Rate (seeds per acre) [2]							
5%	132,000	124,000	117,000	111,000	171,000	161,000	152,000	144,000
10%	139,000	131,000	123,000	117,000	179,000	168,000	159,000	151,000
15%	147,000	138,000	131,000	124,000	187,000	176,000	166,000	157,000
20%	156,000	147,000	139,000	132,000	195,000	184,000	173,000	164,000
25%	167,000	157,000	148,000	140,000	203,000	191,000	181,000	171,000

[1] Assumed stand loss is anticipated loss in stand due to equipment, planting date, and field c onditions including potential for flooding ant known diseases in field.

[2] Seeding rates are rounded to the nearest thousand.

Double crop or late (June and July) planting and eroded ground tend to produce shorter soybean plants with fewer main stem nodes and pods per plant. A higher seeding rate hastens canopy closure on narrow rows by increasing plants per acre and can increase yield from more total pods per acre, but only if soil moisture is adequate. **Final stands of about 130,000 to 140,000 plants per acre at harvest can produce adequate double crop yields.** Extremely high populations seldom pay off since soil moisture is usually limiting at critical stages with delayed planting.

Suggested planting rates in ***Table 4-3*** are based on seed tag germ percentage and assumed stand loss at planting from unfavorable field conditions. Stand loss is usually greater (10-15 percent) with early planting, wet, cool soil condition and where there is known history of soil diseases. Properly calibrated planters tend to singulate seed drop at more uniform planting depths than older drill equipment into wheat stubble, where seed loss may approach 25 percent or more of what is planted. Seed treated with fungicide and insecticide should produce better stands than nontreated seed.

Replant Situations

Yields decline for all MG when planting is delayed into June. Because late planting usually results in lower yields and a replant involves added cost per acre unless covered by insurance, it is preferable to keep fields with uniform but lower populations than to replant. A uniform population on narrow rows of 75,000 plants per acre or more might be preferable to a late replant in June.

ROW WIDTH

The best row width for soybeans is one that allows closing of the soybean canopy or “lapping the middles” by the time the crop begins flowering. A typical MG 4 variety will bloom about 40 days from planting. **Narrow rows (20 inches or narrower) yield similar to or better than wide (≥ 30 inches) rows. Thirty-inch row beans sometimes yield similarly to narrow rows but do not yield better.** Both narrow and wide rows are suited to full season production, but narrow rows are necessary for double crop soybean production in order to canopy row middles faster in a shortened growing season.

Limited work with “skip row” soybeans where a pair of narrow rows is flanked on either side by a skipped row, resulted in similar yields to 15-inch row beans with possibility of reducing seeding rates; however, skip row beans are less effective at shading out weeds such as Palmer amaranth, which is of great concern in many counties. Reduced weed suppression with skip rows and the fact that yields are similar to a 15-inch row system without being better makes this a less practical system.

The increased yield potential from narrow rows is due to a more rapid canopy closure, which allows leaves to intercept more total sunlight beginning earlier during the season. Greater light interception increases vegetative growth and leaf area and thus seed yield. The faster shading of the soil surface between rows can help reduce loss of soil surface moisture and delay weed emergence, thereby improving the efficacy of weed control programs.

Table 4-4. *Soybean population (plants/A) and yield at different planting depths behind mixed-species cover crops, 2021, Jackson, TN.*[1] *Source: McClure, unpublished data, 2021.*

COVER CROP TERMINATION	SEED DEPTH *(inches)*	SOYBEAN *(plants/a)*	SOYBEAN *(plants/a)*	LODGING *(%)*	YIELD *(bu/a)*
		June 3	June 10	Oct 10	Oct 18
Early Termination					
<1 T/A biomass	<1	101,930	110,640	3	76.5
	1.0	105,705	108,610	3	76.4
	1.25-1.5	113,550	119,935	3	76.0
				Average	76.3
Late Termination					
1.8 T/A biomass	<1	85,670	92,058	15	71.9
	1.0	72,020	86,248	18	70.9
	1.25-1.5	101,350	115,896	3	74.2
				Average	72.3

[1] Variety Asgrow 46XF0 was planted at 140,000 seeds/A on May 24th.

PLANTING DEPTH

Plant soybean seeds deep enough to get good seed-to-soil contact but not too deep that emerging plants use more energy than necessary to push through the soil. Seeds planted too deep produce weaker plants that might struggle in unfavorable environments. Seeds planted too shallow are prone to fluctuations in soil temperature and moisture causing inconsistent emergence and potential standability issues later in the season. Planters control seed depth more effectively than older drill equipment, but it is recommended that seed depth be adjusted on a field-to-field basis.

Most soybeans are planted at 1 to 1.5 inches deep. Shallower planting helps with emergence when planting ahead of rain, especially for cool, moist, tilled ground or when planting into clay soils. Planting to moisture (no deeper than 1.5 inches or up to 2 inches in sandy soils) can improve water absorption by seed and increase germination and uniformity of emergence.

When planting into trashy no-till or dense cover crop residue, seed should be planted deep enough (about 1.5 inches) to actually make contact with the soil. Although seed will germinate at different depths, limited work at Jackson supports deeper planting in heavier cover crop residue (late cover termination) to improve soybean stand, reduce late season lodging and at least numerically increase yield (***Table 4-4***).

PUTTING IT ALL TOGETHER

Plant soybeans as early as practical for full season or double crop production, when soil temperatures and moisture are adequate, with good quality seed from high yielding genetics. Tennessee variety data is available through the UT Institute of Agriculture's UT Crops website, where producers can find multiple options within each MG that will perform well.[5] For more information on duplicate genetics, check the latest version of University of Arkansas Cross Reference Guide for Common Soybean Varieties.[6]

When planting in April, MG 4 and MG 5 varieties are good options across Tennessee. Group 5 varieties in particular respond to early April planting *as long as field conditions are favorable*. Seed vigor should be high in anticipation of cooler, wetter soils, and seed must be treated with fungicide and insecticide. Plant good yield genetics with tolerance to Sudden Death Syndrome if planting behind corn and Stem Canker and Phytopthora resistance if planting behind soybean. Taller varieties will shorten with early planting but pay attention to standability or lodging scores. Increase planting rate by 10 to 15 percent in cool wet springs and when planting into heavy residue.

When planting in May, MG 4 varieties fit well as do MG 3 varieties on productive soils. Early May planting produces the tallest beans, which can create standability issues with a tall variety. In early May, choose shorter statured varieties or those with excellent standability scores to minimize lodging. If planting a tall variety, reduce seeding rate and delay planting "strong ground" or high fertility fields (with history of producing lodged beans) until

[5] See UT Crops. "Variety Trials."

[6] See University of Arkansas Cooperative Extension Service. "Cross Reference Guide for Common Soybean Varieties – 2022."

late May. Pick good yield genetics with Sudden Death and Stem Canker resistance and apply seed insecticide and fungicide. Lower vigor seed can be planted in May when soils are warm enough for rapid germination and emergence.

When planting in June, MG 4 and MG 5 varieties perform well as a dryland option. Under irrigation, a MG 3 bean can be an option that allows for earlier harvest. Charcoal rot ratings may be important with delayed planting. Taller beans fit as a late planted option because delayed planting reduces main stem nodes and internode length, shortening the plant and helping with standability. Consider a high vigor seed to help offset negative impact of very high soil temperatures and treat seed with an insecticide and fungicide. Adjust planting rate for type of equipment and field conditions for a final stand of about 130,000 plants per acre and plant on narrow rows (≤ 20 inches).

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