Nebraska Lincoln EXTENSION

Know how. Know now.

EC145

Soybean Planting Date — When and Why

James E. Specht, Professor of Agronomy and Horticulture; Jennifer M. Rees, Extension Educator; Gary L. Zoubek, Extension Educator; Keith L. Glewen, Extension Educator; Brandy S. VanDeWalle, Extension Educator; James W. Schneider, former Extension Educator; David L. Varner, Extension Educator; Allan R. Vyhnalek, Extension Educator

Why Soybean Planting Date Matters

The yield potential of any soybean production system can be enhanced by planting as early as possible. Early planting allows the soybean plant to collect more solar radiation and transpire more available water than if planted later. This will increase the number of soybean nodes per plant and thus yields.

It is important for the soybean crop to collect as much of the seasonally available solar radiation as possible because plants require the energy of sunlight to convert carbon dioxide into carbohydrates, protein, and lipids (oils). The late June photos of four strips of soybeans that were planted about two weeks apart from late April or early May to mid-June show how you can use planting date as a crop management tool to optimize crop light capture (*Figure 1*). With earlier planting, a soybean crop canopy will cover the ground sooner in the growing season, collecting nearly all of the incoming sunlight from that day forward. Producers need their soybean crop to harvest as much sunlight as possible to create pods, seeds, and ultimately yield. To do that, its leaves have to start collecting sunlight as soon as possible. The goal for a Nebraska soybean producer each year should be: "Have the soybean canopy green to the eye by the 4th of July." A soybean crop, when planted in late April or early May, is likely to close its canopy within a week or so after the summer solstice, the longest day of the growing season. Later planted soybean crops will be deprived of the opportunity to collect as many hours of sunlight as earlier planted crops, and thus will invariably have less yield potential (*Figure 2*).

Because there is a linear relationship between the amount of total water transpired and the final crop yield, it is important for the soybean crop to transpire a greater fraction of the seasonally available water. This includes off-season rainfall that was stored as soil water prior to planting and all in-season rainfall. For plants to acquire carbon dioxide to produce plant and seed organic dry matter, the pores in the leaves (known as stomata) must open, allowing water inside the leaf to escape. In effect, plants must exchange water for carbon dioxide. As a general rule, the soybean exchange ratio translates into about one acre-inch of water (27,154 gallons) being required for every three to four bushels of soybean seed produced per acre.

Figure 1. Comparison of the development of soybeans planted at four dates in late June 2003 and 2004. The signs indicate when the four-row strips were planted.

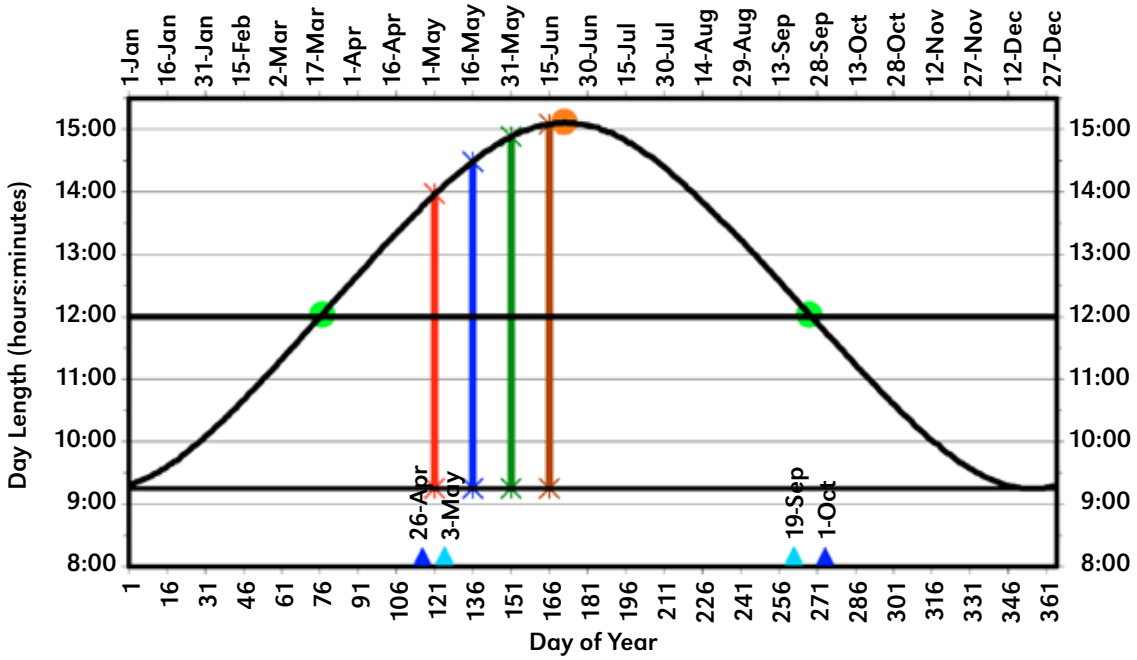

Figure 2. The seasonal daily change in day length at Lincoln is shown as a curved black line. The spring and fall equinoxes — when day and night lengths are equal — are shown as two solid green circles. The summer solstice — the longest day of the year (15 hours 7 minutes) — is shown as a solid orange circle. If one identifies a no-later-date for a late spring frost (32°F) and a no-earlier-date for an earlier fall frost (32°F), based on near-zero probabilities (sky blue triangles), or on 20 percent probabilities (dark blue triangles), the growing season lengths would be a respective 139 or 157 days. The red, blue, green, and brown vertical lines denote theoretical planting dates of May 1, 15, 31 or June 15.

Crop water use includes water lost through evaporation directly from the soil, as well as water lost as transpiration from the leaves. Crop water use efficiency can be improved by reducing evaporative water loss from the soil, which makes more water available for transpirational water loss from the leaves. Early planting helps with this because:

- the cooler soil and air temperatures prevailing in late April or early May are much less conducive to soil water evaporation than are the temperatures in late May and early June;
- the canopy closes earlier in the season (see *Figure 1*), reducing the interception of solar radiation by the soil surface and lessening the surface heating that drives soil water evaporation; and
- the higher humidity that often prevails in a closed (versus an open) soybean canopy minimizes the degree of evaporative soil water loss.

In addition to allowing plants to collect more seasonal solar energy for use in photosynthesis, early planting increases yield potential by allowing the crop to use more of the seasonally available water for transpiration because less soil water is lost to evaporation.

Soybean stem nodes are where the plant produces flowers, pods, and ultimately seeds and yield. The goal is to have as many nodes per main stem as possible. The rates of soybean germination and emergence are temperature sensitive, so these processes are slower in cooler soil temperatures that prevail during early plantings. However, once soybean plants reach the V1 stage (*Figure 3*), nodal development is not temperature sensitive. A new node is produced on the main plant stem about once every 3.7 days or about two nodes per week. Node accrual does not cease until the R5 stage (*Figure 3*), when seed enlargement begins in the pods on the four uppermost stem nodes. The node accrual rate between V1 and R5 is not affected much by the calendar date of planting.

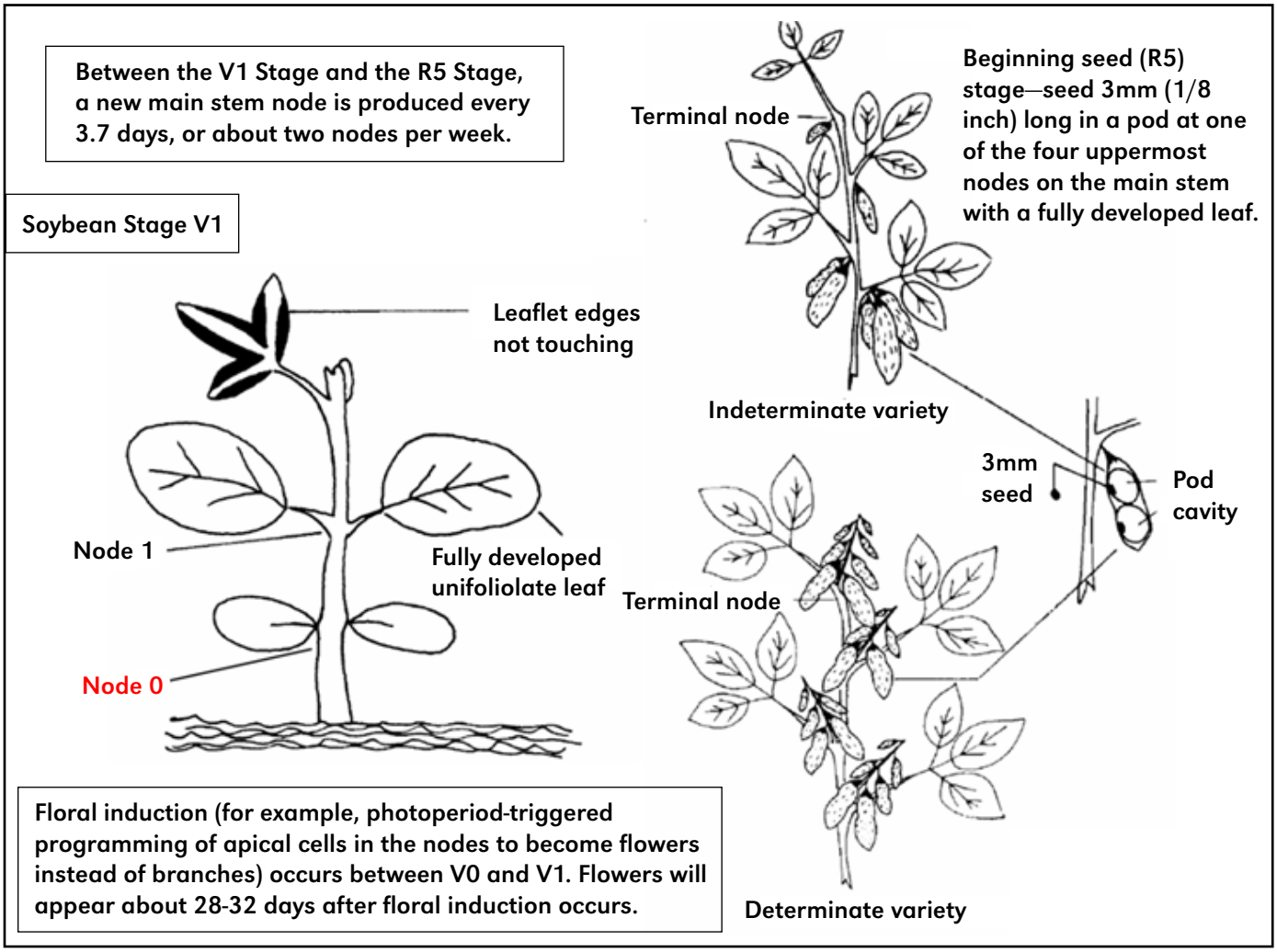

Figure 3. V1 and R5 soybean plant stages. Node accrual — one node every 3.7 days – begins at stage V1 and ends at stage R5. Stage V0 is not specifically shown here, but describes a seedling with fully expanded cotyledons, and unifoliolate leaves that are just beginning to unfold.

What *is* impacted by planting date is the calendar date when V1 occurs. This is quite important, given that the V1 date establishes the earliest date that linear node accrual can start. Moving the planting date earlier typically results in an earlier V1 date, even though an earlier planting lengthens the number of days from planting to V1 due to the sensitivity of soybean germination and emergence to soil temperatures.

Later planted soybeans simply do not have the opportunity to catch up to the soybean node development of earlier planted soybeans. Earlier soybean planting can increase crop yield potential by allowing plants to generate more stem nodes earlier. The earlier the planting date, the earlier the beginning of flower stage (R1), which may even occur before the summer solstice.

Research on Soybean Planting Dates

Given these benefits for early planting soybeans, what kind of yield advantage can a producer expect? Nebraska research reported in the *Agronomy Journal* demonstrated that for each day that soybean planting was delayed after May 1 (*Figure 4*), the yield penalty per day was as much as ⅝ (0.63) bu/ac in a "great" soybean year (like 2004), and ¼ (0.25) bu/ac in a "not so great" soybean year (like 2005). Multiplying these yield penalties by the current soybean price provides a clear indication of the importance of planting date in terms of optimizing the net profit potential in a soybean production system. The yield penalties accruing from planting soybean after May 1 have also been documented in Wisconsin, Indiana, and Iowa.

From 2008 to 2010, additional planting date studies were conducted in producer fields throughout south central and southeast Nebraska. The producers conducting these studies were part of two on-farm research groups: the Greater Quad County and the Nebraska Soybean and Feed Grains Profitability Project. They conducted on-farm research evaluating early (April 18-May 3) and late (May 14-May 24) planting dates at 12 sites and found that early planted soybeans consistently out-yielded later planted beans by 1-10 bu/ac, even in cold, wet springs (*Table 1*). Combining this data, the early planted soybeans significantly out-yielded the later planted soybeans by nearly 3 bu/ac. These studies were conducted in various combinations of irrigated or rainfed and no-till or ridge-till fields with either 15- or 30-inch rows.

Both the early and later planted beans were treated with a combination of fungicide and insecticide seed treatments to prevent problems with seedling diseases and bean leaf beetles on the early planted soybeans. Ordinarily, seed treatment would only be recommended for very early planted soybeans, but in these trials the later planted seed was treated for research consistency. If

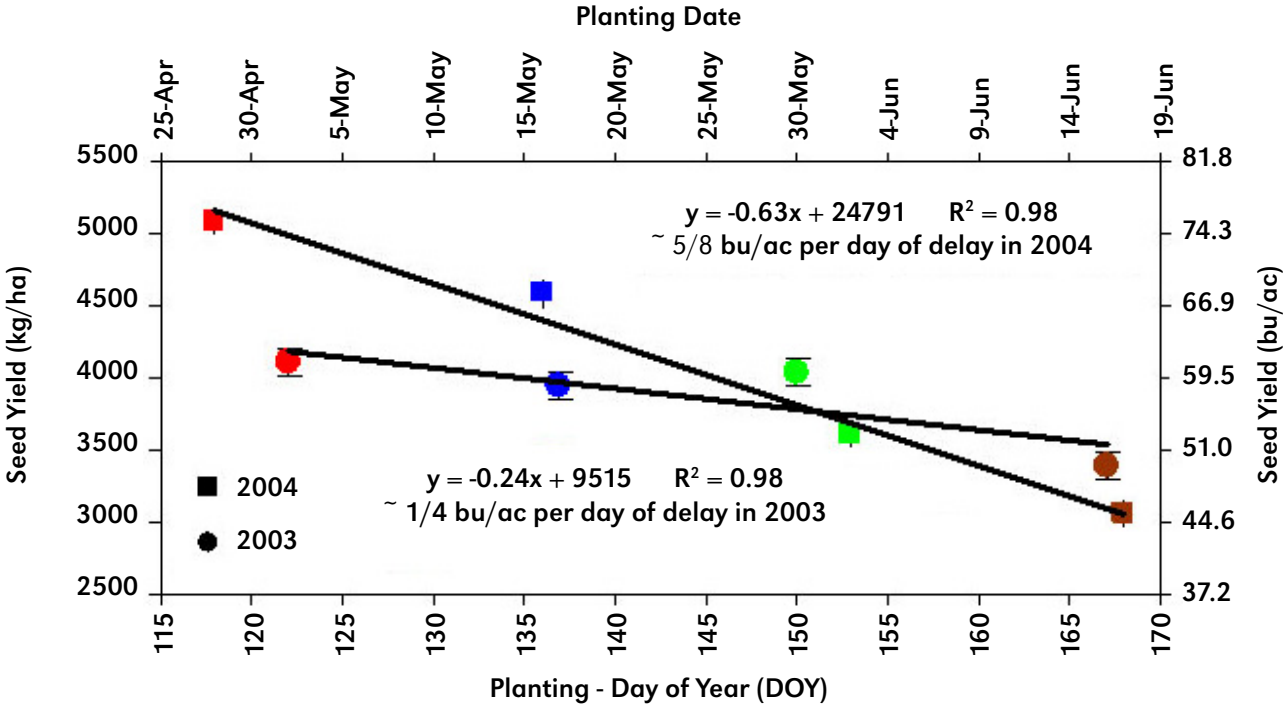

Figure 4. Daily bushel per acre penalties derived from linear yield decline from planting after May 1 in 2003 and 2004. (Average of 14 soybean varieties.)

Table 1. Yields from Nebraska on-farm research of early and late planted soybean (2008-2010)

Year	Producer	Date	Reps	Rainfed/Irrigated	Variety	Row Spacing	Yield (bu/acre)
2008	SCAL Early	Apr. 29	3	Irrigated	Producers 286	30”	67.2
2008	SCAL Late	May 15	3	Irrigated	Producers 286	30”	65.8
2008	Seward Co. Early	Apr. 30	3	Irrigated	NC+ 2895	30”	68.4
2008	Seward Co. Late	May 19	3	Irrigated	NC+ 2895	30”	66.2
2008	York Co. Early	Apr. 23	8	Irrigated	Producers 286	30”	66.9
2008	York Co. Late	May 14	8	Irrigated	Producers 286	30”	63.5
2008	Fillmore Co. Early	Apr. 30	7	Irrigated	Pioneer 93M11	30”	81.0
2008	Fillmore Co. Late	May 19	7	Irrigated	Pioneer 93M11	30”	77.5
2009	SCAL Early	Apr. 27	4	Rainfed	Pioneer 93M11	30”	37.6+
2009	SCAL Late	May 18	4	Rainfed	Pioneer 93M11	30”	37.2
2009	Saunders Co. Early	May 3	6	Rainfed	NC+ A63RR	15”	66.6
2009	Saunders Co. Late	May 21	6	Rainfed	NC+ A63RR	15”	65.1
2009	SCAL Early	Apr. 27	4	Irrigated	Pioneer 93M11	30”	70.2
2009	SCAL Late	May 18	4	Irrigated	Pioneer 93M11	30”	68.1
2009	Fillmore Co. Early	Apr. 24	4	Irrigated	Pioneer 93M11	30”	69.5
2009	Fillmore Co. Late	May 15	4	Irrigated	Pioneer 93M11	30”	68.4
2009	Seward Co. Early	Apr. 24	4	Irrigated	NC+ 2A63	30”	73.2
2009	Seward Co. Late	May 20	4	Irrigated	NC+ 2A63	30”	71.3
2009	York Co. Early	Apr. 30	3	Irrigated	NK 28B4	30”	59.1
2009	York Co. Late	May 15	3	Irrigated	NK 28B4	30”	58.6
2010	Saunders Co. Early	Apr. 18	6	Rainfed	Channel 2751	15”	75.7
2010	Saunders Co. Late	May 18	6	Rainfed	Channel 2751	15”	71.2
2010	Seward Co. Early	Apr. 19	6	Irrigated	Channel 3051RR	30”	72.0
2010	Seward Co. Late	May 24	6	Irrigated	Channel 3051RR	30”	62.3
	Average Early						70.0*
	Average Late						67.1

*Statistically significant at 95 percent level.
+ Yield from the rainfed trial at the UNL South Central Agricultural Laboratory (SCAL) was not included in the combined statistical analysis, but yield from the Saunders County rainfed trial was compared with irrigated yields from other locations.

the seed treatment cost is an estimated $9.50/ac and the soybean price is $9.00/bu, to break even the yield in seed-treated early plantings would need to be 1.1 bu/ac better than with treated later plantings. The economics of the average 3 bu/ac increase based on various soybean prices can be seen in *Table 3*.

Late Planting Cultural Practices

When planting is delayed, and in double crop situations, correct crop variety selection and plant row-spacing decisions are especially important. Also, early season freezes, hail storms, flooding, and other situations can reduce crop stands so much that replanting is necessary. (See *Evaluating Hail Damage to Soybeans,* EC128.)

Table 2. Spring freeze probabilities, based on data from the High Plains Regional Climate Center, for the weather station at the UNL Agronomy Farm in Lincoln, Nebr.

Temp °F	Earliest	90%	80%	70%	60%	50%	40%	30%	20%	10%	Latest
36.5	04/08	04/19	04/24	04/28	005/01	05/07	05/09	05/13	05/15	05/22	06/12
32.5	03/29	04/13	04/17	04/19	04/22	04/27	04/30	05/02	05/07	05/14	06/12
28.5	03/21	03/31	04/06	04/09	04/13	04/15	04/19	04/22	04/26	05/02	06/12
24.5	03/09	03/17	03/23	03/27	03/29	04/01	04/05	04/10	04/14	04/24	06/12
20.5	02/25	03/07	03/16	03/19	03/21	03/27	03/29	04/03	04/07	04/12	06/12

At the Lincoln campus farm, the probability of a late spring 32°F frost is near 100 percent on March 29, but drops to 50 percent on April 27 and 10 percent on or after May 14.

Table 3. Economic advantage from a 3 bu/ac yield increase due to early soybean planting date

Price of Soybeans	$ 6.00	$ 7.00	$ 8.00	$ 9.00	$ 10.00	$ 11.00	$ 12.00	$ 13.00	$ 14.00
Economic Advantage	$ 18.00	$ 21.00	$ 24.00	$ 27.00	$ 30.00	$ 33.00	$ 36.00	$ 39.00	$ 42.00

Late-planted soybeans, however, are often subjected to extreme environmental stresses. Due to their short stature and flowering habit, determinate varieties are not recommended for planting after mid-June in Nebraska. If planting soybeans after mid-June, choose an early to mid-season, adapted, indeterminate variety. Non-adapted varieties do not have the yield potential to begin with, and later maturing varieties might not fully mature before the expected fall freeze date. Indeterminate varieties are much more suited to the stressful conditions associated with late planting and would have greater yield potential in this circumstance.

When soybeans are planted later than mid-June, vegetative growth is reduced. Without changing the planting pattern, a large portion of the available light energy is lost, evaporative water loss increases, and weeds are more competitive. Row widths less than 20 inches combined with plant populations 20 to 25 percent higher than normal will provide a more rapid canopy closure for light capture. This will help the late-planted crop produce as much yield as possible. Late-planted soybeans are shorter and sometimes have lower podding heights. Narrow rows and slightly higher planting rates will result in somewhat taller plants and fewer pods at the lower stem nodes.

Risks and Caveats of Early Planting Soybeans

While there is a positive yield advantage from planting soybeans as early as possible, there also are increased risks related to frost, germination failure, and bean leaf beetle migration.

Frost

The probability of damage from a killing frost rises substantially with late April and early May planting dates. The key to assessing this risk is to think in terms of the expected date of seedling emergence rather than the planting date, since damage occurs only when emerged soybean tissue is exposed to a freezing air temperature of 32°F.

To learn more about the timing and probability of late spring freezes in your area, visit the High Plains Regional Climate Center website at *http://hprcc.unl.edu*. In the upper left grey box, click on the yellow arrow topic titled *Historical Climate Data Summaries*. The next screen will show a map of red squares in Nebraska (and surrounding states). Click on the red box representing your area, then on the left side select *Spring Freeze Probabilities,* and then *Tabular Output.* Depending on your risk probability choice (for example, 10 percent or 20 percent), you would not want your soybeans to have emerged between the historical dates of 10 percent or 20 percent in the columns between 28.5°F and 32.5°F. For example, for the University of Nebraska agronomy farm in Lincoln, the probability of a late spring 32°F frost is near 100 percent on March 29, but drops to 50 percent on April 27 and 10 percent on or after May 14 (*Table 2*). Soybeans typically take 7-10 days to **emerge**, so planting 7-10 days earlier than the risk factor with which you are comfortable is a good rule of thumb. Given the cool soil temperatures that can prevail in late April in many years, it would likely take soybean more than seven days to emerge. (Seven days is a conservative choice, given the

variance over years in terms of warm or cold spells during this period.)

Germination Failure

Today's soybean varieties have much greater germination cold tolerance than older varieties. Indeed, this is why producers can now push the limits of early planting by sowing the new varieties into 40°F rather than 50°F seed beds. Germination failure in early planting is not so much due to cold temperature, but instead arises from soggy soil conditions coupled with cold temperatures immediately after planting. Soggy soils favor fungal pathogens and, if accompanied by cooler temperatures that slow soybean seed germination, can give pathogens a favorable environment and more time to infect the seedlings before they emerge.

Seed fungicide treatments typically provide good protection against germination failure and seedling loss under soggy, cold conditions, but might be unnecessary if these conditions do not occur. Still, given the potential yield reward from early planted soybeans, most producers would consider a fungicide seed treatment to protect at least the earliest planted fields a worthwhile "insurance" cost.

Bean Leaf Beetles

These insect pests are attracted to the first emerging soybean seedlings of the growing season. They feed on the cotyledons, unifoliolate, and trifoliolate leaves for a short time, mate, lay eggs in the soil around the base of soybean plants, and then die. The hatched larvae feed on soybean roots with a preference for root nodules. Little is known about the economic impact of underground feeding injury. In most instances, the seedling leaf feeding injury is not economically significant enough to warrant an insecticide spray treatment; however, bean leaf beetles can transmit bean pod mottle virus. If enough plants are infected early, economic yield reductions can occur. If bean leaf beetles are common in your area every spring and incidence of the bean pod mottle virus is high, an insecticide treatment (for example, a systemic seed treatment or post emergent spray) may be necessary to help protect the yield potential of early planted soybeans. Contact your local Extension office or the University of Nebraska–Lincoln Department of Entomology to see if a bean leaf beetle forecast is available for your area for the current planting season.

Recommendations

Based on five years of UNL and on-farm research, early planting does seem to provide a yield advantage, even in cold springs. A broad recommendation would be for the southern two-thirds of Nebraska to begin planting soybeans the last week of April and the upper third to begin planting the first week of May. For early planted rainfed soybeans, extend the growing season to take advantage of August rains by changing to a one-quarter or one-half longer relative maturity (RM) than you would use for a later May planting. For example, in a southern Nebraska rainfed field you might change from a 3.0 to a 3.3 or a 3.5 relative maturity so that the seed-filling period is more likely to occur later in the season when temperatures are cooler but seed-filling can still be completed before the first fall frost.

While we can't control the weather, planting soybeans early allows you to take advantage of warmer springs and weather conditions that favor high yielding soybeans. With early planting we recommend treating the seed with an insecticide and a fungicide. If a field has a history of Sudden Death Syndrome (SDS), plant that field last, as the fungus causing SDS is favored by cool soil conditions during early planting.

The yield reward arising from early planting should not be used as a reason to plant seed into seedbeds that are too wet to plant. Exercise good judgment in all seed planting practices.

Resources

Learn more about conducting research on your farm or view reports from other on-farm research in the Farm Research section in *CropWatch.unl.edu*.

Acknowledgments

The authors extend their appreciation to the farmers and UNL Extension Educators involved with the soybean planting date on-farm research effort. They would also like to thank the Nebraska Soybean Board for funding Dr. Jim Specht's research on soybean planting dates.

This publication has been peer reviewed.