

Managing Delayed or Frost-Damaged Soybeans

Soybean maturity is determined primarily by day length, but planting date affects soybean maturity as well. Agronomists estimate that soybean maturity can be delayed by about one day for every four days of planting delay beyond the normal date. Growing conditions such as abnormally cool summer temperatures can also affect soybean growth, development, and maturity. When crop maturity is delayed, the risk of damage due to a fall frost increases, especially in northern states where the full growing season is commonly used. This article will discuss managing delayed soybeans and those damaged by a freeze prior to crop maturity.

Freeze Damage to Soybeans

Soybean plant tissue is more tolerant of freezing temperatures than that of some other crops, such as corn. However, temperatures below 0° C can damage leaves, and temperatures below -1° C for an extended period can damage stems, pods, and seeds. The severity of damage depends on the growth stage of the soybeans, the low temperature reached, and the duration of the freezing temperatures.

Oftentimes, a first fall frost is light and limited in duration. Such a frost is most likely to damage only the leaves in the upper canopy of the plant. In such cases, soybean pods and seeds can continue to develop, and yield may be only minimally affected. However, a more severe freeze that damages stems, pods, and seeds has the potential to reduce both the yield and quality of the crop.



Two different soybean varieties showing damage from early fall frost in Minnesota.

Soybean Reproductive Growth Stages

Soybean researchers have divided soybean reproductive development into eight stages – two each for flowering, pod development, seed development, and maturity. Because flowering, pod development, and early seed development occur in July and August, soybeans are rarely exposed to a frost at these stages. However, soybeans are exposed to potential frost damage at the full seed and maturity stages in a late-planted season and/or one with cool summer temperatures. Should a frost occur before maturity, growers need to determine the soybean growth stage at the time of the freeze to estimate potential yield loss (Table 1 and Figure 1).

Table 1. Description of soybean growth stages R6 to R8.



Stage	Description of Soybean Growth Stage
R6 – Full Seed	“Green bean” stage. A pod containing a green seed that fills the pod cavity found at one of the top four nodes of the main stem.
R7 – Beginning Maturity	One normal pod on the main stem has mature color (brown or tan). At this stage, almost all pods and seeds have lost their green color. About 50% of leaves have turned from green to yellow.
R8 – Full Maturity	95% of pods have reached their mature color. From this stage, harvest moisture (13 to 16%) is usually reached in about five to 10 days.

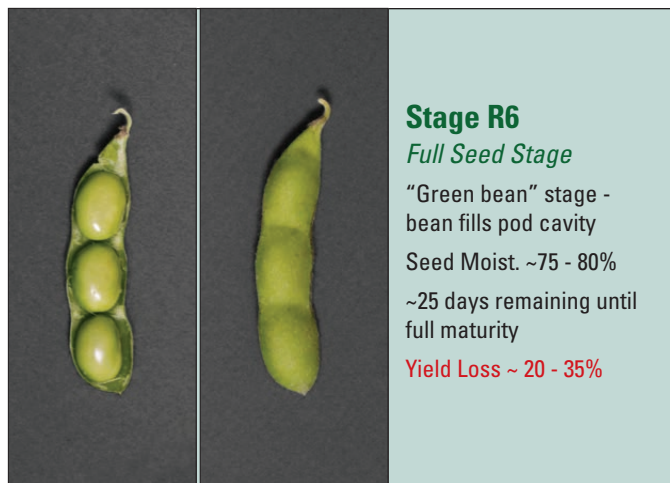
Assessing Soybean Damage

Frost damage within a soybean field may vary considerably, depending on microclimate effects, landscape position in the field, canopy density, and other factors. Generally, thick plant canopies formed by narrow rows and/or high plant populations tend to hold the soil heat better and protect the lower portion of the plants and pods to some extent. After a frost, it is best to wait two or more days before making a crop assessment to allow damage to be fully expressed.

If only a light frost occurs, damage may be confined to the upper leaves in the canopy. After a waiting period, damaged leaves will appear wilted and dried but usually remain on the plant. Undamaged leaves (likely lower in the canopy or in higher landscape positions in the field) should still appear green and healthy. Some maturity delay (several days) may be expected on damaged plants, and small pods near the top of the plant may abort or fail to fill normally.

If a more severe freeze occurs, leaves in the lower canopy, as well as stems and pods, may also be damaged. Frost-damaged stems turn dark green to brown. Beans that were still green and soft at the time of the freeze will shrivel, reducing soybean yield (seed size and test weight), quality, and drying rate. If beans had reached physiological maturity (R7) prior to the freeze, these yellow beans should dry normally, and quality should not be affected.

Soybeans are graded by USDA standards to determine the quantity of damaged seeds (e.g., heat damaged), splits, foreign material, and off-color (e.g., green) beans and loads with a musty or sour odor. With delayed maturity or frosted soybeans, loads could be discounted for most or all of the above criteria. For that reason, care must be taken in harvest, handling, drying, and storing of this year’s crop.



Stage R6
Full Seed Stage
 "Green bean" stage -
 bean fills pod cavity
 Seed Moist. ~75 - 80%
 ~25 days remaining until
 full maturity
 Yield Loss ~ 20 - 35%



Stage R6.5
*Mid-way from Full Seed
 to Maturity*
 Pod/seed color between
 green and yellow
 Seed Moist. ~65-70%
 ~16-18 days remaining
 until full maturity
 Yield Loss ~ 10 - 15%



Stage R7
*Beginning Maturity
 Stage*
 All green color lost from
 seeds and pods
 Seed Moist. ~55 - 60%
 ~8 - 10 days remaining
 until full maturity
 Yield Loss ~ 0 to 5%



Stage R8
Full Maturity Stage
 95% of pods are mature
 color (but about 5 - 10
 days are still needed to
 reach harvest moisture)
 Seed Moist. ~25 - 35%
 Yield Loss ~ 0%

Harvesting/Drying Freeze-Damaged Soybeans

If soybeans have been frosted prior to maturity or have higher than normal moisture at harvest, combine settings may have to be adjusted to minimize harvest losses. Reduce the concave clearance, and then begin to increase rotor or cylinder speed if more aggressive threshing is needed for wet, tough soybeans. Check behind the combine and readjust settings as conditions change throughout the day or season.

Soybeans should be at 16% seed moisture or below for ideal threshing, but with delayed maturity or early frost, some fields may be wetter than this late in the season. In those cases, harvesting at 18% or slightly higher moistures can be attempted if soybeans are sufficiently defoliated, but drying is required. Dryer temperatures need to be significantly lower for soybeans than for corn, as too much heat causes excessive seed coat cracking and eventually splits. Keeping the relative humidity of the drying air above 40% minimizes cracking, but this greatly limits dryer temperature and may not allow the throughput needed. For more on soybean drying, see:

www.ces.purdue.edu/extmedia/GQ/GQ-27.html

Storing Freeze-Damaged Soybeans

A normal soybean crop should be dried to 13% for a 6-month storage period and 12% for 12 months of storage. For lower quality soybeans, experts suggest drying grain one or two points below that required for a normal crop, monitoring grain closely while in storage (at least twice monthly), and storing this grain for only six months rather than a year.

Green soybeans may be the primary concern of growers with this year's crop. Studies have shown that green soybeans, if properly dried, have the same storage properties as normal soybeans. However, preliminary studies have also shown that green beans do not lose their internal green color, although the surface color may lighten or mottle somewhat after weeks or months in storage. For this reason, growers may want to screen grain prior to storage to remove smaller green beans to help avoid significant discounts at the elevator.

References

- Berglund, D. Assessing frost damage in soybeans. North Dakota State University. Online: <http://www.ag.ndsu.edu/winterstorm/winter-storm-information-farm-and-ranch-information/farm-and-ranch-crops-soybeans/assessing-frost-damage-in-soybeans>
- Maier, D. and Parsons, S. 1996. Harvesting, drying, and storing frost-damaged corn and soybeans. Grain Quality Task Force Fact Sheet #27. Purdue University. Online: <http://www.ces.purdue.edu/extmedia/GQ/GQ-27.html>

Figure 1. Soybean growth stages and approximate seed moisture, days to maturity and yield loss from a hard, killing frost that stops seed development.

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