SDSU Extension

iGrow Soybean

BEST MANAGEMENT PRACTICES

Chapter 50:
Seasonal Hazards

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Weather and climate is an ever-changing element in soybean production, and is rarely the same from year to year. The impacts of weather and climate-related hazards vary, depending on the growth stage. For example, hail that defoliates a crop at the V3 growth stage will have a different impact than hail that defoliates the crop at R3. The purpose of this chapter is to discuss flooding, drought, frost, and hail impacts on soybean growth. Table 50.1 provides rules of thumb when considering how to manage seasonal hazards. If damage is serious, we recommend that you contact your insurance agent (Chapter 46).

Table 50.1. Rules of thumb for managing seasonal hazards.

- Understand your climate risks.
- Keep your head.
- Document the problem.
- Contact your insurance agent.
- Collect images and note where and when.
- Carefully consider your management options.

Flooding

Yield losses from flooding can range from total crop failure to minimal. The extent of flooding loss depends on the amount of water movement, the duration, air temperature, and the growth stage of the plant.

Flooding of standing soybeans

Soybean plants are tolerant of flooding for up to two to four days under ideal conditions with virtually no impact on yield. If flooding lasts four to six days, some reduction in stands, vigor, and yield may occur. This duration may also delay plant growth and cause plants to be shorter with fewer nodes. After seven or more consecutive days of flooding, there is likely to be a significant yield loss or loss of the entire crop. This is due to decreased oxygen concentration, increased CO_2 concentrations, and sediment deposition.

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Soil oxygen is necessary for maximum productivity. When a field is flooded, it reduces the amount of oxygen available to the plant, because the oxygen content of water is less than soil. Without oxygen, the plant cannot properly respire. If there is little water movement, research has shown that oxygen concentration can approach zero within 24 hours in a flooded field. In addition to the lack of oxygen, flooded fields often have higher levels of toxins and carbon dioxide. Some research from Minnesota has shown that the increased carbon dioxide levels are more dangerous to the plant health than the low oxygen levels (Coulter et al., 2008). This build-up can amount to 50 times higher than in non-flooded soils.

Air temperature can also play a role in the success of soybean in a flooded field. Higher temperatures cause soybean plants to use its energy stores more quickly. If oxygen levels are reduced in the soil, the plant can become stressed. High temperatures can also affect carbon dioxide levels, because of increased respiration by the plants and soil microbes. Generally, a submerged soybean plant fares better under cool cloudy conditions than warm sunny conditions.

Water movement has an effect on soybean plant health as well. If stream flooding was the cause, oftentimes water is moving across or through a field. This is common during flash flooding situations, and could arrive and recede quickly. The resulting damage to the soybean plants may include plant scouring or sand and/or silt deposition on the plants. Rainfall can help clean these leaves.

In lowland flooding, water is retained in depressed areas of fields, and may remain for several days. Although silt or soil deposition is less of an issue, waterlogged or saturated soils may be a prolonged problem after the surface water has receded. Soils in these types of areas tend to be heavier, such as clay. These types of soils do not drain as well, and yield reductions are often higher on clay than on silt loam soils, even when flooded for the same length of time.

The rate of drying will impact yield (Sullivan et al., 2001). Research has shown that for each day of flooding at V4 stage, yield loss is about 1.8 bu/(acre×day) on clay soil and 0.8 bu/(acre×day) on silt loam soil (Scott et al., 1989). In the reproductive stages, yield loss is even higher. At R1 growth stage, clay soil yield loss is 2.8 bu/(acre×day) and silt loam soil yield loss is 1.5 bu/(acre×day). Larger yield losses would be expected at R3 to R5.

Flooding can also result in surface crusting, which has the potential to reduce seedling emergence. If crusting is an issue, light tillage with a rotary hoe, coulter cart, or even the planter or seed drill can help with emergence. Note, however, this may cause 10% loss of emerged beans. If there is an adequate stand present, "crust busting" may not be necessary, as the tillage would not improve recovery or yield.

Post-flood concerns

When the plants are recovering from a flood, avoid management practices that will further place the plant under stress. For example, postpone the use of pesticides and consider cultivation to improve aeration. Flooding may also have killed the soil bacteria responsible for N_2 fixation and may have produced an environment favorable for many diseases. If the plants are killed and reseeding is an option, check with your insurance agent and estimate your yield potential (Chapter 51). Before reseeding, make sure that soil is dry enough to support heavy machinery. Some yield potential is already lost due to the later planting date, and ensuring a good seedbed is the best way to get your crop off to a good start.

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End-of-season flooding

When flooding occurs at harvest time, it is a challenge to determine the proper action to take when heavy equipment cannot enter the field. Yield losses are difficult to estimate at this stage. There are several concerns when flooding occurs at the end of the growing season:

1. **Sprouting in the pod.**
2. **Shattering of beans as they dry out.**
   If the soybeans were mature and dried before flooding, they may shatter as they dry out. It is tempting to harvest these as soon as they are dry enough for combining, but this risk should be balanced against other concerns listed here.
3. **Saprophytic fungi on the seed.**
   This could cause discoloration on the seed and black dust during harvest. If the crop is not affected and the soybean seeds are mature, it is ideal to harvest as soon as possible. If there is some infection, the decision to harvest should be weighed with other concerns listed here.
4. **Lodging of plants in wet soils.**
   Some seed will be lost to the ground, and the remainder will be difficult to harvest. If they are in contact with the soil, there will be reduced seed quality and harvest will be very slow. Yield losses will be very likely.
5. **Silt and mud deposits.**
   Silt coating on the leaves can delay drying out of soybean plants, and will create dusty harvest conditions. If the plants are still standing, harvest should be postponed. The silt and dust will create extra wear and tear on the combine, so it is best to keep the equipment clean until it is necessary to harvest the silted and dusty field.
6. **Grain quality.**
   Flooded fields will likely have lower seed quality than non-flooded fields. Monitor each field for grain quality prior to harvest. If damage is extensive, there may be a dockage at the elevator, or the seed may not be accepted.
7. **Soybeans not progressing to maturity.**
   If soybeans were flooded for more than 24 hours and were not quite at R7 stage, they will have some yield loss. If the plants had green foliage (R5 to early R6), then there is likely to be a reduction in seed quality. In these cases, seed may be green and off-color, shriveled, and/or small in size.

There are a number of ways that a late-season flood can be managed to minimize losses and maintain the best quality grain possible. Scout your fields to determine the extent of flood damage and harvest order. Each farmer will have to make his or her own decisions, as no two flooding events are the same, nor do any two fields recover the same from flooding.

1. For fields that have extensive damage, consult your crop insurance advisor for advice.
2. Separate the soybeans harvested from flooded fields apart from the non-flooded fields, as seed quality may be reduced in the flooded fields. If they are mixed, that may reduce the overall quality of the load of soybeans.
3. If multiple fields are ready to harvest at the same time, consider harvesting the dry fields before the wet ones. Yields will likely be reduced in the flooded fields, whereas the dry fields will have reached maximum yield and will also harvest faster.
4. If shattering is a real threat, it may be advised to harvest those areas first. But, if there is dust or silt deposited, it may be advised to move that area down in the harvest order.
5. If a field has fungi, the level of severity could be considered as well. Keep in mind that harvesting a field that has been flooded will take longer than a dry one.

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Drought

Drought can be defined as a shortage of available water when plants need it, but oftentimes dryness and warmer than average temperatures occur together in South Dakota. In combination, dryness and heat can provide a "double whammy," and can negatively impact soybean production if these climatic conditions occur at the reproductive stages or last over a significant portion of the growing season.

Dry soil conditions can affect soybean at two primary growth stages, at planting and at reproductive stages (from bloom through pod fill). During the vegetative stages, drought stress does not greatly impact yield.

At germination, a soybean seed absorbs water equal to about 50% of its weight. This is the first critical stage, where some soil moisture is needed to get the germination process started. During the vegetative stages, drought or water stress does not typically impact yield. Early signs of water stress are difficult to see from the road. A walk through the field will give the best indication of stress response. Shorter plants and smaller leaf size may be visible indicators. This usually takes a few weeks to develop, and will be noticed if the plants do not appear to be growing.

A second indicator of drought stress is leaf flipping, where the leaves literally turn over to the silver-green underside. The lighter color will reflect more light and conserve water by absorbing less sunlight and reducing photosynthetic processes.

Third, severely drought-stressed soybeans will clamp their leaves, similar to leaf rolling in drought-stressed corn. By doing this, the plant is trying to reduce its exposed leaf area to sunlight to conserve water. Leaf flipping and clamping may occur throughout the growth of the plants from emergence to seed fill.

As the soybean transitions to the reproductive stages, soil moisture availability becomes a determining factor in yield, although soybean is somewhat more resilient to water stress than corn. At the R1 stage, extreme heat can reduce growth, flowering, and pod development. If it is water stressed at the same time, flowers may be aborted. Between the R1 and R3 stages, water and heat stress can be overcome if the stress is relieved. At this point, there are several opportunities for soybean to continue to flower if a prolonged stressful period occurs.

Indeterminate soybean varieties will bloom for four to six weeks. As the plant progresses through the reproductive stages, the opportunity to recover is reduced and potential yield loss is increased. Soybean's initial response to stress will be to increase the number of seeds per pod and increase seed size to compensate for aborted flowers and young pods. If severe stress is present (water and/or heat stress) during these early reproductive stages, the bloom period could be shortened. If no pods are set after the normal blooming period, it is possible that the crop will not set many pods at all, or seed yield will be reduced.

By the time the soybean reaches R4, a decision may need to be made if drought has impacted enough of the potential yield to cut for hay. Soybeans that have 50% to 90% leaves and a good number of pods at this stage will have a decent chance of producing a good crop. This is particularly true if favorable conditions return. However, if the crop has set very few pods the yield will be low.

At R5, the demand for water and nutrients is at its maximum during the rapid seed filling period. A shortage of available water will reduce N fixation and N availability. Water and heat stress at the R5-R6 stage generally results in fewer pods per plant and fewer beans per pod, and sometimes smaller seed size. If weather and climate conditions have been favorable up to this point, there may be some reduction in seed size and yield, but not as much as would have occurred due to pod and seed abortion in the earlier reproductive stages. Late rains can help fill out seeds, but increasing seed size cannot fully compensate for the reduction in seed number.

The best way to reduce vulnerability to drought stress is to manage the land to maintain favorable soil moisture. Without soil moisture, roots will not be able to take in nutrients or grow in the upper soil areas

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where the soil dries. Soil and tillage practices affect the temperature and moisture of the soil, which can impact the entire growing season.

Irrigation can help reduce drought stress in soybeans as well. Irrigation scheduling and planning for the growth period with the most water demand can help alleviate drought and temperature stress. Refer to Chapter 49 in this book for more information on irrigation.

Frost

Frost is a concern both in the spring and the fall seasons (Figs. 50.1, 50.2, 50.3, 50.4). Researchers at North Dakota State University generally advise that it is better to plant early and risk a spring freeze than plant late and risk a fall freeze (Halvorson et al., 1995). After a spring freeze, replanting is often an option, whereas few options are available after an early killing fall freeze. As a result, in general, it is better to try to maximize your growing season than risk a fall freeze. Information on replant options is available in Chapter 51.

Soybean can be affected by temperatures in the 28°F to 32°F range early in the growing season. This largely depends on the length of time that temperatures hold at these low levels. Plants in the VE to VC stage can tolerate short periods of 29°F to 30°F, and can be hardened after repeated short exposures so that they may tolerate temperatures down to 28°F. Once true leaves emerge, soybean plants are more susceptible to any extended period below 32°F.

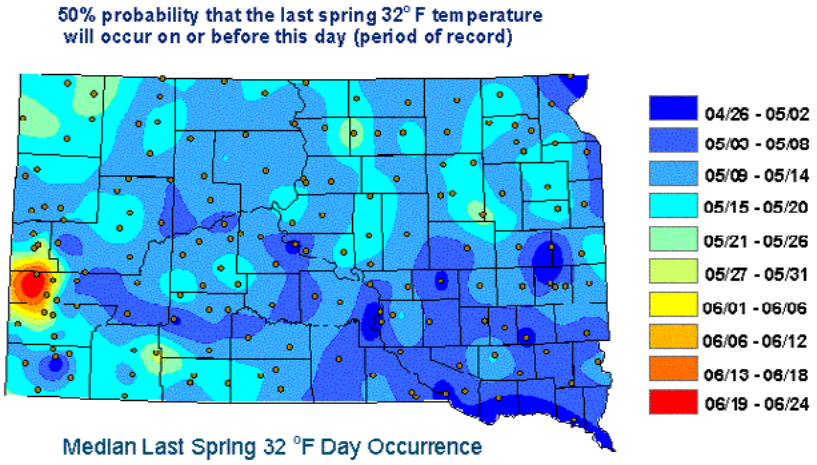

Figure 50.1. Median last spring frost (32ºF) date in South Dakota. (Image courtesy of South Dakota State Climate Office; http://climate.sdstate.edu/w_info/frost/frost.asp)

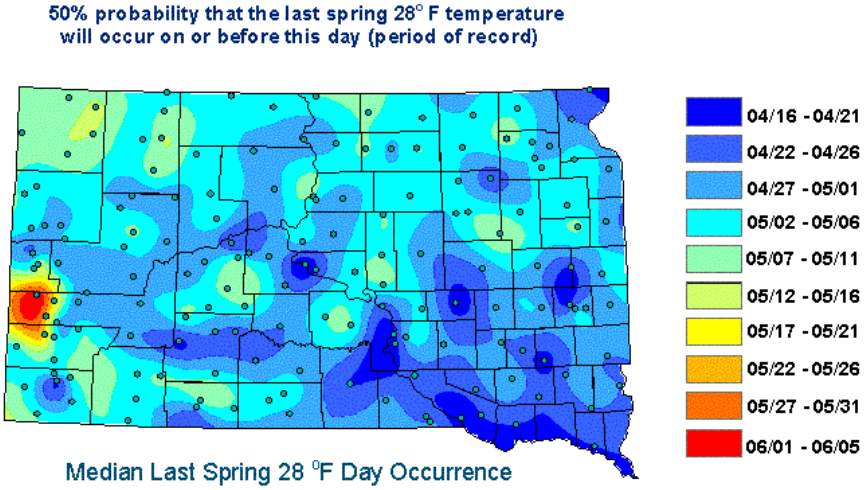

Figure 50.2. Median last spring freeze (28ºF) date in South Dakota. (Image courtesy of South Dakota State Climate Office; http://climate.sdstate.edu/w_info/frost/frost.asp)

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If a fall season hard freeze (28ºF or lower) occurs after the R7 stage, then yields are not impacted (Figs. 50.3, 50.4). If there is an early killing frost in the fall when leaves are light green or yellow, let those frost-damaged soybeans dry down in the field to reach mature color whenever possible. Keep in mind that leaves may not fall from frost-damaged plants. This dry-down period will help green seeds turn yellow and minimize the need for forced drying. Beans that are still green will soften and shrivel. If the frost occurred after R6, it is unlikely that oil and protein content of the harvested seed will be reduced. Generally, the most serious potential impact will be on quality for seed purposes.

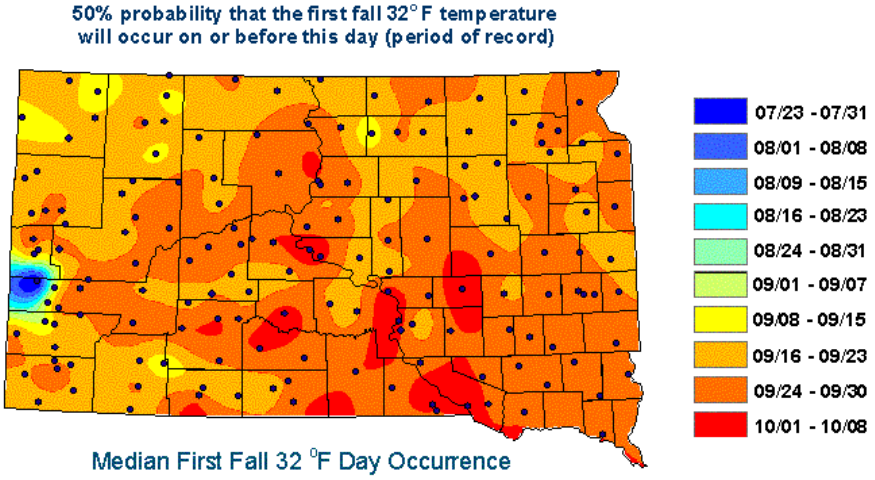

Figure 50.3. Median first fall frost (32ºF) date in South Dakota. (Image courtesy of South Dakota State Climate Office; http://climate.sdstate.edu/w_info/frost/frost.asp)

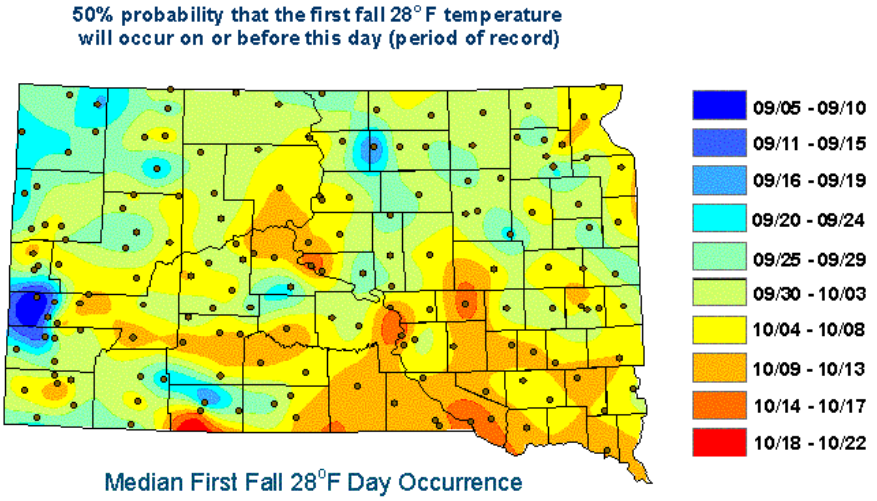

Figure 50.4. Median first fall freeze (28ºF) date in South Dakota. (Image courtesy of South Dakota State Climate Office; http://climate.sdstate.edu/w_info/frost/frost.asp)

If you have experienced some frost or freeze damage, it is best to wait for about three to five days before making a damage assessment. For more information on how to estimate yield loss after a frost or freeze event, or to determine if replanting is economical, refer to Chapter 51.

Hail

Hail can occur at any time during the growing season. Damage can range from slight leaf damage to total loss. It is advised to complete a damage assessment three to five days after the hail event to get the most accurate estimate. Yield loss predictions are generally made on the basis of two factors:

- The growth stage at the time of damage.
- The degree of plant damage.

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Plant damage can be classified as leaf defoliation, stand reduction, stem damage and pod damage.

Oftentimes, a widespread event with small, soft hail may cause less damage than large, icy hailstones. Small, soft hail will impact the plants and leaves with less force than large stones. In addition, they are more likely to fall between plants, roll off of leaves, and melt faster. Plants in the early growth stages are most susceptible to small hail damage, as the growing point is most exposed and vulnerable at the VE and VC stages.

Large, icy hailstones will impale the plants with more force, and thus could cause more stem breakage. Damage may be very localized, but severe, with large stones. As a general rule, the larger the hail is, the fewer stones per area. For more details on how to assess hail damage, consult Chapter 51.

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