



# Green-stem Syndrome in Soybean

## EXTENSION

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Soybean continues to play a prominent role in Oklahoma crop rotations. The crop provides growers with a high value summer broadleaf crop that can be easily rotated with traditional wheat systems. With better genetics and improved management practices, soybean can be successfully grown in most regions throughout the state. Generally, the soybean crop in Oklahoma has fewer pests and lower disease pressure compared to other soybean-producing states. However, a disorder known as green-stem or green pod syndrome has become one of the biggest challenges for Oklahoma soybean producers.

### What is Green-stem Syndrome?

The green-stem syndrome has not been well characterized, as symptoms vary across environment and years. In fact, there is no established name for the syndrome, with greenbean,



Figure 1. Symptoms of green-stem syndrome causing excessive leaves on the plant and green stems. Notice soybean in the background are near harvest mature.

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green-stem, green pod, flat pod and greening disease all being used to describe soybean maturity disorder(s) in the U.S. Generally, the condition occurs when all or part of the soybean plant remains green, while the rest of the plant or neighboring plants senesce (mature). Most commonly, this is seen in the stems, leaves or pods but can also occur when petioles and leaves remain attached to the stem, resulting in green leaves remaining on the plant when plants would normally mature.

### Causes of Green-stem Syndrome

The direct cause of these green stem has been highly debated. In most cases, it can be attributed to an imbalance in the source-sink relationship within the plant. Typically, as the plant matures, photosynthates created by the leaves, stems



Figure 2. Green-stem syndrome from bud proliferation caused by phytoplasma.



**Figure 3. Impact of stinkbug damage on a mature soybean seed.**



**Figure 4. Aborted seeds within a pod. The surrounding pods had already reached or surpassed the R6.5 growth stage.**

and even the pods are translocated into the seeds. If a stress occurs in-season and causes reproductive structures (i.e. flowers, pods and seeds) to be aborted while vegetative biomass remains uninfluenced, some of the developed photosynthates will not be able to move into the seeds located on the lower portions of the plant. This causes the photosynthates to be locked in these structures, resulting in them remaining green even as the plant matures.

The agent that causes this physiological response is unknown and often times solely referred to as a “stress.” Several factors have been theorized as potential causes, including: stinkbugs, aphids, thrips, diseases, viruses, management practices and environmental stresses. A direct cause may be identifiable within a given location or year; however, the cause is rarely consistent across environments. It has been documented that manually depodding soybean results in green-stem syndrome universally across years (Egli and Bruening, 2006). This suggests that any disease, insect or environmental stressor that aborts or diminishes pod development could create these symptoms. The exact cause will continue to be

evaluated; however, due to the widespread occurrence of this condition through the soybean production regions of the U.S. and even the world, it is unlikely to be influenced by a single source.

## Challenges

Green-stem syndrome can cause several challenges for soybean production systems, depending on the symptoms observed. A high percentage of green stems will most likely be associated with decreased harvest efficiency. While there is not a direct link between green-stem and grain yield losses, decreased harvest efficiency could greatly impact realized yield (yield collected by the combine rather than the yield available at harvest). Harvesting green soybean plants with excessive moisture and leafy material could either increase foreign material in the harvested soybean crop or decrease the speed at which the crop can be harvested.

Untimely harvest can be another major issue. When a high number of green stems and green pods are present in a field, it can be difficult to know if the field is fully mature, resulting in harvest practices being delayed to a point where shattering and seed quality would be a concern. This is typically a greater issue where green pods are present, as opposed to green-stems, as it may appear that the crop would not be able to thrash properly. Therefore, it is essential that field maturity be checked.

## Managing Green-stem Syndrome

Determining how to manage green-stem syndrome is difficult. In most years, growers will not know there is an issue until most of the crop has matured. Desiccants are typically used to help terminate growth and dry-down the plant. Research has suggested these desiccants can be used to help remove green leaves (Griffin et al., 2010). However, the value for use in desiccating green stems and pods has produced inconsistent results (Villanueva and Bradley, 2018). Research is currently ongoing at OSU to evaluate the impact of desiccants on soybean dry-down, yield and green-stem syndrome.

Managing against green-stem syndrome in-season is difficult. As several factors can influence green-stem syndrome, growers’ best practice is to manage in-season stress, particularly during pod fill stages of soybean development. Stink bugs must be controlled (given a threshold) via insecticide application. While fungal diseases have not been associated with causing green-stem syndrome, fungicide use may reduce fungal pathogens attacking pods and seeds, which may elevate source sink imbalances. However, fungicide application may delay maturity by a week or more due to plant health responses and/or control of late-season foliar diseases that hasten defoliation and crop maturity. The application of insecticide and fungicides can help mitigate any biological stress but managing late-season environmental stress is a greater challenge. Planting practices also can be a method to help mitigate this disorder. Shifting planting date to minimize the impact of unfavorable conditions, typically experienced in late June through July, has shown to greatly decrease the incidence of green-stem syndrome. This can be accomplished by planting early or later in the season. Even with earlier planting, a large portion of seed fill will occur during early to mid-July. This timing can still result in diminished yields and develop green-stem syndrome if suboptimal conditions exist,

but the risk is lowered. With later planting, the intent is to have the soybean at a vegetative phase through the sub-optimal conditions that typically exist in mid- to late- July and have a larger portion of the reproductive development during late-August through October when rainfall is more frequent. While risks still exist with later planting, it greatly decreases the risk of experiencing suboptimal conditions during reproductive growth.

Cultivar selection can also be a tool for managing green-stem syndrome. Indeterminate cultivars are typically thought to have a higher potential of developing green-stem syndrome as they will continue to produce vegetative growth even as the plant switches to reproductive growth. This is fairly inconsistent, as differences will often be associated with individual varieties and not maturity groups. Testing for this factor in most commercial variety programs has not been common; however, several university testing programs do provide ratings growers could use to evaluate individual cultivars.

Supplemental irrigation is another potential management practice. As late-season environmental stress, such as temperature and moisture stress, has been noted to be a major contributing factor to green-stem syndrome, providing irrigation in periods of prolonged moisture stress can help off-set this stress. As with the other management considerations, irrigation solely functions to lower the risk associated with moisture stress later in the season. However, as several

factors influence this disorder, soybean with green-stem syndrome are still found in irrigated fields.

## Summary

Green-stem syndrome can be a challenging condition to manage for soybean production systems in Oklahoma. Because there are many symptoms and causes, it can be difficult to manage in season. However, options are available. Managing stress is often the best approach for growers, including insect, weed and environmental stresses. Sometimes these in-season stresses are unforeseen or cannot be avoided, but management options such as desiccation exist. However, due to its non-uniform distribution in a field, harvesting at a slower pace or avoiding severely affected areas may be the best option.

## References

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