

Drought Effect on Pod Fill in Soybeans

Introduction

- The impact of drought on soybean yield potential can be difficult to predict. Not only can yield production be drastically affected but nodulation and nitrogen fixation can also be reduced if high temperatures and low moisture persist, further inhibiting growth.¹
- If heat and drought occur during the reproductive phases, soybean plants can abort flowers and pods (Figure 1).
- Overall, the greatest yield reductions in soybean from drought stress occur between the R4 and R6 (full pod through full seed) growth stages.²

Drought Loss Potential in Soybeans

The greatest risk for potential yield loss due to drought stress in soybean occurs during the R4 through R6 growth stages. When drought persists during these growth stages, soybean flowering stops and plants are unable to compensate for lost pods. Research has shown that from the second through the fourth week of seed fill, a 39 to 45 percent yield decrease can occur when there are four days of visible moisture stress.³ Drought stress during seed fill can also reduce the number of seeds per pod and seed weight.⁴ Understanding the differences between how indeterminate and determinate soybean plants react to dry growing conditions may help in the formulation of drought management decisions. (Note, indeterminate soybean plants continue to grow after flowering has begun, while determinate soybean plants essentially halt vegetative growth once flowering begins.)



Figure 1. Aborted soybean seed pods.
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How a Soybean's Flowering Habit Can Affect Drought Stress Management

Drought stress can affect indeterminate and determinate soybeans differently.

Indeterminate soybean

Indeterminate soybeans continue growing upward at the tip of the stem for several weeks after flowering begins on the lower stem. Flowering will progress up the stem, and plants will continue to flower for six to eight weeks depending on plant maturity and growing conditions. Most northern commercial varieties are indeterminate. Indeterminate soybean varieties usually grow taller and do well in regions with short growing seasons. Indeterminate flowering-type soybean can recover from a short-term drought during the flowering growth stages by producing flowers and pods over a longer period. An indeterminate flowering growth habit should be advantageous to recovery from drought stress.⁵

Determinate soybean

By contrast, determinate soybean plants complete their growth in height and then produce all the flowers at about the same time. These plants are also usually one-half to two-thirds as tall as indeterminate varieties. Most southern soybean varieties are determinate. Drought during this shorter flowering period can negatively affect a higher percentage of the blooms and ultimately yield potential. Severe drought can have a devastating effect on yield potential in determinate soybean varieties, because flowering stops and plants cannot compensate for lost pods.

How Heat and Drought Stress Effect the Soybean Plant

Drought Effects

Drought stress can cause flower and pod abortion, while reducing the number of seeds per pod and seed size. Moderate to severe drought stress can also substantially reduce or stop nitrogen fixation, disrupting seed development.¹

If adequate rainfall occurs and photosynthates become available after R5, the plant may compensate for earlier losses by producing larger seeds (within its genetic capacity).² Once the plant reaches R6, pods are not normally aborted.

If soybean plants are drought stressed to the point of losing leaves, it is time to decide whether to leave the plants in the field or cut them for hay. This decision depends on the stage of growth and condition of the plant, along with the producer's need for soybean hay or the market for this type of hay. Plants with 30 percent of the leaves still attached may be considered for hay. These plants can produce 0.75 to 1.25 tons of dry matter per acre with 13 percent protein and 48 percent in-vitro dry matter digestibility.⁶

Heat Effects

It can be difficult to distinguish the effects of high temperature from the effects of water stress on soybean plants. Often these stresses occur together and magnify each other's effects. Temperatures above 95 °F (35 °C) can severely stress soybean plants, have been shown to substantially decrease pod set, and may potentially increase leaf loss. Very high soil temperatures of 90 °F (32 °C) or above can cause decreased nodulation and nitrogen fixation in soybean. High soil temperatures are most likely to occur on coarse textured soils and in later-planted bean (like those planted into double-crop production systems). While flower production of indeterminate soybeans can occur for 30 to 40 days or more under good conditions, moisture stress and high temperatures can shorten the flowering period.⁵

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Problems to Consider When Harvesting a Drought-Stricken Soybean Crop

1. **Smaller seed size.** Combines should be adjusted to keep harvest loss of small seeds to a minimum.
2. **Green seeds.** Soybean plants that senesce before maturity due to stress may produce green seed that can result in dockage at the elevator.
3. **Green stems.** Plants that die prematurely due to drought may have green stems at harvest that can slow harvest by wrapping on the header.
4. **Pod shattering.** This is especially problematic if there are weather cycles of wetting and drying before harvest.
5. **Sprouted seed.** Drought-weakened pods can allow moisture to infiltrate the pod and reach the seeds. This can result in seeds sprouting while still in the pod.
6. **Poor grain quality.** Drought-stricken soybean pods are more susceptible to invasion by fungi, which can result in reduced grain quality.⁶

Management Decisions

Managing stress from insect, disease, or nutrient sources can also help reduce the overall stress load on the plant and potentially limit drought stress-associated yield losses. When drought stress becomes severe, a management decision to keep the crop in the field or harvest the soybean for hay should be made when leaves start to curl and plants begin to defoliate. This decision should be based on the crop condition, growth stage, and on hay needs or hay markets.

Any producer who is considering using the production from a drought-stressed soybean crop for planting next year's crop should understand that seed produced under severe drought stress, especially during the reproductive grow stages, may exhibit reduced germination and vigor.⁷

Sources

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Performance may vary, from location to location and from year to year, as local growing, soil and environmental conditions may vary. Growers should evaluate data from multiple locations and years whenever possible and should consider the impacts of these conditions on their growing environment.

The recommendations in this material are based upon trial observations and feedback received from a limited number of growers and growing environments. These recommendations should be considered as one reference point and should not be substituted for the professional opinion of agronomists, entomologists or other relevant experts evaluating specific conditions.

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