IOWA STATE UNIVERSITY
Extension and Outreach

Integrated Crop Management

Influence of Drought on Corn and Soybean

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Water is extremely important for crop production. When water becomes limiting to the plant it is important to understand how plants use water. We often hear the term evapotranspiration (ET) in relation to plant water demand. ET is a combination of soil water evaporation (E) and water used by the plant during transpiration (T). Soil evaporation is the major loss of water surface and typically is higher after rain and under high temperature conditions.

Plant transpiration increases as corn leaf area increases. Transpiration is the mechanism by which water moves from the soil through the plant into the atmosphere. The greatest water demand for corn occurs from the late vegetative stages through the blister stage and for soybean from the early pod set through the mid seed fill stages. In other words, the greatest demand for transpiration occurs during periods of rapid growth.

Evapotranspiration demand that exceeds soil water supplies will result in yield reductions at any time during the crop life cycle. When plant water uptake by the roots is limited so is nutrient availability, uptake, and transport. Additionally, water stressed plants are more susceptible to insect and disease pathogens and have diminished stem integrity.

Iowa soils hold 1.5-2.5 inches per foot of effective rooting depth. Root depth in Iowa has been found at depths greater than six feet. The importance of proper early root development cannot be underestimated. Crops with deep root systems explore a greater volume of soil are able to withstand drought conditions better.

Drought symptoms in corn

Corn leaf rolling is the primary symptom of drought. Greying of leaf tissue will occur under extremely severe conditions. The earlier leaf rolling occurs in the day or the longer the duration of leaf rolling the greater the stress the crop is under. Yield loss estimates are assumed when drought stress occurs for four consecutive days or more.

Drought stressed corn.

Effects on vegetative corn

Drought stress during vegetative stages results in reduced stem and leaf cell expansion (shorter plants with less leaf area). The effect of drought stress on leaf morphology is much larger than that of photosynthesis. When drought stress is combined with heat stress vegetative development will progress more rapidly. Any stress that occurs during the sixth to eighth leaf stage (V6-V8) can result in fewer kernel rows, whereas stress from eighth leaf to seventeenth leaf stage (V8-V17) can result in fewer kernels per row.

Effects on pollinating corn

Drought stress 7-10 days ahead of silking can result in delayed silk development. When combined with heat stress this delay could result in poor anthesis silking interval (ASI). Water stress during pollination (tasseling through silking) not only delays silking, but also reduces silk elongation, and if severe, impedes embryo development. With temperatures greater than 95°F, low humidity, and low soil moisture level, silks will desiccate or become non-receptive to pollen. Pollen grains may also be damaged from desiccation when they are released for tassel anthers. When temperatures greater than 100°F , pollen grains are killed. Drought stress during pollination ultimately results in poor pollination and fewer kernels per ear.

Effects on corn during grain fill
During grain fill drought stress results in premature death of leaf tissue, shortened grain fill periods, increased lodging, fewer kernels, and light kernel weights. Kernel abortion near the ear tip will occur in the two weeks following pollination. Continued drought into the milk stage will result in further kernel abortion and smaller, lighter kernels. Drought that occurs in the mid to late grain filling period (milk, dough, and dent stages) results in decreased kernel weights and premature physiological maturity. Once physiological maturity occurs additional drought stress will have no impact on grain yield. Because drought stress typically coincides with higher than normal temperatures the grain fill period is often reduced.

Corn management and yield loss
Management depends on the remaining yield potential. Each field provides a unique combination of soil, management, hybrid, and water supply so not all the fields will have the same yield reduction. After pollination a key is to determine how successful pollination was; that is how many kernels per ear were attained. This can be determined by performing a shake test to see if silks are still attached to the ovules (unfertilized kernels); silks will easily drop from fertilized ovules (kernels). Or wait until seven to ten days after pollination when the ear is in the blister stage (plump kernels with watery liquid inside) to see how many kernels are expanding.

If pollination is good, manage the field as normal. If pollination is poor, those kernels will develop normally with reduced yield potential. These field may be considered for forage or silage harvest. If there is no pollination, there are two options; (1) harvest as near to pollination as possible for the highest quality forage possible or (2) leave the crop as a living cover crop until the fall before mowing or chopping. Continual leaf rolling of the plant in the weeks leading up to pollination can result in a yield loss of 1-5 percent per day. During pollen shed and silking severe stress can reduce yields by up to nine percent per day. In the weeks following pollination drought stress can reduce yield by up to six percent per day.

Table 1. Example corn yield loss estimates when stress occurs for four or more consecutive days. Adapted from Classen and Shaw, 1970; Rhoads and Bennet, 1990; and Shaw, 1988.

Corn Development Stage	Early vegetative (VE - V12)
Estimated Yield Loss per Day of Stress	1 – 3
Corn Development Stage	Late vegetative (V12 to VT)
Estimated Yield Loss per Day of Stress	2 – 5
Corn Development Stage	Pollination to Blister (R2)
Estimated Yield Loss per Day of Stress	3 – 9
Corn Development Stage	Milk (R3)
Estimated Yield Loss per Day of Stress	3 – 6
Corn Development Stage	Dough (R4)
Estimated Yield Loss per Day of Stress	3 – 5
Corn Development Stage	Dent (R5)
Estimated Yield Loss per Day of Stress	2 – 4
Corn Development Stage	Maturity (R6)

Estimated Yield Loss per Day of Stress	0

Drought symptoms in soybean

Soybean respond to drought stress by flipping their leaves over so the underside of the soybean leaf is turned up. A less obvious sign of drought stress in soybean is diminished vegetative growth which normally occurs prior to leaf flipping. In severe drought conditions, the leaf trifoliates will close or clamp together with the center leaflet being sandwiched between the outside leaflets.

Drought stressed soybean.

Effects on vegetative soybean

Vegetative growth of soybean during drought is diminished. Drought stressed soybean are often shorter with smaller leaves due to a lack of water, nutrient availability, and nutrient uptake. Soybean root growth increases during drought conditions because plant carbohydrates are shifted to root growth. When adequate rainfall or soil moisture returns, vegetative growth will resume until the mid-seeding filling stage (R5.5). Under severe drought stress, soybean flowering may occur earlier than normal in an effort to produce seed before premature death.

Effects on soybean during grain fill

Drought effects on soybean are generally not as severe as corn. This is a result of overlapping of development stages. When short-term drought stress results in flower or pod abortion, new flowers and pods will set when conditions improve. During prolonged drought stress, or when the stress occurs during pod set and seed filling stages, the compensatory ability is not as likely to occur. Drought can reduce pod number by up to 20 percent as a result of flower and pod abortion. Seeds per pod and seed size can also be affected by drought stress but to a lesser extent than the number of pods. Drought stress often results in earlier maturity or shortening of the grain filling period resulting in lower seed weights and yields. Soybean yield loss from drought stress is compounded by the lack of nitrogen mineralization and nitrogen fixation. In dry conditions, nodules cease nitrogen fixation because of a lack of soil moisture and lack of carbohydrate supply from the soybean plant. If water deficits are short lived, nodule nitrogen fixation can resume.

Resources

Weather Stress in the Corn Crop (NCH-18)
Utilizing Drought-Damaged Corn (NCH-58)
Making Quality Silage (IBC)
Soybean Response to Drought (PM 3046)
Soybean for Forage (Recovery 19)
Alternatives for Drought-Damaged Soybeans (ICM News)

References

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Crops:

Corn Soybean

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