Early season drought effects on corn

Key points:

- Corn is less susceptible to drought during vegetative growth than during pollination and grain fill, but severe early-season drought can significantly reduce yield.
- Drought stress during the vegetative stages can reduce corn plant size and leaf area and limit the number of kernels on the ear.
- Development of nodal roots and brace roots can be inhibited in dry soil.

Early season drought

- Water availability is the most common yield-limiting factor in corn production.
- In North America, drought stress most often occurs during the latter half of the growing season during pollination and grain fill, when crop demand for water is greatest (Table 1).
- Drought stress early in the season is less common and generally less detrimental to corn yield, but it can negatively impact the crop depending on the severity and duration of the stress.

Table 1. Average daily corn water use, water use per growth stage and cumulative water use over the course of the growing season.

Growth stage	Daily water use rate (in.)	Water use per stage (in.)
Emergence (VE)	0.08	0.8
4-leaf (V4)	0.10	1.8
8-leaf (V8)	0.18	2.9
12-leaf	0.26	1.8
Early tassel (R1)	0.32	3.8
Silking (R2)	0.35	4.1
Blister kernel (R3)	0.32	1.9
Beginning dent (R4.7)	0.24	3.8
Full dent (R5.5)	0.20	3.8
Maturity (R6)	0.10	1.4

Corn germination and emergence

- Corn seeds need to imbibe 30-35% of their weight in in water to initiate the germination process.
- If the soil surrounding the seed is too dry to supply the necessary moisture, germination will be delayed.
- Dry soils at planting often lead to uneven emergence, as some seeds germinate more quickly than others due to variation in the soil microenvironment.
- Shallow planting can exacerbate the problem, as soil near the surface dries more quickly.
- Poor seed to soil contact and residue in the seed furrow can also compound the effect of dry soil by reducing the ability of water to move from the soil to the seed.
- Fertilizers placed in the seed furrow may also inhibit germination due to their salt effect being more pronounced in drier soil. Salts have an affinity to water and can draw moisture away from or out of the germinating seed or root tissues.

Corn response to drought stress

- Reduced water uptake under drought conditions can limit the rate of photosynthesis in the plant.
- Corn plants respond to drought stress by closing stomates and rolling leaves to reduce the volume of water transpired through the plant. This response benefits the plant by protecting it through short bouts of drought stress.
- However, closing the stomates also reduces the ability of the plant to take in carbon dioxide, which slows down photosynthesis and plant growth.
- The eventual impact on yield is determined by the severity and duration of stress. Drought stress lasting four or more days is likely to reduce yield (Table 2).

Table 2. Estimated corn yield loss when drought stress persists for four or more consecutive days. (Drought stress indicated when the uppermost, fully expanded leaf was visibly wilted.)

Corn growth stage	Estimated yield loss per day of stress (%)
Early vegetative (VE-V12)	1 – 3
Late vegetative (V12 to VT)	2 – 5
Pollination to blister (R2)	3 – 9
Milk (R3)	3 – 6
Dough (R4)	3 – 5
Dent (R5)	2 – 4
Maturity (R6)	0

Licht, Mark and Sotirios Archontoulis. "Influence of Drought on Corn and Soybean." Iowa State Univ. Extension. 2017. https://crops.extension.iastate.edu/cropnews/2017/07/influence-drought-corn-and-soybean

Effects on corn growth and development

- Although not outwardly visible, there is a lot of physiological development happening inside corn plants during the early- to mid-vegetative growth stages.
  - By V6, all above-ground plant parts have been initiated, including all leaves, ear shoots and the tassel.
  - Development during this time establishes the size of the overall plant and the size of each leaf.
- Drought stress during this time can impact the eventual yield potential of the plant by reducing:
  - The number of kernel rows on the ear
  - The number of kernels per row
  - Total leaf area and photosynthetic capacity of the plant

Drought effects on root development

- Some degree of soil dryness early in the season can actually be beneficial, as it facilitates deeper initial rooting.
- However, excessive dryness can limit root growth and eventually lead to root desiccation and death.
- Extreme dryness and high soil surface temperatures can kill developing nodal roots, resulting in a condition known as "rootless" or "floppy" corn, where the plant is supported solely by the seminal root system and is prone to fall over.
  - Shallow planting can exacerbate the risk of rootless corn by placing developing nodal roots closer to the soil surface.
- Drought conditions can also inhibit brace root development, causing the roots to grow out horizontally over the surface of the hard, dry soil instead of penetrating the soil, making the plant more susceptible to lodging.

Drought effects on nutrient uptake

- Reduction in water uptake by a corn plant can also mean a reduction in nutrient uptake.
- The nutrient most likely to become deficient under drought stress is potassium.
  - Potassium exists as a cation in the soil solution.
  - As soil water is depleted, potassium ions become more tightly bound to the negatively charged surfaces of soil colloids, making them less available for plant uptake.
- Potassium deficiency can exacerbate the effect of drought stress on the plant.
  - Potassium plays a key role in regulating the opening and closing of stomata.
  - Plants with insufficient potassium can be slower to close their stomates in response to the onset of drought stress.

How to improve corn resilience to drought

Five management practices can help make the crop more resilient to early-season drought stress when it occurs:

1. Ensure adequate potassium fertility.
2. Reduce or eliminate spring tillage, if possible, to help preserve soil moisture.
3. Avoid planting too shallow—target a depth of around 2 inches in most situations.
4. Ensure good seed to soil contact at planting.
5. Manage soils to improve structure and water-holding capacity and minimize compaction.