

AGRONOMIC Spotlight



Drought Stress in Shallow Rooted Corn

Wet conditions this spring have caused shallow rooted corn in some areas of Iowa. In southwest Iowa as much as 90% of the root mass has been reported to be in the top 2 to 4 inches of the soil and deep penetrating roots have also had poor establishment (Figures 1 and 2). Shallow roots can cause many problems later in the season. Corn may be prone to root lodging and may not be able to pull in the nutrients that a growing plant needs. If dry conditions continue, shallow rooted corn may also show symptoms of drought stress.

Shallow Roots

Wet, saturated soils have lower levels of oxygen and can also have lower soil temperatures. These conditions can reduce root growth and cause shallow roots. If conditions surrounding the shallow root zone become dry, corn plants may experience stress.

Drought Stress

Because the soil surface dries first and deeper soils hold moisture longer, corn fields that have shallow roots may experience drought stress earlier than corn roots at a normal depth. Drought stress prior to pollination may reduce ear length and reduce the number of potential kernels. Heat and moisture stress during pollination and the period immediately following can cause significant reductions in yield potential and possibly complete barrenness. The level of yield reduction is dependent on severity of drought, field environment, and hybrid. Table 1 shows potential yield reductions due to stress at different growth stages.



◀ **Figure 1.** Shallow rooted corn with root mass in the top 3 inches of the soil.



◀ **Figure 2.** Shallow rooted corn with some deep penetrating roots.

Table 1. Potential corn evapotranspiration and yield loss per stress day during various stages of growth.

Growth Stage	Evapotranspiration inches per day	Estimated Yield Loss
		Percent Per Day (min-avg-max)
V12-V16	0.21	2.1 - 3.0 - 3.7
V16-Tasseling	0.33	2.5 - 3.2 - 4.0
Pollination (R1)	0.33	3.0 - 6.8 - 8.0
Blister (R2)	0.33	3.0 - 4.2 - 6.0
Milk (R3)	0.26	3.0 - 4.2 - 5.8
Dough (R4)	0.26	3.0 - 4.0 - 5.0
Dent (R5)	0.26	2.5 - 3.0 - 4.0
Maturity (R6)	0.23	0

Source: Rhoads and Bennett (1990) and Shaw (1988)

Silks are approximately 95% water; therefore, when there is dry weather in combination with high temperatures of >90° F, delay in silk emergence is common. Corn pollen shed typically lasts 5 to 7 days with silk emergence beginning 1 to 2 days after tassel emergence. In drought, pollen shed is often reduced to 2 to 3 days and silk emergence delayed 4 to 5 days, resulting in a reduction in viable pollen to fertilize the silks. Temperatures above 95° F often reduce pollen viability.

Continuation of dry and hot weather in late July and early August can cause post-pollination kernel and ear abortion. Kernels are most susceptible to abortion in the days immediately following pollination. Kernel abortion begins at the ear tip and works its way down the ear. Shallow root systems, high plant populations, nutrient

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deficiencies, and hybrid can impact the severity of kernel and ear abortion. Water use in the plant is highest from silking to milk stage of development. This is when the largest reductions in yield can occur.

Corn hybrid performance can vary greatly. Corn hybrids with good drought tolerance have a better ability to handle the lack of water and excessive heat. Drought-tolerant hybrids may still experience yield reductions because they are not drought resistant. Early hybrids may be favored in drought this year due to earlier flowering and grain fill in more favorable moisture conditions. However, if the weather would turn cool and rain is received, then later hybrids may be favored because of the timing of flowering and grain fill better coinciding with rainfall.

Leaf rolling in corn is a way for the plant to respond when it is stressed. Leaf rolling results in a reduction of photosynthesis within the plant. Under normal conditions a plant can take in water during the nighttime hours which provides the plant with moisture for daytime photosynthesis; however, in drought, this may not be possible. Leaf rolling

does not always indicate yield performance at harvest but can indicate root development throughout a field. Shallow rooted, poorly developed root systems, or root injury from corn rootworm larvae often result in leaf rolling due to inability to take in water.

Management

Corn may have the ability to recover from drought stress. Therefore, harvesting a crop for silage instead of grain should be delayed until the situation has been assessed. Table 2 gives an example of how to estimate yield potential. If corn has reached tassel, has leaves that do not unroll at night, and the tips start to brown, it will probably not recover. If half the leaves were dead or dying, the field may be a candidate for silage. If the decision to harvest the crop for silage is made, the next step is deciding when to harvest the silage. As browning of the corn plant continues, forage quality decreases. Therefore, delaying silage harvest will reduce yield and quality and may reduce the chance for planting a second crop. Corn moisture should be checked prior to harvest. If the moisture is greater than 75-80%, harvest should be delayed to avoid seepage and loss of silage quality.

Table 2. Estimating Pre-harvest Corn Yield

1. Estimate the number of kernel rows on a representative ear.
2. Count the number of kernels per row, if the kernels near the tip are less than half-size do not count them.
3. Determine the number of ears per acre.
4. Multiply the kernel rows by the kernels per row and then by the ears per acre.
5. Divide this number by 90,000 to get bushels per acre.
6. Repeat this process at several areas in the field to get a representative sample of the crop.

*The final yield will depend on conditions during grain fill. This estimate is for average sized kernels. If drought stress is continuous throughout grain fill, the resulting estimate may be greater than actual yield.

Source: Pennsylvania State University

Sources: Hall, R.C. and Twidwell, E.K. 2002. *Effects of Drought Stress on Corn Production*. South Dakota State University Cooperative Extension Service. Extension Extra. ExEx 8033. Available On-line: agbio-pubs.sdstate.edu (verified 7/2/10); Lauer, J. 2003. *Drought Stressed Corn*. University of Wisconsin Extension. Available On-line: www.uwex.edu (verified 7/2/10); Lauer, J. 2007. *How Do You Manage A Corn Crop After Stress?* University of Wisconsin Extension. Available On-line: www.uwex.edu (verified 7/2/10); Purdue Extension. 2010. *Corn and Soybean Field Guide*; Rhoads, F. M. and Bennett, J. M. 1990. *Corn*. In Stewart, B. A. and Nielsen, D. R. (editors). *Irrigation of agricultural crops*. p. 569-596. ASA-CSSA-SSSA, Madison, WI; Roth, G. 1999. *Managing Drought Stressed Corn*. Department of Crop and Soil Sciences, Pennsylvania State University. Available On-line: cornandsoybeans.psu.edu (verified 7/2/10); Shaw, Robert H. 1988. *Climate requirement*. In Sprague, G. F. and Dudley, J. W. (editors). *Corn and Corn Improvement*. p. 609-638. American Society of Agronomy, Madison, WI; Wisconsin Corn Agronomy Extension. 2010. *Corn Development*. Available On-line: <http://corn.agronomy.wisc.edu> (verified 7/2/10).

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