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Drought Stress Effects on Corn and Soybean During Reproductive Stages

This document focuses on yield effects from drought stress on corn and soybeans at reproductive stages

Water requirements for the reproductive stages of corn and soybeans are given in the following table. Both crops need about 7" of water to complete these stages without stress.

Table 3: Estimated normal water requirements for corn and soybeans between various stages of growth and maturity in central Minnesota

Stage of Growth	Approximate Number of Days to Maturity	Water Use (ET) to Maturity
		----- inches ------
Corn		
Blister kernel	50	7.0
Milk	40	4.7
Dough	28	2.50
Beginning dent	24	2.00
Full dent	20	1.50
½ milk line	13	0.80
¼ milk line	7	0.30
Soybeans		
Full flower (R2)	51	7.25
Full Pod Development (R4)	37	4.40
Beginning Seed fill (R5)	29	2.90
Full Seed Fill (R6)	17	1.20
Beginning Maturity (R7)	10	.40
(R2) full flower – a flower at the node immediately below the upper most node with completely unrolled leaves		
(R4) full pod development – a pod ¾ inch long at one of the four upper most nodes with unrolled leaves		
(R5) beginning seed fill – the presence of bean seeds in pod at one of the four upper most nodes		
(R6) full seed fill – a pod with full-sized green beans at one of the four uppermost nodes		
(R7) beginning maturity – one normal pod on the main stem has reached its mature yellow or brown color		

Drought Stress Effects on Corn in Reproductive Stages - Once pollination has occurred the total number of potential kernels is set. However, drought stress after pollination can cause kernel abortion from the tip down, and can cause reduce seed size. The following table shows yield loss per day of stress at various stages, and the discussion focuses on effects during the reproductive stages.

The following article is adapted from an article by Dr. Joe Lauer, Corn Agronomist, U of WI, 'What Happens Within The Corn Plant When Drought Occurs?' August 21, 2003 10(22):153-155.

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

Growth stage	Evapotranspiration	Percent yield loss per day of stress (min-ave-max)
	inches per day	%
Seedling to 4 leaf	0.06	---
4 leaf to 8 leaf	0.10	---
8 leaf to 12 leaf	0.18	---
12 leaf to 16 leaf	0.21	2.1 - 3.0 - 3.7
16 leaf to 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	0.0

Derived from Rhoads and Bennett (1990) and Shaw (1988)

Drought Effects During Kernel Development (grain-filling)

Water stress during grain-filling increases leaf dying, shortens the grain-filling period, increases lodging, and lowers kernel weight. Water stress during grain-filling reduces yield 2.5 to 5.8% with each day of stress (Table 1). Kernels are most susceptible to abortion during the first 2 weeks following pollination, particularly kernels near the tip of the ear. Tip kernels are generally last to be fertilized, less vigorous than the rest, and are most susceptible to abortion. Once kernels have reached the dough stage of development, further yield losses will occur mainly from reductions in kernel dry weight accumulation.

Severe drought stress that continues into the early stages of kernel development (blister and milk stages) can easily abort developing kernels. Severe stress during dough and dent stages of grain fill decreases grain yield primarily due to decreased kernel weights and is often caused by premature black layer formation in the kernels. Once grain has reached physiological maturity, stress will have no further physiological effect on final yield (Table 1). Stalk and ear rots, however, can continue to develop after corn has

reached physiological maturity and indirectly reduce grain yield through plant lodging. Stalk rots are seen more often when ears have high kernel numbers and have been predisposed to stress, especially drought stress.

Premature Plant Death

Premature death of leaves results in yield losses because the photosynthetic 'factory' output is greatly reduced. The plant may remobilize stored carbohydrates from the leaves or stalk tissue to the developing ears, but yield potential will still be lost. Death of all plant tissue prevents any further remobilization of stored carbohydrates to the developing ear. Whole plant death that occurs before normal black layer formation will cause premature black layer development, resulting in incomplete grain fill and lightweight, chaffy grain. Grain moisture will be greater than 35%, requiring substantial field drydown before harvest.

Drought Effects on Soybeans in Reproductive Stages - The following table shows yield loss in soybeans during reproductive stages due to drought. As you can see in the table, the reproductive stages of soybeans overlap - the 1st week of pod development occurs at the same time as the 2nd week of flowering, etc. Most soybeans in the area are in the seed filling period. Drought stress at this time causes abortion of small pods, reduced seeds per pod, and reduced seed size.

Table 2: Effect of 4 Days of Visible Moisture Stress on Soybean Yield

	Percent Yield Decrease
1st week flowering	8
1st week pod development	19
2nd week flowering	
1st week of seed filling	
3rd week pod development	36
4th week of flowering	
2nd-4th week of seed filling	39-45
5th week of seed filling	12

**Source: Iowa State*