AGRONOMIC ALERT

Technology Development & Agronomy by MONSANTO

Heat and Drought Stress Impacts on Corn

In the 2012 growing season, high temperatures and drought conditions have taken their toll on the corn crop in the western Corn Belt. The amount of yield loss due to these stresses depends on growth stage, severity of the stress, and the number of days the crop is stressed. General guidelines for potential yield loss by growth stage are shown in Table 1.

Generally, heat and drought stress cause an increase in respiration and a decrease in photosynthesis. The greatest impact of drought/heat stress occurs during the four weeks around pollination, which is the most critical period for determining yield potential. Leaf rolling, leaf loss, short plant height, pollination disruption, and/or premature plant death caused by severe drought and heat stress are indicators used to evaluate the current status of the crop.

Leaf Rolling

This physiological characteristic is a defense mechanism which helps protect plants against excessive moisture loss through transpiration as less leaf surface area is exposed. Leaf rolling amount depends on the hybrid, some will leaf roll quicker than others. If leaf rolling occurs for just a few hours early in the season in response to a daily high temperature, it is likely to have little effect on yield potential. However, if leaf rolling persists for 12 hours or more a day, grain yield potential may decrease, especially during the period from two weeks before to two weeks after pollination[1].

Leaf Loss

Lower leaf loss is usually caused by a reduction in photosynthesis. However loss of the lower three to four leaves has little impact on yield potential.

Loss of the upper leaf (Dieback) is more likely due to severe heat and/or drought stress[2].

Look for the following symptoms as the result of drought and/or heat stress to the upper leaf:

- ***Leaf scald*** occurs most commonly when air temperatures are in the high 90s or highr. At these air temperatures plant cells become damaged and desiccate quickly, leaving the scalded appearance.

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

Growth Stage	Evapotranspiration* (inches per day)	Percent yield loss per day of stress (min-avg-max)
1 to 4 leaf	0.06	---
4 to 8 leaf	0.10	---
8 to 12 leaf	0.18	---
12 to 16 leaf	0.21	2.1 - 3.0 - 3.7
16 leaf to VT	0.33	2.5 - 3.2 - 4.0
Silking (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

Source: Rhoads and Bennett (1990) and Shaw (1988).
*Under severe conditions ET can increase by 50% above normal.

Leaf rolling in corn due to drought/heat stress.

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- ***Scorching of larger leaves*** due to water stress is related to the inability of the plant to uptake water. Under severe conditions the entire leaf may die.
- ***Leaf area*** is reduced under drought conditions, which in turn causes a reduction in photosynthesis. Minor reductions in leaf size will have little impact on yield potential, while major reductions (40-60%) could reduce yield potential by 5 -10 percent[1].

Short Plant at Pollination

Shortened internodes can result in a shorter plant than normal. The following factors can result in shorter internodes during the stalk elongation phase:

- ***Planting Date.*** Early planted corn tends to be shorter than later planted corn[3]. Later planted corn usually has longer internodes as increased day lengths can result in internode elongation[4]. Corn planting in 2012 was earlier than the 5-year average and likely contributed to the shorter stature of the 2012 corn crop.
- ***Insufficient Moisture.*** Internode elongation depends on cell elongation, which is dependant on the ability of the plant to obtain soil moisture[5]. Plants can be drought-stressed due to poor root growth, poor soil conditions, and/or drought conditions[1].
- ***Air Temperatures.*** Shorter internodes can also occur when cool temperatures increase the rigidity of basal internode cell walls and limit cell expansion[6]. It is difficult to accurately determine how much effect the overall warmer than average temperatures combined with the short bouts of cooler than average temperatures had on the height of corn in 2012.

Pollination Disruption

Stress during the two weeks before tassel emergence can reduce the number of kernels per row, resulting in a smaller ear. Extreme heat prior to and during pollen shed can reduce pollen viability. Drought stress can reduce silk growth to the point that pollen may be shed before the silks emerge. If fertilization occurs successfully under severe heat/drought stress, kernels may abort during the first several days of development.
All of the above factors can reduce successful pollination, kernel set and kernel development, and the number of kernels per acre, which determines grain yield.

Premature Plant Death

Severe stress during grain fill can result in premature death. This shortens the grain fill period, increases lodging potential, and lowers kernel weight. In addition, death of the plant tissue prevents remobilization of stored carbohydrates to the developing ear. After the corn plant has died, stalk and ear rots can continue to develop. Stalk rots often occur when ears have high kernel numbers and have been predisposed to stress, especially drought stress. Aspergillus ear rot is commonly observed during hot, dry years. Keep in mind that feeding damage from ear-invading insects also contributes to disease development and the production of aflatoxin.

Management Options for Drought Stress Corn

Dryland Corn. Deciding your best option will depend on the potential grain yield. If kernel set is good, the crop have some potential to produce grain. The first step is to estimate potential yield based on number of ears, kernels per ear and kernel size. Severe drought-stressed corn will have around 110,000-120,000 kernels per bushel. If potential yield is less than 25 bushels per acre, harvesting for silage/hay may be the best option. If potential yield is 50 bushels or more, harvesting for grain could be the best option. If the yield is between 25 and 50, the decision will depend on the price of corn, the quality of the silage, and on a producer's ability to use or sell the silage.

Between silage and hay, silage is usually the preferred option. However, enough moisture in the plant is required to properly ensile. Corn for silage should have 65 to 75 percent moisture. If plants are drought stressed, have lost some of the bottom leaves, and the top leaves have browned off or turned white, they probably do not have 65 percent moisture. In this case, the only option is to chop and graze, or hay the crop, making sure to cut at least six to eight inches above the ground to help avoid nitrate toxicity. Plants that do not grow normally can have high nitrate levels, especially in the lower portion of the stalk [8]. Haying high nitrate corn will not reduce the level of nitrates. A crop that is high in nitrates prior to cutting and baling will be higher in nitrates after baling and storage. It is strongly recommended that the hay be tested for nitrates before feeding.

Irrigated Corn. Some irrigated farmers may face a decision of abandoning all or a portion of a field if irrigation does not keep up with crop use. With high temperatures and low humidity, as much as 0.4-0.5 inches of moisture is being used per day. One needs to decide at what point water resources

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are being stretched too thin to carry the planted acres.

Factors to consider

The average daily water use for corn during the two weeks before and after silking is 0.30-0.35 inches per day for the north high plains. If drought conditions remain extreme, average daily water use can exceed these levels by 25-50%. Low soil moisture and insufficient irrigation capacity to meet average daily water use of at least 0.34 inches (6.5 GPM/ acre) force producers to either use deficit irrigation or abandon a portion of corn acres[10].

1. **Deficit irrigation (irrigation at less than full water use demand).** An irrigation capacity of 4.7 GPM/acre is necessary to meet 75 percent of typical corn water demand through August, assuming no rainfall[10]. If center pivot irrigation is used, it's best to apply between 1.00-1.25 inches per irrigation[10]. Larger applications increase irrigation efficiency. For windshield-wiping pivots, 0.75 – 1.0 inch is a good compromise[10].
2. **Switch a portion of corn acres** to silage but be aware of the nitrate concentration in stressed corn that is chopped for silage. In addition, secure the pricing of the abandoned forage prior to making the decision to abandon the crop for grain.

In summary, shorter plants and smaller leaves are the result of insufficient photosynthetic material. However, if dry weather continues through pollination, the risk of poor pollination/fertilization is likely a larger threat to reduced yield potential than smaller plants with smaller leaves.

Management options for a stressed corn crop include leaving the crop for grain, salvage for silage/hay, or leave it in the field for its residue, all of which depend on the condition of the current crop in each field.

Sources:

[1] *Nielsen, R.L.90 (Bob). 1995. Leaf Rolling as an Indicator of Soil Compaction. Pest Management & Crop Production Newsletter, Purdue University, IN 47907-1150, http://www.agry.purdue.edu, (6/27/12).*

[2] *Nielsen, R.L. (Bob).2011. Top Leaf Death or "Dieback" in Corn. Purdue University, http://www.kingcorn.org, (6/27/12).*

[3] *Hoeft, R.G., et. al. 2000. Modern corn and soybean production. First edition. MCSP Publications. Champaign, IL. 85.*

[4] *Neilsen, R.L. 2001. Short corn at tasseling. Purdue University Extension.*

[5] *Nafziger, E. 2012. Short corn, short yields? The Bulletin. Issue 13. Article 4. University of Illinois Extension. http://bulletin.ipm.illinois.edu, (6/28/2012).*

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[7] *Kraig Roozeboom, K. et al. 2012. The effect of high heat and drought on corn. Agronomy Kansas State University Extension, e- Update, 356.*

8 Crunch time for Kansas corn crop. 2011. http://www.pratttribune.com, (6/27/12).

[9] *Brent Bean, B. 2011. Heat- and water-stressed corn require extra management, Texas AgriLife, http://southwestfarmpress.com, (6/27/12).*

[10] *Bean, B & Kenny, N. 2011. Managing heat and water stressed corn in the Texas Panhandle. Texas A&M System, AgriLIFE Extension. http://amarillo.tamu.edu, (7/3/2012).*

Individual results may vary, and performance may vary from location to location and from year to year. This result may not be an indicator of results you may obtain as local growing, soil and weather conditions may vary. Growers should evaluate data from multiple locations and years whenever possible.