AGRONOMIC Spotlight

Technology Development by MONSANTO ®

High Temperature and Humidity Effects on Kernel Development

South Dakota

High temperatures and humidity have taken their toll on the corn crop in some areas of the U.S. this season. These environmental factors have stressed corn this July and can have a negative effect on corn yield potential. Reviewing some physiological concepts and comparing environmental conditions over the past three years may shed some light on the current crop status.

Environmental Conditions

High temperatures and humidity effects

This growing season is consisting of temperatures that were similar to last year and higher than were experienced in 2009 (Figure 1). These high temperatures put the corn crop under a high degree of stress during much of the kernel development stage. Environmental stress on corn can be a result of low water availability and high temperatures. However, even with sufficient moisture, high temperatures can cause a high degree of stress on the plant. Both high day and night temperatures can have an impact on corn yields. Optimal corn growth and development is obtained when high temperatures do not exceed 86° F. Temperatures above this optimum threshold reduce photosynthesis and affect the corn plant's ability to maintain an appreciable level of carbohydrates for kernel development.

High temperatures are not the only environmental factor that can have an impact on corn growth and development. High humidity levels can also reduce the effectiveness of the plant's natural cooling mechanisms. The inability of the plant to cool itself to an optimal photosynthetic temperature is due to it's inability to transpire water at an acceptable rate. Thus, the effects of the high day time temperature cannot be mitigated, leading to high photorespiration and low net photosynthesis. When air temperature is higher, and if the leaf can transpire water, it can cool itself to an optimal temperature. If water is limited and/or humidity is high, transpiration is reduced causing leaf temperatures to increase. These changes reduce the amount of carbohydrates for kernel development. When carbohydrates are reduced, corn yields will go down. The plant spends more energy in trying to stay cool and shifts its focus from cell growth to cell maintenance in the high temperatures. This is of particular importance during the night hours as the plants try to recover from the intense daytime heat. The high night time temperatures (Figure 2) that are being experienced this month are responsible for higher than normal GDU accumulations. Typically, Parkston, SD receives 1471 GDUs by this time of year[1]. Over 1578 GDUs accumulated this year, similar to the rate of GDU accumulation in 2010 (1599 GDUs).

Effect on kernels

The stressful effects of high temperatures and humidity can combine to reduce the overall availability of carbohydrates to feed the developing kernels. In order to manage its supply of carbohydrates, the plant will balance feeding the kernels with other metabolic functions. Kernel abortion and reduced dry weight accumulation in the kernels are the two major impacts of these stresses on corn yield potential. Kernel abortion can occur when temperatures are high and moisture is limited. The first two weeks after pollination are the most sensitive time for the developing kernels and the time when they are most prone to abortion. As the ear fills from the butt to the tip, the tip kernels are more susceptible to abortion. Dry weight accumulation is the yield component that is affected after the kernels have reached the dough stage. Limited photosynthate to nourish the developing kernels will cause them to be smaller and lighter, which results in "shallow kernels". The premature formation of black layer during high temperature periods can also reduce grain fill, which stops further kernel development.

Driving maturity

Corn development is driven by the amount of heat units that the plant receives. These heat units are commonly referred to as

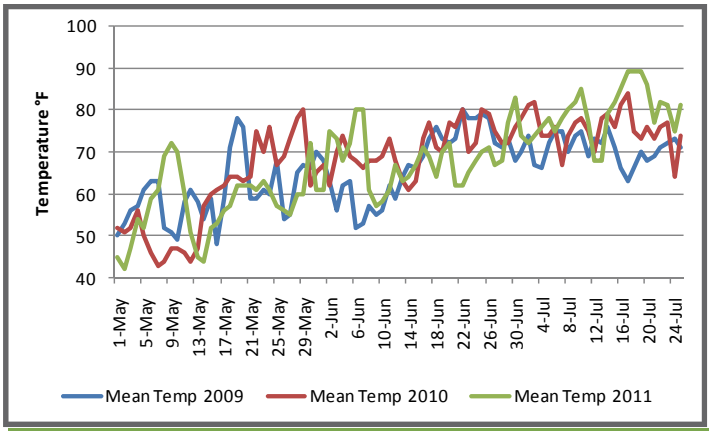

Figure 1. Mean Temperatures during May 1 - July 25th in Parkston, SD for 2009, 2010, & 2011.

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growing degree units (GDUs). General statements can be made about the plant's growth stage relative to the amount of GDUs the plant has accumulated. As temperatures increase, the amount of heat units that accumulate over time can speed up the development of the plant beyond what would normally be expected for a certain geography, as plants grow relative to their environment and not the calendar date. In many areas, GDUs for 2011 have accumulated at a fast rate, similar to 2010 and in contrast with 2009 (Figure 3).

In summary

Environmental conditions during the 2011 growing season suggest heat unit accumulation may once again drive the crop to mature much faster than in recent years. In addition to an early crop, stresses from high temperatures and high humidity may affect kernel development by causing a reduction in carbohydrate production, resulting in aborted kernels and lighter kernels. These results may affect yield potential in various geographies across the U.S.

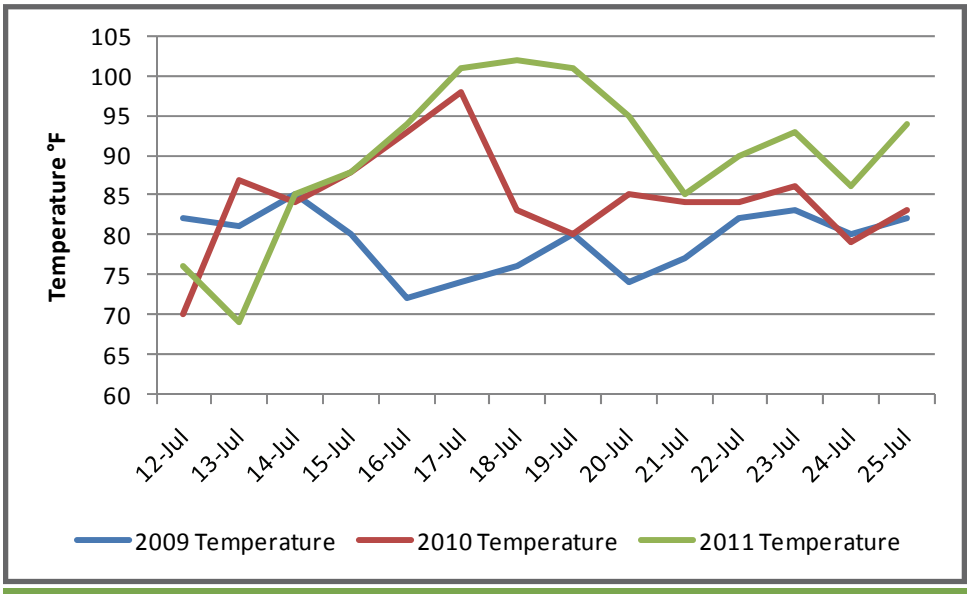

Figure 2. Temperature at 9:00pm during July 11 to July 25th in Parkston, SD for 2009, 2010, & 2011.

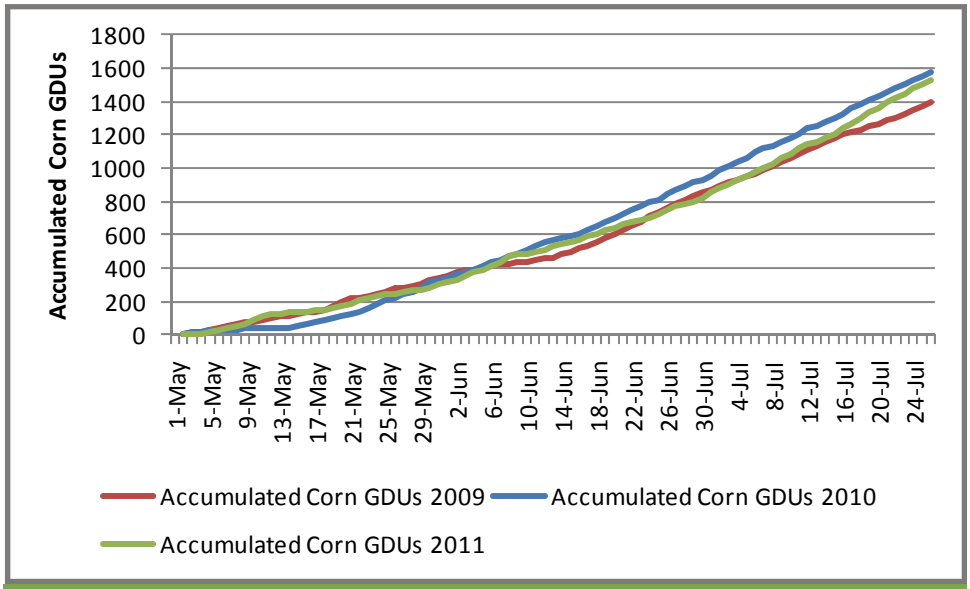

Figure 3. Accumulated corn GDUs during May 1 to July 25th in Parkston, SD for 2009, 2010, & 2011.

Sources:
[1] Weather Channel. Farmer's Forecast– Growing degree days calculator. www.weatherchannel.com (verified 7/22/2011).

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Weather data supplied by: Meridian Environmental Technologies Inc. weatherplot.com