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Use Thermal Time to Predict Leaf Stage Development in Corn

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Being able to predict when a field of corn will reach particular leaf stages can be useful for scheduling post-emergence applications of certain herbicides and sidedress N fertilizer, especially if your farming operation is so large that regular field inspections are difficult to work into your busy schedule. Leaf stage can be predicted on the basis of heat unit accumulation (aka growing degree days) from planting to the date in question.

Review of Concepts. For a refresher on how corn leaf staging is done, read my article "*Determining Corn Leaf Stages*" (Nielsen, 2014). Another topic that probably needs reviewing is the concept of heat units (HUs) or growing degree days (GDDs). The concept is important because corn phenology is very dependent on temperature. Heat unit or GDD calculation for corn phenology is described in another accompanying article "*Heat Unit Concepts Related to Corn Development*" (Nielsen, 2012).

Useful Tip: A new online tool is available that provides real-time estimates plus future projections of GDD accumulations on a county-level basis. The "Corn Growing Degree Day Tool" is available at <https://drinet.hubzero.org/groups/u2u/tools/gdd> and was developed as part of a USDA-funded research and Extension project titled "Useful to Usable".

Predicting Corn Phenology. Given an understanding of corn leaf stage development and heat unit calculation, you can predict the leaf stage of development for a particular field given its planting date and temperatures since planting. It is useful if you know when the crop emerged, but if not you can estimate that event also. Corn emergence typically requires from 100 to 120 GDDs from planting.

We know from previous research that corn leaf development rates can be accurately described by separate linear response curves for early and late vegetative development (Wuethrich, 1997). From emergence to leaf stage V10 (ten visible leaf collars), leaf collar emergence occurs at about one leaf every 82 GDDs (Wuethrich's data suggested 85 GDDs, but 11 years of plot data since suggests closer to 82 GDDs). From leaf stage V10 to the final leaf, leaf collar emergence occurs more rapidly at approximately one leaf every 50 GDDs.

Useful Tip: From planting to about V6, plant development, including time to emergence,

responds more closely to soil temperatures than to air temperatures. This time frame corresponds to that when the main growing point (apical meristem) of the corn plant is positioned below the soil surface. Rapid elongation of stalk internodes after V6 elevates the growing point above ground. From that point forward, plant development is affected more directly by air temperature. Consequently, leaf stage prediction up to about V6 is

more reliable if soil temperatures are used to calculate daily GDDs. After V6, air temperatures are the more predictive basis for GDD calculations.

Example 1: A field was planted on April 28 and emerged on May 5. Since May 5, approximately 535 GDDs have accumulated. Based on our research data, the estimated leaf stage for the crop (without looking at the field, mind you) would be between V6 and V7 (6 leaves x 82 GDDs = 492 GDDs; 7 leaves x 82 GDDs = 574 GDDs).

Example 2: A field was planted on April 28, but you do not know exactly when it emerged. Since planting, approximately 785 GDDs have accumulated. If you assume that the crop emerged in about 120 GDDs, then the estimated leaf stage for the crop would be about V8. This estimate is calculated by first subtracting 120 from 785 to account for the estimated thermal time to emergence, then dividing the result (665) by 82 (equal to 8.1).

Example 3: A field was planted on April 28 and emerged on May 5. Since May 5, approximately 1220 GDDs have accumulated. Your familiarity with these calculations tells you that the crop is likely beyond V10 (equal to 10 x 82 or 820 GDDs since emergence). So, first subtract 820 from 1220 (knowing the crop is at least at V10). Divide the result (400) by 50 to equal 8 additional leaves; for a total estimated leaf stage of V18.

Keep in mind that estimates of leaf stage development are only that, estimates. One of the factors that most influences the accuracy of these estimates is the existence or not of other growth-limiting stresses. Severe plant stress will generally retard stem and leaf sheath elongation, thus delaying the appearance of leaf collars. However, what I have described here will put you in the proverbial ballpark in determining which fields are at which leaf stages on a given day.

Related References

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