Growing Degree Units and Corn Growth

Key Points

- Growing Degree Units are used to measure corn growth relative to temperature.
- A leaf is fully emerged when the leaf collar or ligule is completely visible; designating a vegetative (V) growth stage.
- During V5 to V6, the uppermost ear, tassel initiation, and the number of kernel rows are determined within the growing point.
- Black layer formation (physiological maturity) signals the termination of grain fill.

Growing Degree Units

Growing Degree Units (GDUs) are used to measure corn growth relative to temperature. Each Channel® brand corn product is identified with a GDU number that indicates GDUs needed to reach mid-pollination and black layer. For example, a 109 Relative Maturity product may be characterized by the units required to reach mid-pollination and black layer as 1300 and 2730 GDUs respectively. The formula to calculate the number of GDUs accumulated in a day utilizes the average of the high (Tmax) and low (Tmin) temperatures (°F) for the day minus the base temperature (Tbase), which is established as 50° F for corn development. Tmax and Tmin are limited to 86° F and 50° F, respectively. GDU is thus calculated as follows:

\[ \text{GDU} = \frac{(\text{Tmax} + \text{Tmin})}{2} - \text{Tbase} \]

Examples:
- Tmax = 84° and Tmin = 53°  GDUs = \((84 + 53)/2 - 50 = 18.5\)
- Tmax = 89° and Tmin = 65°  GDUs = \((86 + 65)/2 - 50 = 25.5\)
- Tmax = 83° and Tmin = 50° GDUs = \((83 + 50)/2 - 50 = 16.5\)

As the growing season progresses, daily GDU accumulations are added together to obtain or define corn growth stages. For clarity, GDGs (Growing Degree Days) and GDUs refer to the same formula and can be used interchangeably. Table 1 references GDU accumulations from the day of planting and the number of GDUs required to reach different growth stages. Note this information is based on the leaf collar growth stage method, while the Federal Crop Insurance Corporation (FCIC) utilizes a variation of this scale. All normal corn plants follow the same general pattern of development, but the specific time interval between stages and total developed leaves may vary between different corn products, seasons, planting dates and locations. An online GDU calculator, utilizing temperatures based on zip codes, can be accessed at http://adstest.climate.weather.com/outlook/agriculture/growing-degree-days.

VE (Emergence)

Activity within the seed begins soon after it is placed into the soil. Imbibition is the term that describes the absorption of water by the seed causing it to swell; allowing the radicle or first root to appear from the seed. This phase is highly dependent on soil temperatures being at or above 50° F and favorable seedbed moisture. Soon after the radicle breaks the seed coat, the plumule, which contains embryonic leaves and is enclosed within the coleoptile, breaks through the seed coat and heads upward toward the surface. Seminal roots emerge from the seed to anchor and provide water and nutrients to the developing seedling. Within 4 to 8 days and under ideal conditions, the coleoptile should begin emerging from the soil (Figure 1). Emergence is highly dependent on soil temperature, depth of planting, soil moisture, compaction, and herbicide interactions and may take as long as 2 weeks under cool or dry conditions.

V1 (Coleoptile leaf expansion)

The V1 stage occurs about 3 to 4 days after emergence when the first leaf (coleoptile leaf) has fully emerged. Fully emerged implies the collar or ligule of the leaf has become completely visible outside of the whorl. The coleoptile leaf has a rounded tip, while all remaining leaves have more pointed tips (Figure 2). Each succeeding V stage is characterized by the number of fully emerged leaves.

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Table 1. Approximate Growing Degree Unit Requirements When Timely Planted to Reach Different Corn Growth Stages from Date of Planting (0 GDUs) for 2350 and 2700 GDU Corn Products.

<table>
<thead>
<tr>
<th>Growth Stage (Leaf Collar Method)</th>
<th>Growing Degree Units</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2350 GDU product¹</td>
</tr>
<tr>
<td>VE (Emergence)</td>
<td>125</td>
</tr>
<tr>
<td>V2 (2 leaves fully emerged)</td>
<td>240</td>
</tr>
<tr>
<td>V6 (growing point above soil)</td>
<td>470</td>
</tr>
<tr>
<td>R1 (silking)</td>
<td>1250</td>
</tr>
<tr>
<td>R5 (dent)</td>
<td>2130</td>
</tr>
<tr>
<td>R6 (physiological maturity or black layer)</td>
<td>2350</td>
</tr>
</tbody>
</table>

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V2-V4
These stages occur when two and more leaves are fully emerged. V2 occurs about 7 to 10 days after emergence and the V3 stage occurs around 10 to 20 days after emergence. During V3, the seedling begins to rely on the nodal root system for nourishment.

V5-V6
Within the growing point, initiation of the uppermost ear, tassel initiation, the total number of leaves, and the number of kernel rows are determined. The growing point is near the soil surface and the plant is 8 to 12 inches in height.

V7-V9
The growing point extends above the soil surface and rapid growth begins to occur. Plants could become brittle and be more susceptible to snapping during high winds or when growth inhibitor herbicides are used. Lower leaves may die if the plant is subjected to stress. The potential kernels per row begins to be determined. Plants are around 24 inches in height.

V10-V17
Plants are rapidly growing and are susceptible to moisture and nutrient stress. New leaves are appearing every 2 to 3 days and ear shoots are developing. V10 is characterized by stalk elongation and rapid tassel development within the plant whorl. Potential kernel row number is nearly complete at V12 and brace roots are appearing. The plant is nearing the pollination phase around V15 to V17.

V18-R1 (Pollination)
Pollination begins around 9 or 10 weeks after emergence. Moisture and heat stress during pollination may cause the greatest yield reduction, which can result in barren tips or loss of entire ears. VT or tasseling begins when the last branch of the tassel is visible, but silks have not emerged. Tassels normally appear 2 to 3 days before silk emergence. Pollen shed typically occurs in the morning or evening. The silking stage (R1) begins when silks are visible outside the husk. Ovules or potential kernels are awaiting pollen for fertilization. Pollen shed lasts for 5 to 8 days and can extend up to 2 weeks. Each silk has the availability of approximately 2,000 to 5,000 grains of pollen.

R2-R6 (Grain fill)
During the grain fill stages for a 2700 GDU product, the plant provides nutrients for reproductive growth instead of vegetative growth. Kernel size is being determined and can be influenced by any stress factor, including drought, nutrient deficiencies, deficient root system (as a result of compaction or insect feeding), and leaf diseases that reduce the ability of the plant to produce photosynthetic sugars. Freezing temperatures prior to kernel black layer formation can prematurely kill the plant, which slows drydown, reduces grain quality, and reduces final yield potential.

Blister stage (R2). Occurs approximately 10 to 14 days after silking, the kernel is white and blister-shaped (Figure 3).

Milk stage (R3). Occurs 18 to 22 days after silking. The kernel is yellow with a white milky inner liquid. At this stage dry matter accumulation is very rapid. Silks on the corn ear are brown and dry. Moisture content is around 80%.

Dough stage (R4). Occurs approximately 24 to 28 days after silking. The inner fluid begins to thicken due to starch accumulation. The kernels will have accumulated half of their total dry weight. Kernel moisture content is around 70%. Unfilled or chaffy kernels can result if some form of stress reduces nutrient and water flow to kernels.

Dent stage (R5). Occurs approximately 35 to 42 days after silking or 2190 to 2450 GDUs for a 2700 GDU product. The kernels begin to dry down from the top of the kernel towards the cob, which now has a distinct white, pink, or red coloration (Figure 4). Each kernel will have a dent at the top. If frost occurs during this stage, the black layer can form prematurely, preventing additional dry matter accumulation. Kernel moisture content is around 55%.

R6 Stage (Maturity). The kernels continue to gain weight until black layer formation, which occurs approximately 55 to 65 days after silking or around 2700 GDUs (Figure 5). The black layer forms where the kernel attaches to the cob. Kernel moisture is approximately 30 to 35%.

Sources:

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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. ALWAYS READ AND FOLLOW PESTICIDE LABEL DIRECTIONS. Channel® and the Arrow Design® and Seedsmanship At Work® are registered trademarks of Channel Bio, LLC. All other trademarks are the property of their respective owners. ©2015 Monsanto Company: 1405293060410 050315DLB