Growing Degree Days (GDDs)

Introduction
Development of many crops, weeds, and insect pests is temperature dependent. The onset of important stages, such as crop maturity and insect pest emergence, can be predicted by tracking the accumulation of heat over time. Growing degree days (GDDs) are a measure of heat units accumulated during a day or over multiple days in a growing season (Figure 1). Because temperature varies from day to day and year to year, cumulative GDDs are more useful for forecasting crop and pest development than calendar days or dates. Monitoring GDDs is useful for timing specific crop management decisions such as nutrient and pesticide applications, as well as cultivation for weed control. This fact sheet will discuss how to calculate GDDs and use this information for management decisions for common field crops.

Base temperature threshold is the temperature below which no significant plant or insect development occurs. This varies among species of plants and insects. For example, the base temperature is 50°F for corn and 32°F for wheat. For cabbage and onion maggot, the base temperature is 40°F versus 39°F for seed corn maggot.

For many crops and pests, no upper limit is applied. However, development of some species stops or slows significantly above certain temperatures. For example, 86°F is the maximum temperature threshold for corn because heat beyond 86°F does not contribute to additional corn growth or development.

If the average daily temperature is below the base temperature, no heat units are accumulated (GDD=0). If the maximum daily temperature is above the maximum temperature threshold for the species, the daily maximum temperature is set at the maximum temperature threshold. Two examples for corn are shown in Box 2 and 3.

\[
\frac{44°F + 74°F}{2} - 50°F = 59 - 50 = 9 \text{ GDDs}
\]

Box 2: If the daily low is 44°F, the daily high is 74°F, the daily GDD accumulation for corn is 9.

\[
\frac{54°F + 86°F}{2} - 50°F = 70 - 50 = 20 \text{ GDDs}
\]

Box 3: If the daily low is 54°F and the daily high is 94°F, the daily GDD accumulation for corn is 20.

Cumulative Growing Degree Days
Growing degree day values for multiple, consecutive days can be summed to determine the cumulative GDDs for a growing season or a year. The starting date of the cumulative GDDs is commonly referred to as a ‘biofix’. The biofix varies by species. It may be the date that a crop is planted, a specific plant growth stage such as tasseling, or the emergence of a particular pest.

The Cornell Climate Smart Farming (CSF) program has developed a GDD calculator. A user can simply select a field location from a

---

**Figure 1:** Cumulative GDDs for March 15-October 12, 2020, from Cornell Northeast Regional Climate Center.

**Box 1:** Growing degree day calculation for a day is based on minimum and maximum daily temperature compared to a base temperature that is species-specific.

<table>
<thead>
<tr>
<th>Min temp + Max temp</th>
<th>base temp = daily GDDs</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \frac{1}{2} )</td>
<td></td>
</tr>
</tbody>
</table>

**Box 2:** If the daily low is 44°F, the daily high is 74°F, the daily GDD accumulation for corn is 9.

**Box 3:** If the daily low is 54°F and the daily high is 94°F, the daily GDD accumulation for corn is 20.
map, select the biofix, and choose a base temperature threshold from a dropdown menu. The calculator automatically displays the cumulative GDDs for the season to date and provides a season outlook as well (Figure 2).

![Cumulative Growing Degree Days](image)

**Figure 2:** Growing degree day accumulation using a biofix of May 1 (base 50°F, maximum 86°F). Adapted from the CSF Growing Degree Day Calculator.

**Use of Growing Degree Days in Agriculture**

*Cumulative GDDs* can be used to predict harvest dates for crops. For corn silage, whole plant dry matter (DM) content of 32% is reached at about 750-800 GDDs after tasseling/silking. If 35% DM is desired, harvest may be 4-7 days later. Crop development can vary from predictions based on GDDs when a crop has experienced atypical stressors, such as drought or excessively wet conditions. Thus, in-field confirmation of corn moisture content levels will remain necessary as cumulative GDDs is only an approximation.

**Insect, Weed, and Disease.**

Pest control measures are most effective when implemented at vulnerable developmental stages. Important physiological stages for insect control vary among species, and can include egg hatch, larva, nymph, pupa or adult stages. Stage onset can be predicted based on GDDs. For example, main egg hatch of the alfalfa weevil takes place about 280 GDDs (base 50°F) after adults are observed (consistently) in spring (biofix). For more information see the Degree Day Calculator from the Network for Weather and Environmental Applications (NEWA).

Knowledge about germination and early growth stages is important for effective weed control. For example, foxtail species have a large increase in seedling emergence around 400 GDDs with 50% seedling emergence between 380-420 GDDs (base 50°F, biofix January 1). Thus, pre-emergence herbicide application is most effective before 300 GDDs.

**Nutrient Management.**

Knowledge of cumulative GDDs can improve the accuracy of variable rate or sensor-based nitrogen side-dress applications. However, sensor-based approaches are more complicated and require the use of a nitrogen rich reference strip to guide nitrogen application decisions. Research is ongoing to refine these sensor-based technologies. For more information, see Agronomy Fact Sheet #89.

**Summary**

Growing degree days are typically more reliable than calendar days for weed, insect, disease and nutrient management decision making because weather can be highly variable among years. Accurate assessments of cumulative GDDs at important crop or pest life stages over time can aid in timely implementation of best management practices.

**Additional Resources**

- Nutrient Management Spear Program Fact Sheet Series: [nmsp.cals.cornell.edu/guidelines/factsheets.html](http://nmsp.cals.cornell.edu/guidelines/factsheets.html)

**Disclaimer**

This fact sheet reflects the current (and past) authors’ best effort to interpret a complex body of scientific research, and to translate this into practical management options. Following the guidance provided in this fact sheet does not assure compliance with any applicable law, rule, regulation or standard, or the achievement of discharge levels from agricultural land.