Calculating Growing Degree Days

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Are you calculating degree day accumulations and finding your values don't match the values being reported by MSU or your neighbor's electronic data collection unit? There is a logical reason! Three different methods are used to calculate degree days; i.e., 1) *Averaging Method*; 2) *Baskerville-Emin (BE) Method*; and 3) *Electronic Real-time Data Collection*. All methods attempt to calculate the heat accumulation above a minimum threshold temperature, often referred to the base temperature. Once both the daily maximum and minimum temperatures get above the minimum threshold temperature, (i.e., base temperature of 42degrees, 50degrees or whatever other base temperature of interest) then all methods are fairly comparable. However, differences do occur and these are accentuated in an exceptionally long period of cool spring temperatures, such as we experienced this year. Let me briefly explain:

1. *Averaging Method*: Easy to calculate
Degree Days(DD) = Average daily temp. - Base Temp. = (max. + min.) / 2 - Base temp.

If answer is negative, assume 0.

Example: Calculate DD Base 50 given 65 degrees max. and 40 degrees min.

Avg. = (65 + 40) / 2 = 52.5 degrees

DD base 50 = 52.5 - 50 = 2.5 degrees.

But look what happens given a maximum of 60 degrees and a minimum of 35 degrees:

Avg. = (60 + 35) / 2 = 47.5

DD base 50 = 47.5 - 50 = -2.5 = 0 degrees.

The maximum temperature was higher than the base of 50° , but no degree days were accumulated.

A grower called about the first of June reporting only about 40% of the DD_{50} that we have recorded. Why? He was using the averaging method. It will always underestimate early season accumulation, but never have I seen it this far off!!

2. *BE Method:* Fits a curve (more specifically a sine curve for the mathematicians in the crowd) to the maximum and minimum temperature to simulate how the temperature varies, then calculates the area of the curve above the base temperature using calculus. Easy for you math majors! This does a better job of simulating the heat accumulation above the base temperature than does the averaging method when the minimum daily temperature is below the base (or lower threshold) temperature. This BE method is used by MSU to calculate the degree days reported for the ag weather sites around the state. When the min daily temperature exceeds the base threshold temperature, then the averaging method and the BE give similar results. To calculate your own degree days without a computer, I suggest using the BE lookup chart during the early season, then switch to the averaging method when the season gets warmer. For those of you who want the real thing, here is a step by step calculationfor Baskerville-Emin method from Dr. Jeff Andresen at MSU

3. *Electronic Weather Data Collection* devices don't need to go through these arithmetic calculations. Instead, these devices record temperatures every few minutes. These can then be programmed to simply take the temp reading, subtract the base threshold and accumulate the readings for the day. Hence, these results will be the most accurate; however, keep in mind that virtually all of the research

equating pest and plant development to degree day accumulations has been done based on the BE method of accumulation. So what does the greater accuracy mean? Probably not much at this time. However, when one begins working with the degree <u>hour</u> accumulations (vs degree day accumulations) necessary for simulation models such as for fireblight, then maybe it will make a difference.

Well, is this clear or clear as mud? As my former (now retired) colleague Jim Myers often said, "You may still be confused, but at least now you're confused at a higher plane."

An additional article has been written that describes how GDDs fit insect and disease phenology, which is found below:

Degree Day Calculations

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Since insects are cold-blooded animals, temperature plays a major role in their growth and development. There is a threshold temperature for each insect; entomologists find this threshold in laboratory and field experiments. No development occurs when temperatures are below that level. Insects have an optimum temperature range in which they will grow rapidly. Then, there is maximum temperature (termed upper cutoff) above which development stops. These values can be used in predicting insect activity and appearance of disease symptoms during the growing season.

The threshold and maximum temperatures for development of an insect are used to calculate the number of degree days for a specific day. One degree day results when the average temperature for a day is one degree over the threshold temperature. With codling moth (50 degrees F threshold temperature), on a day when the average temperature was 51 degrees F, one degree day accumulated. These daily accumulations can be added over a period of time and used to predicting insect development. Accumulation of degree day totals usually begins in one of two ways. It is common to start keeping track of degree days for many pests on a calendar date (January 1, for many). While this is simple, there is the disadvantage of having to keep up with temperatures long before any insect development will occur. The second method, used for other pests, starts from a specific biological event called a biofix. Often, this is the date of the first sustained capture of adult insects in traps. Use of a biofix starting point means keeping up with degree days over a shorter period of time and often provides a more accurate prediction.

With integrated pest management (IPM), degree day accumulations are used to predict important events in the life of an insect. Examples include egg laying, egg hatch, scale crawler movement, or appearance of symptoms. These biological events are in turn used to schedule particular activities such as scouting and synchronizing insecticide sprays. The easiest way to calculate degree days for a specific date is to add the daily high and low temperature and divide by two. Then, subtract the threshold temperature for the particular insect. For example, if the min/max thermometer indicates a low of 45 degrees F and a high of 75 degrees F, then the average temperature for the day was (45+75)/2 = 60 degrees F. If the threshold temperature was 50 degrees F, then 10 degree days would have accumulated. Check your thermometer and make this calculation each day. Add the daily value to the total from all the previous days. You can keep up with the progress toward your target number. Minimum and maximum temperatures should be recorded from a Min/Max thermometer about the same time each day, preferably in the midmorning or late afternoon. PestNet (www.mifruit.com) is also a good way to help predict degree day accumulations as well as pest life stages.