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Calculating Degree Days

Richard O. Pope
Iowa State University, ropope@iastate.edu

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Abstract
Warm-blooded animals including humans generate their own internal heat and have regulatory systems to hold maintain body temperature in an operational range. These systems provide insulation from fluctuations of temperature in the environment and allow growth and development based on the passage of time in minutes, hours, weeks, months and years.

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By Rich Pope, Department of Entomology

Warm-blooded animals including humans generate their own internal heat and have regulatory systems to hold maintain body temperature in an operational range. These systems provide insulation from fluctuations of temperature in the environment and allow growth and development based on the passage of time in minutes, hours, weeks, months and years.

In contrast, most of the creatures we manage in agriculture don't have an internal heat regulatory system and depend on environmental temperatures to drive their development. For plants, disease organisms, insects and other “cold-blooded” creatures, development is dependent on the temperature around them. So if we understand the key temperatures needed for a given species, we often can monitor and predict development based on measuring how much heat each species accumulates from the environment, relative to its functioning temperature range.

Readers of the *Integrated Crop Management News* are likely familiar with the weekly crop development degree day-postings, and also with the insect-specific degree-day models, including those for black cutworm, stalk borer and bean leaf beetle.

Scientists have estimated a temperature that approximates the coldest temperature where effective development occurs for many species. That is the lowest cardinal temperature. For some species, there is also a high cardinal temperature, which is a point where growth and development are at their peaks. A list below shows some of the cardinal temperatures frequently used in Iowa crop management.

Regardless of the base (lower cardinal temperature), the process to calculate degree days is similar. To model crop or pest growth, we estimate the accumulation of heat on a daily basis. We look at each day as a provider of heat that leads to development. Let's go through this process step by step for a given day and degree-day base, as follows:

- collect the daily high and low temperatures for a site, or average highs and lows across a region that occur that day.
- average the high and low temperatures to estimate the average heat gained for that day, with the following adjustments:
    - temperatures below the base temperature contribute nothing to development; therefore, whenever the actual low temperature is lower than the base you should artificially reset the low to the base temperature, to estimate the heat received more closely. Adjust the high temperature the same way, if actual highs are greater than the maximum cardinal temperatures.
- subtract the averaged temperature from the base temperature and, voila!, you have the accumulated degree days for that organism on that date.
- calculate the heat-units gained for subsequent days and add them to estimate the accumulated degree days over a time period.

Here is an example. Let's calculate how many base 50 degrees F degree days (for example for black cutworm development) accumulated on two days in May for a farm somewhere in Iowa.

Day	Low	High
May 4	38	69
May 5	55	75

May 4
First, adjust the low temperature to the base (50 degrees F) because no development occurs below 50 degrees F. That means we average the high (69) and the adjusted low (50), which comes out to 59.5. Subtract the base, 50 degrees F, and that means there are 9.5 degree days for May 4. (if the average is below the base, do not subtract, rather

you simply gain 0 degree days that day.)

May 5
Repeat the process for May 5. However, because the low is above 50, the low temperature needs no adjustment. As with May 4, we average the high (75 degrees F) and the adjusted low (55), which comes out to 65. Subtract the base, 50, and that means there are 15 degree days for May 5. The two-day accumulation is 9.5 plus 15, or 24.5 base-50 degree days.

Although there are some assumptions involved in making development models based on degree-days, the information allows pest management efforts to be well timed and effective.

Minimum and maximum cardinal temperatures in crop and pest management and use of information.

Crop or pest	**minimum**	**maximum**	**information use**
Corn	**50°F**	**86°F**	**crop development**
Soybean	50°F	86-90°F	crop development
Black cutworm	50°F	--	300 DD from egg to cutting
Stalk borer	41°F	--	predicting migration
Bean leaf beetle	46°F	--	2nd generation emergence
Seedcorn maggot	39°F	--	seed treatment on replant
Alfalfa weevil	48°F	--	larval presence in fields
Western bean cutworm	50°F	--	adult emergence/ egglaying

Rich Pope is an Extension program specialist working in the Corn and Soybean Initiative

Category: Crop Production

Crops:
Corn

Soybean

Tags: Weather growing degree day