Calculation of Baskerville-Emin ("BE") Growing Degree Days

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Noticeably absent in the previous discussion of the calculation and use of different growing degree days (GDD's) was an example of Baskerville-Emin ("BE") GDD calculation which is the degree day chosen for use in the *CAT Alert*. Computation of BE degree days requires a calculator with trigonometric functions and some patience. I have chosen a new example this year which is a little more involved numerically than last year's.

If all else goes wrong, you can still obtain a free copy of growing degree day software from the Ag. Weather Office (517-355-0231) that will calculate degree days with up to three different methods (including BE) on a desktop computer. Finally, a special note of recognition to readers who discovered typos and missing parentheses in last year's example!

Given Max. Temperature = 60F
Min. Temperature = 34F
Base Temperature = 50F

Step 1) Adjust data for observation time. If you have a station with an AM observation time, set the maximum temperatures back one day to the day the maximum most likely occurred. For example, if you recorded a high of 60 degrees taking data Wednesday morning, then the high of 60 most likely occurred on Tuesday (afternoon) and should be set back to Tuesday. Stations with PM observation times need not set back maxima.

Step 2) Determine if maximum temperature is less than the base temperature. If so, GDD total for the day = 0. If not, proceed to the next step.

Step 3) Calculate the mean temperature for the day. In the example, this is (60F + 34F)/2 = 47F.

Step 4) Determine whether the minimum temperature is greater or equal to the base temperature. If so, then

GDD = Average Temperature - Base Temperature.
(This is the same as for the Average Method.)

If not, as is the case in our example, proceed to the next step.

Step 5) Calculate GDD, Defining:

TAVE = Average Temperature (already calculated in our example at 47F).
BASE = Base Temperature (50F).

Then calculate the following:

W = (Max. Temperature - Min. Temperature) / 2.
= (60F - 34F) / 2.
= 13

A = Arcsin ((BASE - TAVE) / W)

You can obtain this on most calculators by pressing either the "ARCSIN" button or by pressing "INV" and "SIN" buttons in succession. In using this function, the argument must be between +1.0 and -1.0. For arguments greater than 1.0, set equal to 1.0, and for arguments less than -1.0, set equal to -1.0. Next, make sure your calculator is calculating in radians and take the ARCSIN (if your calculator does not have radian capability, divide by 57.30, the number of degrees per radian). Then;

A = Arcsin ((50F - 47F) / 13.)

= Arcsin (3.0 / 13.)

= 0.23

Then,

GDD =((W * Cos(A)) - ((BASE-TAVE) * ((3.14/2.)-A)))/3.14

Since Cos(.23 radians) = .97), we substitute all our variable arguments and obtain

= ((13.* 0.97) -((50F - 47F) * ((3.14/2)-0.23)))/3.14

= (12.61 - (3.0 * (1.57 - 0.23)))/3.14
(compute within parentheses first)

= (12.61 - (3.0 * 1.34))/3.14

= 8.59 / 3.14

= 2.75, which rounds up to 3 GDDs for the day.

This result compares to 0 GDDs computed with the Average Method and 5 GDDs computed with the Modified Average Method. As was mentioned in last week's *Alert*, The BE degree days are superior to those calculated with the other methods when the minimum temperature is below the base temperature. This is most apt to occur in the spring or fall. Otherwise, the degree days are calculated in an identical manner to those in the simple Average Method.