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Growing Degree Days (GDD)

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South Dakota State University, Brookings
U. S. Department of Agriculture

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A New CORN Maturity Rating

Growing Degree Days (GDD)

By **Lyle A. Derscheid,** Extension agronomist, and **William F. Lytle,** associate professor of agricultural engineering and climatology, Agricultural Experiment Station.

There is a new way of rating the maturity of corn. It is more accurate than the old "days-of-maturity" ratings. It will help you estimate which hybrids will use all of your growing season and yet produce mature corn.

This new method is called "Growing-Degree-Days" (GDD) or "Heat Units" because it is based on the number of growing degree days between planting time and physiologic maturity (or first killing frost). Most seed corn companies are now using this rating. This publication will help you determine which hybrids are of the right maturity for you.

Two new terms are being used: Growing Degree Days (or heat units), and the *black layer* on the tip of the kernel to denote when the seed is mature. It is not necessary for you to understand either term. You can simply use the map, or the table or both to determine the number of growing degrees for your area.

Use Map or Table

Since most corn in South Dakota is planted after May 3 and is physiologically mature by October 3, the map was developed to give a rough estimate of the number of growing degree days for the 5-month period in all areas of the state. If you plant in early May and hope to have mature corn by early October, all you need to do is select a hybrid with a lower growing degree day rating than shown for your area on the map.

For example, if you live in Minnehaha County, you probably plant corn early in May and plan to have it mature by early October. The map shows that you usually have 2,600 to 2,700 growing degree days between May 3 and October 3. So you select a hybrid with a maturity rating of 2,600 or less. By selecting a hybrid that requires fewer GDD, you have a safety factor for years when you get an early frost.

Different Planting Dates

You can use the table to estimate the growing degree days for a different season. You may not plant corn as early as May 3 or you may not ordinarily have the first killing frost until after October 3. It is not necessary to have corn mature before the first killing frost.

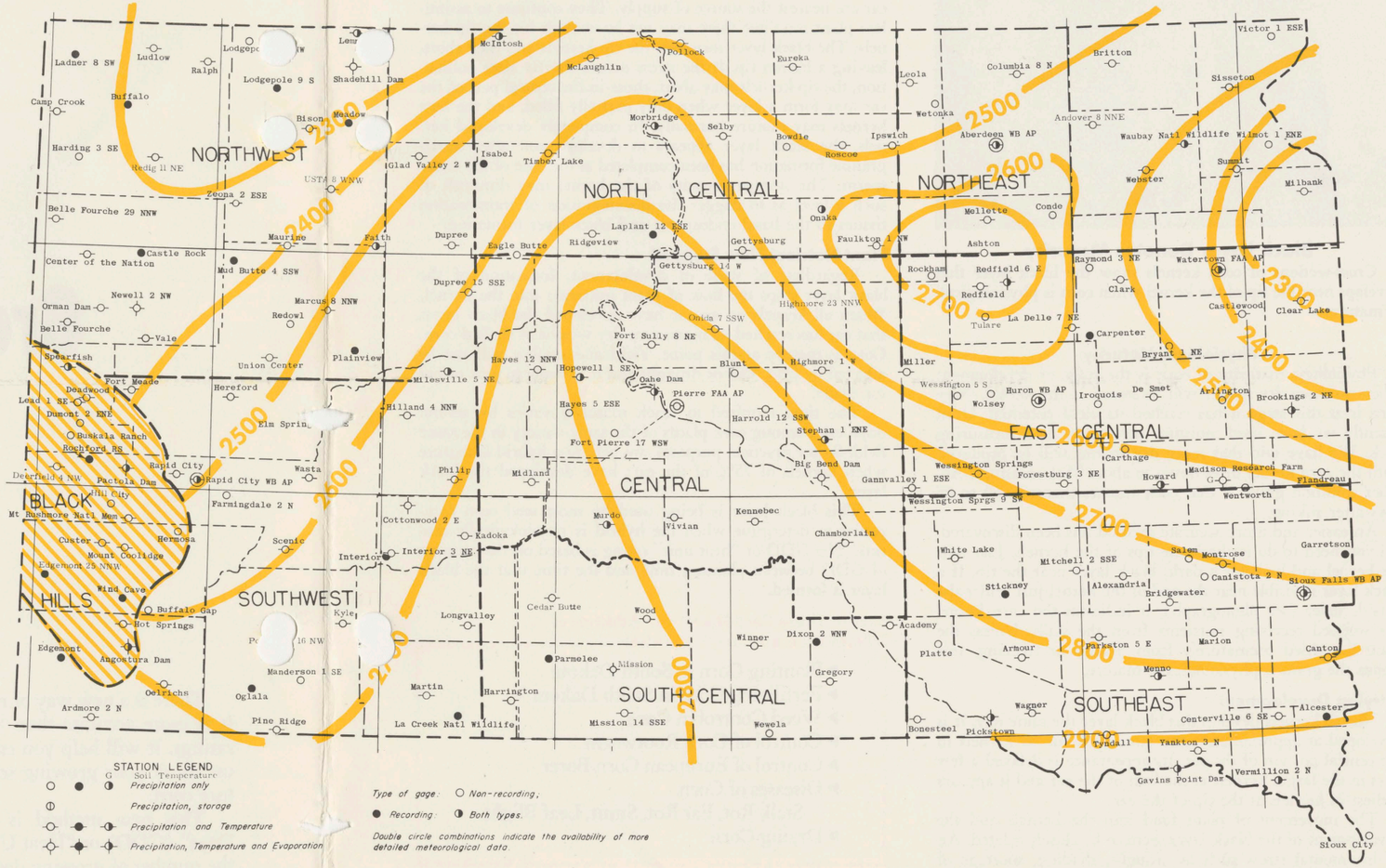
For example, you live in Minnehaha County and used the map to help you decide on a corn with a GDD rating of 2,600. But your corn was hailed out in late May. You plan to replant on May 27. You can look in the table at columns for May 23 and May 30 for Sioux Falls and see that you can expect to have between 2,421 and 2,511 growing degree days before

Average date of first killing frost and average adjusted Growing Degree Days—base temperature 50° F. for period May 3 to first killing frost.

	Growing degree days from this date to first killing frost*						Date of first killing frost*
	May 2	May 9	May 16	May 23	May 30	June 6	
Aberdeen	2523	2470	2402	2325	2240	2145	Oct. 1
Academy	2859	2798	2726	2638	2548	2450	Oct. 9
Ardmore	2913	2791	2715	2625	2531	2424	Oct. 9
Brookings	2416	2360	2298	2223	2141	2052	Sept 30
Camp Cook	2175	2124	2062	1990	1912	1834	Sept. 24
Centerville	2877	2811	2737	2651	2554	2445	Oct. 9
Cottonwood	2625	2564	2491	2410	2321	2227	Oct. 2
Dupree	2570	2515	2449	2371	2284	2196	Oct. 3
Eureka	2312	2261	2197	2125	2045	1962	Oct. 1
Highmore	2564	2509	2446	2369	2287	2200	Oct. 2
Hot Springs	1461	1438	1408	1371	1327	1279	Oct. 4
Huron	2621	2563	2496	2420	2337	2245	Oct. 7
Lemmon	2280	2237	2180	2114	2040	1965	Oct. 3
Lead	1902	1874	1840	1794	1739	1682	Oct. 2
Long Valley	2771	2713	2641	2561	2472	2381	Oct. 8
Mitchell	2834	2769	2697	2612	2520	2416	Oct. 9
Mobridge	2608	2555	2486	2409	2322	2229	Oct. 3
Newell	2400	2352	2295	2230	2154	2077	Oct. 4
Pierre	2955	2893	2821	2739	2646	2541	Oct. 15
Pine Ridge	2575	2514	2442	2360	2272	2178	Sept. 27
Pollock	2323	2266	2199	2124	2040	1953	Sept. 24
Rapid City	2505	2461	2407	2345	2276	2203	Oct. 13
Redfield	2812	2747	2673	2585	2489	2380	Oct. 4
Redig	2177	2131	2074	2007	1930	1854	Sept. 24
Sioux Falls	2721	2659	2591	2511	2421	2318	Oct. 9
Sisseton	2562	2508	2441	2365	2281	2187	Oct. 10
Tyndall	2954	2888	2815	2729	2630	2521	Oct. 11
Vermillion	3034	2963	2886	2792	2689	2572	Oct. 18
Watertown	2297	2250	2193	2125	2048	1965	Oct. 3
Wood	2811	2744	2679	2588	2494	2399	Oct. 4

*Date when temperature drops to 28° F. half of the time.

Adjusted Growing Degree Days in South Dakota—base temperature of 50° F. for period May 3 to October 3.



you expect to have a killing frost on October 9 (last column of the table). So you select a hybrid with a GDD rating of around 2,400.

Or, you live in Codington County where you may not plan to plant corn until around the middle of May. You ignore the map which shows that you can expect to have between 2,300 and 2,400 GDD, and use the column for May 16 in the table. It shows 2,193 GDD for Watertown so you pick a hybrid with a rating of 2,200 or less.

By using these examples as a guide, you can determine the GDD for your area from the map or table. If you wish to know more about the GDD concept, however, a more detailed discussion of growing degree days and physiologic maturity follows.

Growing Degree Days

A "Growing Degree Day" is not the same as a calendar "day" of 24 hours. The term "Growing Degree Day" or GDD is used to designate calculations based on temperature factors or "heat units." The sum of these "heat units" for each calendar day of the growing season provides a figure—ranging from 2,300 to 2,900 in South Dakota—that may better pin down the maturity period or rating of corn.

Growing degree days are calculated by subtracting a base temperature from the average of the maximum and minimum temperatures for the day. Corn doesn't grow much at temperatures of 50° to 55° (F). As temperature rises to a range of 80° to 86°, corn grows faster if moisture is plentiful. But at a temperature above 86° the roots have increasing difficulty taking in water fast enough to keep the plant cells turgid (full of water) and working at top speed.

Consequently only temperature extremes of 50° and 86° are used in calculating GDD. The mathematical expression for calculating GDD is:

$$\text{GDD} = \frac{\text{Max Temp.} + \text{Min. Temp.}}{2} - \text{Base Temp.}$$

The maximum temperature is the highest temperature for that day and the minimum temperature is the lowest for the day. The base temperature (below which there's very little corn growth) is 50°. The formula is adjusted to correct for extreme high or low temperatures. Minimum temperatures below 50° are counted as 50° and temperatures above 86° are counted as 86°.

For example, if the maximum temperature for the day is 84° and the minimum is 60° so:

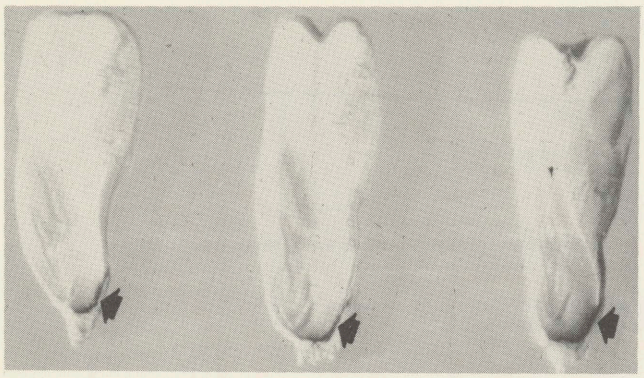
$$\text{GDD} = \frac{84 + 60}{2} - 50$$
$$= 72 - 50$$
$$= 22$$

Then 22 growing degree days occurred on that day. Or, another day the high temperature is 90° and the low is 40°, so:

$$\text{GDD} = \frac{86 \text{ (for } 90°) + 50 \text{ (for } 40°)}{2} - 50$$
$$= 68 - 50$$
$$= 18$$

Then 18 growing degree days occurred that day.

This method is used because temperature is one of the most important environmental factors affecting the rate of plant development. Is is recognized that growth is also affected by several other environmental factors such as moisture, nutrients, length of time temperature is above 50°, and photoperiod. Perhaps some of these environmental factors can eventually be used in a formula to help estimate maturity ratings, but "Growing Degree Days" seems to be the best rating developed to date.



Black Layer Denotes Maturity

Cross-sections of corn kernels show the black layer that develops near the tip of the kernel when corn is physiologically mature.

Physiologic Maturity

Physiologic maturity of corn is the stage of development when no more dry matter will be stored in the kernel. Once corn is at this stage it has reached its yield potential. Until recently we have used moisture percentage as a measuring stick. We have said that more dry matter will be produced until the corn kernel dries down to about 35% moisture. Another common guide is that corn reaches maturity 60 to 65 days after silking.

An easier and more accurate method has been discovered. All you need to do is check the tips of the kernels. Just split the kernel and look for a dark, black layer near the tip. If a black layer is visible near the end of the kernel just under the outside layer (see photograph), it indicates the corn kernel has stopped receiving nutrients from the stalk. Unless the plant has dried prematurely from disease or freezing, this means the grain is physiologically mature.

Varying Development

Not all kernels develop this black layer the same day. It is developed at approximately the same time for all kernels in the central portion of the ear. Its appearance is delayed a few days in the larger kernels at the butt of the ear and it appears earliest in kernels at the tip of the ear.

The movement of plant food into the kernels and the development of the black layer seem to be closely related. An environmental stress such as drought, shading, shortage of nutrients, or intense heat causes a reduction in the supply of plant food being moved to the ear. Kernels on the butt of the ear are nearest the source of supply. They continue to assimilate plant food but there may not be enough for the tip kernels. The black layer forms on the tip kernels and they abort, leaving a barren tip. If the stress occurs shortly after pollination, the tip kernels may abort, those in the central part of the ear may form a layer when only partially filled, and the butt kernels may mature normally. In completely developed kernels, the black layer appears to develop soon after starch granule formation has been completed at the base of the endosperm. The storage capacity of the kernel may diminish to such a level as to trigger the disintegration of translocation tissues in the basal endosperm and black-layer formation.

Plant Nutrient Flow Stopped

Regardless of stage of development, formation of the black layer stops the flow of plant nutrients into the kernel. When all kernels on an ear have developed the black layer, that ear has reached its maximum dry weight of shelled corn. Corn is mature at this point. Yield and quality will not be affected by frost, hail or drought and it is ready to pick or cut for silage.

The time required to reach maturity varies by several days, even among corn plants of the same variety in the same field. So for practical purposes, we believe a hybrid is mature when kernels of 75% of the ears have developed the black layer.

This black layer is being used by most seed corn companies to determine when the hybrid is physiologically mature. The GDD or "heat unit" rating is based on the number of GDD between planting time and the time that the black layer is formed.

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- ▶ Control of European Corn Borer
- ▶ Diseases of Corn
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- ▶ Drying Corn

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