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Taifun Soy Info

Taifun Zentrum für Sojaanbau

Specialist information for soy producers and processors

Crop-Heat-Units for soybeans

Soybeans varieties can be divided into different maturity groups. This categorization should make it easier for farmers to find the right variety for their location. The CHU system was developed for maize over 30 years ago and now also maps the maturity groups for soybeans in the USA and Canada. Similar to degree-days, which are often used in Germany, the so-called Crop Heat Units are calculated for each region during the frost-free vegetation period and are indicated for the corresponding varieties.

Calculation of the CHU (Brown, 1993)

The development rate of plants is mainly influenced by temperature. Cool temperatures slow down growth and warm temperatures can accelerate it. Other environmental factors such as photoperiod, soil fertility and water availability also have an influence. The air temperature is usually measured as the daily minimum and maximum.

With these values the daily CHUs can be calculated. For the daily CHUs, 10 °C is assumed as the base temperature and 30 °C as the optimum, since thermophilic crops do not develop below 10 °C and growth is fastest at 30 °C (if there is enough water). For the night temperatures, 4.4 °C is used as the base temperature with no optimum value. The daily CHUs can be calculated by taking the average of the results of the formulas for maximum (day) and minimum (night) temperatures:

$$CHUmin = 9/5\ (Tmin - 4.4)$$

$$CHUmax = 3.33\ (Tmax - 10.0) - 0.084\ (Tmax - 10.0)^2$$

For North America there are also tables from which the values can be read directly.

Geographical Representation

The accumulated CHUs are often also shown graphically for North America (e.g. Ontario in Canada, Fig. 1). These figures show the average CHU from the earliest sowing date to a "normal" harvest. For the calculation, the daily averages of day and night temperatures for each year from 1961-1990 are added together.

Figure 1: Representation of CHUs for Ontario for the years 1971-2000 with sowing date on May 1. Ontario Ministry of Agriculture, Food and Rural Affairs, 2016.

In comparison, there are also representations of the growing degree days as in Fig. 2.

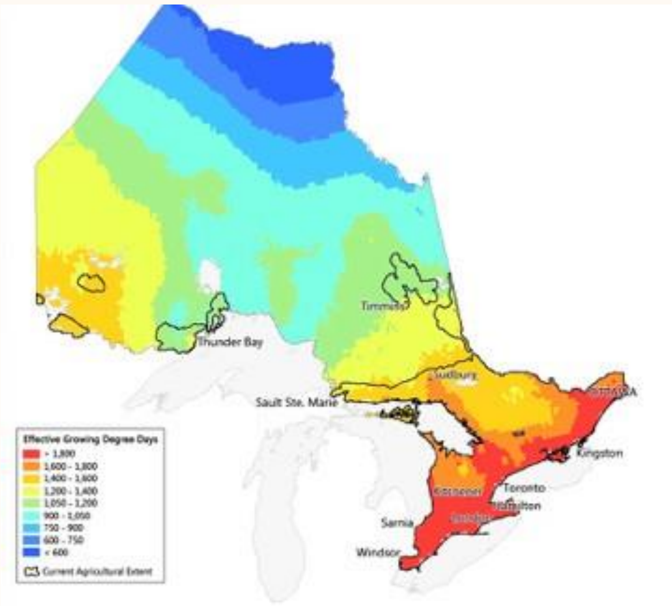

Figure 2: Representation of growing degree days in Ontario from 1971-2000, Agriculture and Agri-Food Canada, 2014.

Calculation of the Growing Degree Days (GDD)

In Germany, agricultural meteorology often calculates growing degree days in order to compare different locations, plan fertiliser or pesticide application, estimate heat stress or predict certain phenological events such as flowering or ripening. The basis for this is the assumption that development without extreme events (such as drought or disease) occurs gradually depending on the ambient temperature and only begins at a certain base temperature. This base temperature was determined experimentally and varies for different crops (Table 1).

Table 1: Base temperature for calculating the GDD for some crops

Crop	Base temperature
Wheat, barley, rye, oats	5 °C
sunflower, potato	8 °C
Soybean, corn, rice	10 °C

To calculate the GDD, the daily average temperature is required. This is calculated by adding the daily minimum and maximum temperatures and dividing the result by two. The average temperature is then corrected by the base temperature (Tz), which is subtracted (see below). The Growing Degree Days calculated in this way are summed up from the beginning of vegetation. Any temperature that falls below the base temperature is changed to the base temperature before calculating the average. Frequently, temperatures are also capped at 30°C, as most plants do not grow faster at higher temperatures.

$$GDD = (T_{min} + T_{max})/2 - T_z$$

A graphical representation of GDD for Ontario, Canada, is shown in Figure 2.

The North Dakota Agricultural Weather Network offers an online tool that can be used to generate a growth curve for a specific maturity group and sowing date based on the GDD. This can, for example, be used to predict maturity: https://ndawn.ndsu.nodak.edu/soybean-growing-degree-days.html

Classification of maturity groups

In the USA, soy varieties are divided into 13 maturity groups, from 000 to X. These main groups are in turn divided into 10 relative maturity groups. Thus, for example, a soybean variety with the maturity specification 1.4 is divided into the 4th subgroup of maturity group I. In order to be able to apply this classification directly in practice, there is a simple mnemonic in the USA: Each subdivision of the maturity group stands for a specific day in September when this soybean variety ripens at 42 degrees north latitude. Thus, a variety of relative maturity 1.4 should be ripe on September 14 in a normal year; a variety of relative maturity 2.1 would not reach the R7 stage until September 21, etc. (iGrow, 2015).

The CHU totals for each maturity group are given in Table 1. A comparison of the FAO figures for maize and soybean maturity groups is shown in Table 2.

Table 2: CHU groups and maturity classification in North America (gosoy.ca)

Ontario CHU	US Maturity Group
<2400	000
2400-2550	00
2550-2800	0
2800-3000	I
3000-3300	II
>3300	III

Table 3: Comparison of maturity groups with FAO figures in maize and CHUs (Berschneider, 2016).

MG in the USA	Comparison with FAO figure in maize cultivation	CHU
000.0	210 – 230	2075
000.5	240 – 250	2200
00.5	260 – 300	2425
0.5	> 300	2675
1.5	> 350	2925

In Europe, varieties are also divided into maturity groups from 000 (e.g. Merlin, Sultana) to II (e.g. Ecudor, Santana). The European ripening groups usually correspond to one ripening group earlier than the groups used in North America. For example, the variety Primus is classified as 00. However, in its country of origin, Canada, it is classified in maturity group 0. This "shift" by one ripening group is probably due to the more continental climate in the Canadian soybean regions.

Within the framework of a master's thesis at the University of Hohenheim, an attempt was made to classification in America and Europe, since even within Europe there is no uniform classification system (Berschneider, 2016).

In Austria, for example, in addition to the maturity groups, there are also the fine gradation levels 1 (very early) to 9 (very late). The levels 1 – 4 are associated to the maturity groups 0000 and 000, grades 5 - 7 to maturity group 00 and grade 8 to maturity group 0. The above-mentioned variety Primus would be in maturity group 00 with level 5. In the same maturity group, there is also the variety ES Mentor, which has the level 7. Among the very early ripening varieties (0000), the variety Tiguan is given level 1 and is therefore the earliest among the very early ripening varieties. The variety SY Livius, for example, with level 4 would be one of the rather late varieties in this maturity group.

Thus, varieties that are classified in a specific maturity group in one country do not necessarily remain in the same maturity group in other countries. Within the above mentioned master thesis, a table was created in which the different maturity group systems in Europe are summarized and the difficulty of comparability becomes clear.

Therefore, even in intra-European comparisons, it is always advisable to compare the variety with a known reference variety whose maturity can be easily assessed. Because of these inconsistent groupings, it can often help to look at the CHUs and compare them with known varieties, if they are indicated.

Suitability of soybean cultivation in Germany

A current study by Roßberg and Recknagel (2017) calculates the suitability for soybean cultivation in Germany based on various influencing factors such as temperature, precipitation, soil quality and global radiation. Since global radiation has an influence especially during the generative development of soybeans, it was included in the model. The CHU-total, as calculated above, is modified with the global radiation in order to obtain a better mapping. In the period from 1st of June to 30th of September, the mean values of the global radiation were added up and the values were then divided into 7 classes. For each of the classes a surcharge or reduction on the CHU total is calculated. In combination with the other factors a map with 1 km x 1 km grid size was created.

The map shows the suitability of each cell for soybean cultivation in Germany. Here, an interactive map can be found to check the exact suitability of each location for soybean cultivation.

Sources

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For comprehensive information on all aspects of soy cultivation visit:

www.sojafoerderring.de

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