EXTENSION

Utilizing Heat Units in Oklahoma Cotton Production

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Heat units are commonly used in cotton to monitor crop development, predict the onset of squaring or blooming and make decisions regarding crop inputs or crop protection products. For cotton, heat units are determined by using a base temperature of 60 F and are often referred to as degree day 60 or DD60s (Kerby et al., 1987; Oosterhuis, 1990). The amount of DD60s a crop accumulates in a day is determined by the following formula:

$$\text{Daily Accumulated DD60s} = \frac{(\text{Maximum Daily Temp} + \text{Minimum Daily Temp}) - 60}{2}$$

Recent work from across the Cotton Belt hints there may need some adjustments made to the traditional formula, but as of now this method is widely used to gauge growing conditions and estimate plant progress. Table 1 taken from Oosterhuis et al. (1990) and modified by the National Cotton Council, shows the average range of heat units required, and the typical range of days needed to accumulate them, to reach certain growth stage milestones during the season in a mid-south environment.

Often, heat unit accumulation can be reflective of growing conditions. For example, comparing a given season's heat unit accumulation to the long-term average will provide insight as to how far ahead or behind the current season is trending compared to historical pattern. Heat units also can be utilized to determine a favorable schedule depending on growing environment. While season length or seasonal heat unit accumulation isn't a concern in many areas of the U.S. Cotton Belt, there are many areas in Oklahoma that are considered short-season environments. In these areas, producers can utilize historical heat unit accumulation, available through the Oklahoma Mesonet, to map out ideal planting windows based on when they would like the crop to begin blooming, and working backwards to determine a range of planting dates to accomplish this. Information on heat units for the current season is easily accessed through the Agriculture tab on the Mesonet site, and long-range historical heat unit information can be accessed through the raw weather data in the Past Data tab. While historical heat unit pattern shouldn't be the only consideration when determining production practices, it can provide an idea of the production environment. It also gives an idea of how long, on average, the effective blooming window is and a realistic time frame for reaching certain growth stages.

While heat units can be used to provide a general idea of growing conditions and can help us develop a desirable production schedule, there are some shortcomings to utilizing heat units solely, particularly for Oklahoma. This information was originally developed in the mid-south and doesn't replicate the growing conditions experienced in the majority of Oklahoma. It is also important to note that factors, such as water or heat stress, will delay the onset of these growth stages regardless of the amount of heat units accumulated. Variety maturity characteristics also will affect when certain growth stages are reached. Early maturity varieties may reach first square or first white flower before late-maturing varieties. Many of the varieties planted in areas of Oklahoma are earlier maturing than varieties commonly planted when this DD60 data was first generated, so in some instances cotton could be ahead of this schedule. The amount of sunlight the crop receives also will impact growth and development, and this not reflected in heat unit accumulation. For instance, it is likely cotton will benefit more from a day with highs in the mid to upper 80's and full sun than a cloudy day with highs in the low to mid 90's, due to increased light interception. Multiple cloudy days will slow growth and even lead to fruit shed if a plant has a high boll load. It is unable to provide resources for all developing fruit with the low light conditions of cloudy days.

Table 1. Average range of days and heat units needed to reach various cotton growth stages; values generated from research conducted in the mid-south.

Growth Stage	*Days*	*Heat Units – DD60s*
Planting to Emergence	4 to 9	50 to 60
Emergence to First Square	27 to 38	425 to 475
Square to Flower	20 to 25	300 to 350
Planting to First Flower	60 to 70	775 to 850
Flower to Open Boll	45 to 65	850 to 950
Planting to Harvest Ready	130 to 160	2,200 to 2,600

Source: Oosterhuis et al., 1990; National Cotton Council

Other Uses for Heat Units in Cotton

Heat units in cotton can be used in a variety of ways beyond just mapping out growth stages and categorizing growing conditions. Heat units are utilized when making decisions on insecticide applications to control tarnished plant bugs (*Lygus lineolaris*), bollworm (*Helicoverpa armigera*), stinkbugs (*Halyomorpha halys; Nezara viridula; Chinavia hilaris*) and fall armyworms (*Spodoptera frugiperda*). Recent research found that once cotton has reached cutout (node above white flower = five) and 250 DD60s to 350 DD60s has accumulated, the probability of economic damage from tarnished plant bugs (250 DD60s) and cotton bollworm (350 DD60s) is low. Insecticide termination for stink bug and fall armyworm is at cutout plus 450 and 500 DD60s to 550 DD60s, respectively (University of Arkansas Cooperative Extension Service, 2021).

Heat units also have been utilized to time harvest aid applications. Studies conducted in the early 2000's found harvest aid applications could be scheduled based off the amount of heat units accumulated after the plants had reached physiological cutout, or five main stem nodes between the uppermost first position white flower and the terminal (Bynum and Cothren, 2008; Siebert and Stewart, 2006). For a more detailed explanation of cutout, refer to fact sheet PSS-2181 Defining Cutout in Cotton. However, this method is not widely utilized to schedule harvest aid applications because of the wide variability in the amount of heat units needed to optimize yield and fiber quality across different production environments.

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