UNIVERSITY OF CALIFORNIA COOPERATIVE EXTENSION

COTTON GUIDELINES

HEAT UNIT AVERAGES AND TIME TO MATURE BOLLS

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Research in CA and elsewhere has established some good relationships between heat units or degree days and developmental stages of cotton. Long-term observations of Acala varieties and shorter-term measurements on CA Upland and Pima varieties have yielded some generalized relationships between heat units (or average number of days) and attainment of specific developmental stages (Table 1). Values in this table can be compared with accumulated heat units to see if your crop is progressing much faster or slower than "typical". In general, Upland varieties managed for relative earliness will reach these growth stages at the lower end of each range of time or heat units. To reach the same growth stages, longer-season Pima cotton varieties will generally require closer to the upper range of days or heat units shown, or for the most indeterminate varieties, as much as 10 percent more.

The values shown in Table 1 can only be considered guidelines, since the number of heat units required to take a fruiting site from flower to open boll can be influenced by position on the plant, timing and intensity of any environmental stresses such as water or nutrient or high temperature stress, relative boll load, and type of cotton and corresponding boll characteristics (size, carpel wall thickness). In addition, prevailing conditions during flower and fruit development (such as temperature extremes that greatly increase heat unit totals, but that are not necessarily beneficial to total plant or boll retention and development can also impact the relationship between degree days and crop developmental stage.

Table 1. Approximate number of days and heat units (degree days 60F) from emergence to specific phenological (growth) stages in San Joaquin Valley cotton.

	Range in Number of Days To Reach Each Growth Stage			Heat Units (60F)
Growth Period	**Lower**	**Upper**	**Average**	**Heat Units**
Emerge to 1st square	35	55	45	425-500
Emerge to 1st bloom	60	82	68	750-900
Emerge to peak bloom	82	95	88	1350-1500
Emerge to 1st Open Boll	120	145	130	1650-1850
Emerge to 60% Open Boll	155	185	165	2200-2350

Some of the cotton varieties now available in the SJV have been described as “early-maturing” or “short-season”. Experience to date has indicated that while there are some differences in the duration of fruiting and even the number of heat units required to mature a boll from a flower, we have seen few varieties which consistently are earlier to first square or first bloom. What has been apparent is that varieties can differ in the duration of effective bloom, the rate of development and relative importance of 2nd and 3rd position bolls, and to a limited degree, in the number of heat units required to mature (open) a boll from a flower.

Differences seen have been associated with both varietal characteristics and sensitivity to some management factors. For example, during the 1998 and 1999 growing seasons, with cool springs and early summer, some grower practices (including delayed irrigations, more aggressive growth regulator use and timing) impacted crop “earliness”, particularly the timing of first open boll and readiness for harvest. Many of these management practices or varietal characteristics that can produce earliness can reduce, rather than improve yield potential if a long growing season and good fall conditions prevail. However, a season like 1998 demonstrated that with late plantings, these factors producing “earliness” can be very important in allowing a timely harvest of good-quality cotton.

There is evidence of some differences across varieties in the degree days associated with bringing a fruiting site from an open bloom to a mature (open) boll. Harvest aid chemicals can alter the time required to open bolls by as much as several days, but generally do not dramatically influence the timing, since certain physiological practices must occur to mature out fibers and open bolls.

Table 2. Examples of differences in degree-days (base 60F) required to go from open flower to mature, open boll based upon 1998 through 2000 data.

	Degree days required (60F)	
Type of Cotton	Early-season Flowers	Late-season Flowers
Acala varieties (average)	900 to 1025	825 to 875
Pima varieties (average)	960 to 1050	900 to 980
Some CA Uplands with thin boll walls	830 to 950	775 to 860

Table 3 shows long-term daily and "half-month" average degree-days (base 60F) at Shafter REC in Kern County. These can be used in estimating crop progress under "average" expected weather conditions during July through mid-November. Note that average degree-day accumulations differ with location in the SJV, and can be as little as 5% or as much as almost 20% lower in the northern SJV as compared with Shafter REC (Table 3).

Table 3. Long-term average daily heat units (DD60 = degree days base 60F) at Shafter during specific time periods (averages and ranges determined using 1974 to 1999 data).

	Degree days (60F) (in DD60 per day)		26-year average Total for period
TIME PERIOD	AVERAGE DAILY DD60	RANGE	TOTAL DD60 FOR THE PERIOD
July 1-15	18.3	14-21	274
July 16-31	18.6	13-22	297
Aug. 1-15	18.7	15-22	281
Aug. 16-31	16.3	11-19	262
Sept. 1-15	15.1	10-22	227
Sept. 16-30	11.6	5-17	175
Oct. 1-15	8.2	5-15	122
Oct. 16-31	5.6	2-8	90
Nov. 1-15	2.3	1-5	34

Use of this information if you have or are trying to avoid a late crop. In a "late" year, we have recommended that growers / consultants work back from a desired harvest date to use the data of Tables 2 and 3 to determine the likely period available for fruit production. Using the information from Table 2, you can assume about 850 degree-days (Acala) and 950 degree-days (Pima) to mature out a mid-to late-season bloom to an open boll. If you add numbers in the right column of Table 3 starting at your desired time for harvest and work through the earlier periods, you can estimate how long it will take to accumulate degree-days to open that last harvestable flower for which you are "aiming".

As an example, if you select October 31 as a target harvest date, the last fruiting site you should try to mature out (requiring about 850 degree-days for late-season Acala boll) would be expected to flower on about Aug. 16 (using right-hand column of Table 3: 90+122+175+227+262 = 876 degree days). In days, early-season flowers can take 55-60 days to mature from flower to open boll, while late-season blooms can take 70-75 days or more during fall periods of declining degree days. The Table 3 column showing "range" during each period shows that while opportunities for warm temperatures exist even in September and October, so does the chance of lower degree days and harvest delays.

Table 4. Use of this information for planning. Estimate when the last bolls will be open if your crop reaches "vegetative cutout" and you estimate the following dates of the last productive blooms on the plant (use the approach shown in the Table below).

Last date of bloom carried to maturity after cutout	Degree days (DD60F) accumulated between last date of bloom and expected date of opening of the "last" boll	Estimated date of boll opening of last date of bloom
August 1	281 (8/01 to 8/15) + 262 (8/16 to 8/31) + 228 (9/01 to 9/15) + 79 (9/16 to 9/22) = 850 degree days total	9/22
August 8	150 (8/08 to 8/15) + 262 (8/16 to 8/31) + 228 (9/01 to 9/15) + 175 (9/16 to 9/30) + 33 (10/01 to 10/05) = 856 degree-days	10/05
August 16	262 (8/16 to 8/31) + 228 (9/01 to 9/15) + 175 (9/16 to 9/30) + 122 (10/01 to 10/15) + 62 (10/16 to 10/26) = 849 degree days	10/26
August 23	147 (Aug.) + 228 +175 (Sept.) + 122 + 90 (Oct.) + 34 (Nov. 1-15) = 796 degree days (does not reach 850 by mid-November)	total available less than 850