Last Effective Cotton Flowering Date in the Texas Panhandle

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The Texas Panhandle is a cotton growing degree day (GDD) limited region. Cotton is generally planted in May and first white flowers bloom in mid- to late-July depending on GDD accumulation and planting date, with physiological maturity (cutout) occuring in mid-August. Once the plant reaches cutout, the terminal is 5 nodes above the uppermost first position white flower (https://extension.okstate.edu/fact-sheets/defining-cutout-in-cotton.html). When cutout is reached in mid-August the plant will usually have enough time to mature existing bolls, but additional fruiting positions may not become a harvestable boll. Cutout timing and resource availability are important considerations for determining the last effective flowering date, or the last calendar date that a large percentage of white flowers will become harvestable bolls. While calendar dates are general guidelines for management decisions due to year-year variations in weather and crop condition, understanding crop physiological stages can inform producers of the best time to terminate irrigation and other inputs. Producers often irrigate in excess of crop needs beyond cutout hoping to retain **late flowers** and mature additional bolls (Image 1). Although late season flower shed can be concerning and an indication of crop stress, previous observations in the Texas Panhandle confirmed that less than 40% of post cutout flowers are retained as harvestable bolls (https://amarillo.tamu.edu/files/2020/01/2019-Texas-Panhandle-RACE-Report.pdf). It is also important to consider that under heat and water stress, cotton can enter early cutout during flowering period, but with timely irrigation or rainfall (and time), the crop will resume growth and continue boll development. If cutout happens in mid-August, the field has reached final cutout in the Texas Panhandle. Continuation of irrigation, unless the soil profile is very dry, can encourage new terminal growth. Excessive growth at this stage will consume resources at the expense of resource allocation to maturing fiber. When considering the last effective flowering date for a region, a producer must consider each field's condition individually, as well as maturation time and potential for GDD accumulation for each boll. Following pollination of the **white flower**, it takes a cotton boll an additional 50 days to develop, but the majority of fiber lengthening is completed within 25 days post flowering (Fig. 1). Fiber thickness or micronaire development occurs 15-45 days post flowering. Becasuse of rapidly cooling fall temperatures in GDD limited regions, there is often

Image 1. Boll shedding on August 25, 2020 (photo credit J. Bell).

insufficienttime to fully develop fiber from late season flowers and bolls. As a result, producers do not need to waste resources retaining bolls that will not fully mature.

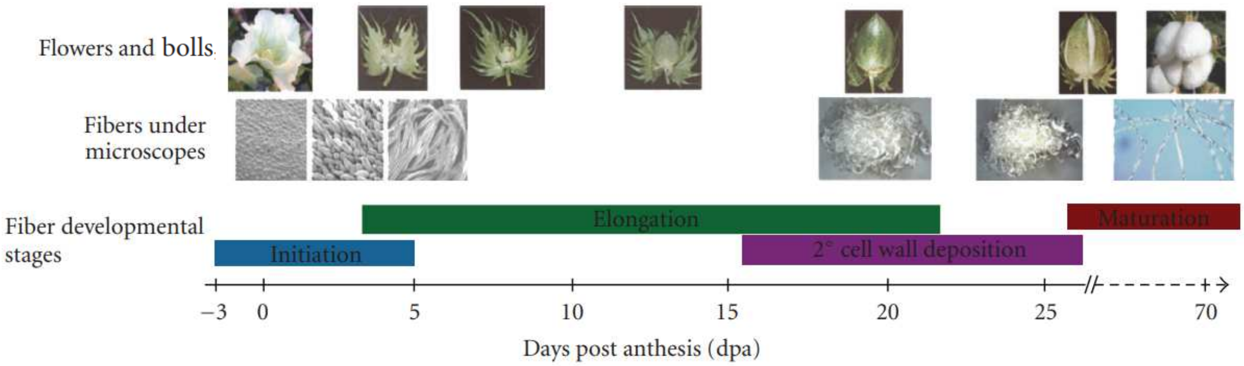

Figure 1. Cotton fiber development and corresponding plant stage post flowering (anthesis) source: Zang et al., 2008.

A cotton flower tagging experiment was conducted in 2020 to determine the last effective flowering date in the Texas Panhandle. The objective of the research was to provide producers better understanding of late season flower and boll retention in order to optimize late season inputs. Flowers were tagged with their respective bloom date in the 2020 Texas A&M AgriLife cotton variety trial at the North Plains Groundwater Conservation District Water Conservation Center in northern Moore County, Texas. Forty plants were tagged in two varieties (Deltapine 1820 B3XF and NexGen 2982 B3XF; 20 plants per variety) for 30 days starting at first white flower (July 27 to August 25, 2020), which was 10-days past cutout (August 15, 2020). The varieties represented early and early-medium maturity classes commonly planted in the Texas Panhandle. Flowers were counted and tagged every other day to capture the current days white flowers and the previous days pink flowers. Plots were on drip irrigation. In-season irrigation totaled 8.9 inches, and in-season precipitation totaled 14.2 inches. After defoliation, all plants were collected for lint yield and fiber quality. Since cotton in the Texas Panhandle is mostly stripper harvested and all harvestable bolls contribute to lint production, harvestable bolls were counted and separated by flowering date, not their position on the plant. Lint from harvestable bolls was composited for all 20 plants of each variety. Samples were ginned at the Texas Tech University Fiber and Biopolymer Research Institute, and HVI (High Volume Instrument) and AFIS (Advanced Fiber Information System) fiber quality analyses were completed. Data confirmed that cutout occurs during the peak flowering period, and plants continue to produce flowers well past cutout (Fig. 2).

First white flowers (July 27) accumulated 318 GDDs to cutout (Fig. 3). Cutout occurred on August 15 at which point seasonal GDD accumulation was 1,566 (Fig. 3). Total GDD accumulation from planting to the harvest aid application was 2,163. Consequently, there were only 598 GDDs accumulated after cutout. Although there was a cold front on September 9, seasonal GDD accumulation was inline with the recent 6-year average for the Texas Panhandle (2,172 GDDs). The number of harvestable bolls in 2020 substantiated 2019 results which demonstrated that less than 40% of post-cutout **white flowers** become a harvestable boll (Fig. 4), whith less than 10% of **white flowers** past August 20 became a harvestable boll. Although heat and water stress can increase the rate of flower shed, moderate temperatures and ample moisture were present during the evaluation period (Fig. 5).

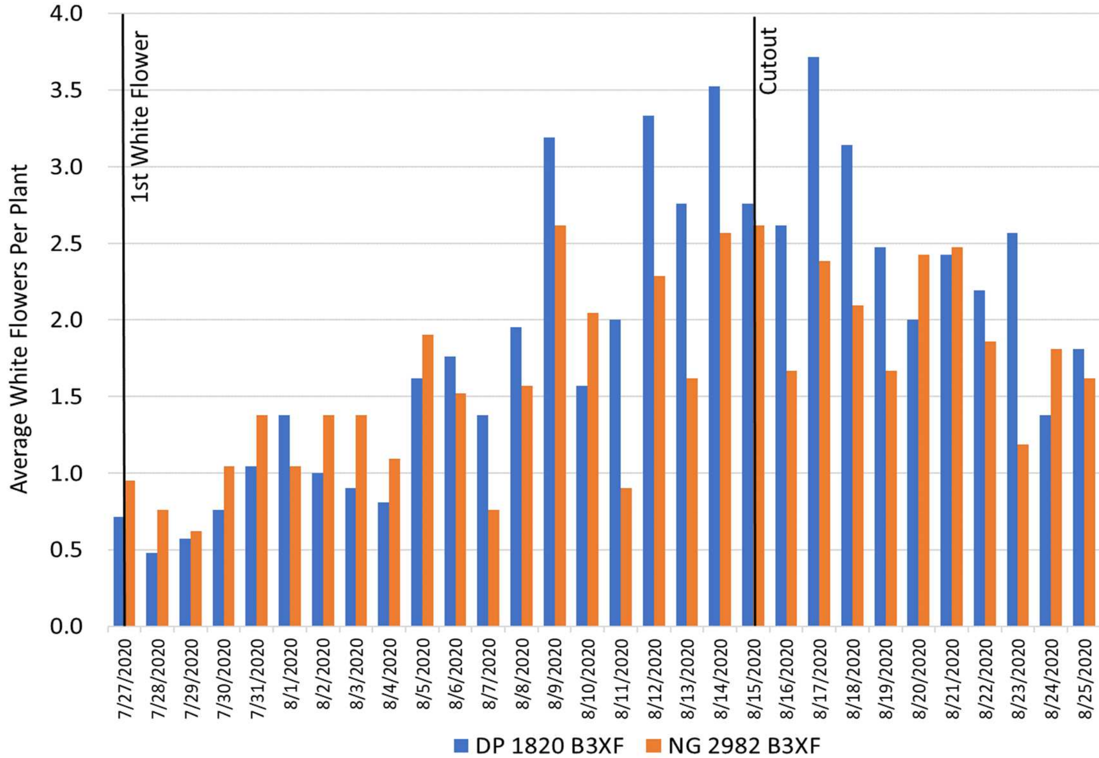

Figure 1. Average number of white flowers per plant from first white flower through 30 days post anthesis for DP 1820B 3XF and NG 2982 B3XF.

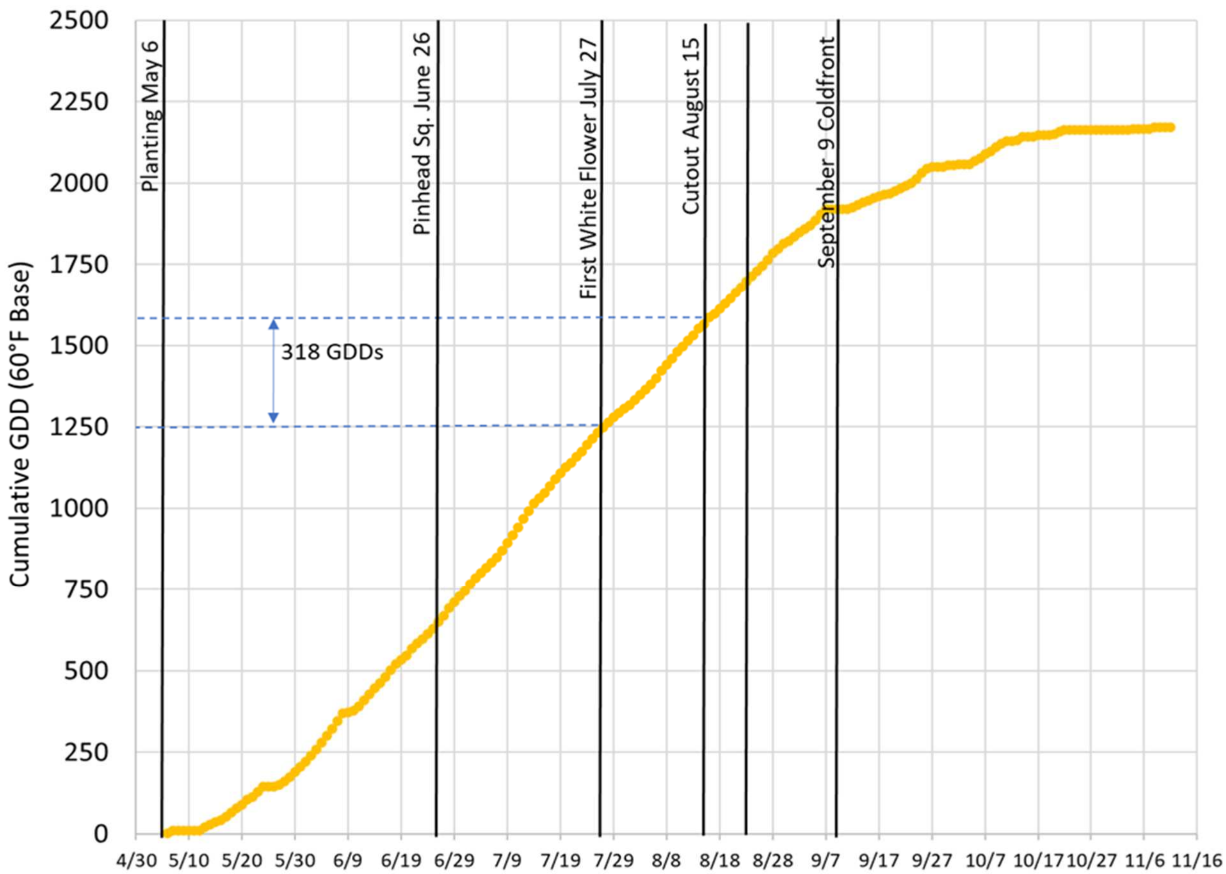

Figure 2. Cumulative growing degree days (60°F base) from planting for the evaluated cotton at the Moore County, Texas field site. Key growth stages are noted.

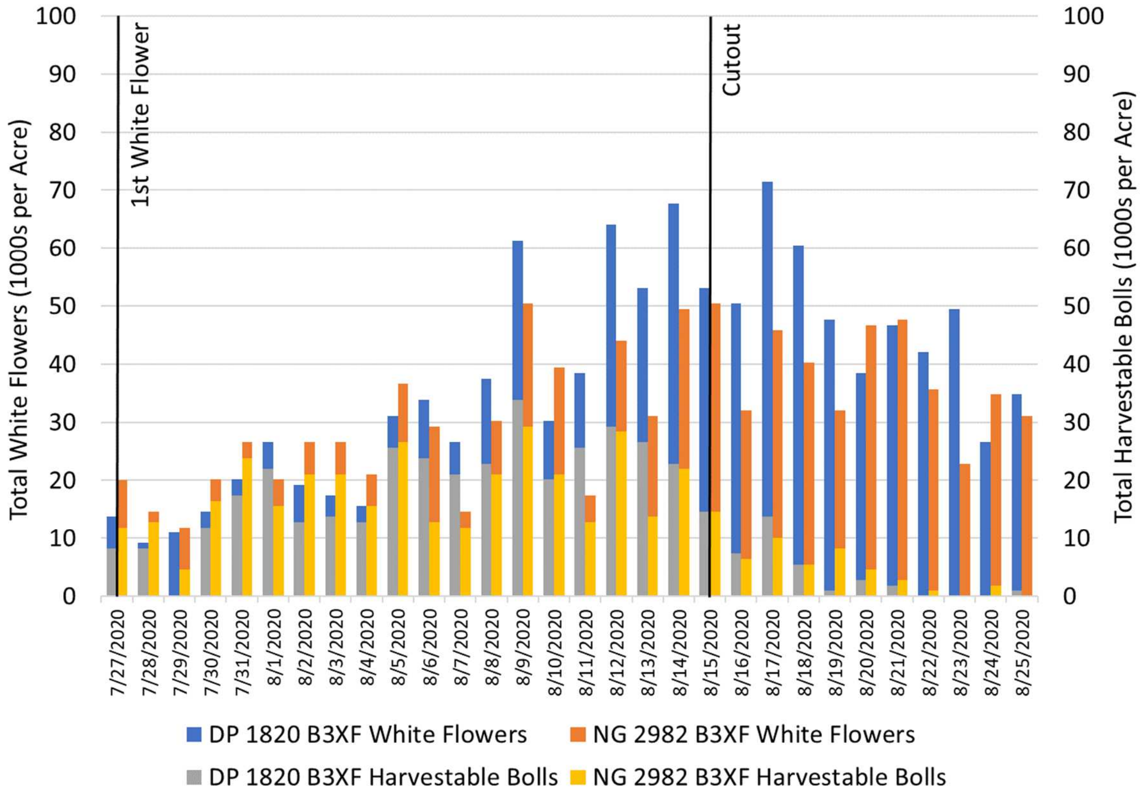

Figure 3. Total number of white flowers and harvestable bolls for DP 1820 B3XF and NG 2982 B3XF from first white flower to 30 days post anthesis.

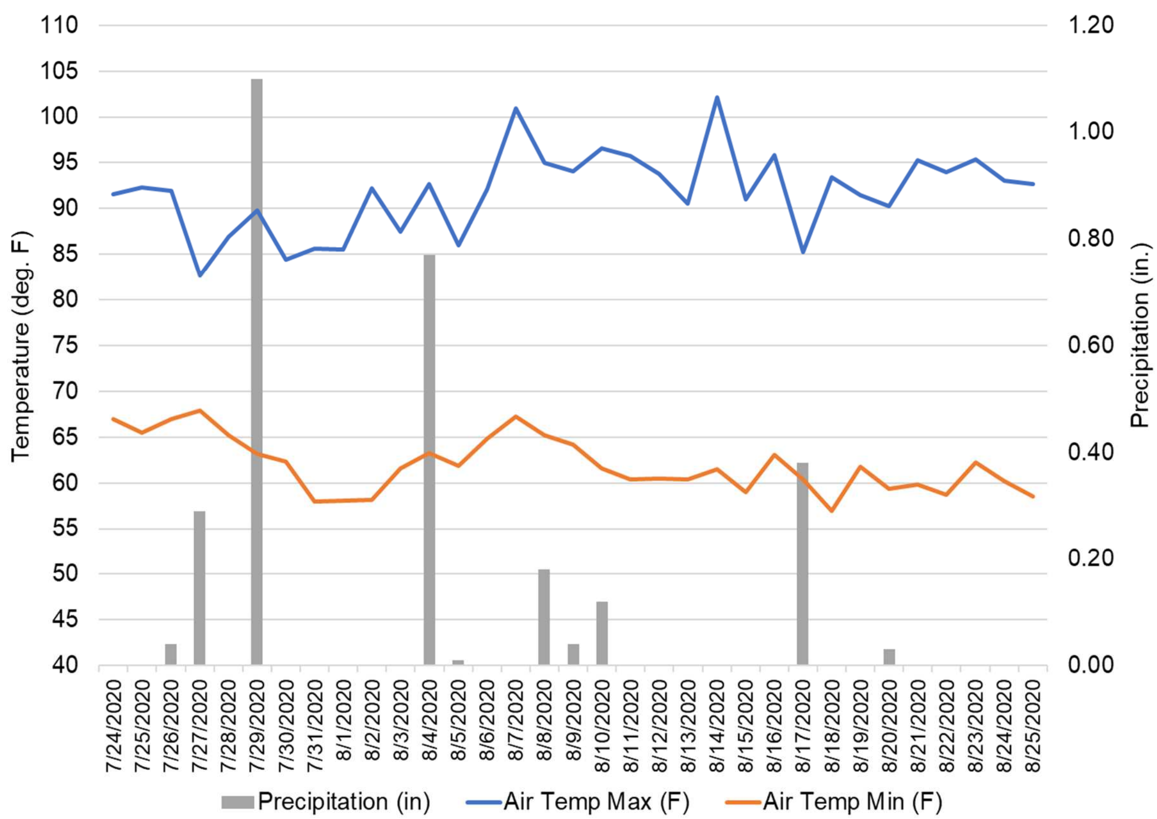

Figure 4. Maximum and minimum air temperatures and daily precipitation during the 2020 observation period.

Lint yields composited by day demonstrated that more than 90% of the lint produced was from flowers that bloomed from July 27 to August 15 (Table 1 and Fig. 6). Data suggests that the effective flowering period for the Texas Panhandle is from first flower to cutout (mid-August) based on the growing conditions and varieties evaluated. Evaluation of daily data also demonstrated the impact of rainfall on flower retention. On the morning of July 29, there was a 1.1 in. rainfall event (Fig. 5), and 12 and 13 white flowers were tagged for DP 1820 B3XF and NG 2982 B3XF, respectively (Fig. 4). At the end of the season, 12 and 8 of the tagged flowers for DP 1820 B3XF and NG 2982 B3XF, respectively, had shed (Fig. 4). It is likely the flowers quickly shed as a result of rainfall, which can negatively impact pollination. Rainfall can wash pollen grains off the stigma and cause pollen grains to clump on the anther preventing pollen dispersal. Whilere there was a 0.77 in. rainfall event the evening of August 4, this was after pollination and flower shedding was not as severe. Regardless of the reason, poorly pollinated flowers will often shed.

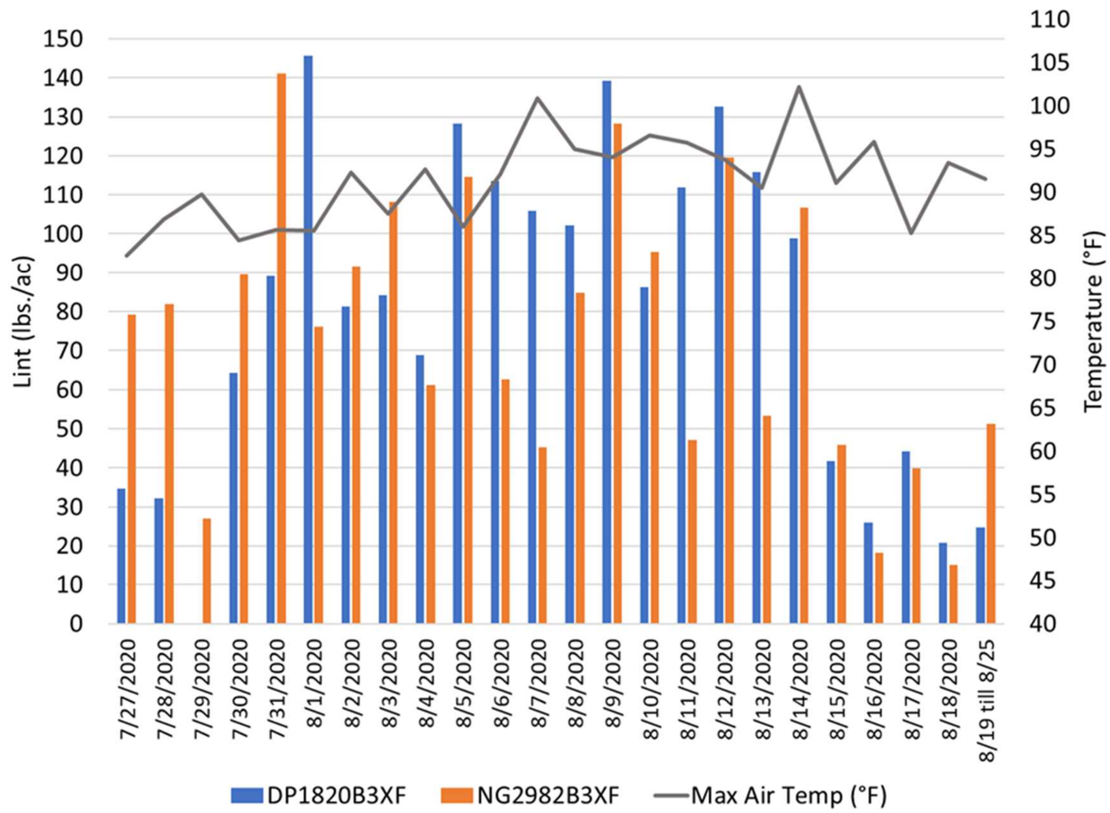

Figure 5. Maximum air temperature and lint yield produced by day during the 30-day evaluation period showing the rapid decline of daily lint production after cutout (8/15).

Table 1. Seed cotton and lint production by flowering period for hand picked cotton samples.

	Seed Cotton (lbs./ac)				Lint (lbs./ac)			
Variety	Produced from All Flowers	Produced from 7/27-8/15 Flowers	Produced from 8/16-8/25 Flowers	Turnout (%)	Produced from All Flowers	Produced from 7/27-8/15 Flowers	Produced from 8/16-8/25 Flowers	% Lint from 7/27-8/15 Flowers
DP 1820 B3XF	4,183	3,902	281	0.45	1,892	1,776	116	0.94
NG 2982 B3XF	4,642	4,288	354	0.38	1,784	1,660	124	0.93

Cold weather can also affect flower retention. There was a cold front on September 9, 2020 with a low temperature of 34.8 °F. The air temperature was lower than 40 °F for 5.5 hours. This occurred 25 days after cutout, past what we define to be the effective flowering period (first white flower to cutout). Additionally, there was not a killing freeze, and optimum plant health prevented defoliation and plant death. Even with the September 9 cold front, seasonal GDDs were inline with regional average of 2,172. Evaluation of fiber yield and quality data suggests that this event did not negatively impact fiber development. Lint produced after August 10 showed a steady decline in fiber development as a result of boll age, not a rapid cessation in development that would correspond to a "killing" weather event. Fiber quality properties such as micronaire and length, are key indicators of fiber development and suggested a linear decrease in development in response to flowering date and boll age (Fig. 7). Micronaire was influenced by variety, and decreased linearly with boll age. Linear regressions of micronaire by day (DP 1820 B3XF: $y=-0.0739x+4.4555$, $R^2=0.7184$ and NG 2982 B3XF: $y=-0.0582x+3.3982$, $R^2=0.8762$) indicated that the micronaire decreased 0.066 points per day from the first flower date for the varieties evaluated. Fiber length was also greater for older bolls, but did not decrease to less than 1.08" during the 30-day evaluation period as determined by HVI. Fiber stength (grams per tex) representing the force (in grams) required to break one tex bundle of fibers was also higher for older, more mature bolls. Numerical strength grades ranged from strong to intermediate, but grades were weak for younger bolls. Fiber elongation was not impacted by boll age maturation like other properties. The AFIS results also showed strong linear reduction in fiber length over time (Fig. 8). Regression analysis of the AFIS average length data suggested a 0.009 in. reduction in length per day. Conversely, nep size and number were smaller for older, more mature fiber when compared to younger, less mature fibers. Of significance, the total fiber and seed coat neps for both varieties increased after cutout. There was a 47% and 51% increase in the total neps for NG 2982 B3XF and DP 1820 B3XF, respectively, after cutout. The average nep count from first flower to cutout was 383 neps per gram for NG 2982 B3XF, and after cutout, the average number of neps increased to 807 neps per gram. Although there were fewer total neps for DP 1820 B3XF, the average neps increased from 213 from first flower to cutout and to 418 after cutout.

Trends in fiber quality data are in agreement with lint production and the definition of cutout as the last effective flowering date with the period between first white flower and cutout being the effective flowering period. Producers should use cutout as an indication for irrigation and fertility termination. While late season crop stress including water, insects, and disease should continue to be managed, data indicates that excessive irrigation and fertility past cutout may not be cost effective. There should be minimal water stress through first cracked boll. Irrigation beyond cracked boll will likely not generate sufficient lint to recover irrigation costs in GDD-limited production regions. Based on this data, cutout in mid-August (~August 15) can be considered the last effective bloom date for the Texas Panhandle cotton production region.

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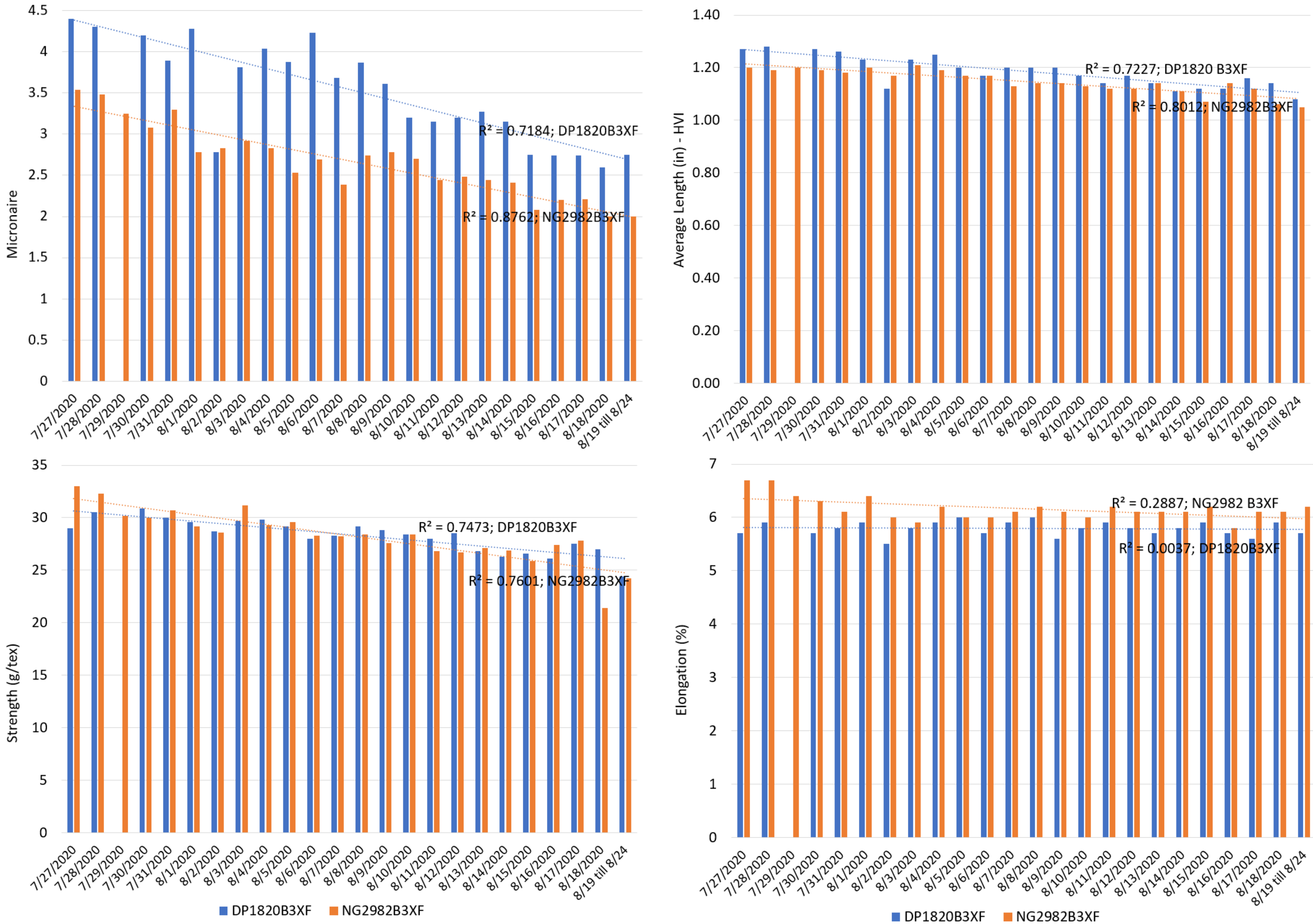

Figure 6. Fiber quality from HVI analysis for lint composited by flowering date.

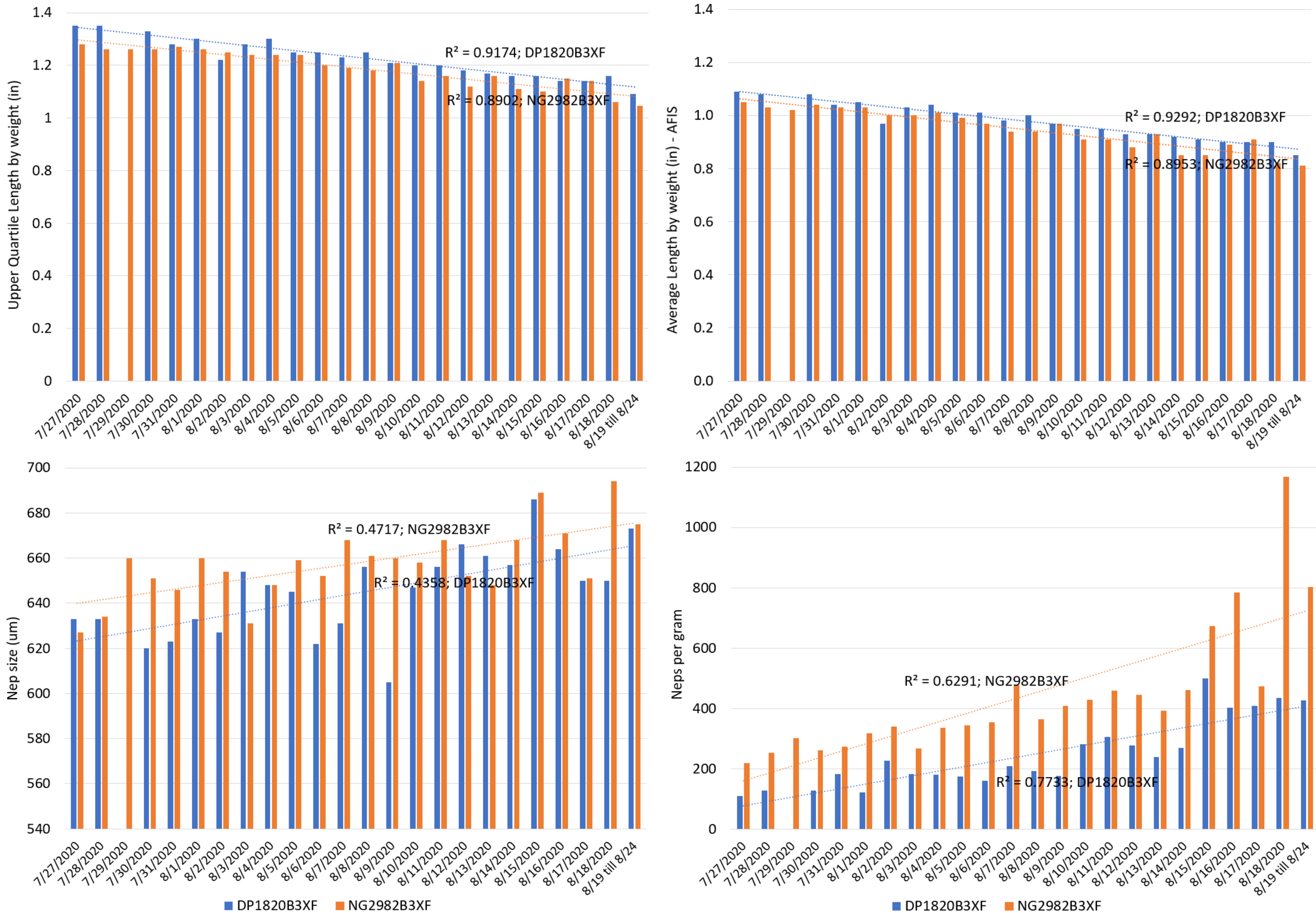

Figure 7. Fiber quality from AFIS for lint composited by flowering date.