OPTIMAL PLANTING DATES FOR COTTON IN THE TENNESSEE VALLEY OF NORTH ALABAMA

M.L. Norfleet
USDA-NRCS Soil Quality Inst.
Auburn, AL
D.W. Reeves
USDA-ARS-NSDL
Auburn, AL
C.H. Burmester
Auburn University
Belle Mina, AL
C.D. Monks
Auburn University
Auburn, AL

Abstract

Weather and soil climate data simulated for 100 years indicate planting in the Tennessee Valley in early to mid-April may be risky. Low soil temperatures and slow accumulation of growing degree days (DD60s) can cause yield reductions from poor germination and disease. Soil conditions tend to be optimum for germination around late April to early May.

In delaying moving the planting date a couple of weeks or more from the regional norm of April 15th to 20th, growers are able to get the full benefit of their cover crop dollar with biomass production doubling by allowing it to grow until April. Cover crops have been shown to increase yields, reduce herbicide use, reduce erosion, reduce compaction, and improve the soil's water holding capacity.

Planting around the 1st of May allows for rapid germination and the plant reaches its effective bloom period in time for the normal summer rainfall patterns which tend to occur in late June and July. The DD60-based growth requirements for *early*, *medium*, and *full season* varieties are so similar early in the season, the choice of which to grow may not make a difference. Also, this later planting date still gives the plant enough DD60s to mature before the first frost (October 30th).

The improved germination rate, reduced herbicide costs, and increased yields make use of cover crops and delayed planting good economic sense and a sound investment. The added benefit of doing something good for your soil's health makes this management decision all the better, a *Lagniappe* for your land.

Reprinted from the *Proceedings of the Beltwide Cotton Conference*
Volume 1:644-647 (1997)
National Cotton Council, Memphis TN

Introduction

Traditionally cotton growers begin planting in North Alabama in early to mid April, peaking around the 15th, with most of the cotton in the ground by end of the third week. It is not uncommon for many growers to have to re-plant some of the early acreage because of poor stand establishment and disease.

Also, many producers use a cover crop in the winter as a conservation practice and to reduce compaction in no-till systems. However, in order to meet the early planting schedule, many kill their cover crops in mid to late February. This prevents the cover from producing the large amounts of biomass necessary for providing weed control, moisture conservation and maintaining or improving the soil. For cotton growers in North Alabama to realize the full benefit of cover crops, they need to have good weather and soil climate data.

This poster will correlate weather and soil climate information generated by a computer model with established research on cotton development. Our goal is to illustrate:

- How late cotton can be planted and still have enough days to mature.
- How early planting may cause poor germination and seedling disease.
- Timing plant date with seasonal rainfall and critical growth periods.
- The benefits of using cover crops, letting the cover crops grow longer into the spring, and still hit these dates.

Weather Data Generation

The long term weather data for this presentation was generated by the EPIC (Erosion Productivity Impact Calculator) program. This program uses measured weather data from established stations and statistically generates weather patterns for 100 or more years. Periods of drought, intense rainfall, abnormal temperatures are all estimated based on their past occurrences. Stations located in Muscle Shoals, Huntsville, and Bankhead Locks in Alabama supplied the weather for this work. The daily average for soil temperature, maximum and minimum air temperature, rainfall, and root zone soil moisture was generated for a 100 year period in North Alabama. This data was used to develop average dates of frost, soil temperature at 4 inches, weekly rainfall patterns, and growing degree days (DD60's). The Dewey and Decatur silt loam soils were used in the simulations.

DD60 and Cotton

Cotton's base temperature for growth is 60^{o} F, below this temperature plant growth is hampered and seedlings tend not to germinate. Daily heat units or DD60's are calculated by adding the maximum and minimum temperatures for each day, dividing by 2, and subtracting the base temperature of 60º F. For example:

$$[(86_{max} + 60_{min}) / 2] - 60_{base} = 13 \text{ DD60s}).$$

Cotton breeders in the Southeastern US have established the amounts of DD60's required for various growth stages or developmental landmarks of the cotton plant (Table 1). These categories are: *early*, *medium*, and *full season* varieties. *Full* season varieties are not typically planted in the Tennessee Valley area.

Germination and Emergence

Once cotton is planted, it will germinate readily under favorable moisture conditions and temperatures above 60ºF (Figure 1). In 1960, Holekamp et al., reported there needed to be a 10 day soil average temperature above 60ºF before the start of planting. Lower soil temperatures had emergence rates of less than 40%. The 10 day average rule of thumb has since been used successfully for many years. Riley et al. (1964) in Mississippi showed an average temperature of 68ºF was optimum for a good rate of germination. Other studies have found 3 day averages of 65ºF to be an optimum temperature to begin planting (Silvertooth and Brown, 1993). The chart on COOL FACTS (Table 2) shows that for the 60º rule, planting should not start until after April 10th in the Tennessee Valley and the *OPTIMUM* temperatures for planting don't occur until after May 1st.

After planting, the accumulation of DD60s become important to seedling emergence. Under optimal conditions of adequate moisture and temperatures approaching 70ºF and DD60s of 50, emergence may occur in 5 to 6 days. Soil temperatures nearer 60ºF may cause emergence to take up to 15 days or more due to the slower accumulation of DD60s. Delayed emergence also affects yield. A field study in Texas showed survival rates of seedlings that emerged on the 5th, 8th, and 12th day after planting to be 87, 70, and 30 percent, respectively, and corresponded with relative yields of 100, 46, and 29 percent (Wanjura, 1986). Other researchers have shown field emergence to be 50, 72, and 77 percent, when 10, 20, and 30 DD60's accumulated in the first 5 days after planting. These survival rates and yield reductions are a reflection of the extra time for disease development and cold injury when seed are planted too early.

In North Alabama, 10 DD60's do not occur until April 7th, 30 DD60's do not accumulate until April 22nd , and 50 DD60s, the optimum required for rapid emergence, do not occur until MAY 1st (Figure 2).

Timing Plant Dates with Cotton's Development Landmarks and Rainfall

Adequate rainfall is important throughout the growing season, but is vital during the bloom period for achieving maximum yields (Figure 3). In the Tennessee Valley, moisture stored in the soil and seasonal rainfall are sufficient for the crop to progress into the bloom period according to its DD60-based developmental landmarks.

The Average Weekly Rainfall chart is plotted to show the amount of rainfall for the week ending on any particular day (Figure 4). Points for any day on the chart are the average the previous week. The chart indicates there is traditionally a rainy period in late June and early July. Therefore, by planting around the first of May, the cotton plant develops its early blooms in time with these summer rains. Early planting may cause these early flowers to miss the needed rainfall for pollination, especially during warm springs.

During the bloom period, temperature and moisture stresses slow the development of the plant and DD60s are often "wasted". This extends the effective bloom period to around August 16th, instead of the July 10th to 24th dates indicated by the Development Landmark table (1050 to 1350 DD60s). Also, the total amount of DD60s accumulated before harvest is increased to around 2000. The August 16th date is about 750 DD60s before the first fall frost on October 30th, which allows the last bolls to develop.

Another aspect of the bloom period is the moisture requirements. For the cotton plant to produce during this period, 0.3 inches of water daily or 2.1inches/week is needed to prevent moisture stress. The rainfall chart shows that 0.7 to 1.5 inches/week are from summer rains; the rest must come from water stored in the soil and that is if all rain goes to the plant. Therefore, management practices controlling runoff and increasing soil organic matter and available water holding capacity are vital to overcoming this shortfall.

Benefits of Cover Crops

The best way to control runoff and increase soil organic matter is through the use of cover crops, regardless of the amount of tillage. In no-till systems, cover crops eliminates the compaction problems inherent in north Alabama soils. The following are some additional benefits to using cover crops:

- Control runoff and erosion: Soil organic matter is not lost with the topsoil and water enters the profile. A rye cover crop can reduce erosion on conventional cotton by over 2.5 times and decrease runoff up to 45%.
- Improves the soil's water holding capacity by increasing levels of soil organic matter. An

increase in Soil Organic Matter of 1% can add as much as 2 days water supply to your soil (Hudson, 1994).

- ♦ Increases yield (10 year average; Burmester et al)(Figure 5).
- ♦ Improves Weed Control (Reeves and Patterson) (Figure 6).

Cover Crop Management

When Do I Kill?

Killing the cover crop in February or early March does not allow the crop to get the early spring growth spurt from the rising temperatures of March and early April. The Cover Crop Biomass chart, Figure 7, is the average production from rye for a 100 year simulation, actual field studies indicate production could be 500 to 1000 lbs more (D.W. Reeves, personal communication). By moving the plant date to late April or early May and killing the cover crop 3 weeks prior to planting, residue inputs from cover crops can double. Early killing is almost not worth the effort or expense of planting a cover since 1500 lbs/acre will only give about 50% coverage. More importantly research has shown that infiltration of rainfall increases linearly up to around 4,000 lbs residue/acre

Do I Need a Cover Crop Every Year?

The climate in the Southeast is generally warm enough for year round biological activity. Researchers in Georgia found only 20% of the rye litter remained under a conventional tillage system and 40% remained with no-till after one growing season (Beare et al., 1992). If a cover is not used annually, the soil organic matter will begin to be "mined" and the benefits of previous years work will be readily lost. Also, with conventional tillage systems, its needed annually for erosion control through the winter. It may be allowable to miss a year after a few years of 'build-up', especially with a no-till system, but why take the risk?

References

Holekamp, E.R., E.B. Hudspeth, and L.L. Ray. 1960. Soil Temperature-A guide to timely cotton planting. Texas Agric. Exp. Sta. MP. Pp. 465.

Riley, J.A., D.H. Newton, J.W. Measels, D.A. Downey, and L. Hand. 1964. Soil temperatures and cotton planting in the mid-south. Miss. Agr. Exp. Sta. Bull., pp. 678.

Silvertooth, J.C., and P.W. Brown. 1993. Managing for an optimum planting date. Ariz. Coop. Ext. Ser.

Hudson, B.D. 1994. Soil organic matter and available water capacity. J. Soil and Water Cons. 49(2) 189-194.

Beare, M.H., R.W. Parmelee, P.F. Hendrix, W. Cheng, D.C. Coleman, and D.a. Crossley, Jr. 1992. Microbial and faunal interactions and effects on litter nitrogen and decomposition in agroecosystems. Ecolo. Monogr. 62, 569-591.

Table 1. Estimated Minimum DD60's required selected development stages for selected variety types.

Development Landmark	Very Early ST 132	Early ST 474	Medium ST LA887
Germination	50	50	50
Planting to 1st Square	350 (350)	400 (400)	400 (400)
1st Square to Early Bloom	350 (700)	400 (800)	400 (800)
Early Bloom to Cutout	350 (1050)	450 (1250)	550 (1350)
Cutout to Harvest	500 (1550)	500 (1750)	500 (1850)

*Information compliments of Dr. David Guthrie, Stoneville Pedigreed Seed Company, Stoneville, MS. Number in ( ) is cumulative DD60 total.

Table 2. COOL FACTS. The following data was determined by 100 Year Simulated Average Dates using the EPIC program on conventionally tilled Decatur silt loam and corresponds with published data from extension, NRCS soil survey reports, and other literature:

TEMPERATURE BENCHMARK	DATE
Last Spring Frost	April 4
First Day of Positive DD60's	April 1
First day DD60>10	April 7
Soil Temperatures at 4 inches	
10 day average>60°F begins	April 10
4 days>62°F begins	April 10
3 days>65°F begins	May 1
Optimum Germination Temperature 68°F.3 days begins	May 4
First Fall Frost	October 30

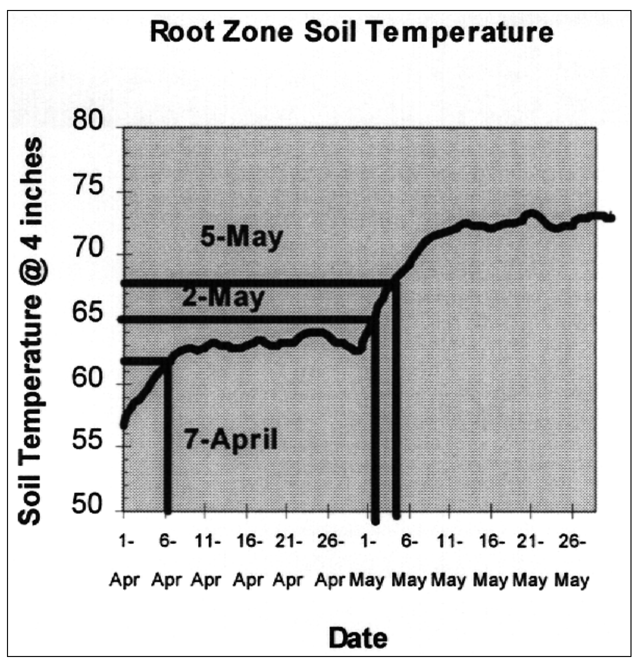

Figure 1. Simulated soil temperature for determining planting dates.

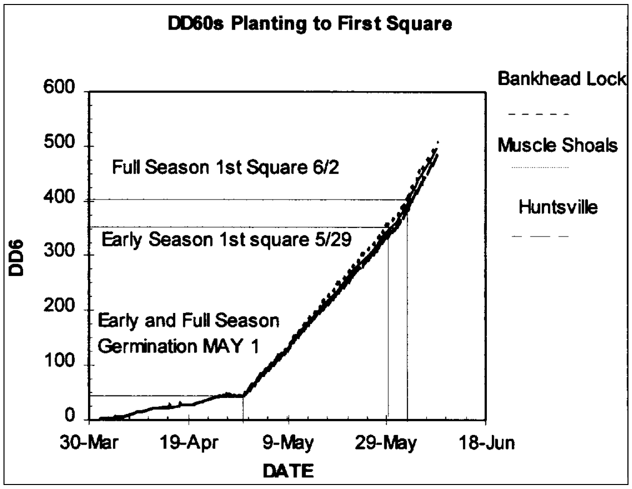

Figure 2. Average dates for 50 DD60's needed for germination and the minimum necessary for first square.

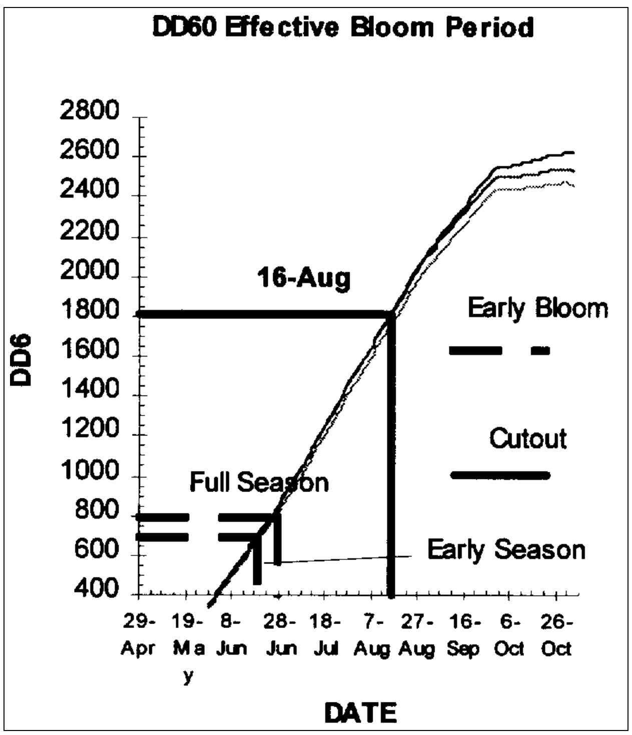

Figure 3. Date of first square and accumulated DD60s at first square.

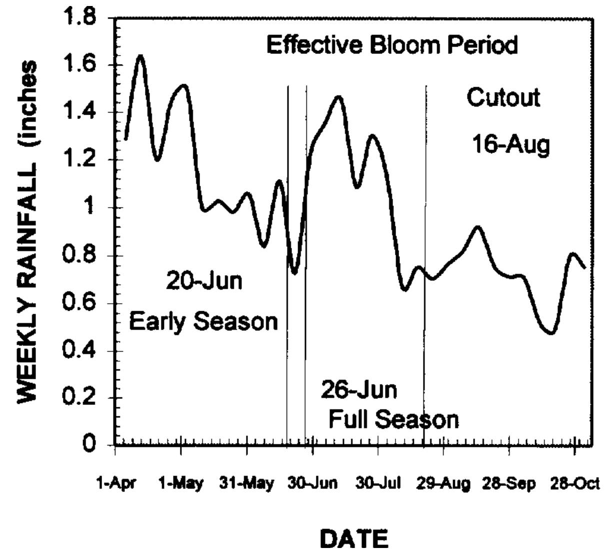

Figure 4. Timing rainfall with bloom period.

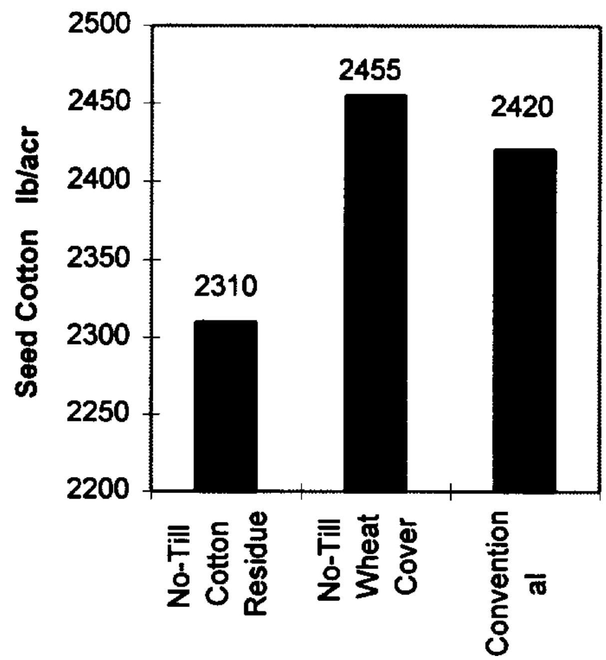

Figure 5. Yield response to cover crops (Burmester et al.)

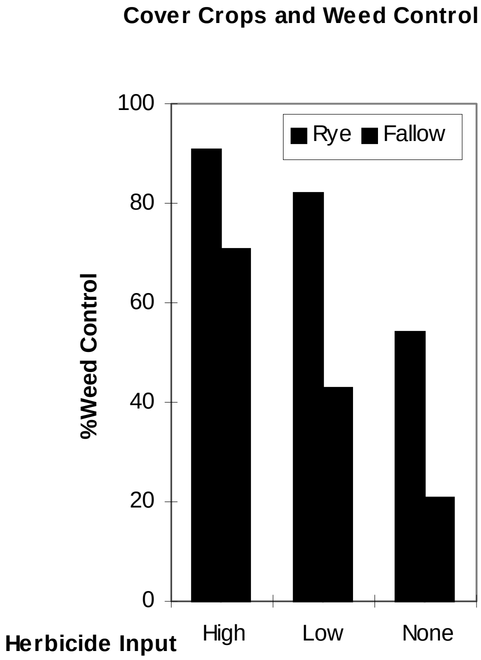

Figure 6. Weed Control using cover crops (Reeves and Patterson).

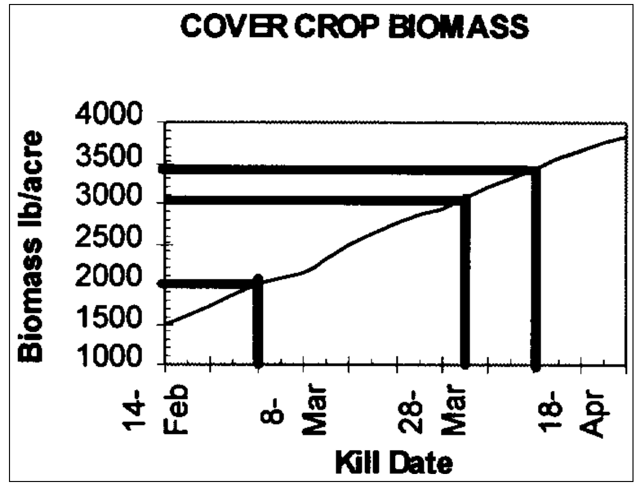

Figure 7. Simulated growth of rye biomass showing benefit of allowing cover crop to grow longer into the spring.