Guide to Earliness Management in Short-season Cotton Production

Managing for earliness is particularly important to producers along the northern edge of the cotton belt. This publication highlights the potential benefits of managing a cotton crop for earliness and the management practices which encourage timely maturity and harvest.

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Introduction

"Managing for earliness" describes practices used to minimize the time in which it takes to set and mature a profitable boll load. This is particularly important when producing cotton due to its perennial, indeterminate nature. Thanks to these characteristics, the plant is in a balance between vegetative and reproductive growth for much of its life. Producers managing for earliness use their growing season to quickly produce adequate vegetative growth to support a profitable boll load without forcing the plant to reach physiological cutout too early. This approach has been practiced for a number of years in every cotton-producing state in the United States. Since an overly aggressive attempt to maximize "earliness" can reduce yields in some environments, the term "timeliness" has occasionally used in place of "earliness."

Regardless of name, these concepts are particularly important to producers along the northern edge of the Cotton Belt. Whereas timeliness may help producers in South Georgia or Arizona reduce input costs, producers in the Upper Mid-South and Southeastern regions are at risk for drastic reductions in yields if their crop has not reached maturity at the end of the effective growing season. For these producers, timely maturity hinges upon reaching physiological cutout (five nodes above white flower) within a few days of the seasonal cutout (last effective flowering date).

This publication intends to highlight the benefits of managing for earliness in short-season environments, define parameters which influence maturity of the system, and describe an integrated set of crop management practices which may help achieve more timely maturity. Included practices should help Tennessee cotton producers consistently producing high-yielding, mature crops for harvest at the optimum time.

Benefits of Managing for Earliness

The benefits of managing for earliness are numerous and span multiple subjects. First, this approach can reduce late-season crop input costs at all latitudes. Several cotton pests, such as Heliothine insects, become more prevalent late in the calendar year. By shifting the window of susceptibility of the crop closer to planting, the damage caused by these pests can be minimized and the costs of controlling these pests can be reduced. Additionally, earlier termination of insecticide applications for plant bugs and stink bugs may reduce the total number of required applications for the season. Cost savings also apply to other late-season inputs such as irrigation and herbicides.

Managing for earliness will additionally improve the efficacy of defoliants and boll openers. Regardless of whether the selected harvest aid is hormonal or herbicidal, they rely upon the physiological response of the plant to form abscission layers at the base of the petiole and the sutures in the boll walls. Since these processes are physiological in nature, they are temperature dependent. A crop that has been managed for timely maturation will likely receive applications of defoliants earlier in the year, which will increase the probability of these applications being made under periods of warmer temperatures. This will result in more predictable and favorable outcomes from harvest aid applications at reduced rates than would be required at lower temperatures.

A season-long earliness management approach should also improve the likelihood of favorable weather conditions for harvest. Avoiding the wet weather of late fall improves harvest efficiency and reduces damaging effects of running heavy equipment on soft ground. In Tennessee, the number of hours within the day suitable for picking and number of days suitable for picking generally decline later in the fall. Subsequently, a week of harvest early in September or October may save several weeks of harvesting later in November or December. Prompt harvesting usually results in superior fiber quality and greater lint yields. Additionally, these practices commonly result in a more compact fruiting zone, which reduces weathering time on open bolls and a reduced potential for freeze damage to closed bolls. An earlier maturing crop also can allow sales contracts to be filled earlier (potentially at a premium) and allow timelier planting of winter wheat or cover crops.

Parameters influencing Timely Maturity

Parameters that impact earliness can be divided into three main categories: environment, genotype and management.

Environment

Although many environmental factors can be partially addressed through genotypic or management-based adjustments, occasionally, environment drives maturity more than any other factor. Frequent rainfalls may prevent timely planting or timely applications of herbicides and or insecticides. Low temperatures (either day or night) may delay maturity even for the most prepared and committed producer. Even though the

environmental parameter is largely out of the producer's control, implementation of the following practices will still encourage timely maturity even under adverse environmental conditions.

Genotype

Genotype, which can be considered as variety in this discussion, is a substantial factor in determining the maturity realized during a given season. Maturity varies among commercially available varieties marketed in each region and this varietal characteristic should be considered during variety selection. UT Extension publication PB 1742 Tennessee Cotton Variety Trial Results (extension.tennessee.edu/publications/Documents/PB1742.pdf) includes data on relative maturity of varieties tested in Official Variety Trials (OVTs) each year. Earlier maturing varieties (classified as early or early-mid) will typically set and mature a profitable boll load in a shorter time frame than later maturing varieties (classified as mid to full). However, since early or early-mid varieties reach cutout earlier in the season, they are typically out-yielded by later maturing varieties in years with a longer growing season. Still, planting later maturing varieties is a risky endeavor along the northern edge of the cotton belt as the average season is not long enough to allow the later-maturing varieties to consistently outperform their earlier-maturing counterparts. If an early-mid or mid maturing variety is planted in a short-season environment, several management practices encouraging the early onset of flowering and continuous flowering until the last effective bloom date will have to be implemented to capture yield potential. In Tennessee, a mid-maturing variety should only be grown if weather allows planting early in the recommended planting window. Additionally, its maturity will need to be aggressively managed throughout the season to capture its yield potential before the weather turns in the fall.

Figure 1: Commercially available varieties marketed within a given region generally fit the expected season length. Still, maturity within these subsets can vary.

Management

Management is often more important than genotype to the maturity of a given crop. Management decisions that encourage earliness can be divided into four timeframes: Pre-plant and planting, early-season, mid-season and late season.

Pre-plant and planting

Soil testing should be conducted at least once every two years and lime, macro- and micro-nutrients should be applied as recommended by UT Extension publication SP 763 UT Fertility Recommendations for Tennessee Row Crops (extension.tennessee.edu/publications/Documents/SP763.pdf). Maintaining optimum pH and nutrient levels will support rapid early season growth, avoid premature cutout, and ensure a yield-limiting deficiency does not develop. Applications of nitrogen (N) should be split, if possible, to reduce the potential of loss and allow mid-season adjustment. These practices will reduce incidence of excessive nutrients which can complicate management and delay maturity.

Rapid seedling emergence and establishment has become more important in recent years due to increased use of pre-emerge and residual herbicides required to manage resistant weeds and increased pressure from early-season insect pests. If not addressed, these factors can interact to delay maturity and ultimately decrease yields. Proper seedbed preparation will encourage rapid seedling emergence and establishment by preventing the seedlings from suffering through saturated, cool soil common early in the spring. On poorly drained bottom ground, commonly characterized as saturated early in the season, beds should be considered to

help warm and dry the seedbed. For well-drained soils managed in no-till, consider burning down a few days early to allow the seedbed to warm and dry.

Plant high quality seedlots with cold germination tests greater than 65 percent. When planting several seedlots over several planting dates, progress through seedlots by planting the highest quality seed first. This should maximize the germination of lower-quality seedlots by shifting their planting into more favorable weather. Seed should be treated with fungicides and insecticides or these should be applied in-furrow to ensure a rapid grow-off. If the seedbed is cool or wet, consider adding an extra fungicide at planting to combat seedling diseases. Calibrate the planter to achieve 3 to 4 plants per foot if planting in 38- to 40-inch rows. Ideal planting is into moisture at a depth between ½ inch to 1 inch with seeds never placed deeper than 1.5 inches. Planting should occur when: 1) the five-day forecast calls for at least 20 degree day 60s (DD60s, calculated as average daily temperature minus 60), 2) there are no minimum temps below 50 F in the forecast, and 3) seedbed temperatures exceed 65 F at the 3-inch depth. In Tennessee, plant as many acres as the weather allows between April 20 and May 15. If planting later than May 10, only plant an early maturing variety. Heat unit ranges expected for a given growth stage and date estimates based on 30-year temperature normals in Jackson, Tennessee, can be found in Table 1. These dates highlight the ideal planting window in Tennessee. Although delaying planting 10 days from April 20 to May 1 only delays harvest by five days, on average, delaying planting an additional 10 days from May 1 to May 10 delays harvest by 17 days. This shift occurs because average daily temperatures in Jackson, Tennessee, decline to below 60 F in mid-October and GDDs stop accumulating.

Table 1: Heat units typically required to reach growth stages in the Mid-South and corresponding dates based on DD60s calculated from 30-year normals observed at the West Tennessee AgResearch and Education Center in Jackson, TN.

Growth Stage	Heat Unit range (DD60s)	Average	Date estimates for Jackson, TN, based on 30 year temperature normals		
Planting Date	-	-	**4/20**	**5/1**	**5/10**
Planting to Emergence	50-60	55	5/03	5/09	5/15
Planting to First Square	475-535	505	6/12	6/15	6/18
Planting to First Flower	775-850	813	6/29	7/01	7/04
Planting to Open Boll	1625-1800	1713	8/13	8/14	8/17
Planting to Harvest	2200-2600	2400	9/27	10/02	10/19

Heat unit ranges relative to growth stage are modified from Oosterhuis, 1990

Early season management

Insects, weeds and nitrogen are the main factors that should be addressed during the early-season management period. Beginning at emergence, scout for thrips. Recent research has highlighted the benefits of a one- to two-leaf stage foliar application even to insecticide treated seed, particularly under conditions of slow or poor seedling growth. The crop should additionally be monitored for the appearance of squares to initiate plant bug scouting. Threshold populations, insecticide products and rates can be found in UT Extension publication PB 1768 Tennessee Insect Control Recommendations for Field Crops (extension.tennessee.edu/publications/Documents/pb1768.pdf).

Due to the relatively slow development of cotton's canopy from seedling to first square, this period is generally associated with the largest percentage of weed emergence and establishment. Residual herbicides should be overlapped to maintain control of resistant weeds. Fields should be monitored for breaks in residuals and timely post applications should be made when yield-impacting populations are present. Since many of these chemicals may delay cotton maturity, the preferred method of application for many herbicides is post-direct or hooded; even sloppy applications from post-direct or hooded sprayers will still generally be preferred over a broadcast application to a sub-tolerant crop. Additional information on sprayer calibration directions, herbicides, rates and remarks can be found in UT Extension publication PB 1580 Weed Control Manual for Tennessee (extension.tennessee.edu/publications/Documents/PB1580.pdf).

The second half of a split N application should be applied near the time of first square. This application should consider potential N loss which may have occurred since the first split with the purpose of meeting demand without providing an excessive amount of available N. Excessive N applications delay maturity by promoting rank growth which shades lower fruiting positions and subtending leaves, shifting boll set to later in the season.

Mid-season management

Figure 2: Maintaining high fruit retention through the flowering period will increase the timlieness of maturity and naturally regulate vegetative growth, thereby reducing the need for plant growth regulators.

Mid-season management of weed and insect pests is similar from early-season to mid-season, although concerning species may shift between these periods. Still, fields should be scouted and populations addressed when thresholds are met to protect low position fruit and maintain 80 percent or higher square retention into flowering.

In addition to insects and weeds, mid-season management also includes management of plant growth and irrigation. Prevent rank growth by applying a mepiquat-based growth regulator per label instructions. The best plant growth management approaches utilize in-season plant observations such as internode length of the top five internodes or height-to-node ratios. Increased rates of plant growth regulators may be justified: 1) in varieties with tendencies for rank growth, 2) in fields with histories of rank growth, 3) if cotton exceeds 24 inches in height without a bloom or 4) in cotton with less than 80 percent square retention at first bloom.

Irrigation events to support growth through the squaring stage are not typically required if rainfall is adequate, as over-application of water during this period can delay maturity and reduce yields. Applications of irrigation water to pre-flower cotton should not be made unless the established deficit irrigation threshold has been met. As the crop moves into the flowering period, water use increases substantially. Allowing water stress to develop during this stage may result in the abortion of first or second position fruit, creating a fruiting gap and delaying maturity. Properly timed irrigation events during the flowering period can minimize stress and encourage the plant to retain these fruiting positions. Additional information on irrigation management can be found in Cotton Irrigation Management for Humid Regions (www.cottoninc.com/fiber/AgriculturalDisciplines/Engineering/Irrigation-Management/cotton-irrigation-web.pdf).

Late-season management

Many benefits of managing for earliness come to fruition during the late season. Management decisions during this period focus on terminating insecticide and irrigation applications and triggering harvest aid applications. For Tennessee, the last effective blooms (LEBs) are considered to appear on August 15. The physiological stages of boll development and date estimates based on a LEB date of August 15 in Jackson, Tennessee, can be found in Table 2. From these dates, it is evident that blooms appearing past August 15 will require heat units in October to mature. Due to diminishing heat units in October, it is unlikely that blooms

appearing past August 15 will contribute to yield. One approach to help identify this last effective fruiting population later in the season is to flag or label blooms present on August 15 and monitor them through the remainder of the season. This approach will prevent managing for "phantom bolls" that mature too late to make their way into the picker.

Table 2: Events during Boll Development, typical event lengths in days after flower, and date estimations based on a last effective bloom date of August 15.

Events during boll development	Days after flower	Dates
Flower	-	8/15
Pollen tube growth and seed fertilization	0- 3	8/15- 8/18
Fiber lengthening	3- 25	8/18- 9/9
Fiber thickening	15- 45	8/30- 9/29
Protein and oil accumulation	25- 50	9/9- 10/4
Boll opening	50	10/4

Event description and lengths in days are modified from Stewart, 1986

Figure 3: Managing for earliness can shift the window of boll susceptibility to bollworms and budworms closer to planting and prevent the need to control late-season flights.

Cotton becomes less susceptible and less attractive to insect damage when 350 or 450 DD60s have accumulated after cutout (NAWF 5). Therefore, insecticide thresholds should be increased and applications for some pests ultimately terminated at the end of the effective susceptibility window, as defined in UT Extension publication PB 1768 Insect Control Recommendations for Field Crops (extension.tennessee.edu/publications/Documents/PB1768.pdf). Furthermore, cotton should generally not need an additional application of irrigation water after first cracked boll.

Applications of harvest aids should be made when two or more maturity indicators have been met. One of the most commonly used triggers is 60 percent open boll (based on boll counts, not visual estimates). Another method which may give a better indication of crop maturity if fruiting gaps are present is the node above cracked boll (NACB) method; harvest aids should be applied using this method when there are four or fewer nodes above the highest first-position cracked boll to the highest harvestable boll. The last method, which should be used as a "check" for both of the above methods, is the sharp-knife technique. This method triggers applications when the uppermost harvestable boll is difficult to slice with a sharp knife, has seed coat color with no jelly in the seed, and the fiber strings out when sliced. Preconditioning treatments, or treatments applied prior triggering by two or more of these methods, do not accelerate maturity of the fiber or seed. On the contrary, preconditioning treatments can slow boll maturity and may reduce lint yields and/or fiber quality under certain circumstances. After satisfactory defoliation and boll opening, the crop should be harvested in a timely manner to reduce boll weathering and loss of cotton from the plant. Additional information on harvest aids can be found in the Mid-South Cotton Defoliation Guide (www.mississippi-crops.com/wp-content/uploads/2014/09/2014-Cotton-Defoliation-Guide_Final.pdf).

Conclusion

There are numerous reasons to manage cotton for timely maturity, the most important being more consistent, higher yields at reduced costs. Managing for earliness involves an integrated set of practices that start with seedbed preparation and continue through harvest. If properly implemented, this integrated approach may allow short-season cotton producers to plant mid-maturing cultivars that offer superior yield potential and/or fiber quality. Any single practice may only gain one or two days in maturity, but when combined, the total set may decrease time to maturity by one or two weeks or more. In Tennessee, a two-week gain in maturity can often shift the harvest period back from November into October, when maximum profit potential of the crop can be captured by the picker.

Further Reading

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