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CAPITALIZING ON EARLINESS

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Earliness is one of the most universal goals in a cotton management scheme. Yet if you question growers in different cotton growing regions, each will have a slightly different interpretation of what the term means. This diversity likely reflects their specific production challenges and approaches to maximize profitability. A northern grower must contend with a limited growing season. A lower Delta producer hopes to minimize insect management costs and will take steps accordingly. Both are using practices that promote earliness – however those practices may be appropriate in one area and not the other. This newsletter will discuss how key components of earliness can be shaped into a coordinated management strategy that optimizes profitability and timely development.

Cotton producers across the Belt would agree on many of the benefits of early maturity – decreased insect pressure, higher quality, lower costs and frequently higher yields. But if you ask growers about their formula for achieving earliness, it might differ widely one side of the Belt to the other or perhaps even from individual neighbors. The plurality of practices that promote earliness can create confusion if not placed in context. It is impossible to fashion a coordinated earliness management plan without understanding the factors that affect maturity. More importantly, you must understand how these factors interact with each other (i.e., nitrogen and irrigation management, or variety selection and Pix use). The key to fashioning a flexible strategy that can capitalize on changing crop conditions is first understanding the factors that affect maturity and modifying these factors to fit the intended earliness scheme.

Defining Earliness

Before proceeding, it is essential to mention that earliness can be defined in several ways. Earliness can be both relative and absolute. It is probably most often thought of in *absolute* terms such as the shortest amount of time to produce a profitable crop. This aspect of earliness has enabled producers along the northern tier of the Belt to increase yields consistently. Short season production systems push the boundaries of the Belt further north with the advent of new varieties, technologies and management philosophies.

Earliness also has a *relative* component that must be recognized when selecting management pathways. It is obvious that southern Georgia producers can grow cotton during a longer portion of the year than producers in Oklahoma.

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What may not be obvious is that earliness practices differ significantly across these regions. The common principle underlying each earliness doctrine is matching the crop season with the most favorable environmental time frame for the area. Earliness is sometimes achieved by delaying planting. Two examples illustrate this point. In rain-fed regions without supplemental irrigation, planting may be delayed to coincide the bloom period with increased rainfall projections. Delays in planting also have been advocated to minimize boll weevil reproduction following their spring emergence from diapause.

Measuring Earliness

First Flower is frequently associated with earliness. One long-held benchmark of early season success is the presence of white flowers by July 4. This particular measure is fitting for many areas that begin planting in mid-April. Early flowering is beneficial to growers because it tends to maximize the effective bloom period while simultaneously limiting the crop's window of vulnerability to insect attack. The effective bloom period is from 1st bloom to the last day one can reasonably expect to mature and harvest a boll that blooms that day or NAWF reaches 4 or 5. A long effective bloom period provides the crop more opportunities to set bolls. Periods of stress that limit boll retention can reduce the effective bloom period. When flowering is delayed, this buffer period is incrementally lost. While two-bale cotton can be loaded in four weeks or less, there is a strong relationship between planting dates (and first flowering date) and final yield. Insect pressure also increases during the summer season with successive generations and the associated increases in populations. The inherent limitation in measuring earliness by date of first flower is that this assesses solely potential earliness. It does not account for events that perturb earliness after first flower, such as rank growth, low fruit retention or insect damage.

Days to Cutout

Recent assessments of earliness are beginning to refer to the length of time from planting to cutout (or NAWF = 4 or 5). This approach measures the end of the effective bloom period rather than the beginning. This technique is attractive because it gauges how rapidly the crop was set. Managers can evaluate variety, cultural practice or production system by comparing its associated days to cutout with the available favorable season length. Integration of the developmental sequence beyond first flower makes this a more comprehensive measure of earliness. The limitation in this approach is that it does integrate a wide range of factors, some of which are completely independent of one another. If a variety has short days to cutout, does that indicate a determinant growth habit, drought conditions or limited fertility? It is helpful to determine which factor was dominant in affecting time to cutout.

Flowering/Fruiting Profile

Final plant mapping provides an extremely precise method to evaluate maturity. The exact position and relative maturity of the entire crop, including immature bolls and those lost to boll rot, can be recorded. This method can determine both the duration and intensity of boll loading. Because this technique traces a profile of the actual boll loading process, it enables practitioners to recreate the effective flowering period to estimate the impact of management decisions and environmental stresses on yield development. For example, extended periods of rain, cloudy weather or unrestrained insect pressure will leave signatures (gaps in the plant) that can be read during final mapping. The permanent record that results from final mapping also provides a benchmark for future reference. The investment in time cited as a disadvantage with this technique can be lessened if the plants are collected prior to harvest and mapped once the season's immediate demands have concluded.

Percent Open Bolls

Plant breeders utilize this technique to measure the relative maturity of cotton varieties. A large number of varieties, lines or candidates for release can be compared through rank of percent open. While this approach is widely used by breeders and researchers, it has two drawbacks that limit its use by growers. Year-to-year environmental variations make comparisons between years difficult. Furthermore, even within an experimental trial, specific management decisions have differential impacts on the diverse varieties or treatments under review. This unavoidable complication is at the heart of arguments to base decisions on varieties or other inputs on data across years and environments. The larger body of data dampens year-to-year fluctuations.

Genetic Influences on Maturity

Cotton's genetic makeup has a dominant impact on maturity and earliness. The **node of the first fruiting branch** varies greatly with variety. Full season varieties tend to produce their first fruiting branch one or two nodes later than short season cultivars. This distinction between varieties is most evident when compared in replicated trials with identical planting dates and cultural practices. Some cultivars produce their first squares on node 5, while others have minimal fruiting squares until node 7 or higher. This single character can create a 5-7 day span in first flower.

Nodes Above White Flower (NAWF) at early bloom is associated with both the node location of the first fruiting branch and earliness. Varieties that produce squares on lower nodes tend also to have fewer NAWF at early bloom. This association accentuates earliness by limiting the potential number of fruiting branches. Varieties with this disposition of early fruiting and lower early bloom NAWF must be intensively managed to avoid an abrupt end to boll loading, especially if environmental stress overwhelms the crop's limited carrying capacity.

The **boll retention** patterns of varieties are currently being investigated by researchers across the Belt. The data obtained to date demonstrates clearly that varieties differ in the distribution of bolls. While the information is still preliminary, it is apparent that ideal or target boll retention must be developed for each variety or class of varieties. So called determinant varieties may exhibit this characteristic due to higher initial boll retention. The distinction between a variety's determinacy and boll retention patterns could provide valuable clues in breeding efforts. Lines with excellent boll retention and indeterminacy would enable producers to calibrate inputs with season length and desired yield.

Morphology of a variety also can influence maturity directly and indirectly. Morphological traits that can impact earliness include leaf shape and root/shoot ratios. Deeply divided leaves allow sunlight to penetrate deeper into the canopy, which improves the light environment and potentially early boll set. Varieties with lower root/shoot ratios expend less carbohydrates on soil exploration which can enhance earliness if coupled to early fruiting in favorable environments.

Varietal differences in hormonal balances and how this can impact maturity is an intriguing area for additional research. Differential responses to Pix among varieties may stem from differences in hormone balances as well as vegetative tendencies. If present, these varied balances also may explain boll retention patterns as well as varieties' response to stress.

Environmental Influences on Maturity

The genetic complement only determines a variety's potential maturity. Maturity can be accentuated or dampened by a wide assortment of environmental modifiers. Several of the most commonly encountered conditions that impact earliness are soil moisture, fertility level, temperature, cloudy weather and pest pressure.

Soil Moisture

Moisture availability is the single most important agronomic limiting factor. Most regions, including intensively managed areas with irrigation capabilities, encounter some degree of moisture stress sometime during the season. When rainfall is abundant without other limiting environmental factors present, varieties can reach more closely their genetic potential. In these situations, the intrinsic properties of each variety discussed previously will be fully expressed.

On the other hand, in the presence of water stress, variety character can change markedly. Even moderate drought stress prior to bloom will decrease vegetative vigor and NAWF. A full season variety that routinely produced 9-10 NAWF at 1st bloom under non-stressed conditions may enter early bloom with 6-7 NAWF under moderate stress. It is not clear if short season varieties are impacted to the same degree under this same drought scenario. Field observations suggest that early season drought which is not relieved, subsequently shortens the maturity of all varieties. This tends to dampen the relative differences in maturity between varieties.

Drought occurring after the arrival of bloom can have a completely different impact on relative varietal performance. Varieties with lower node of first flower and higher initial boll retention will be less impacted by mid-season drought that terminates further loading.

Cultivars with longer boll loading periods may have an atypically earlier maturity than normal following mid-season drought, but at a substantially higher yield loss. On the other hand, full season varieties have an advantage if the drought is relieved.

Temperature

Temperature effects on maturity can be related to drought stress. When drought-stressed plants wilt, transpirational cooling stops and with it the leaves' ability to moderate extremely hot temperatures. Tissues are damaged, which lowers their ability to support yield development. This stress further limits crop growth and accentuates the affects mentioned in the last section. Earliness is enhanced and yield is reduced.

Extreme heat also can delay maturity in certain varieties. Varieties that are bred in more temperate regions may experience pollen sterility and/or reduced boll retention when produced in the lower desert or during abnormally hot seasons. This problem is associated with high nighttime temperatures when lows remain in the 80s. Heat intolerant varieties, that are normally early, mature later as boll loading is interrupted while terminal growth continues. This continues until the nighttime temperature moderates.

Pest Pressure

Insect damage to squares can, in some situations, significantly delay crop maturity. Delays in maturity are most damaging when excessive early season squares are lost, which delays boll loading and accelerates terminal growth. This familiar malady can perpetuate itself as each cycle of shed-growth-shed repeats. In contrast, late season square shed can be tolerated if boll loading has neared completion. Under these conditions, earliness is unaffected.

Boll damage from insects may not impact earliness if the damage occurs to bolls that are more than 10-15 days old. Bolls are damaged but not shed. In this instance, the plant's investment of carbohydrates and nutrients is largely wasted in the affected tissue. Although earliness may not be affected, both yield and quality of cotton will be decreased. Damage from foliage feeders while the leaf area is developing may have a pronounced impact on earliness. Uncontrolled thrips feeding on young terminals may delay maturity by 7 days or more along the northern tier of the Belt. Foliage damage once leaf area development is complete may limit boll development and size without arresting maturity.

Cloudy Weather that is sufficient to limit fruit retention will similarly retard maturity. Cloudy weather prior to bloom is less damaging as sink size is relatively small. Once flowering occurs, prolonged cloudy weather can stimulate shed leading to later maturity. Cloudy weather in late season can cause an increase in earliness due to shedding of small bolls and allowing only the older bolls to mature.

Managing Maturity

The previous discussion has centered on how preplant decisions and post-plant conditions can effect earliness. The most dominant determinant on crop maturity rests in the manager's decisions. The available choices can promote or delay maturity – both of which can improve crop performance.

A more appropriate concept than earliness is timeliness. Earliness at the cost of profitable yield is a poor investment. Additional productivity can be realized when all the factors that determine maturity are balanced to complement seasonal conditions. Many of these decisions are in-season management calls based on available crop and environmental conditions. Good management means continuously adjusting cultural practice decisions based on available insect scouting, plant mapping, tissue monitoring, weather forecasts, etc. Once obtained, the information must be analyzed and compared to chronological targets which reflect the overall management objectives. This dynamic approach enables the producer to modify the expression of each variety's potential maturity by conducting specific practices which are based on an accurate read of the environmental and crop conditions to date. As conditions change, so do management practices. Several practices should be considered:

Irrigation

Irrigation capabilities in traditionally rainfed production regions have demanded a rethinking in overall management strategies. A common complaint is that irrigation delays maturity. Undoubtedly there are instances where the production of additional fruiting branches which are subsequently used for boll set will contribute to lengthening the effective boll loading period. This is a predictable and beneficial outgrowth of irrigation that increases field productivity. It should be added that irrigation can increase retention at existing fruiting sites which will not impact maturity. Other complaints of delayed maturity can be tracked to higher insect pressure which can dilute or eliminate the benefits of prolonging boll set. Insects such as bollworms will congregate in fields where plants remain lush. Without increased vigilance, insect damage, increased control expenses and later maturity can be anticipated.

Pix

Research trials have consistently found that Pix applications speed maturity. Detailed plant mapping has indicated that boll retention on the lower fruiting branches increases following treatment. This enables treated fields to approach their capacity more rapidly. Ongoing research continues to refine how best to utilize this tool. It is becoming clear that varietal genetic characters that impact maturity, such as vegetative tendencies, boll retention patterns and determinacy interact to effect response to Pix. Environmental influences on maturity, such as moisture status and cloud cover, also must be considered. The gradual process of developing field-specific Pix use guidelines will entail use of an array of monitoring tools including in-season plant monitoring and computer-based predictive models.

Nitrogen Fertilization

Nitrogen fertilization practices are closely associated with maturity because this nutrient drives vegetative and reproductive growth, boll filling, crop attractiveness to insects and its susceptibility to boll rot. Countless experiments have explored the many facets in physiological, developmental and management interactions with nitrogen. There is a growing reliance on in-season tissue monitoring and plant mapping to match nitrogen to crop conditions. This approach allows managers to make mid-course corrections rather than relying on presumptive and usually overly optimistic pre-season predictions.

Insect Management

Crop management is undergoing an evolution as insect management and agronomic concerns blend together. Researchers and producers long have recognized the maturity delay associated with unrestrained insect pressure. More recently, several researchers are suggesting that square loss, perhaps even boll loss from insects, may have desirable consequences. This suggestion runs counter to an accepted cornerstone of cotton production. The seeming contradiction can be resolved by examining the close connection between NAWF at early bloom and final productivity. Evidence to date demonstrates that fields with excellent square retention but poor vigor are at an unacceptably high risk of premature cutout. Without additional leaf area, early loading stifles overall productivity.

Low NAWF at early bloom is commonly associated with prebloom drought stress, particularly in early maturing varieties. With resumption of stress-relieving rainfall, leaf area and the final crop carrying capacity can increase – if boll loading has not progressed to the point where it also limits further vegetative growth. If square and boll retention are managed to allow some additional vegetative growth in previously drought-stressed cotton, productivity can be increased without sacrificing timely crop development. Further research is required to provide practical guidelines on managing this strategy in commercial production. Any attempt to surgically prune fruiting sites introduces a precarious balance between manageable risk and catastrophic loss.

Wrap Up

Crop maturity is decided by a multitude of factors that all interact. Genetic influences establish a range in maturities that are variety specific, but not fixed. Environmental conditions can either hasten and/or dampen the inherent earliness of selected varieties. Counteracting influences often work simultaneously to shape the maturity of specific fields. Producers can take deliberate actions which suit their management strategies and deliver timely maturity for any given season and region. By adopting in-season monitoring techniques such as plant mapping and tissue monitoring, you can choose tactics that enable you to optimize profitability every year.

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