COTTON PHYSIOLOGY TODAY

Newsletter of the Cotton Physiology Education Program — NATIONAL COTTON COUNCIL

Vol 5, No. 5, June, 1994

NEGOTIATING THE PATH TO PEAK BLOOM

Dave Guthrie, Claude Bonner, Johnny Crawford, Will McCarty and James Supak

Cotton is recognized as a demanding row crop that responds to management and is intolerant of neglect. However, the intensity of management does not remain constant throughout the season but tends to ebb and flow with the crop's growth stage and requirements. At developmentally critical crossroads, production decisions set a course and speed which drive the crop toward the next management moment. This newsletter will discuss the premier management moment, early square to peak bloom.

When producers reflect back on their level of success with a cotton crop, certain crucial moments during the season tend to surface over and over. Everyone is familiar with the uncertainty of the planting season and the decisions that must be made: variety, planting date and rate, crop protection measures, etc. At season's end, the decisions surrounding the harvest preparation are likely second guessed. Insect management may provide a series of judgment calls on treatment thresholds and appropriate responses. Each of these situations requires reasoned and deliberate actions.

The 5- to 6-week period between early square and peak bloom is not so much one crossroad but a series of management intersections that once negotiated determine the course of the remaining season. This is no time to leave the crop's developmental course to chance. Deliberate informed decisions during this time frame can enhance yield, earliness and profit.

Three elements important to crop development and profit merge during this critical time frame. The first is the variety of cultural practices that are required to effectively produce the crop. The second is the precarious transition in the cotton plant's physiology from vegetation to fruiting. The third is the window of opportunity to manage the crop's development prior to heavy boll loading. After significant boll demands are expressed little can be done to change crop direction.

Diverse Production Challenges

Both the range and volume of crop management decisions peak during this time period. Weed management, demanding high priority earlier, is beginning to approach completion as late post-directed and lay-by sprays are applied. Sidedress fertilizer application decisions -- type, rate and timing -- command our attention. These considerations are becoming increasingly complicated as potassium, sulfur, boron and other micronutrients may be included. Insect management priority begins to expand beyond foliage feeders, thrips and aphids to include fruit feeding plant bugs, boll weevils and worms. Modifying crop development through Pix applications becomes a relevant concern as leaf area and height-to-node ratios (HNR) increase. Crop modification deliberations must also include irrigation decisions (where available) if moisture availability becomes limiting. Each of these inputs can and often do exert effects on each other.

Crop in Transition

These varied production practices are conducted on a crop in transition. Although the initial squares are differentiated weeks earlier, the first visible evidence of reproductive growth is emerging. Simultaneous with the arrival of pinhead square, the vegetative growth rate begins to accelerate rapidly due to increased leaf area and improved environmental conditions. Internodes, fruiting branches and leaves that will support the boll load are expanding.

This transition to reproductive growth has important implications for crop managers. The enlarging squares are subject to increasing risk of insect damage. Any damage that aborts squares, particularly first position squares, will modify the balance of vegetative and reproductive growth once boll loading starts. Loss of any first position squares on those initial fruiting branches reduces the reproductive demand or sink for carbohydrates. With this reduced demand from fruit, the plant is capable of supplying additional resources to vegetative terminals. At the same time, the elevated growth rate is creating more leaf area to supply carbohydrates to either energy sink, the desired sink of boll load or the unwanted sink of rampant vegetative growth.

This shifting balance of reproductive/vegetative growth is extremely dynamic, subject to many factors. If environmental conditions are excellent, vigorous vegetative growth shifts the balance toward a larger source or carbohydrate factory. Stresses reduce plant vegetative vigor and subsequently the ability to support boll loading. Aborted squares reduce the initial reproductive sink strength which puts fewer demands on the carbohydrate supply. At the other extreme, high square retention and low vigor create high carbohydrate

National Cotton Council OF AMERICA

demand but inadequate supply. Any combination of these forces creates a new balance point at the onset of boll loading.

Square retention and crop vigor play central roles in this shifting balance. Square retention determines, in part, when the shift toward reproductive growth will occur. When the early squares abort, that shift is delayed. Crop vigor determines the vegetative momentum or horsepower of the crop. Favorable growing conditions add momentum. Together these related forces impact the timing and rate of boll loading along with the final carrying capacity. Delay in fruit loading allows the momentum to build. With a long delay and built up inertia, explosive (rank) vegetative growth is likely. Low early bloom vigor positions the crop perilously close to cutout.

Two examples help illustrate the dynamic relationship between square retention and vegetative growth at early bloom and the impact that these growth characteristics can have on crop maturity and yield. In the first example, favorable growth conditions stimulate a growth rate that exceeds 3 inches per new node. New nodes are added in about 3 days. Therefore, in less than one week terminal growth has added 2 nodes and 6 inches with similar growth in lateral branches. If boll loading is delayed one week due to square shed, plants in this field may grow an additional 6 inches or more with accompanying increases in width. Boll set in the remaining early fruiting sites may subsequently suffer due to inadequate light penetration into the canopy, this shed-growth-shed cycle is the source of the expression that the crop went "vegetative."

At the other extreme, where pre-bloom stress has limited the HNR and nodes above white flower (NAWF) is less than 7 at early bloom, the developing boll load and declining growth rate may precipitate premature cutout. Without immediate intervention to stimulate terminal growth, the advancing bloom up the stalk will soon consume the remaining positions. The earliness gained by a 2-week effective bloom period will be at the cost of lost yield. Alert crop navigation is vital at this developmental crossroads.

Management Maneuverability

The third reason this development point is pivotal to crop performance is that a manager still retains the ability to maneuver the crop with minimal boll load interference. NAWF, a description of the crop's momentum or vegetative velocity, reaches a maximum value soon after first bloom, then begins a decline that culminates in cutout once the plant's carrying capacity is reached. In many cotton production regions, NAWF averages 8-9 at early bloom. Stress may reduce NAWF to below 7 at early bloom. Full season varieties or square shed may push NAWF to 10-11 at early bloom.

With favorable conditions, 80 to 90% of harvestable yield may be set as young bolls in 3 to 4 weeks. As boll loading proceeds, the plant's resources are increasingly directed toward seed and lint development. Cutout, the end of significant boll loading, occurs once NAWF declines to about 4 or 5. With the approach of cutout, attempts to extend the boll loading period become more difficult. Further inputs may add weight by setting bolls from squares that were initiated earlier in the terminal, and by filling and protecting earlier bolls. However, terminal growth and the management maneuverability that comes with it ceases as the reproductive sinks consume all available carbohydrate supplies, and we can not expect renewed terminal activity to be productive because of a lack of time to allow maturation.

A grower's ability to affect crop development becomes more restricted by the developing boll load. The decline in NAWF is driven by all the factors previously mentioned. Depending on crop history and management system, the rate of decline may vary from less than 1 node per week to more than 2. In either case, peak bloom intensifies the reproductive sink's demand. Stresses occurring then or later will trigger immediate crop compensation as small bolls and squares are shed. These fruiting sites are lost with little hope of their replacement. Crop management inputs that are intended to increase the plant's carrying capacity or modify the rate of boll loading must be in place prior to peak bloom. In that short 3- to 4-week boll loading time frame, producers relinquish their control of crop development as physiological processes within the plants set the timetable for crop maturity and harvest.

Management Strategies

So what should managers do to successfully maneuver through these production intersections? Keeping developmental goals in mind will help guide decisions in each of the major management areas.

Weed Management -- Goal: A clean field without crop injury as the canopy closes.

Avoid overtop applications of herbicides that are known to damage terminals and delay development. If salvage treatments are unavoidable, maturity delays and damage can be reduced if the crop is growing vigorously when overtop treatment is applied. Salvage treatment decisions should be made as early in the season as possible. Delays resulting from herbicide injury are likely to be more severe if the crop is drought-stressed. Post-directed herbicide treatments should be carefully calibrated and applied. Squares may abort if contacted by spray or drift. Windy conditions or high sprayer pressure increases this risk. As growing points, terminals are particularly sensitive to herbicide injury.

Plant Nutrition -- Goal: Balanced fertility that supplies required nutrients for optimum yields and maturity.

The nutritional demands of the developing crop change dramatically during this time period. During early squaring, nutrient requirements are low and soil fertility is generally adequate. Excessive nitrogen during this time period can stimulate luxuriant growth that is attractive to insect pests and may lead to rank growth. Application of phosphorous and potassium during this period should be based on quantified requirements as determined by soil or tissue testing. Boron applications may be required if warranted by local conditions, such as recent liming or low soil organic matter content.

During the early weeks of bloom, nitrogen fertility may become limiting. To adequately assess crop nitrogen status, some form of plant monitoring is required. Plant mapping that tracks the crop's NAWF, coupled with petiole nitrate-nitrogen testing can match nitrogen applications to crop demand. This combined nutrient/plant monitoring process can also enable dryland growers to take advantage of beneficial rains that boost yield expectations. Additional nitrogen applications should be based on some objective, realistic measure of yield expectations. For example, research conducted in the High Plains has led to guidelines for applying additional nitrogen per increment of additional mid-season rainfall (5 lbs N/1 inch of water). Automatically applying N, without considering whether it is needed, can delay maturity and increase problems with insect pests, boll rot and harvest preparation.

Irrigation -- Goal: Create plant structure that can support rapid boll loading and desired yield potential.

Irrigation technology in traditionally rain-fed areas has evolved tremendously in recent years. Conventional wisdom held that pre-bloom irrigations were unwarranted and perhaps detrimental. Current recommendations recognize that irrigations should be based on crop requirements rather than the calendar. Sufficient fruiting sites and leaf area must be developed prior to the onset of boll loading to realize maximum economic yields and benefits from irrigation. As mentioned previously, NAWF below 7 at early bloom is frequently associated with drought stress that predisposes a crop to premature cutout. In this case, immediate irrigation is required to stimulate terminal growth prior to unstoppable decline in NAWF. Many regions have developed practical irrigation programs and guidelines that growers can consult. This systematic approach has demonstrated the potential benefits from irrigations prior to bloom. Contact your local extension agents for specific irrigation guidelines for your region.

Square Retention -- Goal: Sufficient numbers of 1st and 2nd position squares to promote earliness and rapid boll loading.

Squares are differentiated in the terminal about 40 to 45 days prior to bloom. Pinhead squares precede the bloom stage by 20 to 25 days. Any loss of these squares will have a long term impact on crop maturity due to this lag time. A wealth of evidence has demonstrated that apart from herbicide spray injury, the vast majority of square shed prior to early bloom is insect-related. Plant bugs can be devastating to small squares. Boll weevils are primarily associated with damage to larger squares. Bollworms and budworms can destroy squares of all sizes. Together, these pests and related species can force maturity delays which may also reduce yield. Plant bugs and bollworms/budworms can also destroy terminals, causing "crazy cotton". Square retention guidelines have been developed in most states. As a general rule, 1st position square retention levels prior to early bloom should exceed 80 to 90%, depending on region. Remember that in most areas, by early bloom all of the fruiting sites which will be harvested are present in some form. Crop protection is essential.

Plant Growth Regulation -- Goal: High crop vigor <u>plus</u> high square retention.

Plant mapping can describe the crop's growth and developmental status in practical terms that help diagnose problems early to minimize maturity delays or yield reductions. Plant mapping can also be beneficial when good crop conformation is present, by avoiding unnecessary inputs or to signal that increased inputs may be necessary to support a greater than average fruit load.

During pre-bloom, growers should be aiming for high vigor coupled with high square retention that channels the crop's resources to rapid boll loading. Vigilant insect control and careful herbicide application insure adequate square retention. Plant vigor can be described by its height-to-node ratio (HNR), calculated simply by dividing the crop's height from the seedling leaves to the terminal by the number of mainstem nodes. The total number of mainstem nodes is determined by counting each node from the first true leaf equaling 1 to the terminal node, defined as highest node with unfurled mainstem leaf greater than 1 inch in diameter. The target HNR at early bloom varies by region but is typically 1.5 to 1.8 inches per node. This HNR zone helps to maximize early boll retention <u>and</u> total boll carrying capacity. Eliminating stresses (commonly drought stress) can increase crop vigor. Pix applications can favorably reduce HNR to the target range without reducing crop vigor.

Wrapup

Successful cotton production is founded on recognizing and responding to the crop's requirements. From early square to peak bloom, crop demands are high but so are the rewards. The path to peak bloom also leads to profit potential. Negotiate it carefully.

For additional reading on management, refer to the following issues of *Cotton Physiology Today:*

- Monitoring Plant Vigor, June 1993, Vol. 4, #5
- Charting a Course to Cutout, July 1993, Vol. 4, #6
- Environmental Causes of Shed, December 1989

To obtain copies of these issues, call or write the National Cotton Council, PO Box 12285, Memphis, TN 38182-0285 (phone: 901-274-9030). For more information on nitrogen management, the subject of last month's newsletter, you are referred to *Nitrogen Nutrition of Cotton: Practical Issues*, published by the American Society of Agronomy, Inc., Madison, Wisconsin.

The Cotton Physiology Education Program is supported by a grant to The Cotton Foundation from BASF Agricultural Products, and brought to you as a program of the National Cotton Council in cooperation with the State Extension Service.