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MONITORING PLANT VIGOR

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A pronouncement that someone is in "Tall Cotton" is taken to mean success or good fortune. Many farmers in the past associated crop height with final yield. To them, big plants produced big yields. Now we know that isn't exactly true. Still, the question of what is a desirable plant height can liven up a discussion. This newsletter will explore some of the factors that control cotton height, and some useful indices that growers can use to turn tall cotton into profitable yields.

Monitoring Plant Height

Cotton monitoring can mean many things to many people, depending on their background and objectives. It might mean views from the seat of a pickup truck or microscopes and analytical instruments in laboratories. But there is one measurement that everyone agrees on: "How tall is the crop?". The importance placed on height is appropriate because experience and experiment agree that cotton yield is directly related to height — at least to a point.

Researchers have attempted to identify the ideal plant height. This effort is complicated by the fact that early season temperatures, wind, variety, water, fertility, plant type, row spacing and plant density all influence plant height. Some general "rules of thumb" have been developed suggesting that end-of-season plant height for full-season varieties should be approximately the same as row spacing to avoid limiting yield. However, this guideline does not apply to varieties bred for West Texas and the High Plains which have "naturally" shortened internodes.

Selecting a target height enables producers to manage their crop with a goal in mind. End-of-season monitoring will tell the story of "what happened" but producers need a tool to manage the crop as it is growing.

Node Development

Prior to bloom, node development is primarily dependent on temperature. A new node is developed approximately every 50 DD60s, whether that accumulation occurs in 2 days or 10 days. Therefore, node number is a reliable indicator of plant age through early bloom. By monitoring and reporting crop age by nodes, producers can speak a common language that avoids the year and location differences in temperature that hamper day-based age descriptions.

Node development is remarkably insensitive to environmental stress such as drought, salinity, diseases, insects and nematodes. However, leaf area and age, plant carrying capacity, square and boll retention, and plant growth regulator (PGR) applications can alter node development, particularly after early bloom.

Internode Elongation

The portion of stem between each node is called the internode. Unlike nodes, internodes are very sensitive to environmental and plant conditions. This sensitivity makes internodes reliable growth indicators. A long internode (3 to 5 inches) indicates favorable growth conditions and the potential for rank growth. A short internode (1.5 to 2 inches) results from stress encountered during the development of the associated node. A moderate internode (2 to 3 inches) indicates adequate vegetative development.

Cell elongation in a developing internode stops between the fourth and fifth node from the terminal. That internode is the last fully mature internode and is the best indicator of present plant activity.

Tree Rings and Cotton

Node development and internode elongation can be likened to rings found in trees. A cotton plant produces a new node with each 50 DD60s similar to the new growth ring formed by a tree each season. Count the tree rings on a tree or main-stem nodes on a cotton

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plant to determine the plant age. The length of the internode in cotton plants is analogous to the thickness of each tree ring. Wide rings in trees and long internodes in cotton develop under favorable conditions. Narrow rings and short internodes occur during less favorable growth periods. Observers of cotton node numbers and internode lengths can read the pre-bloom history of the growth conditions recorded by the plant.

Height-to-Node Ratio (HNR)

The history of cotton growth can be recorded simply as a ratio of the plant's height to its node number. This technique introduces a dynamic monitoring tool that can be used to track past growth and predict tendencies. As a standard measurement, height is recorded from the plant's cotyledons (seedling leaves) to the top of the terminal whorl of developing leaves. Node number is determined by counting the number of main-stem nodes or true leaves (or scars indicating where a leaf has been). By definition and to insure consistency stop counting at the uppermost node that is associated with an unfurled leaf at least 1 inch in diameter (the size of a quarter).

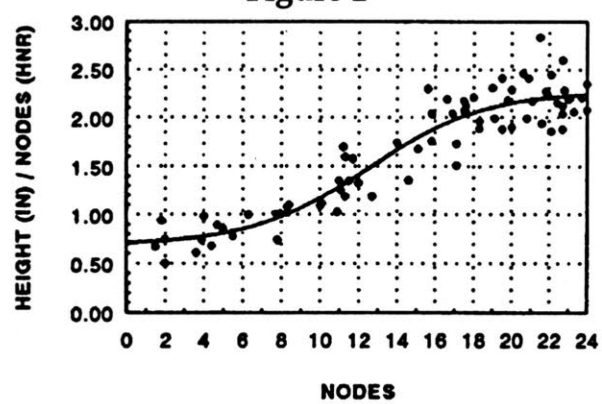
Like a ruler, the end or the seedling leaves are counted as node 0. To calculate HNR, divide the plant height by the number of nodes. Using this technique, a plant that was 20 inches tall with 15 nodes would have a HNR of $20 \div 15 = 1.33$.

Height-to-node ratios normally change as the season progresses. Following emergence, the plant leaf area is small and temperatures are normally cooler. This combination limits both node development and internode elongation. Once leaf area and temperatures increase, HNR similarly increases. After bloom begins, internode length should decrease as developing bolls progressively increase their demands for carbohydrates and nutrients.

If internode length continues to increase, the boll load is not slowing the plant down enough. Management inputs to slow plant growth should be implemented ASAP. Pix or Mepichlor applications may be required to help slow down the plants. Most available evidence indicates that water-stress is not a good method of reducing a vegetative tendency. Holding back on additional N applications can be appropriate in dealing with excessive vegetative growth.

Height-to-node ratios reflect the sum total of a particular plant's experiences, the availability of water, nutrients, heat, sunlight, etc. As these vary, so does the HNR. Attempts have been made to develop HNR guidelines that describe desirable crop vigor. These HNR guidelines are derived from non-stressed fields with excellent final yields (Figures 1 and 2). Growers can compare current crop development with this benchmark data to make push/pull-type decisions for crop management. A low HNR indicates low relative vigor and suggests that efforts to push the crop are needed to relieve the stress. A high relative HNR indicates robust growth.

Figure 1

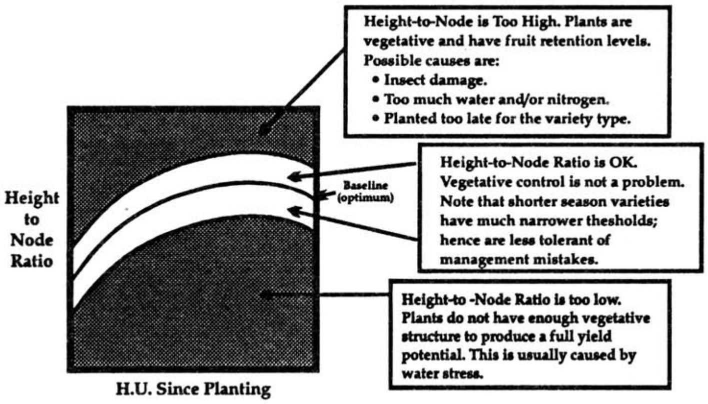


(Kerby and Hake, 1993)

Vigorous growth and high HNR values (1.3 to 1.6 inches) in pre-blooming picker cotton indicate that the stage is being set to support high yields. The challenge is to convert this vigor into harvestable yield, not cord wood. Increasing HNR after early bloom suggests that this conversion is not occurring, which should be evaluated more closely to determine the possible cause. In stripper cotton, moderate HNR values (1 to 1.3 inches) during pre-bloom are needed to balance plant development with the shortened boll loading period.

Height-to-node ratio calculations are most meaningful for nodes that support the dominant boll load. This zone varies from node 5 to 15 (fruiting branches 1 through 11) in more northern regions to node 7 to 18 (fruiting branches 1 through 12) in longer season areas. In the low desert regions, this zone may extend from node 7 to 32 (fruiting branches 1 through 26). Excellent plant vigor in those main stem leaves and associated fruiting branches apparently serve to increase boll retention and maturation. This is supported by research indicating that boll growth is supported by the closest leaves.

Figure 2



(Silvertooth, 1993)

Growth Rate (GR)

While the HNR provides a good average indication of overall plant vigor and growth potential, it has one main limitation. Managers often are concerned most with growth response to recent production events and near term future potential. As an average, the HNR integrates the entire growth history into a single number. It is relatively insensitive to recent changes in growth that can indicate the need for management intervention, particularly if HNR's are not measured periodically to provide trends for a given field.

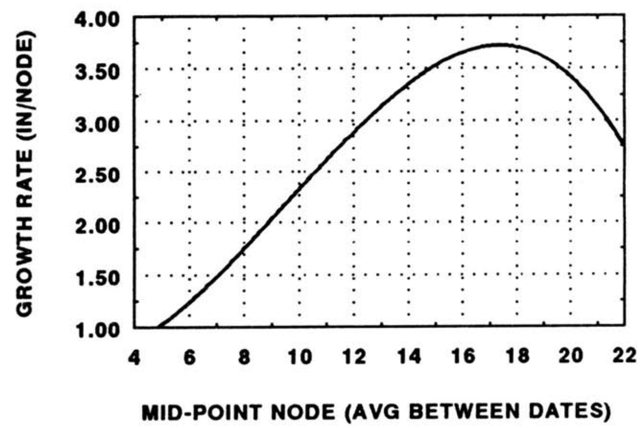
Managers who monitor the crop regularly can calculate growth rates (GR). The GR measures the short term changes in internode elongation. Growth rate is a sensitive measure of recent growth patterns. It is calculated as the change in height between two monitoring dates divided by the change in node number. As an example, if height increased from 16 to 24 inches and node number increased from 13 to 15 nodes between two sampling periods, the GR would equal [(24-16)÷(15-13)] = 8÷2 = 4 inches/new node. The GR can add to the value of the height-to-node ratio. Both measurements are valuable.

The sensitivity of the GR can be illustrated by comparing how the HNR would reflect the same recent growth. The HNR for this same period would change from 16÷13 = 1.23 to 24÷15 = 1.6. The GR shows that while average internode length is 1.6 inches (a short internode length) recent growth has increased dramatically.

Research is underway to determine how frequently GR should be calculated. Data from the Beltwide Monitoring Project suggests that it may not be necessary or desirable to calculate a weekly growth rate. The variation in field conditions and sampling sites can contribute to erratic and confusing growth rate trends. Growth rates probably can provide the most meaningful information if calculated every 2 to 3 weeks.

Growth rates through the season have been calculated in several regions of the Cotton Belt. Figure 3 depicts a typical growth rate curve for cotton growing under favorable conditions in the San Joaquin Valley. As more data is accumulated in other areas, the suggested GR values for those areas will be developed. Marked departure from these lines should alert growers to pay close attention to field conditions.

Figure 3



(Kerby and Hake, 1993)

As the chart shows, growth rates tend to reach a maximum during early bloom. The horsepower driving vegetative growth is highest just as the developing boll load begins to progressively draw on the plant's reservoir of carbohydrates and nutrients. A declining GR is anticipated with a developing boll load, particularly if the GR was high prior to boll loading. If the GR does not begin to decline once flowering begins, managers should suspect reduced boll and/or square retention. Immediate action is called for to avoid further maturity delay or yield reduction.

Wrap-up

The basic concepts discussed here are consistent across the belt, but regional differences may exist. Growers are advised to obtain HNR and GR guidelines developed in their regions with common varieties.

A manager's challenge prior to bloom is twofold: to create conditions that favor vigorous growth, then set the stage to transform that vigor into profitable yield.

Vigor indices are useful measures of growth potential prior to bloom. During flowering, however, boll loading dynamics begin to dominate further crop development. Monitoring indices such as nodes above white flower (NAWF) and considerations of effective flowering periods will be discussed in the next newsletter.

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Thank you,
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