Chapter 11:

Utilization of COTMAN to Enhance Yield and Revenue of Cotton

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COTMAN™ is a crop management system based on in-season plant monitoring. The COTMAN computer software makes it easy to enter data and generate the reports used to make management decisions. The program is divided into two parts, SQUAREMAN and BOLLMAN. SQUAREMAN is used to monitor crop development up to the time of first flower. Monitoring with BOLLMAN begins at first flower and is used to monitor boll-loading stress and to assist with end-of-season crop termination decisions. The overall program was designed to facilitate crop management, protect yield potential, and increase profits.

At First Square

SQUAREMAN, the first part of the COTMAN program, is primarily used to monitor pre-flowering plant development. At or near first square, plant stand counts and average first-fruiting node numbers are recorded. During squaring, 10 plants at each of 4 sites per field are monitored weekly for presence or absence of first-position squares. Reports provide feedback on square retention and plant stress based on nodal development. Square shed information alerts growers to possible pest problems and augments insect scouting reports. A quick comparison to the *Target Development Curve* (TDC) shows if the actual pace of crop development is too slow, too fast, or just right for an early crop and high yields.

At Flowering

BOLLMAN, the second part of the COTMAN program, is used to monitor post-flowering plant development. Monitoring with BOLLMAN begins when the crop starts to flower and is used to monitor boll-loading stress and to assist with end-of-season crop termination decisions. Beginning at first flower, *nodes above white flower* (NAWF) counts are recorded weekly from 10 plants at each of 4 sites per field. Establishing the last effective boll population—the last group of bolls that will contribute significantly to yield and profit—is essential for making end-of-season decisions. Cutout is reached when NAWF counts become less than 5 or when accumulating sufficient heat units (850 DD60s) to mature a flower is unlikely to occur. From cutout until defoliation, daily high and low temperatures are recorded from a local weather source. Crop termination guidelines are based on heat unit accumulation beyond cutout.

Monitoring and Ensuring Good Crop Growth and Development

The perennial and indeterminate nature of cotton often forces managers to manipulate growth and development to optimize seed and lint production. Maintaining the proper balance between vegetative and reproductive growth is essential to optimize yield and earliness. During squaring it is important to maintain good square retention and to develop the plant structure necessary to achieve yield goals. A realistic goal at first flower is to achieve a range of square retention from 80 to 85% and nodes above first-position white flower of 8 to 10. Square retention values prior to first flower are generally impacted greatest by insect pressures. COTMAN allows producers to follow crop growth during the season, detect potential problems, make timely in-season management decisions, determine end-of-season termination of inputs, protect yield and fiber quality potential, and increase revenues.

Detecting Crop Stress

The development of plant structure prior to flowering is impacted negatively by stress. Fertility and moisture are the dominant factors contributing to plant structure prior to flowering. Square retention values less than 80% will often result in delayed maturity and excessive vegetative growth because of the lack of fruiting forms during boll development. Boll weevil eradication efforts and *Bt* technologies have helped to reduce the occurrences of low retention rates through squaring as well as into flowering. Retention rates of 90% or greater can present logistical challenges to managers in that margins of error for input timings are small. Delays in timing can result in excessive square shed. High retention values coupled with poor plant structure will result in premature cutout, significantly impacting yields. Shed as a result of environmental stresses is often greater in situations where retention rates are very high.

Managing inputs to achieve 8 to 10 NAWF at first flower will result in the plant having the necessary "horsepower" to avoid premature cutout in most instances. Fields in which NAWF values are in a range of 6 to 7 will require immediate action to alleviate stress to avoid premature cutout. High retention values will magnify the urgency to relieve the stress in this situation. As a rule, early or more determinate cultivars are more sensitive to having adequate growth vigor at first flower to achieve desired yield potential than later-maturing or less determinate cultivars. Being on track at first flower or taking corrective actions to get back in line shortly thereafter is necessary to achieve both high yield goals and profitable production.

The BOLLMAN component of COTMAN is much less labor intensive than the SQUAREMAN component. BOLLMAN provides the manager great insight about the crop with little additional time requirements to collect NAWF data. Tracking NAWF from first flower to cutout and evaluating the slope of the resulting growth curve can help managers identify fields that are potentially early- or late-maturing so that management practices can be used to help preserve existing yield potential. The target for comparison during flowering is a value of NAWF=9.25 at first flower or 60 days after planting and NAWF=5 at 80 days after planting. The actual growth curve from the field does not necessarily have to match the TDC exactly but should run parallel to it. The rate at which this curve declines is a measure of stress.

Two types of stress may occur. A great boll load stresses the plant and is thought of as a good stress. Lack of moisture and fertility also stresses the plant and is thought of as a bad stress. Excessive stress will generally produce a crop development curve that declines much faster than the TDC. Lack of stress, good or bad, will result in a line that runs flatter than the TDC. Fields experiencing slopes of NAWF values that are parallel to the TDC and with high retention values are most often the fields that will respond favorably to additional inputs to preserve the crop.

Insecticide Termination

The decision of when to terminate late-season insect-pest management strategies has been a persistent problem for the cotton industry. Returns through increased yields and improved fiber quality must exceed the cost of these control strategies to justify late-season insecticide treatments. BOLLMAN provides an estimate of the critical time to terminate insect-pest management strategies at the end of the growing season. The program uses *cutout* (NAWF=5) as the endpoint for flowering of the last effective boll population set on the plant (Oosterhuis, 1990; Bourland et al., 1992). Bolls produced by the plant after cutout often do not have enough time remaining in the season to produce mature cotton fibers (Bernhardt et al., 1986). As a general rule, after cutout has occurred and the crop has accumulated 350 to 450 heat units (HU), harvestable bolls are considered safe from attack by all fruit-feeding insect pests (Oosterhuis and Kim, 2004). Physiological cutout is a key factor that must be defined accurately for each situation to eliminate late-season treatments used to protect cotton bolls that may abscise or produce lower quantities of less-mature fiber than earlier bolls.

Once the last effective boll population or cutout is established, HU or DD60s are accumulated to aid in insecticide termination decisions. Termination guidelines are as follows:

- Insecticide termination for lepidopterous and lygus species - NAWF=5 + 350 HU;
- Insecticide termination for stink bug - NAWF=5 + 450 HU;

- Insecticide termination for fall armyworm - NAWF=5 + 500-550 HU; and
- Insecticide termination for defoliating insects - NAWF=5 + 650 HU.

Irrigation Termination

The decision of when to stop irrigation has been a persistent problem for the cotton industry, and rather arbitrary rules or calender days have been used with mixed success. The COTMAN crop monitoring program provides a scientifically based method of timing the last irrigation. The cotton crop requires adequate water during flowering and boll development (from 0.25 inch/day to 0.4 inch/day) for boll growth and fiber development, but timing the termination of watering is essential in order to allow the crop sufficient time to mature prior to defoliation and harvest.

Using COTMAN to time the last irrigation relies on the identification of the last effective boll population at NAWF=5 (i.e., physiological cutout) and the subsequent accumulation of an additional 350 to 500 HU to determine the timing of the final irrigation. After cutout and when the required heat units accumulation is met, the field should be irrigated for the last time if the soil is not already sufficiently moist. The required number of HU after NAWF=5 (i.e., 350 to 500) depends on the location as well as the rainfall and temperature conditions experienced. In “moderate” summer conditions with deep soil moisture availability, the accumulation of 350 HU after NAWF=5 is sufficient for all the state, but an extra week of irrigation is appropriate out to 500 HU under extreme conditions—e.g., in the summer of 2007 when there was almost zero rain in July and August, and temperatures of 100°F were common (and very high yields were obtained). Achieving field capacity was difficult under the conditions in 2007. The following termination guidelines are offered for location, but the weather experienced also needs to be considered to modify these:

- Irrigation termination for North Arkansas NAWF=5 + 350-400 HU;
- Irrigation termination for Central Arkansas NAWF=5 + 400-450 HU; and
- Irrigation termination for South Arkansas NAWF=5 + 450-500 HU.

Defoliation and Harvest

Use of the COTMAN program allows producers to decide with some confidence, and on a scientific basis, when to initiate defoliation. The defoliation timing guidelines in COTMAN are based on heat unit (DD60) accumulation beyond physiological cutout (NAWF=5) or seasonal cutout (last date from which 850 HU can be expected prior to desired harvest completion date). White flowers at cutout represent the last effective boll population or the youngest cohort of bolls that will contribute significantly to yield and profit. Defoliation can be timed by the maturity of the last effective boll population or from the date a field has reached cutout.

To achieve maximum yield and revenue, 850 HU should be accumulated from the date of cutout before defoliation (application of first defoliation) is initiated. The use of cutout (NAWF=5 or seasonal cutout) + 850 HU as a prediction of when to defoliate has been based on numerous field research trials over the past 15 years. Although results varied slightly from year to year, it is generally accepted that 850 HU after cutout are required to ensure earliness and the protection of the yield and quality potential. Overall, the use of COTMAN should allow more precise and confident timing of defoliants, often with improved results and a savings of chemicals.

Early Crop Maturity

Early crop maturity refers to the ability to grow and mature the crop within the confines of the season prior to the onset of adverse weather while ensuring a high yield potential. Crop maturity is related to a field population of plants (in relation to their environmental potential) that has developed to the point that no additional inputs are required, not to be confused with physiological cutout at NAWF=5 (*See* Chapter 14, Terminology). COTMAN provides a method to achieve early maturity provided the program is followed and the resulting data correctly interpreted and used in management.

It is important to promote earliness so as to avoid expensive late-season battles with insects (particularly high bollworm moth counts in late August) to reduce late-season insect control costs and also to reduce selection pressure for insect resistance.

Additional benefits of an early crop include the ability to harvest prior to the advent of bad weather, resulting in greater picking efficiency and improved grades. With the onset of bad weather, harvesting is slowed and requires more fuel and repairs. Less field work is generally required after harvest of dry fields compared to wet fields that may have significant ruts. These factors can provide the producer additional time to do needed field work, collect fertility and nematode soil samples, allow for better cover crop results, and create less producer stress.

A testimonial from a producer: *"I am sure glad we had COTTON-MAN (COTMAN) information on my farm. I am finished with harvest, have my stalks cut, fields ripped and most everything bedded. Most of my neighbors still have several hundred acres to harvest and their pickers are parked…… they have gaps in their defoliation,"* Bob Ramey, Blytheville, Ark.

Scheduling Fields for Harvest

An additional benefit of the COTMAN crop monitoring program is the scheduling of fields for mechanical harvest based on the maturity of the individual fields. In this way, producers can make the best use of their time and harvesting equipment.

Financial Rewards

We continue to see that the BOLLMAN component allows the producer to save money on input costs (chemicals and irrigation water) and overhead (to manage more acres with the aid of COTMAN) while the SQUAREMAN component may have potential to increase net revenue through insights leading to increased square retention and early detection of problems in plant structure. Perhaps the biggest cost saving comes from the ability to predict, with some confidence, when to terminate insecticide applications and irrigation. Research has shown a $15 per acre savings in northeast Arkansas. With the advent of *Bt* cotton and the boll weevil eradication program, the value of BOLLMAN to reduce insecticide costs due to budworm and boll weevil damage has been greatly reduced. However, savings with regard to other cotton pests still exist. In addition, precise determination of irrigation termination and its impact on defoliation timing can result in better or more consistent results of a harvest aid program. Furthermore, COTMAN crop monitoring data can also be used to determine when to start irrigating, to see if irrigation is sufficient during the squaring and flowering stages, and also to help producers know when to stop irrigating.

COTMAN as an Overall Management Tool

COTMAN is an effective management tool. Better information means better decision making. Each field has its own report. COTMAN provides users timely information on square retention as well as plant and fruit numbers per acre. The graph of crop development pace reveals much about the "horsepower" of the crop. Flowering dates of the last effective boll population (cutout) provide the benchmark of all end-of-season decisions. COTMAN reduces end-of-season guesswork. It helps users determine when bolls are safe from insect pests, when irrigation can be safely terminated, and when to defoliate for optimal yield and quality. The cost of full-season crop monitoring is more than offset by savings on late-season insecticide. Timely feedback on crop development pace and stress gives growers the ability to take prompt corrective actions. This program is easily integrated into management systems and helps tie everything together to enhance overall profitability.

Other Benefits of COTMAN

Prevention of Reduced Fiber Quality and Lowered Yield

The proper use of the COTMAN program can reduce the potential of reduced fiber quality and the likelihood of yield losses due to storm damage. Field management to lessen fiber deterioration and storm damage is primarily dependent on an early harvest and reducing the time between defoliation and harvest. COTMAN assists with reducing this time by aligning fields by their crop maturation date for mechanical harvest. Multiple fields may then be defoliated based on their relative maturity, picking capacity of the producer, and expected weather conditions. Timely defoliation and subsequent harvest will also help to ensure acceptable micronaire (fineness of fiber) and grade (trash and color). Timely harvest also reduces the potential for regrowth, which increases as time between defoliation and harvest increases (i.e., delayed harvest). Significant levels of regrowth that require additional harvest aid applications will increase costs and/or reduce fiber quality (color).

Qualifying for Conservation Programs

In conservation programs, which use a point system to demonstrate conservation, COTMAN can be a valuable tool. The use of COTMAN records has made application to the watershed program easier by showing that crop growth was used to help develop the fertility program, that insecticide was not used in excess, and that NAWF data were used to demonstrate that crop maturity was used to terminate irrigation so as not to waste water. Basically, use of the COTMAN program has helped producers qualify for the watershed conservation program, which means additional revenue.

Summary

The COTMAN program has numerous real benefits for cotton management. Money savings from insecticide termination have turned out to be only a means to "spark" interest in COTMAN. However, the ability to clearly follow crop development with relatively simple and easy practical measurements allows producers "to see" if the crop is on track or showing stress symptoms, and this provides the major benefit in crop management. Early crop maturity and timely defoliation help prevent fiber quality and yield losses. The overall benefit of COTMAN is knowledge of the crop development that allows timely management inputs and decisions for higher yield and substantial economic savings.

For more information on COTMAN, visit the following site: http://www.cotman.tamu.edu/index.htm

References

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