The First 40 Days™

The Most Critical Period in Cotton Production

Expert Recommendations for Best Management Practices

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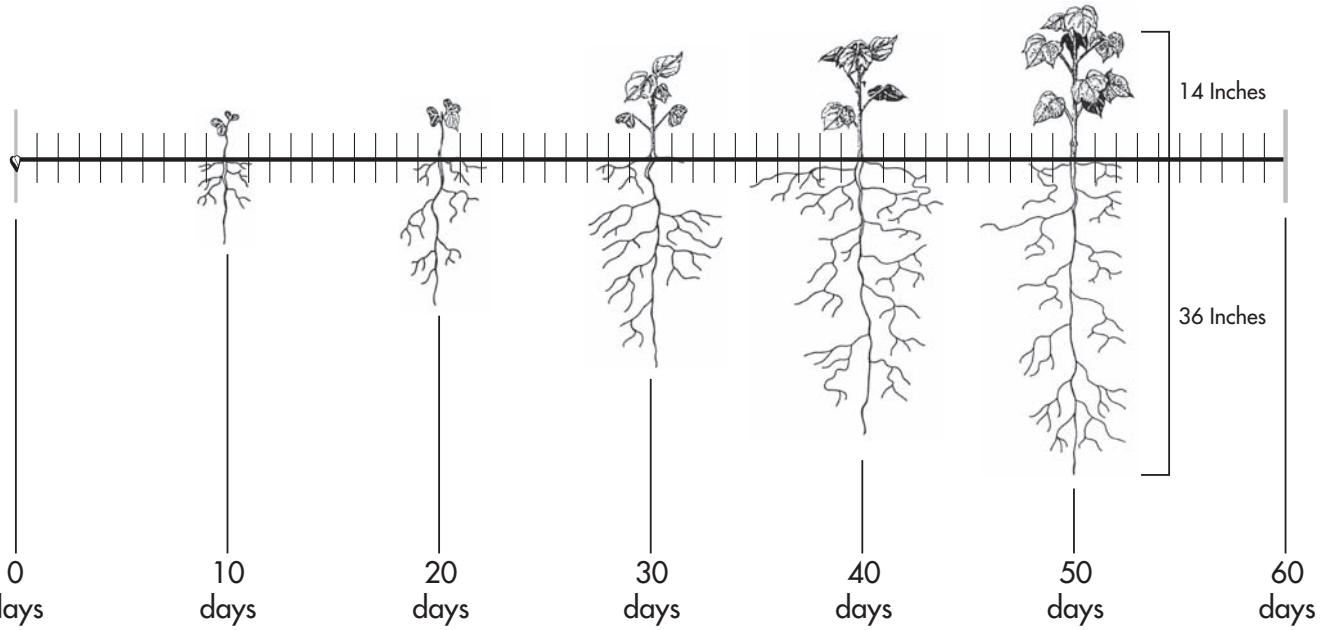
Early Season Cotton Development



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The Goal of the Workshops: To bring focus to the *Best Management Practices* (BMPs) in the new, contemporary cotton production systems, addressing the changing pest spectrum, season-long pest management systems, overall plant health and earliness, with the ultimate goal of high yield and high quality fiber.

Three primary areas of discussion for each group:

1. The impact of at-planting decisions on optimal season-long pest management;
2. The shifting insect spectrum and the emergence of plant bugs and spider mites as significant pests and the importance of making the right crop protection choices during *the first forty days*;
3. The impact of crop uniformity, plant health and fast grow-off on crop management, yield and fiber quality.

The First Forty Days™ after planting is the first and one of the most critical stages of the cotton crop. As the plant and the crop moves into the midseason fruiting period, it must be healthy and uniform in order to produce optimum yield and fiber quality. As the biological clock is ticking, much of the crop's primary yield potential is determined during *the first forty days*, which makes this period the highest priority for efficient crop management. Then the challenge becomes making the most of that yield potential during the balance of the season.

The optimum cotton crop at *forty days* after planting will exhibit these criteria:

• **Stress Free.** Regardless of the tillage and crop production system, the optimum cotton crop will be free of stress from insects, mites, nematodes, seedling diseases, weeds and other manageable factors, such as fertility and water.

• **Plant Health.** In addition to being stress free, the optimum crop will exhibit healthy leaves, its roots will meet in the middles and it will grow off rapidly and uniformly. Earliness is important, which can be measured by a height-to-node ratio of at least 1-inch (1:1) at 40 days after planting. The optimum crop also will have seven to eight nodes and two to three squares per plant.

• **Uniform stand and adequate plant population.** Crop uniformity relates to optimum plant health, but its impact upon season-long crop management is significant. A uniform crop allows for a more efficient crop management system, which ranges from timing of herbicide and plant growth regulator applications through harvest aid and crop termination timing.

An adequate plant population will be at least 30,000 plants per acre and will not exceed 60,000 plants per acre. The minimum stand would have a least one plant per foot, with no two- to three-foot gaps.

The Best Management Practices

A crop management system, regardless of whether it's based in conservation tillage or conventional tillage, is an amalgamation of many inputs and practices. Although these inputs and practices are all important in crop production, some are more critical than others in the overall success or failure of a crop and merit greater attention.

The following inputs and practices impart the greatest impact on optimizing yield and fiber quality at the end of the year. They also have a significant effect upon the efficiency of a season-long crop management system, including weed control, plant growth regulation, insect control and fertility — even harvest aid efficiency at the end of the season. The result is a cost-effective crop management system that delivers optimum yields and fiber quality.

These *BMPs* are in order as prioritized by the workshop participants.

1 Early Season Insect Control

One of the most detrimental influences on crop uniformity, earliness and the season-long crop management system is thrips. These pests can reduce cotton yields by 70 percent or more. Controlling thrips, as discussed in both workshops, may have more impact upon profitability than any other single input or practice during *the first forty days* of crop management. Choices made at-planting to reduce inputs on early season pest management can result in delayed maturity, a higher overall production cost at season's end, lower yields and lower fiber quality.

• **Primary criteria.** *Based upon history, choose an at-planting systemic insecticide with the longest residual possible.* Avoid programs or systems built around "automatic" oversprays for thrips control, which can lead to aphid and mite problems as the season progresses. Poor environmental conditions or slow management decisions also can make timely foliar applications difficult to achieve. Ideally, the at-planting, systemic pest control input would provide control of thrips and other arthropod pests throughout *the first forty days.*

The length of control of various at-planting insecticides ranges from a low of 14 days after planting with a seed treatment up to five to six weeks after planting with an in-furrow granular.

• **Secondary criteria.** *Recognize residual limitations.* Scout and overspray as required to assure insect control through *the first forty days* – especially during periods of cool temperatures or extremely dry conditions. It is absolutely critical to protect the plant and keep it healthy through the 4-true-leaf stage.

If Lygus bug pests are an issue, it's important to keep populations low from the beginning. With all early season insect pests, it is important to limit population growth resulting from immigration and reproduction.

Entomologists agreed that pre-plant weed control and seedbed preparation, as well as weed control around field perimeters are cultural factors that lead to optimal and efficient insect control by eliminating host plants and breeding sites. One recommendation is that seedbeds should be free of all green plant tissue for at least three weeks prior to planting.

Growers also would be well advised to evaluate systemic inputs based upon the range of pests controlled, including nematodes and mites, as well as thrips. An increased incidence of mites in Rain Belt cotton states could be attributed to wider use of foliar applications of broad-spectrum insecticides. It was noted in the Upper South workshop that mites are an "induced pest," due to an increased early use of broad spectrum insecticides – particularly in no-till and conservation-till fields. It also was pointed out that problems with mites have been reduced where an in-furrow insecticide-acaricide was used.

2 Seed & Variety Selection

Variety selection and seed quality have a lasting effect upon the crop's early season vigor, and overall plant health and uniformity during *the first forty days*. The crop's ultimate yield and fiber quality potential at harvest begins with variety selection and seed quality. Less vigorous cultivars are more susceptible to stresses caused by inadequate moisture, cool temperatures, thrips feeding, seedling diseases and other pests.

• **Primary criteria.** *Choose varieties with the genetic potential for higher yield and fiber quality.* Yield still is the ultimate measure for a cotton crop, although the ever-increasing demand for higher fiber quality makes this factor a close second in priority. Eventually, fiber quality could become the single most important factor for American cotton.

Choose varieties with the genetic potential to produce excellent technical fiber … long staple length; a strong, premium micronaire fiber; high length uniformity; and a smooth leaf with a plant conformation that's conducive to efficient mechanical harvesting. Because of the extended fruiting period of the cotton plant and subsequent development cycle, each boll develops under different environmental conditions than other bolls on the plant. Fibers from a single plant, single boll and even a single seed will be variable for length, strength and micronaire. It's the average fiber quality within the plant that determines value; and, plant genetics and environment provide the platform for higher yields of fiber.

Growers are well advised to grow more than one variety – preferably three or four varieties. Larger-seeded varieties with high seed quality and strong seedling vigor are also more desirable. In addition to the standard warm germination test, a cool germination test also is recommended. When cool germ and warm germ numbers are added together, high quality seed will have a germ index of at least 160 (i.e., a warm germ of 90 plus a cool germ of 70 equals 160). Early planting into cool soils requires a high germ index. *When planting early, always begin with a variety that has the highest germ index.*

• **Secondary criteria.** *Trait factors and maturity rank lower in priority.* The general consensus reached at the workshops discourages the selection of varieties based upon trait factors – especially if the available trait factors result in a yield drag or if the traits are coupled with poor-yielding varieties.

3 Seedbed Preparation, Emergence and Plant Population

The two workshop groups addressed overlapping factors – emergence and plant population — with seedbed preparation as a common denominator. The overriding concern among all participants is that growers do not adequately address planting-time considerations and needs, opting instead for speed of planting over all else. The bottom line in cotton production is that one-half the variable costs, as well as the annual fixed costs, are spent prior to or during *the first forty days.* The general consensus is that growers would be well advised to plan better going into the season and to do a better job of planting with precision.

The Upper South group, whose growers generally must deal with cooler planting-time soils and cooler, more fluctuating ambient temperatures, focused on the need for strong, vigorous, uniform emergence and addressed factors contributing to this result. The Lower South group tended to focus on the desired plant population of a strong, vigorous, uniform crop and, likewise, addressed contributing factors. This *BMP* section combines the two.

• **Primary Criteria:** *Plant 3.5 seeds per foot (drilled rows) with good seed-to-soil contact and adequate, warm soil temperatures and soil moisture.* The minimum plant population in the final stand should be about two plants per foot or about 30,000 plants per acre, with a maximum of 60,000 plants per acre. Replanting is discouraged when there is at least one plant per foot and few large skips.

The goal is that soil conditions and planting depth would be optimum, ensuring vigorous and uniform emergence. Replanting is discouraged unless there is a massive loss of stand. It was noted in discussions in both workshops that a stand of one plant per foot would be more desirable than replanting. The University of Missouri Cooperative Extension Service has a Replanting Decision Guide.

Primary Factors:

- Soil and air temperatures are optimum, according to state Extension guidelines. A soil temperature of 68° F for three consecutive days is optimal, although not always realistic for early planting. Although dependent upon growing conditions, it is noted that a delay in planting of four weeks can equate to only a one-week delay in flowering.
- Soil moisture is optimum and seedbeds are firm for good seed-to-soil contact.
- Seed quality is good. Plant the best quality seed first, in cooler soils.
- Planting depth of 1 to 1-1/2 inches.

• **Secondary criteria:** *For consistent performance, all pests should be controlled in and around the field.* Insect management, which ranks number one in priority during *the first forty days*, actually begins with adequate vegetation management in and around the field.

Primary Factors:

- Pest-free seedbed environment. Burndown herbicide application is made at least three weeks prior to planting to ensure no green matter is in the seedbed.
- Farmscape vegetative management. All potential host plants/weeds or insects in and around fields are controlled to eliminate sources of insect pests.
- Adequate soil temperature, which contributes to a vigorous plant.

4 Weed Control

Weed control at planting and three weeks prior to planting, are important for planting efficiency and pest control. Thus, weed control is addressed in planting-time BMPs. Weed control is a primary category in the cotton production system, ranked fourth by participants in both workshops.

The discussions in each workshop were much the same. There was a common theme concerning any weed control system, including Roundup Ready®: To sustain weed control technology, don't rely totally on a single weed control system. The Lower South group recommends rotating systems.

• **Primary Criteria:** *To sustain technology, rotate weed control systems and use residual herbicides in the weed control program.* It was specifically noted and discussed that the incidence of resistant weeds is increasing faster than originally thought among weed scientists, making herbicide rotation extremely important. The Lower South group specifically outlined these recommendations:

- Stop sole reliance on the use of glyphosate;
- Reduce the number of herbicide post-emerge applications;
- Don't increase rates above label guidelines; consider use of residual herbicides and weed populations when developing a program;
- Historical problems by field and/or areas within fields should be the focus;
- Weed spectrum may require residual herbicides;
- Size of weeds and timing of oversprays are very important when selecting a tankmix;
- Be aware of tankmix antagonism when selecting herbicide combinations.

Pigweed was singled out as an example for the need for herbicide resistance management by the Lower South group. One plant produces approximately 400,000 seeds, which makes an additional 5 percent control extremely beneficial.

• **Secondary Criteria.** *Treat weeds in a timely manner and keep weed competition out of the field by three to five weeks after planting.* It was noted that the seedling crop will tolerate weed competition without yield damage up to three or four weeks after planting depending on weed density.

5 Nematodes and Seedling Diseases

The Upper South group addressed the need for optimum control of nematodes and seedling diseases during the crop's formative stages of *the first forty days*. Infections by nematodes and seedling diseases are often inter-related and can be very detrimental to root development, vigor and earliness. With the potential for significant loss of yield, fiber quality and earliness at the end of the season, the need for prevention is paramount. It was noted that nematodes are much more serious than recognized by growers and that the rapidly expanding *Reniform* nematode has cost the industry more than $1 billion over the past five years. *Reniform* can populate any soil type, making it a threat to all cotton producers.

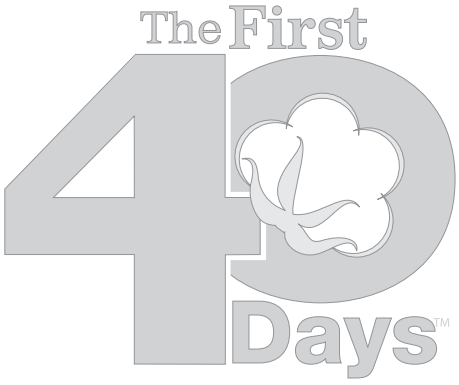
Nematodes ...

• **Primary Criteria.** *Use soil sampling techniques as recommended by state Extension guidelines, apply an in-furrow nematicide at a rate of 5 to 7 pounds per acre where recommended and consider rotating crops to manage nematode populations.* Creating nematode management zones by species, within a field and by soil texture is advisable. It is important to identify nematode species and densities in order to manage the problem in a cotton production system. *Reniform* nematode is spreading rapidly and is the most critical species to manage.

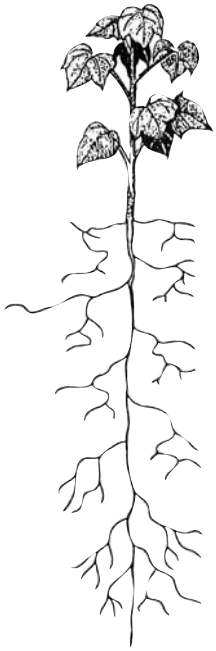
• **Secondary Criteria.** *In fields or management zones of moderate to heavy nematode pressure, side-dress the recommended label rate of a granular nematicide at 21 to 28 days after planting – the 2- to 3-leaf stage.* This is particularly important in continuous cotton and where the *Reniform* nematode is present.

Seedling Diseases ...

• **Primary Criteria.** *Apply additional, broad-spectrum fungicides to the seed or use an in-furrow fungicide on all cotton planted. Growers recognize lethal infections by loss of stand, but workshop participants caution that sublethal infections rob growers of yield and earliness.*



Measurement – How should the plant and crop look at 40 days?



Standardization of measurement at 40 days after planting was a critical discussion point among all workshop participants. A number of criteria were discussed, with above-ground healthy growth settled upon as the "yardstick" for measurement.

• **Primary Criteria.** *A plant height-to-node ratio of at least one with at least 30,000 (one to one-and-a-half plants per foot) uniform, stress-free plants per acre at 40 days after planting is the primary goal for optimizing yield, fiber quality and earliness at season's end.* Supporting criteria could also incorporate leaf size and stem diameter, plant height and width, and plant health assessment, as well as a viable terminal and root system. At this stage the healthy plant meeting this criteria would have two to three squares.

The need for a target development curve also was discussed.

Research and Development Needs

Summarizing the workshop, the group discussion focused on future needs for research and development at Land Grant universities and at USDA/ARS. Following is a summary list of those needs by category, as they were identified by the participants:

1. Insect Control.
- Tools for "bug" management
  - New chemistry
  - Landscape ecology
  - Transgenic varieties for thrips and plant bugs
- Early season insect control alternatives

2. Seed and Variety Selection.
- Seed size and seedling vigor … define seedling vigor and establish correlation among seed size, healthy roots and seedling vigor
- Varieties for cool conditions
- Drought tolerance
- Molecular markers in trait – screen in the lab, not in the field
- Fiber quality factors
- Resistance in seeds to nematodes and other pests

3. Agronomic Research Needs.
- Vegetative growth vs. yield
- Vigor-to-yield correlation
- Update fertility levels by varieties (fertility recommendations are based on very old data)
- Nutrient requirements and management – pre-plant, at-plant, side-dress and foliar
- Heat shock protein
- Plant compensation capabilities
- Cross discipline crop management systems need to be developed, linked and packaged for growers
- Industry and academia need to partner and evaluate products and systems prior to grower introductions
- Herbicide development

4. Diagnostic Tools.
- Site specific technology
  - GPS/GIS for pest and nutrient management
  - RTK system to monitor field variability and for variable application of inputs
  - Veris/SEC to measure soil pH on-the-go for variable application of lime and other inputs
  - Nematode projections without sampling
- Rapid, reliable sampling and/or projection techniques
- Early season crop model incorporating multiple factors
  - DD 60s
  - Solar radiation
- Guidance of planter
- Yield monitoring and more accurate field mapping

5. Nematodes
- Nematicide for longer control or total control

Summary

Participants in *The First Forty Days*™ Workshops felt strongly that this forum for discussion across disciplines was valuable and time well spent. Although all components of the entire crop production system are valuable, a few inputs and practices are more valuable – indeed, more critical – than others to the yield, fiber quality and profitability of the crop. These most critical inputs and practices were captured in the *Best Management Practices (BMPs)* discussed in this white paper compendium. The general consensus of the participants is that these *BMPs* are adopted and promoted within each state's research program and extended through the Cooperative Extension Service to the consulting community and growers.

The *BMPs* may or may not be in line with consultant and grower actions. As discussions of various issues crystallized the *BMPs*, several key points were brought forth:

- Farmers are in a "sustainable ag mode of operation" – fighting for survival -- which is driving their decision process concerning inputs and practices, such as weed control system, seed-applied vs. in-furrow pest control, etc. Planting speed and convenience have become primary decision factors, despite their value to an overall enterprise.
- The reality for consultants, according to consultant participants, is that "automatic" applications of Orthene® and other foliar insecticides help mitigate their liability should thrips or other pest populations explode, thus causing more problems as the season progresses.
- The best yields come from cotton planted in the early part of the planting season.

Other issues were addressed, but were not deemed to be in the top five priority list of inputs and practices. These included:

- Irrigation/water management. Pre-watering is a huge issue prior to planting a cotton crop, as is proper drainage.
- Fertility management. Fertility is a critical issue, from pre-season planning through cutout. It was noted that new calibration curves addressing fertility are needed; because, the high-yielding varieties currently being grown draw down reserves in the soil. It also was noted that it's advantageous to the crop to supply nutrients via the soil.
- Cropping/tillage system. No-till, conservation tillage, ridge-till and conventional tillage all have strengths and weaknesses to consider; but the top five *BMPs* apply across these cropping systems.

According to a follow-up survey of participants, future multi-discipline information exchange forums are encouraged, particularly for "The Second 40 Days" and "The Last 40 Days." Bayer CropScience is committed to working with the Research and Extension Community and looks forward to helping meet your needs in the future.

The First 40 Days™

Special Recognition to the Steering Committee for *The First Forty Days*™ Workshops:

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Roger Leonard, Ph.D. — Louisiana State University
J.C. Banks, Ph.D. — Oklahoma State University
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Acknowledgements

This report summarizes the discussion and subsequent Best Management Practice (BMP) recommendations of a multi-discipline group of university researchers, Extension specialists and consultants representing the Rain Belt cotton states. Two groups were convened to represent comparable agronomic production systems. Group 1 represented the Lower South Agronomic Zone, from South Texas to Georgia. Group 2 represented the Upper South Agronomic Zone, from West Texas to Virginia.

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