Cotton Growth and Development

- Cotton has a complex plant structure, which can make it a very challenging crop to understand and manage throughout the growing season.
- Cotton plants follow a set pattern of growth according to accumulated heat units (DD60s); however, sensitivity to varying environmental conditions can affect development.
- Understanding cotton growth and development can help build a foundation for proper crop management.

Calculating Heat Units

Cotton growth stages may be calculated by the number of days after emergence, or more accurately, by the number of heat units accumulated. In cotton, little to no development occurs below 60°F, so to calculate heat units (DD60s), add the maximum and minimum temperatures for the day, divide by 2 (to find the average), and subtract this number by 60. Total accumulation of DD60s can help determine the growth stage of a cotton crop (Table 1).

| Table 1. Cotton growth stages indicated by the accumulation of days and DD60s. |
| Days | DD60s |
| From planting to emergence | 4-10 | 50-60 |
| From emergence to 1st fruiting branch | 21-27 | 300-340 |
| From emergence to 1st square | 27-38 | 425-475 |
| From emergence to 1st white bloom | 50-60 | 825-875 |
| From emergence to peak bloom | 85-95 | 1385-1435 |
| From emergence to open boll | 105-115 | 1700-1750 |
| From emergence to 60% open bolls | 135-145 | 2180-2230 |


Early Vegetative Growth

Vegetative growth includes development categorized by leaves or nodes. Cotton has an indeterminate growth habit allowing plants to grow very tall and heavy with vegetation if not managed.

1st true leaf. Emerges about 50 DD60s (or in 3 to 7 days) after seedling establishment, shifting the plant’s energy source from cotyledons to 1st leaf emerging.

Main stem leaves. The first structures to appear on the main stem.

Nodes. Points of attachment where leaves and branches form (Figure 2). A new node is produced by the apical meristem an average of every 3 days.

Leaves. Leaves produced from the main stem are called main stem leaves and leaves located on fruiting branches are called subtending leaves.

Branch Development

Cotton plants develop 2 types of branches: vegetative and fruiting.

Vegetative branches. Straight growing branches with the main purpose of producing energy through photosynthesis. Mainstem and other vegetative branches typically form on lower nodes.
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Fruiting branches. Branches that grow in zigzag pattern and contain multiple meristems and form fruiting buds. The first fruiting branch will typically form at mainstem node 5 or 6. New fruiting branches develop about every 3 days and squares form at new positions on fruiting branches every 6 days.

Figure 2. Cotton branch and stem structure. Source: The University of Georgia.

Reproductive Growth

Reproductive growth is characterized by square development and node location on the plant.

Square development. The square (pre-bloom flower bud) forms at the initiation of a fruiting branch.

First square position. This is the location where the first square is produced. As a square develops, the section of the branch between the main stem and square elongates and an auxiliary meristem also develops on the branch adjacent to the square. The auxiliary meristem will produce a second position square and a subtending leaf. The first square typically forms on nodes 5 to 7.

Cotton bud formation. It takes 3 to 4 weeks from square until bloom. There are several development stages of a cotton bud (Figure 3).

Pinhead square (a). The first stage the square can be identified.

Match-head square (b). When the bud is about 1/3 grown.

Candle (d). Just prior to bloom, and shaped like a candle.

White bloom (e). Once the bud blooms. The flowering period typically lasts 4 to 6 weeks.

Bloom growth continues reproductive development and is characterized in terms of weeks of bloom (Figure 4). When a bloom first opens, the flower is white and pollination may occur within hours of opening. By Day 2, the flower will have a pink tint and turn red by Day 3. The flower will dry up and fall off the plant between Days 5-7, exposing a fertilized boll. During early-bloom, the mainstem will continue to grow and add new leaves, nodes, and squares. As more bolls are set, the plant’s energy is diverted from vegetative growth to the boll formation.

Nodes above white flower (NAWF). During flowering, cotton plant development may also be categorized in terms of NAWF. This measurement is taken by the number of nodes separating the uppermost first position bloom and the terminal of the plant. At first bloom there may be 9 or 10 NAWF, and the number decreases as blooms continue to form up the plant. Flower development will eventually slow and cutout occurs at 4 or 5 NAWF when no more harvestable fruit is set on the plant.

Boll Development

Under optimum conditions a boll requires about 50 days to open. The fibers are very sensitive to environmental conditions during boll development. The 3 phases of boll development are as follows:

Enlargement. The fibers produced on the seed begin to elongate and the maximum volume of the boll and seeds are set. The fibers during this stage are a thin-walled tubular structure. This phase typically lasts 3 weeks.

Filling. The filling phase begins during the 4th week after flowering. The secondary walls of the cotton fiber will form, a process also known as deposition. This phase continues for 2 weeks.

Maturation. This phase begins when the boll reaches full size and maximum weight. The fiber and seeds within the boll mature and boll dehiscence occurs. The walls of the boll dry and split, opening the boll.

Sources

For additional agronomic information, please contact your local seed representative. Individual results may vary, and performance may vary from location to location and from year to year. This result may not be an indicator of results you may obtain as local growing, soil and weather conditions may vary. Growers should evaluate data from multiple locations and years whenever possible. ALWAYS READ AND FOLLOW PESTICIDE LABEL DIRECTIONS. All other trademarks are the property of their respective owners. ©2016 Monsanto Company. 120918013703 030116MEC