

Drought Strategies for Cotton



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Drought Strategies for Cotton

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Even though cotton (fig. 1) is a drought-tolerant crop, it responds well to sufficient water by producing lint proportional to amounts of rainfall or irrigation supplied. Each season, cotton uses approximately 21 to 38 acre-inches of moisture. Timely rainfall early in the season will establish stands and in the summer months will sustain squaring, flowering and bolls even beyond that normal 40 to 50 percent of fruiting structures. Fertility, cultivation, cultivar choice, cultural practice, pest management, defoliation treatment, timely harvest, residue management and timely and adequate supplemental irrigations all work to optimize cotton production during drought periods.

The three key periods of cotton growth that should be supplemented with moisture occur at stand establishment, prebloom and shortly after boll set. Ample moisture at seeding will establish healthy, uniform stands. Ample moisture before the first bloom will provide water for pollination processes. Ample moisture between initial boll opening and 50 percent boll opening can provide key reserves for fiber strength and length development.

Severe drought on cotton plants will slow plant development and cause small bolls and squares to shed. Establishment and prebloom irrigations affect total yield, but water deprivation following bloom and into boll development also affects lint quality.

If managed properly, cotton can withstand drought on infrequently irrigated, coarse-textured, sandy soil with hot, dry conditions from June 1 through the end of August. Even during peak bloom, cotton will use only about 0.3 to 0.4 inch of water per day. Irrigated cotton fields, of course, respond well to additional moisture with yields escalating as moisture needs are met. Research shows that timely, supplemental irrigation can bring in 200 to 400 pounds more lint per acre in cotton.

Efficient flood or row irrigation requires land leveling. Leveling ground on slopes of 0.5 percent or greater have increased cotton yields by more than 100 pounds of lint per acre under both furrow irrigated and dryland cotton. Using irrigation systems that limit water evaporation, such as drip or low energy precision application (LEPA) in sprin-



Figure 1. Open cotton boll after defoliation—ready to be harvested.

kler systems, helps to optimize water use in cotton. However, added costs to implement these systems and some salt carryover problems, if water quality is not premium, can limit the worth of these precise irrigation systems.

Consider the following minimal needs based on calendarized waterings and visual plant observations as shown on a daily basis in (fig. 2) or on a plant-condition basis as mentioned below:

- Establish cotton stands by using either a pre-irrigation before seeding or a post-irrigation shortly after sowing.
- Prior to first bloom, provide enough irrigation to supply plants with 0.75 to 1 inch of water whenever wilting plants are observed by midday.
- Continue applying 0.75 to 1 inch of water to the field at any sign of drought stress before first bloom occurs. However, carefully consider moisture use in fields that have had excessive nitrogen supply, insect problems or both, because excess water availability can accentuate problems.

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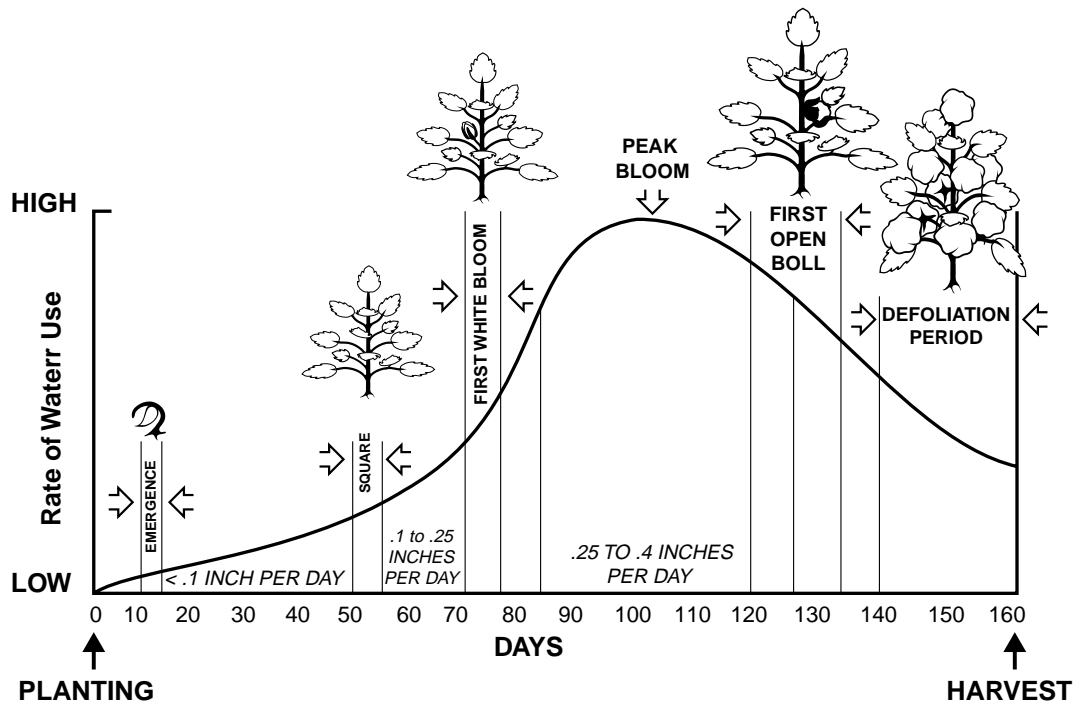


Figure 2. Average rate of water use across cotton varieties in relation to plant development over time.

- After first bloom, irrigate as needed following this weekly schedule based on an estimated 1,000-pound lint yield: week beginning at first bloom, 1 inch; second week after first bloom, 1.5 inches; third week, 2 inches; fourth week, 2 inches; fifth week, 1.5 inches; sixth week, 1.5 inches; and seventh week, 1 inch. These weekly quantities should be adjusted to compensate for runoff, increased evapotranspiration in arid areas, leaching through sandy soils or extreme drought conditions. Examine fields to determine if further irrigation or supplemental adjustments should be made.

Timing irrigation supplements to achieve optimum moisture conditions can be regulated by three evaluations. First, examine soil moisture and plant stress indices to determine need. Second, take evapotranspiration and soil moisture measurements. Third, consult infrared stress graphics to determine the need for supplemental watering.

Supplemental irrigations are timed based on soil moisture or plant stress indices. But they can be calendarized if not managed more intensely through evapotranspiration and soil moisture measurements or, in some areas, with infrared stress graphics. If calendarizing, make sure to include visual monitoring as a backup check on water needs. In coarse-textured sands, intervals may be every three to four days; in more productive loamy sands and sandy loams, every four to six days; and in fine-textured sandy loams or clay soils, every five to eight days after

blooming. By placing irrigation scheduling on an established seven-week schedule with watering occurring each week, an average lint yield of 1,000 pounds per acre can be expected. Increasing moisture each week by about 0.5 inch (4 inches in seven weeks) could increase yields. Providing moisture evenly across fields and minimizing moisture loss from evaporation heightens irrigation efficiency.

In cotton, moisture makes or breaks fiber quality. Water stress below -22 or -23 bars (a bar is a unit of measuring dryness based on the pressure equal to one million dynes per square centimeter), particularly in late-bloom stages, will reduce late-developing bolls and fiber strength in midcanopy bolls and increase micronaire of existing bolls. Cotton fiber length and strength and even seed weight and oil percentage are governed by moisture. Fiber length is most affected at 16 to 20 days after flowering. Fiber strength is most affected 25 to 30 days into boll development through three to four days prior to boll opening. During extreme drought, sudden irrigation right at or just after the peak in flowering will reduce lint percentage. Sudden good moisture during boll development will encourage seed weight rather than lint weight, although fiber length and micronaire value may be improved.

Cultivar choice also is important. Full-season varieties with an indeterminate growth type allow plants to recover from drought stints. Pima and Acala types may demand more moisture than Upland varieties. Full-season varieties often are the best-yielding varieties in stressful situations, as the longer growth period allows more time to adjust, shift and



Figure 3. Cotton field with open bolls maturing under no drought stress and with excellent pest management.

regain yield. Adapted, full-season cotton varieties can be a good choice on too well-drained soils if planted in a timely manner. Drought-tolerant genetics or even slight, timely preconditioning on crop plants also can aid in providing sustainable yields even during drought periods. Unadapted, short-season cultivars may cut out or have reduced recovery ability due to genetics and limited-season growth. Only under severe drought conditions with complete crop loss will little difference be seen across crop maturities. Occasionally, in extreme drought, a short-season variety can develop and yield a small amount as compared to complete losses with later-maturing varieties. Generally, however, the full-season varieties adapt better to seasonal differences. Consider minimizing crop loss risks by planting most fields in adapted, full-season varieties with some date-of-planting variance and some differences in variety choice and maturity, based on ability and timing to get into fields and soil and management needs as shown in a well-managed cotton field (fig. 3).

Tillage eliminates early surface sealing, compaction or hardpans and allows roots to develop to greater soil depths to scavenge for more moisture. Tillage allows the crop to progress through short drought periods without stunting or fruit shed. As a consequence, irrigation scheduling becomes less critical and physiological plant growth proceeds efficiently. Under-row, subsoiling and bedding occasionally can help disrupt hardpans or soil surface sealing early in the season and provide a moist, firm seedbed. No-till or reduced-till situations might allow use of cover crops in some situations by increasing moisture infiltration and retaining water reserves within the cotton rooting zone. Cover crops allow less evaporation, increase organic matter and reduce compaction in areas where plow-down regulations are not imposed or where cover crops could replace conservation regulations set to minimize wind or water erosion. Indeed, in much of New Mexico, excess tillage performed during the season not only adds to

production costs of equipment, labor and fuel, but also may cause more soil compaction, structure and soil erosion problems in fields.

Excess cultivation can cause moisture loss from soils and add to drought severity. Cultivation in established fields can prune roots and reduce the plants' ability to retrieve moisture. Root damage is a severe problem if cultivation is continued into cotton squaring.

Cultural practices that include irrigation, plant population, field system type (tilled, reduced-tilled, no-till) as well as their interrelations can minimize drought stress. Lower plant populations may do better on droughty fields, but only if drought is extreme enough to need lowered plant populations beyond the additional shading and moisture conservation found under high populations. This may occur when extreme stress hampers the crop within peak vegetative and reproductive stages. To optimize cotton production: add moisture in a timely manner, land level slopes to 0.5 percent or less, select varieties carefully, limit tillage and consider cultural operations.

Sufficient nutrient levels help cotton progress through water shortages. However, some nutrients are more limited in uptake during drought. Nitrogen and potassium uptake is limited during drought stress. Supplying extra nitrogen can compound problems late in the season, when rain or irrigation between cut out and harvest cause cotton regrowth or defoliation problems. Indeed, if drought is forecast, it may be wise to use an average, not excessive, fertilizer allotment for an average yield. If moisture conditions improve by midseason, petiole testing and foliar nutrient applications can boost nutrients and, perhaps, yield.

Pest management to reduce drought damage is very important. Early seedling diseases in cotton not only weaken plants but also limit moisture extraction from soils. Drought actually can reduce budworm, bollworm, aphid and corn borer pressures in cotton fields but armyworms, spider mites and grasshoppers can reach alarming numbers. Scouting is even more essential during droughty cropping seasons.

Droughts may make cotton cut out early or may extend early growth cycles in plants, depending on the stress and timing of the dry periods. Ultimately, drought usually causes cotton to open early. If cotton fruiting is compressed, maturity and defoliation are affected. Early crops may need to be defoliated sooner, possibly before 85 percent bolls open in southern New Mexico or before 65 percent in northern, Upland cotton fields. Begin examining and opening a few bolls to determine defoliation timing once 40 percent of the bolls are open in drought years. If boll development is close to the target defoliation time, schedule and apply defoliation materials to ensure a quick and efficient harvest. In cases where residual nitrogen may promote late-season regrowth, desiccant use also may be needed. Timely

acquisition of custom harvesting equipment and module builders is important to speed harvest during drought years.

Harvesting short, drought-stressed plants is difficult, because bolls usually are closer to the ground. Spindle condition is important to optimize stripping or picking within one pass on limited-yield fields. Because stressed fields usually demand slower harvesting, check compression sheet adjustments to maximize boll retrieval. Tension on pressure plates also must be checked to allow harvest of mixed-sized plants. Larger plants that still hold green bolls and smaller plants with short limbs will make harvest difficult.

Before planting a crop following a droughty season, sample the soil to confirm any fertilizer carryover. Destroy any drought-season stalks to either conform to plow-down requirements or to remove potential regrowth that could sap even more moisture from the soil. Dry seasons may offer a chance to eliminate compaction layers if subsoiling or chiseling will not rob the soil of moisture. Minimize any weed growth on fields to eliminate moisture-robbing pests.

In extreme conditions, when farmers must choose between harvesting or plowing down, compare economic returns, insurance payments, price supports and future costs incurred to determine if the lint and cottonseed yields will cover harvesting, hauling and ginning costs. Consider all pricing mechanisms and futures, options, puts and calls, forward contracting, minimum price contracts and other alternatives, such as cooperative pools. Check with crop insurance providers or local or state program offices to gain additional information toward your decision.

As a drought-tolerant crop, cotton can respond better than many other crops during drought years if production management schemes are followed by the producer.

REFERENCES

- Bucks, D.A., S.G. Allen, R.L. Roth and B.R. Gardner. 1988. *Short staple cotton under micro and level-basin irrigation methods*. *Irrig. Sci.* 9:161-176.
- DeTar, W.R., C.J. Phene, D.A. Clark and T.A. Kerby. 1993. *Comparison of water use and yields of Acala and Pima cottons for subsurface drip vs. furrow irrigation*. 1993 Beltwide Cotton Conf.: cotton engineering-systems, pp. 540-541.
- Grimes, D.W., W.L. Dickens and W.D. Anderson. 1969. *Functions for cotton (*Gossypium hirsutum* L.) production from irrigation and nitrogen fertilization variables: II. Yield components and quality characteristics*. *Agron. J.* 61:773-776.
- Grimes, D.W. and H. Yamada. 1982. *Relation of cotton growth and yield to minimum leafwater potential*. *Crop Sci.* 22:134-139.

- Hutmacher, R.B., J.E. Ayars, S.S. Vail, A.D. Bravo, D. Dettinger and R.A. Schoneman. 1996. *Uptake of shallow groundwater by cotton: growth stage, groundwater salinity effects in column lysimeters*. *Agric. Water Mgt.* 31: 205-223.
- McWilliams, D.A. 2002. *Producing quality cotton using irrigation management*. Proc. First Irrigation Efficiency Conf., New Mexico State Univ. Coop. Ext. Ser.
- Morrow, M.R. and D.R. Krieg. 1990. *Cotton management strategies for a short growing season environment: water-nitrogen considerations*. *Agron. J.* 82:52-56.
- North Carolina Cooperative Extension Service. 1994. *Drought management for cotton production*. NCCES, N. Carolina State Univ., Raleigh, AG-519-5, Internet: <http://www.ces.ncsu.edu/drought/dro-17.html>.
- Quisenberry, J.E. and B. Roark. 1976. *Influence of indeterminate growth habit on yield and irrigation water-use efficiency in upland cotton*. *Crop Sci.* 16:762-765.
- Sammis, T.W. 1981. *Yield of alfalfa and cotton as influenced by irrigation*. *Agron. J.* 73:323-329.
- Tanji, K.K. and B. Yaron. 1994. *Management of water use in agriculture*. Springer-Verlag, Berlin, Heidelberg, New York.
- Texas A&M Extension. 1998. *Drought management strategies related to production, management, and marketing of cotton in Texas*. Texas A&M Univ., Internet:<http://agnews.tamu.edu/drought/drghtpak98/drght27.html>.
- Wanjura, D.F., J.R. Mahan and D.R. Upchurch. 1996. *Irrigation starting time effects on cotton under high-frequency irrigation*. *Agron. J.* 88:561-566.



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