Effects of Waterlogged Soils and Reduced Heat Unit Accumulation in Cotton

Dr. Robert Lemon, Professor and Extension Cotton Agronomist

What a difference a year makes! In 2003 we couldn't "buy" an early season rain, and this year it's been the direct opposite. Most of south central Texas and the Gulf Coast have been inundated with unusually high and prolonged rainfall for much of this cotton cropping season and most of the region experienced very heavy rainfall last week. In addition, temperatures have been cooler than normal, resulting in reduced heat unit accumulation and slowing development of the crop. We're all very familiar with the effects of drought conditions on the cotton crop, but the question of how waterlogged conditions and prolonged wet soils impact growth and development is not an issue we contend with very often.

Waterlogging of a field for several days reduces the crop growth rate and can potentially reduce yield. Generally speaking, waterlogged conditions reduce the crop growth rate by replacing the air in the soil with water, depriving the root system of oxygen. Since oxygen diffuses much more slowly through water than air, the roots soon become deprived of oxygen and are unable to maintain normal respiration. Respiration is a necessary process that the plant uses to provide energy and building blocks for growth. As a general rule, respiration rates are greatest in the meristematic tissues of the growing points such as the terminal and the root tips.

When soils become waterlogged they are termed anaerobic (without oxygen) and the effects of this include chlorotic, yellow plants, reduced growth rates for shoots and roots, reduced photosynthesis and respiration, reduced nutrient uptake, altered plant hormone levels, and many other problems. So, if we couple the wet soils with the moderate temperatures and reduced sunlight conditions over the past few weeks it all adds up to a crop that has gotten off to a very slow start (and that may be an understatement). So that brings up some management considerations.

Waterlogged conditions inhibit the production of gibberellic acid and cytokinins (plant hormones that contribute to growth) resulting in reduced internode and leaf expansion. Since most fields are already under stress and are experiencing slow growth due to the reduced production of these phytohormones, we need to be careful about applications of mepiquat chloride (Pix, Pentia - mepiquat pentaborate, etc.) during this stressful period. The primary action of these products is to reduce gibberellic acid production in the plant, which reduces internode and leaf growth. Because mepiquat chloride suppresses plant growth, it can have harmful effects on stressed plants by further limiting growth. Currently, we need dry, warm conditions to stimulate growth and applications of these plant growth regulators will suppress growth and slow the recovery process. Once the crop has returned to a healthy condition, monitor the fields and apply plant growth regulators as dictated by plant growth.

Another concern is the health and size of the root system. Generally speaking, the cotton root system grows rapidly during early season. During the vegetative stage, root development may proceed at a rate of 0.5 to 2.0 inches per day and after 40 to 50 days the root system may be three feet deep. Unfortunately, the wet conditions have restricted root development and this could be a factor during flowering and boll fill. Whenever it dries enough to cultivate, be careful not to set the sweeps too deep or too close to the plant. The last thing we need to do is prune the root system.

Another question that comes up is "Will foliar feeding the crop provide benefits?" Most research indicates that foliar feeding with nutrients, or applying plant growth products will not provide much benefit to young, stressed cotton. The crop is experiencing multiple problems and although its appearance may be slightly improved, a yield response is unlikely. The plant is struggling to grow, photosynthesis is impaired, and nutrient uptake from the soil is reduced. As a result, the utilization of foliar nutrients will be limited.

We're all familiar with the heat unit concept and the effect temperature has on growth and development of cotton. The heat unit (growing degree days) is a measure of the amount of useful heat energy the plant accumulates each day throughout the season. The cotton plant must accumulate a certain number of heat units for it to reach certain developmental stages. The optimum temperature for cotton growth is about 90^{o}F. At lower temperatures the developmental rate will be slower. This season we've experienced moderate temperatures, wet conditions, and an over abundance of cloudy days. All these factors have reduced the growth rate of the cotton crop. Node development is a reliable indicator of crop progress. A cotton plant develops a new node every 50 to 60 heat units whether the heat unit accumulation occurs in two days or 10 days. The attached table shows heat unit accumulations for this season in comparison to 2003 and the long-term average. Comparisons have been made for two planting dates in the Coastal Bend (San Patrico County), mid-Coastal Bend (Victoria County), Upper Coastal Bend (Wharton County), and the Brazos River Valley (College Station). In all cases we've received significantly fewer heat units than last season, which places the crop two to five nodes behind where we were for this same time period in 2003.

The bottom line is that we need warm temperatures and sunshine to "kick-start" the crop. Nothing we can do to this crop can replace good growing conditions.

Table 1. Heat Unit Accumulations for 2003, 2004 and the Long-term Average.

Location	***Planting Date***	***Cumulative Heat Units to Date as of May 14, 2004***			
		2003	***2004***	***Long-term***	***Difference Between 2003 and 2004***
Wharton	March 21	669	574	508	**-95 (2 nodes)**
Wharton	April 7	579	411	415	**-168 (3 nodes)**
College Station	April 1	561	457	485	**-104 (2 nodes)**
College Station	April 15	460	366	382	**-94 (2 nodes)**
San Patricio	March 14	870	637	745	**-233 (4.2 nodes)**
San Patricio	March 25	797	541	667	**-256 (4.7 nodes)**
Victoria	March 17	712	642	689	**-70 (1.3 nodes)**
Victoria	April 20	477	336	384	**-141 (2.6 nodes)**