NATIONAL COTTON COUNCIL

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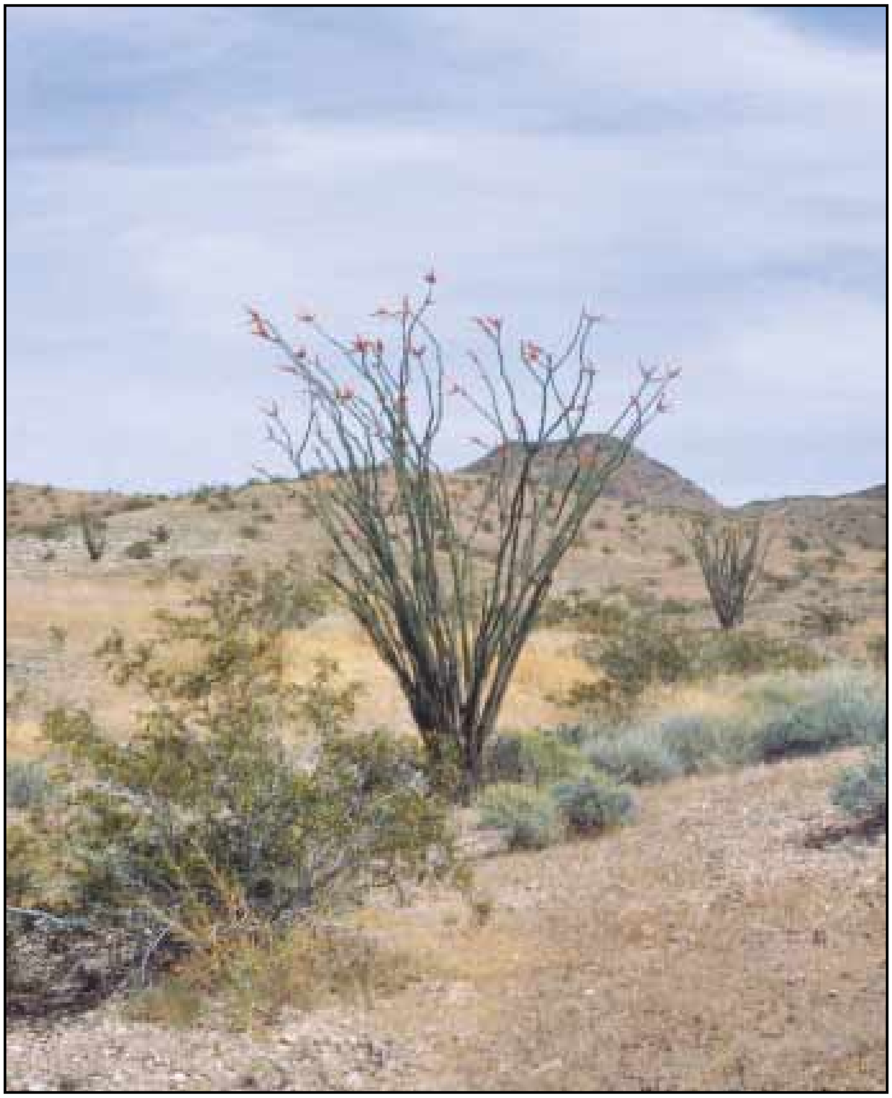
Irrigation Scheduling

A new year, a new look as *Cotton Physiology Today* focuses on techniques and methods used in specific regions of the Cotton Belt - articles focus on understanding physiology through methods used by growers.

Limiting resources

Resources available to growers in different locations around the Cotton Belt vary considerably. The desert Southwest is a region of very little annual rainfall (Fig. 1). To make ends meet, growers in this part of the country have to make every drop of irrigation water count. Water costs can be as high as $160 per acre foot.

In this issue, one of several methods of determining when to irrigate – namely by using the pressure bomb to measure the water status of the plant – is discussed. This plant-based method is particularly well suited to the arid Southwest where most days are sunny and skies are free of clouds.



A.F. Wrona

Figure 1. Ocotillo in bloom in California's arid Imperial Valley.

INSIDE:

The Cotton Physiology Education Program (CPEP), now in its 13th year, is funded by a grant to the Cotton Foundation by BASF, makers of Pix®Plus plant regulator. CPEP's mission is to discover and communicate more profitable methods of producing cotton.

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Examples discussed come from work done in the Imperial Valley of California where less than 3 inches of rain fall annually (Fig. 2). This desert environment where ocotillos bloom (Fig. 1) and roadrunners range experiences summer temperatures of 115º F or higher. Growers use water judiciously to keep 500,000 irrigated acres green and productive.

The entire nation enjoys the fruits of Imperial Valley growers' labor year-round. Alfalfa, artichokes, asparagus, bermudagrass, broccoli, cabbage, carrots, cauliflower, corn, cotton, cucumbers, lettuce, melons, onions, squash, tomatoes, wheat, sudangrass, and sugarbeets are a few of the crops produced in this verdant valley.

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Figure 2. Irrigated crops in California's Imperial Valley.

Knowing when to irrigate

Irrigating with the correct amount of water (not too much or too little) and at the right time can significantly boost yields and reduce costs. Growers used to follow the adage that stressing plants for water early in the season promoted better root growth in cotton that, in turn, helped it later in the season.

Stephanie Johnson Hake (former UC farm advisor) and coworkers showed for each day that the first irrigation after planting was applied too early, yields decreased by 4.5 pounds per acre and for each day it was applied too late, yields decreased by 12 pounds per acre. Her work was done in the San Joaquin Valley of California, approximately 250 miles northwest of the Imperial Valley.

California cotton growers routinely use pressure bombs (tool used by Hake) to determine the best time to irrigate. Tom Kerby, former UC cotton specialist, likens a pressure bomb reading to the pulse your doctor measures – a diagnostic tool that helps to assess health of the plant - or person, in the case of a pulse.

Taking measurements

Between noon and 2 p.m. cotton plants have a relatively constant amount of stress as moisture evaporates from leaf surfaces and water is pulled through vessels (xylem) from the roots to meet the evaporative demand. The amount of pull on the continuous column of water that extends from the soil solution through the plant and to the atmosphere can be measured with the pressure bomb.

To sample the water status of a crop (take its pulse in Tom Kerby's words), a grower or agronomist walks a few hundred feet into the field, so as not to measure an edge effect. He samples in several locations typical of the field, perhaps in zones known to be of different soil types (Fig. 3). To sample, he cuts the stem (petiole) of a cotton leaf four leaves from the top of the sampled plant. When the leaf is cut, the continuous column of water is broken. The sap retreats into the xylem, much like a stretched rubber band goes flaccid when no longer pulled.

The cut leaf is placed upside down in a foam-lined chuck that holds it in a chamber shaded from direct sunlight (Figs. 4, 5). Inert nitrogen gas is pumped into the chamber. The gas pressure forces liquid "backwards" through the leaf blade and petiole. When liquid is seen at the surface of the cut petiole, a reading is taken (Fig. 5). That reading reflects the amount of pull or tension that the column of water in the plant was experiencing at the time it was sampled.

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Figure 3. Sampling cotton water status at solar noon.

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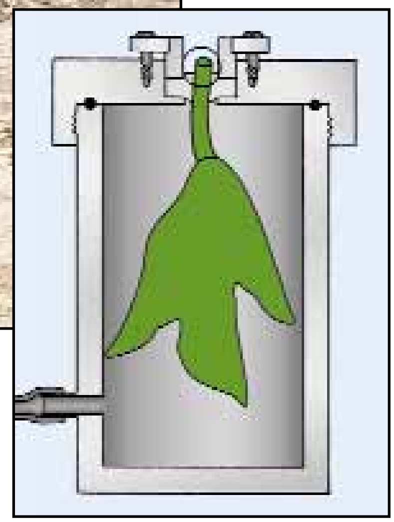
Figure 4. Pressure bomb shaded from direct sunlight.



C.T. Yarwood

Fig. 5. Cut cotton leaf in chamber pressurized with nitrogen gas.

Interpreting results

Using height as a gauge of plant establishment, you can see that research plots irrigated at different timings following planting responded quite differently (Figs. 6, 7). The second row of plots, which looks like waves of green, received irrigation at different times based on when the plants in the plots reached specific treatment leaf water potential values.

Plants in the troughs were stressed to –21 bars before receiving irrigations. Mid-sized plants were watered at –18 bars and the tallest plants were not stressed for water as they were irrigated at –15 bars of leaf water potential.

Irrigation pipe is clearly visible in the late-timed (–21 bar) treatment, but not where the canopy has closed on the adjacent early (-15 bar) and mid-timed (–18 bar) treatments.

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Fig. 6. Different frequency of irrigation results in big differences in growth.

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Fig. 7. Cotton stressed & stunted by witholding irrigation (–21 bar treatment, left three rows).

Height to node ratios (HNR) are routinely used as a measure of cotton development. The diagram in Figure 8 shows a plant of 15 nodes. To obtain its height to node ratio, divide its height (say 24 inches) by the number of nodes (15 branches, not counting cotyledons). For this hypothetical plant the HNR is 1.6.

Comparing height to node ratios as a function of plant age of cotton from the Imperial Valley to those obtained by Tom Kerby over the years in the San Joaquin, we see a similar pattern (Fig. 9). The plants that grew closest to the rate at which they do in the San Joaquin (white line) were those watered early at –15 bars (very little water stress, yellow line). Those that were stunted (green line) were watered at –21 bars which is a fair level of water stress.

Because the evaporative demand is so very high in the much hotter and drier Imperial Valley, the plants never quite catch up with their demand for water and, hence, do not grow as quickly as plants in the more moderate climate.

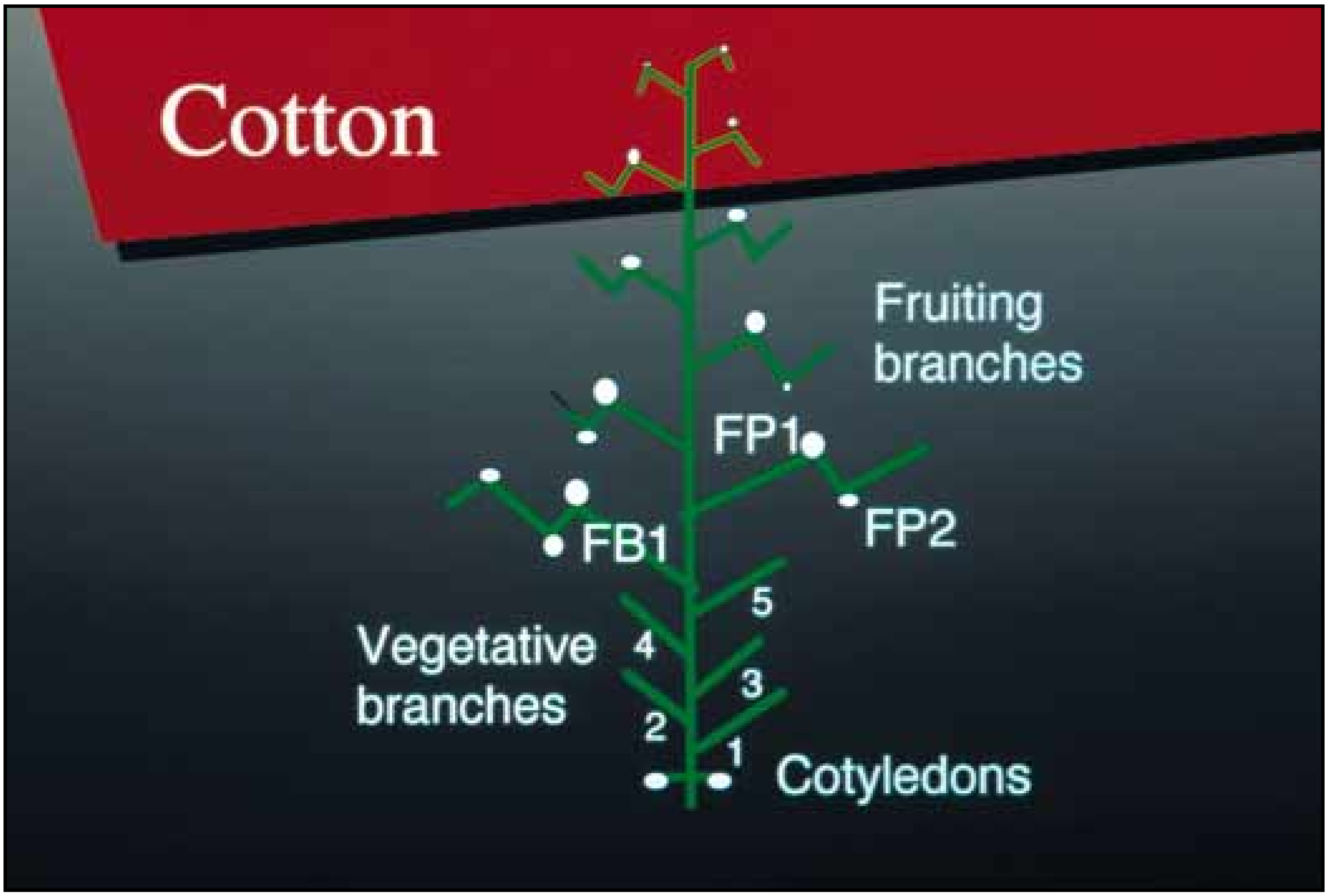

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Fig. 8. Cotton plant schematic of 15 nodes.

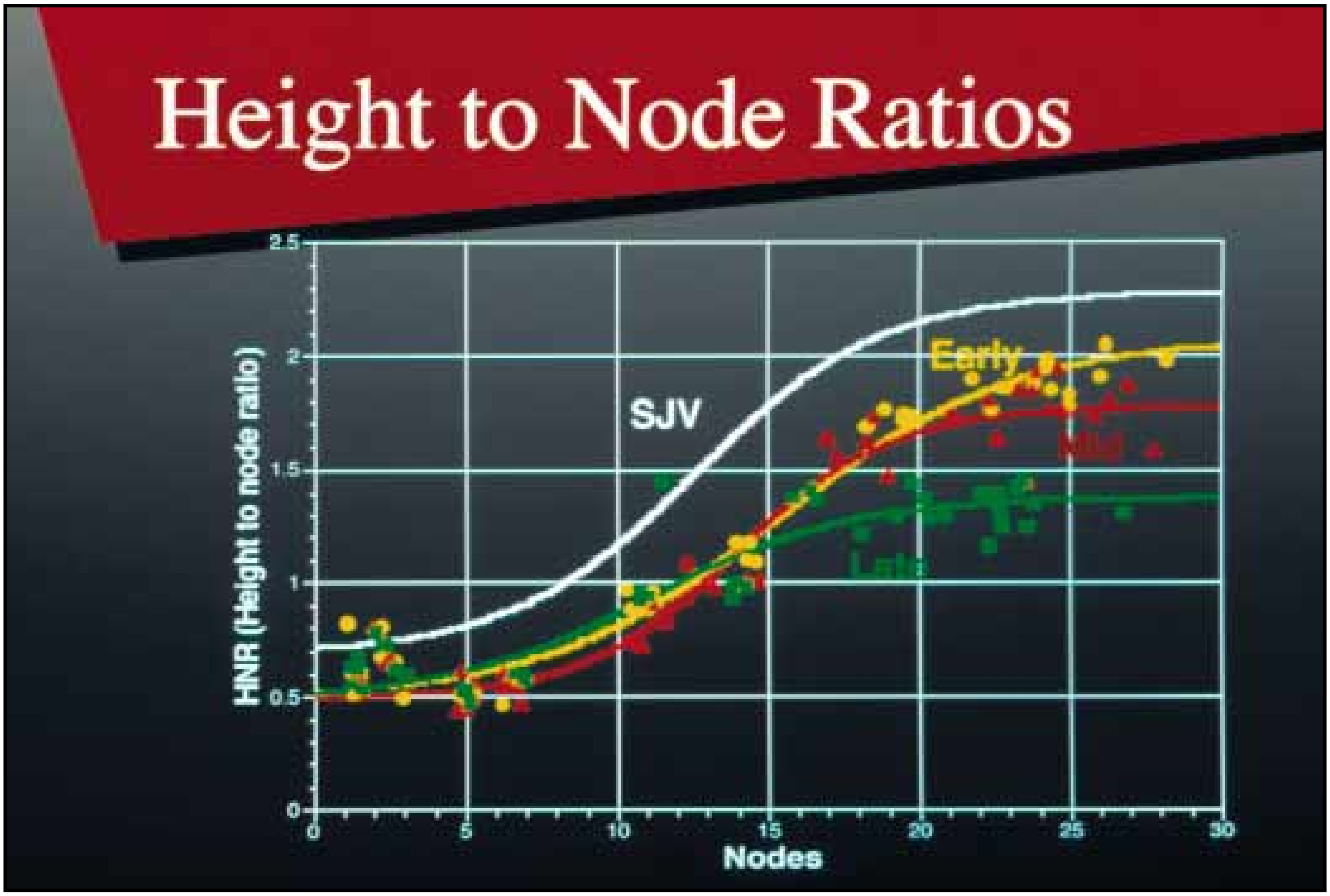

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Fig. 9. Height to node ratios as plant age (number of nodes) for different timings of irrigation.

Conclusions

In the Imperial Valley, as in the more northern San Joaquin, growers irrigate when cotton reaches –15 bars leaf water potential. Yields and quality are higher when water stress is not part of cotton production (Fig. 10).

Urban populations, wildlife, and agriculture all vie for use of water (Fig. 11). As producers continue to fine-tune their production practices to reduce costs, hone resources for environmental and other demands, and improve yields, timing of irrigation plays an important role.

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Fig. 10. Yields improve with plant-based irrigation scheduling.

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Fig. 11. Stilt in drainage canal.

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