Cotton wilting from moisture stress following cultivation in test field.

Effects of MOISTURE STRESS *on* COTTON YIELDS

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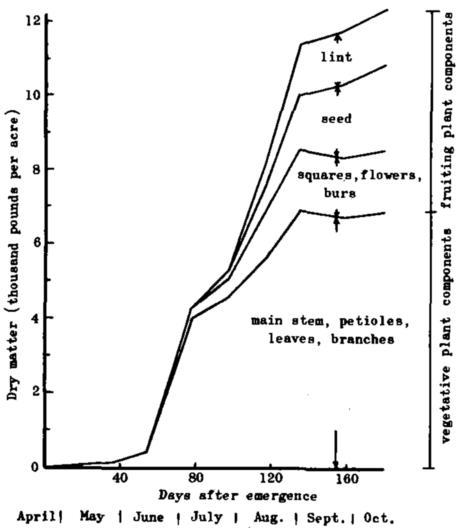
Moisture stress applied when 36% of the cotton bolls were normally set resulted in yield production of 1.47 bales per acre, as compared with 2.37 bales with normal irrigation. Subjecting cotton plants to moderate moisture stress during the peak of the fruiting period (even though followed by normal irrigations) resulted in a shift of boll set to later in the season—a delay causing many bolls at the top of the plants to be unopened at harvest time.

A HIGH-YIELDING COTTON PLANT growing in the San Joaquin Valley requires from 25 to 30 acre-inches of water from emergence to maturity (including evaporation from the soil surface and transpiration from the plant)—nearly all of which must come from irrigation. The amount of water delivered to the field must exceed the 25 to 30 acre-inches actually used by the plant because irrigation efficiencies are always less than 100%. The studies reported in this article were to determine the effects of moisture stress at certain periods in the development and growth of the cotton plant on yields.

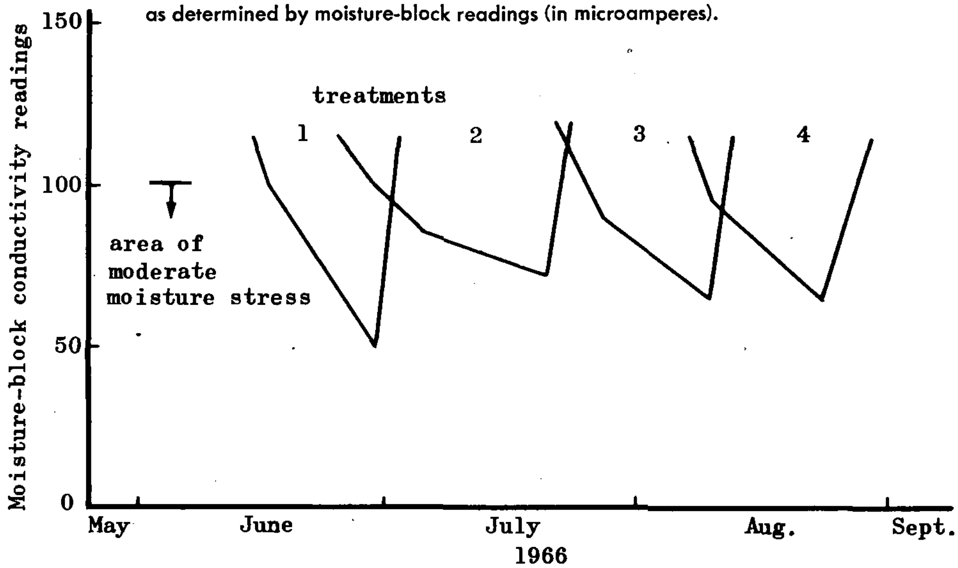
When irrigation water is withheld during a given stage of plant growth, a "stress" condition is imposed on the plant. Visual symptoms of a moisture-stress condition include a general reduction in growth rate and wilting, with an apparent leaf-color change from green to bluish-green. As the stress condition intensifies, definite wilt symptoms become more evident, and during the flowering stage more flowers will be exposed at the tops of the plants. Symptoms of moisture stress are more evident in plants on sandy soils having a low water-holding capacity.

Graph 1 shows the characteristic plant development (when no apparent moisture stress is permitted). The graph shows total dry matter of the plant at any time during the growing season, and the proportion of specific plant parts to the total.

Graph 1. Progressive stages of cotton plant development. Shafter, 1966.



Graph 2. Four moderate moisture-stress periods during growing season as determined by moisture-block readings (in microamperes).



From a mid-April planting date, dry-matter accumulation proceeded at a relatively slow rate until early June. A period of rapid dry-matter accumulation in the vegetative plant parts followed, and was essentially complete by late August. Dry-matter accumulation in the fruiting plant parts began with first square formation. First flowers are normally observed three to four weeks later—approximately the last week in June. Dry-matter accumulation then proceeds rapidly in the fruiting plant parts through August. Water availability during this flowering period (late June through August) is a critical factor from the standpoint of square retention and subsequent fiber development.

1966 tests

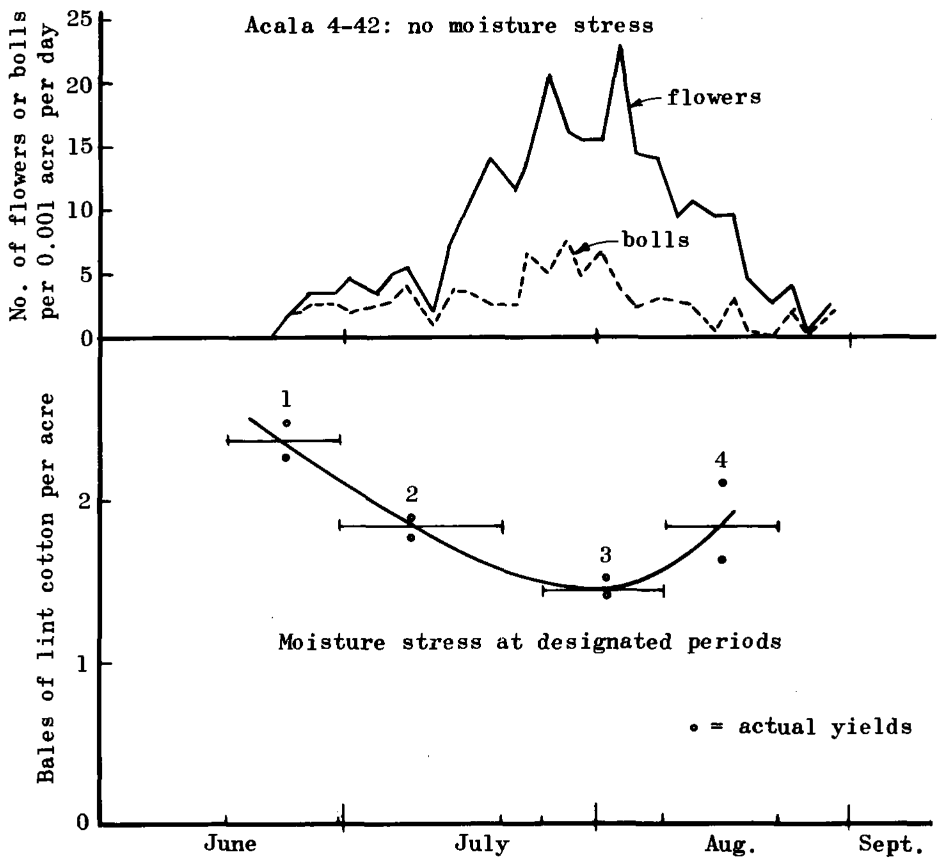
During 1966, four moisture-stress treatments on cotton at different growth stages were studied on Panoche clay loam at the West Side Field Station. Plants in treatments 1 to 4 were stressed for moisture and sampled (leaf-petiole) on the following dates: June 16–29, July 1–15, July 24–Aug. 8, and Aug. 8–22. Plot irrigations were timed according to predetermined readings of gypsum blocks installed at 18-inch soil depths. Moisture blocks were also installed at 36-inch depths to determine changes in the subsoil moisture below the cotton plants. Irrigation for all plots totaled 33 acre-inches of water, including an initial 12 inches immediately following the April 6 planting.

Moisture block

Graph 2 shows the relationship between the moisture-block readings and the dates of moisture-stress periods for treatments 1 to 4. To evaluate the moisture-stress condition, the cotton plants were determined to be under moderate stress when the moisture-block readings at the 18-inch soil depth went below 100 (indicating less than 0.25 inch of available water per foot of soil at that depth). Stress periods are depicted as angular areas below the horizontal line at the graph reading of 100. Timely irrigations during the growing season prevented the available soil moisture content at this soil depth from dropping below 0.25 inch per foot except during the moisture-stress period shown for each treatment. The moisture-stress periods were accomplished by omitting the following irrigations: May 24 irrigation in treatment 1, June 30 irrigation in treatment 2, July 21 irrigation in treatment 3, and August 9 irrigation in treatment 4.

Graph 3 shows the relationship between each imposed stress period and the normal flowering and boll-retention characteristics of Acala 4-42 when no moisture stress was permitted. The flowering and boll-retention data presented were taken from a separate experiment conducted during 1966 on an adjoining field which was not subjected to moisture-stress conditions. Stress treatments 1, 2, 3, and 4 occurred during the periods when 8.0%, 20.0%, 36.0%, and 12.0%, respectively, of the total bolls were set on the adjoining no-stress irrigation treatment (graph 3). The corresponding average maximum temperatures during the moisture-stress treatments 1 through 4 were 97°, 96°, 103°, and 105°F, respectively. Lint yield (in bales per acre) is closely associated with the boll set; moisture stress applied as in treatment 3, when normally 36% of bolls would be set, produced only 1.47 bales per acre in this test, as compared with 2.37 bales in the check plot. Subjecting the cotton plants to moderate moisture stress during the peak of the fruiting period (treatments 2 and 3), and following with sufficient irrigations, resulted in a shift of boll set to later in the season. This delay resulted in many unopened bolls at the top of the plants at harvest time.

Graph 3. Relationship between cotton lint yield and moisture stress at four periods during the fruiting stage. The top part of the graph shows the normal flowering rate and boll set where no moisture stress is imposed.



Research data indicate that the quantity of certain free amino acids may be altered considerably in some plants subjected to moisture stress, resulting in the inhibition of protein synthesis with a subsequent lowering of protein levels. Since nitrogen is an integral part of amino acids which make up the plant's protein, these chemical changes caused by moisture stress could possibly affect the plant's nitrogen metabolism. Leaf and petiole samples collected at four different dates, corresponding to the end of each moisture-stress treatment, will be chemically analyzed for some specific amino acids and perhaps sugars. Results of the chemical analyses and their relationship with the moisture-stress treatments will determine the orientation or direction of future studies.

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