WATER STRESS during flowering of cotton

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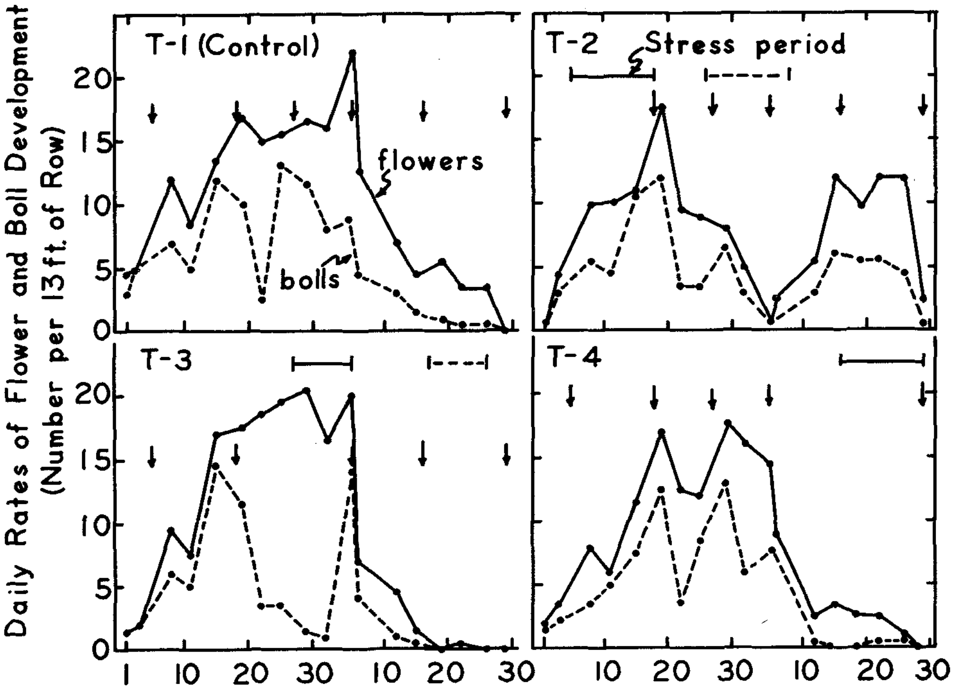
A severe plant water deficit imposed for nine days during the peak flowering period of cotton reduced yield more than stress periods of comparable length imposed either early or late in the flowering period. Water stress occurring early in the flowering period reduced yields by increasing shedding of squares before they flowered. Stress late in the flowering period reduced flowering rates and boll retention.



Graph 1. The influence of water deficits at different periods during flowering on rates of flowering and boll development. The dashed bar following the indicated stress period shows the time interval for flowers developed from squares initiated during the actual stress period. Irrigation dates are shown by arrows.

PERIODS OF PLANT WATER STRESS affect the yield and quality of crop plants in various ways and may prove beneficial in some cases and detrimental in others. The influence of plant water stress on crop yield is primarily a function of the degree and duration of the stress, the nature of the plant part or parts harvested for yield, and the stage of plant growth when stress is imposed. Cotton (*Gossypium hirsutum* L.) is characterized by an indeterminate growth, with a complex relation between yield and vegetative growth rate. Recent studies on alternate-furrow irrigation for San Joaquin Valley cotton have shown that higher lint production results from a period of moderate water stress before flowering. However, excessive shedding of fruiting forms may result when plants are subjected to water stress during the flowering period. The study reported here relates water deficits at specific time intervals during flowering to plant responses causing yield reductions. Information presented could be useful where a programmed allocation of water through irrigation systems is feasible.

The study was conducted at the U. S. Cotton Research Station, Kern County. Field plots were located on soil classed as Hesperia sandy loam (derived from granitic alluvium and showing only slight profile development), and is essentially free of salts. Acala SJ-1 seed was planted in 40-inch rows in mid-April, 1968, at 17 lbs per acre and thinned after emergence to a final stand of 19,000 plants per acre. The plots were 27 × 135 ft, and were

Photo to left shows cotton grown as the control (T-1) treatment on the same date as that on the right near the end of the early stress (T-2) period. Note the large differences in leaf area developed at this stage.

graded level before the beginning of the study.

To eliminate nutritional deficiencies as a yield-limiting factor, nitrogen and phosphorus were applied in late May in a uniform sidedress application. Nematodes were controlled by a nematocide applied before planting, and insecticides were applied as required.

Flower production and boll retention were determined in individual plots in two of the replicates by tagging all flowers in anthesis in 13 ft of a central row twice weekly (on Monday and Thursday). The tagging period extended from July 1 through August 29, with each tagged flower identified with the date of flowering. All tags remaining on plants were removed for retention determinations just before the first mechanical harvest.

Treatments

The study consisted of four treatments replicated three times. Treatments were designed to provide severe water deficits for specific portions of the flowering period: T-2, stressed for 13 days (7/5 to 7/18) during early flowering; T-3, stressed for nine days (7/27 to 8/5) during peak flowering; and T-4, stressed for 13 days late (8/16 to 8/29) in the flowering period. All stress treatments were compared with a control (T-1) which was not allowed to undergo appreciable stress any time during the season.

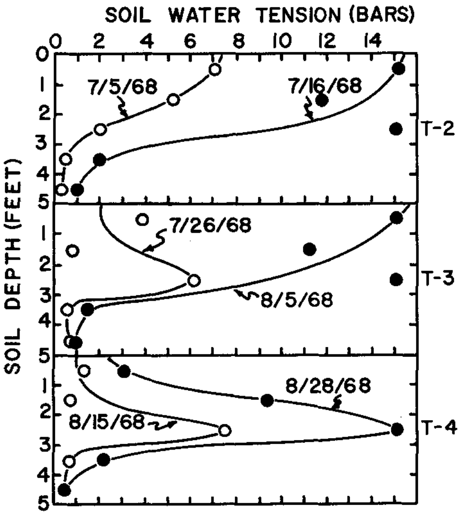
All plots were irrigated uniformly before planting to wet the soil profile throughout the effective rooting depth of five feet. At each irrigation during the season, sufficient water was added to rewet the profile completely. Water was delivered to furrows between rows through gated pipe and measured in individual plots by delivery in a known volume per unit of time. Total water added during the growing season, in addition to what was added pre-plant, amounted to 25 inches for T-1 and 23 inches for the stressed treatments. No significant rainfall occurred during the growing season.

Soil-water tension values before irrigation were determined from gravimetric samples and soil moisture characteristic curves. Water stress conditions at specific time intervals were obtained by eliminating a single irrigation for each of the three stress treatments. For comparison the initiation of stress in a specific treatment is considered to be the day when all other treatments were irrigated. Actual plant water potential, though not measured, can be inferred from soil-water tension values (graph 2). Leaf wilting in mid-afternoon was observed in all stressed treatments at the beginning of the water deficit periods. By the time stress periods were terminated, severe leaf wilting was experienced and some leaf drop was observed. The maximum soil water depletion for the control (T-1) treatment is shown by soil water tension values at the beginning of each stress period (T-2, T-3, and T-4), graph 2.

Of interest is the apparent shift in maximum root activity with time (graph 2). Although a well developed root system was complete before the first stress period, maximum root activity changed from the surface foot to mid-profile depths at later stress periods.

Plant growth

The relatively short periods of severe moisture deficits reduced vegetative plant growth generally only when imposed early during flowering (data not shown). Plant height was 26 inches for T-2 by July 16, compared with 33 inches for T-1. The corresponding leaf area indexes (ratio of total leaf area to a unit of ground area) were 1.7 and 3.0. Numbers



Graph 2. Soil-water tension values during plant water stress periods at different times during flowering. The greatest soil water depletion for the control (T-1) treatment is shown by tension values at the beginning of each of the three stress periods.

of main-stem nodes did not differ significantly among treatments on any measurement date. Leaf-area index (LAI) was significantly lower for T-2 and T-3 than for T-1 on August 5, but by August 22 the differences were gone. A maximum LAI of 6.2 was observed at peak vegetative development.

Flower and boll production

Daily rates of flower production and boll retention for the four treatments are shown in graph 1. The T-1 treatment presents a typical flower and boll rate curve for the variety and climatic conditions of the study, except for the drop in boll retention on July 22. This was probably a result of excessive plant water stress prior to the irrigation on July 27. Typically, first flowers are observed in late June with the rate building to a peak in late July and early August, followed by a rapid decline. The percentage of flowers developing and retaining bolls is highest early during the period with a decline in boll retention as the prevailing plant-boll load increases.

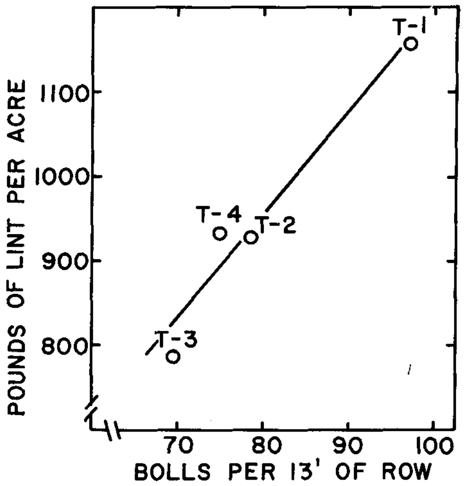
Information on square shedding before anthesis is available indirectly, in this study, from the daily rate of flowering curves. Approximately three weeks are required before a first-visible square opens as a flower. To evaluate the influence of plant water deficits on young fruiting forms, the water stress period is extrapolated three weeks down the time scale in graph 1 and is represented by a broken bar.

Plant water stress

The influence of a plant water deficit on flower production and boll set is strongly dependent on the time the deficit is incurred during the flowering period (graph 1). Early water stress (T-2) had no appreciable affect on rate of flower production or boll retention. However, as indicated by flowering rates three weeks past the stress period, considerable shedding of young squares occurred during the stress period. Because of the reduced boll load associated with excessive square shedding, flower production and daily boll set rates during the latter part of the flowering period were greater than in the T-1 treatment.

A water deficit imposed during peak flowering (T-3) had no pronounced influence on daily flowering rates. Boll retention was reduced sharply by the beginning of the stress period because plants had a prevailing boll load when stress occurred. As with T-2, the T-3 treatment resulted in increased square shedding during the stress period but differs in that insufficient time was available for recovery.

Graph 3. Relation between lint production and total number of bolls counted during the flowering period for the four treatments.



Daily rates of flower production were less with the T-4 stress period than with T-1, indicating that squares of greater age were shed prior to anthesis when water stress was imposed late. Essentially no bolls were retained during the T-4 stress interval.

Lint production

Boll production is determined from the number of flowers produced and the boll retention rate, the yield components primarily affected by periods of water stress during flowering. Lint production is related to total bolls counted during the season (see graph 3). Yield was reduced most severely by T-3 which affected both boll and square retention during the stress interval. Treatments T-2 and T-4 were comparable in yield although they differed in which plant responses caused the reduced yields. The close relation between lint production and boll number indicates that neither boll size nor lint percentage was influenced appreciably by treatments in this study.

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Corporate farms tend to be larger, both in terms of acres of land operated and gross farm sales. California's farming corporations tend to concentrate in the intensive high-risk-capital enterprises. The rate of incorporation appears to have slowed considerably in the past three years. In the future, it is likely that existing corporations will expand the size of their present operations, along with some consolidation of smaller corporations through purchase by, or merger with, large diversified corporations. Also, as farms achieve a larger size, they will tend to adopt the corporate form of business organization.

THERE HAS BEEN a growing concern over the expansion of the corporate form of business organization and interest in what its long-term effects on California's agriculture will be. This report summarizes a recent survey of California farming corporations.

In the spring of 1969, a mail-out questionnaire was sent to 2,566 firms thought to be incorporated and engaged in agricultural operations. A total of 1,915 respondents returned completed questionnaires for a 76 per cent response. Only 1,233 of these schedules qualified for further analysis, the remaining respondents had no agricultural operations in California, were inactive corporations, or were not incorporated. A nonrespondent bias check was made through personal interviews to determine if nonrespondents were significantly different than the earlier mail-in respondents. Nonrespondents corporations were found to be significantly larger operations than the original respondents and all data presented here and in accompanying tables have been adjusted to reflect this bias.