Physiology and Growth Regulation

Changes in the Hormonal Status of Young Bolls and Their Abscission Zones in Relation to Boll Retention

Gene Guinn, Plant Physiologist
D. L. Brummett, Agric. Research Technician
USDA, ARS, Western Cotton Research Lab, Phoenix

Summary

An experiment was conducted to test the hypothesis that a nutritional stress (shortage of photosynthate) affects the hormonal balance in bolls and their abscission zones. It did. The concentration of indoleacetic acid (IAA) in abscission zones of young bolls decreased and boll shedding increased as competition for photosynthate increased. Water deficit also decreased the IAA content of young bolls and their abscission zones, but greatly increased the concentration of abscisic acid (ABA) a hormone that may increase boll shedding.

******

It has been known for many years that cotton fruit (boll) retention decreases when the demand for photosynthate exceeds the supply, or when the plants are subjected to drought. The demonstration (in 1976) that these stresses increase the rate of ethylene production in young bolls provided one explanation for their effects on boll retention (because ethylene can cause abscission). It seemed logical that other hormones might also be affected.

Methods

We altered photosynthate availability by thinning the plant population (to increase light intensity and photosynthesis in the plant canopy) and by removing all bolls from the remaining plants (to decrease the demand for photosynthate). Thinning and defruiting were done on July 1, about three weeks after flowering started. Control plants were neither thinned nor defruited. The effects of water deficit were estimated by harvesting at different times during an irrigation cycle. Bolls and their abscission zones were harvested three days after anthesis and analyzed for ABA and IAA (hormones that have been implicated in abscission promotion and suppression, respectively). Flowers in an adjacent row were tagged for subsequent determination of boll retention.

Results

Thinning and defruiting (T-DF) increased boll retention. Boll retention rates decreased, both in T-DF and control (C) plants, with successive harvests as boll load and water deficit increased. The concentration of free IAA in abscission zones was highly correlated with boll retention rate. Abscission zones on T-DF plants contained more IAA than those on C plants. The IAA content decreased in both as water deficit increased. The IAA content of bolls did not show exactly the same pattern; it was initially higher in C than in T-DF bolls and increased from the first to the second harvest. The IAA content of bolls did decrease by the time of the third (final) harvest during an irrigation cycle. Transport of IAA from bolls into their abscission zones may have been slowed by the stresses, or some of the IAA may have been conjugated and/or destroyed.

The concentration of free ABA was slightly higher in C than in T-DF bolls at all three harvests. Water deficit caused a 2.4-fold increase in the ABA content of bolls and a 3.5-fold increase in the ABA content of their abscission zones.

These results add to the ethylene data (obtained earlier) and indicate that environmental conditions that increase boll abscission do so by changing the hormonal balance in bolls and their abscission zones.

A cooperative experiment was conducted with Bruce Kimball, J. R. Mauney, and J. W. Radin on the effects of carbon dioxide enrichment on photosynthesis, growth, fruiting, fruit retention, water use, and yield. I report only the results of flowering and boll retention measurements. (This is the third year of experiments with carbon dioxide enrichment of field-grown cotton plants in open-topped chambers.) Water was supplied by drip irrigation at two rates calculated to supply 100% and 67% of ET. Carbon dioxide was supplied at ambient (about 350 ppm), 500, and 650 ppm.

The number of flowers produced was increased by carbon dioxide enrichment, but was hardly affected by water deficit. The number of bolls produced was also increased by carbon dioxide enrichment and was decreased by water deficit. Boll retention rates were very low in the dry plots and were lower in the chambers than in the open plots.

Carbon dioxide enrichment did not increase percentage retention. The entire increase in number of bolls produced was due to increased flower production in the carbon dioxide-enriched chambers. The increased flowering rate with carbon dioxide enrichment was probably due to increased growth that resulted in the production of more fruiting sites. The retention of floral buds (squares) may also have been affected but was not measured. Carbon dioxide enrichment did not mitigate the adverse effects of water deficit.

****
****

Effect of Temperature on Floral Initiation and Production of 4-Bract Squares by DPL-90

Jack R. Mauney, Plant Physiologist, USDA-ARS
Western Cotton Research Laboratory, Phoenix

Summary

When DPL-90 was exposed to average daily temperatures above 78°F, the plants were delayed in the location of the first fruiting branch and produced squares which had 4-bracts. At temperatures below 78°F, there were very few 4-bract squares produced.

****

Preliminary observation in 1984 indicated that, while the cultivar DPL-90 produces a great many abnormal, 4-bract squares during early season in Arizona, it produces few such squares in Mississippi. Since 4-bract squares are more susceptible to thrips damage and subsequent shedding, the source of the environmental effect on square morphology was sought.

Analysis of weather data from 1984 showed that temperatures in Arizona during the period 20 to 45 days after emergence averaged 82°F while those in Mississippi averaged 79°F. During 1985 temperatures in Mississippi averaged 82°F during the period 15 to 30 days after emergence and many 4-bract squares were observed. These observations suggest that perhaps cotton forms abnormal bracts when temperatures during primordial flower bud formation are in excess of 80°F.