Irrigation and Nitrogen Effects on Plant Hormones, Boll Retention, and Growth of Fruiting Branches

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ABSTRACT

An experiment was conducted in Phoenix in 1986 to determine effects of water and N deficits on ABA and IAA concentrations in young bolls and their abscission zones in relation to boll retention, and to determine the effects of N on growth of fruiting branches through the season. Water deficit decreased boll retention, decreased the concentration of free IAA in bolls and their abscission zones, and increased ABA in bolls and abscission zones. But, the concentration of ester IAA increased with water deficit (in contrast to free IAA). Because ester IAA resists degradation during stress, it may facilitate recovery when stress is relieved and some of it is converted to free IAA.

N-deficiency symptoms were mild and did not appear early in the season. N had no effect on the ABA and IAA contents of bolls and their abscission zones, and had only a small effect on growth of fruiting branches. The N test is to be repeated in 1987 when N deficiency should be more severe.

THE PROBLEM

Water deficit causes shedding of young cotton bolls, apparently because it changes the hormonal balance in bolls and their abscission zones. Results in 1985 indicated that water deficit decreased the content of free auxin (indole acetic acid or IAA) and increased the content of free abscisic acid (ABA) in bolls and their abscission zones. Because IAA delays or prevents abscission (shedding) and ABA promotes abscission these changes in IAA and ABA should increase the amount of boll shedding. An experiment was conducted in 1986 to confirm the 1985 results and to determine the effects of water deficit on the concentrations of conjugated ABA and ester IAA because these forms may be converted to free ABA and IAA, respectively.

Nitrogen deficit has also been reported to increase boll shedding; it is thought by modelers to limit boll retention and cause early cutout. Nitrogen is a component of IAA. Therefore, a deficiency should decrease the IAA content of plant tissues. Conversely, a N deficiency has been reported to increase the ABA content of leaves.

An experiment was conducted to determine the influence of N deficiency on growth, flowering, boll retention, and the hormonal composition of 3-day-old bolls, their abscission zones, and the fruiting branches from which they were harvested. This experiment was combined with the one on water deficit.

MATERIALS AND METHODS

'DPL 61' cotton seed were planted April 1 in a field at the Western Cotton Research Laboratory in Phoenix. Half the plots were fertilized with urea to give about 150 lbs of N per acre. The remaining plots were not fertilized. Treatments were replicated four times in a randomized block. The eight plots were separated by berms and irrigation was applied with gated pipe on May 7 and 30, June 13 and 27, July 11, and Aug. 1.

The effects of water deficit were estimated by tagging flowers and harvesting bolls and abscission zones on June 16, 26, and 30 for ABA and IAA analyses. ABA and IAA were purified and measured by high performance liquid chromatography.

RESULTS AND DISCUSSION

Water deficit decreased the concentration of free IAA in bolls and their abscission zones, increased the concentrations of ABA, and decreased boll retention (Table 1, June 26 harvest). In contrast to free IAA, the concentration of ester IAA increased with water deficit. Ester IAA is more resistant to enzymic degradation than free IAA, but can be converted to free IAA. Therefore, the tendency to form ester IAA during stress may protect the plant against depletion of free IAA and speed recovery after relief of stress. The free IAA content of abscission zones increased after irrigation and so did boll retention (Table 1, June 30 harvest).

ABA increased with water deficit and decreased after irrigation. Free ABA was negatively correlated with boll retention; r values were -0.83 - 0.85 for ABA content of bolls and abscission zones, respectively.

Nitrogen had little, if any, effect on flowering (not shown) boll retention (Table 1), or the ABA and IAA contents of bolls and their abscission zones. Nitrogen had only a small effect on growth of fruiting branches, although the size of fruiting branches (at a given age) decreased during the season (Table 2). Symptoms of N deficiency were not seen until late in the season. The experiment is to be repeated on the same plots in 1987 when soil N should be depleted.

Table 1. Leaf water potentials, boll retention, free IAA in bolls and their abscission zones, ester IAA, free ABA, and ester ABA at different times during two irrigation cycles.

	Date Harvested		
	June 16	June 26	June 30
Leaf water potentials		---------- *MPa* ----------	
High N	-1.80±0.08	-2.81±0.09	-1.82±0.07
Low N	-1.79±0.04	-2.80±0.17	-1.75±0.07
Boll retention		---------- *Percentage* ----------	
High N	96.4±2.2	27.4±8.8	77.6±5.6
Low N	83.8±1.3	26.2±8.7	83.3±4.1
Free IAA in bolls		---------- *ng/g* ----------	
High N	120±8.6	93.1±11.1	57.5±5.1
Low N	118±7.2	97.2±8.2	52.2±3.2
Free IAA in abscission zones		---------- *ng/g* ----------	
High N	71.6±2.5	43.2±3.0	60.5±3.5
Low N	79.1±10.3	46.9±3.5	71.6±4.6
Ester IAA in bolls		---------- *ng/g* ----------	
High N	1089± 81	1659±161	471±41
Low N	989±104	1300±213	492±18
Ester IAA in abscission zones		---------- *ng/g* ----------	
High N	57.3±3.6	221± 17	185±12
Low N	53.9±8.2	238± 40	246±47
Free ABA in bolls		---------- *mg/g* ----------	
High N	1.88±0.07	6.62±0.44	2.61±0.13
Low N	1.97±0.01	5.39±0.64	2.43±0.23
Free ABA in abscission zones		---------- *mg/g* ----------	
High N	0.45±0.05	1.71±0.06	0.51±0.03
Low N	0.49±0.02	1.85±0.18	0.52±0.01
Ester ABA in bolls		---------- *mg/g* ----------	
High N	1.69±0.08	2.36±0.29	1.54±0.06
Low N	1.73±0.12	2.22±0.32	1.51±0.28
Ester ABA in abscission zones		---------- *mg/g* ----------	
High N	0.99±0.04	2.70±0.17	2.37±0.04
Low N	1.09±0.02	2.69±0.24	2.33±0.21

Data are averages of four replications.

Table 2. Length and weight of fruiting branches at different times during the growing season and as affected by N fertilization.

	Dry wt, mg		Length, mm	
Harvest Date	High N	Low N	High N	Low N
June 16	735±68	632±42	93.8±9.3	78.2±5.4
June 26	561±25	466±28	73.2±1.5	66.1±3.4
June 30	380±22	300±48	52.3±1.5	47.4±4.2
July 10	174±12	94±18	25.1±1.1	15.2±2.2
July 14	133±21	77±23	19.2±2.4	13.7±2.7
July 28	88± 5	35±12	12.3±1.2	5.4±1.3