Hormonal Changes in Relation to Cutout

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Abstract

Experiments were conducted in 1987 and 1988 to determine whether hormonal changes may be involved in the decreases in growth and boll retention commonly referred to as cutout. Nitrogen deficiency decreased the auxin content and growth of fruiting branches. The auxin contents of fruiting branches, squares, and bolls decreased during the season as the plants entered cutout. ABA in bolls increased slightly, but the ABA content of squares and fruiting branches showed no consistent changes. The results indicate that decreases in auxin (IAA) may be involved in cutout.

INTRODUCTION

Growth and flowering rates slow and boll retentioin decreases during the season as cotton plants become loaded with bolls. If this hiatus in growth, flowering, and boll retention is pronounced, it is called cutout. Cutout can be hastened and prolonged by deficits of water and nitrogen. Hormonal changes may be involved in cutout. Abscisic acid (ABA) is a growth inhibitor and a promoter of shedding. Water deficit can cause large increases in the concentration of ABA. A few investigators have reported that N deficit also increases the ABA content of plants. Auxin (indole-3-acetic acid or IAA), on the other hand, is a growth-promoting hormone. Unlike ABA, auxin delays or prevents shedding. We conducted experiments to test the hypotheses that (a) an accumulation of ABA decreases growth and boll retention and (b) that a decrease in auxin decreases growth and square and boll retention as cotton plants go into cutout.

MATERIALS AND METHODS

We conducted an experiment in 1987 in which we measured the length of fruiting branches, beyond the first node, 3 days after a flower appeared at the first node at different times during the season. We measured the concentrations of ABA and IAA in the fruiting branches to see if there was any correlation with growth. We also measured the ABA and IAA in 3-day-old bolls in relation to boll retention rates. In 1988, we conducted an experiment in which we measured the ABA and IAA in squares and flowers during the season to see if ABA accumulated or IAA decreased as the plants went into cutout. Squares and flowers were harvested only from the first node of fruiting branches. Squares that were one and two mainstem nodes above a white flower were considered 3 and 6 days preanthesis, respectively. Because N deficit hastens cutout, we used two levels of N each year (0 and 150 pounds of N per acre). Irrigation was not a variable. To minimize any effects due to water deficit, fruiting branches, bolls, squarres, and flowers were harvested within a week after each irrigation.

RESULTS AND DISCUSSION

There was a drastic decrease in growth of fruiting branches (as measured by length from the first node to the tip) in 1987 as the plants went into cutout (Table 1). Nitrogen-deficient plants had shorter fruiting branches at every harvest than the control pplants. The concentration of ABA initially increased, but subsequently decreased back to the original level in fruiting branches. Furthermore, the concentration of ABA was lower in N-deficient than in control plants even though their fruiting branches were shorter. Therefore, an accumulation of the growth inhibitor (ABA) could not have been the cause of shorter fruiting branches. Decreases in the growth-promoting hormone, auxin (IAA), on the other hand, could have been a cause of shorter fruiting branches. The concentration of IAA decreased during the season as the fruiting branches became shorter, and the concentration of IAA was lower in N-deficient than in control plants, except at the last harvest. The amount of IAA per fruiting branch was lower in N-deficient than in control plants at every harvest (Table 1).

Boll retention also decreased as the plants went into cutout (Table 2). However, N deficit decreased boll retention only at the last harvest. The concentration of ABA in 3-day-old bolls increased slightly and the concentration of IAA decreased during the season. N deficit had no effect on the concentration of either hormone in bolls, but decreased the amount of IAA per boll in the second and third harvest because it decreased boll size.

The ABA contents of squares and flowers were not affected by N deficit and did not change during the season (Table 3). Likewise, N deficit had no consistent effect on the IAA content of squares and flowers (Table 4). But the IAA content of 3-day preanthesis squares decreased greatly during the season as the plants entered cutout. That effect, however, did not extend to the flowering stage. Although flowers contained much less IAA than squares, the concentration of IAA in flowers did not decrease during the early part of the season. Compared to flowers, bolls, and fruiting branches, the squares contained very high concentrations of IAA, especially the 3-day preanthesis squares early in the season.

We conclude that accumulation of ABA is unlikely to be a major cause of cutout in plants that are not water stressed. Conversely, decreases in IAA may be one cause of decreased growth of fruiting branches and increased square and boll shedding as plants go into cutout.

Table 1. Changes in length, ABA content, and IAA content of fruiting branches (FB) during the 1987 season and the influence of N deficiency.

Date	Length	ABA	IAA	IAA
	mm	ng/g	ng/g	ng/FB
		High N		
June 25	89±13	531±15	78±7	66±15
July 9	54 ±8	914±31	47±2	37 ±3
July 23	5 ±0.3	574 ±5	31±1	7 ±0.4
		Low N		
June 25	57 ±6	483±15	51±1	29 ±2
July 9	31 ±5	763±40	39±1	15 ±2
July 23	2 ±0.2	490 ±8	32±1	3 ±0.2

Table 2. Boll retention rates and concentrations of ABA and IAA in 3-day-old bolls during the 1987 season and effects of N deficiency.

Date	Retention	ABA	IAA	IAA
	%	ng/g	ng/g	ng/Boll
		High N		
June 25	85 ±2	1,579 ±51	76 ±7	19 ±2
July 9	43 ±3	1,950 ±35	78 ±5	21 ±1
July 23	26 ±3	2,102±188	52 ±4	12 ±1
		Low N		
June 25	89 ±2	1,580 ±37	88 ±7	23 ±1
July 9	42 ±4	1,981 ±62	76 ±4	18 ±1
July 23	6 ±2	2,434±339	53 ±5	9 ±1

Table 3. ABA concentrations in squares and flowers during the season in 1988 and the effects of N deficiency.

Date	-6 d	-3 d	Flower
	ng/g	ng/g	ng/g
		High N	
June 29	1,108 ±16	1,096 ±27	903 ±33
July 18	1,046 ±37	1,114±105	853 ±35
August 3	1,071 ±42	1,030 ±37	836 ±12
		Low N	
June 29	1,115 ±64	1,126 ±45	829 ±18
July 18	1,116 ±29	1,088±136	822 ±20
August 3	1,090 ±43	1,083 ±31	812 ±36

Table 4. IAA concentrations in squares and flowers during the season in 1988 and the effects of N deficiency.

Date	-6 d	-3 d	Flower
		High N	
June 29	1,062±176	2,567±408	96 ±9
July 18	787 ±73	1,372±159	274±86
August 3	455 ±63	742 ±89	117 ±5
		Low N	
June 29	784 ±41	3,161±590	90 ±2
July 18	610 ±84	1,136±104	170±22
August 3	981 ±53	898±146	99±9