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EFFECT OF INSUFFICIENT NUTRIENTS DURING THE SEEDLING STAGE ON GROWTH AND YIELD OF COTTON PLANTS[1]

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When temperature, light, and water are not limited, growth and yield of crop plants are correlated closely with the available supply of mineral nutrients. Symptoms of a deficiency of a single essential mineral element, such as nitrogen, phosphorus, or potassium, may be striking. On the other hand, when there is an insufficiency of nutrients, but no marked unbalance between the essential elements, the effect on growth and yield is more difficult to evaluate. By regulating the quantity of a relatively balanced nutrient solution applied to cotton plants, the rate of height growth can be controlled without revealing symptoms of nutrient deficiency. Yield may be controlled in a similar manner.

Under field conditions, crops are planted with the fertilizer placed some distance beneath or to the side of the seed. When natural fertility of the soil is low, the seedling temporarily may have an inadequate supply of mineral nutrients for maximum growth. This paper deals with the effect of a temporary insufficiency of mineral nutrients during the early seedling stage on growth and yield of cotton.

METHODS

Cotton (*Gossypium hirsutum* L., variety Arkot 2-1) was grown in the greenhouse in six-inch pots containing quartz sand. Two of the four replications were harvested at 56 days for fresh and dry weights and chemical analyses, and the remaining two were grown to maturity for yield data. A complete nutrient solution was applied daily at the rates shown in Table I. All treatments were maintained on a 1-1-1 nutrient ratio of N-P-K, except Treatment 7 which received a 2-1-2 ratio after the two-week period of insufficiency. The composition of the 1-1-1 solution and a slightly different 2-1-2 solution have been reported previously (1). The molar concentration of N, P, and K in the 1-1-1 ratio was 0.005. The pots were flushed with distilled water twice each week to wash out excess salts. Height measurements were made at weekly intervals.

RESULTS

Heights and fresh and dry weights of the harvested plants are shown in Table II. One week's delay in supplying adequate nutrients had no effect on height or weight, but extending the period of nutrient insufficiency decreased both height and weight of the 56-day-old plants.

The height-age curves for this experiment are shown in Figure 1. Only the three- and four-week delay in adding sufficient nutrients caused an appreciable lag in height growth. Plants receiving less nutrients were shorter (Treatment 1).

The effect of nutrient insufficiency on development of squares, flowers, and mature fruit are shown in Table III. The appearance of the first blossom was delayed a full week because of a three-week period of nutrient insufficiency during the seedling stage and almost two weeks by the four-week period. Where 2-1-2 nutrient solution was applied, there was less delay in the appearance of the first blossom than where 1-1-1 was applied (Treatments 4 and 7).

The yield data for the various treatments are shown in Table IV. The delay in supplying adequate nutrients had no effect on number of mature bolls per plant. The plants receiving the 2-1-2 ratio produced 13 bolls while those receiving the 1-1-1 ratio produced approximately eight bolls.

DISCUSSION

Under the conditions of this experiment, up to a four-week period of nutrient insufficiency during the early seedling stage had no effect on yield as measured by the number of mature bolls per plant. Nevertheless, the delay in onset of

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Table I. Milliequivalents of Nitrogen, Phosphorus and Potassium Applied Daily.

Days from planting date	Treatment Number								
	1	2	3	4	5	6	7		
							N	P	K
0-4	0	0	0	0	0	0	0	0	0
5-6	0.125	0.125	0.125	0.125	0.125	0.125	0.125	0.125	0.125
7-13	0.500	1.000	0.125	0.125	0.125	0.125	0.125	0.125	0.125
14-20	0.750	1.500	1.000	0.125	0.125	0.125	0.125	0.125	0.125
21-27	1.000	1.750	1.500	1.000	0.125	0.125	2.000	1.000	2.000
28-34	1.250	1.750	1.750	1.500	1.000	0.125	3.000	1.500	3.000
35-41	1.250	1.750	1.750	1.750	1.500	1.000	3.500	1.750	3.500
42-48	1.250	1.750	1.750	1.750	1.750	1.500	3.500	1.750	3.500
49-98	1.250	1.750	1.750	1.750	1.750	1.750	3.500	1.750	3.500
98-maturity	1.250	1.250	1.250	1.250	1.250	1.250	2.500	1.250	2.500

Table II. Effect of Insufficient Nutrients During Early Seedling Stage on Height and Weight of 56-Day-Old Cotton Plants.

Treatment number	Nutrient Solution			Height	Weight	
	Ratio N-P-K	Maximum applied	Delay (weeks)		Fresh	Dry
		ml.		cms.	gms.	gms.
1	1-1-1	250	none	64.4	95.67	17.82
2	1-1-1	350	none	71.3	124.82	19.34
3	1-1-1	350	1	76.4	124.35	19.89
4	1-1-1	350	2	67.8	110.59	16.97
5	1-1-1	350	3	54.5	82.82	11.57
6	1-1-1	350	4	41.4	56.29	6.95
7	2-1-2	350	2	62.7	144.82	20.81

Table III. Effect of Nutrient Insufficiency During Early Seedling Stage on Fruiting of Cotton Plants.

Treatment number	Nutrient solution			Delayed appearance (days)						
	Ratio N-P-K	Maximum applied	Delay (weeks)	Squares (0.5 cm) 1st	2nd	3rd	4th	Open blossom 1st	2nd	Open boll 1st
1	1-1-1	250	none	0	0	0	0	0	1	2
2	1-1-1	350	none	0	0	0	0	0	0	3
3	1-1-1	350	1	0	0	0	0	3	4	5
4*	1-1-1	350	2	1	1	1	2	5	6	5
5	1-1-1	350	3	4	5	6	7	7	9	11
6	1-1-1	350	4	8	9	11	13	13	15	15
7	2-1-2	350	2	0	1	1	2	1	1	0

* Values from single plant.

Table IV. Effect of Nutrient Insufficiency During Early Seedling Stage on Yield of Cotton Plants.

Treatment number	Nutrient solution			Number of blossoms	Number of mature bolls	Per cent blossoms producing bolls
	Ratio N-P-K	Maximum applied	Delay (weeks)			
		ml.				
1	1-1-1	250	none	18.0	6.0	33.3
2	1-1-1	350	none	22.0	7.5	34.1
3	1-1-1	350	1	22.5	8.0	35.1
4	1-1-1	350	2	21.0*	7.0*	33.3
5	1-1-1	350	3	21.5	8.5	39.3
6	1-1-1	350	4	16.0	8.0	50.0
7	2-1-2	350	2	30.0	13.0	43.3

* Values from a single plant.

flowering and boll maturation is of practical importance, particularly where the growing season may be cut short by early frosts. For each two-week delay in applying adequate nutrients, there was approximately one week delay in harvest. Under field conditions, the location of adequate fertilizer near the seedling would minimize the period of nutrient insufficiency, thereby insuring maximum early growth as well as an earlier harvest.

SUMMARY

Cotton plants maintained on a low level (0.125 milliequivalents each of N, P and K daily) of mineral nutrients for one to four weeks beginning seven days after planting in the greenhouse, matured as many bolls as plants maintained on a high level (1.00 to 1.75 milliequivalents each of N, P, and K supplied daily) during the same period.

Height growth was curtailed sharply during the third and fourth weeks of this period of insufficiency. Lengthening the period of nutrient insufficiency also delayed resumption of growth following application of adequate nutrients. A four-week period of insufficiency delayed opening of the first blossom and boll 13 and 12 days, respectively. Each week of delay in providing adequate mineral nutrients resulted in approximately a three-day delay in harvest. The data suggest that height growth may be curtailed more readily by nutrient insufficiency than differentiation of floral primordia.

REFERENCES

1. Snyder, F. W. "Effect of Different Ionic Ratios of Nutrients on the Growth Response of Young Cotton Plants." *Proc. Ark. Acad. Sci.5*, pp. 79-81 (1952).