Cotton seedlings can withstand some early leaf loss

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Early wind or insect damage to cotyledons could affect growth of the plant only if most of the cotyledon area is lost.

Cotyledons, the first or "seed leaves" of cotton plants, serve a dual purpose: they protect the embryo and are prospective "light-harvesting" organs that supply photosynthetic energy to the growing plant for approximately two weeks after emergence, until true leaves develop.

Cotyledons can be damaged by pests or by mechanical means. High winds, such as those that occurred in the spring of 1984 and 1985, cause damage. Since planting dates vary across the San Joaquin Valley, the damage may occur to some seedlings on the day they emerge, while others may be large enough to have as many as two true leaves. Both the time of leaf area loss and the quantity of leaf area damaged may affect subsequent growth.

We conducted a study to document the effects of time and quantity of leaf loss on subsequent growth. Acala SJ-2 was planted at Shafter on April 18, 1985, and plants emerged from May 1 to May 3, when the first treatment was imposed. Plants were thinned to one per foot of row (13,068 plants per acre) to avoid early interplant competition.

Each of 20 leaf-removal treatments was repeated 12 times in a randomized

TABLE 1. Leaf removal treatments, time of removal, and effect of early-season leaf loss on five growth parameters

Treatment	Leaves removed			Days after emergence when leaf removed	Effect of removal on growth June 22 to 25				
	Cotyledons	True leaf			Height	Nodes	Leaf area	Leaf weight	Total dry weight
		First	Second						
					inches	*number*	*dm^2/plant*	*g/plant*	*g/plant*
1	0	0	0	0	14.5	12.8	8.6	6.8	11.5
2	1	0	0	0	14.0 (=) *	13.6 (=)	8.6 (=)	6.7 (=)	11.2 (=)
3	1	0	0	5	18.8 (=)	12.8 (=)	7.0 (=)	5.3 (=)	9.0 (=)
4	1	0	0	10	14.2 (=)	12.7 (=)	8.7 (=)	6.7 (=)	11.3 (=)
5	1	0	0	15	14.3 (=)	13.1 (=)	8.2 (=)	6.5 (=)	10.9 (=)
6	1	0	0	20	14.1 (=)	13.3 (=)	8.1 (=)	6.4 (=)	10.8 (=)
7	2	0	0	0	5.8 (<)	7.9 (<)	1.8 (<)	1.3 (<)	2.1 (<)
8	2	0	0	5	9.7 (<)	10.6 (<)	3.8 (<)	2.8 (<)	4.5 (<)
9	2	0	0	10	12.3 (<)	12.4 (=)	5.9 (<)	4.6 (<)	7.3 (<)
10	2	0	0	15	12.4 (<)	12.3 (=)	6.4 (<)	4.8 (<)	8.0 (<)
11	2	0	0	20	13.3 (=)	12.9 (=)	7.9 (=)	6.4 (<)	10.6 (=)
12	1	1	0	15	12.8 (=)	12.6 (=)	8.1 (=)	6.3 (=)	10.5 (=)
13	1	1	0	20	13.5 (=)	12.8 (=)	7.9 (=)	5.9 (=)	10.0 (=)
14	2	1	0	15	11.6 (<)	12.3 (=)	5.2 (<)	4.0 (<)	6.6 (<)
15	2	1	0	20	11.9 (<)	12.6 (=)	4.8 (<)	3.4 (<)	5.6 (<)
16	1	1	1	20	12.1 (<)	12.7 (=)	6.4 (<)	4.8 (<)	8.0 (<)
17	2	1	1	20	10.8 (<)	11.8 (=)	4.0 (<)	3.0 (<)	4.8 (<)
18	0	1	0	15	14.4 (=)	13.5 (=)	9.0 (=)	7.0 (=)	11.9 (=)
19	0	1	0	20	13.3 (=)	12.8 (=)	6.4 (=)	5.0 (=)	8.2 (=)
20	0	1	1	20	13.4 (=)	12.9 (=)	8.6 (=)	6.6 (=)	10.9 (=)
L.S.D. 0.05					2.1	1.3	2.4	2.0	3.4

* Equal to (=) less than (<) comparison to control plants according to orthogonal contrasts at p = 0.10.

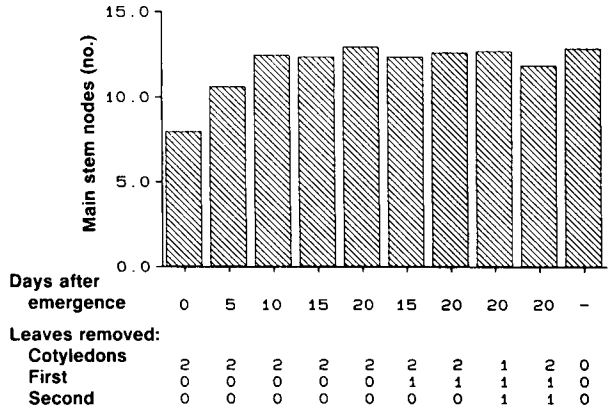

Fig. 1. The number of main stem nodes was affected only by removing both cotyledons in the first five days after emergence.

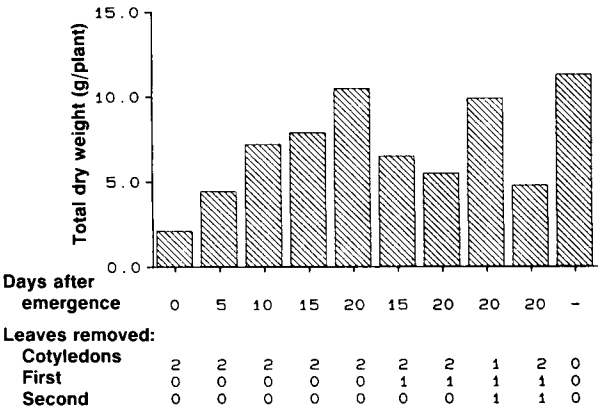

Fig. 2. Total plant dry weight was the most sensitive growth measurement. Several leaf removal treatments reduced growth.

complete block design. The treatments were begun on the day of emergence or 5, 10, 15, or 20 days after emergence. Heat units (base 60°F) following planting were 78, 108, 127, 169, and 223 at the five respective leaf removal times. From planting until harvest, 716 heat units elapsed.

Plants were harvested at the cotyledons at the rate of three replicates per day from June 22 to 25. We measured plant height, number of main stem nodes, leaf area, leaf dry weight, and total aboveground dry weight.

Results

As expected, leaf removal treatments did not stimulate growth (table 1). Total dry weight, leaf dry weight, and leaf area all proved to be sensitive to leaf removal, with the most damaging treatment resulting in growth that was 18, 19, and 22 percent, respectively, of untreated control plants. Plant height was less sensitive to leaf removal (40 percent), and the number of main stem nodes was the least sensitive (62 percent of control).

Loss of only one cotyledon (50 percent of the early leaf area) at any stage of growth did not cause differences in growth (treatments 2 to 6). The first true leaf was not visible until 10 days after emergence, and it measured approximately 1 inch in diameter by day 15. The second true leaf began to unfold on day 15 and was approximately 1 inch in diameter by day 20. Loss of both cotyledons at day 20 (treatment 11) did not reduce growth, since the first leaf and the expanding second leaf apparently were able to meet growing point (meristem) demands for energy. Likewise, loss of the first leaf and one cotyledon at day 15 or 20 (treatments 12 and 13) did not decrease growth.

One or both early true leaves (treatments 18 to 20) could be entirely removed without any loss in growth, as long as the cotyledons were present. These ten treatments (2 to 6, 11 to 12, and 18 to 20) indicate that the cotyledons or early true leaves are both effective in supplying energy for developing meristems. Loss of up to 50 percent of the leaf area did not reduce growth.

Eight leaf removal treatments significantly decreased total plant weight, leaf area, leaf weight, and plant height, while only two treatments reduced the number of main stem nodes on June 22 to 25 (table 1). For illustration, we will discuss total dry weight and number of main stem nodes, because they were the most and the least sensitive growth parameters measured.

Removal of both cotyledons during the first 5 days after emergence was the only treatment that reduced the number of main stem nodes (fig. 1). Removing both cotyledons at any time during the first 15 days after emergence reduced plant dry weight (fig. 2). The time of cotyledon removal had a highly significant effect on total dry weight ($r = 0.988$). Total dry weight on June 22 to 25 was reduced by 0.41 gram per plant (3.9 percent) for each day both cotyledons were removed before 20 days after emergence. This is a very close linear relationship that explains 97.6 percent of the variability in dry weight due to the single factor of when both cotyledons were removed.

When both cotyledons and the first true leaf were removed at days 15 and 20 (treatments 14, 15, and 17) the dry weight was reduced (fig. 2). If one cotyledon was left but both true leaves were removed on day 20 (treatment 16), the growth rate was not reduced as much, but differences were detectable. Apparently, one cotyledon at the three-leaf stage is not sufficient to supply the needs of an increasing amount of meristematic tissue. Five days earlier (treatment 12), when the second leaf was beginning to unfold, one cotyledon produced sufficient energy for the plant until the second leaf began to supply energy.

Conclusions

Loss of all leaf area reduced the growth rate at all stages of development. Plants are most sensitive to loss of cotyledons at emergence because of the length of time before the first leaf produces energy. Early-season leaf area does not appear to be limiting to growth. Cell division and production of new meristematic tissue appear to be the limitation. Computer simulation models indicate that the supply of energy does not limit the growth rate until after a boll load begins to accumulate, unless nutrients or moisture alter the capacity of the leaf area to supply energy.

When loss of early leaf area was sufficient to decrease growth in late June, these losses might or might not have translated into yield losses. There is no reason to believe that early losses of leaf area that did not alter plant height, number of nodes, leaf area, leaf weight, or total weight could have resulted in reduced yield.

These results suggest that early wind damage to cotyledons would affect growth only if most of the cotyledonary area is lost. If the loss is delayed until the first leaf is beginning to form, the effect will be greatly reduced. Cotton growers sometimes apply insecticides at planting to control early-season thrips that may damage leaves. Thrips do not remove entire leaves as we did in this study. Studies are under way to determine the impact of thrips on growth. At this point, the benefits associated with thrips feeding on mite eggs appear to more than offset any potential damage due to loss of some early leaf area.

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