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Differential Recovery Among Cotton Genotypes Following Early-Season Defoliation[1]

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ABSTRACT

An objective of many cotton (*Gossypium hirsutum* L.) breeding programs is the development of faster fruiting or earlier maturing cultivars. Such cultivars may allow producers to avoid production problems associated with early planting or late harvest as well as aid in disrupting the parallel buildup of certain pests with increased fruit load. Three cotton genotypes exhibiting different genetic maturities were evaluated over a 3-year period to determine degree and speed of recovery from early-season defoliation, simulating stress due to hail damage. Arkugo 4, a fast-fruiting strain; 'DES 56', a moderately early-maturing, mid-South cultivar; and 'Deltapine 61' (DPL 61), a full-season, mid-South cultivar were defoliated immediately above the first true-leaf node when at the V5 and R2 stages of growth. A nondefoliated control of each genotype was included. When compared as a percent of nondefoliated controls (to remove the confounding effects of yield potential), the faster fruiting Arkugo 4 was not significantly lower yielding than its control when defoliated at the V5 stage in 1980 and 1981. Defoliation of DES 56 and DPL 61 at stage V5 caused a significant decrease in yield each year. Defoliation of all genotypes in all years at the R2 stage, except for Arkugo 4 in 1982, reduced or further reduced yield below that of defoliation at the V5 stage. Arkugo 4 also recovered more rapidly than DES 56 or DPL 61 following defoliation at both growth stages in 1980 and 1981, but not in 1982. These data indicate that yield-competitive, fast-fruiting cultivars have the potential to recover from early-season stress more rapidly and to a greater degree than moderately early-season or full-season, mid-South cultivars.

Additional index words: Earliness, Fast fruiting, Hail damage, *Gossypium hirsutum* L.

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An objective of many cotton (*Gossypium hirsutum* L.) breeding programs throughout the USA is earlier maturing cultivars. Fast-fruiting cotton cultivars may be beneficial in several ways including: (i) avoidance of seedling disease problems by allowing for later planting when temperatures have moderated, (ii) escape from insect pests such as boll weevils (*Anthonomus grandis* Boh.), plant bugs (*Lygus* spp.), and worms (*Heliothis* spp.) by disrupting the parallel buildup of pest populations with their food source and by developing fruit faster than a given poulation of insects can damage it, (iii) avoidance of moisture-related harvest problems, and (iv) improved harvest efficiency by shortening the length of time from first to final open boll. Another area of impact might be to enhance the probability of and degree of recovery from plant damage such as that caused by hail or insects.

Earliness, or crop maturity, reflects the rate of fruit production and/or development and is measured in a number of ways, for example, node of first fruiting limb, days from planting to first bloom or first open boll, vertical and horizontal blooming intervals, and mean maturity date (2, 5, 6, 7, 8). Richmond and Radwan (7) found significant correlations among seven methods of identifying early-maturing genotypes. Ray and Richmond (6) reported that the node of first fruiting limb was adequate to identify early-maturing segregates in a cultivar development program.

Smith and Varvil (10) reported nearer normal productivity in faster fruiting genotypes than in full-sea-

Table 1. Analyses of variance for seed cotton yield and percent first harvest of cotton defoliated at two growth stages.

		Mean squares					
		Seed cotton yield			Percent first harvest		
Source	df	1980	1981	1982	1980	1981	1982
Blocks	3	6.38	116.45	59.99	3.16	0.64	22.51*
Genotype	2	6.94	8.53	27.06	25.22*	8.98**	11.06
Error (a)	6	11.82	51.64	23.18	2.96	0.26	2.92
Defoliation	2	43.40**	1465.39**	621.06**	249.76**	122.27**	148.25**
Gen. × Def.	4	2.60	64.36	33.26**	21.44**	1.68**	4.65*
Error (b)	18	1.81	48.38	3.68	3.08	0.13	1.51

*,** Significant at the 0.05 and 0.01 levels of probability, respectively.

son cultivars of Upland cotton when planted after wheat. They also found (11) that earlier maturing types can be planted later than full-season cultivars without sacrificing yield. Kittock et al. (4) reported similar findings among several Pima (*G. barbadense* L.) strains following midseason hail.

Wilson et al. (12) suggested that early-maturing cultivars could be an integral part in combating pink bollworm [*Pectinophora gossypiella* (Saunders)] in Arizona. In south Texas, a cultural system has been developed which employs faster fruiting cultivars for earlier harvest to combat boll weevil population buildup and to avoid possible storm loss during the hurricane season (1).

The objective of this research was to assess the usefulness of the fast-fruiting characteristic as a means of recovery from early-season stress such as that caused by hail.

MATERIALS AND METHODS

Three genotypes, Arkugo 4, 'DES 56', and 'Deltapine 61' (DPL 61), were planted as whole plots in a randomized, complete block design with four replications in 1980, 1981, and 1982. Arkugo 4 is a fast-fruiting genotype selected for early flowering and early maturity under Arkansas conditions; DES 56 is a moderately early-maturing, mid-South cultivar; and DPL 61 is a full season, mid-South cultivar.

Defoliation treatments were randomized as subplots within genotypes and consisted of hand removal of the top portion of the cotton plant above the first true-leaf node, C1, when plants were at the V5 or R2 stages of growth (3). The two center rows of each four-row plot were defoliated as described while the border rows were defoliated in a manner approximating the treatment. A nondefoliated control of each genotype was included. Plots were 15-m long with 97 cm between rows.

All cultural practices were normal for Memphis silt loam (a fine-silty, mixed, thermic Typic Haplustalf) in east Arkansas. No supplemental irrigations were applied in any year. Planting dates were 9 May 1980, 1 May 1981, and 11 May 1982. The two center rows of each plot were harvested twice with a spindle picker modified for experimental-plot harvest. Harvest dates were 19 Sept. and 3 Nov. 1980, 23 Sept. and 9 Nov. 1981, and 18 Oct. and 8 Nov. 1982. Seed cotton yields and rapidity of recovery, as indicated by percent seed cotton harvested at first harvest, were obtained each year of the experiment while fiber properties were determined from first-harvest yields in 1981 only.

RESULTS AND DISCUSSION

In 1980, all three genotypes had reached the V5 stage of growth by 13 June; however, Arkugo 4 had progressed to the R2 stage by 23 June, 2 days earlier than DES 56 or DPL 61. In 1981, Arkugo 4 reached the V5 stage 2 days earlier than DES 56 and DPL 61 and developed to the R2 stage 5 days earlier than DES 56 and 7 days earlier than DPL 61. In 1982, no differences among genotypes were observed in length of time from planting to the V5 or R2 stages.

Averaged over defoliation treatments, no significant differences in seed cotton yields were detected among the three genotypes tested in any year (Table 1). Removal of the shoot above the first true-leaf node at stage V5 or R2 had a highly significant effect on seed cotton yield in each year. The significant interaction among genotypes and defoliation treatments in 1982 was one of relative magnitude of differences and not in direction of response.

No significant reductions in actual seed cotton yield were observed within the fast-fruiting Arkugo 4 genotype when plants were defoliated at the V5 stage in 1980 or 1981 (Table 2). In 1982, a more favorable growing season than 1980 or 1981, the V5 stage defoliation treatment in Arkugo 4 significantly reduced yield by 26% compared to no defoliation. Defoliation of Arkugo 4 at the R2 stage of growth significantly reduced yield below the V5 stage defoliation in 1980 and 1981, but not in 1982. These Arkugo 4 results contrast with those for DPL 61 and DES 56 in that the V5 stage defoliation significantly reduced actual seed cotton yield below the nondefoliated check in every case and that the R2 stage defoliation treatment further significantly reduced yield compared to its respective control in each year.

Seed cotton yield was expressed as a percent of the appropriate nondefoliated control to compare defoliation treatments across genotypes without the confounding effect of genotypic yield potential (Table 2). Actual percent data are shown in Table 2, but mean separations were based on arcsine-transformed percentages. Based on percent of the control, defoliation of Arkugo 4 at the V5 growth stage did not signficantly reduce yield below that of the nondefoliated controls of any genotype in 1980 and 1981. However, precent of nondefoliated yields of DEs 56 and DPL 61 following defoliation at stage V5 were significantly reduced each year. In 1982 all three genotypes were reduced equally when defoliated at stage V5.

When plants were defoliated later in the growing season at the R2 stage of growth, the degree of recovery, as indicated by percent of the appropriate nondefoliated yield, of the faster fruiting Arkugo 4 was not significantly different than that of DES 56 or DPL 61 in 1980 or 1981 (Table 2). However, in

Table 2. Seed cotton yield, expressed in actual units and as a percent of the control, of three cotton genotypes following defoliation at two growth stages.

Treatment	Seed cotton yield 1980		1981		1982	
	kg/ha	%	kg/ha	%	kg/ha	%
Deltapine 61	1980 a†		1644 a		2696 a	
C1/V5	1857 b‡	77 bc§	1660 b	79 bcd	2261 b	56 bcd
C1/R2	1656 c	68 c	1197 c	57 cd	1860 c	46 d
Control	2427 a	100 a	2076 a	100 a	3967 a	100 a
DES 56	1972 a		1586 a		2493 a	
C1/V5	1972 b	90 b	1648 b	82 bc	2288 b	67 bc
C1/R2	1761 c	81 bc	1063 c	52 d	1799 c	53 cd
Control	2184 a	100 a	2045 a	100 a	3394 a	100 a
Arkugo 4	1773 a		1607 a		2362 a	
C1/V5	1852 a	92 ab	1714 a	95 ab	2149 b	74 b
C1/R2	1452 b	72 c	1322 b	74 cd	2018 b	69 bc
Control	2014 a	100 a	1788 a	100 a	2920 a	100 a
CV	10		15		9	

† Kilograms seed cotton/ha among genotypes within a year followed by the same letter are not different at the 0.05 level of probability.
‡ Kilograms seed cotton/ha within genotype and year followed by the same letter are not different at the 0.05 level of probability.
§ Percents of nondefoliated control yield within a year followed by the same letter are not different at the 0.05 level of probability.

Table 3. Percent first harvest and fiber quality characteristics of three cotton genotypes following defoliation at two growth stages.

Treatment	Percent first harvest 1980	1981	1982	Fiber quality (1981) Micronaire	2.5% Span length	Strength (T_1)
	%	%	%		mm	mN/tex
Deltapine 61	56 b†	36 c	76 a			
C1/V5	61 bc	35 e	72 bc	4.7 ab	29.0 a	257 a
C1/R2	32 e	5 g	63 d	4.0 c	29.0 a	282 a
Control	74 a	69 b	91 a	5.0 a	27.9 a	268 a
DES 56	57 b	42 b	81 a			
C1/V5	60 bc	46 d	79 b	4.6 abc	29.2 a	279 a
C1/R2	41 d	3 g	70 cd	4.4 bc	27.7 a	257 a
Control	70 a	75 a	92 a	4.7 ab	28.2 a	340 a
Arkugo 4	64 a	53 a	81 a			
C1/V5	70 a	63 c	78 b	4.8 ab	27.4 a	288 a
C1/R2	55 c	21 f	75 bc	4.7 ab	27.4 a	232 a
Control	68 ab	75 a	90 a	5.0 a	25.7 a	238 a
CV	9	8	5	6	3	9

† Values within a column followed by the same letter are not different at the 0.05 level of probability.

the more favorable growing season of 1982, Arkugo 4 recovered a significantly greater percentage of its nondefoliated yield than did DPL 61, but not significantly more than DES 56.

Another important aspect of the recovery potential of fast-fruiting cotton genotypes is their speed of recovery. The earliness of a cotton crop is commonly defined by the percent of the crop harvested at first harvest. When averaged over defoliation treatments, significant differences among genotypes were detected in 1980 and 1981, but not in 1982 (Table 1). Significant differences among defoliation treatments and in interactions among genotypes and treatments were detected each year. Arkugo 4 matured significantly earlier than DES 56 and DPL 61 in 1980 and 1981, but not in 1982 (Table 3). When compared across defoliation treatments, Arkugo 4 recovered more rapidly than DES 56 or DPL 61 from each defoliation treatment in 1980 and 1981. No significant differences in percent first harvest among defoliation treatments were detected in 1982 because of the higher yielding environment or because the later first-harvest date in that year masked the earliness differential of these genotypes.

Previous work (9) indicated that severe defoliation as late as the R5 stage of growth had little effect on standard fiber properties. Fiber maturity, length, and strength following defoliation in 1981 are shown in Table 3. The only significant differences in fiber quality among treatments were for fiber maturity, as indicated by micronaire. Again, as reported earlier (9), these differences appear not to be of great concern, although the R2 stage defoliation in DPL 61 resulted in a decrease of one micronaire unit compared to its control. In certain years or environments such a decrease in fiber maturity would lower micronaire below the premium range and therefore reduce the value of the crop.

These data suggest that agronomically acceptable, fast-fruiting cotton cultivars may have an advantage in recovery from the type and degree of stress imposed in this study up to the V5 stage of growth and occasionally as late as the R2 stage. Development of fast-fruiting cotton cultivars could provide a margin of safety from early-season stress such as hail and possibly insects.

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