Published November, 1969

Agronomic and Fiber Properties of Smooth, Nectariless 'Acala' Cotton[1]

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ABSTRACT

Genes for semi-glabrous leaf and nectariless plant were transferred into 'Acala 1517' cotton (*Gossypium hirsutum* L.) from the insect-tolerant strain 1514, which carries the Sm_1^{sl}, ne_1 and ne_2 genes. The F_2 progeny of this cross approached the midparent in agronomic and fiber properties. A semi-glabrous, nectariless selection from the above cross was hybridized with a selected experimental strain from Acala 1517. The unselected F_2 progeny of the second cross appeared to be essentially equal to the Acala 1517 parent in disease resistance and agronomic and fiber properties.

Additional index words: **Insect tolerance, *Gossypium hirsutum* L.**

POPULATIONS of several insect pests of cotton (*Gossypium hirsutum* L.) are affected by the amount of pubescence, and by the presence or absence of nectaries on the plant. Semiglabrous plants were less damaged than hirsute ones by the cotton bollworm *Heliothis zea* (Boddie) (4, 5), the tobacco budworm, *Heliothis virescens* (F.) (3), and the cotton fleahopper, *Psallus seriatus* (Reut.) (5, 6). Nectariless plants apparently support lower populations of the pink bollworm, *Pectinophora gossypiella* (Saunders) (4), the cabbage looper, *Trichoplusia ni* (Hbn.) (3), and the cotton leafworm, *Alabama argillacea* (Hbn.) (3). Nectariless plants suppressed *Heliothis* species populations, so that the smoothness modification and the nectariless modification were partially additive in this respect (4, 5).

Nectariless plant is controlled by the recessive ne_1 and ne_2 genes derived originally from *G. tomentosum* Nutt. ex Seem (8). Floral nectaries are still present, but the leaf, bract, and involucral nectaries are absent in the homozygous ne_1, ne_2 genotype (8). These two genes have been combined with the Sm_1^{sl} (2) gene of *G. armourianum* (Kearn) (7) in Meyer's strain 1514 (5). Although strain 1514 resulted from several backcrosses of upland cotton (doubled haploid 'Deltapine' strain M-8), I was not certain, at the beginning of these studies, that this strain would be tractable in a practical breeding program.

The primary purpose of the experiments described in this paper was to determine if the genes controlling the semiglabrous and nectariless traits could be incorporated into high yielding, high quality Acala cottons without deleterious effects. Theoretically, the task becomes much harder if the genes being incorporated are linked with other genes determining disease susceptibility, poor plant type, or inferior fiber quality.

MATERIALS AND METHODS

First Cross: Acale B4464 hirsute-nectaried (Hne +) × 1514 semiglabrous-nectariless (Sne —)

B4464 is a breeding line of Acala 1517 that is resistant to bacterial blight, selected in the F_4 from the cross Acala 9136 × 'Deltapine Smooth Leaf.' Acala 9136 is a blight resistant line with high fiber quality, and some 'Tanguis' (*G. barbadense* L.) introgression (about 1940). It carries some genes for Verticillium wilt tolerance and for heavy pubescence. Deltapine smooth leaf, a well-known commercial variety, carries sm_3 (2) for reduced pubescence.

The 1514 strain, as mentioned above, carries the Sm_1^{sl} (2, 6), and the ne_1 and ne_2 genes. Its genetic background is primarily Deltapine.

The first cross was made in the summer of 1965. The F_1 was grown at Iguala, Mexico during the winter 1965-66. Fifty seed of both parental strains and 1,300 seed of the F_2 were planted in 7.5-cm peat pots in the greenhouse, April 10 to 15, 1966. The F_2 segregated into four classes: hirsute-nectaried (Hne+), hirsute-nectariless (Hne—), semiglabrous-nectaried (Sne+) and semiglabrous nectariless (Sne—). Twenty plants were recovered from the smallest class (Sne—), limiting the size of the experiment. Twenty plants were taken at random from the other groups of segregates and from the parental lines and transplanted to the field about May 15.

The experimental design used for the analysis of the first cross was a randomized complete block, with each treatment having four replicates of five plants each. The plants were set 30 cm apart in 96 cm rows. End plants and alleys were avoided in order to eliminate border effects.

Agronomic data obtained from each plant included plant height, boll number, boll size, lint yield, lint percentage, and Verticillium wilt symptoms. Verticillium wilt damage was graded on a 0 to 4 scale, with plants graded 0 showing no symptoms and plants graded 4 being completely defoliated.

Fiber data obtained from each plant included the upper half mean length (UHM), the mean length (M), uniformity ratio (UR), micronaire (Mic), strength (T_1) and elongation (E_1).

Second Cross: Strain 2-7-5 (Sne—) × Acala B5029 (Hne+)

Strain 2-7-5 was a line with the longest fiber in the progeny from an F_4 of the first cross mentioned above, but it had a low lint percentage and no wilt tolerance.

The pedigree of Acala B5029 is as follows: (Acala 2503 × 'Coquette') × [9136 × (Acala 49 × 'Hartsville')]. Selections

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[1] Journal No. 337, New Mexico Agricultural Experiment Station, Las Cruces, New Mexico. Received May 31, 1969.

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from (Acala 2503 × Coquette) resulted in Acala 1517V and other breeding lines that were both early and tolerant to Verticillium wilt. Acala 49 and Hartsville were two of the earliest breeding stocks selected for tolerance to Verticillium wilt. Strain B5029T had good bacterial blight and Verticillium wilt tolerance, excellent fiber quality and a high lint percentage.

The procedure used in selecting plants from the second cross was the same as that used in selecting plants from the first cross. Parental-type plants from the first cross were included in the second test as a reference point for measuring the progress achieved in the two crossing cycles. This experimental design consisted of six plants each of the eight treatments replicated five times. The plants were transplanted to the field in late May 1968, without apparent setback. Differences in fiber property values of Acala B4464 and strain 1514 in 1966 and 1968 were caused mainly by changes in laboratory instrumentation. However, their relative values were similar in both years.

RESULTS AND DISCUSSION

Fiber lengths of the F_2 smooth-nectariless segregates of the first cross were roughly intermediate to the median values of the two parents (Table 1). Fiber strength and elongation exceeded the low parent but did not equal the mid-parent. Lint percentage and fiber uniformity tended to be equal to the higher parent, B4464. There was no evidence that genes closely linked to Sm_1^{sl} and sm_3, ne_1, or ne_2 affected yield or fiber properties deleteriously.

Nectariless plants were classified rigidly as smooth or hirsute. Plant terminals in the smooth, nectariless class (Sne—) were more glabrous than plants carrying the D_2 genome (Sm_1^{sl}) smoothness. (Lee, Joshua A. 1964. A preliminary report on the genetics of trichome distribution on the leaves of upland cotton. Proc. of the 16th Annual Cotton Improvement Conference. pp. 8-13.) These plants also may have carried sm_3 in the homozygous state. The hirsute, nectariless (Hne—) plants, on the other hand, were mostly heavily pubescent, and may have carried some factors from the Tanguis.

The fiber properties of the F_2 segregates of the second cross were not significantly different from those of B4464 (Table 2). Significant improvement over 1514 was achieved in every character except fiber elongation, and some loss of elongation is often associated with rapid improvement in fiber strength. It should be noted that Experimental Acala B5029 had stronger fiber than commercial Acala 1517.

Plants in the Sne— class yielded the most lint in the test involving progeny from the first cross, and ranked second to B5029 in the test involving progeny from the second cross. Table 2 shows the yield of Sne— plants was associated with a greater boll size in this selection than parental stocks (with the exception of B5029), and with high boll retention under moderately severe wilt stress.

Tolerance to Verticillium wilt is important in the Acala 1517 breeding program. Strain 1514 was equal in yield to Acala B4464 in the 1966 test (Table 1) where Verticillium wilt was not a limiting factor. However, strain 1514 and its daughter strain 2-7-5 yielded much less lint in 1968, because the test was grown on moderately to severely Verticillium-infested soil. Results suggested that wilt tolerance was recovered in the second cross progeny even though strain 2-7-5 was susceptible.

Lint percentage requires continuous selection pressure since hairy segregates appeared to have a slight advantage and the mean of the Sne— segregates fell some 2% below acceptable levels. Individual plants of the Sne— F_2 were acceptable in all traits measured, and had a lint percentage of 36 to 37%.

Thus, it may not be difficult to incorporate the semi-glabrous and nectariless traits into agronomically desirable lines of Acala cotton. However, these characters may not be equally tractable in other breeding material. Long-fibered Acala 1517 normally has a lower lint percentage than shorter-fibered, mid-south varieties. Furthermore, Acala 1517 is large bolled and nonprolific by mid-south standards. The two crosses in this experiment resulted in progenies that were closer to the theoretical optimum with respect to boll size and prolificacy than any of the parental strains.

Table 1. Mean agronomic and fiber properties of first cross analysis (1966) parental strains and segregating classes of F_2 progeny.

	Agronomic properties						Fiber properties					
							Upper half mean length					
	Wilt grade	Plant height, cm	Boll number /plant	Lint per boll, g	Lint yield, g	Lint percent-age	mm	in.	Unifor-mity ratio	Micro-naire	T_1 strength (g/Tex)	Elonga-tion (E_1 index)
B4464 (Acala)*	1.75	81.8	15.0	1.51	22.6 b‡	36.0	31.0	1.22 a	81.5	3.70	25.1 a	8.8 b
1514 (Sne-)*	1.40	73.7	18.8	1.24	23.3 b	33.8	27.4	1.07 b	79.5	3.15	21.0 b	10.6 a
Hne+ †	1.85	58.4	10.9	1.93	21.1 b	38.2	28.0	1.10 b	79.0	3.70	21.3 b	8.6 b
Hne- †	2.45	63.5	12.3	1.80	22.0 b	36.1	28.5	1.12 b	80.5	3.92	21.5 b	8.3 b
Sne+ †	1.75	73.7	14.3	1.56	22.4 b	35.0	28.5	1.12 b	81.8	3.70	21.8 b	9.1 b
Sne- †	1.35	76.2	18.2	1.74	31.5 a	36.0	29.0	1.14 b	83.0	3.95	22.1 b	9.0 b
Significance level	ns	ns	ns	ns	.05	ns		.01	ns	ns	.01	.01

* First cross parental strains. † Segregating progeny genotypes. ‡ Means followed by the same letter are not significantly different at the stated significance level according to Duncan's new multiple range test.

Table 2. Mean agronomic and fiber properties of second cross analysis (1968) parental strains and segregating classes of F_2 progeny.

	Agronomic properties						Fiber properties					
							2.5% span length					
	Wilt grade	Plant height, cm	Boll number /plant	Lint per boll, g	Lint yield, g	Lint percent-age	mm	in.	Unifor-mity index	Micro-naire	T_1 strength (g/Tex)	Elonga-tion (E_1 index)
B4464 (Acala)*	2.15 bcd§	96.8 a	15.5	1.57 cd	27.0 cd	35.8 ab	29.7	1.17 b	46.0	4.01 bc	22.3 ab	7.6 b
1514 (Sne-)*	3.39 d	85.3 b	13.0	1.03 e	15.1 c	33.7 c	26.4	1.04 c	45.0	3.55 d	18.3 d	8.5 a
B5029 (Acala)†	0.70 a	84.6 b	13.3	2.22 a	29.6 a	36.7 a	30.5	1.20 ab	47.8	4.27 a	23.7 a	5.7 c
2-7-5 (Sne-)†	2.90 cd	91.4 ab	9.9	1.35 d	14.4 c	33.4 c	30.0	1.18 ab	46.1	3.58 cd	21.3 c	7.7 b
Hne+‡	1.53 ab	85.1 b	12.2	1.88 b	25.4 ab	36.4 a	30.5	1.20 ab	47.0	4.15 ab	21.0 bc	6.4 c
Hne-‡	2.32 bcd	90.9 ab	10.3	1.76 bc	18.8 bc	34.8 b	30.7	1.21 ab	47.8	3.80 bcd	22.8 ab	6.5 c
Sne+‡	2.31 bcd	90.2 ab	11.7	1.74 bc	21.3 abc	34.7 b	31.2	1.23 a	47.0	3.72 bcd	22.6 abc	6.5 c
Sne-‡	1.78 abc	89.9 ab	14.6	1.85 b	29.3 a	34.9 b	31.2	1.23 a	47.3	4.32 a	21.9 bc	6.1 c
Significance level	.01	.05	ns	.05	.05	.05		.01	ns	.05	.01	.01

* First cross parental strains. † Second cross parental strains. ‡ Segregating progeny. § Means followed by the same letter are not significantly different at the stated significance level according to Duncan's new multiple range test.

(cf. Kerr, Tom. 1966. Yield components in cotton and their interrelations with fiber quality. Proc. of 18th Annual Cotton Improvement Conference. pp. 276-87.)

In addition to the crosses described in this paper, 12 Acala 1517 and 'Del Cerro' strains have been used in crosses with 1514 (or similar related material) at this location. On the basis of these results and observations on the additional crosses, it seems safe to conclude that the semi-glabrous and nectariless characters can be transferred to Acala 1517 without adversely affecting yield, disease resistance, or fiber properties. The second cross Sne— segregates described here, and other second and third cross progenies appear ready for intensive selection.

Although there is general agreement as to the value of the nectariless character in reducing populations of *Lepidoptera*, much of its effectiveness may be lost if it also adversely affects populations of insect predators. This problem is being studied at this location but data are insufficient to establish meaningful trends. The ultimate effect of the nectariless character on insect populations can be assessed only when it has been incorporated into successful commercial varieties.

The optimal degree of smoothness for insect protection has not been established and may vary with regions. Sm_1^{st} lowers the trichome number sufficiently to suppress *Heliothis* and fleahopper populations (4, 5, 6). Therefore, breeding for a higher degree of smoothness may not be warranted in areas where thrips cause occasional extensive damage (9) unless some type of antibiosis resistance to thrip can be incorporated [c.f. Hawkins et al. (1)]. Some trichomes may also be necessary to protect tender seedlings against wind and sand in western areas.

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