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GENETIC CHARACTERISTICS OF COTTON VARIETIES IN TEXTILE VARIETY TESTS

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Abstract

The USA is losing its textile industry to foreign competition. In turn, the cotton grower is losing its best customer, the USA textile industry. A modern textile industry needs modern fiber that can only be obtained through improved varieties. The Regional High Quality test (RHQ) is a variety test, which evaluates the fiber quality of newly developed varieties and strains. In 2001, the RHQ was coordinated with a Textile Variety Test (TVT) that evaluated the spinning efficiency of varieties, which were processed through modern ring, rotor, and vortex spinning units. The TVT involved evaluating eight bales/variety for cottons produced in South Georgia, Mississippi Delta, and West Texas. The number of varieties for each area was six, seven, and eight, respectively. The combination of variable environments and varieties produced a wide range of fiber properties. In 2001, the RHQ evaluated 19 varieties and strains that were grown in nine states from the Carolinas to East Texas. The objective of the RHQ test was to provide a broader array of genotypes in which data obtained from the TVT could be used to evaluate each variety's textile performance and mill value. The six varieties common to Georgia and the Delta were grown in the RHQ. They showed similar fiber properties as when grown in the TVT. There were large genetic variances for yield, which were negatively correlated with desirable fiber traits. The correlation of yield with HVI length, strength, and micronaire was –0.33 –0.62, and 0.75, respectively. These results show that by coordinating existing variety tests with specialty tests, such as the TVT, that much more useful information can be obtained which can enhance many segments of the cotton industry.

Introduction

Many believe the USA cotton growers' and their principal customer, the USA textile industry's, very survival is threatened. The USA cotton and textile industry competes with countries that have low labor costs, few regulatory controls, and lower technology fees. To better compete, the surviving textile mills have modernized their operations by introducing new spinning equipment that operates much faster than the spinning operations of a decade ago. This new equipment together with consumer's demand for higher quality textiles has combined for the need of higher quality fiber. The textile industry recognized that an essential component in producing high quality products is to have high fiber quality cotton varieties. The textile industry, through the American Textile Manufacturer's Institute (ATMI) and ARS organized what is known as the "Textile Variety Test" (TVT).

The major objectives of the TVT are to determine: 1) The optimum fiber properties for a modern spinning system, both for efficiency of operation and quality of product; and 2) The potential for breeders to develop varieties that have these desired properties. The research approach is to use both TVT and conventional variety testing to meet these objectives. The purpose of using the Regional High Quality Tests (RHQ) is to relate newly developed germplasms and varieties to Objective 2.

The TVT differs from that conducted by cotton breeders in four ways. These are: 1) the lint produced will be evaluated by processing through mill commercial, rotor, and vortex spinning equipment; 2) fiber sample size required is much larger (about 8 bales/variety) than the 15 to 450 gram samples used by breeders; 3) the large sample requires large commitments of land, funds, and other resources; and 4) the expense and logistics of testing are too large for conventional experimental designs which require numerous replications and environments.

The TVT was grown in three areas; South Georgia, Mississippi River Delta, and West Texas. The number of varieties in each area was six, seven, and eight, respectively. A total of 13 varieties from three breeding companies were used. Two were common to all areas, and six were common to Georgia and Delta areas. All tests were conducted on grower fields under the direction of the grower and ginned in commercial gins. Also, most varieties were grown in about 10 acre plots with one replication. This type of experimental design does not lend itself to the usual statistical analyses practiced by breeders, so comparisons among varieties is limited. Most of the varieties tested will be off the market within two years, and therefore, practical use by growers would be limited.

However, these tests provide a much more valuable resource for determining what fiber properties are most important for modern spinning methods. This data set from variable environments and varieties will be useful beyond the life of current varieties being grown. The algorithms developed from the TVT can be used to a much larger population of current and future varieties. The first year results are presented in this conference by McAlister (2003).

Conventional Breeder Variety Tests

The objectives of coordinating a conventional variety testing program with the TVT are:

1. Determine if the fiber trait variability of the six varieties used in the Georgia and Delta area is a reasonable sample of the fiber trait variability available to breeders.
2. Determine the association of yield and key fiber traits
3. Determine the contributions of environments, varieties, and their interaction on fiber traits upon completion of the multi-year TVT.
4. When textile performance due to fiber trait variation is determined, use developed algorithms to estimate the spinning efficiency of other varieties, present and future would be.

The breeder variety test coordinated with the TVT is the Regional High Quality Tests (RHQ). The RHQ consisted of 19 varieties and strains grown by volunteer cooperators in nine states. Six of these varieties are the same as the six common to both the Georgia and Mississippi River Delta. These states are: North Carolina, South Carolina, Georgia, Alabama, Mississippi, Missouri, Arkansas, Louisiana, and East Texas. Yield was determined in all nine states, HVI and arealometer fiber traits from seven states, and AFIS fiber properties from five states. The average yield and selected fiber traits are given in Table 1. A wide range of statistical significant variability for all traits is evident. The six varieties grown in the Georgia and Delta areas are noted in Table 1. The range for the entire test and the six varieties is given in Table 2. The range of performance is about the same for the selected six varieties as for the entire tests.

The correlations of major fiber properties and yield are shown in Table 3. The regression of yield on length, strength, micronaire, and fineness are shown in Figures 1, 2, 3, and 4, respectively. As in many previous studies, the negative variety performance association for yield and better fiber quality is evident. For each 0.01 increase in length, an average decrease in lint of 11.9 lb/acre occurs; for strength, the loss in yield is 31.6 lb/acre; for each increase in 0.01 micronaire there is an increase in yield of 35.7 lb/acre; and for AFIS fineness, yield increases 10.7 lb/acre for each increase in micronaire. Increased micronaire results in more discounts to growers in the MidSouth. The current marketing system is weighted more for increasing yields rather than increasing fiber quality.

Table 4 show that there is considerable genetic variability for all traits. The set of locations in this study covers a nine state area. Such factors as variety, soil types, fertility, irrigation, and average length of growing season are essentially fixed or under the control of the grower. The part of location variability not under grower control is weather. Traits that have large variety effects are fiber length, short fiber content, strength, and fineness. These traits can be selected for with a smaller number of replications and environments than that needed for yield determinations.

One question is how closely do breeders (RHQ) variety tests relate to growers test results. The average length, strength, and micronaire for the six TVT varieties from the Georgia and the Delta, growers are compared with the average performance of these varieties in the RHQ in Figures 5, 6, and 7, respectively. It is encouraging that the high, low, and mid performance of these six varieties is about the same regardless of whether it is grown by the grower or breeder.

Summary

The major objective of the TVT is to determine the best fiber properties needed for efficient modern spinning mills.

The RHQ determines the relative yield and fiber quality of specific varieties and strains and gives the producer good data for comparative purposes. The algorithms produced in the TVT can be applied to a larger sample of current and future varieties than were in the TVT.

Coordination of specific types of genetic evaluations, such as the TVT, with breeder variety tests, such as the RHQ, can be very informative and profitable for growers, breeders, and the textile industry.

References

McAlister, David. 2003. Proceedings of the 2003 Beltwide Cotton Production Research Conferences. January 6- 10, 2003. Nashville, TN. In Press.

Table 1. Average yield and fiber properties of 19 entries in the 2001 Regional High Quality (RHQ) Variety Test.

			SL-HVI Starlab		AREALOMETER DATA		AFIS DATA			
VARIETY NAME	LINT YIELD (lb/acre)	MICRO-NAIRE (reading)	2.50% S.L. (in.)	STRENGTH (g/tex)	Maturity (%)	p (micro)	NEPS Cnt/g	SNCNT g	SCF wt	FINE NESS
JAJO 8192	1181	4.34	1.17	30.6	85	47.68	.	.	.	.
SG 747	1162	4.86	1.13	28.0	87	52.25	80	6.4	7.4	189
PHYTOGEN PSC 355	1119	4.80	1.11	31.2	86	52.66	78	6.7	6.5	192
MS 3-2-19	1075	4.59	1.10	30.8	88	49.30	92	8.3	7.2	187
ARK 9111-57-12	1075	4.52	1.13	30.8	89	47.30	91	9.8	6.9	183
FIBERMAX 966	1062	4.46	1.15	35.0	94	44.05	79	6.7	7.8	173
DPL 491	1056	4.38	1.19	31.6	89	47.32	84	6.1	8.0	178
STV 8M009	1047	4.32	1.13	32.4	83	48.83	104	11.3	8.4	173
NU 33 B	1035	4.43	1.12	29.5	85	49.29	105	5.4	8.1	183
STV 580	1027	4.53	1.12	31.1	85	49.95	91	5.0	8.6	184
JAJO 8164	1026	4.40	1.09	34.9	87	48.18	74	7.2	7.4	182
DELTA PEARL	998	4.44	1.16	30.3	89	47.00	85	6.4	8.6	179
SS 0102	985	4.49	1.11	31.0	87	48.15	93	5.4	10.0	181
JAJO 8067	968	4.33	1.18	32.1	82	50.01	106	7.7	7.5	180
FIBERMAX 832	943	4.13	1.19	33.1	88	44.80	109	7.6	8.2	168
NC 98-34	932	4.43	1.14	34.2	86	48.34	77	7.4	6.5	179
SS 0101	918	4.51	1.12	30.6	87	48.74	87	6.9	8.2	179
ACALA 1517-99	851	4.10	1.21	33.7	88	44.44	111	9.2	6.9	167
NM 970513	707	4.23	1.18	38.7	91	43.50	86	8.6	5.4	169
LSD	97	0.24	0.03	1.4	3	1.61	16	2.6	0.9	5

Table 2. Mean and range for traits in the Regional High Quality (RHQ) Tests for all 19 varieties and its subset of six varieties used in the Textile Variety Tests (TVT).

	Mean		Range for 19 varieties		Range for 6 varieties	
Trait	19 vars	6 vars	Low	High	Low	High
Yield (lb/acre)	1008	1057	707	1181	943	1162
HVI length (inches)	1.14	1.15	1.10	1.21	1.11	1.19
HVI strength (g/tex)	32.1	31.5	28.0	38.7	28.0	35.0
HVI micronaire	4.22	4.51	4.10	4.86	4.13	4.86
Arealometer perimeter	48.0	48.0	43.5	52.7	44.0	52.7
Arealometer maturity (%)	87	89	82	94	86	94
AFIS, neps/Cntg	91	85.9	77.5	118.4	77.6	109.1
AFIS, seed coats/Cntg	7.5	6.7	5.0	11.3	6.1	7.6
AFIS, short fiber wt. %	7.7	7.8	5.4	10.0	6.5	8.6
AFIS, fineness	178	180	164	192	168	192

Table 3. Correlation (r) [1] of average yield and fiber traits among varieties in the 2001 Regional High Quality (RHQ) Tests.

	Length	Strength	Micronaire	Neps	Short Fiber	Seed Coat Fragments	Fineness
Yield	-0.331	-0.624	0.755	-0.325	0.107	-0.403	0.766
	0.154	0.003	0.0001	0.171	0.663	0.088	0.0001
Length		0.316	-0.585	0.434	-0.191	0.216	-0.678
		0.174	0.007	0.063	0.433	0.374	0.001
Strength			-0.561	-0.071	-0.461	0.370	-0.652
			0.010	0.773	0.047	0.119	0.002
Micronaire				-0.592	-0.079	-0.500	0.915
				0.008	0.748	0.029	0.0001
Neps					0.269	0.371	-04.84
					0.266	0.118	0.036
Short Fiber						-0.316	-0.030
						0.188	0.903
Seed Coat Fragments							-0.504
							0.028

[1] Upper data indicates simple correlation r; lower data indicates probability level.

Table 4. Percentage of total variation among states and varieties grown in the 2001 Regional High Quality (RHQ) Tests.

Source	Yield Lint/ac	Length (inches)	HVI Strength	Micro-naire	Arealometer		AFIS			
					Mat.	Per.	fineness	SCFw	Neps	VFM
States (S)	65.3	58.1	22.1	73.3	82.4	21.9	46.0	57.3	56.7	82.4
Vars (V)	24.7	31.9	61.7	19.2	14.0	74.3	51.5	38.3	37.0	6.2
V X S	10.0	10.0	16.2	7.5	3.6	3.9	2.5	4.3	6.3	11.4
Var "F"	42.2	16.2	69.8	15.8	7.7	20.3	20.4	10.6	4.0	6.4
V X S "F"	3.0	1.6	3.2	1.7	1.2	1.1	1.2	1.2	1.1	2.4

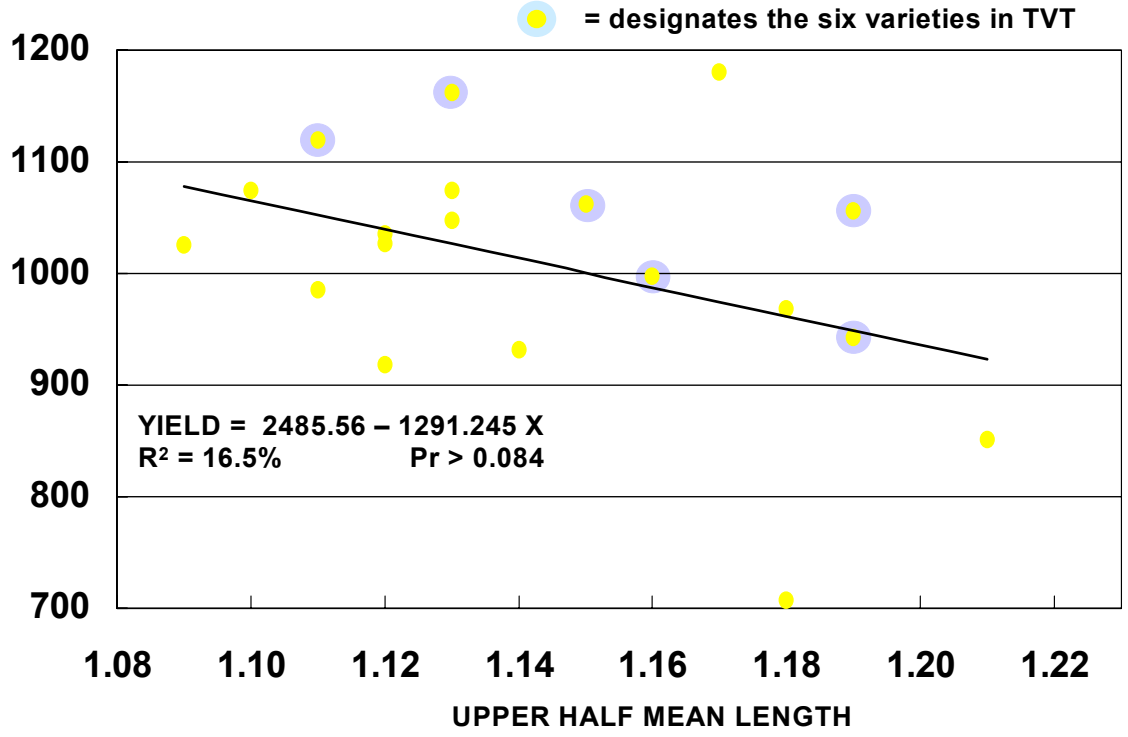

Figure 1. Relationship of average lint/acre and upper half mean length in 2001 Regional High Quality tests.

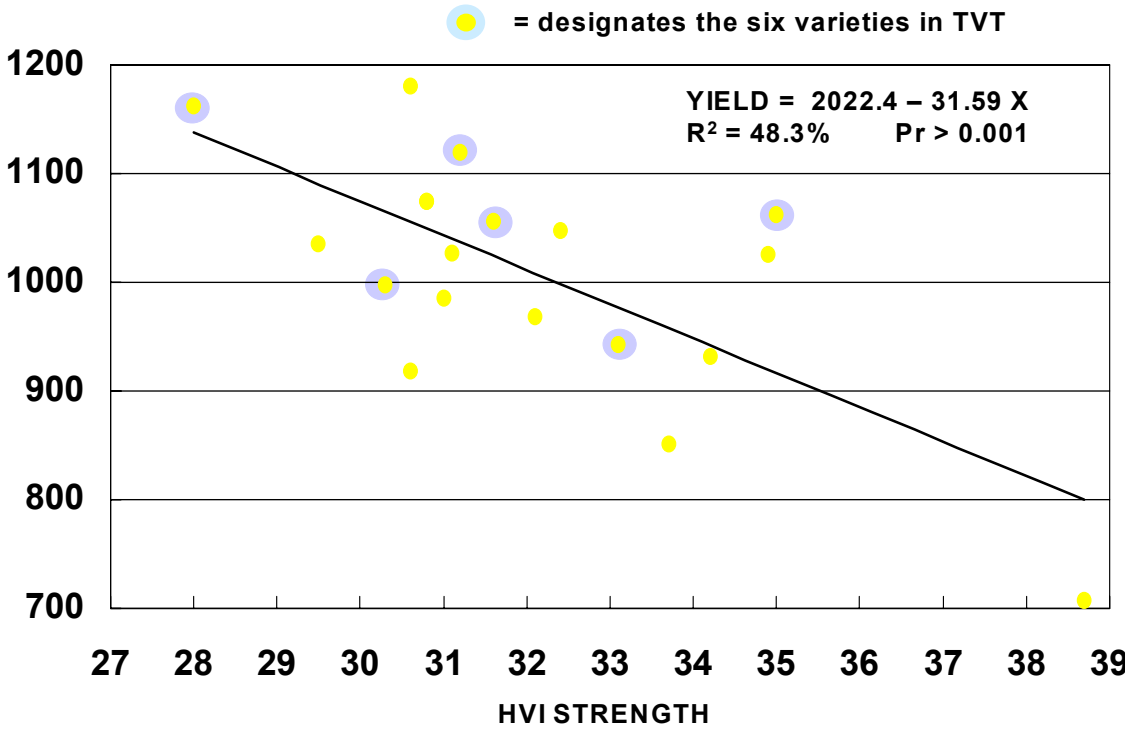

Figure 2. Relationship of average lint/acre and HVI strength in 2001 Regional High Quality tests.

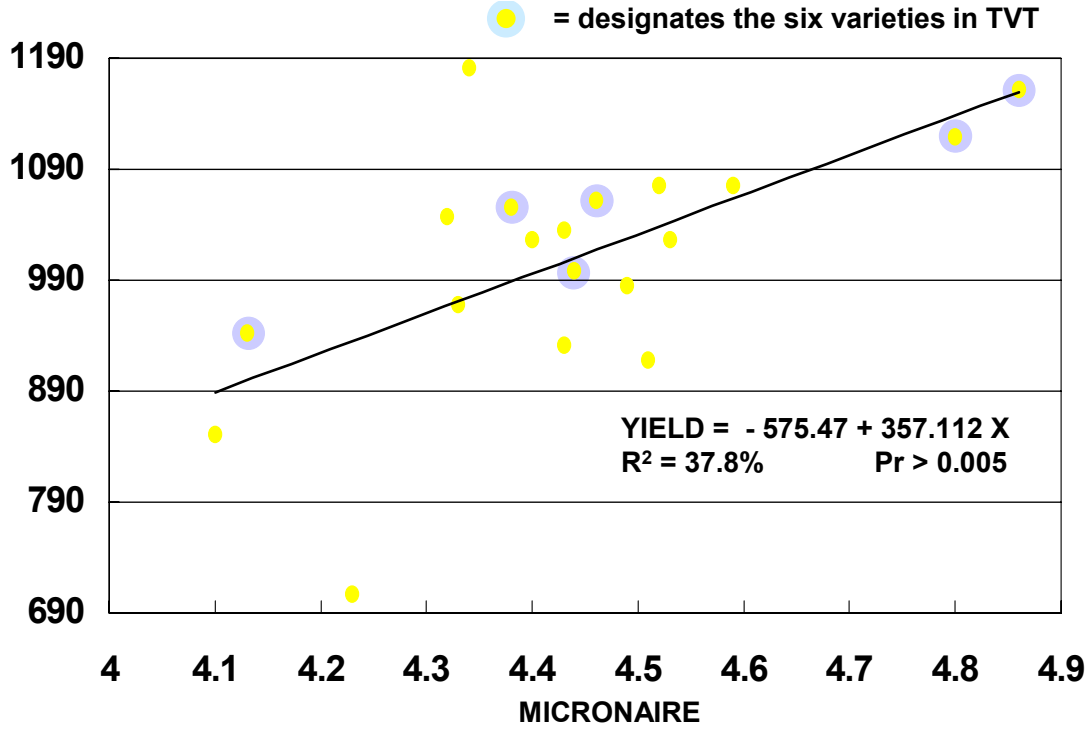

Figure 3. Relationship of average lint/acre and micronaire in 2001 Regional High Quality tests.

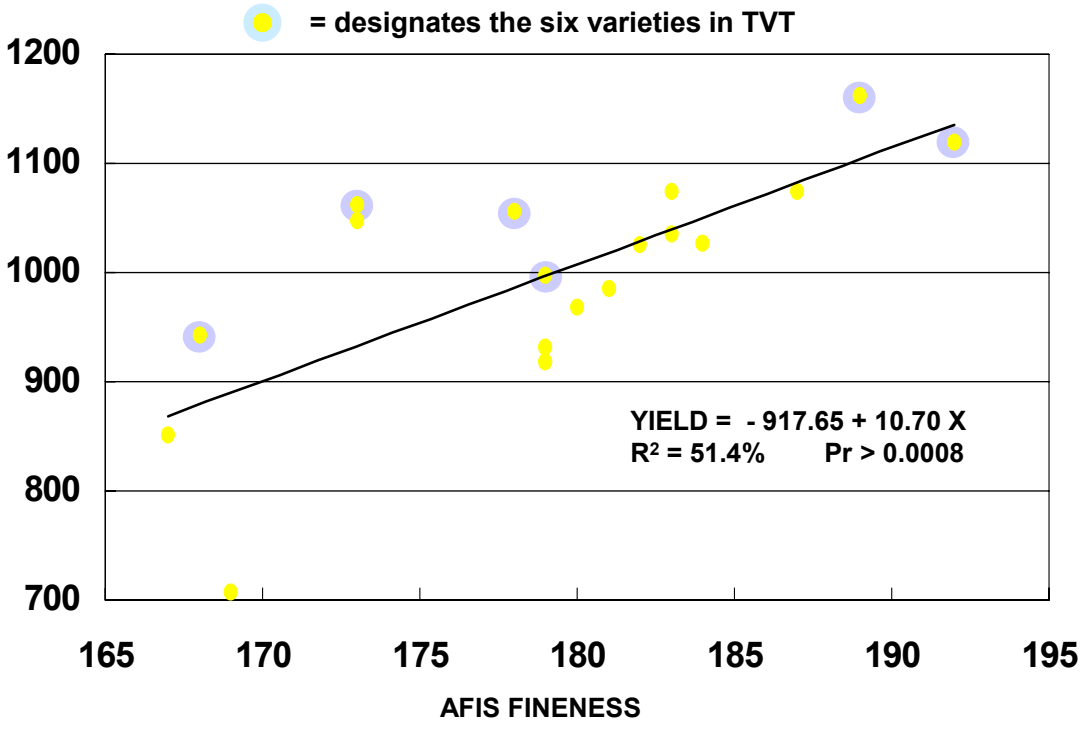

Figure 4. Relationship of average lint/acre and AFIS fineness in 2001 Regional High Quality tests.

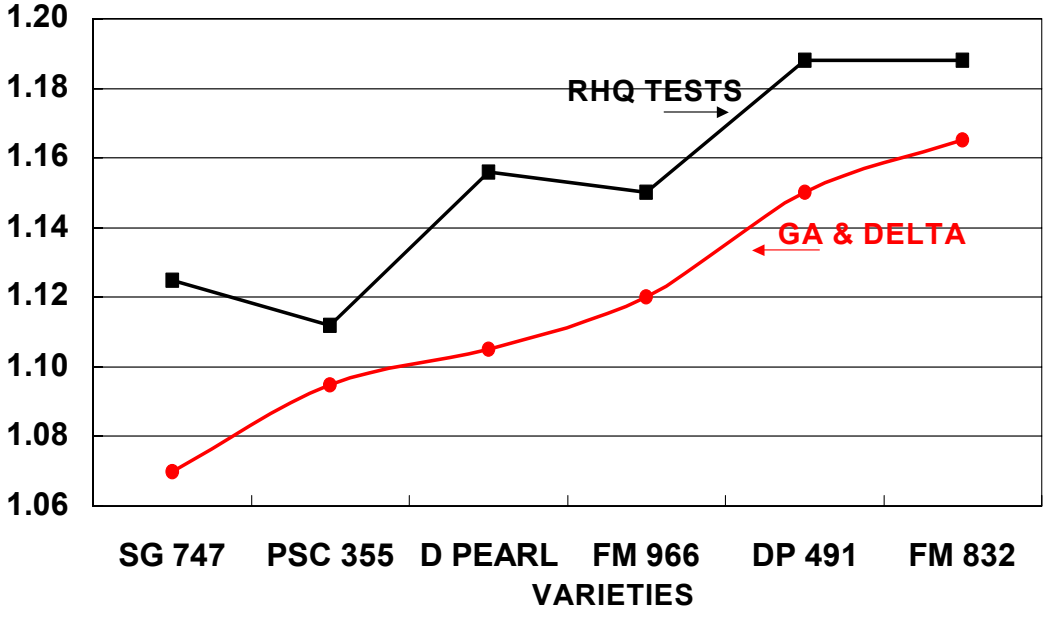

Figure 5. Average upper half mean length (inches) of 6 varieties grown in GA and Delta and their average in the RHQ tests.

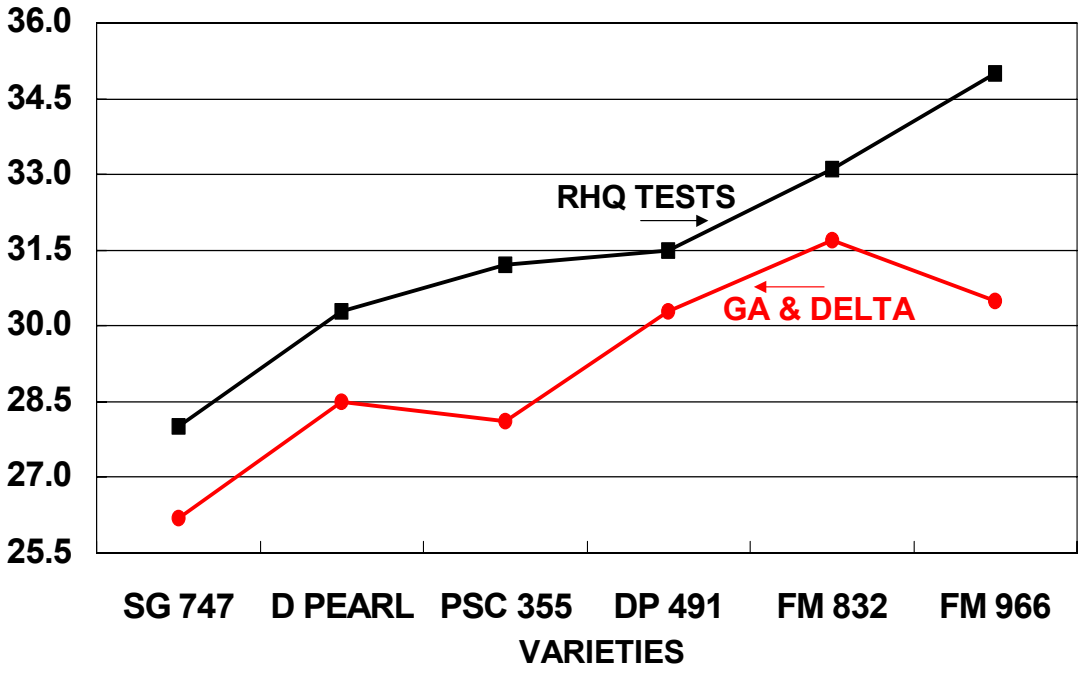

Figure 6. Average HVI strength of 6 varieties grown in GA and Delta vs. their average in RHQ tests.

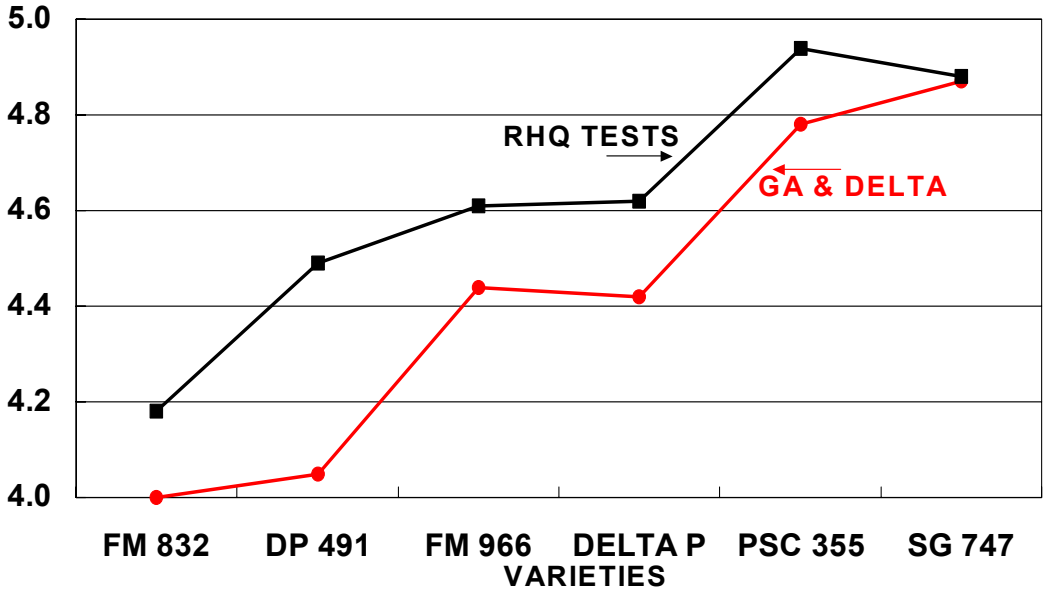

Figure 7. Average micronaire of 6 varieties grown in GA and Delta vs. their average in RHQ tests.