THE SINO-AMERICAN COOPERATIVE GERMPLASM EXCHANGE AND EVALUATION PROGRAM: RESULTS OF THE SECOND EXCHANGE, 1991-1992

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Abstract

Three Pee Dee germplasm lines and three Chinese cotton cultivars were compared for lint yield, yield components, and fiber and spinning properties at two locations in China and at Florence, SC, for two years. The Chinese cultivars produced equivalent lint yields at Florence, but significantly outyielded the Pee Dee lines at both locations in China. Relative to the Pee Dee lines, the Chinese cultivars had higher lint percents, similar boll size, and smaller seed. Fiber length of the Chinese cultivars was generally equivalent to the Pee Dee lines, but the cultivars Simian 2 and Zhongmian 12 produced weaker fiber. The cultivar Zhongmian 17 had high fiber and spinning properties that were similar to the Pee Dee lines. Zhongmian 17 represents a major improvement in fiber quality of Chinese cultivars and may be useful in a breeding program as a new source of variation for lint yield and disease resistance.

Introduction

The first stage of a Sino-American cotton germplasm exchange and evaluation program was initiated in 1986 to facilitate sharing of germplasm and scientific expertise between the United States (U.S.) and China. This test was conceived by Dr. T.W. Culp, Research Geneticist, USDA-ARS (retired) and Mr. Lai Minggang, Project Leader, National Regional Cotton Variety Test in China. The purpose of this report is to summarize yield and fiber quality data from the most recent cycle of germplasm evaluation from 1991 and 1992. Yield and fiber quality characteristics of Chinese cottons should be of interest to U.S. cotton breeders as the Chinese germplasm may represent new sources of variation for yield, fiber properties, and pest resistance. Yield and fiber quality trends of Chinese cultivars may also have implications on world cotton supply.

In the initial exchange of germplasm between China and the U.S., Culp and Moore (1986) compared yield and fiber properties of three popular U.S. cultivars (PD-3, Coker 315, Deltapine 50) with three Chinese cultivars (Jimian 8, Ering 92, 86-1). They found that although the Chinese cultivars yielded similar to the U.S. cottons, the Chinese cultivars were inferior in fiber properties, particularly fiber strength. They attributed this finding to the emphasis on lint yield alone in most of the cotton breeding programs in China at the time. Since then, the Chinese have been attempting to simultaneously improve lint yield and fiber properties. A second round of germplasm exchange and evaluation was initiated in 1990. Three Pee Dee germplasm lines and three Chinese cultivars were exchanged to be evaluated for lint yield and fiber properties at two major cotton producing locations in China and the Clemson University Pee Dee Research and Education Center near Florence, SC. The purpose of this paper is to summarize lint yield and fiber quality findings from 1991 and 1992.

Materials and Methods

Three Pee Dee germplasm lines, PD 5246, PD 5286, and PD 5300, and three Chinese cultivars, Simian 2, Zhongmian 12, and Zhongmian 17, were evaluated for lint yield and fiber properties at three locations in 1991 and 1992. The locations were the Clemson University Pee Dee Research and Education Center near Florence, SC, and near the cities of Anyang and Anqing in Peoples Republic of China. Anyang is located in the northeastern section of the Yellow River Valley of Henan province, which corresponds to a similar latitude as Raleigh, NC, in the U.S. Anqing lies at a similar latitude as Jacksonville, Florida, and is located in the eastern Yangtze River Valley of Anhui province. The Henan and Anhui provinces of China are major cotton producing areas (Roberson, 1994). At Florence genotypes were evaluated in two-row plots, 10.7 m long with 0.96-m row spacing, in randomized complete block designs with four replicates. Seed cotton yield was determined by machine harvest of both rows, an area about 20.5 m^2. In China the experimental design was the same as at Florence, but plot size was 5 rows per plot with yield recorded from hand picking the center three rows for an area about 20 m^2. At Florence 25 bolls per plot were picked prior to machine harvest for determination of lint percent and fiber properties. Boll samples were combined into two replicates (reps 1 + 2 and reps 3 + 4) at ginning to determine lint percent and provide sufficient lint for fiber and spinning analyses. The following measurements were determined by Starlab, Knoxville, TN: (i) 50% span length = length (inches) at which 50% of the fibers are ≥ this length; (ii) 2.5% span length = length (inches) at which 2.5% of the fibers are ≥ this length; (iii) fiber strength as force (cN/tex) necessary to break the fiber bundle with the jaws of the testing instrument (Stelometer) set 3.2 mm apart; (iv) fiber elongation = the percent elongation at the break of the center 3.2 mm of the fiber bundle measured for fiber strength on the Stelometer; (v) micronaire reading = fineness of the fiber measured by the Micronaire and expressed in standard micronaire units; (vi) yarn strength as force (mN/tex) necessary to break 27-tex yarn derived from a micro-spinning test (Landstreet et al., 1959; 1962). In China, bolls were picked from the lower, middle, and top portions of the fruiting zone according to regulations of the Chinese variety evaluation program. The lint was then blended from these zones and subjected to HVI 900 analysis. The data presented represents the mean of the samples tested on the HVI instrument.

With the exception of fiber and Fusarium wilt data from China, all data were subjected to analysis of variance. Since lint yield was determined from machine harvest at Florence and from hand picking in China, yields were not analyzed over locations in both countries. ANOVAs were conducted over years at Florence and over years and locations in China. With the exception of yarn strength at Florence, interactions of genotypes and years were minor, and thus genotype means averaged over years are presented. In China the genotype x year and genotype x location interactions for lint yield were highly significant ($P < 0.01$). The genotype mean square was about 20 times as large as the genotype x year mean square with only 1 rank change between years. In contrast, the genotype mean square was only 4 times as large as the genotype x location mean square, and there was a complete change in rank among the Chinese cultivars between locations. Thus, genotype means for lint yield at each location averaged over years were separated with the least significant difference.

Results and Discussion

Differences in lint yield among the three Pee Dee germplasm lines and three Chinese cultivars were small and nonsignificant at Florence (Tables 1,2) but were significant in the combined ANOVA over years and locations in China (Table 3). At Anqing all of the Chinese cultivars outyielded the Pee Dee germplasm lines. At Anyang lint yields were lower, and differences among genotypes were smaller. A complete change in rank of the Chinese cultivars between locations may partially explain the significant genotype x location interaction for lint yield in China. It is interesting to note that Simian 2 produced about 3 bales of lint at Anqing, but barely made a bale and a half at Anyang. Lint percentages of Zhongmian 12, Zhongmian 17, and Simian 2 at Florence and both locations in China were higher as a group than the Pee Dee germplasm lines (Tables 2,3). At Anyang and Anqing, the difference in lint percent between the Chinese cultivars and Pee Dee germplasm lines was as much as 4-5 percent. Evidently, the Chinese have emphasized breeding for high lint percent in their cultivar development programs.

Relative to the Pee Dee germplasm lines, the Chinese cultivars produced more bolls per plant with smaller seed but with similar boll size. Since we did not determine seeds per boll, the higher lint percents of the Chinese cultivars could result from either less seed weight per boll or more lint per seed than the Pee Dee lines since boll size was similar. In addition to differences in seed size and lint percent with the Pee Dee lines, Zhongmian 12 and Zhongmian 17 expressed resistance to Fusarium wilt in China (Table 5).

For the fiber properties, significant differences existed at Florence for fiber elongation and fiber strength (Table 1). It is interesting to note that the 2.5% fiber span lengths of the Chinese cultivars did not differ significantly from the Pee Dee germplasm lines. The cultivar Zhongmian 12 at all three locations produced a 2.5% fiber span length similar to the Pee Dee lines. Although Simian 2 and Zhongmian 12 consistently produced weaker fiber than the Pee Dee germplasm lines, Zhongmian 17 produced equivalent fiber strengths as measured by the HVI at both locations in China and only slightly weaker fiber at Florence as measured by the Stelometer (Tables 2,4). The yarn strength of Zhongmian 17 was also similar as measured by ring and open-end spinning tests (Tables 2,4). The finding that fiber properties of some of the Chinese cultivars are similar to those of the Pee Dee lines is in contrast to previous reports that Chinese cultivars were inferior in fiber properties (Culp and Moore, 1986; Miller, 1986). The fiber properties of Zhongmian 17 relative to the Pee Dee lines indicate a major improvement over those reported by Culp and Moore (1986). The combination of Fusarium wilt resistance, yield potential, and fiber properties makes Zhongmian 17 an attractive parent for use in a cotton improvement program. Evidently, we are seeing the results of the increased emphasis on fiber quality in Chinese cotton breeding programs. Although the Chinese have experienced production declines in recent years that have resulted in not meeting domestic demand, should they solve these production problems, an improvement in fiber properties could enhance demand for their cotton on world markets and thus their position as a cotton exporter.

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Table 1. ANOVA of lint yield, fiber, and spinning properties of three Pee Dee germplasm lines and three Chinese cotton cultivars grown at Florence, SC, in 1991 and 1992.

Source	df	Lint yield	MIC	50% Span Length	2.5% Span Length	E1	Fiber Strength	Yarn Strength
				mean square				
Year	1	11161843**	1.50	0.0075	0.0012	9.065*	9.63*	88.2
Rep(Year)	6	26374	0.13	0.0008	0.0018	0.169	0.52	158.2
Genotype	5	11245	0.10	0.0004	0.0015	2.892*	10.93**	316.4
Genotype x Year	5	24494	0.04	0.0005	0.0008	0.396	0.46*	82.8*
Error	30	20561	0.02	0.0002	0.0003	0.188	0.14	18.0 '

df for rep(year)=2 and error=10 for fiber and spinning properties.
*,** significant at $P < 0.05$ and 0.01, respectively.

Table 2. Means for lint yield, fiber, and spinning properties for three Pee Dee (PD) germplasm lines and three Chinese cotton cultivars grown at Florence, SC, in 1991 and 1992.

Genotype	Lint yield	Lint %	MIC	50% Span Length	2.5% Span Length	E1	Fiber Strength	Yarn Strength 1991	Yarn Strength 1992
	lb ac		——— in	———		%	-cN/tex-	--mN/tex	—
PD 5286	1085	42.0	4.93	0.58	1.14	7.9	21.3	133	135
PD 5300	1031	40.0	5.20	0.57	1.13	7.5	20.8	140	130
PD 5246	1019	41.0	5.20	0.57	1.14	7.4	21.9	137	137
Zhongmian 17	1004	44.0	5.20	0.56	1.11	7.9	19.6	123	134
Simian 2	1003	42.0	4.85	0.55	1.09	9.7	18.1	108	124
Zhongmian 12	992	44.0	5.08	0.57	1.13	8.6	18.1	117	121
LSD 0.05	NS	†	NS	NS	NS	1.1	1.2	12	10

' Lint percent not subjected to analysis of variance.

Table 3. ANOVA and means for lint yield of three Pee Dee (PD) germplasm lines and three Chinese cotton cultivars grown for two years at Anqing and Anyang in Peoples Republic of China.

Source	df	Mean square
Yr	1	208134**
Loc	1	2362537
Yr x Loc	1	4018016**
Rep(Yr x Loc)	12	37881**
Genotype	5	770826**
Genotype x Yr	5	38839**
Genotype x Loc	5	179758**
Genotype x Yr x Loc	5	12025
Error	60	7095

Genotype	Lint Yield Anyang	Lint Yield Anqing	Lint Percent Anyang	Lint Percent Anqing
	— lb/ac —		— % —	
Simian 2	644	1288	38.7	40.1
Zhongmian 17	1065	1165	40.0	39.0
Zhongmian 12	863	1051	38.5	38.8
PD 5300	574	861	34.8	34.3
PD 5286	553	804	35.6	35.3
PD 5246	521	734	34.9	34.6
LSD 0.05	141		†	

' Lint percent not subject to analysis of variance.

Table 4. Cotton fiber and spinning properties of three Pee Dee and three Chinese cotton cultivars grown at Anyang (ANY) and Anqing (ANQ), China, in 1991 and 1992.

Genotype	MIC ANY	MIC ANQ	2.5% Span Length ANY	2.5% Span Length ANQ	Fiber Strength ANY	Fiber Strength ANQ	Yarn Strength Ring Spun ANY	Yarn Strength Ring Spun ANQ	Yarn Strength Open End Spun ANY	Yarn Strength Open End Spun ANQ
			—in—		—cN/tex—		—lbs—		—lbs—	
Simian 2	4.4	4.8	1.10	1.15	18.7	18.7	115	117	1741	1714
Zhongmian 17	4.7	4.9	1.12	1.20	23.6	22.9	130	136	1939	1846
Zhongmian 12	4.6	5.0	1.16	1.22	20.7	20.6	124	131	1825	1747
PD 5300	4.2	4.7	1.16	1.22	24.5	23.9	142	143	2029	1971
PD 5286	4.3	4.9	1.13	1.23	23.6	23.3	135	140	1976	1916
PD 5246	4.8	5.0	1.13	1.25	25.5	25.7	137	150	1977	2012

Table 5. Yield components and Fusarium wilt infected plants of three Pee Dee (PD) germplasm lines and three Chinese cotton cultivars grown at Anyang (ANY) and Anqing (ANQ), China, in 1991 and 1992.

Genotype	Bolls/Plant ANY	Bolls/Plant ANQ	Boll/Size ANY	Boll/Size ANQ	Seed Index ANY'	Seed Index ANQ	Percent Wilt Infected ANY
	-- No. --		—g—		—g—		
Simian 2	19.6	22.0	4.3	5.0	9.0	9.8	44.0
Zhongmian 17	18.5	19.5	4.5	5.0	8.8	10.0	1.0
Zhongmian 12	17.6	19.7	4.8	5.1	10.3	11.3	1.9
PD 5300	15.4	16.2	4.5	5.7	10.1	12.4	38.0
PD 5286	16.2	16.2	4.4	5.2	10.0	12.3	29.6
PD 5246	13.2	16.0	4.5	5.3	11.0	12.7	42.4

' 1991 data only