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Primitive Cotton Germplasm: Yield and Fiber Traits for 21 Day-Neutral Accessions

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ABSTRACT

The improvement of cotton (*Gossypium hirsutum* L.) relies on the introduction of desirable traits from germplasm resources. Such a resource is the collection of primitive cotton accessions that contain useful genetic variability; however, many of the accessions are photoperiodic. The short-day photoperiod flowering response is a major hurdle to their utilization in cotton breeding and research programs. Utilizing a backcross-breeding approach, accessions have been converted to day-neutral flowering habit. Twenty-one day-neutral lines have been evaluated, and useful genetic variability has been measured for agronomic and fiber traits. The day-neutral accessions are now available for use in breeding programs for cultivar development and to expand genetic variability.

INTRODUCTION

Cotton (*Gossypium* spp.) has been grown for centuries in warmer climates throughout the world. Cotton produces lint fibers that arise from the seed, which are used in the textile industry. Other important products are oil, meal, seed hulls, and linters.

Vast improvements in cotton yield and fiber quality have occurred during the 20th century due to selection, breeding, and research. These improvements were due in large part to the genetic variability that existed in native-grown cottons and early introductions. To continue improving agronomic and fiber traits, additional sources of genetic variability must be identified and exploited.

The U.S. National Cotton Germplasm Collection is a repository for plant material that has been collected throughout the world. The ancestors of modern U.S. upland cultivated cotton are the primitive accessions that have been collected through Mexico and Central America. Currently, there are more than 2,500 primitive accessions in the *Gossypium* collection (Anonymous 1974, Percival 1987, Anonymous 1997).

Variability exists for many traits in the collection of primitive accessions based on collection descriptor information and limited evaluation data. This identified variability has not been extensively utilized because most of the primitive accessions are photoperiodic and require short days to initiate flowers and produce fruit. Because of this flowering response to day length, their genes are not readily available for incorporation in cotton-breeding programs.

A program has been developed and utilized to incorporate day-neutral genes in the primitive accessions. McCarty and Jenkins (1992, 1993, and 2001) presented data for 95 day-neutral accessions. This report presents data for 21 additional accessions, which have been converted to day-neutral flowering types.

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Materials and Methods

The day-neutral (DN) lines were developed following the procedure described by McCarty et al. (1979). The short-day primitive accessions were crossed as male parents to 'Deltapine 16' (day-neutral donor parent) at a Cotton Winter Nursery located at Tecoman, Colima, Mexico. The F1 generation was self-pollinated at the Winter Nursery, and the F2 generation was grown at Mississippi State University where segregation for flowering response occurred. One plant that set fruit at a low node and continued to fruit was selected from each F2 population, and its F3 progeny was backcrossed to the accession at the Winter Nursery. The same procedure was followed for each backcross generation. Equal numbers of open-pollinated bolls were harvested from each BC4F2 plant that set fruit, and the seed were bulked for each population to provide seed for increase and testing. Except for selection for day-neutrality after each backcross cycle, no other selection pressure was applied.

Day-neutral BC4F4 lines of 21 primitive accessions of cotton and three commercial cultivars were grown and evaluated in field plots at Mississippi State University's Plant Science Research Center in 2001 and 2002. The commercial cultivars, which are well adapted to the Midsouth, included 'Deltapine 50' (Dpl 50), 'Sure-Grow 747' (Sg 747), and 'Stoneville 474' (Stv 474).

The day-neutral lines and cultivars were grown at two locations each year in single-row plots (40 feet long, with rows spaced 38 inches apart). The experimental design was a randomized complete block with four replicates. The soil type was a Leeper silty clay loam (fine, montmorillionitic, nonacid, thermic Vertic Haplaquepts). The entries were planted in a solid planted pattern at location one; entries were planted in a two-planted/one-skip row pattern at location two. Field plots were maintained with standard culture practices.

Seed cotton yield was determined by mechanical harvest. A 25-boll sample was hand-harvested from each plot prior to mechanical picking. Boll samples were weighed and ginned on a laboratory 10-saw gin to determine boll weight (grams of seed cotton per boll), lint percentage, and seed index (weight of 100 seeds). Lint samples were sent to Starlab, Inc., of Knoxville, Tennessee, for determination of micronaire, elongation (E1), fiber strength (T1), 2.5% span length (2.5% SL), and 50% span length (50% SL). Fiber elongation, as a percentage and strength, expressed as grams per tex force, was measured with the 1/8-inch gauge stelometer. Length was measured on a digital fibrograph and expressed in inches.

Data for all traits were subjected to analysis of variance. Means were separated according to Fisher's protected least significant difference (LSD).

Results and Discussion

The accessions were collected at diverse locations in Mexico, Guatemala, and Belize (Table 1). Descriptor information for these accessions has been published in Anonymous (1974), Percival (1987), and the USDA Germplasm Resources Information Network (GRIN) database at www.ars-grin.gov. A wide range of variability exists in the primitive accessions for the characters that have been evaluated.

Agronomic and fiber data for 2001 and 2002 are presented in Tables 2 through 6. The day-neutral lines tended to produce seeds that were larger than the commercial cultivars in the test. Lint percentage for the Stoneville 474 and Sure-Grow 747 was in the low 40s, while that for the day-neutral lines was in the low 30s. This difference was consistent for both years and locations. The year-by-location interaction was examined and deemed nonsignificant for traits evaluated. Most of the day-neutral lines produced seed cotton yields that were significantly lower than the cultivars. As expected, lint yields were low for the day-neutral lines because of low lint percentages. Higher yields and larger bolls were produced in the two-planted/one-skip row pattern, as compared with the solid-planted pattern. Other traits measured were little affected by planting pattern.

Most day-neutral lines produced fibers that were significantly shorter than cultivars. Fiber micronaire values tended to be lower, while fiber strength tended to be higher, compared with the cultivars evaluated. Several day-neutral lines produced fibers that were stronger than cultivars during both years of testing.

The converted primitive accessions are useful for the diverse germplasm they contain. Researchers looking for new traits can now exploit the day-neutral lines. These lines can also be used to expand the genetic base of cotton.

Table 1. Texas number, race, plant inventory number, year collected, and collection location for 21 primitive accessions of cotton.[1]

T #	Race	Plant inv. #	Year collected	Country of origin	State of of origin	Site of origin	Latitude	Longitude
41	*latifolium*	154052	1946	Mexico	–	–	–	–
50	*latifolium*	154068	1946	Mexico	Chiapas	Zapotal	16.06N	92.21W
64	*latifolium*	154100	1946	Mexico	Chiapas	Rosario	–	–
81	*latifolium*	153970	1946	Guatemala	–	–	–	–
93	*latifolium*	163654	1948	Guatemala	Jutiapa	Santa Catarina Mita	–	–
149	–	163609	1948	Guatemala	Santa Rosa	Orataria	–	–
171	*morrilli*	163305	1948	Mexico	Oaxaca	Ejutla	16.33N	96.10W
173	*latifolium*	163623	1948	Guatemala	Jutiapa	Progreso	17.18N	90.08W
178	*latifolium*	163688	1948	Guatemala	Chiquimula	Chiquimula	14.48N	84.32W
209	*latifolium*	163711	1948	Guatemala	Chiquimula	–	–	–
219	*latifolium*	165671	1948	Guatemala	Jalapa	Jalapa	14.39N	89.59W
221	*latifolium*	163706	1948	Guatemala	Chiquimula	Tierra Blanca	–	–
241	*latifolium*	163733	1948	Guatemala	Baja Verapaz	Sanarate	–	–
338	–	165361	1948	Mexico	Guerrero	Zacualapan	18.44N	99.48W
347	–	165389	1948	Mexico	Guerrero	Acapulco DeJuarez	16.51N	99.56W
620	–	154062	1946	–	–	–	–	–
636	–	158461	–	Guatemala	–	Motagua River sys	–	–
725	–	265159	–	Belize	–	Belize City	17.29N	88.10W
763	–	201599	1952	Mexico	San Luis Potosi	Tamazunchula	21.18N	98.46W
764	–	201600	1952	Mexico	San Luis Potosi	Axtla	–	–
790	–	267179	–	Belize	–	Corozal	18.23N	88.23W

[1]Additional descriptor information for these accessions can be found in Anonymous, 1974; Percival, 1987; and the Germplasm Resources Information Network (GRIN) database at [www.ars-grin.gov].

Table 2. Agronomic and fiber characteristics of 21 BC4F4 day-neutral accessions grown at location one (solid-planted pattern), Mississippi State University, 2001.

Entry	Boll size	Lint percent	Seed index	Seed cotton yield	Lint cotton yield	Mic.	50% SL	2.5% SL	Elongation	Strength
	g	*%*	*g*	*lb/A*	*lb/A*		*in*	*in*	*%*	*g/tex*
T-41 DN	6.26	33.96	12.89	970	329	5.00	0.53	1.02	7.13	19.69
T-50 DN	5.76	33.55	10.93	1394	468	5.00	0.54	1.07	7.13	19.08
T-64 DN	5.56	33.64	11.67	1436	483	4.98	0.54	1.07	6.44	19.73
T-81 DN	5.94	34.28	11.58	1400	480	5.20	0.53	1.06	6.31	19.86
T-93 DN	4.47	29.42	10.74	1251	368	4.88	0.56	1.06	7.88	20.63
T-149 DN	5.31	31.86	11.40	1337	426	4.90	0.56	1.11	6.69	22.03
T-171 DN	4.13	28.59	10.10	1169	334	4.70	0.56	1.11	7.56	21.15
T-173 DN	4.03	30.15	9.99	1474	444	4.45	0.56	1.11	7.81	21.34
T-178 DN	4.39	30.08	10.36	1290	388	4.43	0.56	1.11	8.06	20.66
T-209 DN	4.23	29.95	10.44	1391	417	4.23	0.57	1.15	7.38	21.49
T-219 DN	4.53	32.80	10.44	1361	446	4.50	0.56	1.12	8.44	18.85
T-221 DN	4.34	29.13	10.42	1080	315	4.70	0.55	1.06	7.38	21.04
T-241 DN	4.67	33.47	10.67	1673	560	4.45	0.55	1.10	8.38	18.81
T-338 DN	4.21	29.46	10.25	1125	331	4.33	0.56	1.13	8.38	19.25
T-347 DN	4.24	30.19	11.13	1558	470	4.83	0.54	1.11	6.63	20.56
T-620 DN	5.54	34.68	10.59	1422	493	5.00	0.54	1.07	7.50	19.91
T-636 DN	4.59	30.62	10.37	1269	389	5.13	0.55	1.08	6.56	21.46
T-725 DN	4.17	30.70	10.31	1351	415	4.75	0.55	1.10	7.31	21.54
T-763 DN	4.13	29.61	10.56	970	287	4.68	0.55	1.06	7.00	20.86
T-764 DN	4.05	31.18	9.67	843	263	4.43	0.56	1.09	7.38	21.68
T-790 DN	5.37	30.51	11.61	1213	370	4.65	0.55	1.08	7.88	20.81
Stv 474	5.01	43.91	9.91	1837	807	5.20	0.55	1.10	7.56	18.86
Sg 747	5.34	42.62	9.84	1541	657	5.20	0.55	1.12	8.44	17.15
Dpl 50	5.19	38.19	10.38	1989	760	5.18	0.54	1.12	8.56	18.51
LSD 0.05	**0.38**	**1.28**	**0.71**	**338**	**112**	**0.30**	**0.02**	**0.04**	**0.98**	**1.39**

Table 3. Agronomic and fiber characteristics of 21 BC4F4 day-neutral accessions grown at location two (two-planted/one-skip row pattern), Mississippi State University, 2001.

Entry	Boll size	Lint percent	Seed index	Seed cotton yield	Lint cotton yield	Mic.	50% SL	2.5% SL	Elongation	Strength
	g	*%*	*g*	*lb/A*	*lb/A*		*in*	*in*	*%*	*g/tex*
T-41 DN	6.79	33.40	12.87	2001	668	5.13	0.54	1.04	7.31	18.99
T-50 DN	5.43	33.27	10.85	2131	709	5.25	0.54	1.06	7.94	19.81
T-64 DN	5.81	34.35	11.86	2226	765	4.98	0.53	1.04	6.69	19.03
T-81 DN	6.14	35.33	11.85	2167	766	5.30	0.55	1.04	7.13	19.13
T-93 DN	4.92	29.65	10.63	1883	558	4.98	0.54	1.05	7.56	21.60
T-149 DN	5.35	31.66	11.04	1870	592	4.85	0.55	1.10	6.94	22.75
T-171 DN	4.63	30.10	10.56	1644	495	4.75	0.56	1.08	7.88	21.03
T-173 DN	5.00	30.56	10.47	2070	633	4.55	0.54	1.07	7.06	20.78
T-178 DN	4.36	31.10	10.53	2166	674	4.58	0.56	1.11	7.88	20.55
T-209 DN	4.81	29.52	10.88	2066	610	4.53	0.56	1.11	7.75	20.29
T-219 DN	4.90	33.27	10.73	2168	721	4.40	0.57	1.15	7.94	18.58
T-221 DN	4.61	28.70	10.86	1731	497	4.85	0.54	1.06	8.56	20.29
T-241 DN	4.89	33.77	11.03	2138	722	4.58	0.56	1.09	8.00	19.25
T-338 DN	4.59	28.88	11.01	1809	522	4.45	0.56	1.13	8.31	20.45
T-347 DN	4.46	31.06	10.94	2303	715	5.05	0.56	1.09	7.06	19.20
T-620 DN	5.89	34.67	11.30	2318	804	5.28	0.54	1.04	7.06	19.36
T-636 DN	5.00	30.50	10.30	1681	513	5.25	0.54	1.03	7.94	20.95
T-725 DN	4.35	30.55	9.99	2139	653	4.75	0.54	1.05	7.69	21.45
T-763 DN	4.58	30.35	10.84	1920	583	4.80	0.55	1.06	7.31	22.00
T-764 DN	3.68	30.32	9.34	1212	367	4.40	0.54	1.05	7.94	22.00
T-790 DN	4.73	30.69	10.63	1975	606	4.63	0.54	1.07	7.94	20.74
Stv 474	5.47	42.62	10.52	3185	1358	5.20	0.56	1.12	7.81	19.05
Sg 747	5.76	41.92	9.80	2385	1000	4.93	0.56	1.13	8.06	17.91
Dpl 50	5.36	37.66	9.99	2896	1090	4.90	0.55	1.13	8.69	18.66
LSD 0.05	**0.40**	**1.23**	**0.76**	**738**	**247**	**0.39**	**0.02**	**0.03**	**1.04**	**1.55**

Table 4. Agronomic and fiber characteristics of 21 BC4F4 day-neutral accessions grown at location one (solid-planted pattern), Mississippi State University, 2002.

Entry	Boll size	Lint percent	Seed index	Seed cotton yield	Lint cotton yield	Mic.	50% SL	2.5% SL	Elongation	Strength
	g	*%*	*g*	*lb/A*	*lb/A*		*in*	*in*	*%*	*g/tex*
T-41 DN	6.80	32.63	12.13	1255	409	4.73	0.54	1.09	7.25	19.11
T-50 DN	5.24	33.08	10.31	1202	398	4.90	0.54	1.08	8.50	19.93
T-64 DN	5.72	33.59	10.90	1308	439	4.78	0.55	1.12	6.38	20.46
T-81 DN	5.56	34.43	11.00	1261	434	5.03	0.55	1.10	6.81	20.58
T-93 DN	4.65	28.22	10.58	1250	353	4.85	0.55	1.10	7.69	20.19
T-149 DN	5.08	30.98	10.65	1341	415	4.83	0.55	1.13	6.75	22.81
T-171 DN	3.77	28.78	9.77	1074	309	4.53	0.54	1.10	7.38	21.71
T-173 DN	4.14	31.48	9.18	1039	327	4.40	0.54	1.11	7.50	20.36
T-178 DN	3.95	30.36	9.77	1167	354	4.48	0.55	1.13	7.56	21.04
T-209 DN	4.49	28.91	10.15	1251	362	4.38	0.56	1.17	7.25	21.93
T-219 DN	4.78	33.40	10.39	1535	513	4.40	0.56	1.15	8.25	18.60
T-221 DN	4.19	29.61	9.82	1148	340	4.53	0.53	1.09	7.75	21.14
T-241 DN	4.51	32.19	10.08	1229	396	4.38	0.54	1.12	8.44	19.16
T-338 DN	3.77	30.34	10.55	1312	398	4.45	0.56	1.17	8.38	20.63
T-347 DN	4.05	30.80	9.73	1334	411	4.73	0.55	1.10	7.44	20.64
T-620 DN	5.55	34.64	10.49	1205	418	4.98	0.53	1.11	7.50	20.33
T-636 DN	4.33	30.25	9.80	1392	421	4.95	0.54	1.10	6.88	19.78
T-725 DN	3.90	32.00	9.35	1082	346	4.85	0.54	1.10	6.81	22.34
T-763 DN	4.05	31.31	9.36	879	275	4.48	0.54	1.08	7.13	22.13
T-764 DN	3.69	30.73	9.08	711	219	4.18	0.53	1.07	7.75	21.85
T-790 DN	5.06	29.72	10.70	1117	332	4.45	0.55	1.12	7.50	22.25
Stv 474	4.85	42.97	9.29	2177	935	4.83	0.55	1.13	7.81	18.71
Sg 747	5.17	42.99	9.23	1647	708	5.08	0.56	1.16	8.69	17.96
Dpl 50	5.04	37.66	9.45	1752	660	4.83	0.55	1.16	8.81	18.15
LSD 0.05	**0.44**	**1.43**	**0.43**	**336**	**113**	**0.31**	**0.02**	**0.03**	**0.88**	**1.43**

Table 5. Agronomic and fiber characteristics of 21 BC4F4 day-neutral accessions grown at location two (two-planted/one-skip row pattern), Mississippi State University, 2002.

Entry	Boll size	Lint percent	Seed index	Seed cotton yield	Lint cotton yield	Mic.	50% SL	2.5% SL	Elongation	Strength
	g	*%*	*g*	*lb/A*	*lb/A*		*in*	*in*	*%*	*g/tex*
T-41 DN	6.21	34.54	11.73	2087	721	4.65	0.54	1.10	6.31	20.83
T-50 DN	4.95	33.62	10.00	2306	775	4.85	0.54	1.09	7.75	20.85
T-64 DN	5.81	34.89	10.81	1958	683	5.00	0.54	1.09	6.31	19.84
T-81 DN	5.78	34.54	10.40	1937	669	4.88	0.54	1.10	7.19	20.71
T-93 DN	4.35	29.44	10.01	2144	631	4.73	0.54	1.10	7.63	21.53
T-149 DN	5.29	31.71	10.70	2262	717	4.85	0.56	1.14	7.06	23.24
T-171 DN	3.90	30.25	9.32	1887	571	4.80	0.55	1.10	7.50	21.84
T-173 DN	3.72	30.78	9.17	2443	752	4.25	0.55	1.13	7.19	21.14
T-178 DN	4.47	30.66	9.15	2287	701	4.70	0.56	1.12	7.88	21.84
T-209 DN	4.27	29.40	10.00	2039	599	4.33	0.55	1.16	7.06	22.56
T-219 DN	4.58	33.42	9.65	2801	936	4.18	0.56	1.14	8.00	18.86
T-221 DN	4.04	29.11	9.31	1797	523	4.38	0.54	1.09	8.13	20.15
T-241 DN	4.36	32.55	9.85	2306	751	4.30	0.53	1.10	8.25	19.01
T-338 DN	4.12	29.63	9.83	2095	621	4.28	0.55	1.14	8.56	20.99
T-347 DN	3.92	30.36	10.05	2424	736	4.68	0.56	1.12	7.19	21.24
T-620 DN	6.03	34.82	10.30	2523	879	5.05	0.52	1.08	7.75	19.83
T-636 DN	4.78	29.86	9.43	2308	689	5.05	0.54	1.09	7.25	20.55
T-725 DN	4.07	30.00	9.67	2392	718	4.95	0.54	1.09	7.38	22.98
T-763 DN	4.15	30.24	9.57	1794	542	4.20	0.56	1.10	7.88	22.44
T-764 DN	3.85	28.99	8.79	1619	469	4.10	0.53	1.06	7.81	22.28
T-790 DN	4.79	30.90	9.73	2145	663	4.78	0.54	1.10	8.25	19.75
Stv 474	4.39	43.05	8.99	2174	936	5.00	0.55	1.14	7.50	19.46
Sg 747	4.93	43.22	9.16	2263	978	4.70	0.56	1.14	9.06	17.94
Dpl 50	5.16	37.73	9.39	2293	865	4.80	0.55	1.15	8.44	18.31
LSD 0.05	**0.42**	**1.47**	**0.82**	**472**	**166**	**0.42**	**0.02**	**0.03**	**0.81**	**1.30**

Table 6. Agronomic and fiber characteristics of 21 BC4F4 day-neutral accessions averaged across two locations for two years, Mississippi State University.

Entry	Boll size	Lint percent	Seed index	Seed cotton yield	Lint cotton yield	Mic.	50% SL	2.5% SL	Elongation	Strength
	g	*%*	*g*	*lb/A*	*lb/A*		*in*	*in*	*%*	*g/tex*
T-41 DN	6.51	33.63	12.41	1578	532	4.88	0.54	1.06	7.00	19.65
T-50 DN	5.35	33.38	10.52	1758	587	5.00	0.54	1.08	7.83	19.92
T-64 DN	5.73	34.12	11.31	1732	593	4.93	0.54	1.08	6.45	19.76
T-81 DN	5.85	34.65	11.21	1691	587	5.10	0.54	1.07	6.86	20.07
T-93 DN	4.60	29.18	10.49	1632	478	4.86	0.55	1.08	7.69	20.98
T-149 DN	5.25	31.55	10.95	1702	538	4.86	0.55	1.12	6.86	22.71
T-171 DN	4.11	29.43	9.94	1443	427	4.69	0.55	1.10	7.58	21.43
T-173 DN	4.22	30.74	9.70	1756	539	4.41	0.55	1.11	7.39	20.90
T-178 DN	4.29	30.55	9.95	1728	529	4.54	0.56	1.12	7.84	21.02
T-209 DN	4.45	29.45	10.37	1686	497	4.36	0.56	1.15	7.36	21.57
T-219 DN	4.70	33.22	10.30	1966	654	4.37	0.56	1.14	8.16	18.72
T-221 DN	4.29	29.14	10.10	1439	419	4.61	0.54	1.08	7.95	20.65
T-241 DN	4.61	33.00	10.41	1837	607	4.43	0.55	1.10	8.27	19.06
T-338 DN	4.18	29.58	10.41	1585	468	4.38	0.56	1.14	8.41	20.33
T-347 DN	4.17	30.60	10.46	1905	583	4.82	0.55	1.11	7.08	20.41
T-620 DN	5.75	34.71	10.67	1867	648	5.08	0.53	1.07	7.45	19.86
T-636 DN	4.68	30.31	9.97	1662	503	5.09	0.54	1.08	7.16	20.68
T-725 DN	4.13	30.81	9.83	1741	533	4.83	0.54	1.09	7.30	22.08
T-763 DN	4.23	30.38	10.08	1391	422	4.54	0.55	1.07	7.33	21.86
T-764 DN	3.82	30.30	9.22	1096	330	4.28	0.54	1.07	7.72	21.95
T-790 DN	4.99	30.46	10.67	1613	493	4.63	0.54	1.09	7.89	20.89
Stv 474	4.93	43.14	9.68	2343	1009	5.06	0.55	1.12	7.67	19.02
Sg 747	5.30	42.69	9.51	1959	836	4.98	0.56	1.14	8.56	17.74
Dpl 50	5.19	37.81	9.80	2232	844	4.93	0.55	1.14	8.63	18.41
LSD 0.05	**0.20**	**0.67**	**0.34**	**246**	**83**	**0.18**	**0.01**	**0.02**	**0.46**	**0.70**

SUMMARY

The primitive accessions in the U.S. Cotton Collection are a valuable source of genes for diversity and crop improvement. Converting their flowering habit to day-neutrality will facilitate their utilization. Twenty-one day-neutral germplasm lines have been developed and evaluated, and they are now available for use in cotton improvement programs.

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