

BREEDING CULTIVARS AND GERMPLASM WITH ENHANCED YIELD AND QUALITY, 2011

Edward L. Lubbers and Peng W. Chee
Dept. of Crop & Soil Sciences, University of Georgia, Tifton, GA

Introduction

The classical breeding component of the University of Georgia cotton improvement program works to develop germplasm with traits that can be used to meet the requirements of both producers and consumers. Higher and more stable yields combined with the fiber properties requested by the yarn and textile manufacturers are the goals for profitable production and processing to support the Georgia Cotton Industry. The objective of this report is to update progress made toward meeting these goals during the 2011 production season.

Materials and Methods

Our crosses mate elite University of Georgia breeding lines with promising germplasm and non-transgenic commercial cultivars to produce 10 sets of 5 half-sib families. These F_2 -bulk populations from crosses made in the previous year and advanced at the counter-seasonal nursery in Tecoman, MX are evaluated for lint yield in 2-replicate, randomized complete block designs, with each set of half-sib F_2 families, the GA breeding line parent, and the check cultivar, GA 230, constituting a test. Of the F_2 -bulk populations evaluated, the highest yielding populations are advanced in to F_3 for single plant selection. The first level of selection of the F_3 plants are decided by visual determination with more individuals selected from the best populations, fewer individuals from the better populations, and perhaps none from the poorer populations. If a segregation of a desirable and non-desirable class is evident in the poorer populations, individual desirable plants are selected from each of these populations. Of the approximately 1,000 selected F_3 plants, the plants with lint fractions less than 39% are discarded and then further selected on the basis of HVI fiber properties. One thousand two hundred ninety-five plants were selected from the field in 2011. The plants have yet to be selected based on lint % and fiber quality. Six hundred eighty selections were advanced to F_4 progeny rows in Plains, GA, in 2011 (fields 29/30) for evaluation in an un-replicated grid design, with the middle row of each 9 row set of the trial assigned to the University of Georgia cultivar GA 230. The F_4 test is machine harvested and the seed-cotton yield of each F_4 progeny row is compared with the seed-cotton yield of the nearest row of GA 230 which is, in turn, modified depending on the distribution of the yield values across the test field. Further selections of the F_4 are based essentially on the fiber quality measures of length, strength, and fineness and on lint percentage to promote for testing in the F_5 preliminary yield trials (PTs). Separate, late-planted seed increase plots that are grown in isolation near Tifton, GA allow additional visual selection and hand harvest of seed-cotton to maintain genetic purity of the F_4 , F_5 , F_6 , and elite generation experimental lines. Additional increases are planted at the

University of Arizona's Maricopa Agriculture Center in Maricopa, AZ to provide excellent quality seed for the field tests in the subsequent years. The seven 2011 PTs were conducted at the William Gibbs Research Farm, UGA – Tifton Campus, Tifton, GA in fields 04210, 04211, 04212, and 04213. Each PT had 18 F₅ breeding lines and 2 commercial conventional checks (GA 230 and Deltapine DP 493) in a three replicate, randomized complete block designs for a total of 126 experimental entries. The F₆ Advanced Trials (ATs) were conducted at the University of Georgia – Tifton campus, Tifton, GA (AT1 at the William Gibbs Research Farm, fields 04243 and 04244) and Southwest Georgia Research and Education Center, Plains, GA (AT 1 in fields 27/28). The AT1 consisted of 28 experimental entries with three checks (GA 230, GA 2004303, GA 2004143, and Monsanto DP 493) that were planted in a three replicate, randomized complete block design. Prior to machine harvest of all trials except the F₂ and F₄ generations, 25 unweathered, open bolls from the middle of the fruiting zone were harvested from each plot, and subsequently ginned on a 10-saw laboratory model gin to determine lint percentage. Fiber samples of the PTs and ATs were submitted to Cotton Incorporated in Cary, NC for HVI fiber analysis. The elite (material > F₇) germplasm lines with high potential were tested in the 2011 Georgia Official Strains Trial (OST) and Official Variety Trials (OVTs) (Day and Thompson, 2012).

Results and Discussion

Six of our lines (GA 230, GA 2007095, and GA 2008083 with the later maturing varieties and GA 2004143, GA 2006106, and GA 2008057 with the earlier maturing varieties) were tested in the 2011 GA OVTs (Day and Thompson, 2012). The following is a general synopsis of these lines with further details found in the Georgia 2011 Peanut, Cotton, and Tobacco Performance Tests (Day et al., 2012). All of our lines were affected to some degree with emergence issues that came from undetermined causes. Furthermore, the growing season was different from the last 2 years in that a late crop was not favored by the environment.

In the irrigated Earlier Maturity Trial, GA 2004143 was ranked 17th over all of the locations for lint yield out of 31 entries with an excellent fiber quality package. It was the most uniform and 2nd best length and strength; subjectively #1 overall as a complete fiber package. It yielded better in Midville (8th) and Tifton (7th) than it did in Bainbridge (16th) and Plains (24th). It did not yield relatively as well in the dryland trial with a small drop, ranking 20th overall (16th to 21st), but it maintained an overall very good ranking in fiber quality. In lint yield in 2010 and 2011, both the irrigated and dryland yields of GA 2006106 compared poorly to the best yielding variety and it will not be retested even though its fiber quality is very good. GA 2008057 also compared poorly to the best yielding variety this year, but since its fiber quality package was excellent and the field population density was suspect, it will be tested again. Another point of interest, all the conventional cotton cultivars ranked toward the bottom of the test; it could be that this is a proper comparison of the genetics unconfounded by transgenes or it could be that the Bt cultivars are showing their inherent strength.

In the Later Maturity Trial, the three GA entries (GA 230, GA 2007095, and GA 2008083) ranked in the bottom third of the trial. All persist in showing solid fiber packages in the irrigated trial while there was some separation in the dryland trial. GA 230 continues to show excellent length under all conditions with very good uniformity, strength, and micronaire. GA 2007095 also had solid fiber quality across the board, but GA 2008083 did not fare as well under dryland conditions in length and uniformity.

Five lines were promoted last year to the 2011 Georgia OSTs from the 2010 ATs: GA 2009037, GA 2009100, GA 2009147, GA 2009148, and GA 2009180 with a sixth retested line GA 2008016 (Day et al., 2012). We had some emergence issues here in this irrigated trial as we did in the OVTs. The entire group had solid to excellent fiber packages, as good as or better than the competition. GA 2009100 was the best yielder of our material; ranked 7th across the three locations (Midville, Plains, and Tifton). Some of these may be retested in 2012 given their excellence in length or strength. They would have good possibilities to be released as germplasm.

The 2011 AT1 trial had the most severe emergence issues of all our field experiments. AT1 in Tifton gave us unreliable data and will be replanted in 2012. The AT1 in Plains did not have as much emergence difficulty as we had in Tifton. Using lint yield and fiber quality measures, only one line GA 2010098 was promoted to the 2012 GA OSTs (Table 1). One line GA 2010064 had excellent fiber length, uniformity, strength, and micronaire, but low lint %; it will be used as parental material and also reviewed for possible germplasm release after further study (Table 1).

From the 2011 PTs (Tables 2, 3, 4, and 5), twenty-six lines were selected for testing in the 2012 ATs based primarily on lint yield and fiber qualities as compared to checks. Higher lint % and uniformity index as well as of course increased lint yield are the primary components of the selection within these populations looking to develop a cultivar better than our GA 230.

Based on lint yield comparisons, one hundred forty-seven F₄ progenies were selected for placement in the 2012 PTs with further selections to be made utilizing fiber quality measures. One thousand two hundred ninety-five single plants were selected in the F₃ populations to be placed in the F₄ plant-to-row yield test, again, with further selections based on fiber quality.

Fifty F₁ crosses, 43 were made in the summer of 2011 and 7 from previous crosses that we wanted to revisit, were sent to the USDA-ARS Cotton Winter Nursery in Tecoman, Mexico for selfing to the F₂ generation. These will be placed in replicated 2012 F₂ yield tests to determine the suitability of the germplasm populations to be further tested. The 2011 F₂ yield test will be redone because it was mowed down inadvertently.

Acknowledgments

The authors thank the Georgia Commodity Commission for Cotton for funding this research (Project Number 00-860GA CY 2003), Cotton Incorporated for providing HVI fiber analysis and seed production in Arizona under Core Funded Project 03-404, Don Day, Larry Thompson, and staff for conducting the University of Georgia Official Variety Trials, Stan Jones and Ronnie Pines at Southwest Georgia Branch Experiment Station, Plains, GA, and Gordon Sephus Willis at the William Gibbs Research Farm, Tifton, GA for providing technical support in the conduct of trials at their respective locations.

References

Day, J.L. and L. Thompson. 2012. 2011 cotton variety trials. p. xxx-xxx. *In* Guy Collins et al. (ed.) 2011 Georgia Cotton and Extension Reports. UGA/CPES Research – Extension Publication No. x, The University of Georgia.

Thompson, Larry G. 2012. Cotton. p. 15-44. *In* J. LaDon Day, et al. (eds.) Georgia: 2010 peanut, cotton, and tobacco performance tests. Ann. Pub. 104-2, The Georgia Agricultural Experiment Station/College of Agriculture and Environmental Sciences, The University of Georgia.

Table 1. Results of 2011 Advanced (F₆) Trial 1 from Plains.

ENTRY	Lint Yield, lbs./acre	Lint %	UHM in.	UI %	mic	Str g/tex
DP 493	1,749	39.88	1.14	83.50	5.34	30.45
GA 2010098	1,697	36.38	1.21	84.60	5.02	32.70
GA 2010085	1,594	42.83	1.21	84.10	5.13	30.85
GA 2010106	1,560	40.28	1.21	83.70	5.10	31.60
GA 2010002	1,547	39.01	1.23	85.00	4.67	32.50
GA 2010102	1,536	37.28	1.22	85.10	5.07	34.15
GA 2004303	1,534	39.75	1.18	83.10	5.03	32.40
GA 2010024	1,499	40.14	1.21	85.60	4.88	32.75
GA 2010070	1,496	42.93	1.17	82.90	4.80	31.30
GA 2010064	1,465	36.55	1.31	87.10	4.27	34.50
GA 230	1,463	38.39	1.28	86.40	4.91	32.00
GA 2010032	1,454	39.65	1.25	84.15	4.64	30.40
GA 2010019	1,443	37.96	1.26	84.85	4.54	32.90
GA 2010038	1,421	41.32	1.22	85.30	4.51	32.85
GA 2010079	1,395	36.88	1.21	84.10	5.08	32.05
GA 2010050	1,368	37.26	1.17	83.55	5.11	31.75
GA 2010052	1,355	37.88	1.17	83.90	4.96	32.00
GA 2010015	1,346	38.17	1.25	84.45	4.46	32.25
GA 2010016	1,304	34.84	1.24	84.40	4.28	32.80
GA 2010069	1,293	38.40	1.22	85.25	4.82	33.30
GA 2010063	1,292	37.89	1.22	86.00	4.60	33.05
GA 2010047	1,292	37.73	1.17	85.35	5.08	32.40
GA 2010068	1,271	39.08	1.26	85.00	4.45	34.80
GA 2010074	1,266	40.66	1.20	84.60	5.26	32.25
GA 2010067	1,246	35.84	1.25	85.15	4.78	32.50
GA 2004143	1,198	42.02	1.20	83.30	5.15	33.45
GA 2010058	1,187	37.99	1.23	84.45	4.37	31.85
GA 2010076	1,140	34.63	1.26	83.40	4.74	35.15
GA 2010049	1,118	38.02	1.24	84.90	5.14	35.05
GA 2010021	1,075	34.77	1.26	84.45	4.32	31.75
GA 2010030	1,061	35.33	1.24	85.05	4.52	31.85
GA 2010086	854	38.36	1.21	84.95	5.02	33.05
LSD_{0.10}	236	1.30	0.04	0.97	0.35	ns

The bold type indicates the lint yields that are not significantly different from the top performer.

'ns' signifies no significant differences within the list.

Exception: acceptable micronaire (mic) is a range; so the significant differences above 5.0 that are considered unacceptable are highlighted (i.e. > 5.35 is significant).

DP 493, GA 230, and GA 2004303 are check varieties for comparison purposes.

Table 2. Results of 2011 Preliminary (F₅) Trials 1 and 2.

2011 PT1							2011 PT2						
ENTRY	Lint Yield	Lint %	UHM in.	UI %	Str g/tex	mic	ENTRY	Lint Yield	Lint %	UHM in.	UI %	Str g/tex	mic
GA 2011002	1391	41.80	1.15	84.05	32.70	4.96	GA 2011019	1521	45.01	1.07	81.85	29.25	4.46
GA 2011005	1389	43.54	1.14	83.60	29.60	4.54	GA 2011030	1467	42.01	1.17	84.25	29.45	4.47
GA 2011015	1365	44.24	1.13	82.60	30.15	4.71	GA 230	1435	40.94	1.23	83.80	32.15	4.44
GA 2011004	1321	42.96	1.18	83.35	31.85	4.77	GA 2011032	1407	43.84	1.13	82.45	27.75	4.35
GA 2011013	1309	44.08	1.11	83.30	28.95	4.88	GA 2011020	1377	45.39	1.10	82.40	30.45	4.77
GA 2011010	1308	47.76	1.10	84.20	29.35	4.78	GA 2011023	1364	43.32	1.16	82.85	27.55	4.68
GA 2011014	1290	44.32	1.10	83.25	30.20	4.95	GA 2011021	1348	43.10	1.11	83.75	29.25	4.77
GA 2011008	1259	45.77	1.14	83.35	29.00	5.12	GA 2011017	1329	43.44	1.08	82.10	28.15	4.83
GA 2011011	1239	45.90	1.09	83.65	30.55	4.98	GA 2011022	1318	42.55	1.17	84.00	30.20	4.66
GA 2011009	1238	43.61	1.12	81.90	30.00	4.63	GA 2011024	1308	42.10	1.13	82.55	28.85	4.57
GA 2011007	1221	45.81	1.08	82.20	28.85	4.99	GA 2011034	1293	42.70	1.16	82.35	28.30	4.85
DP 493	1195	42.97	1.09	82.25	29.50	4.96	GA 2011018	1232	44.06	1.13	83.25	29.40	4.62
GA 2011006	1184	44.53	1.15	83.20	31.15	4.80	GA 2011026	1220	43.26	1.11	81.30	27.30	4.92
GA 2011012	1145	43.16	1.12	83.00	31.05	4.62	GA 2011028	1217	42.97	1.13	82.70	27.95	4.60
GA 2011003	1049	43.83	1.14	82.75	31.00	4.92	GA 2011031	1213	44.20	1.13	81.75	28.20	4.62
GA 2011001	1004	46.12	1.11	81.85	29.65	4.54	GA 2011033	1184	41.40	1.12	82.60	28.60	4.75
GA 2011016	890	44.42	1.16	84.50	30.00	4.82	DP 493	1169	43.33	1.08	81.75	28.45	4.91
GA 230	882	40.46	1.19	82.10	31.50	4.38	GA 2011029	n/a	41.63	1.14	82.40	29.60	4.79
LSD_{0.10}	248	1.63	0.03	ns	1.26	0.15	LSD_{0.10}	ns	1.07	0.03	1.05	1.04	0.12

The bold type indicates the lint yields that are not significantly different from the top.

'ns' signifies no significant differences from top to bottom of the list.

mic in bold type indicates values outside of the acceptable range.

GA 230 and DP 493 are check varieties for comparison purposes.

Table 3. Results of 2011 Preliminary (F₅) Trials 3 and 4.

2011 PT3							2011 PT4						
ENTRY	Lint Yield	Lint %	UHM in.	UI %	Str g/tex	mic	ENTRY	Lint Yield	Lint %	UHM in.	UI %	Str g/tex	mic
GA 2011038	1556	41.70	1.16	84.05	27.95	4.45	GA 2011082	1683	44.03	1.13	80.95	27.25	4.52
GA 2011042	1465	43.91	1.15	83.15	29.80	4.25	GA 2011090	1587	39.03	1.12	83.30	29.55	4.83
GA 2011044	1447	42.73	1.10	84.45	29.55	5.35	GA 2011093	1577	43.44	1.14	84.65	31.15	4.77
GA 2011036	1423	41.41	1.18	82.60	28.80	4.53	GA 2011057	1499	43.68	1.13	83.55	30.05	4.79
GA 2011040	1411	41.94	1.15	83.75	28.40	4.29	GA 2011061	1469	43.72	1.12	83.70	31.65	5.01
GA 2011039	1399	42.15	1.16	84.05	29.15	4.37	GA 2011089	1455	43.05	1.13	83.60	29.80	5.02
GA 2011035	1388	43.15	1.14	82.95	27.95	4.52	DP 493	1428	41.83	1.08	82.55	30.80	4.83
DP 493	1372	42.67	1.09	82.25	30.00	4.89	GA 2011078	1398	42.58	1.16	81.90	28.55	4.80
GA 2011051	1363	38.87	1.13	83.25	29.80	4.70	GA 2011088	1386	40.13	1.16	83.80	31.95	4.91
GA 2011053	1341	44.96	1.13	83.20	30.00	4.58	GA 2011056	1386	41.60	1.12	83.25	30.55	4.39
GA 2011041	1333	41.05	1.15	83.40	30.10	4.60	GA 2011085	1350	40.40	1.17	82.00	29.80	4.39
GA 2011043	1263	44.20	1.12	84.10	29.90	4.35	GA 2011068	1041	39.93	1.11	83.65	29.65	4.51
GA 2011037	1149	40.82	1.11	83.50	27.90	4.33	GA 230	983	38.73	1.22	83.55	32.00	4.46
GA 2011055	1148	42.40	1.14	85.05	34.15	4.36	GA 2011060	810	47.16	1.07	83.25	28.45	5.13
GA 2011054	1118	43.29	1.10	83.75	29.30	4.93	GA 2011087	757	36.71	1.14	84.10	32.80	4.73
GA 2011048	1031	39.69	1.09	84.42	31.06	4.79	GA 2011065	n/a	n/a	n/a	n/a	n/a	n/a
GA 2011050	987	38.69	1.14	83.85	30.75	4.30	GA 2011069	n/a	43.35	1.14	83.75	31.15	4.51
GA 230	n/a	39.71	1.21	84.30	29.65	4.19	GA 2011083	n/a	43.99	1.14	83.25	29.15	4.92
LSD_{0.10}	185	1.55	0.04	ns	2.13	0.28	LSD_{0.10}	239	1.35	0.03	1.16	1.38	0.22

The bold type indicates the lint yields that are not significantly different from the top.

'ns' signifies no significant differences from top to bottom of the list.

mic in bold type indicates values outside of the acceptable range.

GA 230 and DP 493 are check varieties for comparison purposes.

Table 4. Results of 2011 Preliminary (F₅) Trials 5 and 6.

2011 PT5							2011 PT6						
ENTRY	Lint Yield	Lint %	UHM in.	UI %	Str g/tex	mic	ENTRY	Lint Yield	Lint %	UHM in.	UI %	Str g/tex	mic
GA 2011095	1652	42.97	1.12	82.40	27.40	4.75	GA 2011151	1825	45.31	1.11	84.05	30.75	5.37
GA 2011124	1638	43.82	1.12	83.30	30.20	5.05	GA 2011157	1784	42.96	1.11	83.10	30.05	5.29
GA 2011108	1500	37.79	1.16	82.45	29.40	4.51	GA 2011156	1696	44.20	1.15	84.15	31.50	4.76
GA 2011127	1411	43.55	1.07	82.05	28.05	5.24	DP 493	1674	42.32	1.13	83.15	30.30	5.11
GA 2011096	1346	39.81	1.11	82.95	29.95	5.01	GA 2011136	1630	43.41	1.10	82.10	28.60	4.70
GA 2011121	1339	42.79	1.19	82.55	32.40	4.48	GA 2011144	1630	43.37	1.10	82.90	29.05	5.16
DP 493	1321	42.13	1.09	82.15	29.85	5.03	GA 2011158	1563	42.77	1.14	83.95	29.95	4.82
GA 2011113	1316	43.28	1.14	82.60	29.60	4.89	GA 2011131	1525	43.95	1.14	83.65	30.80	5.28
GA 2011106	1310	39.74	1.12	82.05	27.90	4.74	GA 2011146	1475	42.54	1.12	84.35	28.95	5.34
GA 2011119	1261	42.07	1.12	82.85	28.70	4.81	GA 2011140	1471	43.18	1.08	82.50	30.40	5.43
GA 2011103	1213	42.46	1.11	83.25	29.50	4.82	GA 2011154	1460	43.13	1.14	84.10	30.10	5.36
GA 2011125	1205	42.20	1.19	82.70	31.80	4.75	GA 2011134	1325	43.55	1.13	82.85	29.20	5.01
GA 2011118	1143	41.47	1.11	83.35	32.10	5.09	GA 2011155	1271	43.65	1.12	82.85	28.15	5.18
GA 2011114	1114	41.96	1.12	83.05	32.05	4.78	GA 2011149	1261	43.82	1.11	82.70	29.70	5.00
GA 2011117	1053	40.91	1.15	83.95	32.05	5.01	GA 2011141	1242	42.44	1.12	83.80	29.70	5.23
GA 230	883	38.65	1.20	83.20	31.35	4.62	GA 2011133	1237	43.53	1.08	82.15	29.00	5.54
GA 2011126	830	43.19	1.10	82.30	30.45	5.18	GA 230	1226	39.81	1.23	84.35	31.90	4.18
GA 2011097	n/a	39.11	1.13	82.70	29.90	5.25	GA 2011159	1185	44.30	1.12	83.25	29.85	5.05
LSD_{0.10}	241	1.60	0.04	ns	1.42	0.22	LSD_{0.10}	208	1.42	0.02	0.77	1.33	0.22

The bold type indicates the lint yields that are not significantly different from the top.

'ns' signifies no significant differences from top to bottom of the list.

mic in bold type indicates values outside of the acceptable range.

GA 230 and DP 493 are check varieties for comparison purposes.

Table 5 Results of 2011 Preliminary (F₅) Trial 7.

2011 PT7						
ENTRY	Lint Yield	Lint %	UHM in.	UI %	Str g/tex	mic
GA 2011167	1686	41.21	1.11	84.24	30.77	4.93
GA 2011164	1651	43.57	1.10	82.60	29.85	4.83
GA 2011182	1626	39.80	1.11	81.95	29.95	5.30
GA 2011161	1620	42.56	1.10	82.55	29.35	4.85
GA 2011174	1490	40.17	1.12	83.35	31.75	5.00
GA 2011181	1460	41.45	1.12	83.20	31.80	4.77
GA 2011191	1447	42.86	1.12	82.65	29.75	4.95
GA 2011179	1438	40.80	1.09	81.35	29.90	5.17
GA 2011163	1438	42.60	1.12	83.25	29.85	4.93
GA 2011177	1433	39.68	1.12	83.20	30.90	5.08
GA 2011165	1410	42.22	1.08	81.85	31.15	5.01
GA 2011180	1353	42.32	1.11	81.70	28.90	4.80
DP 493	1258	42.84	1.05	81.40	29.15	5.19
GA 2004303	1256	42.75	1.11	81.70	30.05	5.03
GA 2011178	1249	37.98	1.13	81.25	32.00	5.10
GA 230	1066	37.49	1.22	83.70	32.40	4.41
GA 2011186	312	36.31	1.11	82.16	32.73	4.76
GA 2011169	n/a	43.59	1.09	82.14	29.17	5.30
LSD_{0.10}	259	1.27	0.03	1.11	1.54	0.23

The bold type indicates the lint yields that are not significantly different from the top. 'ns' signifies no significant differences from top to bottom of the list. mic in bold type indicates values outside of the acceptable range. GA 230, GA 2004303, and DP 493 are check varieties for comparison purposes.