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BREEDING AND GENETICS

Quantifying Genotypic and Environmental Contributions to Yield and Fiber Quality in Georgia: Data from Seven Commercial Cultivars and 33 Yield Environments

John L Snider*, Guy D. Collins, Jared Whitaker, and Jerry W. Davis

ABSTRACT

Although genotypic and environmental contributions to yield and fiber quality have been studied extensively in cotton for decades, the near-constant release of commercially available genotypes necessitates re-evaluation for specific cotton production regions. Consequently, lint yield, lint percent, fiber length, fiber strength, fiber micronaire, and uniformity index were evaluated for seven commercially available cotton cultivars across 33 yield environments in on-farm trials throughout Georgia. The following were quantified: the percentage of variability in each response variable accounted for by genotype and environment, trait stability for each cultivar across all yield environments, and genotypic and environmental correlations between all parameters of interest. Environment was the dominant factor governing lint yield (96.1% environment, 1.2% genotype), fiber length (80.6% environment, 5.1% genotype), strength (47% environment, 27.7% genotype), micronaire (63.8% environment, 9.9% genotype), and uniformity (69.8% environment, 6.5% genotype). In contrast, lint percentage was impacted more by genotype (51.5%) than by environment (38.8%). 'PHY 565 WRF' was identified as the most stable cultivar across all yield environments for all agronomic and fiber quality traits examined. Environmental correlations showed that fiber length, strength, and uniformity were all positively correlated with yield. These findings suggest that any improvements in the yield environment brought about through improved production practices or favorable environmental conditions will be conducive to improving fiber quality in cotton.

J.L. Snider* and G.D. Collins, Dept. Crop and Soil Science, Univ. Georgia, Tifton, GA 31794; J. Whitaker, Dept. Crop and Soil Science, Univ. Georgia, Statesboro, GA 30460; and J.W. Davis, Experimental Statistics Unit, Univ. Georgia, Griffin, GA 30223
*Corresponding author: jlsnider@uga.edu

Production of all agronomic crops is governed by three primary factors: genotype, environment, and cultural practices. However, these factors should not be considered separately because genotype determines the yield potential of a given species or cultivar, whereas the environment encountered or the cultural practices employed during crop development will govern the extent to which genotypic potential is realized. The same can be said of fiber quality, which is important to both the producer and the fiber processor, where the ideal cotton crop for producers and processors alike would be high in quantity and quality (Bradow and Davidonis, 2000).

Quantifying the contributions of genotype and environment to agronomic and fiber quality parameters can aid in cultivar selection for a given yield environment. Consequently, numerous authors have reported the percentage of variability in yield and fiber quality data that could be explained by genotype and environment (Meredith et al., 2012). Lint yield is largely governed by environment, accounting for 76 to 94% of total yield variability in a number of multi-year, multi-environment, variety trials. Environment also accounts for the majority of variability in fiber micronaire (49-82%). Lint percentage, fiber length, and fiber strength have shown variable results, where the majority of data variability for each of these response variables has been explained by genotype in some instances and environment in others (Meredith et al., 2012).

Extreme year-to-year variability in yield increases the risk associated with cotton production (Gingle et al., 2006). The production environment can be influenced through changes in cultural practices (e.g., tillage, fertilization, irrigation) and factors beyond the grower's control (e.g., sunlight, temperature, rainfall). For instance, the yields of crops with reproductive structures of agronomic importance, including cotton yields, are exceptionally sensitive to abiotic stress conditions during the growing season (Boyer, 1982; Loka et al., 2011; Oosterhuis and Snider, 2011; Snider and Oosterhuis, 2011). This sensitivity to abiotic stress explains, in part, the large environmental control over yield and some fiber-quality parameters reported previously by a number of authors (reviewed in Meredith et al., 2012). Cultivars that exhibit greater phenotypic plasticity in response to environmental and cultural changes will likely exhibit greater yield stability (Gingle et al., 2006), thereby reducing grower risk. Therefore, yield stability across a wide range of environmental conditions is nearly as important as the genetic potential for yield (Bowman, 2000). Similarly, the stability of fiber-quality traits to a range of production environments will be an important characteristic of any commercial variety due to increased demand for high-quality cotton (Meredith, 2005; Wang, 2011).

Although the topic of genotypic and environmental contributions to yield and fiber quality in cotton has been studied extensively by a number of authors for decades (Blanche et al., 2006; Bradow and Davidonis, 2000; Campbell and Jones, 2005; Campbell et al., 2011, 2012; Meredith and Bridge, 1984; Meredith et al., 2012), the near-constant release of new cultivars for commercial use necessitates re-evaluation of the genotypic and environmental contributions to yield and fiber quality for commercially available cultivars in different regions of the U.S. For Georgia cotton production, *Gossypium hirsutum* L. cv. DP 555 BR, was grown from 2003 to 2010 and accounted for as much as 85% of the total cotton acreage in the state (Schafer and Johnson, 2009). This cultivar was popular among cotton producers because it was capable of producing suitable yields under a wide range of environmental conditions (Schafer and Johnson, 2009). With the removal of DP 555 BR from commercial production, there has been renewed interest in identifying commercially available cotton cultivars that produce suitable lint yields and fiber quality in a wide range of Georgia production systems. Consequently, a number of cotton cultivars have been evaluated for lint yield and fiber-quality parameters in large-scale, on-farm trials throughout Georgia. The resulting data set encompasses seven common cotton cultivars, 33 yield environments (year-location combinations), and 23 counties, thereby offering an opportunity to evaluate genotypic and environmental contributions to yield and fiber-quality parameters in cotton.

The objectives of the current study were 1) to quantify the effect of genotype and environment on yield and fiber-quality parameters, 2) to estimate the percentage of variability in lint yield and fiber quality explained by genotype and environment, 3) to characterize the genotype x environment interaction for yield and fiber quality, and 4) to quantify genotypic and environmental correlations between lint yield and fiber-quality parameters for a range of cotton cultivars grown in diverse yield environments throughout Georgia.

MATERIALS AND METHODS

Description of Field Trials. To evaluate genotypic and environmental contributions to agronomic and fiber-quality parameters in cotton, data were obtained from field variety trials conducted from 2010 to 2011 throughout the state of Georgia. The resultant data set was obtained from trials conducted in 23 counties and provided 33 location-year combinations. Seven cotton cultivars were common to the 2010 and 2011 on-farm trials and are as follows: 'DP 1048 B2RF', 'DP 1050 B2RF', 'FM 1740 B2RF', 'PHY 375 WRF', 'PHY 565 WRF', 'ST 4288 B2F', 'ST 5458 B2RF'. Because the cotton crop integrates its total environment (i.e., biotic, abiotic, and management factors) into a yield response, each location-year combination is hereafter referred to as a yield-environment. Each yield-environment was ranked from 1 to 33, where 1 was the highest yielding environment and 33 the lowest yielding environment.

At each on-farm trial, seven cultivars were arranged in a randomized, complete block design with three replicate plots per trial. Plot widths ranged from four to six rows wide, depending upon the capacity of the picker utilized by each producer, with a 0.91-m inter-row spacing. Plot lengths ranged from a minimum of 152 m to a maximum of 914 m. At every location, the cotton crop was managed according to the typical production practices of each producer with regard to insect and weed control, plant growth regulator application, fertilizer application, seeding rate, planting date, and irrigation.

At crop maturity for each location, commercially available spindle pickers were utilized to harvest each plot, and seed cotton weights for each plot were determined by a boll buggy equipped with a load cell scale system in the field. Additionally, a 9.1-kg sample of one replicate plot was transported to the University of Georgia Micro Gin in Tifton, GA to obtain a lint percentage for each genotype x location and calculate a lint yield for each plot harvested. After ginning, a 0.45-kg fiber sample was sent to the USDA Classing Office in Macon, GA for HVI measurement of fiber length, strength, micronaire, and uniformity index. Because one replicate plot was utilized for fiber-quality determination, each parameter evaluated was represented by one value for each cultivar x yield-environment (This included lint yield, lint percentage, and fiber quality parameters.). Consequently, the 33 yield-environments provided replicates for evaluating cultivar effects.

Statistical Analysis. To determine genotypic differences in agronomic and fiber-quality parameters (lint yield, lint percentage, fiber length, fiber strength, micronaire, uniformity) average values for each yield-environment were determined for each cultivar and data were pooled from all yield-environments (n=33 per cultivar). To determine environmental differences in agronomic and fiber-quality parameters, average values for each cultivar were determined and data were pooled across all cultivars (n=7) in a given yield-environment prior to statistical analysis. Subsequently, the effect of genotype and environment on agronomic and fiber-quality parameters was evaluated separately using one-way analysis of variance and conventional LSD *post hoc* analysis.

The relative contributions of genotype and environment to each parameter of interest were quantified using a combined analysis of variance. For the genotype and environment main effects, the sum of squares due to each main effect was expressed as a percentage of the total sum of squares. To evaluate genotype x environment interaction and trait stability across a wide range of environments for each cultivar, each trait of interest (e.g., lint yield, lint percentage, fiber length) was averaged for each cultivar at a given location-year. An environmental index was calculated by subtracting the grand mean for a given trait from the trial mean (the mean of all cultivars for a given year-location) (Eberhart and Russell, 1966). To assess trait stability, linear regression models were fit by regressing the response variables on-site effects for each cultivar, where the slope (b) of the line for a given cultivar represents the responsiveness of each cultivar to environment. For example, cultivars having the lowest slopes represent the most stable cultivars across a wide range of environments. Heterogeneity of slopes was determined by utilizing pair-wise F-tests to test for differences in slope estimates among cultivars. The aforementioned stability analysis was conducted using SAS version 9.3 (SAS Institute Inc., Cary, NC). To quantify genetic and environmental correlations between agronomic and fiber-quality traits, cultivar and yield-environment averages were determined for all parameters of interest, and the multivariate platform in JMP 9 (SAS Institute Inc., Cary, NC) was utilized to develop correlation coefficient matrices. JMP 9 was also used for all other statistical analyses except for the aforementioned trait stability analysis.

RESULTS AND DISCUSSION

When agronomic and fiber-quality data were averaged across 33 yield-environments for each cultivar, there was not a significant effect of cultivar on lint yield or fiber length (Table 1). In contrast, lint percentage, micronaire reading, fiber strength, and uniformity index were significantly affected by cultivar ($p<0.05$). For example, lint percent was highest for DP 1050 B2RF (40.3%) and DP 1048 B2RF (39.6%), where these two cultivars produced statistically higher lint percentage than the five remaining cultivars. ST 4288 B2F produced the lowest lint percent (35.1%), which was lower than the six remaining cultivars evaluated. The highest micronaire was observed for ST 5458 B2RF (4.86), which was not statistically different than ST 4288 B2F (4.72), and higher than the five other cultivars. Micronaire readings were lowest for PHY 375 WRF (4.42) and lower than two other cultivars (ST 5458 B2RF and ST 4288 B2F). Fiber strength was highest for PHY 565 WRF (325 kN m kg^{-1}) and higher than the remaining six cultivars, whereas fiber strength was lowest for PHY 375 WRF (294 kN m kg^{-1}). For PHY 375 WRF fiber strength was less than three other cultivars (ST 5458 B2RF, PHY 565 WRF, and FM 1740 B2RF). The highest mean uniformity index was observed for PHY 565 WRF (82.9%), which was higher than three other cultivars (ST 5458 B2RF, ST 4288 B2F, PHY 375 WRF). The lowest uniformity index was observed for ST 5458 B2RF (81.9%), which was less than three other cultivars (DP 1050 B2RF, DP 1048 B2RF, and PHY 565 WRF). Although lint yield was not significantly affected by cultivar, our data suggest that fiber micronaire, strength, and uniformity index, all important characteristics for fiber processors (Bradow and Davidonis, 2000) can be enhanced through proper cultivar selection. When averaged across yield-environments, micronaire was within the base range for upland cotton for all varieties evaluated; fiber strengths ranged from strong (PHY 375 WRF) to very strong (PHY 565 WRF); fiber length uniformity ranged from intermediate (ST 5458 B2RF) to high (PHY 565 WRF) (USDA Agricultural Marketing Service, 2001).

Table 1. The effect of cultivar on lint yield, lint percent, micronaire, fiber strength, and uniformity index. All values are means (n=33), and values not sharing a common letter within a column are significantly different (LSD; p<0.05).

Cultivar	Lint Yield (kg ha^{-1})	Lint Percent (%)	Micronaire Reading	Fiber Length (mm)	Fiber Strength (kN m kg^{-1})	Uniformity Index (%)
DP 1048	1082^{a}	39.6^{a}	4.55^{bc}	29.0^{a}	296^{d}	82.7^{ab}
DP 1050	1127^{a}	40.3^{a}	4.61^{bc}	29.0^{a}	295^{d}	82.7^{ab}
FM 1740	1045^{a}	38.0^{b}	4.56^{bc}	28.2^{a}	307^{bc}	82.2^{abc}
PHY 375	1032^{a}	38.0^{b}	4.42^{c}	28.4^{a}	294^{d}	82.1^{bc}
PHY 565	984^{a}	36.8^{c}	4.48^{c}	29.0^{a}	325^{a}	82.9^{a}
ST 4288	1022^{a}	35.1^{d}	4.72^{ab}	28.7^{a}	303^{cd}	82.1^{bc}
ST 5458	1083^{a}	37.3^{bc}	4.86^{a}	28.7^{a}	315^{b}	81.9^{c}

When agronomic and fiber-quality data were averaged across seven cultivars for each of 33 yield-environments (1 being the highest yielding environment and 33 being the lowest yielding environment), there was a significant effect of yield-environment on all parameters investigated (Table 2; p<0.05). For example, lint yields ranged from 1807 kg ha^{-1} for yield-environment 1 to 207 kg ha^{-1} in yield-environment 33. Lint percent ranged from 40.5% in yield-environment 33 to 34.3% in yield-environment 30; micronaire reading ranged from 3.69 in yield-environment 30 to 5.23 in yield-environment 8; fiber length ranged from 30.2 mm in yield-environment 2 to 26.4 mm in yield environment 33; mean fiber strength ranged from 324 kN m kg^{-1} in yield-environment 3 to 260 kN m kg^{-1} in yield-environment 31; uniformity index ranged from 83.9% in yield-environment 4 to 79% in yield-environment 31. Consequently, the genotypic and environmental contributions to agronomic and fiber-quality parameters in commercial cotton production systems in Georgia were evaluated using a robust data set, encompassing a wide range of yield-environments, large differences in lint percentages, micronaire values ranging from optimal (premium range) to high (penalty range), fiber strength ranging from average to very strong, and fiber uniformity ranging from low to high (Table 2) (USDA Agricultural Marketing Service, 2001).

Table 3 shows the percentage sums of squares accounted for by genotype and environment from the combined ANOVA of seven cultivars and 33 yield-environments. Lint yield is primarily explained by environment, where environment accounts for 96.1% of yield variability. These findings are similar to other authors (Campbell et al., 2011, 2012; Meredith et al., 2012) who reported a substantial environmental influence over lint yield in cotton (72-94% of yield variability explained by environment). These findings suggest that either changes in cultural practices or uncontrollable environmental factors (e.g., temperature, sunlight, precipitation) exert greater control over potential lint yield than cultivar selection. It is important to note, however, that the percentage contribution of the genotype x environment interaction was not quantified in the present study and has been shown to account for as much as 19% of total lint yield variability (Campbell et al., 2011). Environment was also the dominant factor governing fiber length (80.6% environment, 5.1% genotype), strength (47% environment, 27.7% genotype), micronaire (63.8% environment, 9.9% genotype), and uniformity (69.8% environment, 6.5% genotype). Although a general consensus exists that micronaire (Bradow and Davidonis, 2000; Campbell et al., 2012; Meredith et al., 2012) and uniformity index (Campbell and Jones, 2005; Campbell et al., 2012) are primarily influenced by environment, contrasting reports exist for fiber length and strength. For instance, some authors have reported that these traits are predominantly governed by genotype and other authors report that environment accounts for the majority of variability in fiber length and strength (reviewed in Meredith et al., 2012). It is possible that the narrow genetic base from which current commercial cotton cultivars are derived (Gingle et al., 2006; Van Esbroeck et al., 1998) contributes to the large dependence of yield and fiber-quality traits on environment. Consequently, changes in cultural and environmental factors (both are components of the yield-environment) could markedly influence yield and fiber quality in Georgia cotton production systems. In contrast, 51.5% of variability in lint percent was explained by genotype and 38.8% was explained by environment.

Table 2. The effect of yield environment (location-year) on lint yield, lint percent, micronaire, fiber strength, and uniformity index. All values are means (n=7), and values not sharing a common letter within a column are significantly different (LSD; $p<0.05$). Each yield environment is assigned a number, from 1 to 33, from the highest yields to the lowest yields.

Yield Environment	Lint Yield (kg ha^{-1})	Lint Percent (%)	Micronaire Reading	Fiber Length (mm)	Fiber Strength (kN m kg^{-1})	Uniformity Index (%)
1	1807^{a}	37.0^{fghi}	4.46^{jklmno}	29.7^{cde}	312^{abcdef}	82.8^{bcdefgh}
2	1788^{a}	38.0^{defgh}	4.20^{no}	30.2^{a}	312^{abcdef}	83.6^{ab}
3	1763^{ab}	38.1^{cdefg}	4.79^{defgh}	29.2^{efg}	324^{a}	82.9^{bcdefg}
4	1720^{abc}	37.9^{defgh}	4.51^{ghijklm}	30.0^{abcd}	317^{abc}	83.9^{a}
5	1676^{bcd}	38.8^{abcdefg}	4.47^{ijklmn}	29.2^{efg}	317^{abc}	82.8^{bcdefgh}
6	1599^{cde}	38.0^{cdefgh}	4.59^{fghijkl}	30.2^{ab}	320^{ab}	83.8^{a}
7	1632^{def}	37.3^{efghi}	4.63^{efghijk}	29.7^{bcde}	316^{abc}	83.8^{a}
8	1571^{efg}	40.1^{ab}	5.23^{a}	28.4^{jk}	296^{fghijkl}	82.4^{efghij}
9	1525^{fg}	37.8^{defgh}	4.73^{defghij}	29.5^{def}	313^{abcde}	83.6^{ab}
10	1520^{fg}	36.8^{ghi}	4.47^{ijklmn}	30.2^{abc}	324^{a}	83.4^{abc}
11	1519^{fg}	38.7^{abcdefg}	4.71^{defghij}	28.4^{ijk}	311^{abcdef}	82.0^{hijk}
12	1485^{g}	37.9^{defgh}	4.94^{abcd}	29.0^{fgh}	324^{a}	82.5^{defghij}
13	1363^{h}	38.6^{abcdefg}	5.10^{abc}	29.0^{fgh}	303^{cdefghijk}	82.7^{cdefghi}
14	1345^{h}	38.5^{abcdefg}	4.29^{mno}	29.7^{bcde}	309^{abcdefgh}	82.3^{fghij}
15	1336^{h}	37.8^{defgh}	4.83^{cdef}	28.2^{jkl}	309^{abcdefgh}	82.1^{hijk}
16	1286^{h}	38.8^{abcdef}	4.61^{efghijkl}	30.0^{abcd}	311^{abcdef}	83.1^{abcdef}
17	1269^{h}	38.2^{bcdefg}	4.81^{cdef}	28.4^{jk}	301^{cdefghijk}	82.4^{efghij}
18	1269^{h}	38.2^{bcdefg}	4.89^{cde}	29.2^{efgh}	304^{bcdefghij}	83.2^{abcde}
19	1073^{i}	40.0^{abc}	4.93^{bcd}	26.7^{op}	291^{ijkl}	81.0^{lm}
20	1066^{i}	39.6^{abcd}	4.59^{fghijkl}	29.0^{fghi}	315^{abc}	83.1^{abcdef}
21	1019^{ij}	38.5^{abcdefg}	4.76^{defghi}	28.7^{ghij}	297^{efghijkl}	82.2^{ghijk}
22	977^{ij}	38.6^{abcdefg}	4.67^{defghij}	28.7^{hij}	308^{abcdefghi}	82.8^{bcdefgh}
23	944^{j}	36.0^{hij}	4.50^{hijklm}	28.7^{ghij}	298^{defghijkl}	81.9^{ijk}
24	941^{j}	34.4^{j}	3.81^{p}	28.4^{ijk}	293^{hijkl}	81.7^{jkl}
25	814^{k}	38.4^{bcdefg}	5.21^{ab}	27.7^{lm}	310^{abcdefg}	82.7^{cdefghi}
26	813^{k}	36.8^{ghi}	4.71^{defghij}	29.0^{fgh}	315^{abcd}	82.9^{bcdefg}
27	763^{k}	36.9^{fghi}	4.33^{lmno}	27.9^{klm}	287^{kl}	79.8^{no}
28	753^{k}	39.0^{abcde}	4.86^{cdef}	27.4^{mn}	289^{jkl}	81.4^{kl}
29	749^{k}	37.2^{efghi}	4.17^{o}	27.9^{klm}	286^{kl}	82.0^{hijk}
30	520^{l}	34.3^{j}	3.69^{p}	27.2^{no}	283^{l}	80.5^{mn}
31	474^{l}	35.5^{ij}	4.19^{no}	26.7^{p}	260^{m}	79.0^{o}
32	362^{m}	36.9^{fghi}	4.34^{klmno}	29.5^{def}	318^{abc}	83.2^{abcd}
33	207^{n}	40.5^{a}	4.80^{defg}	26.4^{p}	294^{ghijkl}	80.9^{lm}

Table 3. Percentage sums of squares explained by environment and genotype for lint yield, lint percent, fiber length, fiber strength, micronaire, and uniformity. Sums of squares were calculated for each parameter by analysis of variance of seven commercial cotton cultivars from 33 yield-environments (location-year) from 2010 to 2011.

Source	Lint Yield	Lint Percent	Length	Strength	Micronaire	Uniformity
	---------- Percentage Sums of Squares ----------					
Environment	96.1	38.8	80.6	47.0	63.8	69.8
Genotype	1.2	51.5	5.1	27.7	9.9	6.5

Genotype x environment interaction was evaluated using a regression approach through which mean agronomic and fiber-quality parameters for each cultivar were regressed against an environmental index (the site mean minus the overall mean) (Fig. 1). For all parameters examined, genotype x environment interaction is evidenced by numerous crossing-over events, where a cultivar outranks other cultivars at low site indices but is then surpassed by those same cultivars at higher site indices (Fig. 1). Because the slope of each line presented in Fig. 1 represents trait stability to a range of environmental conditions, cultivars with the lowest slope are the least affected by environmental constraints. Table 4 provides the slopes for each cultivar and trait across 33 environmental indices, where the slope for all traits was significantly affected by cultivar. FM 1740 B2RF and ST 4288 B2F exhibited the greatest sensitivity to environment, as evidenced by having the largest slopes across all traits. PHY 565 WRF exhibited the greatest environmental stability because this cultivar produced the smallest slopes across all traits examined (Table 4). Cultivars that exhibit greater phenotypic plasticity in response to environmental and cultural changes will likely exhibit greater yield stability (Gingle et al., 2006), thereby reducing grower risk.

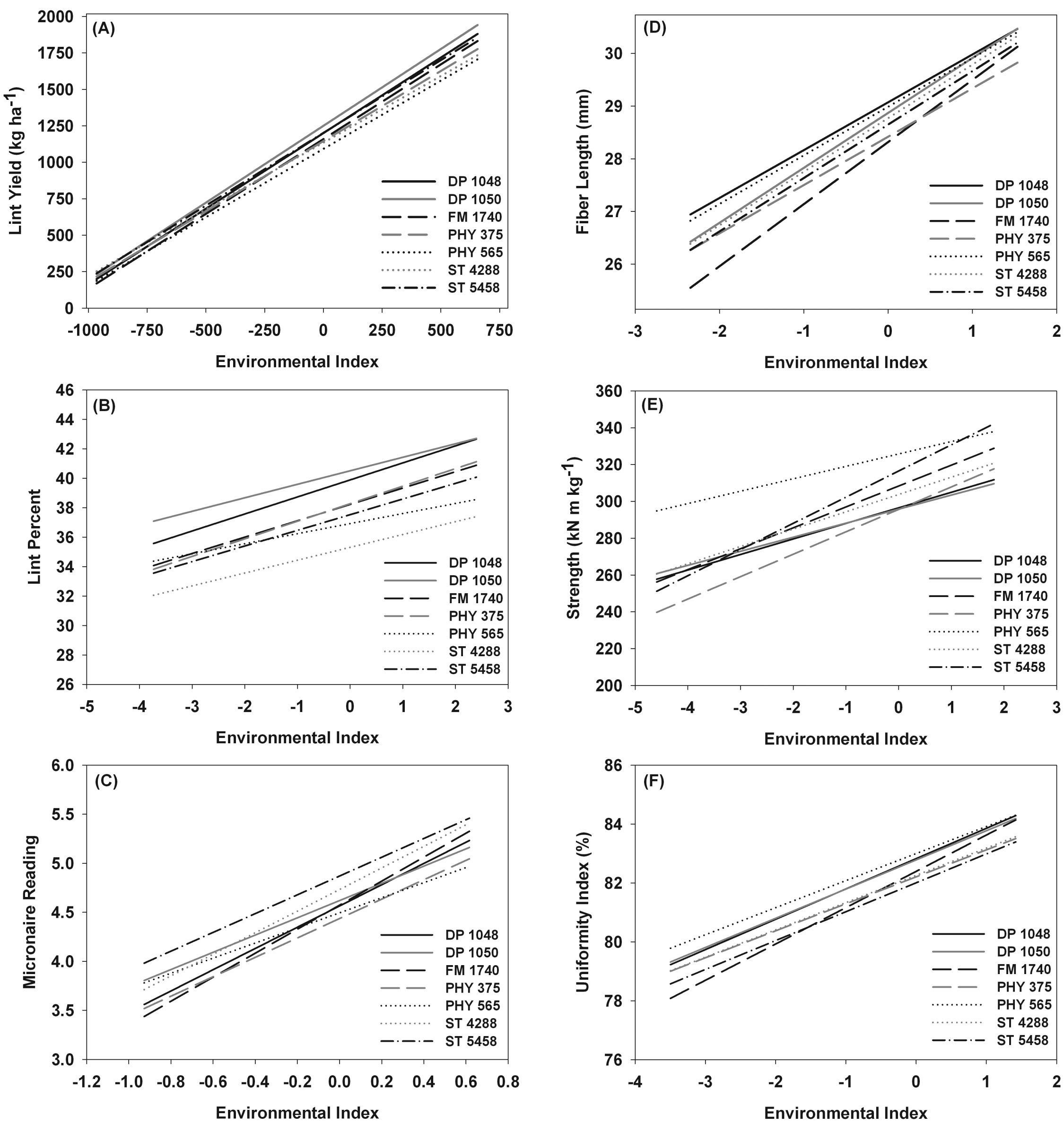

Figure 1. Linear regressions of seven commercial cotton cultivars on an environmental index calculated from the mean of all seven genotypes at each of 33 yield-environments minus the overall mean for lint yield (A), lint percent (B), fiber micronaire reading (C), fiber length (D), fiber strength (E), and uniformity index (F).

Table 4. Environmental stability of agronomic and fiber quality parameters for seven commercially available cotton cultivars. A given slope (b) represents the responsiveness of each parameter to environment, and slopes not sharing a common letter within a column are significantly different (*p*<0.05). The slope for each parameter and cultivar was determined from 33 yield-environments using linear regression analysis of each parameter against an environmental index (site mean minus the grand mean).

Cultivar	b					
	Lint Yield	Lint Percent	Micronaire Reading	Fiber Length	Fiber Strength	Uniformity Index
DP 1048	1.036^{ab}	1.157^{a}	1.083^{ab}	0.908^{b}	0.844^{c}	1.031^{ab}
DP 1050	1.053^{a}	0.917^{bcd}	0.878^{bc}	1.043^{ab}	0.763^{c}	0.992^{ab}
FM 1740	1.025^{ab}	1.112^{ab}	1.223^{a}	1.179^{a}	1.135^{ab}	1.234^{a}
PHY 375	0.962^{bcd}	1.193^{a}	0.989^{abc}	0.917^{b}	1.218^{ab}	0.917^{b}
PHY 565	0.937^{cd}	0.685^{d}	0.770^{c}	0.922^{b}	0.674^{c}	0.919^{b}
ST 4288	0.914^{d}	0.873^{cd}	1.100^{ab}	1.017^{ab}	0.941^{bc}	0.926^{b}
ST 5458	0.998^{abc}	1.063^{ab}	0.957^{abc}	1.014^{ab}	1.423^{a}	0.982^{ab}

Genotypic and Environmental Correlations. Genotypic correlations between agronomic and fiber-quality traits were not statistically significant (*p*<0.05). One noteworthy trend was that genotypes with higher lint percentage tended to also exhibit higher yields (r=0.751; *p*=0.052). A similar relationship between lint percentage and yield has been reported previously (Campbell et al., 2012). In contrast with genotypic correlations, environmental correlations revealed statistically significant (*p*<0.0001), positive relationships between lint yield and fiber length (r=0.712), strength (r=0.629), and uniformity (r=0.641) (Table 5). Environmental conditions conducive to high lint yields also improved the aforementioned aspects of fiber quality. Consequently, identifying the factors that can be influenced through crop management to bring about improved yields will also be beneficial in promoting fiber quality.

CONCLUSIONS

Although genotypic and environmental contributions to agronomic and fiber-quality parameters have been studied extensively in cotton for decades, the near constant release of commercially available genotypes necessitates a re-evaluation for specific cotton production regions. For Georgia, it is concluded that yield and fiber quality vary greatly throughout the state. Additionally, environment impacts yield and fiber qualities to a greater degree than does genotype. In contrast, lint percentage was impacted more by genotype than by environment. PHY 565 WRF was identified as the most stable cultivar across all yield-environments for all agronomic and fiber quality traits examined. Environmental correlations showed that fiber length, strength, and uniformity index were all positively correlated with yield. These findings suggest that any improvements in the yield-environment brought about as a result of improved production practices or favorable environmental conditions will also be conducive to improving fiber quality in cotton.

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Table 5. Genotypic (upper diagonal) and environmental (lower diagonal) correlations for agronomic and HVI fiber quality parameters for seven commercial cotton cultivars grown in 33 yield-environments.

	Lint Yield	Lint %	Micronaire	Length	Strength	Uniformity
Lint Yield	-	0.751	0.367	0.111	-0.552	-0.046
Lint %	0.209	-	-0.288	0.174	-0.524	0.408
Micronaire	0.232	0.735	-	0.046	0.210	-0.521
Length	0.712	-0.028	-0.027	-	0.105	0.718
Strength	0.629	0.244	0.285	0.785	-	0.098
Uniformity	0.641	0.231	0.260	0.851	0.860	-

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