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BREEDING AND GENETICS

Evaluation of Cotton Productivity by Fruiting Zone in Diverse Growing Locations

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ABSTRACT

The amount and quality of cotton (*Gossypium* spp.) produced within a growing season is the result of many factors, but the influence of genotype is substantial. The objective of this study was to determine how growing location, fruiting behavior, and cultivars interact to produce a cotton crop. Five commercial cultivars were studied at multiple locations in Texas and Virginia. Plant height, first sympodia, and number of sympodia were measured. Plants were harvested by fruiting zone and lint yield, lint percent, seed weight, and high-volume instrumentation (HVI) fiber data were ascertained. Results indicate that cultivar had a significant effect on plant height and fruiting habit, but year also significantly affected traits measured. In addition, lint yield, lint percent, seed weight, and fiber traits were significantly affected by fruiting zone at most locations and years. It was determined that relative differences among cultivars remained constant across growing locations for plant morphology and fiber traits. Differences in lint yield per fruiting zone were not distinguishable.

Cotton plants fruit over an extended period of time. During this fruiting period, bolls at different fruiting positions develop under different climatic conditions and with a different source-sink relationship within the plant. These circumstances can result in bolls with different seed and fiber properties (Hague et al. 2002).

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Several biotic and abiotic factors that can be controlled through agronomic management practices influence boll load and fruiting behavior. Insect pests are a common cause of fruit loss (Mauney and Henneberry, 1984). The rate of flowering and fruit retention can be influenced by irrigation treatments (Ungar et al., 1989). Plant growth regulators can also affect fruiting behavior (Dodds et al., 2010). Heitholt and Schmidt (1994) reported from their studies that differences in fruit shed, especially at the second fruiting position, can be influenced by cultivar and assimilate availability. As the canopy size and structure changes, light interception affects boll size and seed weight (Pettigrew, 1994). Bednarz et al. (2006) described improvements in fiber quality from second and third position bolls in response to changes in plant population density. These, along with other factors, can have a cascade effect throughout the growing season on boll development. Finally, as plants age, there is a shift in canopy age-class dynamics. Late season plants accumulate more assimilate from upper leaves and lower leaves become obsolete (Wullschleger and Oosterhuis, 1992). The objectives of this study were to determine the effect of selected locations on cotton productivity and fiber quality within the growing season, and the effects of location and fruiting zone on selected cultivars.

MATERIALS AND METHODS

Experiments were conducted in 2006 and 2007 at College Station, TX (30.55°N, 96.43°W), Lubbock, TX (33.69°N, 101.83W), and Suffolk, VA (36.68°N, 76.73°W). A North Texas location in 2006 was at Chillicothe, TX (34.19°N, 99.55°W), and at Prosper, TX (33.26°N, 96.80°W) in 2007. Prosper was chosen as a test site due to an early-season crop failure at Chillicothe in 2007. Soil types are an Acuff sandy clay loam (fine-loamy, mixed, superactive, thermic Aridic Paleustolls)at Lubbock, Miles Loamy Fine Sand, Fine-loamy, mixed, superactive, thermic Typic Paleustalfs at Chillicothe, a Houston Black clay (fine, smectitic, thermic Udic Haplusterts) at Prosper, a coarse-loamy siliceaous thermic Aquic Hapludults at Suffolk, and a Westwood silt loam, a fine-silty, mixed thermic Fluventic Ustochrept, intergraded with Ships clay, a very fine, mixed, thermic Udic Chromustert at College Station.

Cultivars in this study were 'DP 555 BG/RR' (PVP 200200047), 'FM 960B2R' (US Patent 7626092), 'PHY 72' (PVP 200100115), 'PM 2167RR' (US Patent 7057097), and 'ST 4892 BG/RR' (Stoneville Pedigreed Seed Co., Memphis, TN). These cultivars were being grown as national standards in official cultivar trials at the respective research locations (USDA-ARS, 2011). The official cultivar trials at all locations were planted in a complete randomized block design with four replications. Stands at all locations were between 10-15 plants per meter of row. Row widths at all locations were 96.5cm. Plant height, first sympodia (FS) and total number of sympodia (TS) data were ascertained from ten randomly selected plants per plot at the end of the growing season just prior to harvest. In 2006, cotton was harvested at Suffolk on 30 October, at Lubbock on 03 November, at College Station on 10 September, and at Chillicothe on 11 November. In 2007, cotton was harvested at Suffolk on 22 October, at Lubbock on 08 November, at College Station on 12 September, and at Prosper on 15 November.

Plants were hand harvested by fruiting zones. Boll sampling has been demonstrated as an effective method of predicting lint percent and most fiber qualities (Boykin, 2008). Fruiting zones were designated as top, middle, and bottom. Defining each zone was done by dividing the total number of sympodia into thirds. Because cotton fruits both up the plant and out on sympodia, second and third position bolls were partitioned into the next upper fruiting zone when boll ages were similar. Boll ages were estimated using the assumption that bolls on the same sympodia are 6-days apart in age and 3-days apart in corresponding positions with the next sympodia. There were few bolls on vegetative branches. Because of the difficulty in estimating their boll age, they were not harvested. This boll sampling was done on 3.5 meters of row from the middle of the plot.

Seed cotton samples were subsequently ginned on a Continental-Eagle™ laboratory gin. Fiber properties of length, strength and micronaire were determined by high-volume instrumentation (HVI) at the Texas Tech Fiber and Biopolymer Institute at Lubbock, TX. Seed weight was calculated based on the weight of 100 fuzzy seed. Lint percent was determined by the percentage of lint to seed cotton weight.

Plant height, first-fruiting branch and total number of fruiting branches data were analyzed using PROC GLM (SAS Institute, 2007). The analyses pooled location, year and cultivar effects. Lint yield, seed weight, lint percent and fiber quality data were analyzed as a split plot using PROC GLM. The main plot was cultivar and the split plot was the fruiting zone. Fruiting zone was considered a fixed effect in the analysis. Mean separation was based on LSD (α=0.05).

RESULTS AND DISCUSSION

Plant height and fruiting habit. Differences among cultivars in terms of plant morphology were significant across years and locations (Table 1). Because of interactions, data are presented by year and location. There also was a significant location by year interaction for all morphological traits. In 2006, both location and cultivar effects were significant for plant height, FS and TS. In 2007, location effect was significant for all morphological traits; cultivar effect was significant for plant height and FS.

Table 1. Mean squares of plant height, first fruiting branch (FFB) and total number of fruiting branches (TFB) across locations, across years, and by year.

Source	df	Height	FFB	TFB
Year (Y)	1	2946.37	10.95	733.26
Rep (Y)	3	51.79	0.76	0.61
Location (L)	3	5317.39	7.34	83.02
Cultivar (C)	4	1,026.06*	8.79*	9.77*
C x Y	4	68.49	0.11	1.44
L x Y	3	1,397.93*	7.05*	259.31*
C x L	12	92.75	0.24	0.89
C x L x Y	12	75.32	0.40	0.98

*Significant at the 0.05 probability level.
**Significant at the 0.01 probability level.

Across cultivars, plants were the tallest at College Station during both years (Table 2). Plants were the shortest at Lubbock in 2006 and shortest at Suffolk in 2007. DP 555 BG/RR and PHY 72 were among the tallest cultivars during both years across locations. FM 960B2R and PM 2167RR were among the shortest cultivars during both years across locations.

Cultivar effect on first-fruiting branch was consistent across locations, whereas the effects of years and locations varied. DP 555 BG/RR and PHY 72 had the highest first-fruiting branch, 7.6 and 7.4 respectively in 2006 and 8.2 and 8.3 in 2007, whereas PM 2167RR had the lowest first-fruiting branch at 5.7 across locations in 2006. In 2007, PM 2167RR and FM 960B2R had the lowest first-fruiting branch, 6.6 and 6.9 respectively, which suggests that these genotypes had an influence as to when plants began fruiting.

Table 2. Plant height first sympodia (FS) and total sympodia (TS) for two years (2006-2007) at four locations and five cultivars.

	Height[Z] -cm-		FS[Z] -no.-		TS[Z] -no.-	
	2006	2007	2006	2007	2006	2007
Locations						
College Station, TX	103a	116a	7.5a	7.6b	12.7b	12.2ab
North Texas	85b	101b	6.4b	8.8a	22.0a	11.2b
Suffolk, VA	83b	72d	7.0a	6.6c	21.7a	8.0c
Lubbock, TX	59c	88c	6.0b	6.8c	12.1b	12.7a
Cultivars						
DP 555BG/RR	94a	101a	7.6a	8.2a	18.3a	12.1a
PHY 72	87ab	102a	7.4a	8.3a	18.0a	11.0ab
ST4892BG/RR	81bc	98ab	6.5b	7.3b	17.0b	11.0ab
FM 960B2R	76c	87bc	6.4b	6.9bc	16.3b	10.4b
PM 2167RR	74c	84c	5.7c	6.6c	16.1b	10.8b
Mean	82	94	6.7	7.5	17.1	11.0

[Z] Means with the same letter are not significantly different at the 0.05 probability level as calculated by the Waller-Duncan K-ratio t-test.

Locations differed in regards to the total number of fruiting branches. In 2006, plants at Suffolk and the North Texas location had significantly more fruiting branches than other locations. This could have been in response to periods of drought followed by excessive rain at both sites, which caused plants to re-grow late in the season. This increase in fruiting branches at these locations affected all cultivars equally and did not result in any rank changes. In 2007, plants at Suffolk had the fewest fruiting branches. DP 555 BG/RR and PHY 72 had the most fruiting branches in 2006 and were among the highest again in 2007. This suggests that cultivar is a strong factor in determining number of fruiting branches despite the year or location.

Lint yield and fiber quality. Interactions among various combinations of cultivar, year, location, and fruiting zone were detected for yield and fiber quality (Table 3). Cultivars did not vary ($p<0.05$) in lint yield across other treatment factors except for the C x L x Y and the C x L x Z source of variaiton, but did vary for lint percent, seed size, and HVI fiber traits.

At College Station, there were differences in lint yield, lint percent, seed weight, and fiber traits evaluated among cultivars in most fruiting zones in 2006 (Table 4). There were no differences among cultivars in terms of lint yield in any fruiting zone in 2007. . Lint percent and seed weight are often inversely related because lint percent is a function of lint and seed weight (Woodward and Malm, 1976). DP 555 BG/RR had the highest lint percent and smallest seed weight in both years and in all fruiting zones. There were no differences among cultivars for micronaire in the middle and bottom fruiting zones in 2006. In 2007, there were no differences among cultivars in the top fruiting zone. PHY 72 ranked among the strongest fiber in all fruiting zones in both years.

At Lubbock, the only differences among cultivars for lint yield occurred in 2006 in the bottom fruiting zone (Table 5). DP 555 BG/RR had the highest lint percent in the top fruiting zone in 2007, and the middle fruiting zone in 2006. This same cultivar had the lowest seed weight in all fruiting zones in 2007 and the middle and bottom fruiting zone in 2006. Fiber micronaire tests revealed few meaningful differences by fruiting zone among cultivars. PHY 72 had the longest fiber in all fruiting zones in 2006 and along with FM 960B2R was among the longest again in 2007. FM 960B2R and PHY 72 had the strongest fiber in the middle fruiting zone in both years and the bottom fruiting zone in 2006.

At the North Texas locations, there were no differences in lint yield among cultivars in any fruiting zone in any year (Table 6). DP 555 BG/RR had the lowest seed weight in all fruiting zones in both years, but the lint percent was only the highest among cultivars in the top fruiting zone in 2007. While there were differences among cultivars for fiber micronaire in the middle and bottom fruiting zones in 2006, rankings were not consistent for cultivars between the two fruiting zones. FM 960B2R had among the lowest micronaire values in all fruiting zones in 2007. PHY 72 had among the longest fiber lengths at all fruiting zones in both years. The same was true for PHY 72 in regards to fiber strength.

Table 3. Mean squares of lint yield, lint percent, seed size and fiber traits for years, locations, fruiting zones, and cultivars.

Source	df	Lint yield	Lint Percent	Seed size	Fiber micronaire	Fiber length	Fiber strength
Year (Y)	1	3197	28.91	33.97	5.37	0.06	290.4
Rep (Y)	2	75,807**	2.17	0.42	0.31*	4.65**	31.9
Location (L)	3	224127	194.60	11.83	0.06	14.48	394.6
Fruiting Zone (Z)	2	9118	34.67*	36.77	2.36	3.84	19.7
Cultivar (C)	4	17852	232.92**	76.74**	1.65**	134.46**	39,211.0**
C x Y	4	11153	3.72	3.93*	0.10	1.50	900.3
Y x Z	2	63,376*	0.82	2.36	0.24	2.25	43.4
L x Y	3	333,499**	92.62**	2.44	4.46**	6.44	1229.8
L x Z	6	12745	8.46	1.82	0.19	2.13	1,721.0**
C x L	12	9328	5.78	1.75*	0.23	1.70	409.1
C x Z	8	8845	3.11	0.97	0.10	0.42	224.9
L x Y x Z	6	9,970**	2.21	0.61	0.14	2.59**	156.4
C x L x Y	12	5,722*	4.28	0.54	0.55**	0.81**	418.4
C x Y x Z	8	2910	2.50	0.52	0.05	0.20	94.2
C x L x Z	24	4,607*	2.75	0.72	0.12*	0.28	208.5
C x L x Y x Z	24	2104	3.15	0.37	0.05	0.25	261.4

*Significant at the 0.05 probability level.

**Significant at the 0.01 probability level.

Table 4. Lint yield, lint percent, seed weight of 100 seed, and fiber traits by fruiting zone, year, and cultivar at College Station, TX.

Cultivar	Lint[Z] –kg ha^{-1}-		Lint Percent[Z] -%-		Seed wt. [Z] -mg-		Fiber micronaire[Z] -units-		Fiber length[Z] -mm-		Fiber strength[Z] -k N m kg^{-1}-	
	2006	2007	2006	2007	2006	2007	2006	2007	2006	2007	2006	2007
Top												
DP 555BG/RR	593a	335a	42.5a	44.5a	72c	60c	4.2b	4.0a	28.6bc	26.6c	295b	270d
FM 960B2R	479ab	334a	38.5b	39.1b	108a	103a	4.6a	4.1a	29.5ab	28.7b	305b	309b
PHY 72	482ab	281a	34.9c	37.9b	95b	93ab	4.0b	3.7a	30.2a	30.1a	369a	341a
PM 2167RR	370b	363a	37.0b	38.4b	99ab	88b	4.2b	4.3a	26.3d	25.7c	273b	269d
ST 4892BG/RR	484ab	323a	38.2b	41.3ab	105a	89b	4.8a	4.6a	27.6c	28.1b	280b	285c
Mean	481	327	38.2	40.2	96	86	4.4	4.1	28.4	27.8	304	295
Middle												
DP 555BG/RR	516a	360a	43.9a	45.5a	77d	66c	4.6a	4.7ab	27.7bc	27.8c	284bc	253cd
FM 960B2R	491a	344a	39.2b	40.5c	120a	110a	4.7a	4.5bc	29.5ab	29.1ab	315ab	293b
PHY 72	306a	203a	36.0c	39.2cd	111ab	97b	4.5a	4.1c	30.0a	30.0a	326a	327a
PM 2167RR	416a	382a	37.3c	38.6d	99c	99b	4.6a	4.4bc	26.4c	26.2d	266c	245d
ST 4892BG/RR	522a	388a	39.8b	42.6b	107bc	95b	4.8a	5.0a	27.7bc	28.1bc	271c	263c
Mean	450	335	39.2	41.3	103	93	4.6	4.5	28.2	28.2	292	276
Bottom												
DP 555BG/RR	551ab	201a	42.7a	44.8a	78c	68d	4.5a	4.9a	28.5bc	28.1b	278bc	241cd
FM 960B2R	632a	272a	39.3b	38.4bc	115a	113a	4.3a	4.2b	30.3a	29.9a	305ab	292ab
PHY 72	467ab	251a	36.9c	38.3bc	101b	93c	4.0a	4.0b	30.0ab	30.4a	322a	326a
PM 2167RR	425b	241a	36.0c	35.9c	104ab	104b	4.2a	4.2b	26.3d	25.6c	254c	221d
ST 4892BG/RR	466ab	311a	39.6b	40.7b	107ab	103b	4.5a	5.0a	27.2cd	28.1b	281bc	270bc
Mean	508	255	38.9	39.6	101	96	4.3	4.4	28.4	28.4	288	270

[Z] Means with the same letter are not significantly different at the 0.05 probability level as calculated by the Waller-Duncan K-ratio t-test.

Table 5. Lint yield, lint percent, seed weight of 100 seed, and fiber traits by fruiting zone, year, and cultivar at Lubbock, TX.

Cultivar	Lint[Z] -kg ha^{-1}-		Lint Percent[Z] -%-		Seed wt. [Z] -mg-		Fiber micronaire[Z] -units-		Fiber length[Z] -mm-		Fiber strength[Z] -k N m kg^{-1}-	
	2006	2007	2006	2007	2006	2007	2006	2007	2006	2007	2006	2007
Top												
DP 555BG/RR	217a	425a	47.2a	44.3a	82b	70c	4.7ab	3.3ab	27.2b	28.0bc	286bc	270b
FM 960B2R	254a	585a	44.4a	41.2b	88ab	102a	4.4b	3.3ab	27.6b	29.2ab	299b	294ab
PHY 72	264a	406a	45.7a	40.3b	103a	82b	4.4b	3.9a	30.4a	30.9a	334a	320a
PM 2167RR	205a	458a	42.3a	40.7b	87b	98a	4.7ab	3.7a	24.3c	25.9c	265bc	272b
ST 4892BG/RR	182a	360a	46.6a	41.2b	81b	71c	5.0a	3.0b	26.3bc	28.3b	260c	286ab
Mean	224	447	45.2	41.5	88	84	4.6	3.4	27.1	28.4	289	288
Middle												
DP 555BG/RR	208a	286a	45.4a	43.4a	81c	79b	4.8b	4.2a	28.0bc	28.0bc	267b	258b
FM 960B2R	282a	312a	43.4b	36.3a	108a	105a	4.9ab	4.0a	28.7b	30.4ab	306a	322a
PHY 72	271a	317a	41.8bc	40.9a	107a	102a	4.9ab	4.0a	30.8a	31.3a	326a	325a
PM 2167RR	228a	360a	41.5c	40.1a	99b	95a	5.0ab	4.3a	25.2d	25.9c	267b	265b
ST 4892BG/RR	254a	326a	43.3b	41.4a	108a	100a	5.3a	3.6a	27.2c	28.6abc	275b	278ab
Mean	249	320	43.0	40.4	101	96	4.9	4.0	27.9	28.8	288	289
Bottom												
DP 555BG/RR	232b	325a	44.4a	43.6a	81c	83d	4.8ab	4.2a	28.9b	29.1b	274b	272bc
FM 960B2R	230b	331a	43.8a	41.4a	107ab	105bc	4.7ab	4.2a	29.0b	29.7ab	322a	288b
PHY 72	387a	390a	40.1b	39.8ab	112ab	103c	4.6b	4.1a	30.9a	31.1a	310a	319a
PM 2167RR	394a	340a	41.0b	36.4b	103b	119a	5.1ab	4.3a	24.7c	26.3c	274b	253c
ST 4892BG/RR	328ab	412a	43.7a	40.8ab	117a	117ab	5.4a	4.3a	28.0b	28.2b	267b	261bc
Mean	314	359	42.6	40.4	104	105	4.9	4.2	28.3	28.9	289	278

[Z] **Means with the same letter are not significantly different at the 0.05 probability level as calculated by the Waller-Duncan K-ratio t-test.**

At the Suffolk location, there were no differences for lint yield among cultivars except in the top fruiting zone in 2007. In 2006, DP 555 BG/RR had the highest lint percent among cultivars in the top and middle fruiting zone in 2006. In 2007, ST 4892 BG/RR had the highest lint percent in the top fruiting zone and was among the highest cultivars in the middle and bottom fruiting zone. DP 555 BG/RR had the lowest seed weight in all fruiting zone during both years as was the case in all other locations.

There were no consistent patterns for micronaire among cultivars across fruiting zones. PHY 72 had the longest fiber length in all fruiting zones in 2006 and in the top and bottom fruiting zones in 2007. In regards to fiber strength, once again PHY 72 had among the strongest fiber in all fruiting zones in both years.

CONCLUSIONS

While both location and year can lead to significant variability for plant height and fruiting habit, their effect across cultivars was consistent. Importantly, the lack of any significant interaction between location and/or year with cultivar for plant height or fruiting habit suggests that breeders can select plant size and general fruiting habits at one location with confidence that such parameters will be stable across a large geographical range. Within this study, location had a greater influence on plant height than it did on first-fruiting branch and the development of fruiting branches. Cultivars that had the most total fruiting branches and the latest first-fruiting branches (e.g. DP 555 BG/RR and PHY 72) were among the tallest cultivars in this study.

The lack of differences for lint yield among fruiting zones could be attributed to the nature of the sampling in which bolls were sampled proportionally among the zones. This harvest method likely introduced experimental error into the lint yield assessment. Early maturing cultivars have been found to produce a greater percentage of total lint yields at lower main stem nodes in Georgia (Bednarz and Nichols, 2005). However, the diversity of growing conditions in this study introduced too many unknown interacting factors to estimate which sources of variation tested had significant effects on lint yield.

Table 6. Lint yield, lint percent, seed weight of 100 seed, and fiber traits by fruiting zone, year, and cultivar at the North Texas locations.

Cultivar	Lint[Z] –kg ha^{-1}-		Lint Percent[Z] -%-		Seed wt. [Z] -mg-		Fiber micronaire[Z] -units-		Fiber length[Z] -mm-		Fiber strength[Z] -k N m kg^{-1}-	
	2006	2007	2006	2007	2006	2007	2006	2007	2006	2007	2006	2007
Top												
DP 555BG/RR	321a	203ab	40.8a	47.9a	83b	68d	4.4a	4.9a	28.7ab	25.8b	271b	239c
FM 960B2R	297a	253a	39.6a	40.3b	115a	105a	5.0a	4.1b	29.2ab	27.1b	319a	294b
PHY 72	236a	177b	36.4a	36.9c	121a	95b	4.7a	4.0b	30.6a	28.8a	337a	346a
PM 2167RR	250a	206ab	39.5a	38.6bc	108a	111a	5.7a	4.9a	25.4c	24.2c	250b	274b
ST 892BG/RR	247a	196ab	42.0a	40.4b	113a	85c	5.4a	4.9a	27.4bc	26.9b	261b	268bc
Mean	270	207	39.6	40.8	108	93	5.0	4.5	28.3	26.5	287	284
Middle												
DP 555BG/RR	327a	202a	40.4ab	42.7a	88c	84c	4.9b	4.7abc	27.8ab	26.3bc	278b	268c
FM 960B2R	294a	217a	39.7ab	37.7b	123a	113a	5.5a	4.3c	27.8ab	27.8b	319a	310ab
PHY 72	238a	146a	37.9b	39.3ab	122a	109a	5.5a	4.6bc	29.8a	29.4a	331a	342a
PM 2167RR	278a	189a	38.0b	38.7ab	109b	110a	5.4ab	5.0ab	24.4c	24.9c	277b	279bc
ST 892BG/RR	309a	200a	40.7a	42.4ab	115ab	93b	5.8a	5.3a	26.8b	27.8b	264b	301b
Mean	289	191	39.3	40.1	111	101	5.4	4.8	27.3	27.2	294	300
Bottom												
DP 555BG/RR	332a	185a	41.5a	42.1a	89d	81c	5.1ab	5.0b	27.1ab	27.2b	273c	274bc
FM 960B2R	316a	210a	37.9bc	39.5b	124a	126a	5.1ab	4.4d	26.7abc	27.9b	308b	294b
PHY 72	299a	166a	36.4c	37.5bc	119ab	111ab	4.9b	4.4d	29.1a	29.4a	352a	355a
PM 2167RR	329a	224a	36.5c	37.4c	102c	122ab	5.3a	4.7c	24.3c	25.4c	262c	270c
ST 892BG/RR	283a	198a	40.1ab	42.5a	110bc	110b	5.4a	5.3a	26.0bc	27.4b	259c	294bc
Mean	312	196	38.5	39.8	109	110	5.1	4.7	26.6	27.4	290	297

[Z] **Means with the same letter are not significantly different at the 0.05 probability level as calculated by the Waller-Duncan K-ratio t-test.**

The inverse relationship between seed size and lint percent was evident during this study. As lint percent increases, some researchers have detected not only decreases in seed size but also decreases in fiber length (Meredith and Bridge, 1973). This was the case with DP 555BG/RR in most years and locations. When lint percent was relatively high, both seed size and fiber length values tended to be low. Moreover, cultivars with stronger fiber tended to have lower lint percent, which is confirms earlier findings by McCall et al. (1986) and Smith and Coyle (1997). Overall, fiber quality was difficult to assess by fruiting zones because the in-season growing conditions interacted with the plants' inherent temporal fruiting pattern. Therefore, fiber potential of a genotype should be evaluated as a function of all fruiting zones combined in order to capture the genotype by environment effects. Productivity of a cotton plant ultimately is the result of the crop's ability to react to a series of growing conditions throughout the season (Hague et al., 2009). Evaluating cultivars by fruiting zone is probably not the most effective strategy because cotton has the ability to reallocate resources and recover.

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Table 7. Lint yield, lint percent, seed weight of 100 seed, and fiber traits by fruiting zone, year, and cultivar at Suffolk, Virginia.

Cultivar	Lint[Z] –kg ha^{-1}-		Lint Percent[Z] -%-		Seed wt. [Z] -mg-		Fiber micronaire[Z] -units-		Fiber length[Z] -mm-		Fiber strength[Z] -k N m kg^{-1}-	
	2006	2007	2006	2007	2006	2007	2006	2007	2006	2007	2006	2007
Top												
DP 555BG/RR	242a	392b	46.6a	45.9b	71b	59d	4.4a	4.6b	27.6bc	27.6b	248b	284b
FM 960B2R	343a	517a	43.1b	45.9b	105a	103a	4.5a	5.1ab	28.1b	27.8b	304a	288ab
PHY 72	229a	382b	42.5b	43.0c	95a	76c	4.4a	4.8ab	29.7a	30.0a	296ab	321a
PM 2167RR	201a	347b	40.2c	43.8c	100a	95b	4.7a	4.7b	26.8d	25.2c	273ab	258b
ST 4892BG/RR	202a	465a	42.3b	47.8a	98a	76c	4.3a	5.6a	27.3cd	26.6bc	268ab	278b
Mean	243	420	42.9	45.2	94	82	4.4	4.9	27.9	27.4	278	286
Middle												
DP 555BG/RR	273a	344a	47.7a	48.2a	91c	70c	5.7a	5.1b	28.0c	26.5c	252b	262c
FM 960B2R	317a	377a	42.4b	45.7a	117a	114a	4.7b	4.9b	28.7b	28.3ab	323a	304b
PHY 72	249a	374a	39.2c	42.5c	102b	87b	4.5b	4.9b	30.7a	30a	324a	338a
PM 2167RR	172a	362a	39.3c	41.4c	109ab	96b	4.9ab	4.8b	26.9d	26.5c	257b	275c
ST 4892BG/RR	240a	480a	42.4b	47.6a	103b	95b	4.7b	5.8a	28.1bc	26.8bc	285ab	276c
Mean	250	387	42.0	45.0	104	92	4.9	5.1	28.5	27.6	288	291
Bottom												
DP 555BG/RR	238a	272a	42.7a	46.0a	94b	81b	5.0ab	4.9a	28.6bc	28.5b	288ab	286b
FM 960B2R	303a	260a	41.8a	44.5a	121a	111a	4.6bc	5.2ab	29.0b	28.9b	328a	311b
PHY 72	228a	286a	37.7a	41.6b	114ab	101a	4.4c	4.8b	31.1a	31.1a	325a	350a
PM 2167RR	201a	332a	37.9a	40.9b	119a	108a	5.3a	4.9b	26.6c	26.7c	260b	296b
ST 4892BG/RR	211a	318a	40.9a	45.0a	113ab	102a	4.7bc	5.6a	29.0b	27.9bc	293ab	284b
Mean	236	293	40.2	43.6	112	100	4.8	5.0	28.8	28.6	299	305

[Z] **Means with the same letter are not significantly different at the 0.05 probability level as calculated by the Waller-Duncan K-ratio t-test.**

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