PHY 444 WRF: A NEW HIGH QUALITY VARIETY FROM PHYTOGEN

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Abstract

Fiber quality is important to growers with regard to the USDA loan rate differentials which together with lint yield determine the gross value of the cotton crop. PHY 444 WRF was introduced in 2015 as one of the few Upland varieties with the rare combination of superior lint yield in the Mid-South and Southeast and significantly improved fiber quality. The demonstration of superior HVI fiber quality traits indicated that PHY 444 WRF may yield lint with substantially improved spinning performance relative to other Upland cultivars. Seed cotton samples were collected in 2014 from nine cultivars in the performance trials at Leland, MS and were ginned on the micro-gin at the USDA Cotton Ginning Lab at Stoneville, MS. The lint samples were sent to the Fiber and Biopolymer Research Institute in Lubbock, TX where HVI, AFIS and spinning quality data were collected. The HVI fiber quality traits for PHY 444 WRF were better than for other Upland varieties and were very comparable to that of PHY 755 WRF Acala except that the fiber strength was lower and the Rd fiber reflectance was higher. The AFIS fiber length distribution indicated that PHY 444 WRF was similar to PHY 755 WRF Acala in having more fibers longer that 1.1875" as compared to the average of the other seven varieties in the test. PHY 444 WRF had more short fibers than PHY 755 WRF Acala, but comparable to other Upland varieties. As expected, the 30/1 carded yarn spinning quality of PHY444 WRF was superior to all other Upland varieties and was very similar to PHY 755 WRF Acala with similar yarn tenacity and with lower thick and thin places. These data indicate that lint from PHY 444 WRF should indeed perform in a superior manner in textile mills.

Introduction

The gross value of the cotton crop that a grower produces is determined by the combined value of the lint and the seed after ginning with the value of the lint being determined by the product of pounds produced per hectare and the value of the lint per pound. The value of the lint per pound is determined by the USDA crop loan rate differentials based on High Volume Instrumentation (HVI) fiber quality parameters. The loan rate differentials are intended to reflect the relative value of a bale of cotton to the textile spinning mills, particularly as related to spinning quality and yarn strength.

Cotton grown in the USA can be characterized as Upland, Stripper, Acala and Pima based on where it is grown, boll type, level of fiber quality and species. Upland cotton is grown from Arizona to the Carolinas and has generally had medium levels of fiber quality. Stripper cotton is grown in the High Plains of Texas and Oklahoma and is known by the characteristic of having a boll type that is more storm tolerant than Upland "picker" types. Historically, Stripper cotton has been known to have lower levels of fiber quality, but the recent broad scale adoption of FiberMax Upland varieties in this region with both moderate storm tolerance and significantly improved fiber quality has greatly improved the quality of cotton grown in this region. Acala cotton has been bred in both California and New Mexico to have markedly improved fiber quality and, as a result, cotton grown in these states yield lint with quality that has received substantial premiums. Acala cotton acreage in California has seen dramatic reductions in recent years with a shift in acreage from Acala to Pima which has the highest quality and, thereby receives the highest premiums. Pima cotton is *Gossypium barbadense*, while all of the other types are *Gossypium hirsutum*.

Except for Acala and Pima cotton, USDA loan charts have penalized low quality cotton more than they have provided premiums for cotton with above average quality. As a result of more severe discounts being levied against low quality cotton in conjunction with minimal premiums provided for high quality cotton, growers realize the most profit by choosing to plant cotton varieties with the highest yield potential with fiber quality considerations aimed more at avoiding discounts. Upland and Stripper cotton breeders have in turn focused more on improving lint yield while

maintaining minimal standards of fiber quality. As stated before, fiber quality is receiving more attention from Stripper breeders due to FiberMax varieties setting a new standard, particularly regarding fiber length, in the Texas High Plains. PHY 444 WRF was released for sale by Dow AgroSciences in 2015 as the first Upland cotton variety adapted to the Eastern region of USA with the rare combination of high yield and substantially improved fiber quality.

As the USA cotton crop has moved from domestic consumption to international export, the potential for differentiating USA cotton based on substantially improved fiber quality can result in increased profit potential for USA cotton growers who plant varieties with improved fiber quality. Until recently, very few high yielding Upland cotton varieties have been available with significantly improved fiber quality, but widescale adoption of PHY 444 WRF by growers in 2016 indicated a new focus on fiber quality.

Materials & Methods

Cotton variety yield trials to evaluate elite experimental lines as compared to commercial check varieties were planted in two fields near Leland, MS in 2014. One field had a soil type of Dundee very fine sandy loam that was planted on May 12, 2014 and the other field had a soil type of Sharkey clay that was planted on May 8, 2014. Cotton samples were collected from either 4UETE or 4U_IP adjacent trials. The 4UETE trial was comprised of 36 entries replicated four times in a randomized complete block design with 2-row plots that were 40 feet long. The 4U_IP trial was comprised of 11 entries with a single rep of 4-row plots that were 550 feet long. Seed cotton samples were harvested with a 4-row Case International cotton picker with load cell capability to capture plot weights. After the plot weights were recorded for the short plot trial, the seed cotton for the four plots of test entries PHY 755 WRF Acala, DP 0912 B2RF and DP 1321 B2RF was collected into large mesh bags. The seed cotton samples for the other six test entries were collected into mesh bags from the 4-row by 550 feet plots. The seed cotton samples were ginned on the microgin at the USDA Cotton Ginning Lab at Stoneville, MS. The lint for each sample was returned to the mesh bag and all lint samples were compressed into a single bale for shipment to the Fiber and Biopolymer Research Institute in Lubbock, TX where HVI, AFIS fiber quality and 30/1 carded yarn quality data were collected.

Results & Discussion

Yield and Overall Quality

PhytoGen conducts replicated short plot yield trials across the Eastern region of the USA to identify which experimental lines should be advanced toward market introduction. The elite transgenic trial is comprised of entries that are within two years of release along with an array the best commercial check varieties. Figure 1 is a graph of the over location mean lint yield and Q-Score from the 2014 elite transgenic test. The highest yielding entries in this trial were the broadly adapted early maturing varieties PHY 312 WRF and PHY 333 WRF. The highest quality varieties were PHY 444 WRF and PHY 755 WRF Acala. The yield of PHY 444 WRF was 45 pounds per acre higher than the mean of the other Upland varieties and 500 pounds per acre higher than PHY 755 WRF Acala. These data demonstrate fiber quality comparable to the Acala standard with substantially greater yield.

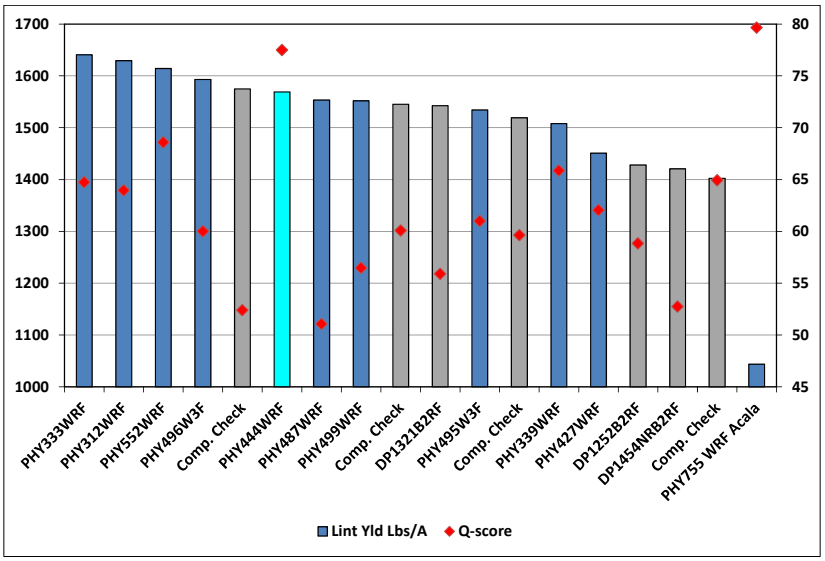

Figure 1. Mean lint yield and Q-Score across all locations of the 2014 PhytoGen elite transgenic trial.

From 2013 to 2015, PHY 444 WRF was widely tested in university variety trials across the Mid-South and Southeast USA. SeedMatrix is a valuable means to summarize these data across states and within regions. Figure 2 is a graph of yield data averaged across all years and locations of public data using the One-to-Many function in SeedMatrix. PHY 444 WRF was the fourth highest yielding variety and it had the highest Q-Score among varieties with at least 70 observations. Note also that PHY 312 WRF and PHY 333 WRF were high yielding with above average fiber quality.

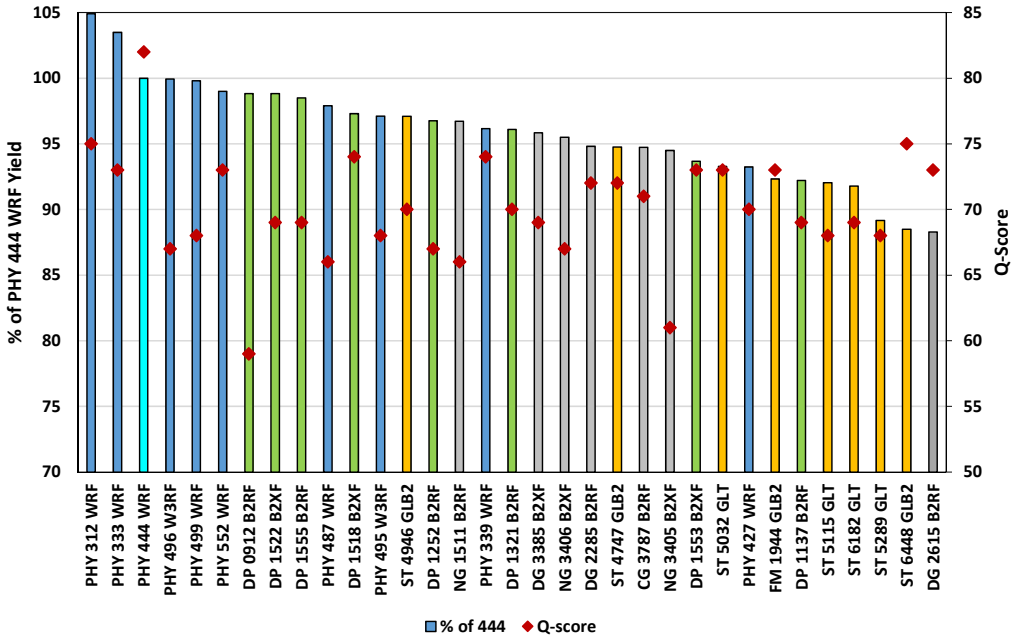

Figure 2. Lint yield as a percentage of PHY 444 WRF averaged over all years and locations of only public data using the One-to-Many function in Seed Matrix and Q-Score calculated from the Head-to-Head function using each variety individually compared to PHY 444 WRF.

HVI Fiber Quality

The HVI fiber quality data for the 9 varieties of the present study grown in 2014 are presented in Table 1 sorted by Q-Score as are the subsequent tables. These data are consistent with data collected in previous years that had demonstrated outstanding fiber quality for PHY 444 WRF and thereby indicated value in collecting spinning quality data. The Q-Score selection index for PHY 444 WRF was second only to PHY 755 WRF Acala and reflected comparable fiber quality. The micronaire for PHY 444 WRF was lower and the Rd component of color was higher than for all other varieties while fiber length was equal to that of PHY 755 WRF Acala with comparable uniformity index. The fiber strength of PHY 444 WRF was equal to the average of the other Upland varieties and lower than the Acala variety.

Table 1. HVI fiber quality collected from a subsample of lint for the spinning test.

Name	Q-Score	Mic	Length	Unif. Index	Strength	% Elong.	Rd
PHY755 WRF	83	4.2	1.26	83.9	35.2	6.4	74.9
PHY444WRF	78	3.8	1.27	83.9	33.0	6.4	78.0
PHY552WRF	71	4.1	1.19	83.8	33.9	6.5	77.4
PHY333WRF	70	4.5	1.19	83.6	31.9	6.4	74.7
PHY499WRF	67	4.7	1.13	83.8	34.9	7.6	75.7
Comp. Check	64	4.5	1.21	82.1	30.9	4.9	78.0
DP1321B2RF	64	5.0	1.16	83.5	31.9	8.1	77.3
PHY487WRF	58	4.7	1.11	82.1	31.5	7.6	75.9
DP0912B2RF	42	5.2	1.10	82.5	30.4	6.9	76.5

AFIS Fiber Quality

Advanced Fiber Information System (AFIS) testing provides both length and maturity data on as individual fiber basis. These data can be used to compare relative differences in distributions between varieties. The relative amount of short fibers as defined by length of 0.5 inches or less is of particular interest to spinning mills with regards to combing waste. Figure 3 graphs the length distribution for PHY 444 WRF, PHY 755 WRF Acala and the average length distribution across the remaining seven varieties of the study. PHY 444 WRF had a similar frequency of the longer fibers as compared to PHY 755 WRF Acala, but it had fewer medium length fibers and more short fibers. These differences are illustrated in Figure 4 which, presents the same data as the difference from the average for the seven other varieties of the study. This graph suggests that the cumulative frequency of fibers 0.5 or less and the cumulative frequency of fibers 1.25 or greater in length may be important variables to demonstrate differences in length distribution between varieties.

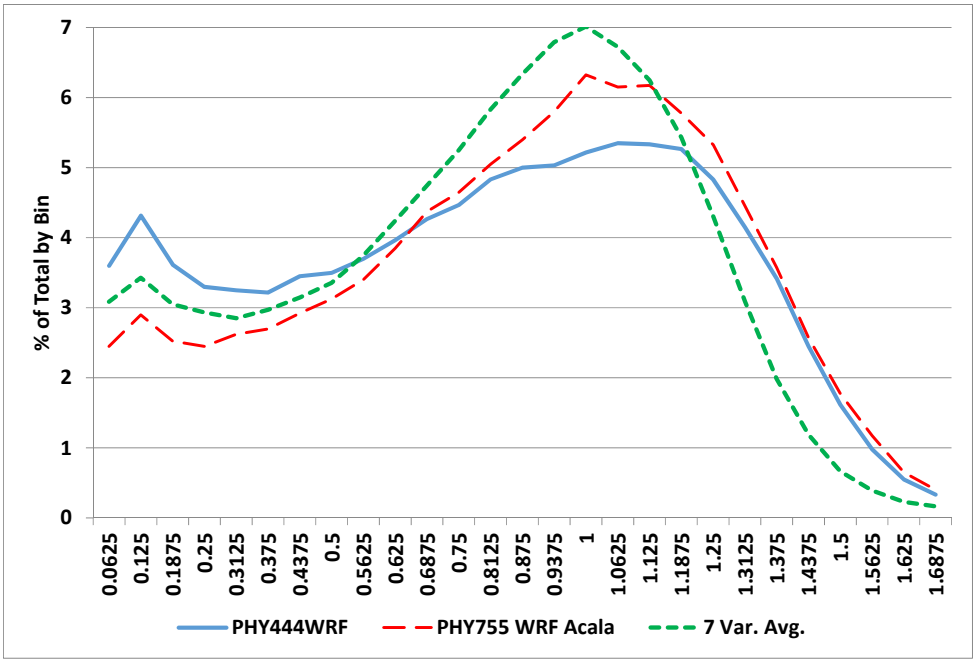

Figure 3. AFIS length distribution averaged over two soil types.

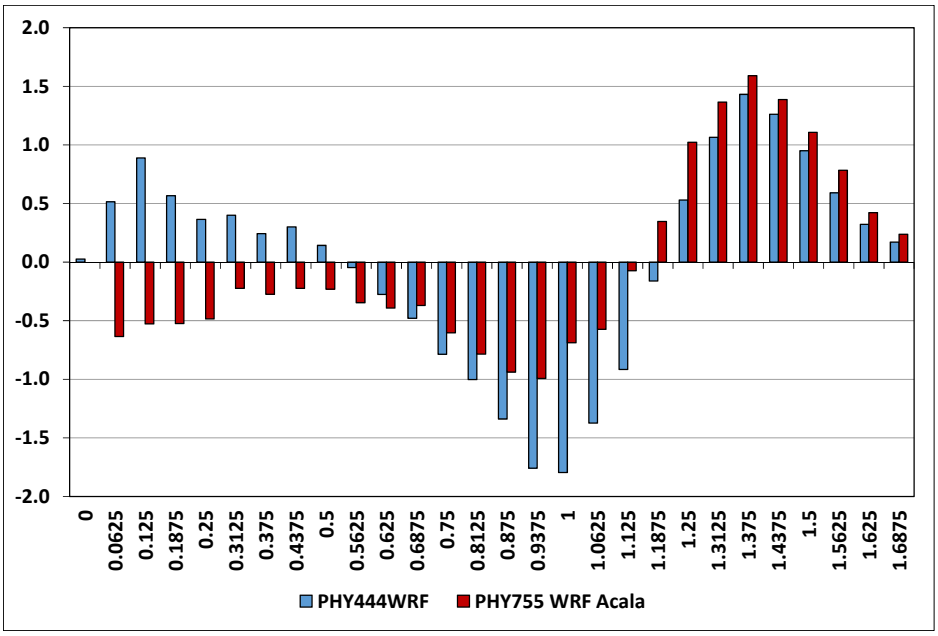

Figure 4. Frequency of length distribution for PHY 444 WRF and PHY 755 WRF Acala as the difference from the mean averaged across the remaining seven check varieties.

AFIS fiber quality data are provided in Table 2. The number of neps per gram was highest for PHY 444 WRF and lowest for DP 0912 B2RF. The correlation between neps and micronaire was -0.95 to indicate that low micronaire is associated with higher nep counts. Both PHY 444 WRF and PHY 755 WRF Acala had the highest UQL which is in agreement with HVI length. Contributing to its low micronaire, PHY 444 WRF had both the finest fiber and the lowest maturity which may also have contributed to the higher frequency of short fibers due to breakage during ginning.

Table 2. AFIS fiber quality data.

Name	Neps/ Gm	UQL (w) [in]	SFC (w) [%]	Trash Cnt/g	SCN Size (um)	SCN (Cnt/g)	Fine [mTex]	Mat Ratio
PHY755 WRF	215	1.32	5.9	101	1175	18.3	158	0.91
PHY444WRF	268	1.32	7.1	80	974	12.0	149	0.84
PHY552WRF	248	1.25	6.3	192	973	20.0	155	0.86
PHY333WRF	214	1.26	7.6	152	1015	21.7	163	0.86
PHY499WRF	206	1.18	6.8	85	1107	24.0	168	0.88
Comp. Check	230	1.27	8.5	158	1085	16.7	161	0.90
DP1321B2RF	188	1.22	7.0	74	1134	11.7	176	0.89
PHY487WRF	202	1.16	7.7	118	956	14.3	177	0.90
DP0912B2RF	174	1.17	8.3	91	1127	15.7	181	0.90

30/1 Carded Spinning Quality

The data from the 30/1 carded yarn spinning data are presented in Table 4. The breaking force and tenacity for PHY 444 WRF were second only to PHY 755 WRF Acala. The number of thick places in the yarn for PHY 444 WRF was lowest of all test varieties and the number of thins was second lowest beside PHY 755 WRF Acala. The number of neps was highest for PHY 444 WRF/ These data indicate the commercial spinning quality of PHY 444 WRF should be similar to PHY 755 WRF Acala.

Table 4. Spining quality data for 30/1 carded yarn.

Name	Work Break	Tenacity	Thin 50%	Thick 50%
PHY755 WRF	563	18.0	2.3	144
PHY444WRF	554	17.2	1.7	112
PHY552WRF	510	16.1	7.3	118
PHY333WRF	459	15.4	8.0	173
PHY499WRF	530	15.7	4.3	130
Comp. Check	360	14.9	8.7	204
DP1321B2RF	465	13.6	9.7	173
PHY487WRF	458	14.0	14.3	159
DP0912B2RF	339	12.3	23.7	280

Conclusion

The agronomic performance of PHY 444 WRF was highly competitive with the best commercial varieties in both PhytoGen R&D and public trials. The enhanced fiber quality observed for PHY 444 WRF as indicated by HVI quality data was indeed associated with improved spinning quality that approached the PHY 755 WRF Acala variety. The frequency of the longest fibers as indicated by AFIS data and the higher fineness of PHY 444 WRF very likely contributed significantly to its enhanced spinning performance. The yarn tenacity of PHY 444 WRF was very similar to PHY 755 RF Acala in being higher than other Upland varieties. The lower proportion of thick and thin places are also regarded as being desirable characteristics. The rare combination of high yield and superior fiber quality of PHY 444 WRF provides growers with a new opportunity to garner new premiums in the marketing of their cotton and thereby their profitability.