1435 Yield and fiber quality performance of cotton varieties across populations of reniform and root knot nematodes

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Southern root knot (*Meloidogyne incognita*) and reniform (*Rotylenchulus reniformis*) nematodes are widespread pests in cotton (*Gossypium hirsutum*) throughout the midsouth and southeast regions of the U.S. cotton belt. Varying field tolerance to both pests has been demonstrated in previous small-plot, single-location studies among commercially-available varieties. The objective of this study was to compare variety yield and fiber quality performance from variety trials conducted throughout the midsouth and southeast regions of the U.S. that differed in the presence of nematode species and populations. Yield and fiber quality data were collected from numerous large-plot, on-farm variety trials conducted by Delta and Pine Land Company, and by Extension county agents, as well as small-plot variety trials conducted by state universities in 2005 and 2006. One composite soil sample was collected during the fall at each trial site for each year for nematode species and population analysis at one laboratory. Significant variation in field tolerance to reniform and root knot nematodes was evident among the six commercially-available cotton varieties evaluated, based on the definition of tolerance as maintaining an acceptable level of productivity under normal nematode infection levels that would reduce yield in non-tolerant genotypes. Since only one of the varieties studied is reported to exhibit moderate genetic resistance to root knot nematode, and none of the varieties studied are reported to display genetic resistance to reniform nematode, our data suggest other factors were contributing to field tolerance of root knot and reniform nematodes aside from genetic resistance.

KEYWORDS: cotton, reniform nematode, root knot nematode, variety, field tolerance

INTRODUCTION

Plant parasitic nematodes accounted for 4% loss of cotton (*Gossypium hirsutum*) yield in the U.S. in 2000. Southern root knot (*Meloidogyne incognita*) and reniform (*Rotylenchulus reniformis*) nematodes are the most widespread pathogenic species in cotton, and are concentrated in the midsouth and southeast areas of the U.S. (Koenning et al., 2004). The most commonly utilized suppression and/or control techniques against these pests are nematicides and crop rotation (Koenning et al., 2004; Zhou and Starr, 2003).

While resistance to root knot nematode has been identified in several genotypes (Bordelon and McPherson, 2003; Robinson et al., 1997; Jenkins et al., 1995; Creech et al., 1995), currently, only one commercially-available upland variety, ST5599BR, exhibits moderate resistance (Williams et al., 2004) accompanied by demonstrated field tolerance (Barfield, 2003). An Acala variety, NemX, exhibits root knot nematode resistance, but is adapted only to the western region of the U.S. (Ogallo et al., 1997).

Resistant genotypes to reniform nematode have been identified in upland (*G. hirsutum*) and Pima (*G. barbadense*) cotton (Robinson et al., 2004). Currently, all commercially-available varieties are susceptible to reniform nematode, but one study suggested some varieties with higher early season vigor have been reported to exhibit field tolerance (Usery et al., 2004). Other studies reported that some commercial varieties had improved levels of tolerance (Cook et al., 2003; Cook et al., 2002).

Because resistance genes to either root knot or reniform nematode exist in genotypes that do not possess agronomically-desirable traits, development of commercially-available cotton varieties with resistance to these pests has not progressed rapidly (Koenning et al., 2004). While gene markers for root knot nematode resistance have been recently developed (Bezawada et al., 2003) and utilized, more time is required before conventional breeding techniques will bring breeding lines to potential commercialization. Additionally, the continued development and adoption of transgenic varieties containing insect- and/or herbicide-resistant traits has resulted in rapid turnover rates of newer varieties (USDA-AMS, 2006). Consequently, limited field data exists on current varieties' nematode tolerance and/or resistance. Continual evaluation of newly-released varieties is needed to assess tolerance levels to root knot and reniform nematodes (Koenning et al., 2004). While resistance is defined as the ability of the plant to inhibit nematode reproduction and/or feeding relative to that of a standard susceptible host, tolerance refers to a trait that allows the plant to maintain an acceptable level of productivity under normal nematode infection levels that would reduce yield in non-tolerant genotypes (Koenning et al., 2004; Robinson et al., 2001; Painter, 1951).

Previous tolerance studies for root knot and reniform nematode evaluated genotypes at a single or limited number of locations in replicated, split-plot designed experiments where the genotypes were grown with a nematicide and the yield performance compared to that of the untreated (Usery et al., 2004; Williams et al., 2004; Cook et al., 2003; Cook et al., 2002; Koenning et al., 2000). However, evaluation of field tolerance must be conducted with a large number of replicates to accurately determine differences in variety performance with and without the nematode pest (Koenning et al., 2004; Bowman and Schmitt, 1994). Additionally, most previous tolerance studies have focused on yield performance only (Usery et al., 2004; Williams et al., 2004; Koenning et al., 2000; Bowman and Schmitt, 1994), and few have evaluated differences in fiber quality that potentially influence the gross revenue generated for the cotton crop (Lege', et al., 2007; Cook et al., 2003; Cook et al., 2002).

Our objective was to compare variety yield and fiber quality performance from wide-scale variety trials conducted throughout the midsouth and southeast regions of the U.S. that differed in the presence of nematode species and populations.

MATERIALS AND METHODS

Lint yield and fiber quality data were compiled from 212 variety trials in 2005 and 161 variety trials in 2006 in the midsouth and southeast areas of the U.S. cotton belt. Large-plot, on-farm variety trials conducted by Delta and Pine Land Company technical service

agronomists comprised 86% of the total trials, of which about two-thirds were non-replicated strip trials, and the remainder was replicated three times. Other similar large-plot trials included county Extension variety trials (7% of total) and private consultant variety trials (2% of total). These large-plot trials averaged eight to ten varieties each, with average plot sizes of eight 96-cm rows 340 m in length. The remainder of the data was compiled from state university small-plot (typically two 96-cm rows 15 m in length) replicated variety trials. All trials were machine-harvested by spindle pickers. Seedcotton samples from the Delta and Pine Land Company trials were ginned on micro-gins designed to simulate commercial ginning on a research scale at Scott, MS, or Harstville, SC. These micro-gins include pre-cleaning equipment, as well as one stage of lint-cleaning. Seedcotton samples from other trial sources were ginned on a range of gins that were typically small, table-top devices with no pre-cleaning or lint cleaning. Fiber quality from the lint produced in the Delta and Pine Land Company trials was determined by High Volume Instrumentation (HVI) located at the Delta and Pine Land Company fiber laboratory at Scott, MS. Fiber quality from the other trial sources was similarly determined by HVI, but these analyses were conducted by other fiber laboratories, as arranged by state universities and county Extension agents.

A composite soil sample was collected by Delta and Pine Land Company technical service agronomists at each of the trial locations during a period from crop defoliation through immediately following harvest, as recommended by most state Extension services (e.g., Koenning, et al., 2004). One composite sample, comprised of at least four randomly-selected subsamples was collected to represent the entire variety trial. Samples were stored in ice coolers and refrigerators prior to overnight shipping to the laboratory for nematode analysis. All samples were analyzed by Usery Consulting, Inc. (Elkmont, AL) to determine species and population level. Population levels of reniform (*Rotylenchulus reniformis*), southern root knot (*Meloidogyne incognita*), and Columbia lance (*Hopololaimus columbus*) nematodes were expressed in nematodes per 150 cm^{-3} of soil. Data reported herein will discuss results associated only with reniform and root knot nematodes.

Data were sorted by the presence or absence of each nematode species. Direct, balanced comparisons (head-to-head comparison of pairs of varieties, where both varieties were present at every trial location) of selected varieties were made within each nematode population category. Lint yield, fiber quality parameters (HVI fiber length, fiber strength, micronaire, and length uniformity), percent gin turnout, crop value (loan value multiplied by lint yield per unit land area), and loan value (price per unit of lint, as determined by 2006 USDA CCC loan schedule, +/- premiums and discounts based on \$1.1466 kg^{-1} lint, available at **www.plainscotton.org/2006LoanPage.html**) were analyzed by t tests to determine if means were statistically different. To minimize confounding due to geography between the nematode population categories, data from the trials for which no nematodes were detected were restricted to the states in which trials where nematodes were detected for that same variety comparison. Selection of varieties to compare was based on the findings of Legé et al., 2007. For root knot nematode comparisons, the yield and fiber quality performance of DP 117 B2RF, DP 445 BG/RR, DP 515 BG/RR, and DP 555 BG/RR were compared to that of ST5599BR, the only known commercially-available root knot tolerant variety (Barfield, 2003). For reniform nematode comparisons, the lint yield and fiber quality performance of DP 117 B2RF, DP 515 BG/RR, and DP 555 BG/RR were compared to that of DP 445 BG/RR, the variety reported to produce consistently higher lint yields compared to several commercially-available varieties in reniform-infested trials (Legé et al., 2007). Comparisons of DP 488 BG/RR, a variety observed as being less tolerant to reniform and rook knot nematodes than other elite germplasm, were also made versus DP 445 BG/RR for reniform and versus ST5599BR for root knot comparisons.

RESULTS AND DISCUSSION

Reniform Nematode

Yield was significantly higher for DP 445 BG/RR compared to DP 117 B2RF in trials across the midsouth and southeast regions of the U.S. where no reniform were detected, but there was no difference in yield performance between the two varieties in reniform-infested trials (Table 1). Similarly, significant differences in crop value, turnout, and fiber length were evident in trials with no reniform detected, with DP 445 BG/RR exhibiting higher crop value and turnout, and DP 117 B2RF producing longer fiber than DP 445 BG/RR. However, there were no differences found between the varieties for these parameters in reniform-infested trials. Length uniformity and loan value were significantly higher for DP 445 BG/RR, regardless of reniform level. Since no differences in crop value or lint yield were detected in reniform-infested soils, these data suggest DP 117 B2RF was as tolerant to reniform nematode as DP 445 BG/RR.

DP 488 BG/RR produced similar yield and crop value compared to DP 445 BG/RR in trials where no reniform were detected, but in reniform-infested trials, DP 445 BG/RR produced significantly higher yield and crop value than DP 488 BG/RR (Table 2). Fiber length was significantly higher for DP 488 BG/RR, but length uniformity was significantly higher for DP 445 BG/RR, regardless of reniform level. Micronaire did not differ between the varieties in trials where no reniform were detected, but DP 445 BG/RR produced significantly lower micronaire values than DP 488 BG/RR in reniform-infested trials. Similarly, DP 445 BG/RR produced significantly stronger fiber than DP 488 BG/RR in reniform-infested trials, whereas in trials where no reniform were detected, there were no differences in fiber strength between the varieties. Loan value did not differ between the varieties, regardless of reniform level. Based on the significantly lower yield and crop value in reniform-infested soils, these data suggest DP 488 BG/RR was less tolerant to reniform nematodes than DP 445 BG/RR.

Yield, crop value, turnout, and fiber length did not differ between DP 515 BG/RR and DP 445 BG/RR, regardless of reniform level (Table 3). However, DP 445 BG/RR had significantly lower micronaire and length uniformity versus DP 515 BG/RR in trials where no reniform were detected, where as those fiber quality parameters did not differ between the varieties in reniform-infested trials. Fiber strength and loan value were significantly higher for DP 445 BG/RR compared to DP 515 BG/RR, regardless of reniform level. These data indicate no difference in tolerance to reniform nematode between DP 515 BG/RR and DP 445 BG/RR, based on the similarity in yield and crop values produced, regardless of reniform nematode infestation level.

DP 555 BG/RR produced significantly higher yield than DP 445 BG/RR in trials where no reniform were found, but produced similar yield in reniform-infested trials (Table 4). DP 555 BG/RR had significantly higher turnout than DP 445 BG/RR, but DP 445 BG/RR produced significantly longer and stronger fiber, with significantly higher length uniformity and loan value, and significantly reduced micronaire than DP 555 BG/RR, regardless of reniform level. Based on these data, DP 555 BG/RR was as tolerant to reniform nematode as DP 445 BG/RR, but was a superior variety to DP 445 BG/RR in fields with no reniform present.

Root Knot Nematode

Lint yield and crop value was significantly higher for DP 117 B2RF compared to ST5599BR, the root knot nematode tolerant standard variety (Williams et al., 2004; Barfield, 2003), in

root knot nematode-infested trials across the midsouth and southeast regions of the U.S.; however, yield and crop value did not differ between the two varieties in trials where no root knot nematodes were detected (Table 5). Turnout was significantly higher for ST5599BR than DP 117 B2RF in trials where no root knot nematodes were found, but did not differ in root knot nematode-infested trials. Fiber length and strength were significantly higher for DP 117 B2RF versus ST5599BR in trials where no root knot nematodes were detected, but these parameters did not differ between the varieties in trials infested with root knot nematodes. Micronaire was significantly reduced for DP 117 B2RF compared to ST5599BR, regardless of root knot nematode level, while length uniformity and loan value did not differ between the varieties in the presence or absence of root knot nematodes. Based on these data, DP 117 B2RF was significantly more tolerant of root knot nematodes than ST5599BR.

DP 445 BG/RR produced significantly higher yield and crop value than ST5599BR in root knot nematode-infested trials, but these parameters did not differ between the varieties in fields where no root knot nematodes were detected (Table 6). Turnout, fiber length, fiber strength, length uniformity, and loan value were significantly increased, and micronaire significantly decreased for DP 445 BG/RR versus ST5599BR, regardless of root knot nematode level. These data suggest DP 445 BG/RR was more tolerant of root knot nematodes than ST5599BR, the root knot nematode tolerant standard variety.

Lint yield and turnout values did not differ between DP 488 BG/RR and ST5599BR, regardless of root knot nematode level; crop values, however, were significantly higher for DP 488 BG/RR versus ST5599BR in trials where no root knot nematodes were found, while in the presence of the pests, no differences between the varieties were evident (Table 7). Fiber length, fiber strength, length uniformity, and loan value were significantly higher, and micronaire significantly reduced for DP 488 BG/RR over ST5599BR, regardless of root knot nematode level. Since crop value and yield did not differ between the two varieties in the presence of root knot nematodes, these data suggest similar root knot nematode tolerance between DP 488 BG/RR and ST5599BR; however, the significantly higher crop values produced by DP 488 BG/RR compared to ST5599BR in trials where no root knot nematodes were found suggests DP 488 BG/RR performed relatively better than ST5599BR, although lint yields did not differ between the two varieties in fields not known to have root knot nematode.

Significantly improved crop value, lint yields, turnout, fiber strength, length uniformity, and loan value, and significantly lower micronaire values were produced by DP 515 BG/RR over ST5599BR in trials where no root knot nematodes were detected, but these values did not differ between the varieties in root knot nematode-infested trials (Table 8). Fiber length did not differ between the varieties, regardless of root knot nematode infestation level. These data suggest that, while DP 515 BG/RR tolerated root knot nematode infestations as well as ST5599BR, the tolerant standard variety, its performance was significantly improved over ST5599BR in trials where root knot nematodes were not found.

In trials where root knot nematodes were detected, yield and crop value did not differ between DP 555 BG/RR and ST5599BR, but DP 555 BG/RR produced significantly higher yield and crop value over ST5599BR in trials where no root knot nematodes were found (Table 9). Turnout was significantly higher for DP 555 BG/RR than ST5599BR, regardless of root knot nematode infestation level. Fiber length and micronaire were significantly higher for ST5599BR than DP 555 BG/RR in trials where root knot nematodes were found, but these parameters did not differ between the varieties in trials where no root knot nematodes were detected. Fiber strength and loan values did not differ between the

varieties, regardless of root knot nematode level. Length uniformity was significantly improved for ST5599BR over DP 555 BG/RR in trials where no root knot nematodes were found, but this value did not differ between the varieties in trials where root knot nematodes were detected. DP 555 BG/RR performed as well as ST5599BR in trials where root knot nematodes were found, indicating its tolerance against the pest may be similar to that of the tolerant standard variety; however, since the yield performance of DP 555 BG/RR was significantly better than ST5599BR in trials where no root knot nematodes were found, this variety may be more well-suited to fields where root knot nematodes are not elevated in population.

Summary

While high levels of resistance to either reniform or root knot nematodes are lacking in current commercial cotton varieties, some studies have reported the existence of varying levels of field tolerance among varieties commercially available (Lege' et al., 2007; Usery et al., 2004; Cook et al., 2003; Cook et al., 2002). Therefore, continued evaluation of commercial varieties is needed to assess tolerance levels to both pests.

Our data indicate that DP 445 BG/RR and DP 117 B2RF had higher tolerance of root knot nematode compared to the standard tolerant variety, ST5599BR (Williams et al, 2004; Barfield, 2003), based on yield performance data across the midsouth and southeast regions of the U.S. cotton belt in 2005-2006 (Table 10). Three other varieties, DP 488 BG/RR, DP 515 BG/RR, and DP 555 BG/RR, had similar tolerance of root knot nematode versus ST5599BR, based on yield performance across the same geography and years.

A previous report indicated that DP 445 BG/RR produced consistently higher lint yields compared to several commercially-available varieties in reniform-infested trials (Lege' et al., 2007). The data reported herein demonstrate that yield performance of DP 117 B2RF, DP 515 BG/RR, and DP 555 BG/RR were similar to that of DP 445 BG/RR in reniform-infested trials, suggesting these varieties have similar tolerance to reniform nematode compared to DP 445 BG/RR (Table 10). DP 488 BG/RR, however, had significantly lower tolerance to reniform nematode versus DP 445 BG/RR, based on the yield data across the midsouth and southeast regions of the U.S. cotton belt (Table 10).

In most of the comparisons reported in this study, differences in turnout and fiber quality parameters between varieties were similar in trials where no nematodes were detected versus trials that were infested with either species. However, several comparisons included in our data showed significant differences of various fiber quality and turnout traits either in the presence of one of the nematode species, and not in trials where we detected neither species, or visa versa (Table 1 turnout and fiber length; Table 2 micronaire and fiber strength; Table 3 micronaire and length uniformity; Table 5 turnout, fiber length, and fiber strength; Table 7 length uniformity; Table 8 turnout, micronaire, fiber strength, length uniformity, and loan value; Table 9 fiber length, micronaire, and length uniformity). The relatively small magnitude of those differences with regard to the presence or absence of either nematode species was very similar for those traits; therefore, any statistical differences for turnout and fiber quality traits were likely due to anomalies related to the difference in the number of trials within each nematode category (i.e., infested trials versus those where no nematodes were detected), or confounding factors related to the locations where we detected a nematode species versus where no nematodes were found for any given variety comparison. The statistical differences detected for yield in those comparisons

were of greater magnitude, and therefore suggest those differences were not due to statistical anomalies, but rather to varietal differences in field tolerance to the nematode pests.

Studies evaluating variety performance in response to nematode infestations reported previously have involved very limited number of trial locations or years, have lacked close examination of potential fiber quality differences, and typically utilized small-plot research techniques. Our data were collected from a wide geography, utilized predominantly large-plot research methods, closely examined fiber quality traits, and included numerous locations over a two-year period to the extent that has not been reported previously. Our data included some confounding effects, however, due to the difference in locations where we detected a nematode species versus where no nematodes were found, but the increased number of environments sampled afforded by our methodology did compensate in our ability to more accurately assess variety performance in a larger number of environments where nematodes were found versus where no nematodes were detected, compared to previously reported studies. Therefore, the methodology utilized in this study provided an effective means by which to evaluate relative varietal differences in field tolerance to reniform and root knot nematodes.

Variation in tolerance to reniform and root knot nematodes was evident among the six commercially-available cotton varieties evaluated in this study, based on the definition of tolerance as a trait that allows the plant to maintain an acceptable level of productivity under normal nematode infection levels that would reduce yield in non-tolerant genotypes (Koenning et al., 2004; Robinson et al., 2001; Painter, 1951). Only one of the varieties, ST5599BR, is reported to exhibit moderate genetic resistance to root knot nematode; however, the other varieties in this study displayed similar or better field tolerance to root knot nematodes than the only variety reported to have genetic resistance. This suggests there are other factors contributing to the observed field tolerance of root knot and reniform nematodes in this study, aside from genetic resistance. Continued evaluation of field tolerance, therefore, is warranted on newly released commercial varieties to reniform and root knot nematodes.

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Table 1. Yield and fiber quality (HVI) performance comparisons of DP 117 B2RF and DP 445 BG/RR in trials infested with reniform nematode versus trials where no reniform were detected in 2005-06 in AL, GA, LA, MS, and SC. Within each nematode population category, both varieties were present at every trial location.

Variety	Crop Value ($ ha^{-1})^{z}	Kg Lint ha^{-1}	% Turn-out	Fiber Length (mm)	Micro-naire	Fiber Strength (kN m kg^{-1})	% Length Uni-formity	Loan Value ($ kg^{-1})^{y}
Reniform-infested trials (n=25; mean reniform = 773/150 cm^{-3})								
DP 117 B2RF	1218	1027	37.0	28.4	4.53	298.5	82.0	1.1739
DP 445 BG/RR	1265	1021	37.8	28.4	4.50	307.6	82.6	1.2324
T test^{x}	ns	ns	ns	ns	ns	ns	*	***
Trials with no reniform detected (n=70)								
DP 117 B2RF	1329	1138	38.0	28.6	4.60	304.0	82.3	1.1658
DP 445 BG/RR	1433	1196	39.4	28.1	4.65	302.0	82.6	1.1944
T test	***	**	***	***	ns	ns	*	***

z Crop value = kg lint ha^{-1} x loan value.

y Loan value based on 2006 USDA cotton loan schedule, with a basis of ($1.1466 kg^{-1}) +/- premiums/discounts.

x *, **, and * indicate significance at prob>|t| = 0.05, 0.01, and 0.001, respectively. ns = not significant.**

Table 2. Yield and fiber quality (HVI) performance comparisons of DP 488 BG/RR and DP 445 BG/RR in trials infested with reniform nematode versus trials where no reniform were detected in 2005-06 in AL, LA, and MS. Within each nematode population category, both varieties were present at every trial location.

Variety	Crop Value ($ ha^{-1})[z]	Kg Lint ha^{-1}	% Turn-Out	Fiber Length (mm)	Micro-naire	Fiber Strength (kN m kg^{-1})	% Length Uni-formity	Loan Value ($ kg^{-1})[y]
Reniform-infested trials (n=28; mean reniform = 1126/150 cm^{-3})								
DP 488 BG/RR	1220	982	36.2	29.2	4.43	300.9	82.1	1.2348
DP 445 BG/RR	1309	1048	37.3	28.9	4.35	311.0	83.0	1.2460
T test[x]	*	*	**	ns	*	*	***	ns
Trials with no reniform detected (n=45)								
DP 488 BG/RR	1386	1141	38.2	29.0	4.57	295.1	82.5	1.2088
DP 445 BG/RR	1354	1136	39.1	28.2	4.50	302.9	83.1	1.2088
T test	ns	ns	***	***	ns	ns	*	ns

z Crop value = kg lint ha^{-1} x loan value.

y Loan value based on 2006 USDA cotton loan schedule, with a basis of ($1.1466 kg^{-1}) +/- premiums/discounts.

x *, **, and * indicate significance at prob>|t| = 0.05, 0.01, and 0.001, respectively. ns = not significant.**

Table 3. Yield and fiber quality (HVI) performance comparisons of DP 515 BG/RR and DP 445 BG/RR in trials infested with reniform nematode versus trials where no reniform were detected in 2005-06 in AL, AR, GA, LA, MS, and SC. Within each nematode population category, both varieties were present at every trial location.

Variety	Crop Value ($ ha^{-1})[z]	Kg Lint ha^{-1}	% Turn-Out	Fiber Length (mm)	Micro-naire	Fiber Strength (kN m kg^{-1})	% Length Uni-formity	Loan Value ($ kg^{-1})[y]
Reniform-infested trials (n=40; mean reniform = 785/150 cm^{-3})								
DP 515 BG/RR	1363	1132	37.4	28.4	4.56	292.3	82.6	1.2128
DP 445 BG/RR	1386	1119	37.3	28.7	4.40	310.3	82.8	1.2377
T test[x]	ns	ns	ns	ns	ns	**	ns	*
Trials with no reniform detected (n=107)								
DP 515 BG/RR	1470	1252	39.0	28.1	4.69	287.0	82.1	1.1737
DP 445 BG/RR	1462	1217	39.0	28.3	4.57	303.6	82.7	1.2011
T test	ns	ns	ns	ns	*	***	***	**

z Crop value = kg lint ha^{-1} x loan value.

y Loan value based on 2006 USDA cotton loan schedule, with a basis of ($1.1466 kg^{-1}) +/- premiums/discounts.

x *, **, and * indicate significance at prob>|t| = 0.05, 0.01, and 0.001, respectively. ns = not significant.**

Table 4. Yield and fiber quality (HVI) performance comparisons of DP 555 BG/RR and DP 445 BG/RR in trials infested with reniform nematode versus trials where no reniform were detected in 2005-06 in AL, GA, LA, MS, and SC. Within each nematode population category, both varieties were present at every trial location.

Variety	Crop Value ($ ha^{-1})[z]	Kg Lint ha^{-1}	% Turn-out	Fiber Length (mm)	Micro-naire	Fiber Strength (kN m kg^{-1})	% Length Uni-formity	Loan Value ($ kg^{-1})[y]
Reniform-infested trials (n=45; mean reniform = 897/150 cm^{-3})								
DP 555 BG/RR	1299	1076	39.1	27.9	4.53	282.2	81.6	1.2002
DP 445 BG/RR	1312	1056	37.4	28.7	4.39	311.4	82.8	1.2372
T test[x]	ns	ns	***	***	**	***	***	***
Trials with no reniform detected (n=111)								
DP 555 BG/RR	1529	1314	40.9	27.7	4.71	279.7	81.2	1.1612
DP 445 BG/RR	1462	1234	39.4	28.3	4.60	301.7	82.9	1.1916
T test	ns	**	***	***	*	***	***	***

z Crop value = kg lint ha^{-1} x loan value.

y Loan value based on 2006 USDA cotton loan schedule, with a basis of ($1.1466 kg^{-1}) +/- premiums/discounts.

x *, **, and * indicate significance at prob>|t| = 0.05, 0.01, and 0.001, respectively. ns = not significant.**

Table 5. Yield and fiber quality (HVI) performance comparisons of DP 117 B2RF and ST5599BR in trials infested with root knot nematode versus trials where no root knot nematodes were detected in 2005-06 in GA, LA, MS, NC, and SC. Within each nematode population category, both varieties were present at every trial location.

Variety	Crop Value ($ ha^{-1})^{z}	Kg Lint ha^{-1}	% Turn-Out	Fiber Length (mm)	Micro-naire	Fiber Strength (kN m kg^{-1})	% Length Uni-formity	Loan Value ($ kg^{-1})^{y}
Root knot-infested trials (n=9; mean root knot nematode = 179/150 cm^{-3})								
DP 117 B2RF	1442	1241	38.0	29.0	4.49	306.6	82.8	1.1545
ST5599BR	1287	1120	37.7	28.3	4.69	289.9	82.2	1.1468
T test^{x}	**	*	ns	ns	*	ns	ns	ns
Trials with no root knot detected (n=29)								
DP 117 B2RF	1388	1170	37.8	28.4	4.55	299.2	82.0	1.1658
ST5599BR	1440	1236	38.4	28.0	4.82	282.1	82.1	1.1944
T test	ns	ns	*	*	***	***	ns	ns

z Crop value = kg lint ha^{-1} x loan value for each individual trial; due to rounding, mean crop value may not be equivalent to the mean lint yield multiplied by mean loan value.

y Loan value based on 2006 USDA cotton loan schedule, with a basis of ($1.1466 kg^{-1}) +/- premiums/discounts.

x *, **, and * indicate significance at prob>|t| = 0.05, 0.01, and 0.001, respectively. ns = not significant.**

Table 6. Yield and fiber quality (HVI) performance comparisons of DP 445 BG/RR and ST5599BR in trials infested with root knot nematode versus trials where no root knot nematodes were detected in 2005-06 in AL, AR, FL, GA, LA, MO, MS, NC, SC, and TN. Within each nematode population category, both varieties were present at every trial location.

Variety	Crop Value ($ ha^{-1})[z]	Kg Lint ha^{-1}	% Turn-Out	Fiber Length (mm)	Micro-naire	Fiber Strength (kN m kg^{-1})	% Length Uni-formity	Loan Value ($ kg^{-1})[y]
Root knot-infested trials (n=38; mean root knot nematode = 185/150 cm^{-3})								
DP 445 BG/RR	1615	1326	37.9	29.0	4.41	307.8	83.2	1.2285
ST5599BR	1487	1247	37.3	28.5	4.59	292.7	82.4	1.1909
T test[x]	***	**	*	***	***	***	***	**
Trials with no root knot detected (n=109)								
DP 445 BG/RR	1465	1215	39.0	28.5	4.44	308.9	83.1	1.22128
ST5599BR	1391	1186	38.3	28.0	4.65	289.6	82.1	1.1768
T test	ns	ns	***	**	***	***	***	***

z Crop value = kg lint ha^{-1} x loan value for each individual trial; due to rounding, mean crop value may not be equivalent to the mean lint yield multiplied by mean loan value.

y Loan value based on 2006 USDA cotton loan schedule, with a basis of ($1.1466 kg^{-1}) +/- premiums/discounts.

x *, **, and * indicate significance at prob>|t| = 0.05, 0.01, and 0.001, respectively. ns = not significant.**

Table 7. Yield and fiber quality (HVI) performance comparisons of DP 488 BG/RR and ST5599BR in trials infested with root knot nematode versus trials where no root knot nematodes were detected in 2005-06 in AL, AR, FL, GA, LA, MS, NC, SC, and TN. Within each nematode population category, both varieties were present at every trial location.

Variety	Crop Value ($ ha^{-1})[z]	Kg Lint ha^{-1}	% Turn-Out	Fiber Length (mm)	Micro-naire	Fiber Strength (kN m kg^{-1})	% Length Uni-formity	Loan Value ($ kg^{-1})[y]
Root knot-infested trials (n=27; mean root knot nematode = 205/150 cm^{-3})								
DP 488 BG/RR	1482	1217	37.2	29.3	4.52	294.9	82.4	1.2147
ST5599BR	1418	1193	34.5	28.4	4.62	288.1	82.1	1.1874
T test[x]	ns	ns	ns	***	*	**	ns	**
Trials with no root knot detected (n=70)								
DP 488 BG/RR	1403	1164	38.1	29.2	4.55	301.5	82.6	1.2044
ST5599BR	1334	1136	38.3	27.9	4.65	286.9	81.9	1.1726
T test	**	ns	ns	***	**	***	***	***

z Crop value = kg lint ha^{-1} x loan value for each individual trial; due to rounding, mean crop value may not be equivalent to the mean lint yield multiplied by mean loan value.

y Loan value based on 2006 USDA cotton loan schedule, with a basis of ($1.1466 kg^{-1}) +/- premiums/discounts.

x *, **, and * indicate significance at prob>|t| = 0.05, 0.01, and 0.001, respectively. ns = not significant.**

Table 8. Yield and fiber quality (HVI) performance comparisons of DP 515 BG/RR and ST5599BR in trials infested with root knot nematode versus trials where no root knot nematodes were detected in 2005-06 in AL, AR, FL, GA, LA, MO, MS, NC, SC, and TN. Within each nematode population category, both varieties were present at every trial location.

Variety	Crop Value ($ ha^{-1})[z]	Kg Lint ha^{-1}	% Turn-out	Fiber Length (mm)	Micro-naire	Fiber Strength (kN m kg^{-1})	% Length Uni-formity	Loan Value ($ kg^{-1})[y]
Root knot-infested trials (n=33; mean root knot nematode = 173/150 cm^{-3})								
DP 515 BG/RR	1583	1222	37.6	28.8	4.56	294.5	82.8	1.1958
ST5599BR	1561	1198	37.2	28.6	4.63	295.0	82.6	1.1896
T test[x]	ns	ns	ns	ns	ns	ns	ns	ns
Trials with no root knot detected (n=87)								
DP 515 BG/RR	1442	1208	38.6	28.1	4.59	291.1	82.3	1.1881
ST5599BR	1346	1149	38.2	28.0	4.68	286.9	82.0	1.1693
T test	***	***	**	ns	**	*	**	**

z Crop value = kg lint ha^{-1} x loan value for each individual trial; due to rounding, mean crop value may not be equivalent to the mean lint yield multiplied by mean loan value.

y Loan value based on 2006 USDA cotton loan schedule, with a basis of ($1.1466 kg^{-1}) +/- premiums/discounts.

x *, **, and * indicate significance at prob>|t| = 0.05, 0.01, and 0.001, respectively. ns = not significant.**

Table 9. Yield and fiber quality (HVI) performance comparisons of DP 555 BG/RR and ST5599BR in trials infested with root knot nematode versus trials where no root knot nematodes were detected in 2005-06 in AL, AR, FL, GA, LA, MS, NC, and SC. Within each nematode population category, both varieties were present at every trial location.

Variety	Crop Value ($ ha^{-1})[z]	Kg Lint ha^{-1}	% Turn-Out	Fiber Length (mm)	Micro-naire	Fiber Strength (kN m kg^{-1})	% Length Uni-formity	Loan Value ($ kg^{-1})[y]
Root knot-infested trials (n=29; mean root knot nematode = 193/150 cm^{-3})								
DP 555 BG/RR	1447	1225	39.5	28.2	4.56	282.9	81.9	1.1806
ST5599BR	1415	1200	37.5	28.5	4.67	289.4	82.3	1.1786
T test[x]	ns	ns	***	*	*	ns	ns	ns
Trials with no root knot detected (n=94)								
DP 555 BG/RR	1440	1224	40.8	27.7	4.62	278.9	81.2	1.1698
ST5599BR	1349	1161	38.7	27.9	4.70	284.6	81.9	1.1647
T test	ns	**	***	ns	ns	ns	*	ns

z Crop value = kg lint ha^{-1} x loan value for each individual trial; due to rounding, mean crop value may not be equivalent to the mean lint yield multiplied by mean loan value.

y Loan value based on 2006 USDA cotton loan schedule, with a basis of ($1.1466 kg^{-1}) +/- premiums/discounts.

x *, **, and * indicate significance at prob>|t| = 0.05, 0.01, and 0.001, respectively. ns = not significant.**

Table 10. Summary of tolerance of selected varieties versus comparison varieties for reniform and root knot nematodes, based on yield performance across the midsouth and southeast regions of the U.S. in 2005-2006.

Variety	Reniform nematode tolerance vs. DP 445 BG/RR	Root knot nematode tolerance vs. ST5599BR
DP 117 B2RF	Similar	Higher
DP 445 BG/RR	n/a	Higher
DP 488 BG/RR	Lower	Similar
DP 515 BG/RR	Similar	Similar
DP 555 BG/RR	Similar	Similar