COMPARATIVE PERFORMANCE OF RENIFORM NEMATODE RESISTANT GERMPLASM LINES

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Abstract

A decade long concerted effort to develop host plant resistance to reniform nematode in upland cotton has resulted in the release of several germplasm lines. During 2013, thirteen such lines were subjected to a comparative field performance study on two nearby fields, one with and the other without a standing reniform nematode population. The trials were repeated in 2014, with the inclusion of six additional germplasm lines, and 2015, with the addition of two further lines. Results confirm that lines belonging to the BARBREN and M713 germplasm groups, which share a common source of resistance, reduce nematode reproduction while offering improved agronomic performance under reniform nematode infestation conditions.

Background

Since 2007, several upland cotton (*Gossypium hirsutum*) germplasm lines with introgressed resistance to reniform nematode (*Rotylenchulus reniformis*) have been released for use by the cotton breeding community. At present, four groups of released germplasm lines can be differentiated based on their source of resistance and developmental background:

(a) the LONREN group, with reniform nematode (RN) resistance derived from *G. longicalyx* (Bell *et al*, 2014),
(b) the BARBREN group, with RN resistance derived from the wild accession GB-713 of *G. barbadense* (USDA-ARS Notice of Release; 2014; Bell *et al*, 2015),
(c) the M713 group, also with resistance derived from the GB-713 accession, but with a different developmental trajectory (McCarty *et al.*, 2013), and
(d) the MT2468 group, with reportedly moderate levels of RN resistance derived from the photoperiodic primitive race accession TX2468 of *G. hirsutum* (McCarty *et al.*, 2012).

In order to further appreciate the production potential of each germplasm line, comparative field evaluations were performed for 3 consecutive years at the Tennessee Valley Research and Extension Center (TVREC) of the Alabama Agricultural Experiment Station near Belle Mina, Northern Alabama. In 2013, the first year of the study, the following 13 germplasm lines were included (Sikkens *et al.*, 2014):

- from the LONREN group: LONREN-1, LONREN-2 and LONREN 21-4, the latter a not formally released elite line;
- from the BARBREN group: BARBEN-713 and BARBREN-713-41;
- from the M713 group: five lines named M713 Ren1 to Ren5; and
- from the MT2468 group: three lines named MT2468 Ren1 to Ren3.

Conventional cultivars FiberMax 966 (FM966) and SureGrow 747 (SG747) were included as reniform nematode (RN) susceptible controls.

In 2014, five additional BARBREN lines were added to the study: BARBREN-713-11, -13, -25, -33 and -48. The introduction of these lines was accompanied by a fresh seed supply of the BARBREN-713-41 line, which was kept as a separate entry. In 2015, two further BARBREN lines completed the study: BARBREN-713-8 and -32. The two RN susceptible cultivars FM966 and SG747 were maintained as controls throughout the study.

Materials and Methods

Field testing was conducted during all three years of the study on the same two fields at TVREC. One field has an established population of reniform nematode (hereafter indicated as the w/RN field). The other field, located some 200 m to the west, is free from reniform nematode (hereafter indicated as the noRN field). Due to tightness of space and field management considerations, the exact location of the yearly tests on the w/RN field varied somewhat. Figure 1 presents a drone image of the w/RN field, on which the locations of the three yearly tests are graphed. The 2013 and 2015 tests were located on the southwestern corner of the w/RN field, whereas the main 2014 test location was on the southeastern corner of the same field. Due to a lack of contiguous space, the additional BARBREN lines of 2014 were planted slightly north of the main test location of that year. On Figure 1 the location of the noRN field can also be distinguished.

Soils on both the w/RN and noRN fields are classified as a Decatur silt loam, with textural composition in the upper 15 cm horizon of 23% sand, 49% silt and 28% clay. Each field test used an independent RCBD lay-out, consisting of 5 replications of two 25-ft row plots for each entry (the additional BARBREN lines of 2014 only had 4 replications on the w/RN field). Planting dates were: in 2013: May 1 (w/RN) and May 2 (noRN); in 2014: May 8 (both fields); in 2015: May 6 (both fields). Soil samples (10 cm depth) were collected from the w/RN field at planting to determine initial nematode infestation levels.

At 41, 53 and 43 days after planting (DAP) in 2013, 2014 and 2015, respectively; four seedlings from each plot on the field w/RN were extracted. Root Fresh Weights (RFW) were determined on a per plot basis. Nematode eggs were collected from the combined root mass of each plot and counted.

By mid-season of 2014, widespread growth stunting was observed on the w/RN field. Subsequently, average plant heights were collected on July 23, 2014 (76 DAP) on both the w/RN and noRN fields. Similar height measurements were made during the 2015 study on July 13, 2015 (68 DAP). No mid-season plant heights were collected in 2013.

Harvesting dates were: in 2013: October 21 (noRN field), October 24 (w/RN field); in 2014: October 22 (noRN field) and October 23 and 24 (w/RN field); and in 2015: October 21 (noRN field) and November 5 (w/RN field). Immediately prior to harvesting, 25-boll samples were collected from each test plot, from which lint turnout percentages were calculated. Seed cotton weights from all plots were collected at harvest, and, using the obtained turnout rates, lint yield computed.

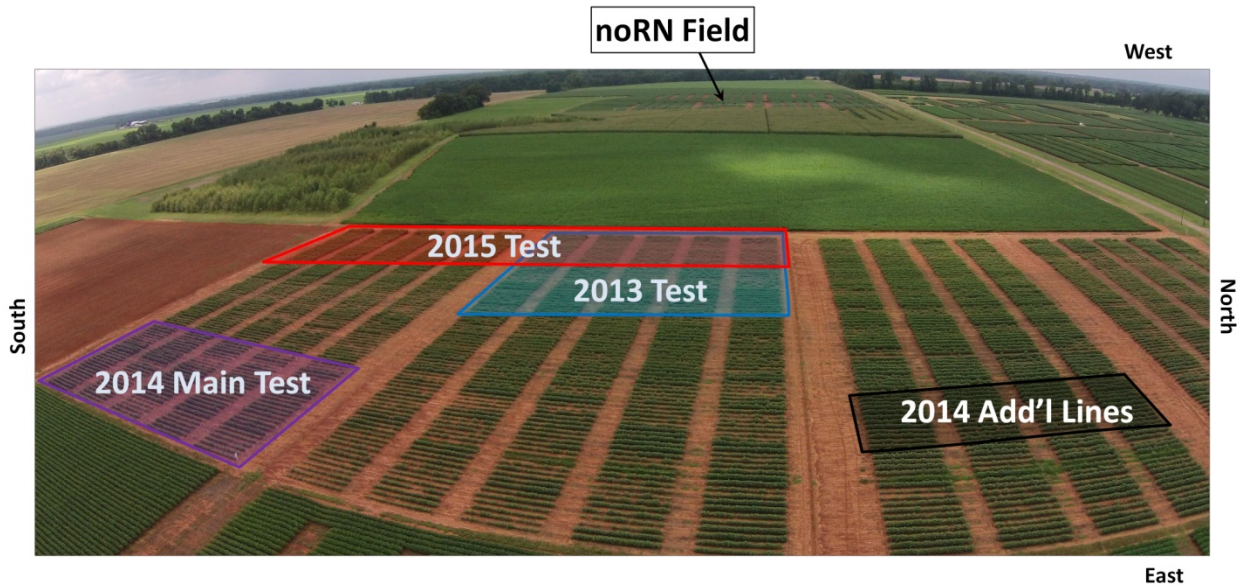

Figure 1. Location of the yearly tests on the Reniform Nematode infested field at TVREC.

Results and Discussion

Reniform nematode infestation levels at planting varied considerably from year to year (Table 1), at least in the 10 cm top soil layer from which soil samples were collected. They were comparatively low on the 2014 main test location, higher on the 2014 location of the additional BARBREN lines and significantly higher on the 2013 and 2015 test locations.

Table 1. Reniform Nematode (RN) infestation Levels at Planting.

Study Year	Sampling Date	Mean	St.Dev.
		(RN/150 cm^3 soil)	
2013	May 1	7602	4251
2014 (Main test location)	May 8	592	577
2014 (Additional lines)	May 8	2994	1847
2015	May 6	8729	3781

The results of early season nematode egg counts are summarized by germplasm group in Table 2. Remarkably, egg counts on roots of seedlings from the LONREN lines matched those of the susceptible controls. Lines of the BARBREN and M713 groups had consistently lower egg counts compared to those of the controls; the MT2468 lines also showed moderately lower egg counts.

Mid-season plant heights measured in 2014 and 2015 are presented in Table 3, again summarized by germplasm group. Reduction in plant heights was much more pronounced in 2014 compared to 2015. This is the more remarkable as nematode counts at planting and early-season egg counts were lower in 2014 than in 2015 (Table 1).

Table 4 presents a summary of lint yields obtained each year on both the w/RN and noRN fields, and indicates the relative difference in yields between the two fields. Differences in yield between the w/RN field and the noRN field were quite pronounced in 2014, reaching 43% reductions in the w/RN field for both the BARBREN and M713 groups on the main testing location (compared to 65% for the susceptible controls). That same year, however, yield losses for the additional BARBREN germplasm lines, planted slightly away from the main test site, were negligible, although initial RN infestation levels were higher there. Compared to 2014, overall yield losses in test years 2013 and 2015 were much more limited, especially for the BARBEN and M713 germplasm groups. Yield losses of LONREN lines exceeded those of the susceptible controls in each year of the study. The MT2468 group obtained only slightly better yields in 2013 and 2015 than the control group.

Conclusions

The results of this field experiment, conducted for 3 consecutive years on the same fields, are truly a study in contrasts. Despite much higher reniform numbers at planting time in 2013 and 2015, yield losses were much more limited compared to those observed in 2014. This remarkable outcome is the more astonishing when early-season egg counts are taken into consideration. It seems that local conditions influence the outcome of reniform nematode resistant related field trials. That being said, it is equally apparent that germplasm lines of the BARBREN and M713 groups, both with introgressed resistance originating from *G. barbadense* accession 713, suffered less yield losses in all three years compared to the susceptible controls. Yield losses for LONREN lines exceeded those of the susceptible controls in all three years, while the MT2468 lines offered only limited improvements. However, although the BARBREN and M713 lines fared comparatively better, they clearly are not unaffected by the presence of reniform nematode, as demonstrated by lower mid-season plant heights in 2014 and 2015. More insight in the plant - parasite interaction is probably needed to further improve nematode resistance and limit nematode related yield losses.

Acknowledgments

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Table 2. Mean early-season nematode egg counts by group.

Germplasm Group	2013 (41 DAP)	2014 (53 DAP)	2015 (43 DAP)
		(RNeggs/gRFW)*	
LONREN	17936	2604	5972
BARBREN (original)	3948	970	2077
M713	1349	760	2327
MT2468	5291	1357	4373
BARBREN (add'l lines)		200	1161
Susceptible Controls	17287	2347 / 1557**	6157

* Nematode eggs per gram of Root Fresh Weight.

** Controls planted with the additional BARBREN lines.

Table 3. Mean mid-season plant heights by germplasm group.

	2014 (76 DAP)			2015 (68 DAP)		
	Plant Heights		w/RN vs	Plant Heights		w/RN vs
Germplasm Group	noRN	w/RN	noRN	noRN	w/RN	noRN
	(cm)		(%)	(cm)		(%)
LONREN	89	29	-68	87	50	-42
BARBREN (original)	81	48	-39	80	69	-14
M713	85	51	-40	84	71	-15
MT2468	84	43	-49	80	64	-20
BARBREN (add'l lines)	71	63	-11	80	76	-5
Susceptible Controls	90	40	-56 / -43*	77	56	-27

* Controls planted on the location of the additional BARBREN lines.

Table 4. Mean lint yields by germplasm group 2013-2015.

	2013			2014			2015		
	Lint Yield		w/RN vs	Lint Yield		w/RN vs	Lint Yield		w/RN vs
Germplasm Line	noRN	w/RN	noRN	noRN	w/RN	noRN	noRN	w/RN	noRN
	(lbs/acre)		(%)	(lbs/acre)		(%)	(lbs/acre)		(%)
LONREN	1602	276	-84	1650	308	-81	1335	734	-45
BARBREN (original)	1598	1306	-18	1374	776	-43	1147	1104	-3
M713	1258	1193	-5	1339	755	-43	1124	1125	0
MT2468	1334	572	-57	1401	485	-65	994	818	-17
BARBREN (add'l lines)				1242	1210*	-3	1256	1303	4
Susceptible Controls	1511	511	-66	1638	570 / 798*	-65 / -51*	1317	905	-31
Seasonal Mean	1421	809	-43	1396	770	-45	1199	1075	-10

* In 2014, the additional BARBEN lines and supplementary controls were planted on a different tier of the w/RN field.

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