Use of LONREN Germplasm in a Breeding Program

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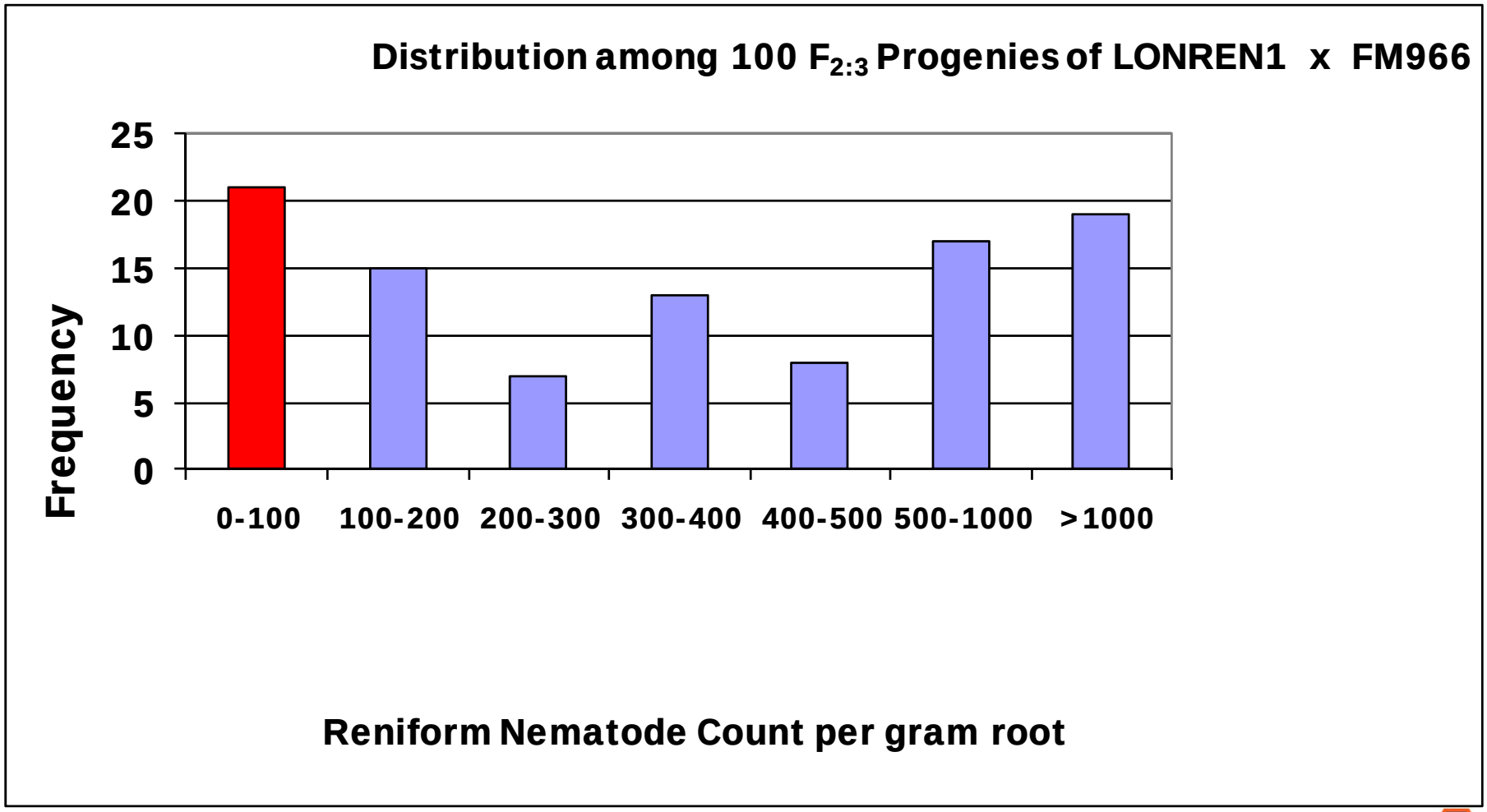
LONREN germplasm introgression

- Crosses have been made between several adapted cultivars and LONREN germplasm
- First population developed was LONREN-1 × Fibermax 966 (2007)
- Objectives (among others) were to observe effects of *REN*^{lon} gene on
  - Reaction to nematodes
  - Agronomic traits (with and without nematodes)
  - Fiber quality

LONREN germplasm introgression

- Lines advanced to $F_{2:3}$ generation
- 100 random lines subjected to nematode screening in greenhouse using standard protocols
- Lines evaluated for presence/absence of SSR marker BNL1066_156

Distribution of 100 random $F_{2:3}$ lines



Study initiated to determine effects of *REN*^{lon} gene in LONREN on agronomic and fiber traits

- Field experiments in nematode-infested fields (resistant and susceptible lines – 20 each, plus checks LONREN-1 and LONREN2, FM 966, DP 393)
  - 5 replicate 25 foot single row plots in infested and noninfested (confirmed by sampling) adjacent fields
  - Agronomic and fiber quality data collected

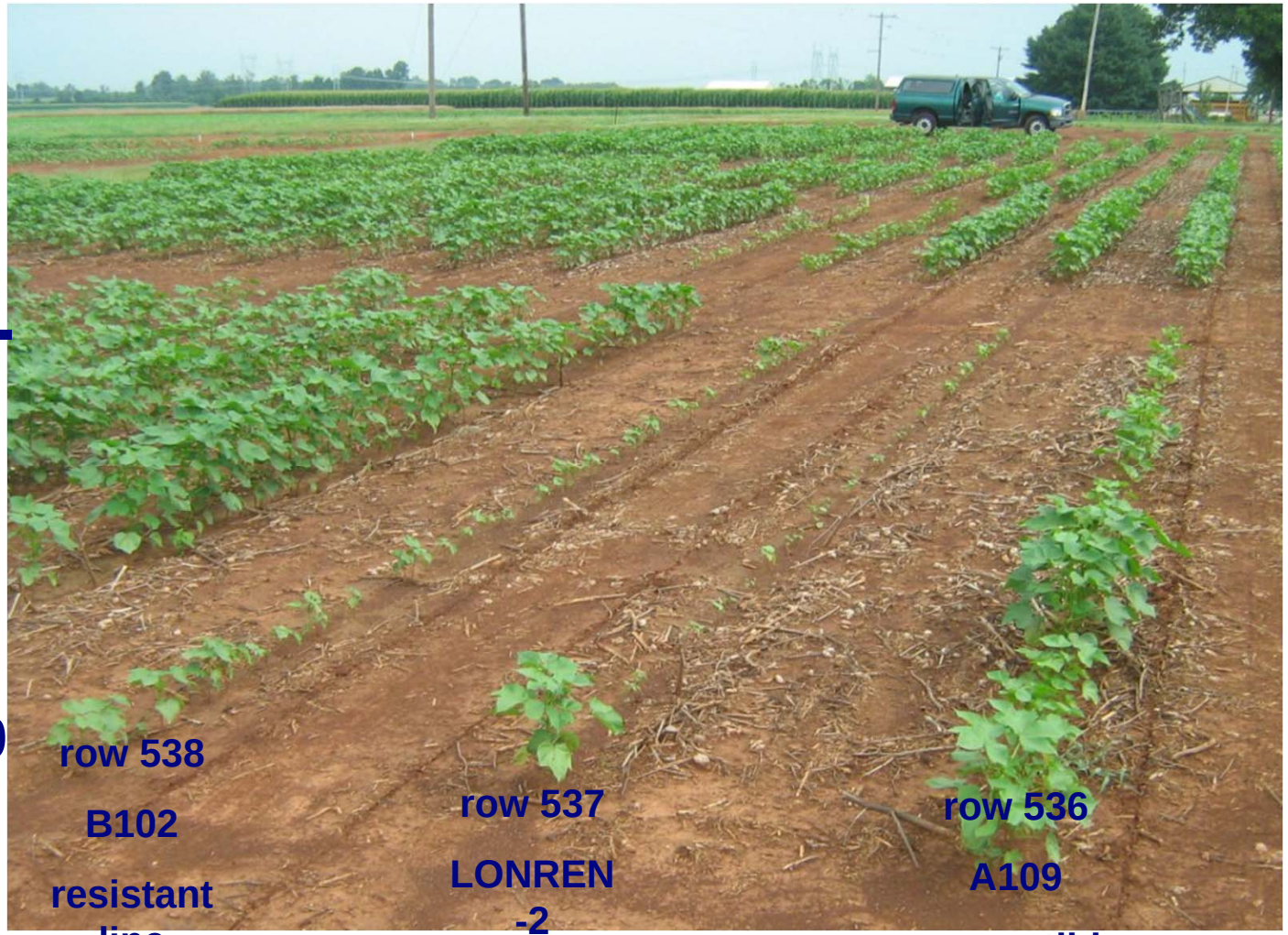
Seedling

Stunting

nematode-infested field

June 16, 2010

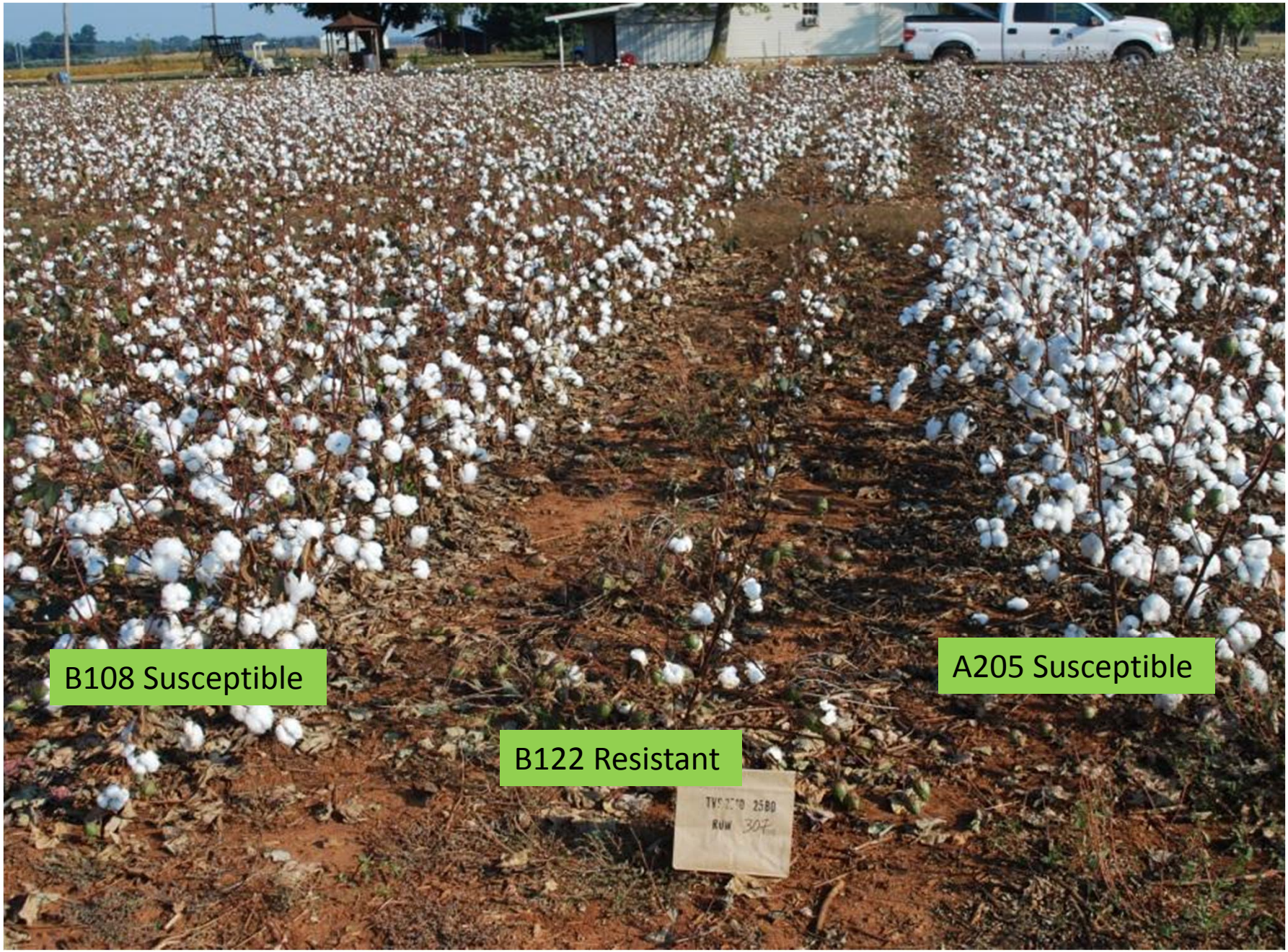
46 days after planting



Healthy Stand non-nematode-infested field

June 16, 2010

46 days after planting


B108 Susceptible
B122 Resistant
A205 Susceptible

Yields - TVREC 2010

Group means / Contrasts	Reniform present			Reniform absent			Yield Reduction
	Yield Estimate (lbs/acre)	StdErr	Probt	Yield Estimate (lbs/acre)	StdErr	Probt	
Group means							
Resistant lines	**834**	79.6		**1372**	52.0		**39%**
Susceptible lines	**1071**	79.6		**1448**	52.0		**26%**
LONREN-1 and -2	**845**	151.8		**1433**	89.3		**41%**
Susceptible checks	**913**	151.8		**1405**	89.3		**35%**
Group mean differences							
Resistant vs. susceptible lines	-237	60.9	**0.0171**	-76	34.3	0.2079	
Resistant vs. LONREN-1 and -2	-11	142.9	1.0000	-61	80.3	0.9331	
Susc. lines vs. susc. checks	158	142.9	0.7857	43	80.3	0.9818	
LONREN-1 + 2 vs. susc. checks	-68	192.7	0.9960	28	108.3	0.9988	

Yields - TVREC 2011

Group means / Contrasts	Reniform present			Reniform absent			Yield Reduction
	Yield Estimate (lbs/acre)	StdErr	Probt	Yield Estimate (lbs/acre)	StdErr	Probt	
Group means							
Resistant lines	**782**	42.8		**920**	19.8		**15%**
Susceptible lines	**921**	41.9		**962**	19.8		**4%**
LONREN-1 and -2	**746**	132.4		**906**	54.7		**18%**
Susceptible checks	**1044**	132.4		**1031**	54.7		**-1%**
Group mean differences							
Resistant vs. susceptible lines	-138	59.4	0.1096	-43	24.0	0.3685	
Resistant vs. LONREN-1 and -2	36	139.2	0.9987	13	56.4	0.9991	
Susc. lines vs. susc. checks	-123	138.9	0.8762	-68	56.4	0.7113	
LONREN-1 + 2 vs. susc. checks	-298	187.3	0.4362	-124	76.0	0.4474	

Two-year average – Lint Yield

Group means / Contrasts	Reniform present Yield Estimate (lbs/acre)	StdErr	Probt	Reniform absent Yield Estimate (lbs/acre)	StdErr	Probt	Yield Reduction
Group means							
Resistant lines	**808**	44.3		**1146**	27.3		**29%**
Susceptible lines	**996**	44.1		**1205**	27.3		**17%**
LONREN-1 and -2	**796**	100.5		**1170**	52.9		**32%**
Susceptible checks	**979**	100.5		**1218**	52.9		**20%**
Group mean differences							
Resistant vs. susceptible lines	-188	42.8	0.0023	-59	21.4	0.0584	
Resistant vs. LONREN-1 and -2	13	100.0	1.0000	-24	50.1	0.9868	
Susc. lines vs. susc. checks	17	99.9	0.9998	-13	50.1	0.9987	
LONREN-1 + 2 vs. susc. checks	-183	134.7	0.6248	-48	67.5	0.9446	

Year × Line interaction for Yield: Not significant

Lint quality - 2010

Group means

Group	Micronaire		UHM Length		Uniformity		Fiber Strength		Elongation		Short Fiber	
	RN field	non-RN field	RN field	non-RN field	RN field	non-RN field	RN field	non-RN field	RN field	non-RN field	RN field	non-RN field
Resistant lines	5.1	5.0	1.06	1.07	83.7	83.5	**31.7**	**31.4**	4.9	4.7	7.4	7.5
Susceptible lines	4.9	5.1	1.08	1.08	83.3	83.1	**30.1**	**30.2**	4.9	4.7	7.6	7.8
LONREN-1 and -2	4.8	5.0	1.05	1.06	83.2	83.3	29.8	29.8	5.3	4.5	8.0	7.9
Susceptible checks	4.8	4.7	1.11	1.12	83.9	83.3	31.4	31.1	5.1	4.9	7.3	8.1

Significant group mean difference

Trait	Group	Location	Standard Error	Proba-bility
Fiber Strength	Resistant vs. susceptible lines	Nematode field	0.33	0.0071
		Non-nematode field	0.29	0.0013

All other group mean differences are not significant

Lint quality - 2011

Group means

Group	Micronaire		UHM Length		Uniformity		Fiber Strength		Elongation		Short Fiber	
	RN field	non-RN field	RN field	non-RN field	RN field	non-RN field	RN field	non-RN field	RN field	non-RN field	RN field	non-RN field
Resistant lines	4.5	4.7	1.14	1.12	**84.2**	84.5	**33.2**	**34.3**	**5.7**	**4.3**	**6.8**	6.8
Susceptible lines	4.5	4.7	1.14	1.13	**83.6**	84.3	**31.1**	**32.1**	**6.0**	**4.6**	**7.1**	6.7
LONREN-1 and -2	4.3	4.5	1.13	1.12	83.4	84.6	30.7	31.9	5.7	4.2	8.0	6.6
Susceptible checks	4.5	4.5	1.19	1.16	84.8	85.0	32.6	32.6	6.2	4.7	7.3	6.6

Significant group mean difference

Trait	Group	Location	Standard Error	Proba-bility
Fiber Strength	Resistant vs. susceptible lines	Nematode field	0.18	0.0000
		Non-nematode field	0.18	0.0000
Elongation	Resistant vs. susceptible lines	Nematode field	0.05	0.0012
		Non-nematode field	0.00	0.0000

Two-year average - Lint quality

Group means

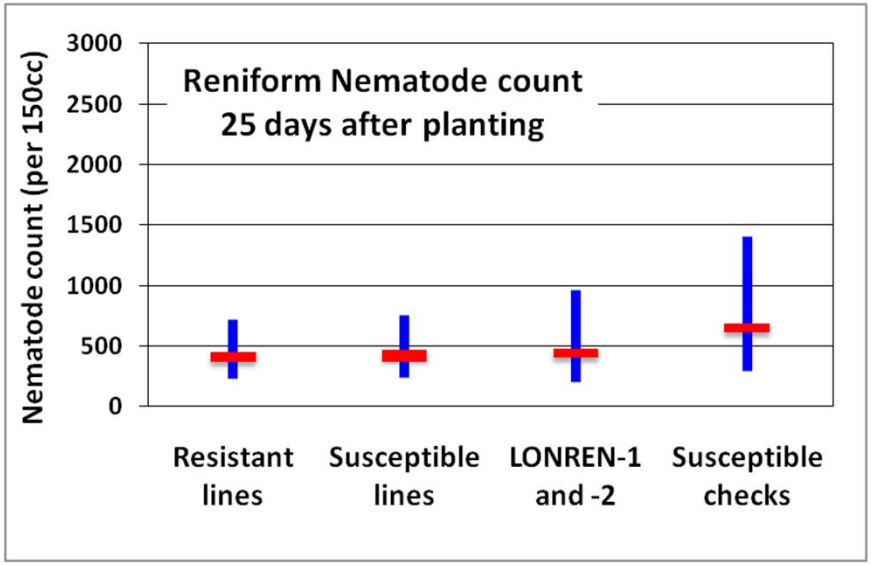
Group	Micronaire		UHM Length		Uniformity		Fiber Strength		Elongation		Short Fiber	
	RN field	non-RN field	RN field	non-RN field	RN field	non-RN field	RN field	non-RN field	RN field	non-RN field	RN field	non-RN field
Resistant lines	4.8	4.8	**1.10**	1.10	**84.0**	**84.0**	**32.4**	**32.8**	5.3	**4.5**	**7.1**	**7.0**
Susceptible lines	4.7	4.9	**1.11**	1.10	**83.5**	**83.7**	**30.6**	**31.1**	5.4	**4.7**	**7.3**	**7.3**
LONREN-1 and -2	4.5	4.7	1.09	1.09	83.3	83.9	30.2	30.9	5.5	4.4	7.6	7.3
Susceptible checks	4.6	4.6	1.15	1.14	84.3	84.1	32.0	31.7	5.6	4.8	7.1	7.3

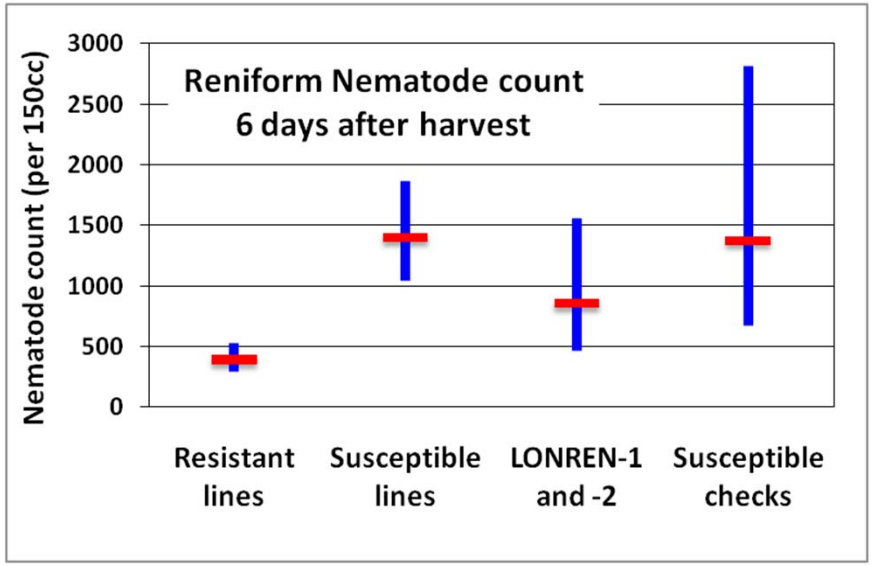
Significant group mean difference

Trait	Group	Location	Standard Error	Proba-bility	Year × Line?
Fiber Strength	Resistant vs. susceptible lines	Nematode field	0.21	0.0000	No
		Non-nematode field	0.18	0.0000	Yes
Uniformity	Resistant vs. susceptible lines	Nematode field	0.09	0.0001	Yes
		Non-nematode field	0.27	0.0697	No
Short Fiber	Resistant vs. susceptible lines	Nematode field	0.21	0.0022	No
		Non-nematode field	0.18	0.0035	No

Nematode counts - 2010

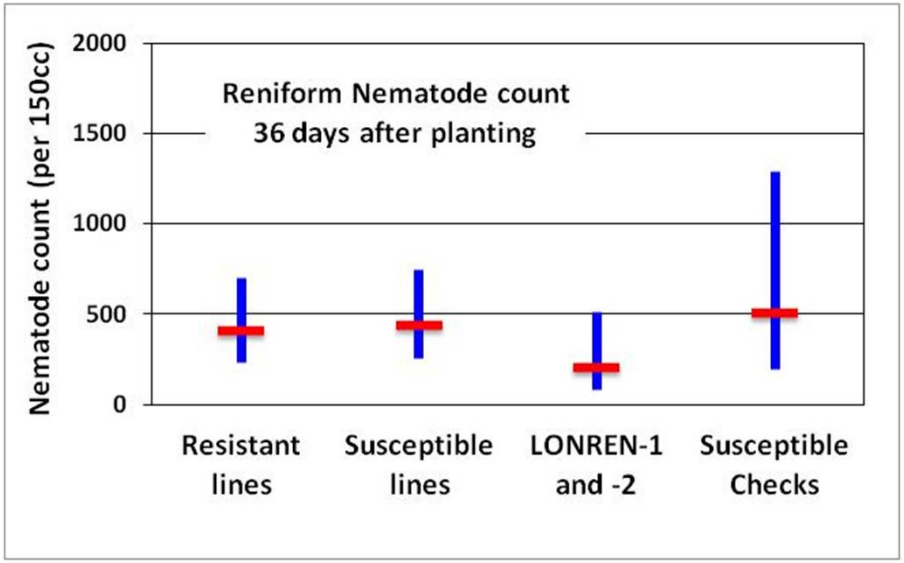
	25 days after planting				6 days after harvest			
Group means / Contrasts	Est.	Lower CL	Upper CL	Probt	Est.	Lower CL	Upper CL	Probt
Group means								
Resistant lines	**407**	230	719		**392**	291	528	
Susceptible lines	**425**	241	751		**1396**	1043	1868	
LONREN-1 and -2	**440**	202	959		**854**	467	1560	
Susceptible checks	**645**	296	1405		**1373**	670	2815	
Group mean differences								
Resistant vs. susceptible lines	-19			0.9980	-1004			**0.0003**
Resistant vs LONREN-1 and -2	-33			0.9995	-462			0.0727
Susc. lines vs. susc. checks	-219			0.7282	23			1.0000
LONREN-1 + 2 vs. susc. checks	-205			0.9115	-519			0.7874

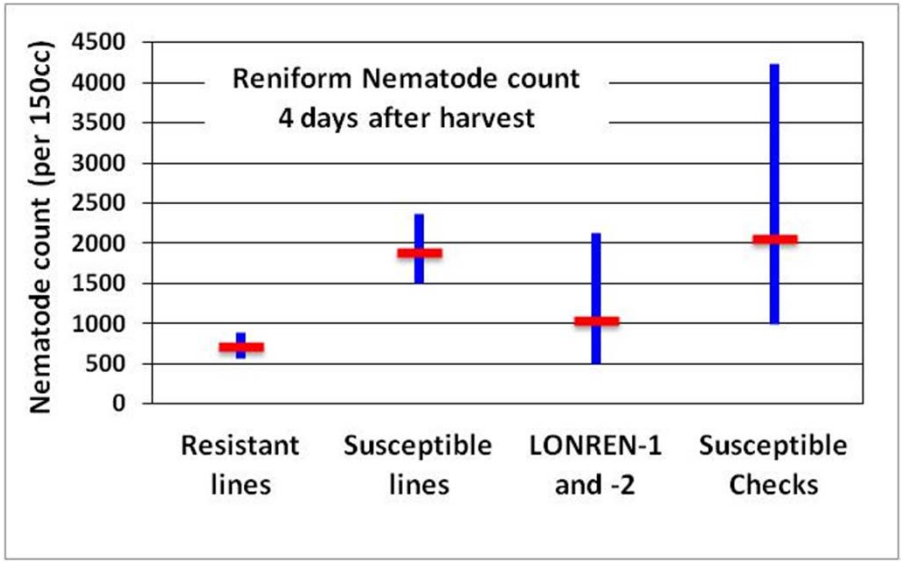




Nematode counts - 2011

	36 days after planting				4 days after harvest			
Group means / Contrasts	Est.	Lower CL	Upper CL	Probt	Est.	Lower CL	Upper CL	Probt
Group means								
Resistant lines	**403**	234	696		**703**	558	884	
Susceptible lines	**432**	250	745		**1885**	1499	2371	
LONREN-1 and -2	**201**	78	514		**1025**	496	2118	
Susceptible checks	**503**	196	1286		**2051**	993	4236	
Group mean differences								
Resistant vs. susceptible lines	-28			0.9966	-1183			**0.0000**
Resistant vs LONREN-1 and -2	203			0.5257	-323			0.8321
Susc. lines vs. susc. checks	-71			0.9971	-166			0.9989
LONREN-1 + 2 vs. susc. checks	-303			0.5503	-1025			0.6017





Conclusions – Field studies

- Lines with *REN*^{lon} gene tended to be lower-yielding under nematode pressure than sister lines without the gene
- Lines with *REN*^{lon} gene had lower at-harvest nematode numbers, and were effective at reducing nematode populations compared to susceptible sister lines
- *REN*^{lon} chromosome segment promoted greater fiber strength, tended to improve uniformity and lower short fiber content

Inoculation density studies

- Focus on response of resistant and susceptible lines to inoculum levels under controlled conditions
- Six genotypes: Two susceptible cultivars, LONREN-1 and LONREN-2 (resistant) and one each of $F_{2:3}$ resistant and susceptible progenies
- Inoculated with 0, 500, 1000, 5000, 10,000 and 50,000 per cone-tainer

Line B104 (LONREN-1 × Fibermax 966) (resistant) response to increasing levels of reniform inoculum

Line B108 (LONREN-1 × Fibermax 966) (susceptible) response to increasing levels of reniform inoculum

Summary of observations

Resistant LONREN genotypes:

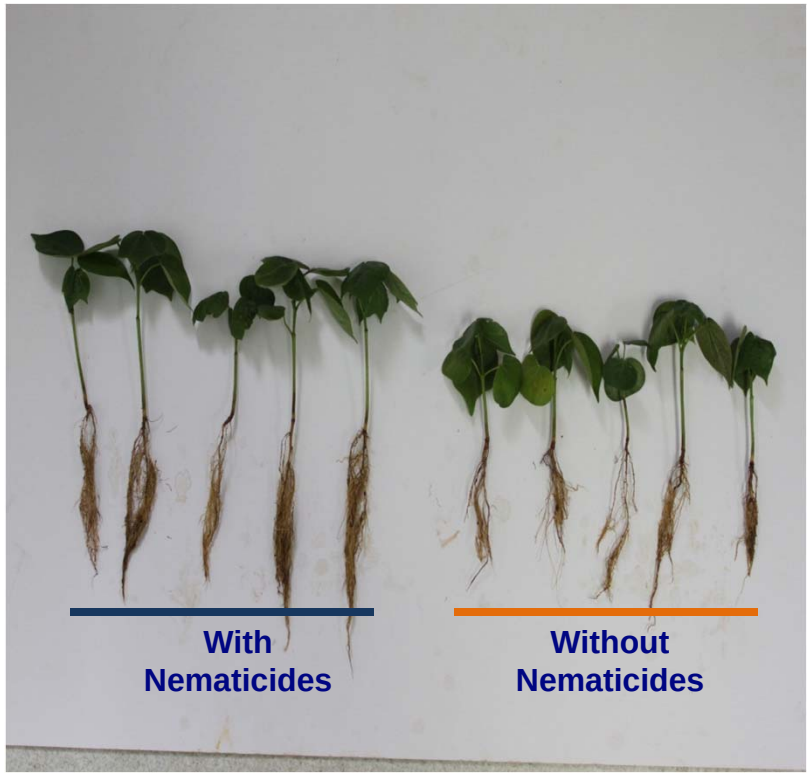
- limited damage at lower R.N. population levels
- considerable root damage at higher R.N. population levels
- root damage occurs at early seedling stage, with simultaneous shoot stunting

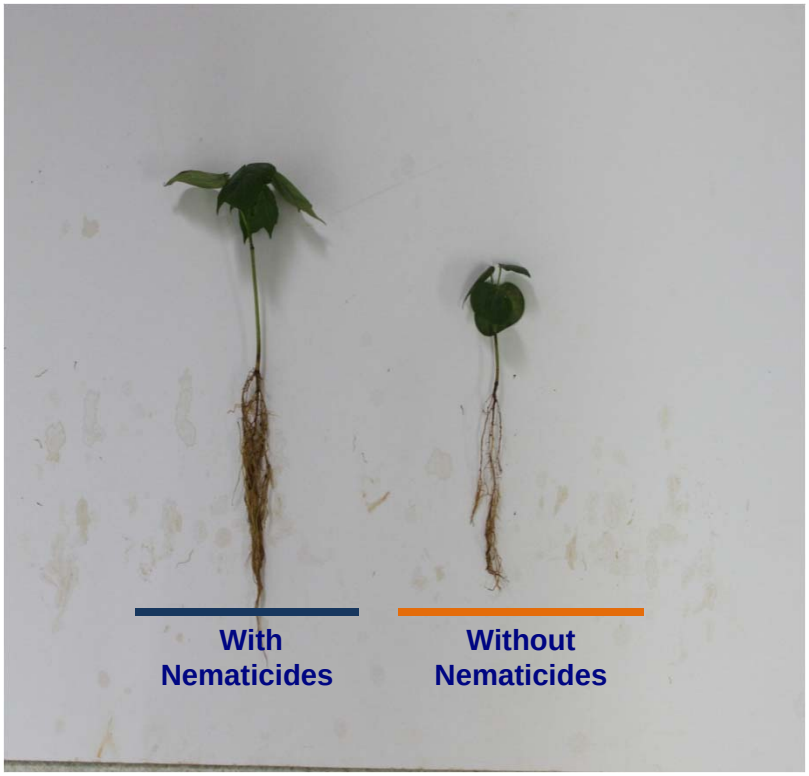
Susceptible genotypes:

- initial response to reniform nematode is increased root development
- delayed shoot stunting

LONREN-1 - 31 days after inoculation

Greenhouse Trial Resistant Line A107





- Significant increases in plant heights, root fresh weights, and shoot fresh weights at 60DAP

Increase in plant height at 45 DAP

Resistant Line LONREN-1
With Nematicides

Resistant Line LONREN-1
Without Nematicides

Increase in plant height at 45 DAP

Resistant Line B219
With Nematicides

Resistant Line B219
Without Nematicides

Evaluation of LONREN Breeding Lines With Nematicides

- Some benefits from nematicide were observed for LONREN breeding lines in greenhouse conditions.
  - Reduction in the amount of females/g root, significantly in resistant line A122
  - Significant increases in plant heights, root fresh weights, and shoot fresh weights at 60DAP
- Some benefits from applying nematicides to LONREN breeding lines were observed in early season growth parameters in field trials.
  - Suppression of reniform populations at 30 and 60 DAP
  - Increase in plant height at 30 and 45 DAP
- However, little yield increases were influenced by nematicides.