

**Accomplishments of a
10-Year Initiative
to Develop
Host Plant Resistance to
Root-Knot and Reniform
Nematodes
in Cotton 2003 - 2013**



Cotton
Incorporated

Authors

R.L. Nichols - Cotton Incorporated

A.A. Bell - USDA-ARS

R.G. Creech - Formerly Mississippi State University

P.W. Chee - University of Georgia

R.F. Davis - USDA-ARS

J. Erpelding - USDA-ARS-CGRU

D. Fang - USDA-ARS-SRRC

O.A. Gutierrez - USDA-ARS (Subtropical Hort. Res. Stn.)

K.D. Hake - Cotton Incorporated

J.N. Jenkins - USDA-ARS

J.E. Jones - Jajo Genetics

K.S. Lawrence - Auburn University

J.C. McCarty - USDA-ARS

C. Overstreet - Louisiana State University

P.A. Roberts - University of California - Riverside

A.F. Robinson - formerly with USDA-ARS

R.B. Sikkens - Auburn University

J.L. Starr - formerly with Texas A&M University

D.M. Stelly - Texas A&M University

S. Stetina - USDA-ARS

R.D. Stipanovic - USDA-ARS-SPARC

P. Thaxton - Formerly Mississippi State University

M. Ulloa - USDA-ARS-SPA

T. Wallace - Mississippi State University

C. Wang - University of California - Riverside

D.B. Weaver - Auburn University

M. Wubben - USDA-ARS

J. Zhang - New Mexico State University



Nematode Management

Rotation – Driven by Crop Prices

Nematicides – Aldicarb Unavailable

Resistant Cultivars

Root Knot – before 2014 partial
resistance

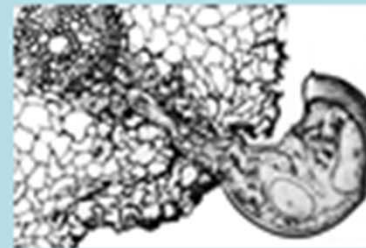
Reniform - none



Cotton
Incorporated

Cotton Incorporated Host Plant Resistance Initiative Situation: 2003

- Root-Knot Nematode
 - Germplasm
'Shepard Source'
 - Variety – LA 887
- Reniform
 - ZERO



Cotton
Incorporated

Cotton Incorporated Sponsored Meeting “Breeding Cotton for Resistance to Nematodes” August 20, 2003 – Austin Texas

Objectives

1. Identify, characterize, and locate genes to develop germplasm with host plant resistance against root-knot (*Meloidogyne incognita*) and reniform (*Rotylenchulus reniformis*) nematodes.
2. Identify the technologies needed to conduct efficient breeding programs and provide them.
3. Address the task of transferring germplasm and necessary breeding technologies to commercial planting seed companies.



Cotton
Incorporated

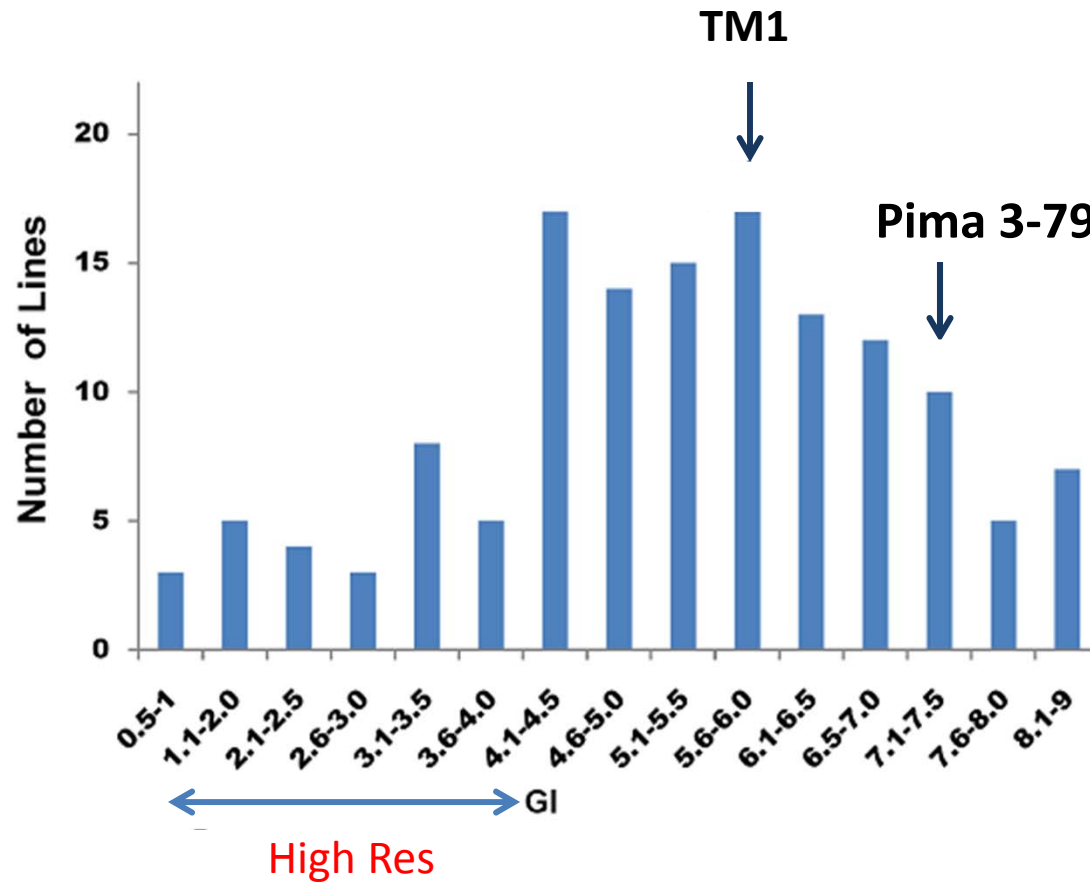
Genetics of Root-Knot Nematode Resistance

Population	Genes/QTL	Markers	Researcher
NemX x SJ-2	rkn-1 – ch. 11 (recessive)	CIR-316 BNL 1066	Roberts Roberts
M 125 x S-6	<i>Mi-A03</i> – ch. 11 (dominant)	CIR-316 CIR-069	Chee Chee
M 240 x STV 213	QTL – ch. 11	CIR-316 BNL 1231	Jenkins Jenkins
M 240 x STV 213	QTL ch 14	BNL 3545 BNL 3661 BNL 3664	Jenkins Jenkins Jenkins



Cotton
Incorporated

Extreme phenotypes of transgressive segregants outside parent range in RIL TM1 x Pima 3-79



Cotton
Incorporated

Segregants from the Population TM-1 x Pima 3-79

**TM-1
Sus.**



X



**Pima 3-79
Sus.**

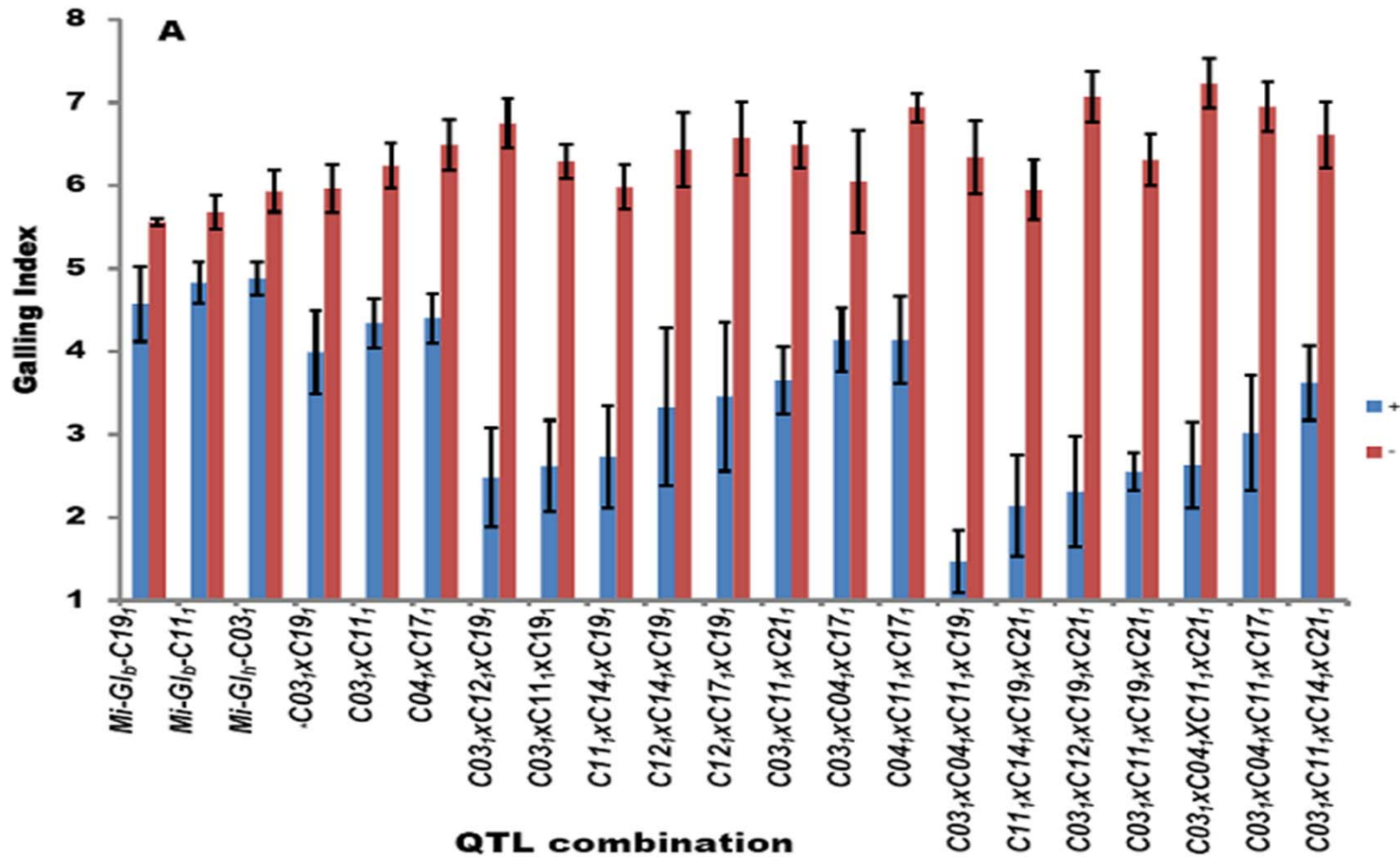
**RIL Progeny
Highly Res.**



**RIL progeny
Highly Sus.**



Comparison of lines with/without combinations of 2 to 4 QTLs showed reduction > 50% in both Gallling Index (GI) and Egg production

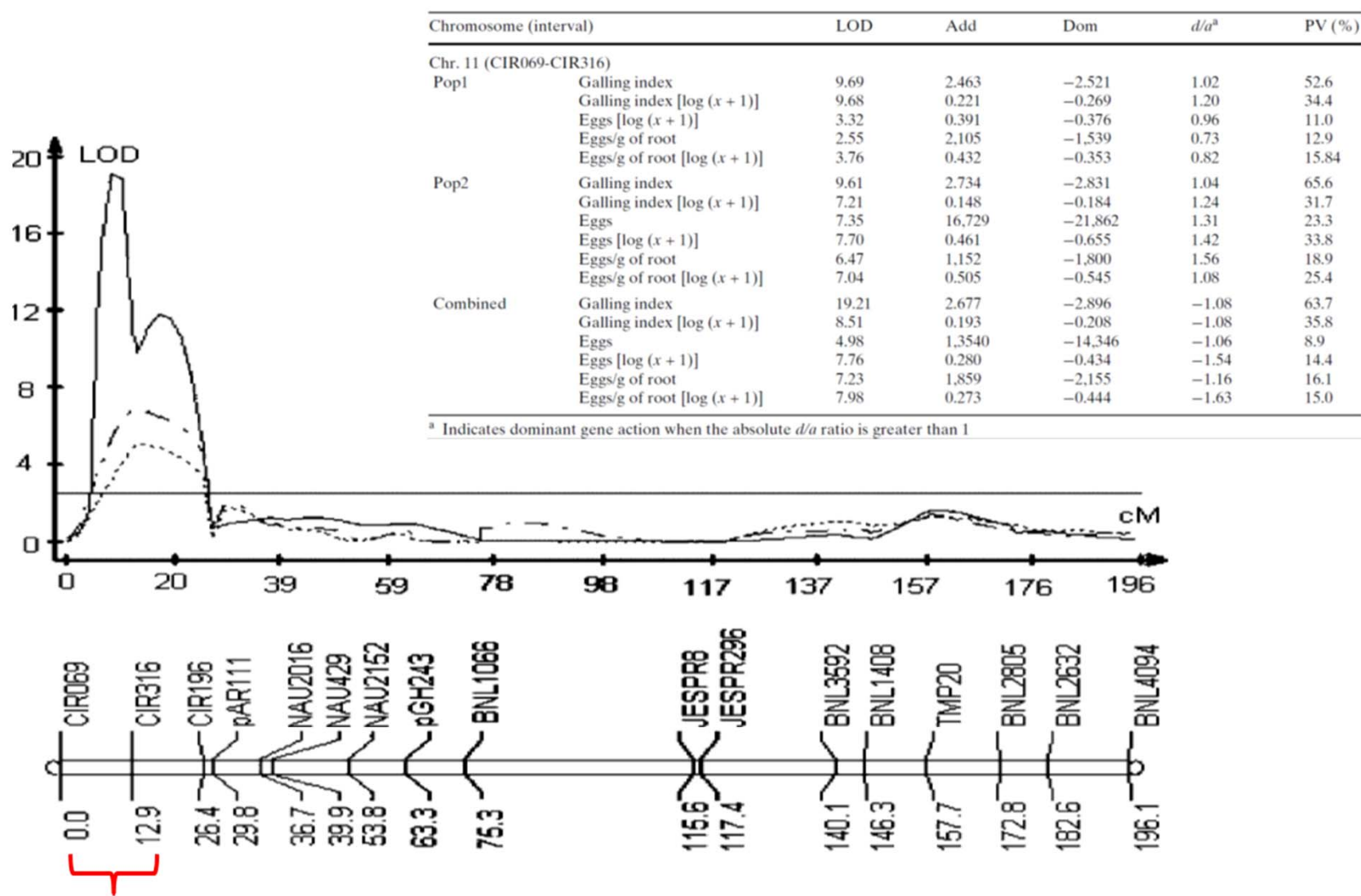


C03 x C04 x C11 x C19 GI 1.7

TM1 x P3-79 x P3-79 x TM1



Cotton Incorporated

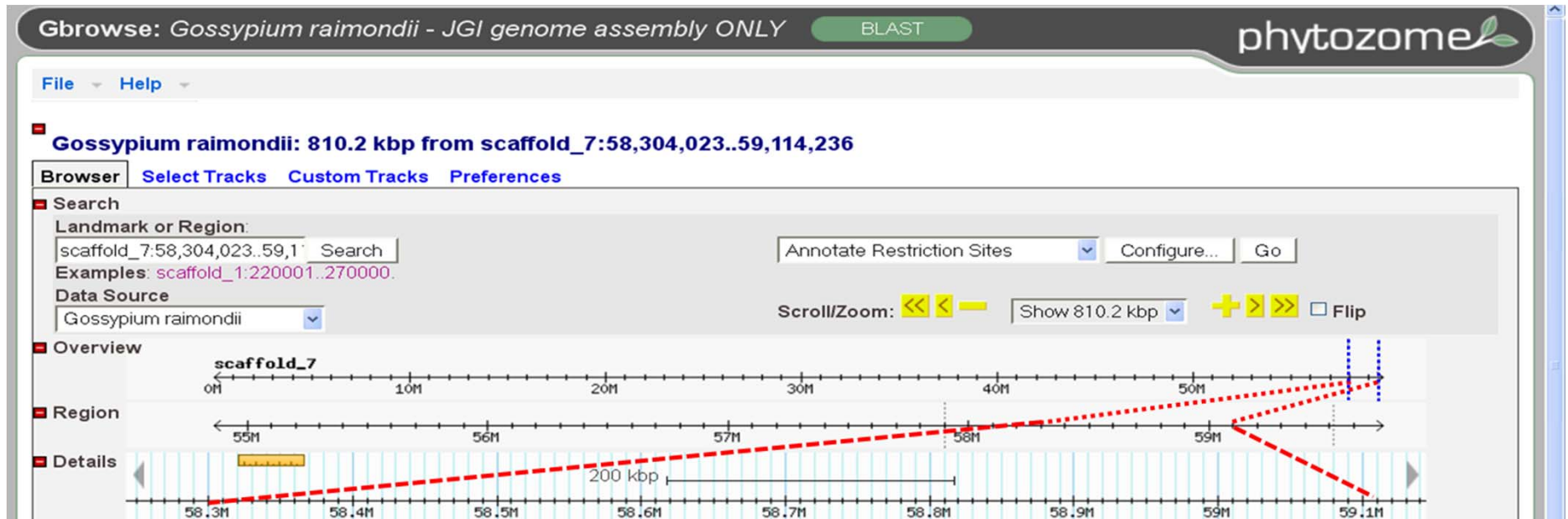


RKN resistance QTL



Cotton Incorporated

Identifying the Resistance-Gene Rich Region of Chromosome 11



CIR316

CIR069

810 Kbp



Cotton
Incorporated

New Sources of Root-Knot Nematode Resistance

- **Dr. Jim Starr showed that five primitive race stocks from Mexico had good to excellent, heritable root-knot nematode resistance.**
- **Markers associated with the resistance in other lines were not associated in the newly evaluated lines.**

**Starr et al. 2010. J. of Nematology
42:352-358.**



Cotton
Incorporated

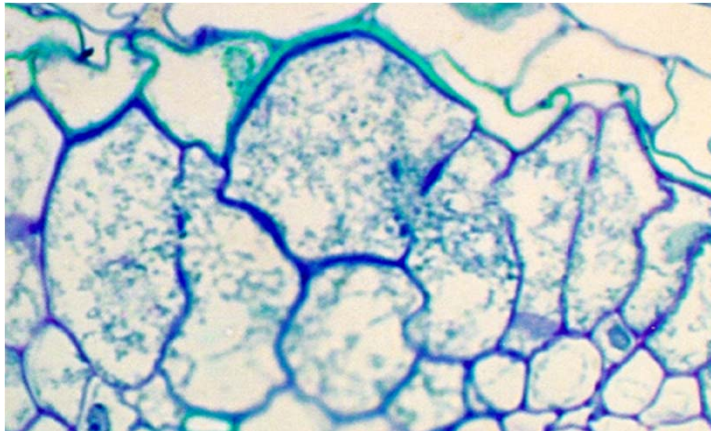
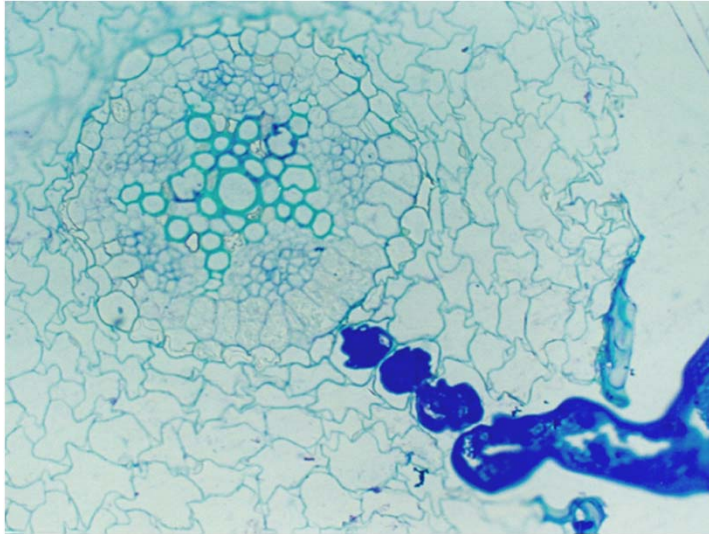
Reniform Nematode Resistance (2003)

Gossypium hirsutum (AADD) – none
G. barbadense (AADD) - primitive
G. arboreum (A) – little known
G. armorianum (D) - little known
G. longicalyx – virtual immunity

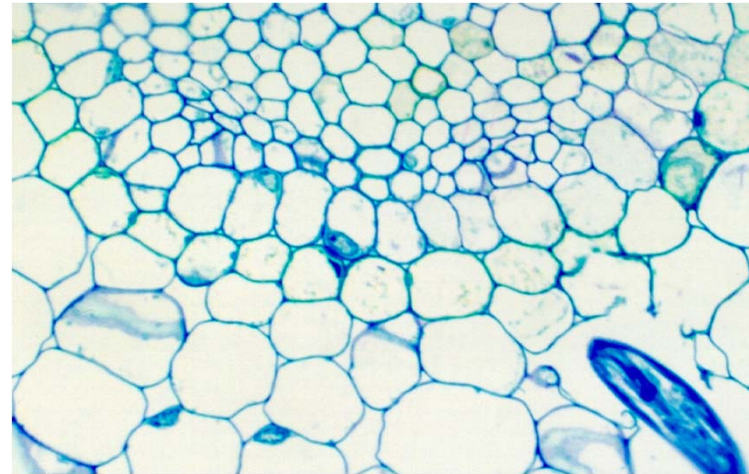
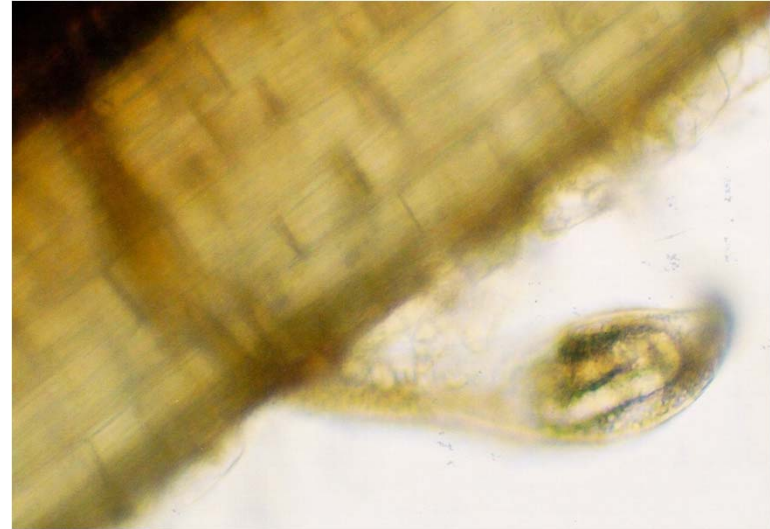


Cotton
Incorporated

SUSCEPTIBLE



RESISTANT



Agudelo et al. 2005. Journal of Nematology 37:444-447.

Triple Species Hybrids

**Gossypium hirsutum x G. longicalyx
x G. armorianum**

AD x F = (FAD)² x D = FADD

G. hirsutum x G. herbaceum x G. longicalyx

AD x A (AAD)² x F = AADF

Robinson et al. 2007. Crop Sci. 47: 1865-1877



Cotton
Incorporated

Belle Mina, July 14, 2011 (58 days after planting)



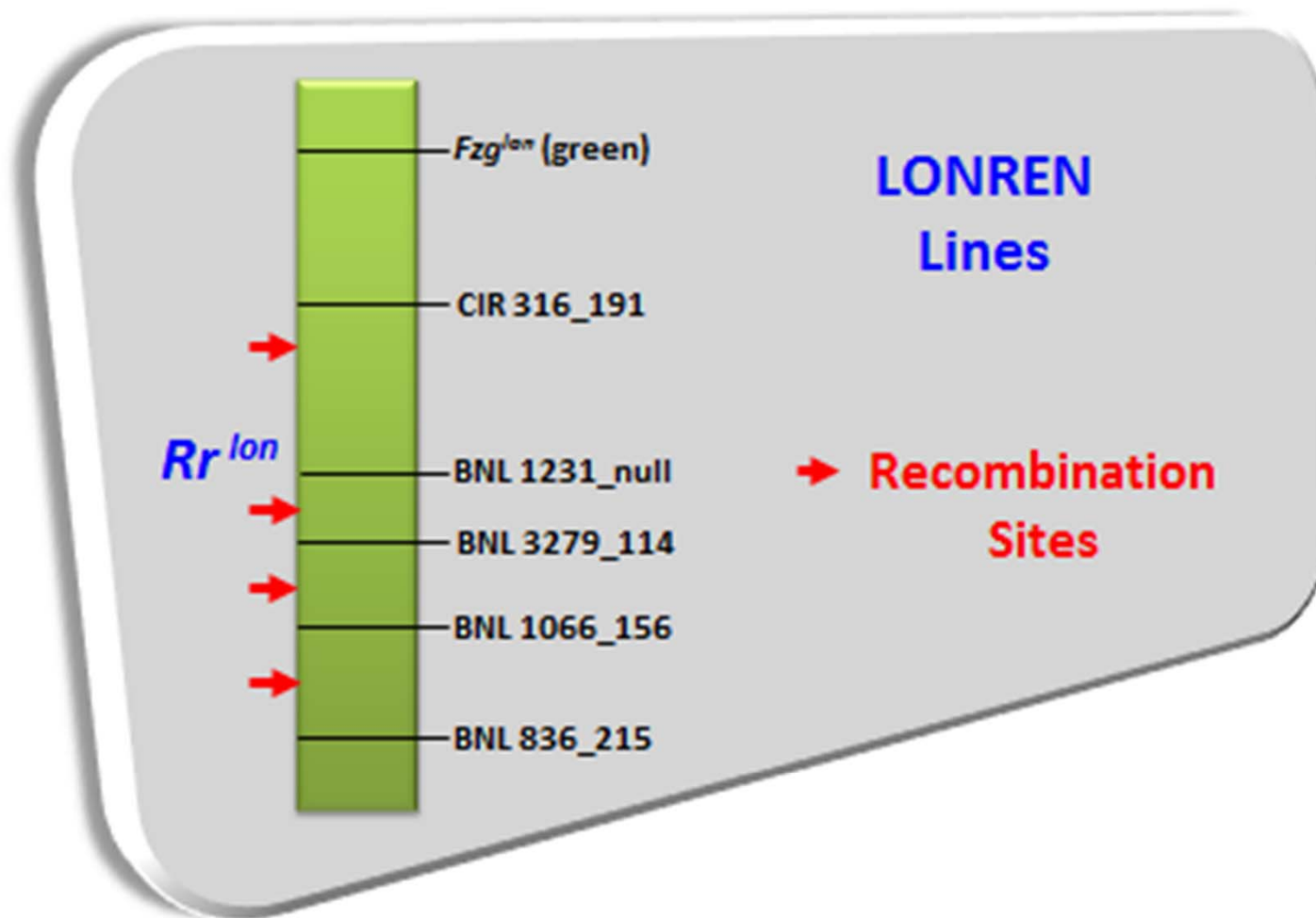
plot 301 – BARBREN-713

plot 302 - LONREN 21-4



**Cotton
Incorporated**

MARKERS ON INTROGRESSION SEGMENTS FROM *G. longicalyx*



Cotton
Incorporated

Triple Species Hybrids

**Gossypium arboreum x
(G. hirsutum x G. aridum)²**

Romano et al. 2009. TAG 120: 139-150

Fang & Stetina . 2011. Plt. Breeding 130: 673-678



Cotton
Incorporated

Reniform Nematode Resistance from GB 713

2004. Robinson et al. report that *Gossypium barbadense* 713 suppresses reniform nematode production

2010. Gutierrez et al. conclude that resistance in GB 713 is due to 3 QTLs.

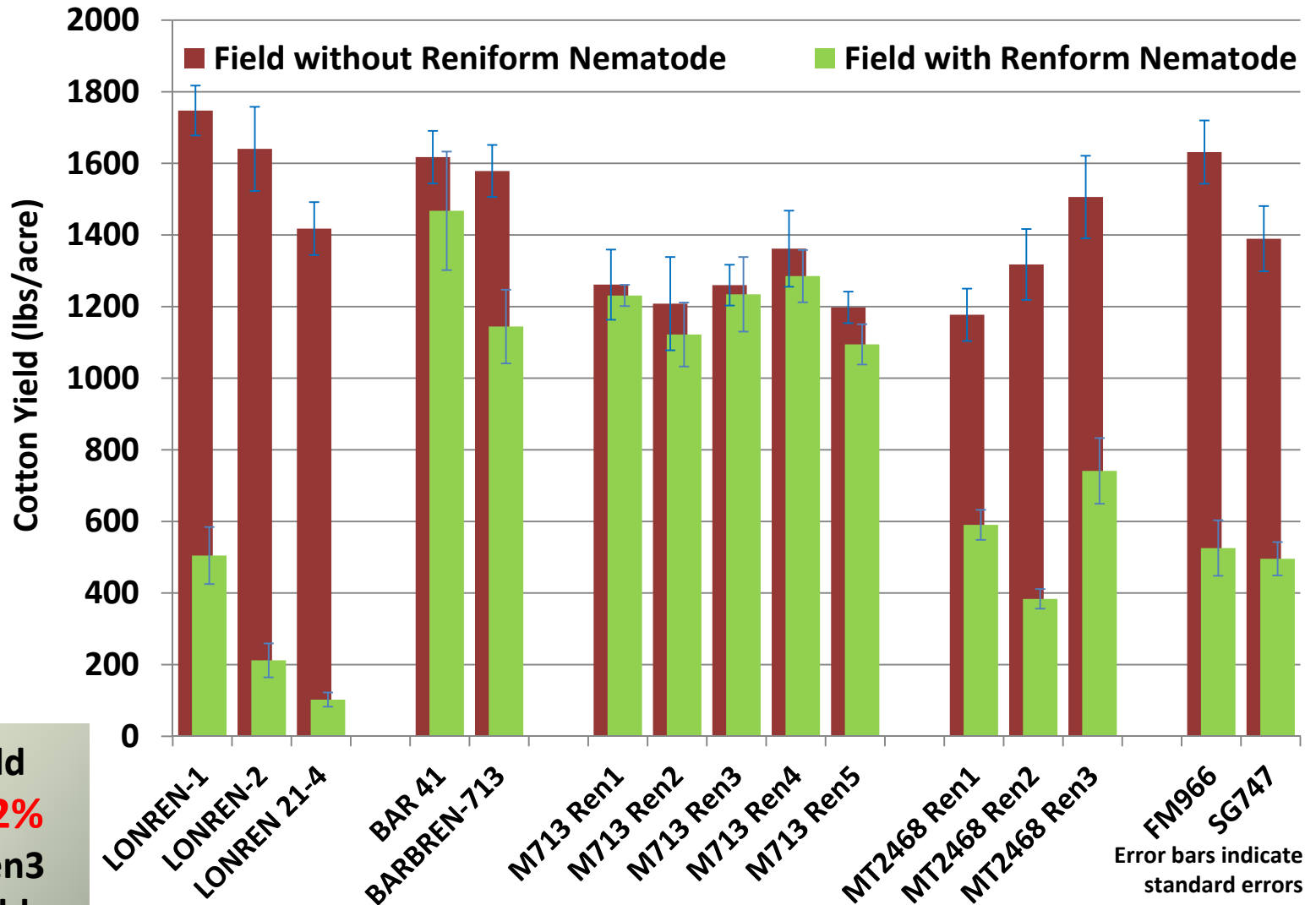
2012. Release Notice for M713 (5 lines).

2012. Release Notice for Barbren (1 line)



Cotton
Incorporated

Yields



Lowest Yield Reduction: **2%** for M713 Ren3
 Highest Yield Reduction: **93%** LONREN 21-4
 Yield Reduction for BAR 41: **9%**

Highest yield: 1748 lbs/acre LONREN-1 on the no RN field
 Lowest yield: 102 lbs/acre LONREN 21-4 on the with RN field

Cotton Resistance to Nematodes

Situation at start of 2014

Root Knot

High Level Resistance is at least a two-gene system – ch. 11 + chs. 7, 14, 21 – possibly others; resistance is epistatic

Delta & Pineland and PhytoGen launch resistant cultivars in 2014

Reniform

Public releases with moderate resistance from
G. hirsutum MT2468

Public releases with high-level resistance from
G. barbadense – Barbren and M713

Numerous markers publically available for both



Cotton
Incorporated

What has been accomplished?

Enabling Technology – Genes Identified, Inheritance Characterized, Published Markers, Germplasm Releases.

Information in Public Domain

Incentive for Development

Grower Awareness of Research Progress



Cotton
Incorporated