

Molecular Markers and Mapping of Root-knot Nematode Resistance in Cotton



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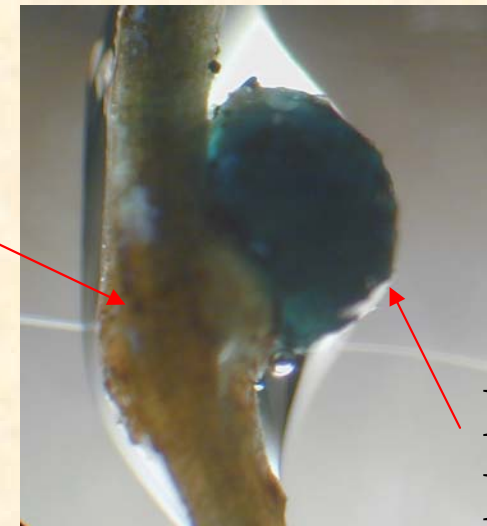
USDA-ARS, WICS, Res Unit, Shafter

Outline

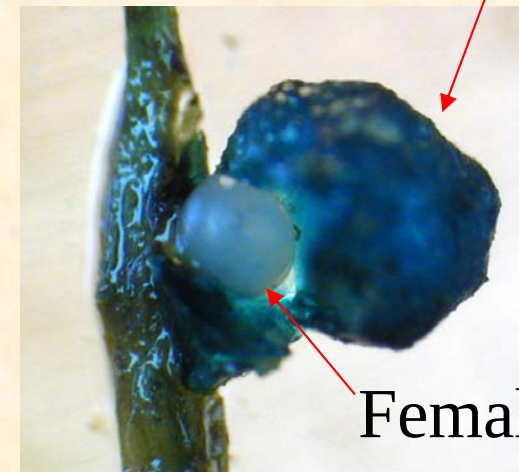
1. Background
2. Markers & Mapping of RKN R genes in *G. hirsutum*
Acala NemX and Auburn 634 sources
3. Transgressive segregation for enhanced resistance
4. Mapping TS genes in *G. barbadense*
5. Search for gene origins in *Gossypium*

Root-knot Nematodes are one of the Most Economically Important Pests in Cotton

- Occur in every cotton-producing area in United States.



Egg
Mass



Female

Parental Reaction to Root-knot Nematode

NemX

Pima S-7

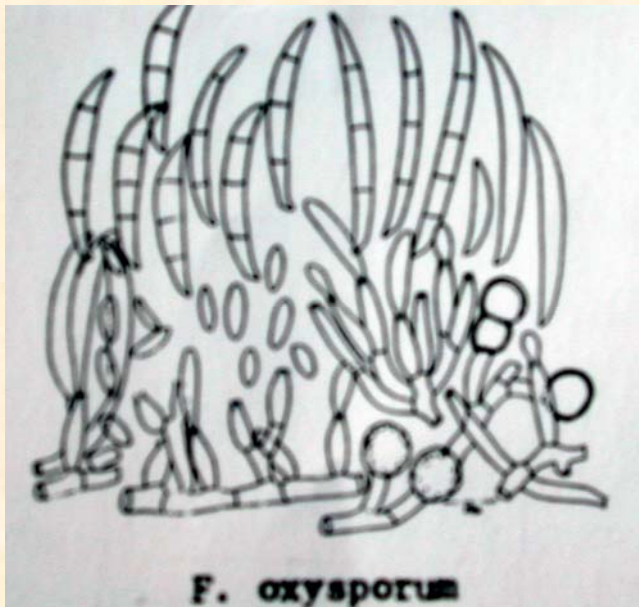
SJ-2



Fusarium wilt of Cotton

Vascular disease caused by
the soilborne Fungus

Pathogen: *Fusarium*
oxysporum f. s.p.
vasinfectum (FOV)



Pima S-7

SJ-2

NemX

FOV

R

S

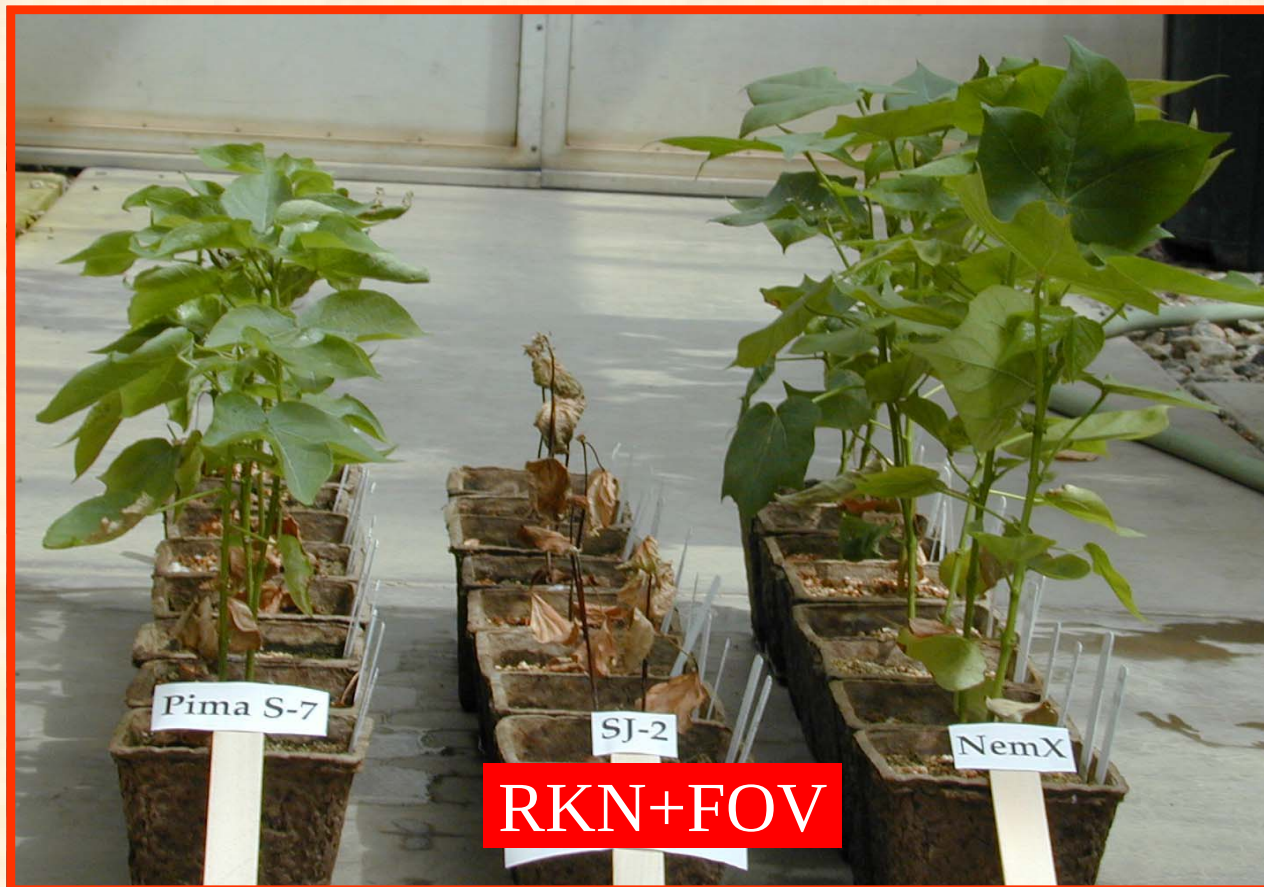
S

RKN

S

S

R



FOV R4

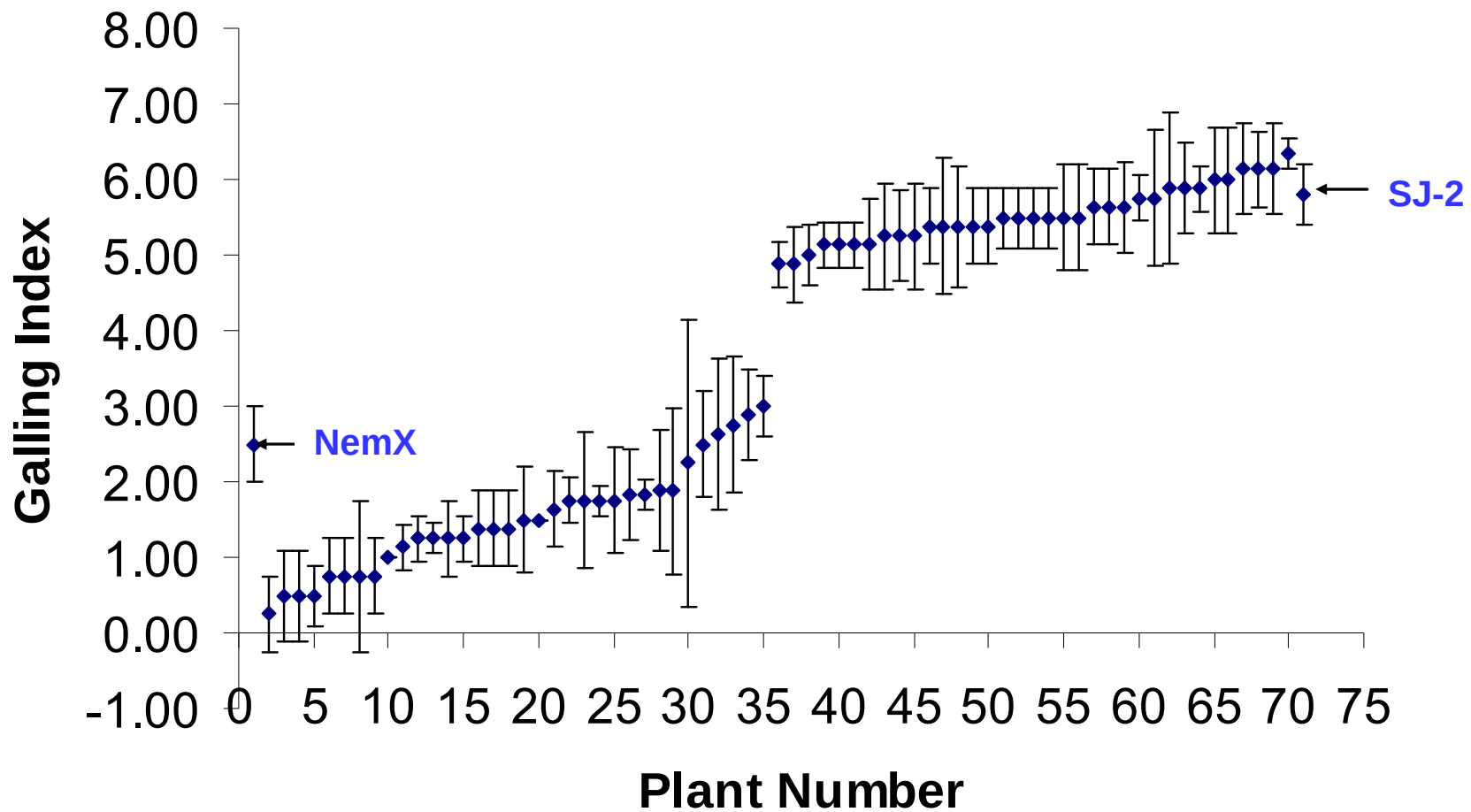
FOV R4

+RKN

NemX

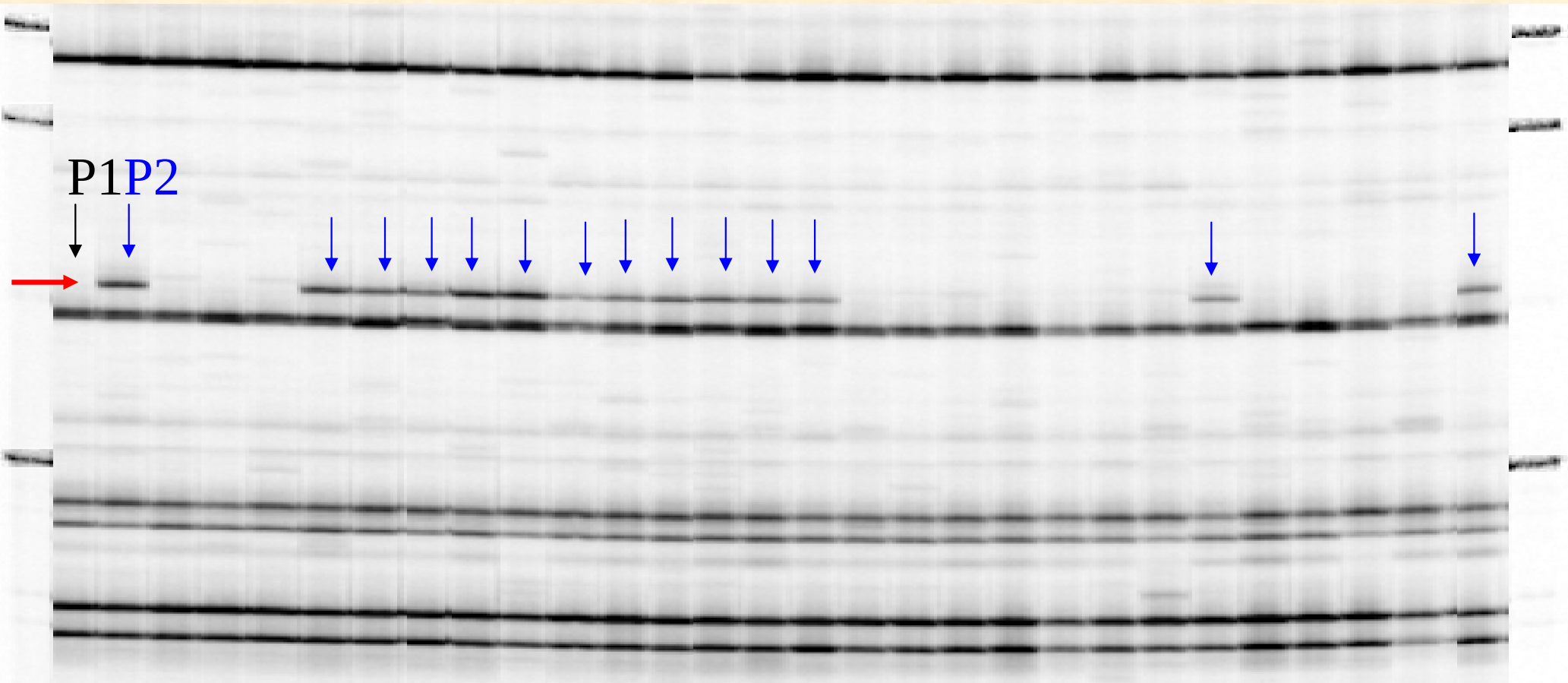


$F_{2:7}$ RIL Gallling Index



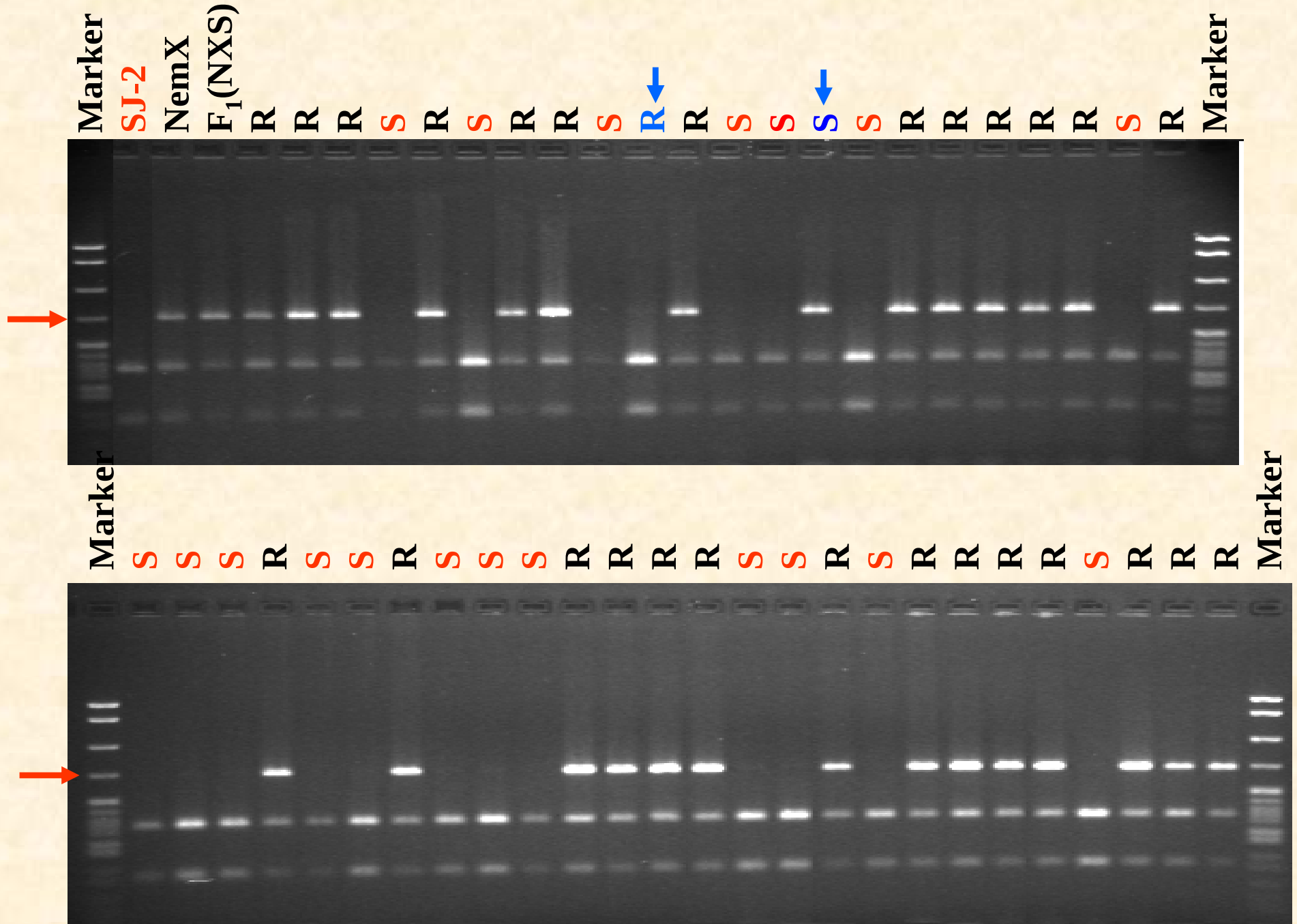
AFLP marker and RIL F_{2:7} (NemX x SJ-2)

M S R S S S R R R R R R R R R R S S S S S S S R S S S S R M



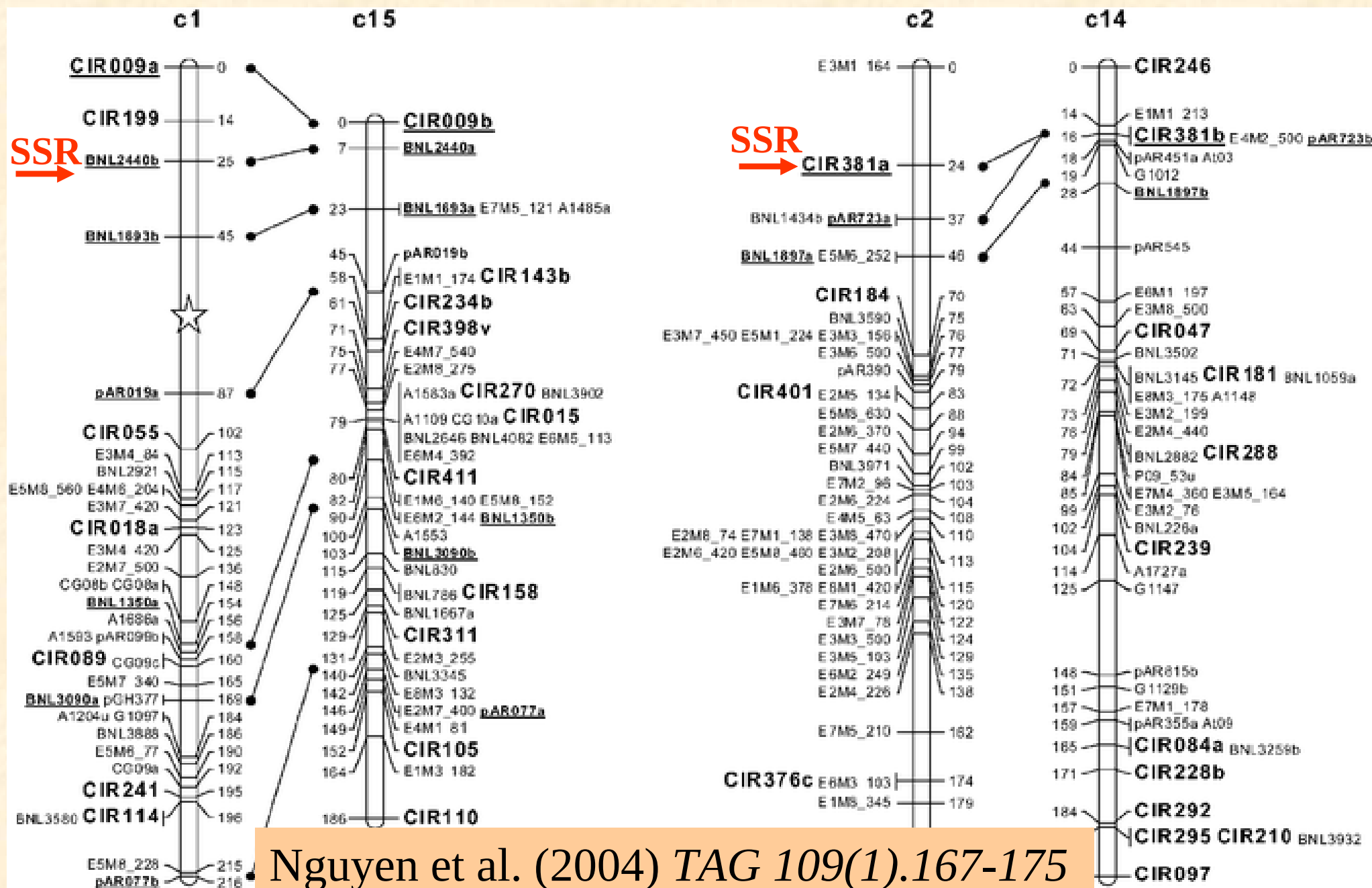
4/128 EcoR1/Mse1

CAPS marker (*Nla*III) RIL₇ (NemX x SJ-2)

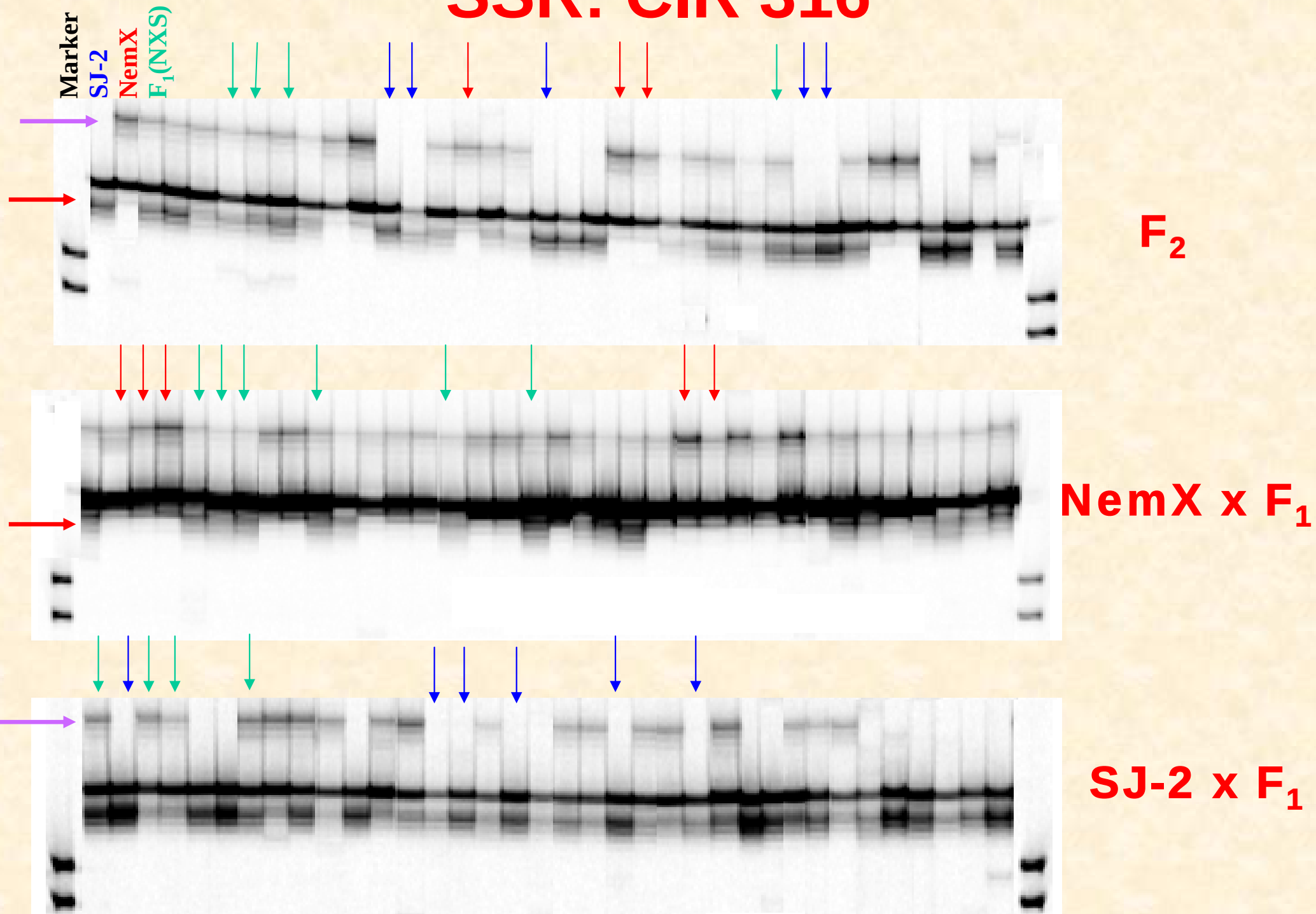


Cotton Linkage map

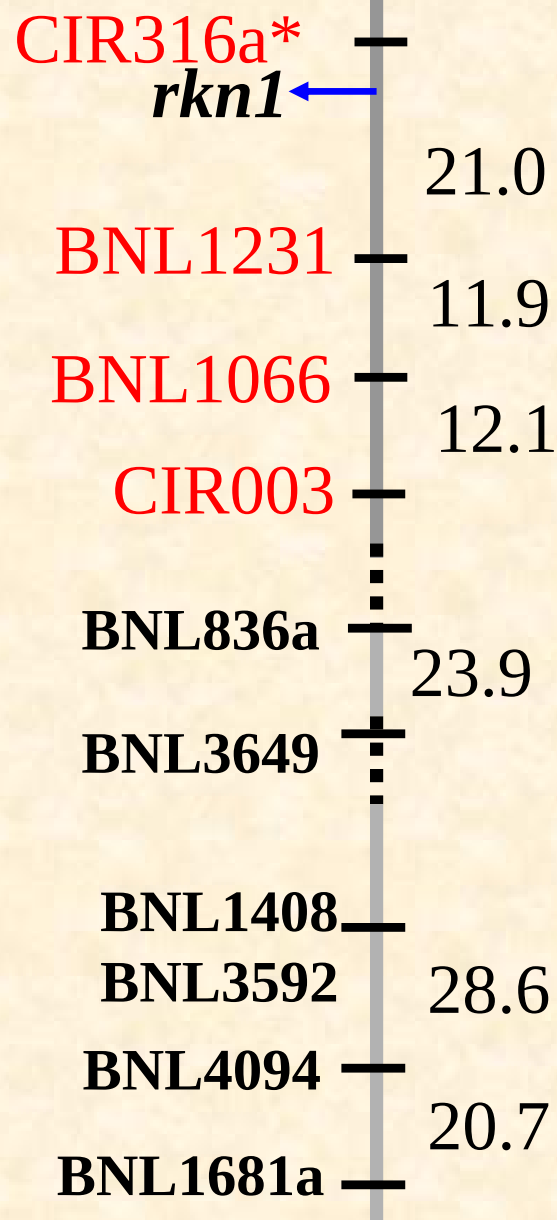
284 primers



SSR: CIR 316



F₂ (Pima S-7 x NemX)



Chr.11

Localization of NemX R gene

Published data:

- Nguyen et al. (2004) TAG
- Rong et al. (2004) Genetics
- <http://cottondb.tamu.edu>
- Frelichowski, Ulloa (2006) MGG
- Unpubl. data Mauricio Ulloa

Other RKN resistance mapping studies in Auburn 634 sources

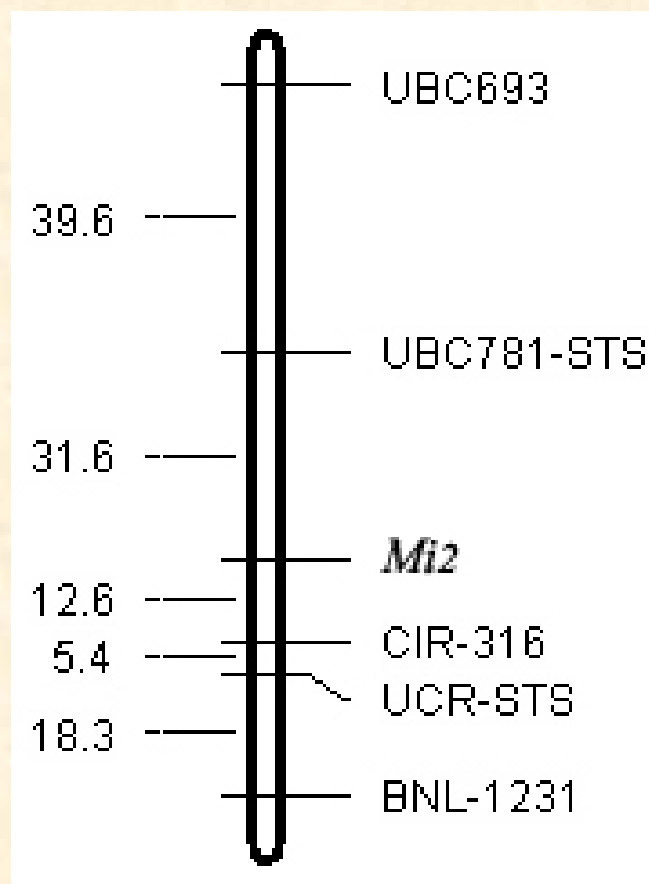
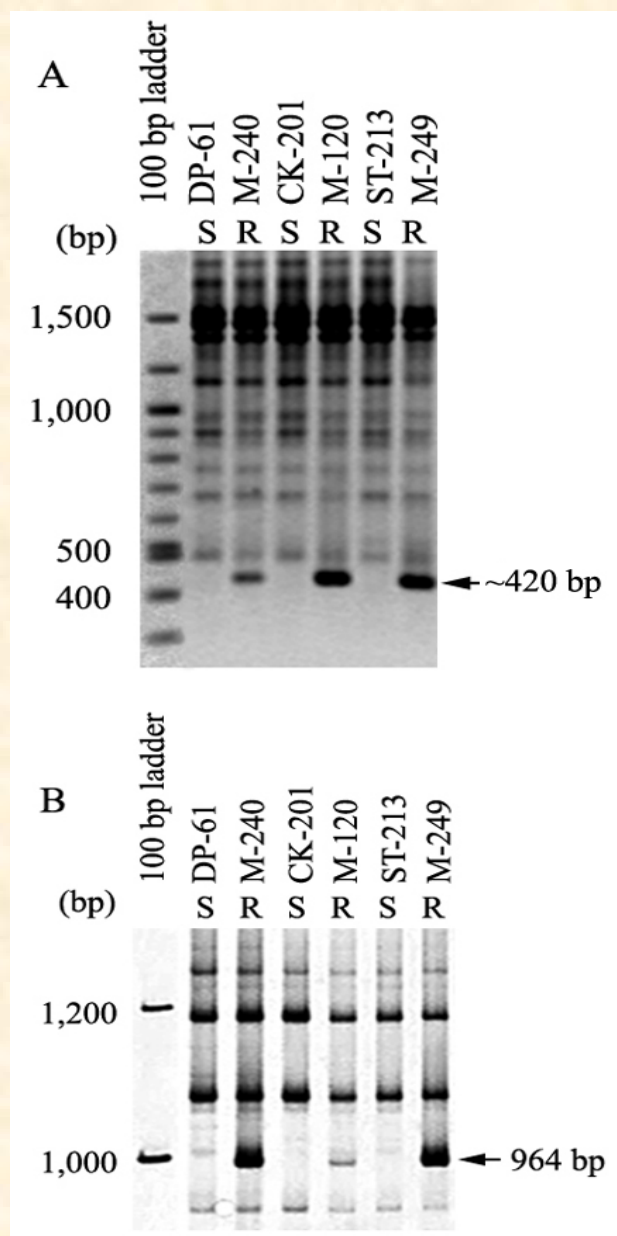
- 1 Shen, Davis, May, Chee et al. TAG, 2006
2 QTL Chr. 11 and Chr. 7 (F_2 with M120)
- 2 Ynturi, Jenkins et al. Crop Sci., 2006
2 SSRs, Chr. 11 and 14 (NIL from A634)
- 3 Nui, Zhang, Wang, Roberts et al. Crop Sci. 2007
Major gene in A634 (*Mi2*) on Chr. 11 (F_2 with A634)

Localization of A634 R gene

Nui et al Crop Sci 2007

Chr.11

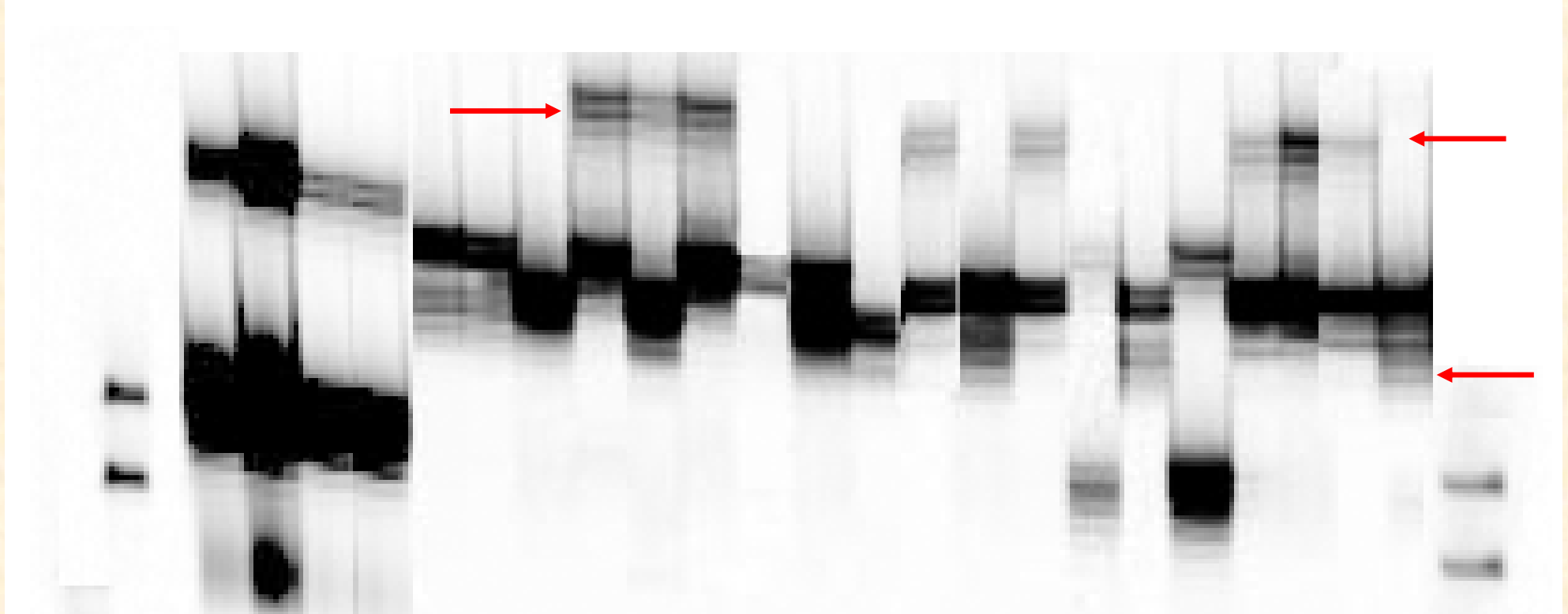
ST 474 x A 634 F₂



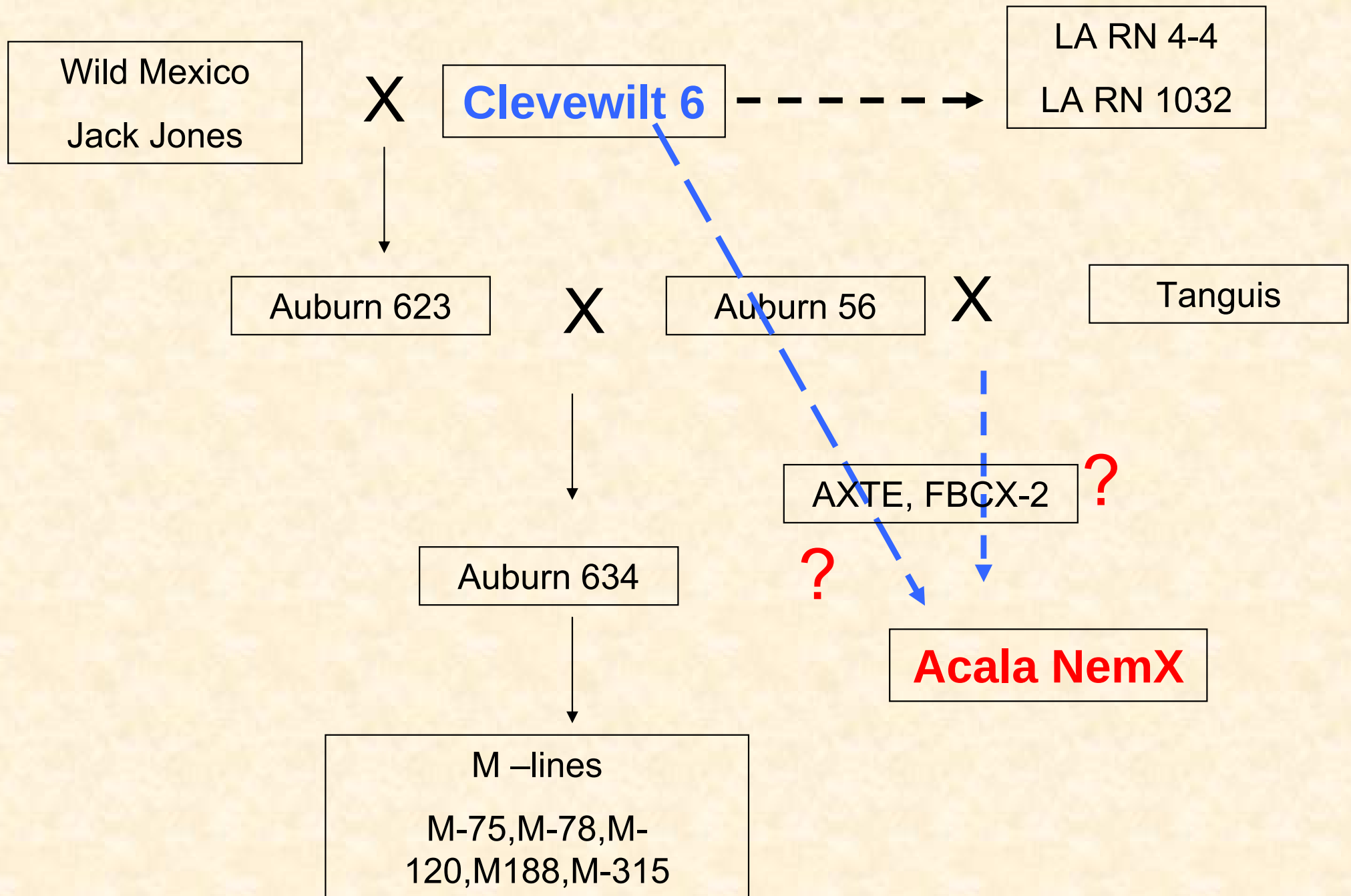
Cotton germplasm: Marker Screening

SSR: CIR 316

Marker
PimaS-2
PimaS-3
PimaS-4
PimaS-7
Coker100
Coker307-6
Wild Mexico
Clewewilt 6
Auburn 623
Auburn 634
Auburn56
M-75
M-78
M-120
M-188
M-315
TX 110
Acala442
Tanguis
LARN 4-4
LA RN 1032
NemX
SJ-2
Marker



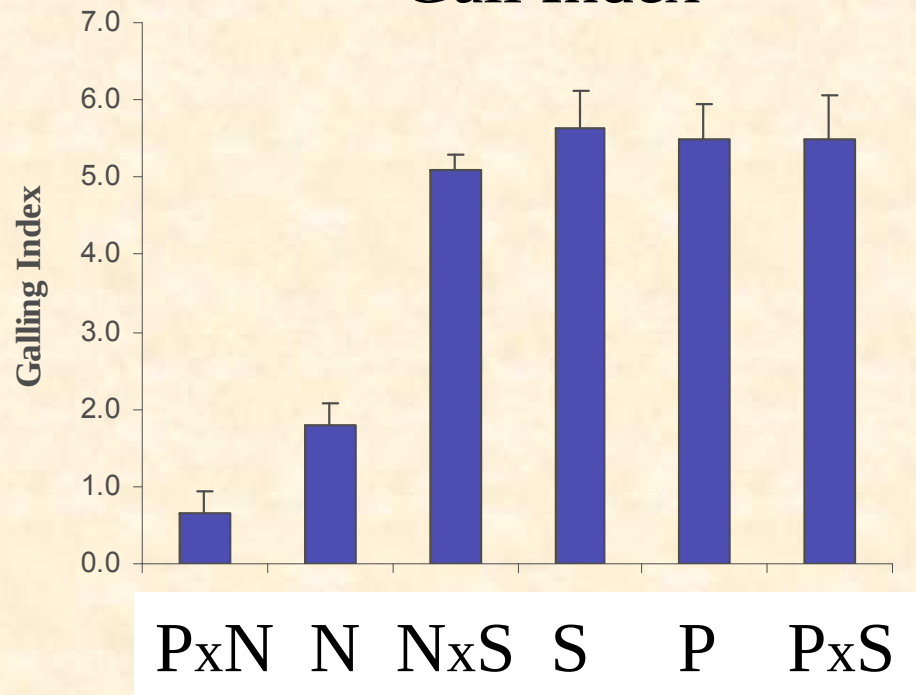
Root-knot Nematode Resistance Sources



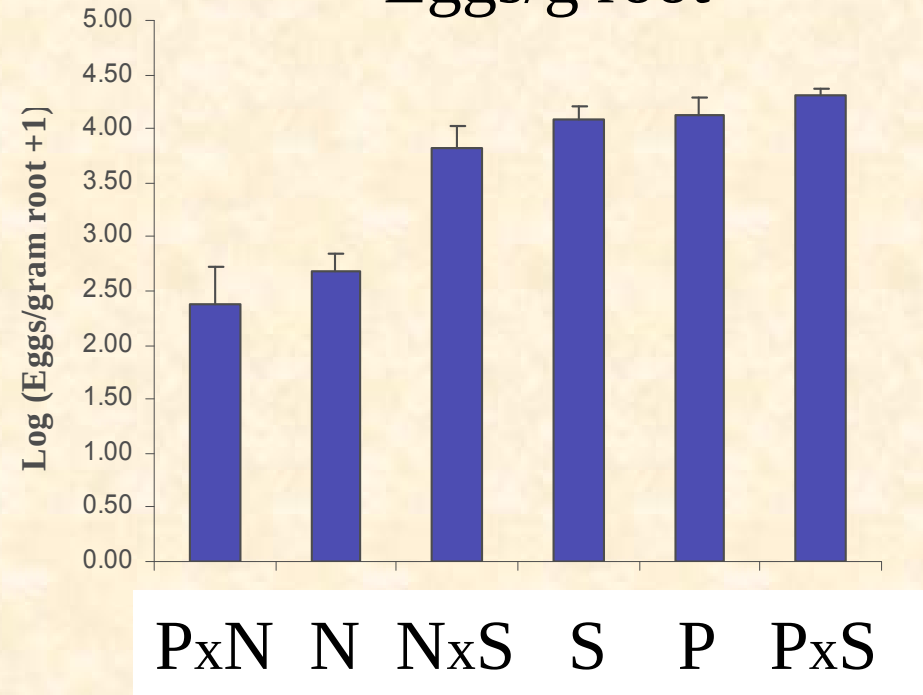
F ₂	SJ-2	NemX	Pima S-7	Cleviewilt 6	Auburn 634	Auburn 623	Tanguis
Cleviewilt 6	✓	✓	✓				
WildMexico	✓	✓					
Auburn 56	✓	✓	✓	✓	✓		✓
Auburn 634	✓	✓	✓	✓			
Auburn 623	✓	✓					
M-75	✓	✓	✓		✓		
M7-78	✓	✓	✓		✓		
M-120	✓	✓					
M-188	✓	✓	✓			✓	
M315	✓	✓	✓			✓	
LA RN 4-4	✓	✓	✓		✓		
LA RN 1032	✓				✓		
Pima S-3		✓					
Pima S-2					✓		
Pima S-1				✓			

F_1 and Parent Resistance phenotypes for NemX, Pima S-7, SJ-2

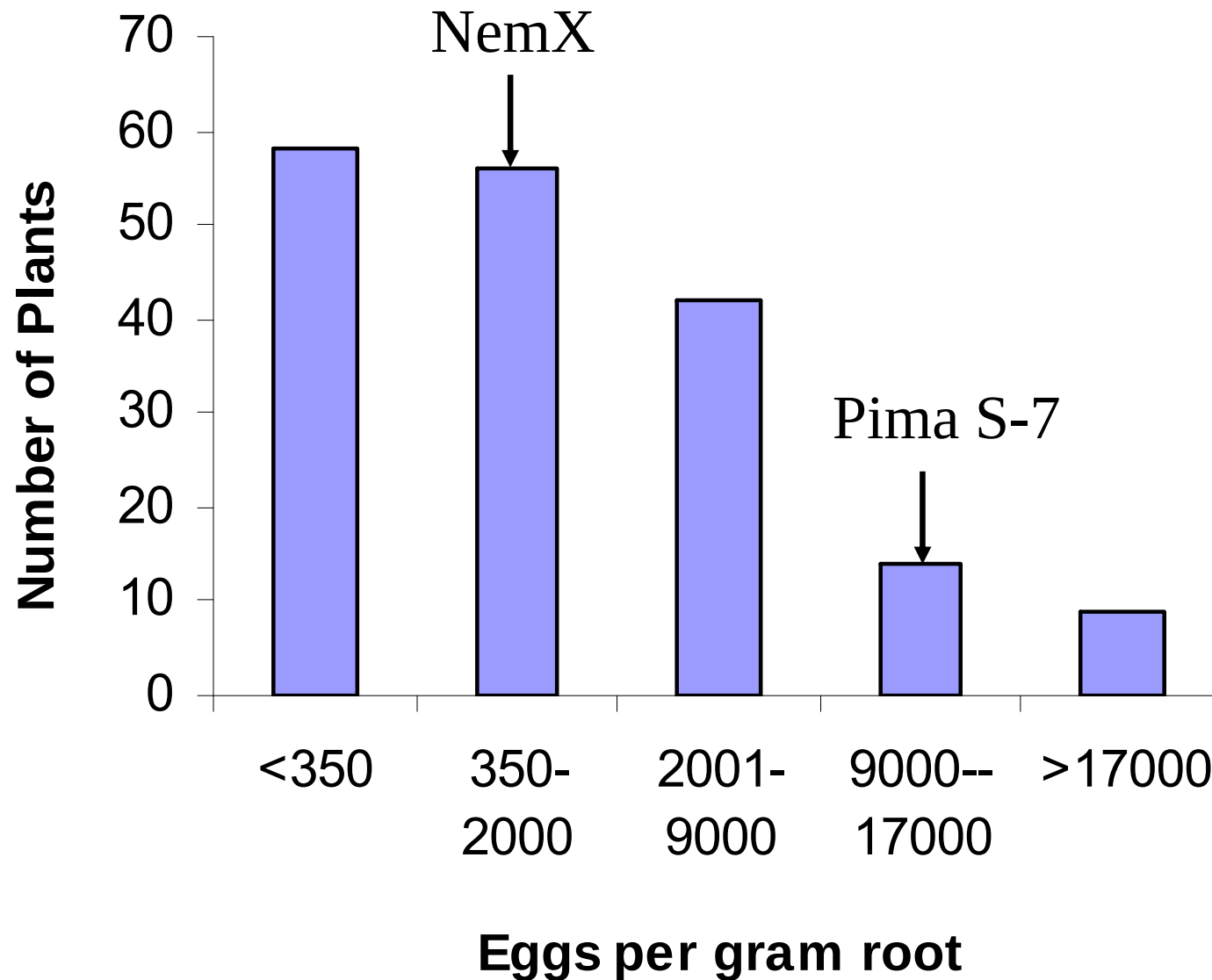
Gall Index



Eggs/g root

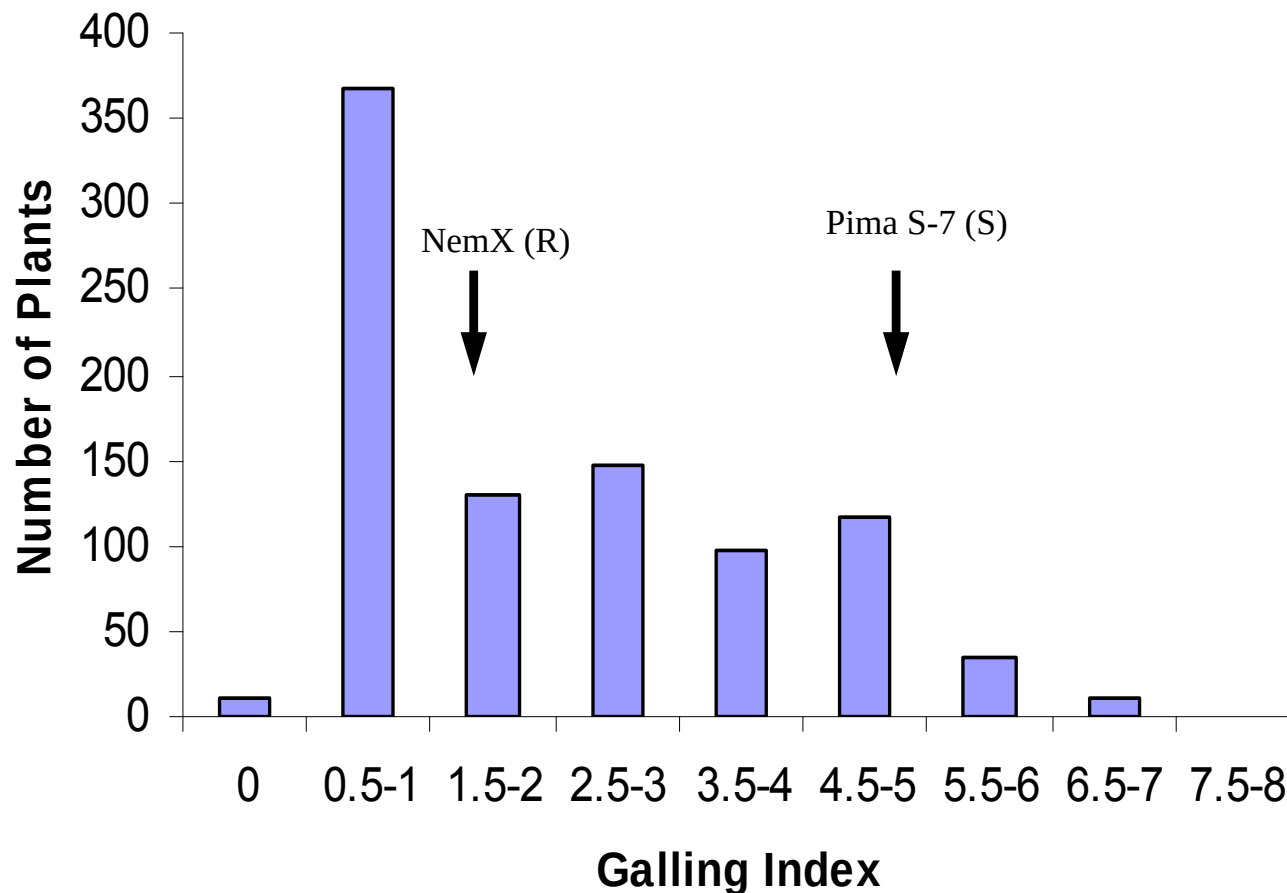


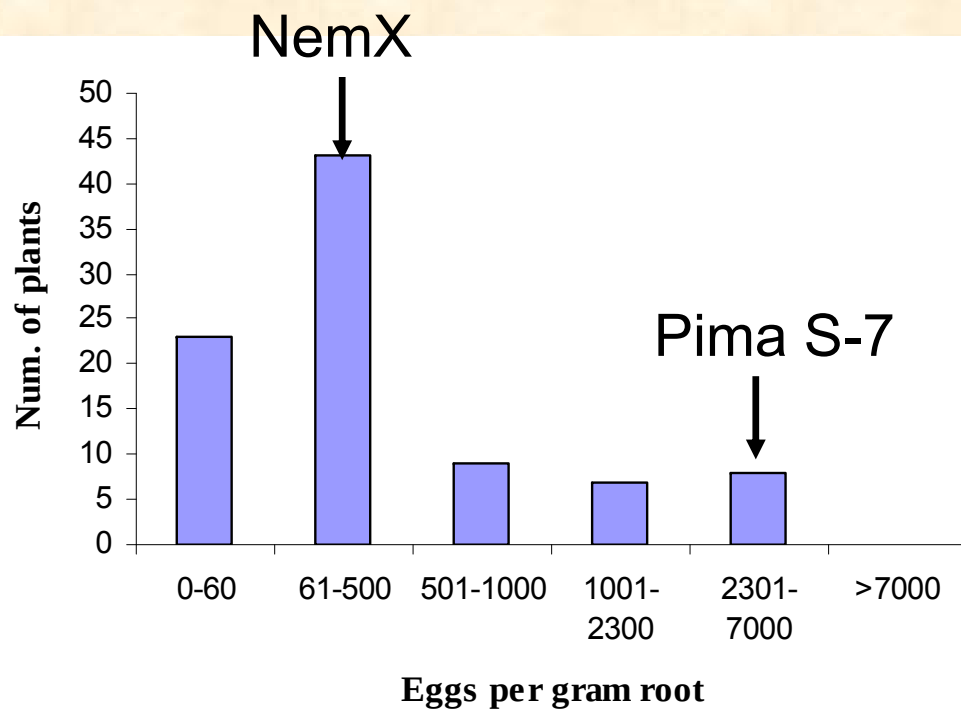
F₂ (Pima S-7 x NemX) 179 plants



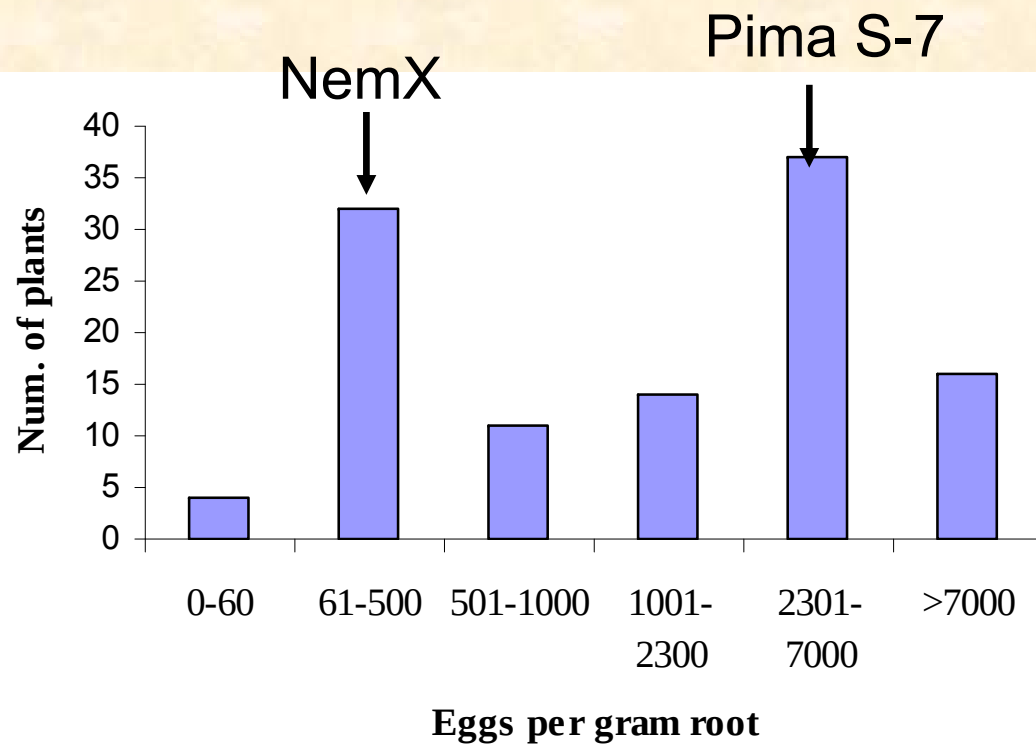
Galling response of plants from 64 $F_{2:3}$ families of Pima S-7 x NemX

Extreme phenotypes of transgressive segregants
outside parent range





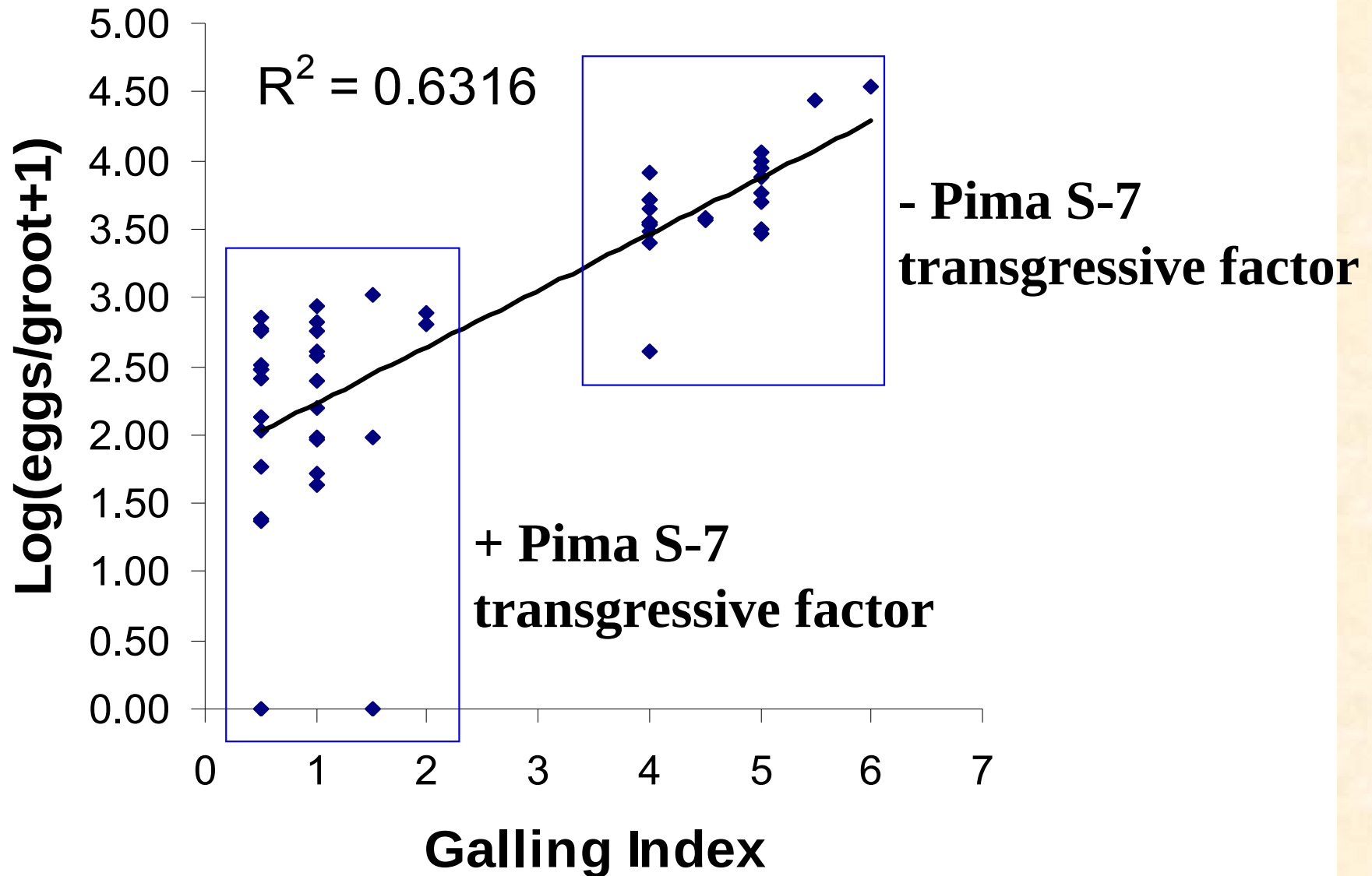
BC_1F_1 (NemX x F_1)
(90 plants)



BC_1F_1 (Pima S-7 x F_1)
(114 plants)

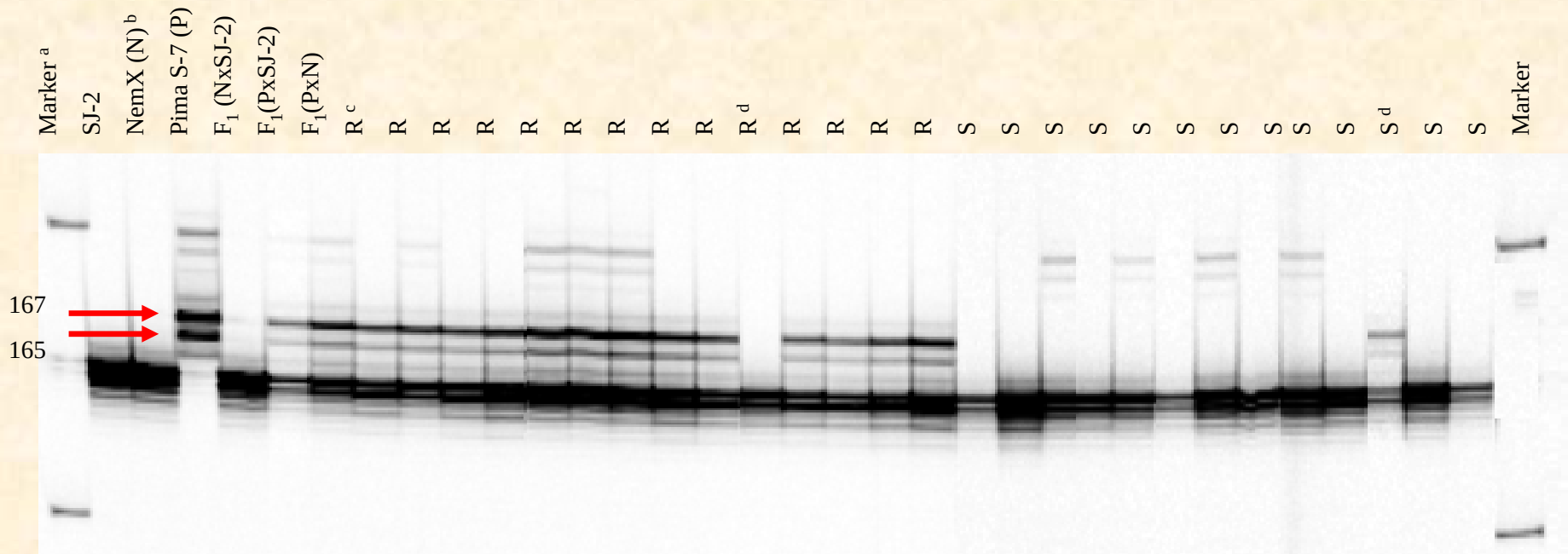
Testcross NemX x F₁ (PimaS-7 x SJ-2)

All plants Het for *rkn1*; $\frac{1}{2}$ have PS7 factor

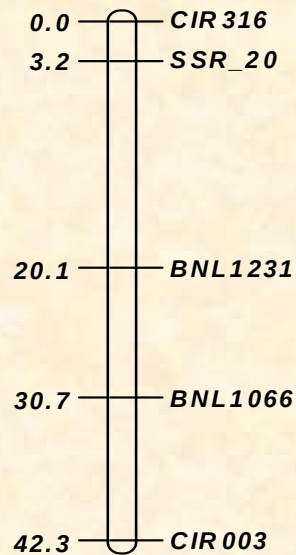


Marker screening P x N with SSR for TS gene *RKN2* from Pima S-7

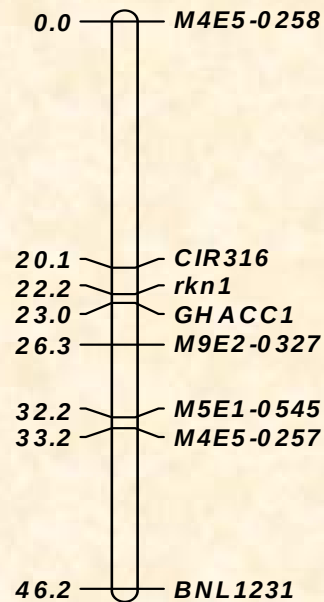
RKN2 SSR marker



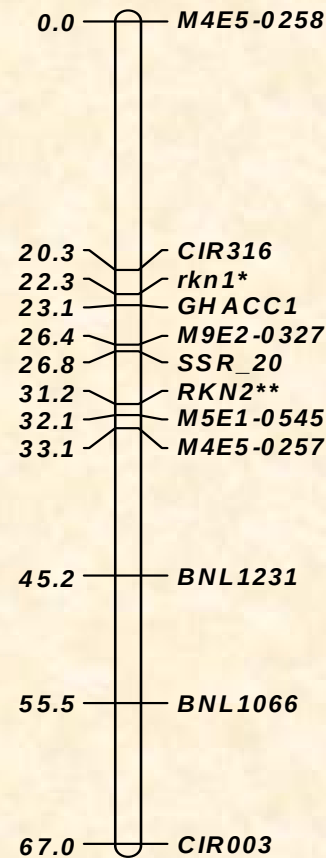
Linkage groups and Joint-group representing Chr 11 showing the distance and position relationships between SSR markers and the nematode resistance genes *rkn1** and *RKN2***.



Pop 1
Chromosome 11
F2 interspecific
(Pima S-7 x
NemX) LOD =4.0



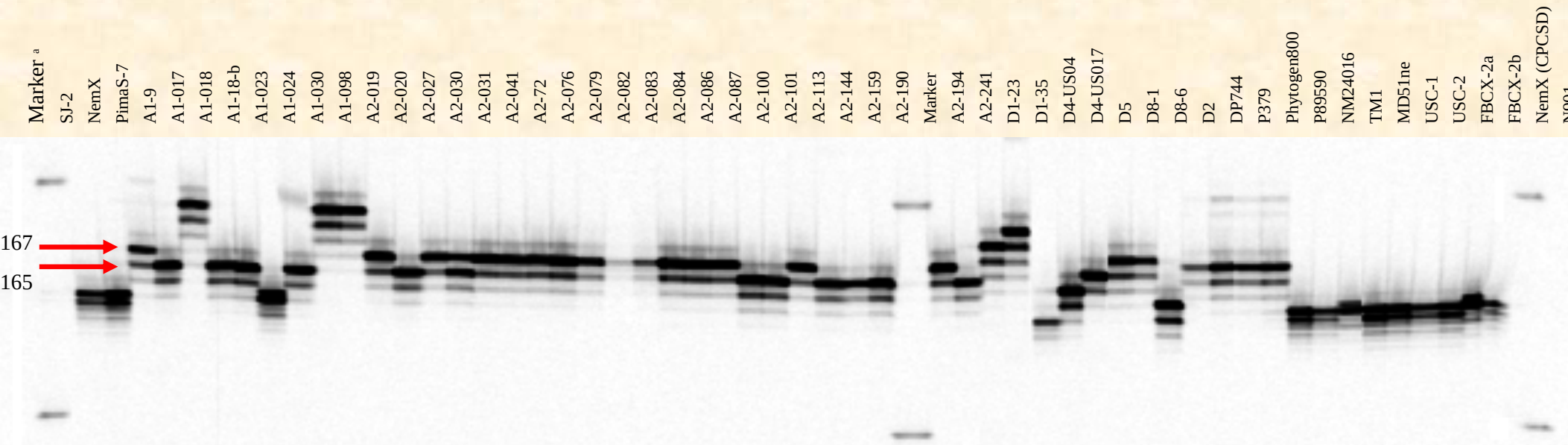
Pop 2
Chromosome 11
F2 intraspecific
(NemX x SJ-2)
LOD = 6.0

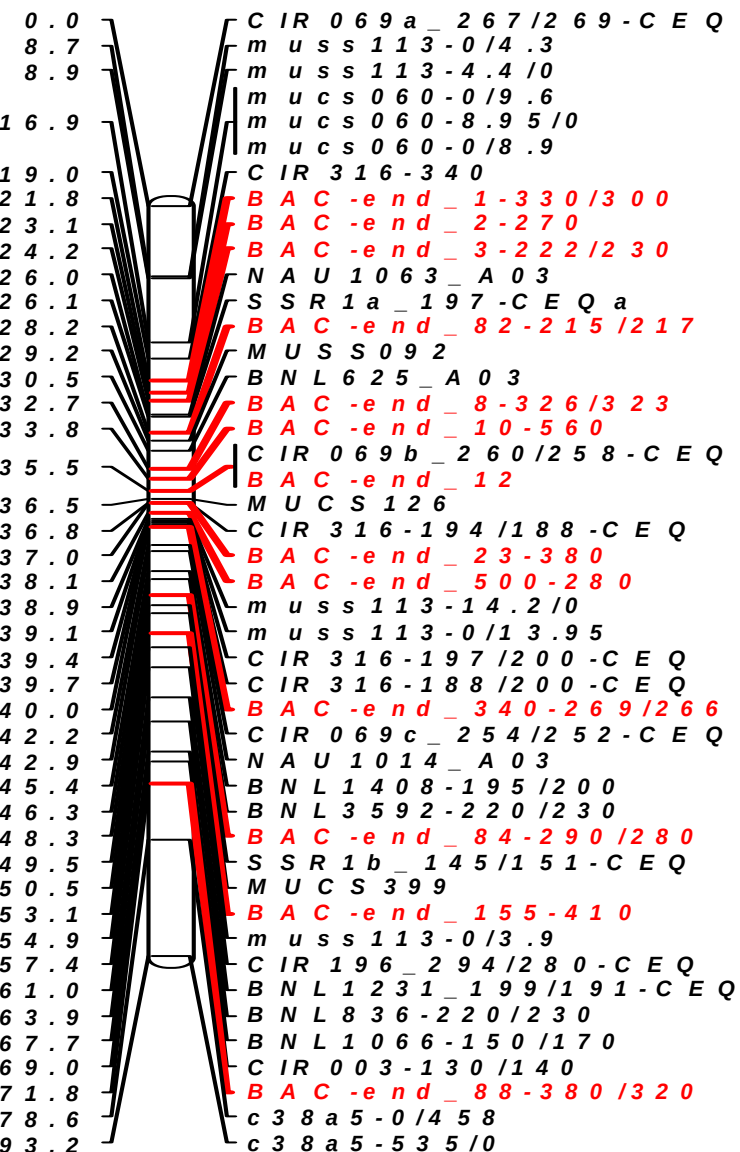


Joint-LG
Chromosome 11

Cotton marker/R gene origin Screening A and D genome donors

RKN2 SSR marker – MUCS-088





Current working map of Chr 11, with BAC-end derived SSRs in the CIR316/BNL1231 region.

Summary

- Chromosome 11 important RKN R gene region: *rkn1*, A634 source, *RKN2*
- Excellent markers linked to *rkn1* and *RKN2* for MAS (SSR, CAPs, SNP)
- Transgressive segregation for enhanced resistance phenotypes
- Marker screening of diverse germplasm - test for unique R genes and origins
- Saturation mapping tied to physical mapping

Acknowledgements

UCR

Bill Matthews

Teresa Mullens

Kathie Carter

Mauricio Ulloa (USDA, Shafter, CA)

Jinfa Zhang (NMSU, Las Cruces)

Bob Nichols (Cotton Inc)

Jim Starr (Texas A&M)

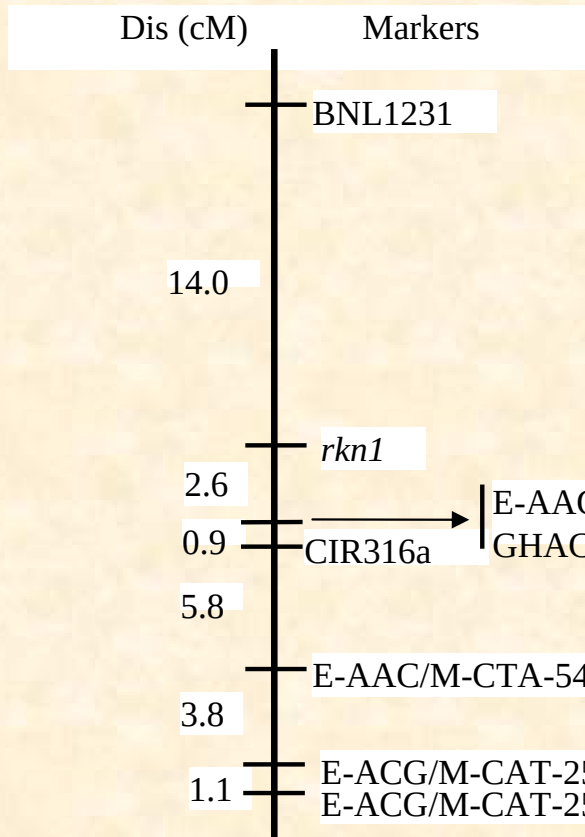
**Richard Davis and Peng Chee
(U. Georgia)**

Johnnie Jenkins (USDA, MS)

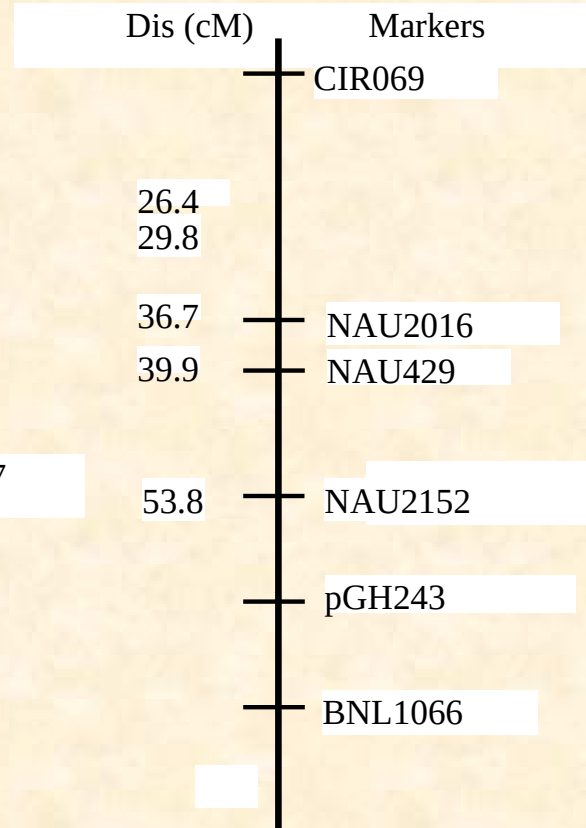
Funding: Cotton Incorporated

UC Discovery Grant Program

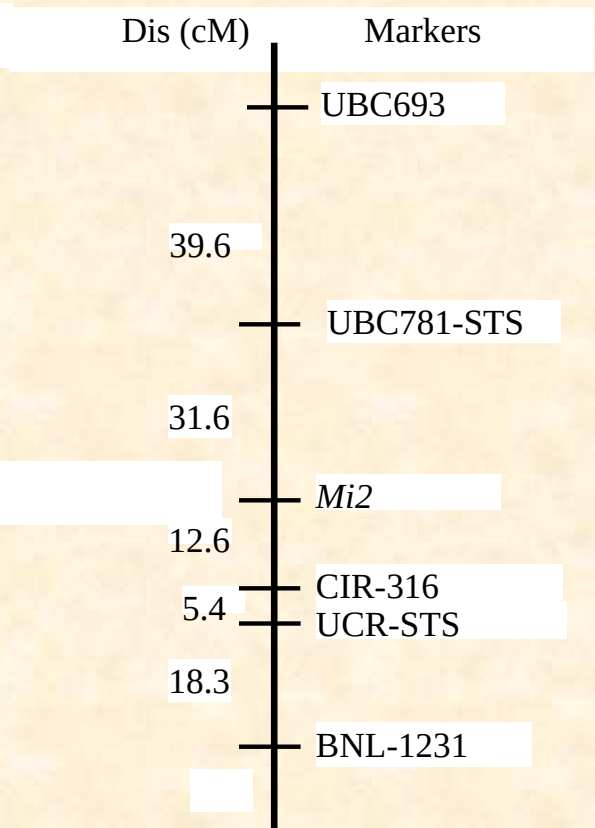
Linkage groups representing Chr 11 showing the distance and position relationships between SSR markers and the nematode resistance genes



Wang et al
Rkn1-NemX



Shen et al
M120-Au 634



Nui et al
Au 634