

Fine Mapping of the Tomato Yellow Leaf Curl Virus Resistance Gene *Ty-2* on Chromosome 11 of Tomato

**Xiaohui Yang, Jay Scott, and Sam Hutton
Gulf Coast Research & Education Center
University of Florida**

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Overview

Tomato yellow leaf curl virus disease (TYLCV)

- The first monopartite begomovirus of the family Geminiviridae.
- First reported in Israel in 1939.
- Serious losses to tomato production in tropical and subtropical regions of the world.
- Vector: Sweet potato whitefly, *Bemisia tabaci* (Genn.).
- Disease symptoms: Leaf curling, yellowing and plant stunting.

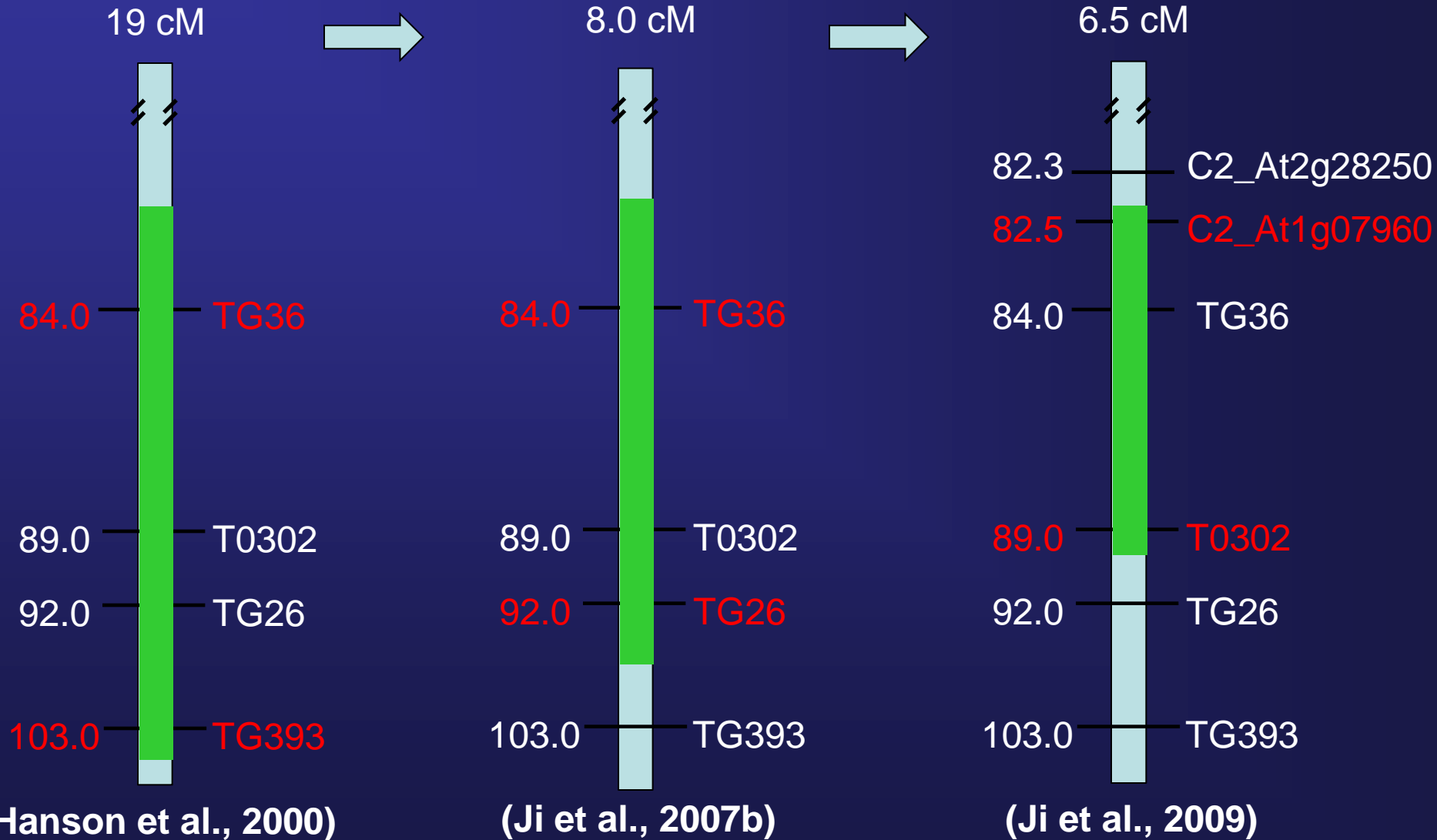
Overview

- TYLCV Resistance Genes:

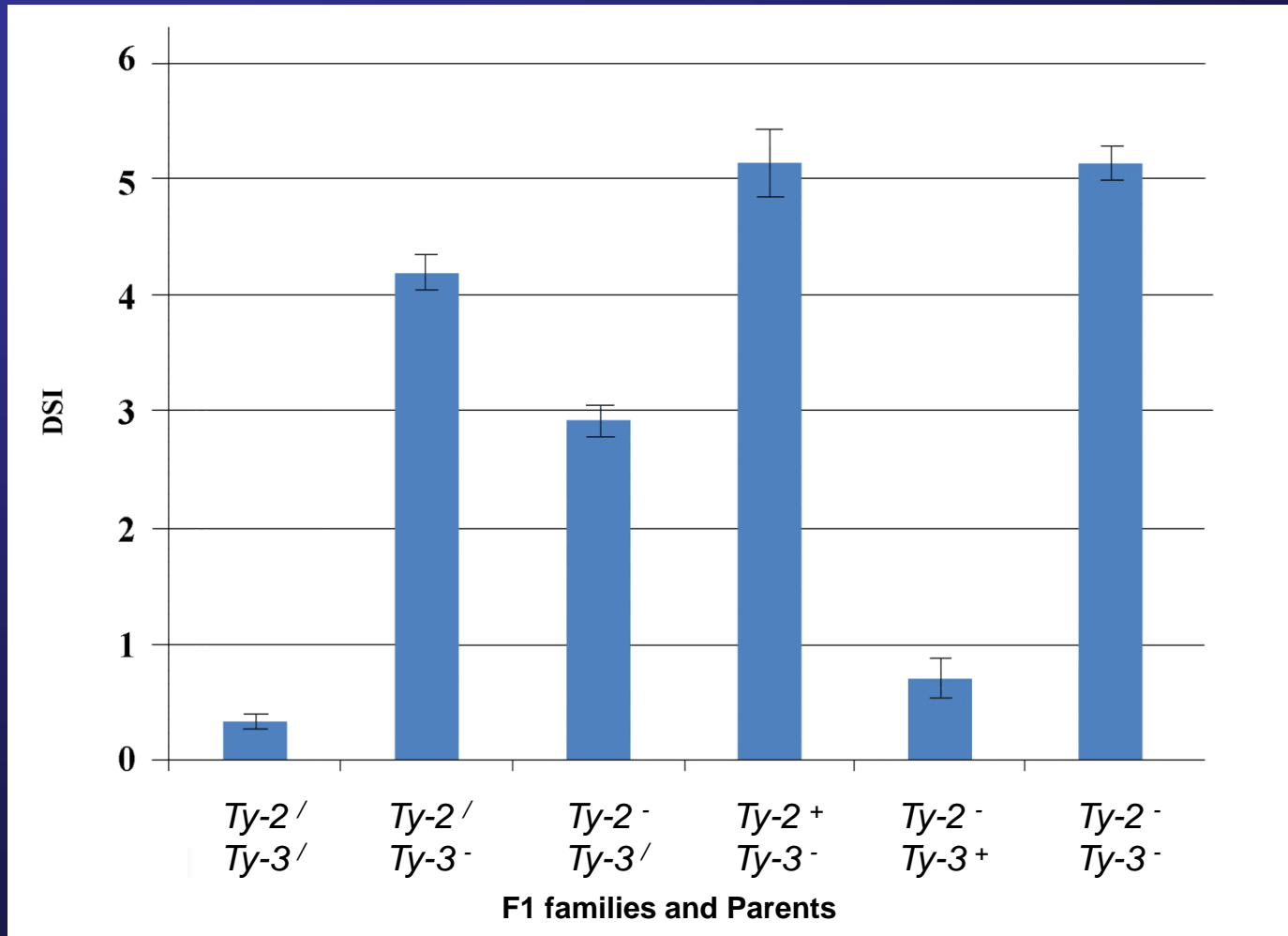
	Species	Chromosome	Reference
<i>Ty-1</i>	<i>S. chilense</i>	6	Zamir et al., 1994
<i>Ty-2</i>	<i>S. habrochaites</i>	11	Hanson et al., 2000
<i>Ty-3</i>	<i>S. chilense</i>	6	Ji et al., 2007
<i>Ty-4</i>	<i>S. chilense</i>	3	Ji et al., 2009
<i>Ty-5</i>	<i>S. peruvianum</i>	4	Anbinder et al., 2009

Ty-2 gene introgressions

Chl.11



Bipartite begomovirus disease severity for combinations of genes Ty3 and Ty2



(from Mejia et al., 2010 TGC report)

Guatemala

•TYLCV inoculation (TYLCV-Is)

**Horizon
(susceptible)**

Ty-3 resistance

Ty-2 resistance



Research Objectives

- Further delimit the *Ty-2* introgression to a shorter interval in the target region.
- Evaluate efficacy of *Ty-2* in combination with *Ty-3* and *Ty-4*.

Materials and Methods

Plant material

- Population derived from Heinz H9205:
 - F_2 plants heterozygous for *Ty-2* introgression selected and F_3 seed used for TYLCV evaluation.
 - *Ty-2* resistant control: homozygous for *Ty-2*.
 - 'Horizon' = susceptible control.

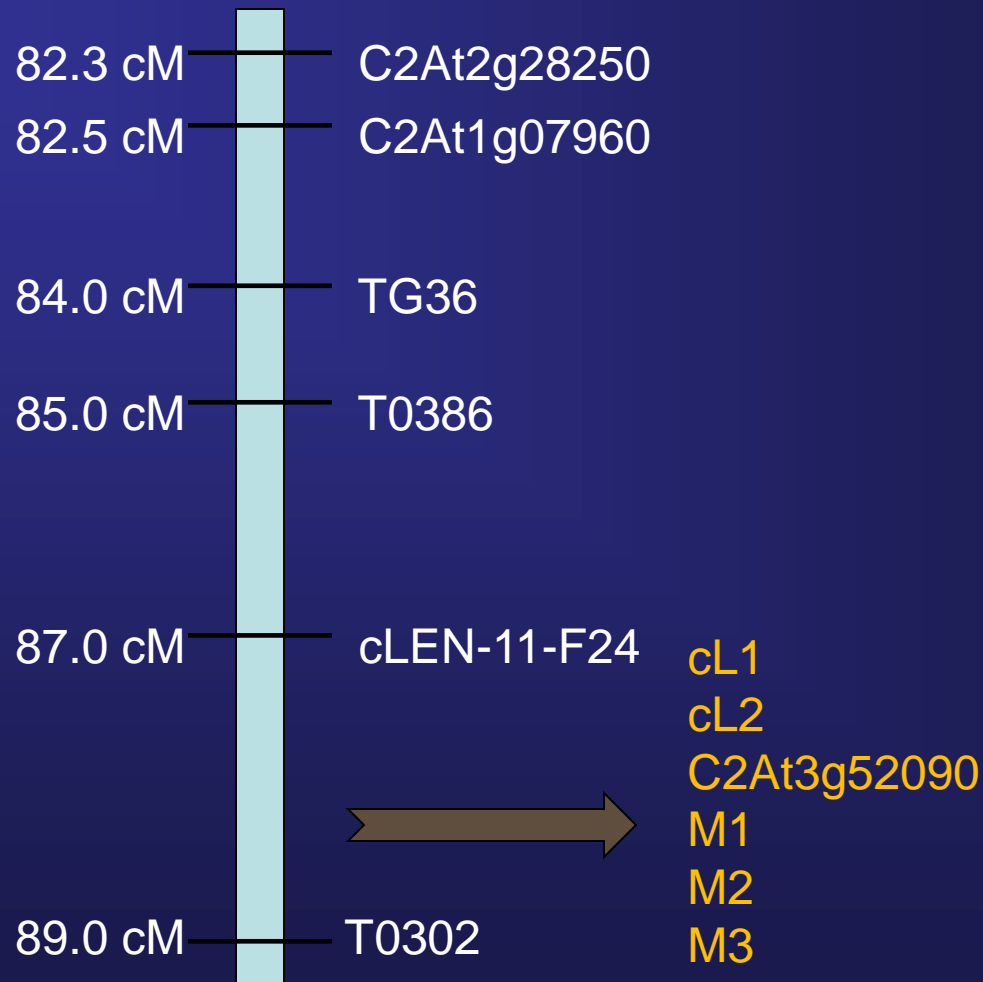
Materials and Methods

Inoculation

- **Seedlings exposed to viruliferous whiteflies for TYLCV for two weeks (Griffiths and Scott, 2001)**
- **Whiteflies killed prior to transplanting to pots or the field**
- **Disease severity rated ~60 days after inoculation**

Materials and Methods

Markers



(Tomato-EXPEN 2000)

ance

1.490

2.068

Physical Position (Mb) Approx. cM

F(L

SL2.40 ch11 51.307

82.2

C2At2g28250

TG3

51.388

82.9

C2At1g07960

TG1

51.490

84.0

TG36

51.503

84.1

T0386

51.549

84.6

cLEN-11-F24

51.561

84.7

cL1

51.573

84.8

cL2

51.607

85.2

C2At3g52090

~500kb

51.646

85.6

M1

51.663

85.7

M2

51.773

86.8

M3

51.879

87.9

T0302



Ty-2 Fine Mapping

Recombinant screen

- Fall 2009: Screened ~4,000 F₂ plants for recombination
~30 recombinants

Genotype	Flanking Molecular markers		No. of recombinants
	C2At1g07960 (82.5 cM)	T0302 (89 cM)	
I	/	-	8
II	-	/	5
III	/	+	11
IV	+	/	6

+: homozygous for *S. habrochaites* alleles; -: homozygous for *S. lycopersicum* alleles; /: heterozygous alleles.

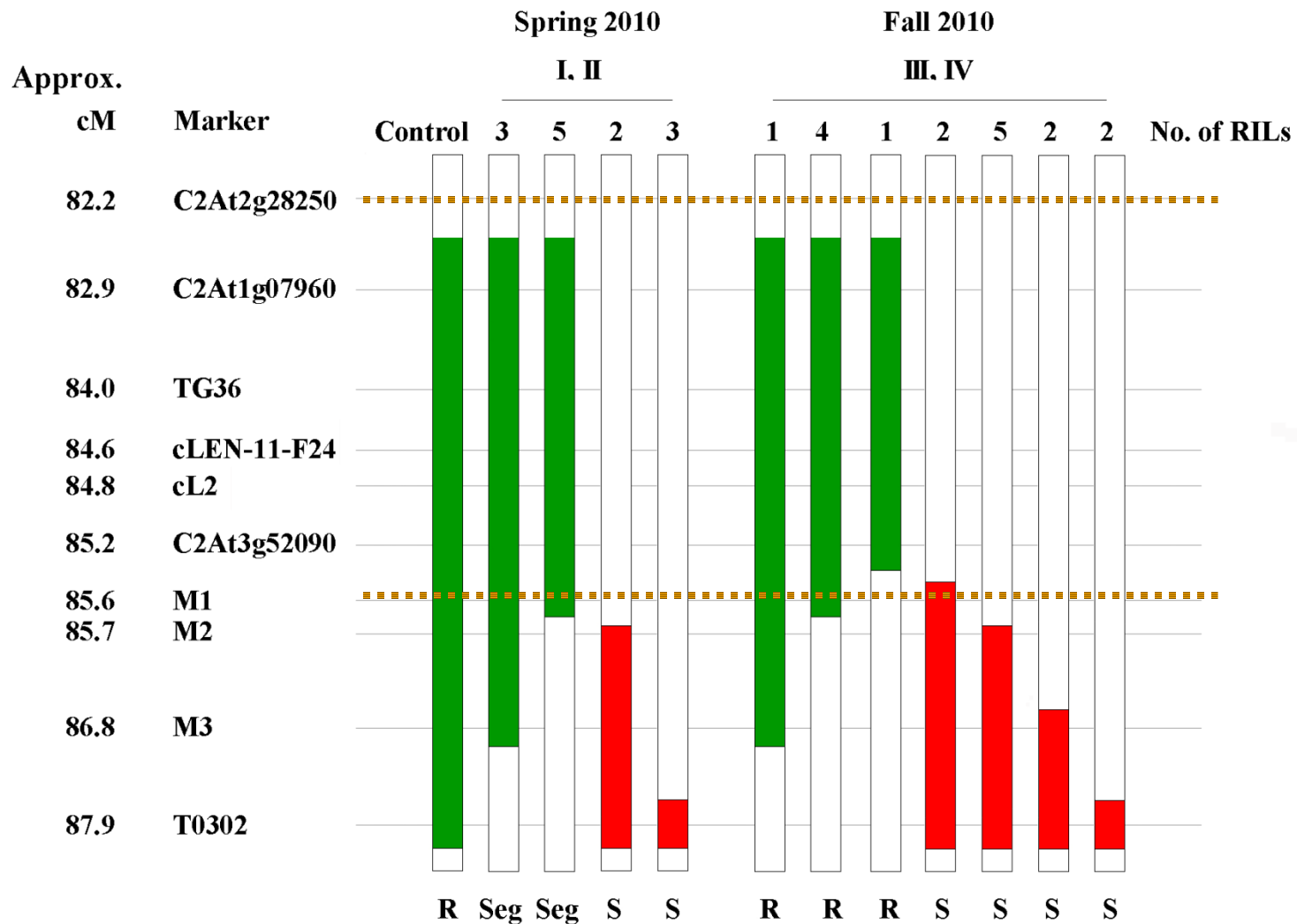
TYLCV Evaluation

◆ Spring 2010

- **Grew progeny of recombinants (categories I and II)**
- **Inoculated seedlings**
- **Greenhouse evaluation of virus symptoms**

◆ Fall 2010

- **Grew out progeny (categories III and IV)**
- **Screened each plant with markers and selected RILs**
- **Inoculated RILs**
- **Greenhouse evaluation of virus symptoms**

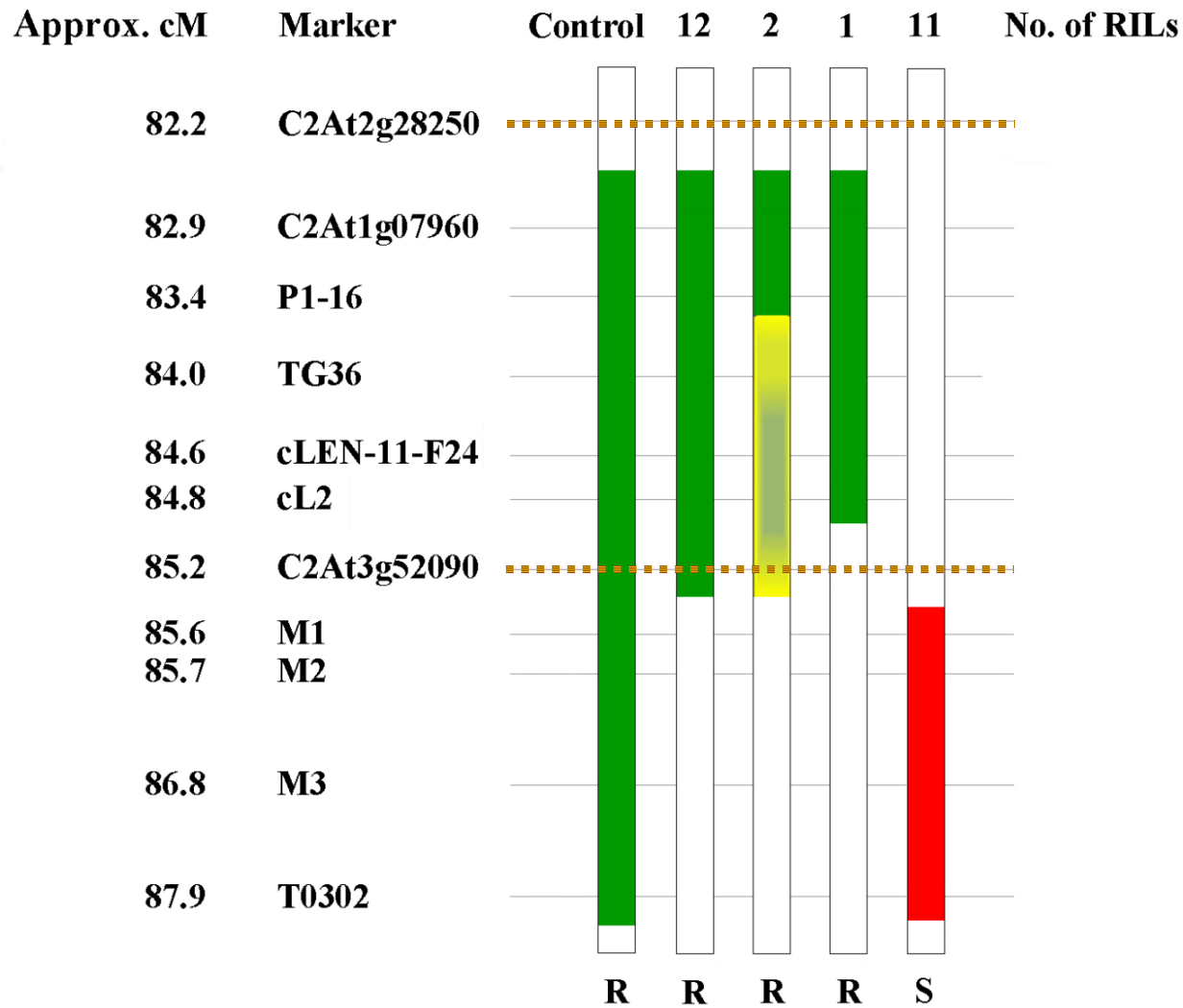


Introgression patterns for **resistant** RILs are shown in green.
Introgression patterns for **susceptible** RILs are shown in red.

Ty-2 fine mapping with additional population

- Spring 2011: Screened ~7,000 F₂ plants for recombination
 - ~127 total recombinants (C2At1g07960 and T0302)
 - ~26 informative recombinants (C2At1g07960 and M1)
- Disease severity evaluations





Introgression patterns for **homozygous resistant** RILs are shown in green. Introgression patterns for **homozygous susceptible** RILs are shown in red. Some part of **heterozygous introgression** are shown in yellow.

Confusing genotype?

Markers	Recombinant
C2At1g07960	+
TG36	/
cL2	/
C2At3g52090	/
M1	/

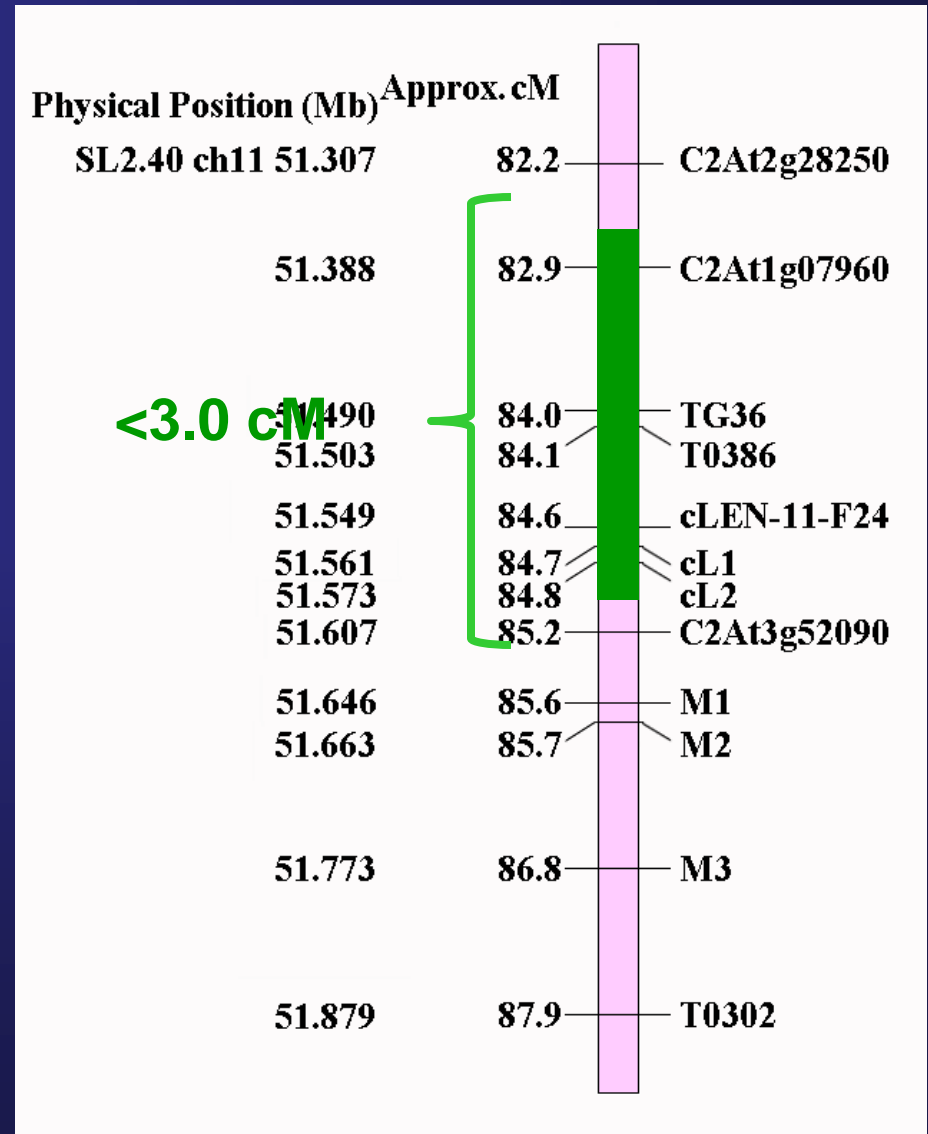


No. of Progeny		
17	53	21
+	+	+
+	/	/
+	/	/
+	/	/
+	/	-

+: homozygous for *S. habrochaites* alleles; **-**: homozygous for *S. lycopersicum* alleles; **/**: heterozygous alleles.

Summary

- The *Ty-2* gene mapped to <3.0 cM region (<300 Kb).
- Severe recombination suppression between C2_At1g07960 and C2_At3g52090.



Future Work

- Efforts underway to sequence resistant material for the *Ty-2* region.
- Candidate gene identification.
- Test resistance of *Ty-2*, *Ty-3*, *Ty-4* gene combinations.

Phy

Line	<i>Ty-2</i>	<i>Ty-3</i>	<i>Ty-4</i>
1	-	-	-
2	+	-	-
3	-	+	-
4	-	-	+
5	/	-	-
6	-	/	-
7	-	-	/
8	-	+	+
9	-	+	/
10	-	/	+
11	-	/	/
12	/	-	/
13	/	/	-
14	/	/	/

Thanks!