Fresh Market Tomato Breeding at the University of Florida

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COMPARING APPLES TO TOMATOES:
Is Tasti-Lee a new paradigm for tomatoes?

Are any of you TBRT people reading this??

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Tomato Varieties with Resistance to Viral and Bacterial Diseases

TBRT: I MAY TELL SOME JOKES BUT I DON’T REALLY CARE IF YOU LAUGH OR NOT

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The Same Old Changes in Tomato Breeding at the University of Florida

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DARUSH IS HAVING 2ND THOUGHTS ABOUT INVITING ME HERE
Approaches for Developing Bacterial Spot Resistant Tomato Cultivars

J.W. Scott, S.F. Hutton, D.F. Francis, S-C. Sim, and D.M. Horvath

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U.S. Fresh Market Tomato Production - 50,544 Hectares

California 13,350 HA

Midwest & Northeast 8,943 HA

Southeast Region 7,810 HA

Florida 17,685 HA
Florida Principle Tomato Producing Areas

- Oxford
- Palmetto-Ruskin
- Immokalee-Naples
- Ft Pierce Pompano
- Dade
- Gadsden
- Wimauma
History of Bacterial Spot in Tomato

Resistance sources:

Race T1
- H7998 (HR)
- PI 114490
- PI 155372

Race T2
- PI 114490
- PI 155372

Race T3
- H7981 (HR)
- PI 128216 (HR)
- PI 126932 (HR)
- PI 114490
- PI 155372
- LA 716 (HR)

Race T4
- PI 114490
- LA 716 (HR)

Xanthomonas euvesicatoria
- race T1

Xanthomonas perforans
- race T2
- race T3
- race T4
- race T5

X. gardneri (2009?)

Various QTL
Correlation coefficients for bacterial spot disease severity ratings between races T1, T2, and T3 in Summer 1998 and 1999 for PI 114490 and T2 or T3 selected lines derived from PI 114490.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>T1/1998</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>T2/1998</td>
<td>0.90 ***</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>T3/1998</td>
<td>0.24 ns</td>
<td>0.10 ns</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>T1/1999</td>
<td>0.70 **</td>
<td>0.80 ***</td>
<td>0.04 ns</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>T2/1999</td>
<td>0.86 ***</td>
<td>0.92 ***</td>
<td>0.23 ns</td>
<td>0.82 ***</td>
<td>-</td>
</tr>
<tr>
<td>T3/1999</td>
<td>0.36 ns</td>
<td>0.27 ns</td>
<td>0.63 *</td>
<td>-0.01 ns</td>
<td>0.16 ns</td>
</tr>
</tbody>
</table>

\( z \) ***=significant at \( P=0.0001 \); **=significant at \( P=0.01 \); *=significant at \( P=0.05 \); and ns=not significant.
1) Good resistance to T1 & T2, only fair for T3

2) Resistance to T1 and T2 closely related, not so close for T3

3) Resistance controlled by 2-3 genes probably

4) Resistance to T4 unknown
Materials and Methods

• PI 114490
  – Highly resistant
  – Race non-specific
  – Quantitative
  – QTL on chromosomes 3 and 11
    (Hutton et al., 2010)

• Susceptible parents
  – Fla. 7324 and Fla. 7613

• Selective phenotyping
  – sp and QTL 11
  – 500 F\textsubscript{2} progeny

• Field evaluations-T4 unless indicated
  – Fall 2010 (F2)
  – Spring 2011 (F3)
  – Fall 2011 (F4)
  – Spring 2012 (F5)
  – Summer 2012-races T1,T2,T3,Xg (Ohio)

• Selective genotyping
  – SoICAP/Illumina Infinium snp array
Materials and Methods

Phenotyping Results:

92 selections

Genotyping Results:

7720 total polymorphic markers
2689 p.m. in Fla. 7324 pop
2488 p.m. in Fla. 7613 pop
2248 p.m. in both populations
2228 known physical locations

Single Marker Analysis
GLM (SAS)
We acknowledge Illumina's technology and USDA-NIFA Agriculture and Food Research Initiative (AFRI) sponsored Solanaceae Coordinated Agricultural Project (SolCAP) for the data presented on the following set of slides
**Chromosome 1**

**F Value**

- **One region:**
  - T1 <0.05
  - T2 <0.01
  - T3 <0.01
  - T4 <0.0001
  - Xg <0.001

- **Two regions:**
  - T1 <0.05 + <0.001 ++++
  - T2 <0.0001 ++ <0.001 +++
  - T3 <0.0001 ++ <0.01 +++
  - T4 <0.01 +++ <0.001 +++
  - Xg <0.0001 ++ <0.0001 ++++

**Chromosome 2**

**F Value**

- **Physical Position (Mb)**
  - P = .05
  - P = .01
  - P = .001
  - P = .0001

- **Physical Position (Mb)**
  - P = .0001
Chromosome 3

F Value

Major QTL:

- T1 < 0.0001
- T2 < 0.0001
- T3 < 0.0001
- T4 < 0.0001
- Xg < 0.0001

Minor region:

- T1
- T2 < 0.05
- T3
- T4
- Xg

Chromosome 4

F Value

Physical Position (Mb)
P = 0.0001

P = 0.05
**Minor effect:**

- T1 < 0.05  ++
- T2 < 0.01  +++
- T3 < 0.05  +
- T4
- Xg < 0.05  +

**Two regions:**

- T1 < 0.05  - < 0.05  ++++++++  
- T2  < 0.05  - 
- T3  < 0.05  --
- T4
- Xg  < 0.05  +++++
Minor effect:

- T1
- T2
- T3
- T4 < 0.05
- Xg < 0.05

One region:

- T1 < 0.001
- T2 < 0.001
- T3 < 0.01
- T4 < 0.01
- Xg < 0.001
Two minor effects:

- $T_1 < 0.05$ ~-$-$ ~$< 0.05$ +++
- $T_2 < 0.05$ - - $< 0.05$ ++
- $T_3$
- $T_4 < 0.05$ ~-$-$ ~$< 0.05$ +++
- $Xg$

Two major regions:

- $T_1 < 0.01$ ++++
- $T_2 < 0.05$ ++
- $T_3 < 0.01$ ++++
- $T_4 < 0.0001$ +++++
- $Xg < 0.01$ +++

Chromosome 9

Chromosome 10

$P = .05$

$P = .001$

$P = .0001$
Two regions:

- **T1** <0.01 +++ <0.01 ++
- **T2** <0.05 +++ <0.05 ++
- **T3**
- **T4** <0.001 ++++ <0.001 +++
- **Xg** <0.05 + <0.05 +

Minor effect:

- **T1** <0.01 +++
- **T2** <0.01 ++
- **T3** <0.01 ++++
- **T4** <0.01 ++++
- **Xg** <0.05 ++
PI 114490 QTL Summary

**Strong Effects- 7 possible QTL**
- Ch. 2: 2 regions all loci
- Ch. 3: large introgression all loci
- Ch. 10: 2 regions > for T4
- **Ch. 11: 2 regions** > for T4, nothing for T3

**Weak Effects- 5 possible QTL**
- Ch. 5: T2 mainly, no T4
- Ch. 6: T1, T2, Xg only
- Ch. 8: all races
- Ch. 9: T1, T2, T4
- Ch. 12: all races

**Negative Effects- 5 possible QTL**
- Ch. 1: >T4 but all races
- Ch. 4: T2 only
- Ch. 6: T3, T1
- Ch. 7: T4, Xg
- Ch. 9: T1, T2, T4
PI 114490 QTL Summary #2

✅ Validation Experiments Need to be Done:
  ✅ Which QTL Complement Each Other?
  ✅ Is There Linkage Drag?

✅ Thus, Much Work Remains but We Have Some Tools to Work With
Fascinating presentation
Dr. Scott
Fla. 7946: Fusarium wilt race 3 resistant, very susceptible to bacterial spot
Fla. 8517: Good bacterial spot tolerant line with PI 114490 and Hawaiian lines in its background
0630 Severity Rating = 2.5
Summary: Non-blighting

- Modified backcrossing proceeding phenotypically by selecting for earliness and yield
- Molecular markers linked to non-blighting would likely expedite our progress
- We will gladly accept funding for this project!
Fla. 8111B: Major Characteristics

- Large globe shaped fruit, strong vine, mid-season maturity
- Smooth, firm, crack resistant
- Graywall Resistant
- Good combiner for $F_1$ hybrids
- Very susceptible to bacterial spot
Is it Time for a Transgenic Tomato Variety?!

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S.F. Hutton, G.E. Vallad,  
J.B. Jones, R.E. Stall, and  
D.M. Horvath
Two Blades Foundation

• Mission to support the development and deployment of disease resistance in crops
• Driven by advances in molecular plant sciences and sequencing permitting access to a larger repertoire of disease resistance genes
• Goal to reduce crop losses due to disease, enhance food security
• Commercial and humanitarian applications
Effective genetic resistance to BLS
Bs2 Project

• Project first undertaken by 2Blades in 1992
• At that time:
  – BLS was a widespread problem on tomato and pepper
  – Known resistances in pepper (BS1-3)
  – Xanthomonas effectors were characterized
Widespread distribution and fitness contribution of *Xanthomonas campestris* avirulence gene *avrBs2*

Brian Kearney & Brian J. Staskawicz

Department of Plant Pathology, University of California, Berkeley, California 94720, USA

<table>
<thead>
<tr>
<th>Strain</th>
<th>Hypersensitivity on ECW20R</th>
<th>avrBs2 Homology</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>X. c. vesicatoria</em></td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td><em>X. c. alfalfae</em></td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td><em>X. c. phaseoli</em></td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td><em>X. c. malvacearum</em></td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td><em>X. c. campestris</em></td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td><em>X. c. vitians</em></td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td><em>X. c. vignicola</em></td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td><em>X. c. glycines</em></td>
<td>no</td>
<td>yes</td>
</tr>
<tr>
<td><em>X. c. holcicola</em></td>
<td>no</td>
<td>yes</td>
</tr>
<tr>
<td><em>X. c. oryzae</em></td>
<td>—</td>
<td>yes</td>
</tr>
<tr>
<td><em>X. c. citri</em></td>
<td>—</td>
<td>yes</td>
</tr>
<tr>
<td><em>X. fragariae</em></td>
<td>no</td>
<td>no</td>
</tr>
</tbody>
</table>

- *AvrBs2* widely distributed
- Function conserved
Crop Development Process

Discovery
proof of concept

Characterization
Line selection
IP filing

Field Trials

Regulatory Approvals
Seed increase, marketing, distribution

New Commercial product

2Blades

UCB

2Blades/UF
I told them it was just a pepper gene in a tomato!
Total and extra-large marketable yield, fruit size and cull weights for tomato inbreds and hybrids with and without the pepper *Bs2* gene, Fall 2011, GCREC.

<table>
<thead>
<tr>
<th>Entry</th>
<th>Marketable yield (25 lb box/A)</th>
<th>Fruit Size (oz.)</th>
<th>Culls (% by wt.)</th>
<th>Bacterial spot disease severity(^y)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total</td>
<td>Extra-large</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fla. 8000</td>
<td>2362 a(^x)</td>
<td>906 bc</td>
<td>5.1 cd</td>
<td>27</td>
</tr>
<tr>
<td><em>Bs2</em> homo</td>
<td></td>
<td></td>
<td></td>
<td>5.4</td>
</tr>
<tr>
<td>Fla. 8314</td>
<td>2237 ab</td>
<td>1232 a</td>
<td>5.6 a-c</td>
<td>21</td>
</tr>
<tr>
<td><em>Bs2</em> homo</td>
<td></td>
<td></td>
<td></td>
<td>4.0</td>
</tr>
<tr>
<td>Fla. 8000</td>
<td>1918 b</td>
<td>1060 ab</td>
<td>5.8 ab</td>
<td>26</td>
</tr>
<tr>
<td><em>Bs2</em> hemi</td>
<td></td>
<td></td>
<td></td>
<td>4.3</td>
</tr>
<tr>
<td>Florida 47</td>
<td>1099 c</td>
<td>682 c</td>
<td>6.2 a</td>
<td>23</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>5.5</td>
</tr>
<tr>
<td>Fla. 8314</td>
<td>1093 c</td>
<td>588 c</td>
<td>5.5 bc</td>
<td>23</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>5.6</td>
</tr>
<tr>
<td>Fla. 8000</td>
<td>1028 c</td>
<td>253 d</td>
<td>4.8 d</td>
<td>28</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>5.1</td>
</tr>
</tbody>
</table>

\(^z\) Genotypes with *Bs2* gene indicated by *Bs2*, hemi = 1 copy, homo = 2 copies.

\(^y\) Rated on the Horsfall-Barrett Scale, 4 = 6-12% defoliation; 5 = 12-25% defoliation; 6 = 25-50% defoliation.

\(^x\) Mean separation in columns by Duncan’s multiple range test at P ≤ 0.05.
### Bacterial spot disease severity for tomato inbreds and hybrids with and without the Bs2 pepper gene, GCREC Spring 2012.

<table>
<thead>
<tr>
<th>Genotype</th>
<th>Disease Severity $^z$</th>
</tr>
</thead>
<tbody>
<tr>
<td>VF 36</td>
<td>9.25 a$^y$</td>
</tr>
<tr>
<td>Fla. 8111 B</td>
<td>8.75 a</td>
</tr>
<tr>
<td>Florida 47</td>
<td>7.38 b</td>
</tr>
<tr>
<td>Sebring</td>
<td>7.13 bc</td>
</tr>
<tr>
<td>Xv4 F$_1$</td>
<td>6.5 b-d</td>
</tr>
<tr>
<td>Fla. 8000</td>
<td>6.5 b-d</td>
</tr>
<tr>
<td>Florida 91</td>
<td>6.25 b-e</td>
</tr>
<tr>
<td>Fla. 8314</td>
<td>6.25 b-e</td>
</tr>
<tr>
<td>Xv4 line</td>
<td>6.13 c-e</td>
</tr>
<tr>
<td>Sanibel</td>
<td>5.67 de</td>
</tr>
<tr>
<td>104009-29 (susceptible)</td>
<td>5.25 e</td>
</tr>
<tr>
<td>104009-8 $Bs2$</td>
<td>2.75 f</td>
</tr>
<tr>
<td>VF36 $Bs2$ hemi</td>
<td>2.5 f</td>
</tr>
<tr>
<td>104009-13 $Bs2$</td>
<td>2.5 f</td>
</tr>
<tr>
<td>VF 36 $Bs2$ homo</td>
<td>2.5 f</td>
</tr>
<tr>
<td>104009-5 $Bs2$</td>
<td>2.45 f</td>
</tr>
<tr>
<td>104009-26 $Bs2$</td>
<td>2.25 f</td>
</tr>
<tr>
<td>Fla. 8111B $Bs2$ homo</td>
<td>2.25 f</td>
</tr>
<tr>
<td>Xv4 $Bs2$ F$_1$</td>
<td>2.25 f</td>
</tr>
<tr>
<td>Fla. 8314 $Bs2$ homo</td>
<td>2.0 f</td>
</tr>
<tr>
<td>104009-12 $Bs2$</td>
<td>2.0 f</td>
</tr>
<tr>
<td>Fla. 8000 $Bs2$ homo</td>
<td>2.0 f</td>
</tr>
</tbody>
</table>

$^z$ Horsfall-Barratt scale, higher number means more disease.

$^y$ Mean separation by Duncan’s Multiple Range Test at P ≤ 0.05.
Total and extra-large marketable yield, fruit size, and cull weights for tomato inbreds and hybrids with and without the pepper *Bs2* gene, Spring 2012, GCREC.

<table>
<thead>
<tr>
<th>Entry²</th>
<th>Marketable Yield (25 lb box/A)</th>
<th>Fruit size (oz)</th>
<th>Culls (% by wt.)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total</td>
<td>Extra-large</td>
<td></td>
</tr>
<tr>
<td>Fla. 8000 <em>Bs2</em></td>
<td>2122 a&lt;sup&gt;y&lt;/sup&gt;</td>
<td>566 bc</td>
<td>5.1 f</td>
</tr>
<tr>
<td>Fla. 8314 <em>Bs2</em></td>
<td>1725 ab</td>
<td>849 a</td>
<td>6.2 cd</td>
</tr>
<tr>
<td>Fla. 8000</td>
<td>1648 b</td>
<td>403 c-e</td>
<td>5.3 ef</td>
</tr>
<tr>
<td>Xv4 <em>Bs2</em> F&lt;sub&gt;1&lt;/sub&gt;</td>
<td>1615 b</td>
<td>507 b-d</td>
<td>5.3 ef</td>
</tr>
<tr>
<td>9-3-20 SUSC</td>
<td>1579 b</td>
<td>228 de</td>
<td>4.9 f</td>
</tr>
<tr>
<td>9-3-5 <em>Bs2</em></td>
<td>1524 b</td>
<td>201 e</td>
<td>4.8 f</td>
</tr>
<tr>
<td>Florida 91</td>
<td>1357 b-c</td>
<td>855 a</td>
<td>6.9 b</td>
</tr>
<tr>
<td>Sanibel</td>
<td>1003 cd</td>
<td>467 c-e</td>
<td>6.2 cd</td>
</tr>
<tr>
<td>Fla. 8314</td>
<td>967 cd</td>
<td>395 c-e</td>
<td>5.8 de</td>
</tr>
<tr>
<td>Fla. 8111 <em>Bs2</em></td>
<td>892 cd</td>
<td>750 ab</td>
<td>7.9 a</td>
</tr>
<tr>
<td>Fla. 8111</td>
<td>764 d</td>
<td>371 c-e</td>
<td>6.2 cd</td>
</tr>
<tr>
<td>Sebring</td>
<td>707 d</td>
<td>367 c-e</td>
<td>6.5 bc</td>
</tr>
<tr>
<td>Florida 47</td>
<td>665 d</td>
<td>272 de</td>
<td>5.9 bc</td>
</tr>
</tbody>
</table>

<sup>²</sup> *Bs2* indicates genotype is homozygous for the *Bs2* gene.

<sup>ɣ</sup> Mean separation in columns by Duncan’s Multiple Range Test at *P* ≤ 0.05.
# MAS Trait Integration

<table>
<thead>
<tr>
<th>Traits</th>
<th>Recurrent Parents</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ty-1</td>
<td>7770 8208 8611</td>
</tr>
<tr>
<td>Ty-2</td>
<td>7776 8249 8620</td>
</tr>
<tr>
<td>Ty-3</td>
<td>7781 8283 8623</td>
</tr>
<tr>
<td>Ty-4</td>
<td>7804 8293 8626</td>
</tr>
<tr>
<td>Ty-5</td>
<td>7907B 8296 8640</td>
</tr>
<tr>
<td>(Ty-6)</td>
<td>7946 8297 8646</td>
</tr>
<tr>
<td>Sw-5</td>
<td>7949B 8436B 8650</td>
</tr>
<tr>
<td>Sw-7</td>
<td>7987 8490B 8653B</td>
</tr>
<tr>
<td>Frl</td>
<td>8000 8495 8735</td>
</tr>
<tr>
<td>Pto</td>
<td>8021 8499 8820</td>
</tr>
<tr>
<td>Ph-2</td>
<td>8044 8589 8834</td>
</tr>
<tr>
<td>Ph-3</td>
<td>8059 8590 8835</td>
</tr>
<tr>
<td></td>
<td>8083 8591 8872</td>
</tr>
<tr>
<td></td>
<td>8111B 8592 8877</td>
</tr>
<tr>
<td></td>
<td>8124C 8599 8878</td>
</tr>
<tr>
<td></td>
<td>8608</td>
</tr>
</tbody>
</table>
Yield of tomato genotypes with the *Bs2* pepper gene compared to genotypes without *Bs2*, Balm, Florida, Fall 2012.

<table>
<thead>
<tr>
<th>Entry</th>
<th>Marketable yield (25 lb. box/acre)</th>
<th>Fruit size</th>
<th>Culls (% by wt.)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total</td>
<td>Extra-large</td>
<td>(g)</td>
</tr>
<tr>
<td><em>8455 Bs2, Ty1</em></td>
<td>2780a</td>
<td>2207a</td>
<td>204a-c</td>
</tr>
<tr>
<td><em>8111B x 7781 Bs2, Ty1 Fr1</em></td>
<td>2737a</td>
<td>1860ab</td>
<td>208a-c</td>
</tr>
<tr>
<td><em>8314 Bs2</em></td>
<td>2508ab</td>
<td>1933ab</td>
<td>195b-e</td>
</tr>
<tr>
<td><em>8735 x 8000 Bs2</em></td>
<td>2505ab</td>
<td>1836ab</td>
<td>184c-e</td>
</tr>
<tr>
<td><em>8000 Bs2</em></td>
<td>2476ab</td>
<td>1654b</td>
<td>177d-f</td>
</tr>
<tr>
<td><em>8726 Bs2, Ty1,I3</em></td>
<td>2424ab</td>
<td>2025ab</td>
<td>214ab</td>
</tr>
<tr>
<td><em>8476 x 8111B Bs2</em></td>
<td>1867bc</td>
<td>1431c</td>
<td>199a-e</td>
</tr>
<tr>
<td><em>8314</em></td>
<td>1434cd</td>
<td>920de</td>
<td>175ef</td>
</tr>
<tr>
<td><em>8000</em></td>
<td>1300cd</td>
<td>398f</td>
<td>142f</td>
</tr>
<tr>
<td><em>8455</em></td>
<td>1202cd</td>
<td>953d</td>
<td>202a-c</td>
</tr>
<tr>
<td><em>Sanibel</em></td>
<td>1129d</td>
<td>904de</td>
<td>203a-c</td>
</tr>
<tr>
<td><em>8726</em></td>
<td>1089d</td>
<td>926de</td>
<td>220a</td>
</tr>
<tr>
<td><em>Florida 91</em></td>
<td>1056d</td>
<td>904de</td>
<td>223a</td>
</tr>
<tr>
<td><em>Florida 47</em></td>
<td>934d</td>
<td>810ef</td>
<td>200a-d</td>
</tr>
</tbody>
</table>
Conqueror III is a green-stem straightneck with transgenic resistance to CMV, WMV and ZYMV and intermediate resistance to papaya ring spot. The fruit is a uniform, creamy yellow color and the plant is vigorous and semi-open.

<table>
<thead>
<tr>
<th>Fruit Color</th>
<th>Glossy lemon yellow, Green pedunde</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fruit shape</td>
<td>Straight, Slightly crooked neck, Tapered</td>
</tr>
<tr>
<td>Fruit size</td>
<td>6-7 in.; 16-18 cm</td>
</tr>
<tr>
<td>Plant type</td>
<td>Vigorous medium</td>
</tr>
<tr>
<td>Relative Days to Maturity</td>
<td>41</td>
</tr>
</tbody>
</table>
## Chemistry Cost

### Per season:

<table>
<thead>
<tr>
<th>Compound</th>
<th>Ave price $/ lb Al</th>
<th>Appln Rate</th>
<th># Applns (with BLS)</th>
<th>Total cost FL</th>
<th>Total cost FL/ EC/ Mex</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mancozeb (Dithane DF)</td>
<td>$1.65</td>
<td>1.5-2</td>
<td>44.8</td>
<td>$3,592,512</td>
<td>$14,414.400</td>
</tr>
<tr>
<td>Copper hydroxide (Kocide 101)</td>
<td>$3.25</td>
<td>1.5</td>
<td>44.8</td>
<td>$7,076,160</td>
<td>$28,392,000</td>
</tr>
</tbody>
</table>

2009 prices from one representative provider

Applications rates and number of applications from discussions with Glades Crop Care (2009)

FL acres average 32,400; Acres for FL, East Coast and Mexico are 130,000.

Costs do not include labor

2Blades
Copper increased linearly with the washing of tomatoes.

Zinc increased more in PKG 1 than PKG 2.
Transgenic BLS Resistant Fresh Market Tomato: From proof of principle to product

• Improved gene cassette
  – Only pepper and tomato DNA
  – No antibiotic selection gene

• Florida adapted varieties-reliable yields

• Green technology-less pesticides needed

• We are testing hybrids that have Bs2 and resistance to TYLCV, fusarium crown rot, fusarium wilt race 3, TSWV

• In the future we hope to improve resistance durability by adding Xv4, EFR genes, and QTLs.
30 years of intensive conventional breeding with no variety vs. an easy solution, but we are held hostage by ignorance....
Thank you! Questions?