Pepper Diseases Through the Years – a Review

Tom Zitter
Department of Plant Pathology & PMB
Cornell University
Ithaca, NY 14853
taz1@cornell.edu
Figure 1.—The Everglades and surrounding areas.
Pepper Production
Ray Volin, Charlie John (Heinz), Henry Ozaki (Morikami Farm, IFAS, UF)

Skip Nault (Ohio State) Jack Simons (JMS Stylet Oil),
Jim Tsai (Ft. Lauderdale, IFAS, UF)
The major vegetable production areas of New York
Current Work progressing on triple genetic resistance: for Late Blight, Early Blight and Septoria Leaf Spot
Serendipity means a "happy accident" or "pleasant surprise"; specifically, the accident of finding something good or useful without looking for it.
Virus Control with Mineral Oil Sprays

Immokalee, FL. – IFAS, UF

Delray Beach, FL Morikami Farm

[Graph showing the effectiveness of mineral oil sprays in controlling virus infected pods across different varieties.]
Serendipity No. 1 – Mineral Oils, Virus Diseases, Aphids and Powdery Mildew Control

• Virus control with oil sprays (Zitter, Sept 1978 AVG; FSHS 1978)
  Use mineral oil sprays to interfere with transmission of virus in multiple crops
  (pepper – Early Calwonder, Florida VR-2, Delray Bell for Pepper Mottle virus;
  Poinsett cucumber and Senator zucchini for WMV-1)

• 60% reduction in virus spread with the weekly application of Mineral oils.

• BUT, also significant control of PM in cucumber and zucchini squash.

RESULT: JMS Stylet Oil is used for PM control commercially in Grapes and Cucurbits along with potassium bicarbonate sprays.
Serendipity No. 2

Mission: Reduce the spread of Bacterial leaf spot in pepper with weekly sprays of harpin protein (commercialized as Messenger by Eden Bioscience Crop, Bothell, WA)

Results:
• Reduction in the occurrence of spread of bacterial leaf spot (*Xanthomonas campestris pv. vesicatoria*)

• Significant reduction in the occurrence of damage due to European Corn borer and associated Bacterial soft rot – *Erwinia carotovora subsp. carotovora*
Tomato spotted wilt Tospovirus Bunyaviridae on Tomatoes

RESULT: SAR products now in use – (Actigard and Messenger) for Diseases and Pests

Iris Yellow Spot Tospovirus Bunyaviridae on Onions

Thrips as vector
6.1 million acres (2.5×10^6 ha)*

*(larger than Yellowstone, Yosemite, Grand Canyon, Great Smoky, and Everglades National Parks combined)
2009 Late Blight and Occurrence of US22 – too close to home!
Late blight – upper and lower leaf infection and sporulation
The 2004 Growing Season

• Very wet!

• Large number of diseases found on potato, tomato, cucurbits
  – Late blight (US-8) & Early blight
  – Bac. Speck and Canker/tomato
  – Phytophthora (many crops) & DM on cucurbits
  – Plectosporium blight as new disease for cucurbits
# Pepper Pathogens

## Bacteria
- *Xanthomonas campestris pv. vesicatoria* (bacterial spot)
- *X. vesicatoria* (bacterial spot)
- *Erwinia carotovora subsp. carotovora* (soft rot)

## Fungi
- *Colletotrichum gloeosporioides*,
- *C. capsici, C. coccodes* (anthracnose)
- *Sclerotinia sclerotiorum* (white mold)
- *Botrytis cinerea* (gray mold)
- *Sclerotium rolfsii* (Southern blight, transplts.)
- *Oidiopsis sicula* (*Leveillula taurica*) (powdery mildew, transplts.)

## Oomycetes
- **Phytophthora capsici** (Phytophthora blight)
- *Pythium spp.* (Damping off and root rot)

## Viruses
- Alfalfa mosaic virus (AMV)
- **Cucumber mosaic virus (CMV)**
- Potato virus Y (PVY)
- Tobacco mosaic virus (TMV)
- Tomato spotted wilt virus (TSWV)

## Nematodes
- *Meloidogyne hapla, M. incognita* (Root-knot nematodes)
Cucumber mosaic virus


http://www.apsnet.org/EDCENTER/INTROPP/LESSONS/Pages/default.aspx
CUCUMBER MOSAIC VIRUS (CMV)
The major vegetable production areas of New York

Pepper and muskmelon virus surveys
Cucumber Mosaic Virus

- family *Bromoviridae*
- genus *Cucumovirus*
- 3 ssRNA particles
- Viral strain/plant age
- Insect vector – aphids, nonpersistent transmission
- Overwinters in perennial weeds (over 1000)


http://ipmworld.umn.edu/chapters/kerns.htm
CMV Management

• Insecticides ineffective
  – Vector deterrence/seedling isolation
  – Quickly acquired, transmission lost within 1 hr
• Mineral oil sprays (primarily in larger production)
• Resistance
  – Multigenic/horizontal
  – ‘Peacework’ M. Mazourek et al.
TMV Symptoms

- Varies by strain
- mosaic, necrosis, veinal pattern and leaf drop
PHYTOPHTHORA CAPSICI
(Phytophthora blight)
The major vegetable production areas of New York

Phytophthora occurrences

- King Ferry: 1977, 1999
- Albany: 1980s
- Other locations: 1980, 1983
Steve Johnston – Rutgers Univ. - Raised beds and Ridomil 2E to Wheel Row - 1988
Avoid planting in low areas of field
Subsoiling to increase soil drainage (clean off tractor tires when done)
Scouting for early symptoms of Phytophthora

Use Plastic covers over boots and dispose of after visiting a suspected field

Recent standing H₂O and after effects on Aug 9, 2005
### Preplant:

- Consider a pre-plant banded fungicide application for fields with known problems with *Phytophthora capsici*. (Ridomil or OLF)
- Plant susceptible crops only in well drained fields.
- Utilize raised beds (6" minimum) whenever possible.
- Do not plant in low-lying areas of the field.
- Do not irrigate a field with water that contains runoff from fields with a history of *Phytophthora* disease.
### Production:

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<table>
<thead>
<tr>
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<tbody>
<tr>
<td></td>
<td>Monitor fields for disease, including damping off, plant stunting, root and crown rot.</td>
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<td>Irrigate conservatively and, if possible, do not irrigate prior to harvest.</td>
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<td>Plow under portions of the field with diseased plants, including healthy plants that border diseased areas.</td>
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<td>Remove diseased fruit from the field.</td>
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<td>Never dump culls or diseased fruit from other fields or farms into production fields.</td>
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<td></td>
<td>Once Phytophthora capsici is introduced, it may remain indefinitely.</td>
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<td>Apply fungicide preventively, especially for known problem fields.</td>
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<td>Rotate the types of fungicides used.</td>
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<tr>
<td>Fungicide, Trade</td>
<td>EPA Group</td>
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<tr>
<td>Gavel - Gowan</td>
<td>22 + M3</td>
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<tr>
<td>Presidio - Valent</td>
<td>43 +</td>
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<tr>
<td></td>
<td>Protectant</td>
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<tr>
<td>Previcur Flex - Bayer</td>
<td>28 +</td>
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<tr>
<td></td>
<td>Protectant</td>
</tr>
<tr>
<td>Ranman - FMC</td>
<td>21</td>
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<tr>
<td>Phosphorous acids (many)</td>
<td>33</td>
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<tr>
<td>Revus - Syngenta</td>
<td>40 + copper</td>
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<tr>
<td>Tanos - DuPont</td>
<td>11 + 27 +</td>
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<tr>
<td></td>
<td>Protectant</td>
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<tr>
<td>Ridomil Gold Bravo - Syngenta</td>
<td>4 + M5</td>
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### Postharvest:

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<tr>
<td>• Harvest fruit as soon as possible from suspect fields, avoiding anything remotely close to lower areas of field</td>
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<tr>
<td>• Keep harvested fruit dry and cool</td>
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Phytophthora capsici spore types

A. Sporangium – lemon-shaped

B. Sporangia releasing zoospores

C. Sporangium germinating under high Relative Humidity

D. Thick-walled oospores
So where do we stand today –

- Wide host range means continued grower diligence [Solanaceae, Cucurbitaceae, Leguminosae (Fabaceae)] (27 families)
- Contaminated surface water (not wind) – distributed by irrigation water
- Dumping of infected culls
- Presence of both A1 and A2 mating types
- Brassicae biofumigants
- Resistant Varieties – Pepper, Cucurbits, etc.
Tomato (*Solanum [Lycopersicon] species*)

- *Solanum lycopersicum* (L. *esculentum*)
- *S. chilense*
- *S. peruvianum*
- *S. pennellii*
- *S. habrochaïtes* (L. *hirsutum*)
- *Solanum lycopersicum* (L. *esculentum*)
- *S. pimpinellifolium*
- *S. cheesmaniae* (L. *cheesmanii*)
- *S. chmielewskii*
<table>
<thead>
<tr>
<th>Families (6)</th>
<th>Crops (16)</th>
<th>Viruses/Viroids (13)</th>
<th>Fungi (Oomycetes) (8)</th>
<th>Bacteria &amp; MLO (5)</th>
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</thead>
<tbody>
<tr>
<td>Apiaceae</td>
<td>Carrot, Celery</td>
<td>CeMV, CMV</td>
<td>Cercospora EB, Septoria LB</td>
<td>Bac. Leaf spot, AY</td>
</tr>
<tr>
<td>Asteraceae</td>
<td>Escarole, Endive, Lettuce</td>
<td>LMV, CMV, BiMoV, BWYV</td>
<td>Downy Mildew, Bottom Rot (R.s.)</td>
<td>AY</td>
</tr>
<tr>
<td>Brassicaceae</td>
<td>Cabbage</td>
<td>TurMosV</td>
<td>Alternaria l spot, DM</td>
<td>Black Rot</td>
</tr>
<tr>
<td>Cucurbitaceae</td>
<td>Cucumber, Muskmelon, W. melon, Summer &amp; Winter Squash, Pumpkin, Gourds</td>
<td>PRSV, WMV, CMV, ZYMV, SqMV</td>
<td>Pow. Mildew, Anthracnose, GSG, Downy Mild., Ulocladium LS, White mold, Fus Wilt, Plecto Blt</td>
<td>Angular LS, Bac. LS, AY</td>
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<tr>
<td>Fabaceae (Leguminosae)</td>
<td>Bean, Pea</td>
<td>BCMV, BYMV</td>
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<tr>
<td>Liliaceae</td>
<td>Onion</td>
<td>OYDV</td>
<td>Botrytis Blt, Neck rot, DM, Alt Pur Bltch</td>
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<tr>
<td>Families (cont.)</td>
<td>Crops (cont.)</td>
<td>Viruses/Viroids (cont.)</td>
<td>Fungi (Oomycetes) (cont.)</td>
<td>Bacteria &amp; MLO (cont.)</td>
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<tr>
<td>(6)</td>
<td>(16)</td>
<td>(13)</td>
<td>(8)</td>
<td>(5)</td>
</tr>
<tr>
<td>Poaceae</td>
<td>Sweet corn</td>
<td>MStV, MDMV, MWLM, BarYDV,</td>
<td>Leaf rust, NC leaf blight, DM, Smut (head and common)</td>
<td>Stewarts wilt</td>
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<tr>
<td>Solanaceae</td>
<td>Pepper</td>
<td>CMV, TEV, PeMV, PVY, PMMV, TMV, TSWV</td>
<td>Phytophthora Blt., Bac. LS, Bac SR</td>
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<td>“</td>
<td>Potato</td>
<td>PVY, PLRV, Pot Spindle</td>
<td>EB, LB, PM, Blk Dot, Silver Scurf, Com &amp; Pwd Scab, Rhizoc., Fus Dry Rot</td>
<td>Ring Rot, Bac SR</td>
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<tr>
<td>“</td>
<td>Tomato</td>
<td>Alf MV, CMV, TMV, PLRV, PCTV, PVY, TEV, TSWV</td>
<td>Anthracnose, EB, LB, PM, SLS, Pwd. Mildew</td>
<td>Speck, Spot, Canker, Bac SR</td>
</tr>
</tbody>
</table>
GROWER HAVING FUN WITH VEGETABLES
Varietal Overview
HEPWORTH FARMS

Amy Hepworth
Gerry Greco
Gail Hepworth
1. Notify/Contact Hepworth Farms before entering premises. You need expressed permission from Amy Hepworth to enter the farm.

2. The use of any tobacco product is strictly prohibited on our farm.

3. Do not enter fields.

4. Do not touch plants.

5. Pets prohibited: It is strictly prohibited for dogs to defecate on our property.
2012 Added 8 Hargrove High Tunnels, each 600 ft. long
# Overview

<table>
<thead>
<tr>
<th>TOMATO TYPE</th>
<th># of Varieties</th>
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<tbody>
<tr>
<td>HEIRLOOM</td>
<td>58</td>
</tr>
<tr>
<td>Cherry &amp; Grape</td>
<td>25</td>
</tr>
<tr>
<td>Field (Red, Yellow, Orange)</td>
<td>22</td>
</tr>
<tr>
<td>Plum</td>
<td>12</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>117</strong></td>
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148,000 TOMATO PLANTS
42 miles of Tomatoes on
55 acres
• 7th generation farm in Ulster Co on backs of the Hudson River (Certified Organic)
• Produces 144 line items marketed as “grown within 100 miles”
• Clients include Whole Foods, 17,000 member Park Slope Food Coop in Brooklyn, plus processors and CSAs
• Follows “whole farm alive systems approach” (4,500 yards/yr. of compost soil health)
• Workers health (stretching exercise & work strategy for day)
Developing Varieties with a good resistance package:

- **Homozygous** resistance for Late Blight (Ph2 + Ph3), tolerance for both Early blight and Septoria leaf spot

- Fresh Market Reds
- Cherry with full complement of genetic resistance plus flavor of ‘Mountain Magic’
- Grape types
- Brandywine heirloom with genetic resistance
Agricultural Advances

- Speedling trays
- Plastic Mulch-covered Beds and Plug Mix (Hayslip 1973)
- Drip irrigation
- Mineral oil and bicarbonate sprays
- Air-assisted and electrostatic sprayers
- Availability of disease resistant or tolerant varieties
- Modern fungicides that are reduced-risk to workers & environment (low EIQ) and IPM
- Third generation growers, organic production, CSAs, Grown Local
Educational Products

Editor of Compendium Series from APS Press
- Tomato Diseases
- Cucurbit Diseases
- Author for Celery, Pepper, Lettuce
http://vegetablemdonline.ppath.cornell.edu
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Growers –
Belle Glade Growers (Duda, South Bay, Hatton Brothers, Wedgeworth Farms, Roth Farms, etc.)
Mr. Ted Winsberg - Green Cay Farms, tandtwin@bellsouth.net, Delray Beach, FL
Ms. Amy Hepworth - amy@hepworthfarms.com, Milton, NY
Mr. A. A. (d) & John Hand – Hand Melon Farm, Greenwich, NY
Mr. Burton Mattice (d) – Mattice Farm, Schoharie, NY – many more

Technicians and Research Assoc. –
Mrs. Geisha Echenique – Belle Glade, FL
Mr. Louis Hus – Cornell (deceased)
Mrs. Jessica Drennan, Cornell
Ms. Helen Griffiths

Colleagues –
John Causey (d) (and many more County Agents in FL and NYS), Jack Simons (d), Dan Purcifull, Bill Zettler, Richard Christie (d), Ernie Herbert, John Edwardson (d), Dick Berger (d), Paul Everett (d), Vic Guzman, Emil Wolf (d), Subu Subramanya, Henry Ozaki (d), Arden Sherf (d), Steve Johnston (d), Alan MacNab (d), Gary Bergstrom, H. David Thurston, William Fry, Steve Slack, Meg McGrath, Dawn Dailey O’Brien (VEG MD), Kent Loeffler (Photography) and many graduate students.
The Weather has not been kind to the Farmer.
Too Much Rain + Not Enough Sun
Vegetables Slow