Tomato IPM in the U.S.

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Two major tomato production areas in the U.S.

Florida - fresh market
and
California - processing/fresh market
92% of processing and 35% of fresh market

1999 Crop Profile for Tomatoes (Processing) in California

Figure 1. Major tomato producing areas in California.
95% of fresh market between Oct – June

Florida Crop/Pest Management Profiles: Tomatoes
Michael J. Aerts
Norman Nesheim
Tomato Insect Pests

90%-CA, 100%-FL, 75%-other areas

- Whiteflies
- Stinkbugs
- Thrips
- Lepidoptera - many species
- Leafminers
- Pinworms
- Aphids
- Flea beetles
- Colorado potato beetle
- Tomato psyllid
- Mites
- Leafhoppers
- Wireworms
- Mole crickets
Bacterial Spot
Target Spot
Early Blight
Late Blight
Fusarium Wilt
Verticillium Wilt
Fusarium Crown Rot
Bacterial Wilt
White Mold
Southern Blight
Powdery Mildew
Viruses

Tomato Diseases
60%-CA, 100%-FL, 60%-Other areas
Tomato Weeds

99%-CA, 100%-FL, 85%-other areas

- Nightshades
- Nutsedges
- Dodder
- Field bindweed
- Grasses
Tomato Nematodes
75%-CA, 98%-FL, 65%-Other areas

- root-knot nematode—several species
- sting nematode
Integrated Pest Management

- Use of multiple control tactics (chemical, cultural, biological) integrated into a single pest control strategy (usually one pest).
- Management of the complex of pests that attack a crop.
- Interactions among pests, the crop and the environment within the context of a social, political and economic matrix.
Pesticide use values for 2004 compared to peak usage data for the period 1992 through 2004 demonstrate a 75% reduction in the application of restricted or "Danger"-labeled insecticides in fresh market tomato.

The reduction in use of the restricted use and "Danger"-labeled pesticides is believed to be due to strong adoption of integrated pest management (IPM) principles by Florida tomato growers, working in conjunction with Extension agents and professionals.
Number of acres treated with (ai) pesticides in CA

Pounds (ai) of Reduced risk pesticides used in CA

CALIFORNIA DEPARTMENT OF PESTICIDE REGULATION, California Environmental Protection Agency
http://www.cdpr.ca.gov/docs/pur/pur04rep/04chem.htm
Cholinesterase inhibiting chemical use-CA

Reproduction toxicity chemical use-CA

Water contaminating chemical use-CA
IPM Continuum:

- **Biointensive**
  - biologically-based controls
  - prevention
  - reduced risk pesticides
  - thresholds

- **Chemically intensive**
  - scouting

**Insects**

**Diseases**

**Weeds**

**Nematodes**

**scouting**

**Chemically intensive**
Scouting

- 90% of all growers in CA and FL ‘scout’ their field in some way—bug counters and consultants

- Vegetables in US:
  - 60% for insect pests
  - 55% for plant diseases
  - 40% for weeds

- Biologically intensive IPM approaches on only 8% of crop acreage
IPM Continuum:

- **Insects** - thresholds
- **Diseases** - models
- **Weeds** – precision ag
- **Nematodes** - ?

**Biointensive**
- biologically-based controls
- prevention
- reduced risk pesticides

**Chemically intensive**
- scouting
- thresholds
Risk assessment models
TOMCAST

Early Blight
Blackmold
Powdery Mildew
Late Blight

Leveillula taurica
Alternaria alternata
Phytophthora infestans

Frank Zalom, UC Davis
California PestCast

Black mold
Late blight
Powdery mildew

Disease Model Database

This database is a catalogue of information about models developed for economically important crop and turf diseases in California. A model is included in the database if it uses weather, host, and/or pathogen data to predict risk of disease outbreak. The database is part of a project called "PestCast" - a regional weather network to support the development, validation, and implementation of crop disease models.

A plant disease model is a mathematical description of the interaction between environmental, host and pathogen variables that can result in disease. A model can be presented as a simple rule, an equation, a graph or a table. The output of a model can be a numerical index of disease risk, predicted disease incidence or severity, and/or predicted inoculum development.

Description of the database contents
- What are plant disease model development, validation, and implementation?
- Fungicides and disease forecasting

Select a Crop Disease

This symbol indicates work conducted in California.

Almond
- Stark
- Starkol
Apple
- Fireblight
- Scab
Carrot
- Alternaria leaf blight
- Septoria leaf blight
Celery
- Septoria leaf blight
- Black spot
Grapes
- Botrytis bunch rot
- Powdery mildew
Lettuce
- Downy mildew
- Scab
Pear
- Fireblight
- Scab
Pistachio
- Alternaria leaf blight
Potato
- Late blight
Stone Fruit
- Brown rot
Strawberry
- Botrytis
- Powdery mildew
Tomato
- Powdery mildew
- Black mold
- Late blight
Turf
- Rhizoctonia blight (Brown patch)
Walnut
- Walnut blight

Frank Zalom, UC Davis
Thresholds

• Growers use some kind of threshold most of the time
  - each grower has a set comfort level

• Some thresholds not realistic commercially
  - following the “best” science does not always mean the best commercial success
  - there is an art to pest management
IPM Continuum:

Biointensive

- biologically-based controls
- prevention
- thresholds
- scouting

Chemically intensive

- reduced risk pesticides

Neonicotinoids
Microbial byproducts
Inorganics minerals
IGRs
Reduced risk pesticides

The FQPA expedited EPA’s review and registration decision-making process for pesticides that are classified as less risky to human health and the environment than existing conventional products.

Advantages of reduced-risk pesticides include:
- low impact on human health
- low toxicity to natural enemies
- low toxicity to non-target organisms (birds, fish, etc)
- low potential for groundwater contamination
- lower use rates
- compatibility with Integrated Pest Management
- low pest resistance potential
<table>
<thead>
<tr>
<th>Trade Name</th>
<th>Chemical Name</th>
<th>How it works</th>
<th>What it controls</th>
</tr>
</thead>
<tbody>
<tr>
<td>Confirm, Intrepid</td>
<td>tebufenozide, methoxyfenozide</td>
<td>IGR – ecdysone agonist causes a premature lethal molt. Mostly through ingestion, some contact, feeding ceases in 24 hrs, death in 2-3 days</td>
<td>Small Lepidoptera larvae (worms or caterpillars) such as armyworms, beet AW, tomato fruit worm, loopers, hornworm, yellow striped AW.</td>
</tr>
<tr>
<td>Spintor</td>
<td>Spinosad</td>
<td>Microbial metabolite-- fermentation product (interferes with nicotine-like receptors in nerve endings) of soil bacteria-Actinomycetes</td>
<td>Lepidoptera larvae, leaf miners, certain thrips species, Colorado potato beetle</td>
</tr>
<tr>
<td>Proclaim</td>
<td>Avermectin-emamectin benzoate</td>
<td>Microbial metabolite, Mostly through ingestion. Disruption of nerve impulses causes paralysis in hours, death in days</td>
<td>Lepidoptera larvae</td>
</tr>
<tr>
<td>Avaunt</td>
<td>Indoxacarb</td>
<td>Inhibits Na⁺ entry into nerve cells, paralysis and death 6-48 hours. Contact and ingestion</td>
<td>Lepidoptera larvae, beet AW, diamond back moth, fruit worms</td>
</tr>
<tr>
<td>Courier, Applaud</td>
<td>Buprofezin</td>
<td>IGR – Chitin synthesis inhibitor, contact and ingestion</td>
<td>White flies, leaf hoppers</td>
</tr>
<tr>
<td>Agri-Mek</td>
<td>Avermectins</td>
<td>Fermentation product of soil bacterium Steptomyces avermitilis, via ingestion. Inhibits signal transmission at neuromuscular</td>
<td>Colorado potato beetle, mites, thrips, some Lepidoptera larvae</td>
</tr>
<tr>
<td>Knack</td>
<td>Pyriproxifen</td>
<td>IGR- Jh mimic sterilizes whitefly adults and eggs</td>
<td>Lepidoptera larvae, good on large beet armyworms</td>
</tr>
<tr>
<td>Rimon</td>
<td>Novaluron</td>
<td>IGR – chitin inhibitor, enters via ingestion</td>
<td>Immature: Whitefly, thrips, some Lepidoptera larvae</td>
</tr>
<tr>
<td>Oberon</td>
<td>Spiromesifen</td>
<td>Tetronic acid derivatives interfere with lipid biosynthesis</td>
<td>Mites, whiteflies</td>
</tr>
<tr>
<td>Admire, Provado</td>
<td>Imidacloprid</td>
<td>Interfere with nerve endings, keeps nerve receptor channels open</td>
<td>Sucking insects, Colorado potato beetle, other beetles</td>
</tr>
<tr>
<td>Actara, Platinum,</td>
<td>Thiamethoxam-neonicotinoids</td>
<td></td>
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</tr>
<tr>
<td>Agree, Cutlass,</td>
<td>Bacillus thuringiensis</td>
<td>Protein toxin attaches to gut of insect causing rupture and death in 24-48 hours</td>
<td>Many Lepidopteran larvae such as hornworm, cabbage looper, fruitworm,</td>
</tr>
<tr>
<td>DiPel, XenTari</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Common Name</td>
<td>Trade Name</td>
<td></td>
<td></td>
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<tr>
<td>-------------------------------------</td>
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<td></td>
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<tr>
<td>Cyprodinil</td>
<td>Vangard</td>
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<tr>
<td>Fenhexamid</td>
<td>Elevate</td>
<td></td>
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<tr>
<td>Fludioxonil</td>
<td>Scholar</td>
<td></td>
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<tr>
<td>Streptomyces lydicus</td>
<td>Actinovate</td>
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<tr>
<td>Pyrimethanil</td>
<td>Scala</td>
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<tr>
<td>Fenamidone</td>
<td>Reason</td>
<td></td>
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<tr>
<td>Boscalid</td>
<td>Endura</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Azoxystrobin</td>
<td>Quadris</td>
<td></td>
<td></td>
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<tr>
<td>Pyraclostrobin</td>
<td>Cabrio</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bacteriophage</td>
<td>AgriPhage</td>
<td></td>
<td></td>
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<tr>
<td>Famoxadone</td>
<td>Tanos</td>
<td></td>
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<tr>
<td>Tolyfluanid</td>
<td>Previcur</td>
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<td></td>
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<tr>
<td>Iprovalicarb</td>
<td>Melody</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cyazofamid</td>
<td>Ranman</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Neem</td>
<td>Trilogy</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dimethomorph</td>
<td>Acrobat</td>
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</table>
Neonicotinoids have revolutionized the growing of crops in several areas of the country:

Tomato in FL -- TYLCV + SLW control

Cucurbits and other crops in Arizona--the SLW

Potatoes in the northern US--CPB
SARs, Systemic Acquired Resistance chemicals are especially important for control of bacterial spot and speck as in some areas the bacteria have become tolerant of copper fungicides
Reduced risk chemical study

Pest densities

Reduced risk chemical study

Natural Enemy Density

Too much dependence on reduced risk chemicals as everyone becomes too comfortable with using these safe, effective products
Q BIOTYPE WHITEFLY: Has developed resistance to many of the insecticides we currently rely on for control.

• High levels of resistance or tolerance to many reduced risk pesticides.

• Some data suggests tolerance to pyrethroid and organophosphate combinations.

• If this pest was to become widespread in vegetable production areas, control options would be greatly limited.
IPM Continuum:

Biointensive

- biologically-based controls
- reduced risk pesticides
- thresholds
- scouting

Chemically intensive

- Crop rotation
- Clean seeds/Transplants
- Irrigation Management
- Sanitation
- Cultivation

prevention
Bacterial canker
Bacterial speck
Bacterial spot

Clean seeds/transplants
Plant resistance (to one race of bacterial speck only)

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<table>
<thead>
<tr>
<th></th>
<th>Farm B</th>
<th>Farm A</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preventive practice cost in transplant production</td>
<td>$3.04</td>
<td>$0.86</td>
</tr>
<tr>
<td>Preventive practice cost in production field</td>
<td>$150.25</td>
<td>$67.00</td>
</tr>
<tr>
<td>Packout (25 lb boxes)</td>
<td>2400</td>
<td>2040</td>
</tr>
<tr>
<td>Value per package</td>
<td>$35.00</td>
<td>$35.00</td>
</tr>
<tr>
<td>Value per acre</td>
<td>$84,000.00</td>
<td>$71,400.00</td>
</tr>
<tr>
<td>Minus cost of preventive practices</td>
<td>$83,846.71</td>
<td>$71,332.14</td>
</tr>
<tr>
<td>Real cost of NOT performing preventive practices</td>
<td></td>
<td>($12,514.57)</td>
</tr>
</tbody>
</table>

Frantz, G. 1992. Glades Crop Care, Inc
IPM Continuum:

Chemically intensive

Biointensive

- Natural enemy preservation
- Parasite releases
- Microbial pesticides
- Plant Resistance
- Pheromones

- Biologically-based controls
- Prevention
- Reduced risk pesticides
- Thresholds
- Scouting
Microbial pesticides are formulated microorganisms or their by-products. They tend to have advantages over botanicals in that they are generally more selective, so specific pests may be controlled with little or no effect on non-target organisms.

• Microbial insecticides include bacteria (Bacillus thuringiensis-strains, B. subtilis and Saccharopolyspora spinosa – spinosad – SpinTor, Entrust) and fungi (Beauvaria bassiana) and various species of the bacteria Pseudomonas, Bacillus, and Streptomyces.

• Other microbial products include beneficial fungi and bacteria (Streptomyces, Gliocladium, Trichoderma harizanum) Metarhizium sp Paecilomyces fumosoroseus control of whiteflies Beauveria bassiana for greenhouse and field use that attack or compete with plant pathogenic fungi.

• Harpins are produced by bacteria and other microbes. Pathogenic bacteria need harpins to infect their host plants. When applied to plants, synthetic harpins stimulate the plant's defense systems.
Integrated Pepper Weevil Management in Florida

- **Cultural control**: The key to success is judicious management of the nightshade by weeding chemically, mechanically or both.

- **Parasitoid releases**: When nightshade vegetation was not amenable to eradication, it became a candidate for the *C. hunteri* release program. 1000 to 2000 wasps/A were released on a bi-weekly basis into nightshade.

- **Pheromone monitoring** of PEW: Indicated where weevil were moving and when the would move into field. Used GPS/GIS to track movement.

- **Reduced Risk pesticides**: With the reduced population size of PEW available to migrate into the pepper fields, the reduced risk chemicals satisfactorily controlled the in-field infestations.

- **Scouting**: Scouting is necessary during the season and fallow for the crop and the nightshade vegetation to anticipate, detect and evaluate infestations for best decision-making. Reduced risk pesticides used for other pests.

- **Third year results**: PEW populations and pepper fruit infestations were reduced by an average of 82% on the 3 farms.
1. Scouting
2. Thresholds/Forecasting
3. Reduced risk pesticides
4. Prevention
5. BiolPM Systems