Tomato and Pepper

Tuesday morning 9:00 am

Where: Grand Gallery (lower level) Room A-B

Recertification credits: 1 (1B, PRIV OR COMM CORE)
CCA Credits: PM(0.5) CM(0.5) PD(1.0)

Moderator: Ron Goldy, District Vegetable Educator, MSU Extension

9:00 a.m. Phytophthora Research and Control in Peppers

- Mary Hausbeck, Plant Pathology Dept., MSU
- Jennifer Foster, Plant Pathology Dept., MSU

9:30 a.m. Early Tomato Yield Without High Tunnels

- Stephen Reiners, Horticultural Science Dept., Cornell Univ.

10:00 a.m. Safe Handling of Peppers and Tomatoes

- Les Bourquin, Food Science Dept., MSU

10:30 a.m. Current Issues in Work Authorization and Enforcement Actions

- Kimberly Clarke, Varnum, Riddering, Schmidt & Howlett, LLP, Grand Rapids, MI

Phytophthora Research and Control in Peppers

J.M. Foster, Graduate Research Assistant and Dr. M.K. Hausbeck, Professor and Extension Specialist
Michigan State University, Department of Plant Pathology (517-355-4752)

Michigan has over 82,000 acres of vegetables that are susceptible to the soilborne oomycete pathogen *Phytophthora capsici*. The pathogen may overwinter in the soil and persist for many years (>10 years). The roots, crowns, stems, leaves and fruits of peppers can all be infected by *P. capsici*. This pathogen is favored by rain and warm temperatures and spreads readily via water. *P. capsici* has been found in irrigation ponds and surface water sources. Integrated management strategies are required to control Phytophthora crown, root and fruit rot of pepper. The most effective control measures are to avoid planting susceptible crops in infested soil and to limit the spread of the pathogen to clean fields. Crop rotation has limited benefits due to the long term survival of *P. capsici* in the soil. Cultural control methods, such as properly constructed raised plant beds, can be helpful by reducing saturated soil conditions. Foliar applications of fungicides directed at the base of the pepper plant applied prior to disease development can be helpful. Several resistant or tolerant bell pepper cultivars are available to Michigan producers. A combination of host resistance, effective fungicides, and cultural control strategies may be used to reduce significant yield losses from *P. capsici*.

Fungicide Trial

Currently registered fungicides were evaluated for control of Phytophthora crown, root and fruit rot of bell pepper (Table 1). The trial was conducted at the Michigan State University Muck Soils Research Farm in Laingsburg, MI on clay loam soil previously planted to pickling cucumber. According to the seed producers, the bell peppers 'Red Knight' (Seminis, Inc., St. Louis, MO) and 'Paladin' (Syngenta Seeds Inc., Boise, ID) are susceptible and intermediately resistant to *P. capsici*, respectively. On 9 Jun, 6-week-old pepper plants were transplanted by hand into raised beds 6-inches-high and covered in black plastic mulch with a single drip irrigation tape under the plastic. In each bed, peppers were planted into double staggered rows; one row of 'Red Knight' and the other of 'Paladin.' The spacing between rows was 12 inches. Drenches were applied to pepper seedlings in transplant trays just prior to planting. Applications of foliar fungicides were initiated at planting, and continued on a 7-day schedule. The plants were inoculated with a virulent isolate of *P. capsici* from Michigan that is insensitive to the fungicide mefenoxam, trade name Ridomil (Syngenta, Greensboro, NC). Plants exhibiting symptoms of Phytophthora crown and root rot, including wilting and death, were counted weekly. The pepper fruits were harvested four times, sorted by cultivar, and graded by size and incidence of Phytophthora fruit rot.

Table 1. Products tested.

Product	Active ingredient	Labeled	
		Peppers	*P. capsici*
Revus 2.08SC	mandipropamid	yes	yes
Presidio 4SC	fluopicolide	yes	yes
Prophyt 4.2EC	potassium phosphite	yes	yes
Tanos 50WG	famoxadone + cymoxanil	yes	yes, foliar and fruit phase only
Reason 500SC	fenamidone	yes	yes, foliar and fruit phase only
Acrobat 50WP	dimethomorph	yes	yes
Forum 4.18SC	dimethomorph	yes	yes
Kocide 2000 54DF	copper hydroxide	yes	no

Disease pressure was high at the test site with 96.3% of the susceptible 'Red Knight' and 30.6% of the tolerant 'Paladin' peppers showing Phytophthora root and crown rot symptoms by 9 Sep (Table 2). Although plants treated with the drench/spray program of a Prophyt 4.2EC drench, followed by Presidio 4FL alternated with Acrobat 50WP alternated with Prophyt 4.2EC significantly limited death of 'Red Knight' plants and had significantly higher yields than the untreated inoculated control, over 83% of treated plants died. 'Paladin' plants treated with Revus 2.08SC and Presidio had significantly less plant death (< 10%) than the untreated inoculated control (30.6%). No statistical differences in yield were observed among treatments applied to 'Paladin.'

Table 2. Evaluation of fungicides for management of Phytophthora crown and root rot of pepper.

Treatment and rate/A	Plant death (%)		Yield (lb/40 ft row)	
	'Red Knight'	'Paladin'	'Red Knight'	'Paladin'
Untreated inoculated	96.3 c*	30.6 d	3.4 cd	109.2
Untreated uninoculated	1.9a	0.6a	78.7 a	76.2
Prophyt 4.2EC 4 pt drench application, Presidio 4SC 4 fl oz *-alternate-* Acrobat 50WP 6.4 oz *-alternate-* Prophyt 4.2EC 6 pt	83.1 b	10.6 bcd	19.1 b	62.5
Revus 2.08SC 8 fl oz	90.6 bc	5.0ab	10.4 bc	113.5
Prophyt 4.2EC 4 pt drench application, Prophyt 4.2EC 6 pt**	90.6 bc	13.1 bcd	5.9 cd	88.2
Presidio 4FL 3 fl oz	91.9 bc	5.6abc	8.3 bcd	121.1
Tanos 50WG 10 oz	94.4 c	26.3 d	5.1 cd	107.2
Reason 500SC 8.2 fl oz	96.3 c	21.9 cd	7.0 cd	104.4
Acrobat 50WP 6.4 oz	96.9 c	15.6 cd	6.0 cd	108.4
Forum 4.18SC 6 fl oz	98.1 c	12.5 bcd	2.2 d	106.7
Kocide 2000 54DF 2 lb	99.4 c	15.0 cd	2.2 d	119.8

*Column means with a letter in common or with no letter are not significantly different (Fisher's Method, P=0.05)
**Foliar application began 14 days after transplanting

Variety Trial

Pepper cultivars and breeding lines were evaluated in the greenhouse for tolerance to Phytophthora root and crown rot. Twenty-seven breeding lines and cultivars with three to four true leaves were transplanted into individual pots. Pots were inoculated using millet seed inoculum with one of four *P. capsici* isolates from Michigan; 12889, OP97, SP98 and SFF3. Eight plants of each breeding line or cultivar were used per isolate. Eight plants per cultivar or breeding line were not inoculated. The plants were evaluated for wilting and plant death every two days. The fruits were harvested from the remaining plants at the end of the trial. The experiment was replicated twice.

Pepper plants exhibited symptoms of infection seven days after inoculation. Infected plants appeared wilted, and in some cases, had a dark brown stem lesion girdling the base of the plant. A week after initial disease symptoms, signs of infection appeared, including mycelia and pathogen sporulation within the stem lesions. The uninoculated control pepper plants never presented symptoms in either of the experiments (data not shown).

Differences in virulence among *P. capsici* isolates were observed across all cultivars and breeding lines screened (Table 3). Inoculation with isolate 12889 resulted in a significantly higher plant death than the other isolates. OP97 was less virulent than 12889, but significantly more virulent than SFF3 and SP98. Differences in cultivar susceptibility to crown and root rot were observed. 'Paladin' had the lowest average plant death (%) among all cultivars across all isolates. The bell pepper PRO3-15x16R-5 and the Poblano pepper XPP2548 had the lowest average plant death (%) among all breeding lines screened across all isolates. All cultivars and breeding lines in the trial were tolerant to the isolates SP98 and SFF3, including those cultivars considered susceptible.

Cultivar selection plays an important role in disease management. Different pepper cultivars will not provide an equal level of tolerance to local isolates of *P. capsici*. Growers should evaluate several pepper cultivars on-site, selecting those which provide the greatest level of tolerance to the isolates at their location.

Table 3. Plant death (%) among bell pepper lines inoculated with four isolates of *P. capsici*.

Pepper lines	Plant death (%) per isolate			
	12889	OP97	SP98	SFF3
Cultivars				
Alliance	100	94	19	6
Aristotle (non-pelleted seed)	100	44	6	6
Aristotle (pelleted seed)	100	31	0	13
Brigadier	100	94	25	13
Camelot	100	94	13	19
Declaration	100	25	19	0
Paladin	63	6	0	0
Plato	100	81	13	6
Red Knight	100	94	13	25
Revelation	100	88	13	0
Revolution	100	25	0	13
Snapper	100	100	19	25
Breeding lines				
9925776	100	63	13	6
9931126	81	25	0	13
9941819	100	69	0	0
9943084	100	44	13	0
9943095	100	94	19	0
PRO3-13x14R-4	69	0	6	6
PRO3-15x16R-5	38	6	0	13
PRO4T-11x12	100	19	6	6
PRO5-C71x72	100	0	0	0
PRO5-81x82	81	0	0	6
PRO5-C85x86	100	6	6	6
PRO5-C87x88	100	0	0	13
Prophet	94	50	0	6
PX9942595	100	63	0	0
XPP2548	25	13	13	0

Early Tomato Yield Without High Tunnels

Stephen Reiners
Department of Horticultural Sciences
NYSAES, Cornell University, Geneva, NY 14456

In an effort to maximize farm profitability, vegetable growers attempt to bring crops to market earlier. Early harvests usually result in price premiums of two to three times that which is received just a few weeks or even days later. An increasing number of tomato growers are opting for high tunnels. But there are other production methods available that growers may want to try before taking the high tunnel step. These include using early varieties, larger transplants, plastic mulch the main focus of today's presentation, row covers.

Variety Selection

Every tomato grower knows that varieties vary by the length of time they take to mature. Generally, the earliest tomatoes are usually small and average 4 to 6 ounces. We usually divide tomatoes into early, mid and late season varieties. I would call early varieties as those producing fruit within 63 days. Mid-season varieties generally come in between 64 and 74 days. Late varieties, more than 74 days. The best early varieties for New York include Sunstart, Sunrise, and Spitfire. Check with your local cooperative extension office for up-to-date variety recommendations.

Larger Transplants

Many commercial growers who are trying to get the first tomatoes in the area will often grow transplants in large, four-inch pots. The belief is that the larger the plant the quicker it recovers from transplanting and the quicker it will produce tomatoes. In work conducted in Florida, however, researchers found that there was no difference in early or total yield whether the plants were 2, 3, 4, 5, or 6 weeks old!! In work I conducted at NJ, larger transplants did not produce any earlier fruit. This does seem to challenge conventional wisdom. The key here is avoiding transplant shock. When transplanted, the plant responds by stopping all growth for a few days to a couple of weeks while gradually getting used to the new environment. To avoid transplant shock, gradually get the plants used to their new environment. That means hardening the plants by exposing them to outdoor conditions and cutting back on the fertilizer and water. This will allow them to slowly acclimate to the new environment and decrease transplant shock considerably. The key is to get the plants growing again as quickly as possible after you plant, and a properly hardened transplant will do just that. Should you go with larger sized plants? As long as their properly hardened, the larger plants would recover more quickly from transplant shock and will probably yield a little earlier.

There has also been some work that shows that severe pruning of plants and/or closer spacing will lead to an earlier yield by several days. On the down side, these severe conditions lowers the overall total yield.

Plastic Mulch

A plastic mulch that warms the soil will increase earliness as compared to bare ground planting. There are basically three types of mulches you can use. The first is clear plastic. Few tomato growers use this for two reasons. First, you have created a perfect environment for every weed seed to germinate under the plastic mulch. And the weeds are protected and they will soon be competing with the tomato plant. Second, the temperature under clear plastic may be too hot and you could actually set the plants back with heat stress!

The second type of plastic mulch to use is black plastic. This has the advantage that it blocks light from the soil so you won't have any weeds germinating underneath. Unfortunately, the soil will not warm as much compared to clear plastic. The third type of mulch is called thermal or IRT mulch. This appears greenish or brown in color. It prevents weed germination like black plastic but it raises soil temperatures to levels similar to clear plastic. IRT plastics will cost more than traditional black plastic. There has been much written recently about the advantage of colored plastics but I'm not convinced they are worth the extra cost. I do not believe there is any consistent yield advantage. Recent studies indicate that the best mulch for tomatoes was a standard black plastic (green IRT was actually the worse). I have not recommend using an organic mulch like straw or a killed vetch or rye cover crop. Some growers have had wonderful success with these methods for mid and late season production **BUT** not for early production. Organic mulches will cool the soil, delaying yield

Row Covers

Tomatoes are warm season plants that cannot tolerate a frost. Even temperatures under 45^{o} will slow growth considerably. To get plants to grow quickly we can do some things that change their environment, providing them with protection and increasing the air temperature. Although tomatoes love heat, they do have their limits. Nighttime temperatures that stay above 80^{o} will kill some of the pollen and prevent fruit set. Daytime temperatures above 90^{o} may also have a similar effect. This can vary by variety and the length of time that the plants are exposed to high temperatures. There are several ways the air temperature around the plants can be increased.

The protected conditions under row covers have resulted in early yield increases for muskmelons and other cucurbits but has had a mixed effect on peppers and tomatoes. I found enhanced early yields of tomatoes using two type of row covers, floating, spunbonded covers and slitted, clear plastic (Table 1). Other researchers have found the opposite, that yield was decreased with covers and blamed that on temperatures that were too high under the cover. Apparently the yield loss in tomatoes grown under plastic may be related to insufficient pollination, blossom drop, or fruit abortion.

Table 1. Effect of two row covers on the early and total yield of fresh market tomatoes (Pilgrim) planted April 28 in central New Jersey.

Treatment	Early Marketable Fruit (lb/Acre)	Total Marketable Fruit (lb/Acre)
No Cover	5,760a	26,020
Floating Row Cover	8,833b	23,235
Clear, Slitted	11,810b	29,284ns

For row covers to be effective they must be managed according to the temperature requirements or limitations of individual crops. A possible reason for the failure of enhanced early yield in some of the other trials may be due to the lateness of planting. Tomato plants set near the time of traditional spring plantings for a region and covered, had reduced early yield. With bell peppers, when 16 pepper varieties were planted early (21 April) and covered, early yield was enhanced by 10 days over unprotected plots. When planted at the more traditional time a month later, protected peppers exhibited an early yield loss across all varieties, with the first harvest delayed 9 days. Clearly, later plantings do not benefit from protection and may well be damaged, possibly from high temperatures. Row covers would seem to be most effective in allowing growers to plant several weeks earlier than traditional planting dates. The challenge encountered when trying to plant tomatoes several weeks early is the inability to work the soil, prepare beds, and lay plastic when the soil is still wet from spring rains. This is especially true on heavier soils that drain slowly. In our row cover trials we could never plant as early as we hoped due to wet soils that could not be worked.

To overcome this problem, we experimented with using beds prepared in the fall (with plastic and trickle) and planted as early as possible in the spring. Fields were prepared with black plastic mulch and trickle irrigation on October 10. Plots survived the winter intact, with just a few holes most likely due to bird pecks. The following spring, 7 week old Sunrise tomato transplants were set in the field on April 13, five weeks before most growers would traditionally plant. Immediately after planting, slitted, clear polyethylene covers were stretched over wire hoops, spaced over every other plant. The treatments included 1) Unprotected, 2) plastic removed on May 20 (37 days after transplanting), 3) plastic removed June 10 (57 days after transplanting), and 4) Unprotected planting on May 20, the traditional time for field planting in the area.

The results can be seen below (Table 2).

Table 2. The effect of row covers and the timing of their removal on early yield of tomatoes.

	Marketable (lb/A)			
Treatment	**Medium (2.5-3 in.)**	**Large (3-3.5 in.)**	**Jumbo (>3.5 in.)**	**Total**
13 April Planting *No Protection*	903	1,425	103	2,432
13 Apr. Planting *Cover Removed 20 May*	3,824	3,057	651	7,533
13 Apr. Planting *Cover Removed 10 June*	4,047	3,911	359	8,318
20 May Planting *No Protection*	0	0	0	0
LSD	1,029	882	195	2,495

Early yield of tomatoes was increased significantly by the use of slitted, clear plastic row covers. With the exception of the yield of jumbo sized tomatoes with the early row cover removal (20 May), there were no differences in early marketable yield due to the timing of row cover removal. Simply planting tomatoes early and without any protection did result in more than 2,400 pounds of tomatoes per acre compared to no early production for those planted at the traditional planting date. It should be pointed out, however, that there was no frost in the area after the early planting, although temperatures fell below 40F on 9 of the first 18 nights. The average last killing frost date in the area is 18 May. In an average year, the early, unprotected planting could have been killed by frost. Despite the chance of a killing frost, growers may wish to take a chance with a small number of plants planted early and without protection.

The positive effect on early tomato yield agrees with the earlier work. Studies that have found negative correlations generally had higher temperatures under the covers than we experienced in this experiment. Three days out of the first 50 did temperatures under the cover exceed 95F, and one day maximum temperature exceed 100F. Temperatures above 95F have been blamed for yield losses in the past. There was no advantage to leaving covers on past the time when tomatoes were traditionally planted. In fact, the date of traditional planting may serve as an effective guideline to indicate when to remove the row covers to avoid the possibility of problems from heat.

These experiments clearly demonstrate that row covers, if used at the proper time, can increase the early yield of tomatoes. Their effectiveness, however, seems to be related to allowing earlier planting rather than accelerating the ripening of later planted tomatoes. The higher temperatures under row covers may decrease the yield in plantings made at traditional times. The traditional planting date for tomatoes in a particular area may serve as a guideline as to when row covers should be removed. Fall bedding seems to be a viable option for growers interested in maximizing the ability to plant very early in the spring. Growers need to work out the economics to determine if it is a cost effective option for their operations.

Safe Handling of Peppers and Tomatoes

Leslie D. Bourquin
December 9, 2008

Foodborne Illnesses in the US

- 76 million cases per year
- 325,000 hospitalizations per year
- > 5,000 preventable deaths per year
- Economic losses estimated to be 10-83 billion dollars per year

Mead et al. 1999. Emerging Infectious Diseases 5:607

Produce-Related Foodborne Illness Outbreaks & Cases per Outbreak, 1998 – 2002 (U.S.)

	Outbreaks/year	Cases/year
Vegetables	38.4	1407.4
Fruits and Nuts	17.4	699.2
Combined Fruit, Veg and Nuts	55.8	2106.6

Mean number ill per outbreak = 37.75

U.S. Centers for Disease Control and Prevention. 2006. Surveillance for Foodborne Disease Outbreaks – United States – 1998-2002. MMWR 55:SS-10.


MSNBC Home ▸ Health ▸ Infectious Diseases

FDA rushes to find E. coli outbreak source

2nd supplier recalls spinach for possible contamination

MSNBC staff and news service reports
Updated: 11:13 a.m. ET Sept 18, 2006

SAN FRANCISCO - The company whose fresh spinach was linked to an E. coli outbreak that's sickened at least 109 people said its organic products had been cleared of suspicion, while health officials continued working to pinpoint the bacteria source.

Natural Selection Foods LLC, the country's largest grower of organic produce, said late Sunday that manufacturing codes from packages of spinach that infected patients turned over to health officials all were from non-organic spinach. Natural Selection packages both organic and conventionally grown spinach in separate areas at its San Juan Bautista plant.

The company, however, did not immediately lift any recalls of 34 brands. Those brands include the company's own labels and those of other companies that had contracts with Natural Selection to produce or package its spinach.

Health
Diet & Nutrition
Fitness
Women's Health
Children's Health
Men's Health
Sexual Health
America Unzipped
Low Blow
Aging
Cancer
Heart Health
Mental Health
More Health News
Pet Health
Health Library
Health Columns
Video
U.S. News
Politics
World News
Business
Sports

NBC VIDEO

Launch

• Spinach-related illnesses continue rise
Sept. 18: The number of people sickened by an E. coli outbreak traced to tainted spinach rises to 109 as federal officials announce that more brands are recalling their products. NBC's Michael Okwu reports.

Today show

Spinach *E. coli* O157:H7 Outbreak
Natural Selection Foods – September 2006

- 204 confirmed illnesses
- 104 hospitalizations
- 31 cases of hemolytic uremic syndrome
- 3 deaths

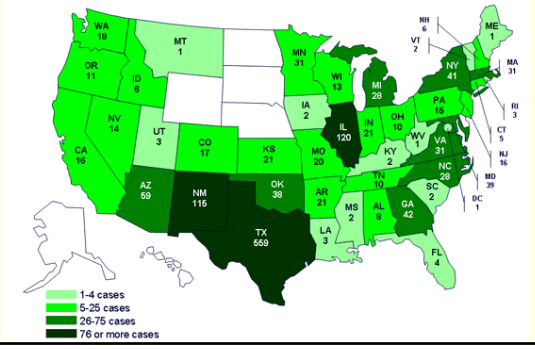
- Illnesses confirmed in 26 states (including Michigan)
- 1 illness in Canada

2008 Food Safety Problems

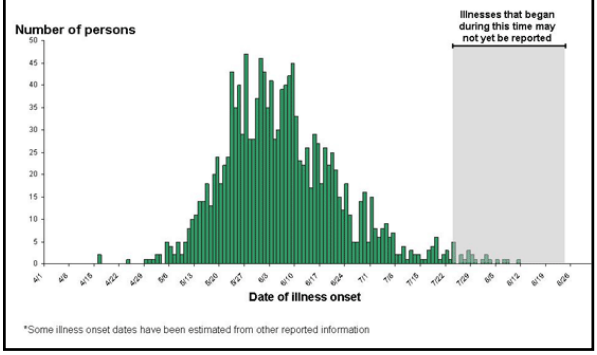
- Tomato / Pepper *Salmonella* Saintpaul Outbreak
- 1442 reported illnesses as of August 2008
- 43 states, District of Columbia, Canada

- Tomatoes initially suspected:
  - Epidemiological association
  - History of outbreaks associated with tomatoes

Cases infected with the outbreak strain of *Salmonella* Saintpaul, United States, by state, as of August 25, 2008



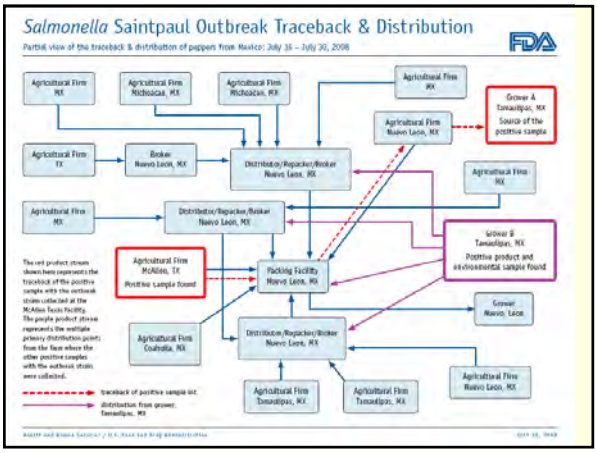
Infections with the outbreak strain of *Salmonella* Saintpaul, by date of illness onset*
(N=1414 for whom information was reported)
(as of Aug 25, 9pm EDT)



*Some illness onset dates have been estimated from other reported information

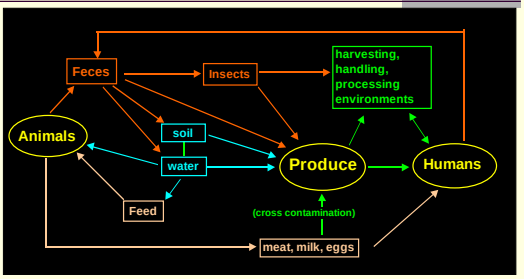
First it was tomatoes, then…….

Salmonella Saintpaul Outbreak Traceback & Distribution



PREVENTION is the Key to Reducing Microbial Contamination of Fresh Fruits and Vegetables

Potential sources of pathogen contamination of fresh produce



Modified from Beuchat, 1996

Food Safety Standards

- Public standards
  - Government laws and regulations
  - Tend to focus primarily on risks due to food hazards
- Private Standards
  - Driven by the food industry: retail buyers, buyer organizations, commodity groups, NGOs, etc.
  - Often consider food hazards (perhaps not risk-based) as well as environmental issues and corporate social responsibility objectives.

US Food Regulatory System

- Federal – USDA, FDA
  - Food processors, eggs, imports, most food products in interstate commerce
- States – e.g. Michigan Dept. of Agriculture
  - Foods in Intrastate commerce, processors, contract inspections for FDA, milk, retail food operations
- Local Health Departments
  - Restaurants, institutional food service operations

US Food Regulatory System

- 21 CFR 110 – Good Manufacturing Practices
  - Basic requirements for all food manufacturers
- Specific regulations for certain food sectors,
- Primary production is generally not regulated
  - Fresh produce production and packing facilities

Good Agricultural Practices

- 1998 FDA guidance document
- "Guide to Minimize Microbial Food Safety Hazards for Fresh Fruits and Vegetables"

  http://www.foodsafety.gov/~dms/prodguid.html

  - Not a federal regulation – guidelines only
  - Produce buyers may require compliance

Good Agricultural Practices

- Broadscope
  - The guide provides general advice for the fresh fruit and vegetable industry. Commodity-specific considerations can be applied.
- Guidance Only
  - The recommendations contained in the guide do not supercede any existing federal or state regulations.
- Focus on Risk Reduction – Not Risk Elimination

Good Agricultural Practices

- Focus is on prevention of food safety hazards during production (pre-harvest) and following harvest (post-harvest)
  - Water sources – irrigation, processing
  - Appropriate use of manure as fertilizer
  - Hygiene (sanitation) in the field, packing facility, and during transport
  - Traceability

Good Agricultural Practices

- Elements of "The Guide"
  - Water
  - Manure and Municipal Biosolids
  - Worker Health and Hygiene
  - Sanitary Facilities
  - Field Sanitation
  - Packing Facility Sanitation
  - Transportation
  - Traceback

GAPs Audits and Third-Party Certification

- No regulatory requirement in the U.S. for produce growers and packers to undergo third-party certification or GAPs audits
- HOWEVER – This is increasingly becoming a requirement driven by the retail sector.
- Why?
  - Enhanced food safety standards
  - Shift liability upstream from retail sector

Examples of GAP Standards and other Food Safety Standards for Primary Production

- FDA Guidance Document
- GlobalGAP
- SQF 1000
- Etc.

- Auditing
  - USDA AMS GAPs Audits
  - Primus Labs
  - Davis Fresh
  - Etc.

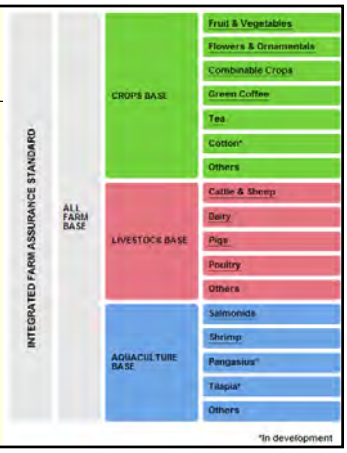
GlobalGAP – Private Standards for Primary Production

http://www.globalgap.org/

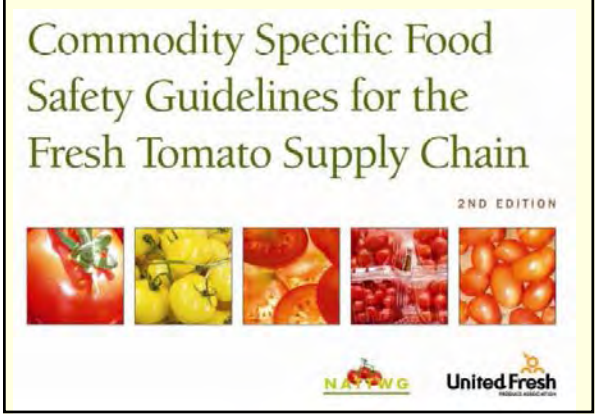
GlobalGAP

Integrated Farm Assurance Standard

Over 92,000 certificates issued worldwide.



http://www.unitedfresh.org/assets/files/Tomato%20Guidelines%20July08%20FINAL.pdf



Tomato Food Safety Guidelines

- General production and handling guidelines related to food safety.
- Given the evolving nature of the science, few quantitative “metrics” included in the guidance.

Tomato Food Safety Guidelines

Guidelines for eight primary modules:

- open field production,
- harvest practices,
- field packing,
- greenhouse production,
- packinghouse,
- repacking and other distribution operations,
- fresh-cut processing (value-added), and
- foodservice and retail.

Multiple modules will apply to many users of these guidelines.

Open Field Production

- Field management
- Animal exclusion
- Adjacent land use
- Water use in the field
- Hygienic practices in tomato field
- Gloves
- Crop production practices
- Equipment and containers
- Record keeping

Harvest Practices

- Preharvest assessment
- Hygienic practices in tomato field
- Gloves
- Equipment and containers
- Tomato or equipment sanitizing agents
- Debris removal
- Exclusion from harvest
- Culling, sorting, removal of damaged tomatoes
- Record keeping and traceability

Packinghouse

- Grounds
- General maintenance
- Water supply and plumbing
- Trash and tomato waste disposal
- Receiving
- Packaging Materials
- Postharvest washing of fresh tomatoes
- Employee hygiene
- Handwashing and Toilet Facilities
- Handwashing practices
- Health policies
- Other hygienic practices
- Gloves
- Storage, ripening rooms and distribution facilities
- Transportation
- Record keeping, product labeling and traceability

A Brief Overview of GAPs Guidance

Review Field Management Practices to Reduce Risks

- Manure
- Crop Selection and Management
- Water quality
- On-Farm Planning and Documentation

Manure = Fecal Matter = Microbes

- Human or animal: DO EVERYTHING you can to keep manure off produce.
- Preventing contamination is the goal.

All Manure Can Carry Pathogens

- Livestock
  - cattle, swine, poultry, horse, & sheep
- Dog and Cat
- Bird
- Rodent
- Deer
- Fly or other insect
- Human

On-Farm Manure Handling

- Manure
  - Active composting is preferred
  - If not composted, store for 6 months prior to field application.
- Slurry storage systems and waiting periods
  - Wait 60 days in summer and 90 days in winter prior to spreading.
  - Consider satellite storage or special management for slurry destined for vegetable ground.

Compost Manure Properly

- Manage piles to have active, uniform composting.
  - High temperatures, good moisture, proper aeration, and mixing.
  - Weed seeds killed means good composting conditions were achieved.
- Exclude animals from compost area to prevent recontamination.

EPA Composting Guidance – Processes to Further Reduce Pathogens in Municipal Biosolids – Appendix B of 40 CFR Part 503

- Static Aerated Pile Composting
  - Maintain temperature of biosolids at 55°C (131°F) or higher for 3 days
- Windrow composting
  - Maintain temperature of biosolids at 55°C or higher for 15 days or longer.
  - During this time when compost is maintained at 55°C or higher, the windrow is turned a minimum of 5 times

Manure Application

- Do not assume any manure is 'clean'.
- Incorporate, Incorporate, Incorporate
- Absolutely NO SIDEDRESSING with fresh manure.
- Know manure source and handling.


Observe Pre-Harvest Intervals

If applying manure in spring to fruit and vegetable fields, wait 120 days to harvest.


Keep Records of Manure and Compost Use

- Know your source of manure or compost.
- Know the methods used to produce compost or the manure storage time.
- Keep records of application rates, timing, and fields receiving manure or compost.

Crops for Manured Fields

- Avoid root/low growing crops (lettuce, beets) in season manure is applied.
- Avoid crops consumed fresh or those where leaves are eaten by humans.
- Apply manure to ground where perennials are being planted.


Irrigation Water

- Well water safest
- Ponds next best
- Flowing water changes continually, so is the riskiest
- Method of application of irrigation water influences risk.
- Differing recommendations on water testing requirements

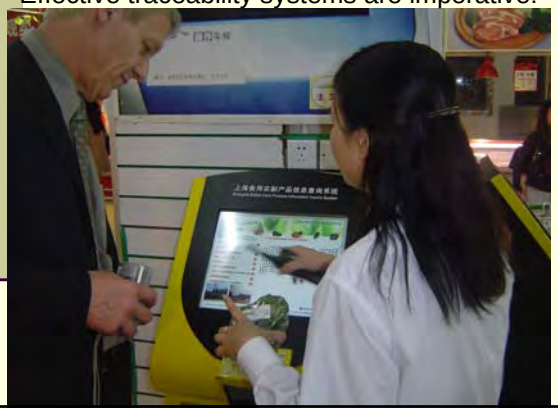
Crop Management

- Use trellis/staking where appropriate, such as tomatoes.
- Use plastic mulch and drip irrigation to reduce leaf wetting.
- Use organic mulches to reduce splash.


Exclude Animals

- Keep wildlife out of production areas as much as possible.
- Manage rodents and birds in packing houses and storage areas.
- No weeder geese in fields prior to harvest.
- No dogs or other pets in the field.

Effective traceability systems are imperative!



For Additional Information

Leslie D. Bourquin
Department of Food Science and Human Nutrition
and National Food Safety and Toxicology Center
Michigan State University
139A G. M. Trout Bldg.
East Lansing, MI 48824-1224

National GAPs Education Program (based at Cornell):
http://www.gaps.cornell.edu/

FDA GAPs Guidance Document
http://www.foodsafety.gov/~dms/prodguid.html

Thank You!