Managing the Uncertainties in Growing and Marketing Fruits and Vegetables

Education Session Abstracts
December 10 - 12, 2002

Compiled by:
Roger C. Brook, Running Water Publishing, LLC
www.runwater.com
ACKNOWLEDGMENTS

PLANNED AND ORGANIZED BY:
Michigan State Horticultural Society
Michigan Vegetable Council
Michigan State University Extension

EDUCATION SESSIONS DEVELOPMENT COMMITTEE:
Tom Kalchik, Coordinator, MSU Extension
Eric Hanson, Fruit Sessions, MSU Extension
Mathieu Ngouajio, Vegetable Sessions, MSU Extension
Robert Tritten and Ron Goldy, Farm Market Programs, MSU Extension

SESSION COORDINATORS:
John Biernbaum, Professor, Horticulture
Jim Breinling, MSU Extension District Vegetable Agent
Myra Buatovic-Danilovich, MSU Extension District Horticultural and Marketing Agent
Ron Goldy, MSU Extension District Vegetable Agent
Eric Hanson, MSU Extension Professor, Horticulture
Rich Hoddup, MSU Extension Ag. and Natural Resources Agent
Tom Kalchik, MSU Extension Value Added Agent
Greg Lang, MSU Extension Professor, Horticulture
Mark Langstroth, MSU Extension District Horticultural Agent
Chris Long, Specialist Crop and Soil Sciences
Norm Myers, MSU Extension Oceana County Director
Mathieu Ngouajio, MSU Extension Asst. Professor, Horticulture
Jim Nugent, MSU Extension District Horticultural Agent
Phil Schwaller, MSU Extension District Horticultural and Marketing Agent
Bill Shane, MSU Extension District Horticultural Agent
Susan Smalley, Specialist Crop and Soil Sciences
Don Smucker, MSU Extension Montcalm County Director
Sieg Snapp, MSU Extension Asst.Professor, Horticulture
Hannah Stevens, MSU Extension Horticultural Agent
Gary Thornton, MSU Extension District Fruit IPM Agent
Robert Tritten, MSU Extension SE Michigan District Agent
Bernard Zandstra MSU ExtensionProfessor, Horticulture

COMMUNITY SUPPORTED AGRICULTURE
Carrot, Celery, Onion
Plum
Farm Market Programs, Plasticulture, Tomato
Berry, Blueberry
Water Rights
Global Marketing
Poster Presentations
Grape
Potatoes
Asparagus
Pickling Cucumber
Cherry
Apple Programs
Peach
Community Supported Agriculture
Potato
Cover Crop
Pepper, Sweet Corn, Vine Crop
Pesticide Use
Cider Programs,
Farm Market Programs
Pickling Cucumber

EXPO PLANNING COMMITTEE:
Calvin Dyk, President
Chris Falak
Abby Jacobson
Joe Klein
Jim Koan
Brian William
Lynne Sage, MSHS
Dave Smith, MVC
Sharri German, Trade Show Manager
Hilary Morolla, Registration Manager
# Table of Contents

**Tuesday morning, December 10, 2002**  
**Apple**  
Developing New Sensing Technologies to Sort Apples for Internal Quality ........... 1-  
State of the Art Organic Fruit Growing in Europe ........................................ 3-  
1-MCP: One Ring to Rule Them All? ...................................................... 5-  
**Asparagus**  
Risk Management for Specialty Crops in Michigan ...................................... 9-  
Asparagus Disease Update ........................................................................... 10-  
**Berry**  
Choosing the Right Raspberry Varieties for your Market Needs .................... 13-  
New Ideas on Managing Weeds in Strawberries ......................................... 15-  
Getting to Know the Multi-colored Asian Lady Beetle .................................. 17-  
**Pickling Cucumber**  
Phytophthora Fruit Rot: Lessons Learned .................................................. 19-  
Weed Control Strategies for Pickles ......................................................... 22-  
Development of an Improved Pickup Head For Tractor-Mounted (Wilde/Raven)  
Pickling Cucumber Harvesters .................................................................... 23-  
**Tomato**  
What Makes A Quality Tomato Transplant .................................................. 25-  
Fresh Market Tomato Production Trends in North Carolina and Adjacent States 26-  
New and Upcoming Variety Releases from the North Carolina Tomato Breeding  
Program ........................................................................................................... 28-  
New Products for Disease Control ................................................................. 29-  

**Tuesday afternoon, December 10, 2002**  
**Apple**  
Nutrition and Soil Management in High Density Apple Orchards .................. 33-  
Controlling Flowering and Cropping of Apple Trees with Growth .................. 36-  
New Marketing Concepts to Commercialize Unknown (Resistant) Apple Varieties  
Successfully .................................................................................................... 38-  
Improving the Performance of Blossom Thinners (Trust Report) .................... 41-  
**Cover Crop**  
Composts and Covers: Roles in Disease Control .......................................... 45-  
Building Fertility with Cover Crops and Manure: What it Takes to Get Profitable 48-  
New Generation of Cover Crops for Tomatoes ............................................. 50-  
Cover Crops in a Seed Corn and Vegetable Rotation ..................................... 51-  
**Grape**  
Grape Berry Moth in Michigan Vineyards ............................................... 53-  
Efficient and Effective Fertilization Programs for Grapevines ......................... 54-
# Table of Contents

**Tuesday afternoon, December 10, 2002**

**Pepper**
- What To Look For In A Quality Pepper Transplant ........................................ -55-
- Biodegradable Mulches in Pepper Production ............................................... -56-
- Plastic Or No Plastic: Using Enterprise Budgets for Decision Making ............. -58-
- Producing and Marketing Peppers for Eastern European .................................. -59-

**Tuesday afternoon, December 10, 2002**

**Vine Crop**
- Avoiding an Invasion of the Rots and Blights ........................................... -63-
- Putting Weed Control Chemicals to Work for you On Pumpkins and Squash ....... -67-
- Fitting Pumpkins Into Your Computer ...................................................... -68-
- Cover Crop Mulches for Pumpkin Production .............................................. -69-

**Wednesday morning, December 11, 2002**

**Blueberry**
- Effective Use of Sprinkler Systems for Blueberry Frost Control ...................... -73-
- Update on Highbush Blueberry Production Patterns ...................................... -76-
- Marketing Fresh Blueberries Around the Calendar ....................................... -77-
- United States Highbush Blueberry Council: Update and Progress Report .......... -78-
- Japanese Beetle Biology and Management Options ....................................... -80-

**Cherry**
- Strategies to Control Brown Rot on Stone Fruit ....................................... -81-
- Promising Sweet Cherry Varieties for the Eastern US .................................. -83-
- Managing Water and Nutrition in High Density Sweet Cherry ....................... -84-
- Processor Viewpoint on the Tart Cherry Federal Marketing Order .................. -86-

**Farm Marketing**
- Promotions: Sowing Excitement, Reaping Profits ....................................... -87-

**Onion**
- Producing Onions in Oswego County, NY .................................................. -89-
- Weed Control in Onions .................................................................................. -92-
- Thrips, Thrips and more Thrips ....................................................................... -93-
- Onion Variety Evaluation Trials and Nutrient Management Tips ....................... -94-
- Produce Branding: Can it Work for Onions? ............................................... -96-
- New Products and Strategies for Disease Control ......................................... -99-

**Potato**
- Agricultural Water Use Research, 2002 ...................................................... -101-
- Managing Manure in Potato Systems ......................................................... -103-
- Early Blight Management with Fungicides in Wisconsin ................................ -106-
- Factors to Consider in Organic Potato Production ....................................... -108-
- Volunteer Potato Management ....................................................................... -110-
#### Table of Contents

**Wednesday morning, December 11, 2002**

**Sweet Corn**
- The Sweet Corn Buyer’s Perspective on Quality .................................................. -113-
- Influence of In-row Spacing Accuracy and Uniformity of Emergence on the Yield of Sweet Corn ................................................................. -116-
- Organic Pest Control in Sweet Corn ........................................................................ -118-
- Managing Frost/Freeze Damaged Sweet Corn Plantings ....................................... -121-
- What Three Years of Research Has Revealed About Stewart’s Wilt ..................... -123-

**Wednesday afternoon, December 11, 2002**

**Apple**
- Michigan Apple Marketing Future: Fresh Apple Perspective .............................. -125-
- Michigan Apple Marketing Future: A Processing Perspective ............................ -126-
- Fire Blight Management .......................................................................................... -127-

**Carrot**
- Weed Control in Carrots ....................................................................................... -129-
- Improving The Tools For Carrot Disease Management ....................................... -130-
- How to Use Scouting and Forecasters for Blight Control ..................................... -132-
- Risk Management for Specialty Crops in Michigan ........................................... -135-

**Celery**
- Risk Management For Specialty Crops in Michigan .......................................... -137-
- Fusarium-tolerant Celery: Are We there Yet? ....................................................... -138-
- Development of Fusarium-resistant Celery Cultivars ....................................... -141-
- The Challenge of Controlling Multiple Insect Pests in Celery ............................ -143-
- Weed Control in Celery ......................................................................................... -144-
- A New Program for Disease Management ......................................................... -145-

**Peach / Plum**
- Peach Disease Management Perspectives from South Carolina ....................... -149-
- Exotic Pests, Diseases, and Nursery Stock - the Stone Fruit Industry At Risk .... -152-
- Growing Peaches in Ontario ................................................................................. -154-

**Plasticulture**
- What Are The Advantages And Disadvantages Of Using Tunnels? .................... -155-
- SWMREC Drip Irrigation Trial Results for 2002 ................................................ -156-
- Plastic Mulch Films – Additives and Their Effects ............................................. -157-

**Thursday morning, December 12, 2002**

**Farm Market Specialty Crops**
- Unusual Small Fruits as Additions to Farm Markets ........................................... -159-
- Rhubarb Production ............................................................................................... -160-
- Tree Fruits for Niche Markets ............................................................................... -162-
# Table of Contents

**Thursday morning, December 12, 2002**

- Land Use Issues - Can You Afford to Farm?
  - Michigan Land Resources for the Future - Projections to 2040 - 165-
  - The Michigan Agricultural Preservation Fund - 166-
  - PA 116 Program (Farmland and Open Space Preservation) - 167-
  - The State Purchase of Development Rights Program - 168-
  - Farmland Agreements: Enrollment, Eligibility & Benefits - 169-
  - Farmland Agreements: Transferring, Dividing & Releasing - 171-

- Pesticide Use Workshop
  - Federal Worker Protection Standards (WPS) From Education to Enforcement - 173-

- Water Rights in the Great Lakes Basin
  - Water Law in a Nutshell: Riparian Rights, The Public Trust Doctrine and Navigability - 175-

- Irrigation Gaamp Progress Report - 177-

**Presenters**

- Presenters - 179-
Consumer surveys have shown that fruit quality is the most important factor in influencing consumer purchase decision on fresh products. If quality of fresh fruit were better, consumers would buy more and pay a higher price. Hence it is critical that the fruit industry deliver high quality and consistent fruit to consumers in order to maintain and improve current market share. Fruit quality comprises many components, including appearance (size, shape, color), texture (firmness, juiciness), and flavor (sweetness, sourness, aroma). Appearance is important, but it is texture and flavor that ultimately determine consumer satisfaction. Technologies that can inspect, grade, and sort individual fruit for their internal quality would provide a means for assuring the quality and consistency of fruit delivered to consumers, increase consumer satisfaction and confidence, and hence improve the competitiveness and profitability of the fruit industry.

Currently, technologies for automated sorting of fruit for appearance such as size and color have been widely used in the fruit industry. However, sorting for texture and flavor still presents a great challenge. In our lab, we are investigating new sensing methods using latest optical technologies to nondestructively measure fruit quality such as firmness and sugar content. Our research is based on the hypothesis that light absorption is related to chemical constituents of fruit, whereas light scattering is more closely associated with the structural or physical properties of fruit. The goal of our research is to develop a new sensing technology that can be used to inspect, grade and sort apple fruit for such important quality attributes as firmness and sugar content. We are applying hyper- and multispectral imaging for assessing firmness and sugar content of apple fruit. Hyperspectral imaging combines imaging and spectroscopy to obtain both spectral and spatial information from a fruit, which allows us to detect some minor and/or subtle characteristics in the fruit that would otherwise be difficult to detect with either imaging or spectroscopy.

In the 2001-2002 season, we assembled and tested a hyperspectral imaging system and a multispectral imaging system for measuring fruit firmness and sugar content. Our hyperspectral imaging system allowed us to acquire hyperspectral images from apple fruit in the visible and short wave near-infrared region. Our multispectral imaging system gave us the ability to acquire five spectral images from apple fruit at selected wavelengths in the near-infrared region. Three apple varieties, Delicious, Golden Delicious, and Jonagold, were used in the hyperspectral imaging study. A total of more than 1000 apple fruit were tested. We also tested our multispectral imaging system with more than 500 Delicious apples. Computer algorithms were developed using neural networks methods to extract image features from hyperspectral and multispectral images and relate them fruit firmness and sugar content.

Our results showed that hyperspectral imaging gave relatively good predictions of fruit firmness for
the three varieties with the correlation coefficient of 0.74 for Golden Delicious and 0.69 for Delicious and Jonagold, with the prediction error of 1.9, 1.7, and 0.8 lbs, respectively. These results compared favorably with those obtained with near-infrared spectroscopy or other techniques. Our research also showed that the hyperspectral imaging system could predict the sugar content of apple fruit accurately; the correlation coefficient of prediction was 0.81 for Delicious apples with the prediction error of less than 0.6 °Brix. These results indicate that the hyperspectral imaging is a promising technique for nondestructive measurement of fruit firmness and sugar content.

In the multispectral imaging study, we identified several important wavelengths that are useful in predicting fruit firmness and sugar content. Our results showed that the multispectral imaging system could predict fruit firmness with a correlation coefficient of 0.87 and the prediction error of 1.3 lbs, a minimal resolving value a trained panelist can predict. The prediction error for the sugar content of Delicious apples was 0.9 °Brix. These results are very encouraging and show that the technique is useful for predicting fruit firmness and sugar content.

For the 2002-2003 season, we will improve our hyperspectral and multispectral imaging systems for better and more consistent predictions of fruit firmness and sweetness. We are also improving our hardware designs to increase image acquisition speed so that the systems can eventually meet online sorting speed requirements.
State of the Art Organic Fruit Growing in Europe

F.P. Weibel (franco.Weibel@fibl.ch), A. Häseli, O. Schmid and H. Willer
Research Institute of Organic Agriculture (FiBL), Ackerstrasse, Postfach
CH-5070 Frick, Switzerland (http://www.fibl.ch)

Organic fruit growing in Europe has experienced remarkable growth rates since the mid 1990's. Southern states, especially Italy, Spain and France, growing also olives, citrus and chestnuts have the largest land area with organic fruit (Table 1). Mainly increasing interest of supermarket chains is responsible for this buoyancy, but also the availability of better plant protection products e.g. granulosis virus and mating disruption against codling moth, Neem oil against Rosy Apple Aphid.

Market potential and key problems of production – State subsidies varying from 600 to more than 1600 Euro ha/y in the EU-countries are less decisive for the conversion of top fruit production. Market share of organic table fruit is only 1 to 2 %, reaching 4 to 5 % in Switzerland. For Switzerland, we estimate a market potential of around 12 to 15 %, which is already achieved with organic vegetables. In order to reach that percentage for several key problems better solutions have to be found, e.g. control of scab, fire blight, sooty blotch, brown rot, weed management, fertilisation and crop load regulation. Also the assortment of organically producible "modern-standard" varieties is not satisfying, in particular with stone fruit.

Economy – Economics of organic fruit growing is comparatively healthy, however depends on higher farm gate prices for the product. In Switzerland the direct cost free benefit of organic orchards is 16 % higher compared to integrated fruit production; but labour hours exceed those of IFP by 7%, due to blossom thinning by hand, manual weed control and mice control.

Perspectives – Supermarkets have a tendency to just "substitute" conventional with organic fruit when requiring disease susceptible varieties with no cosmetic blemishes. This can/does feed back to the growers resulting in "substitutional" production with disease and pest sensitive cultivar and orchards managed with intensive "organic" spray and fertilisation programs. This certainly does not correspond with either the original concept of organic farming or with expectations of organic consumers. Thus, still a lot of development - also on the marketing side - has to be undertaken.

Research – The "European Group of Researchers on Organic Fruit" EUGROF, founded in 2000 is the connecting network for researchers who are predominantly active in organic fruit research from 14 countries (Weibel, 2001b). Some of the EUGRF Members are part of Organic Research Institutes as e.g. Louis Bolk Institute in the Netherlands, GRAB in France or FiBL in Switzerland; others are from an Organic Department within a "conventional" institution as e.g. VZL in Italy. The purpose of EUGROF is the exchange and discussion of information in an annual meeting, but also within working groups, to create synergies to resolve better experimental tasks and sometimes also administrative or legislative jobs. There is a clear tendency that co-operation of "organic" and "conventional" researchers and institutions is increasing that we consider as very positive.

References – The full list of references including web-pages is part of the article "Present Status of Organic Fruit Growing in Europe" by Weibel, F.P. et al. submitted to Acta Horticulturae in August 2002. The reference list is also available from the authors.
### Table 1: Production area and fruit species for organic fruit and berry production in Europe

<table>
<thead>
<tr>
<th>Country</th>
<th>Production area in ha</th>
<th>Species</th>
<th>Sources</th>
</tr>
</thead>
<tbody>
<tr>
<td>Portugal</td>
<td>19,415, 1,815, 692</td>
<td>Olives, Dried Fruit, Fresh Fruit</td>
<td>1)</td>
</tr>
<tr>
<td>Spain</td>
<td>82,246, 33,100, 920</td>
<td>Olives, Dried Fruit, Fresh Fruit</td>
<td>3) and 5)</td>
</tr>
<tr>
<td>Italy</td>
<td>93,863, 31,364, 15,384</td>
<td>Olives, Fruit, In South Tirol 540 ha, Pipfruit, Citrus</td>
<td>4) Ministero Politiche Italiana and 5)</td>
</tr>
<tr>
<td>Greece</td>
<td>12,085, 196, 80</td>
<td>Olives, Currants, Top Fruit</td>
<td>1) and 2) and 5)</td>
</tr>
<tr>
<td>Turkey</td>
<td>21,059, 1,971</td>
<td>Dried Fruit incl. Nuts, Fresh Fruit</td>
<td>2)</td>
</tr>
<tr>
<td>France</td>
<td>1,555, 1,280, 1,255, 490, 220</td>
<td>Nuts, Stone Fruit, Pipfruit incl. Cider, Olives, Citrus</td>
<td>5) and 2)</td>
</tr>
<tr>
<td>Switzerland</td>
<td>390 (additionally 6,000-8,000 t per year pipfruit for organic apple juice production from high stem trees)</td>
<td>Apple (250 ha), pears, apricot, cherries, plums, diff. berries, kiwi</td>
<td>6)</td>
</tr>
<tr>
<td>Austria</td>
<td>598</td>
<td>Apples, currants, strawberries, pears</td>
<td>7)</td>
</tr>
<tr>
<td>Hungary</td>
<td>650</td>
<td>Top Fruit</td>
<td>1)</td>
</tr>
<tr>
<td>Poland</td>
<td>284</td>
<td>Top Fruit</td>
<td>1)</td>
</tr>
<tr>
<td>Belgium</td>
<td>328</td>
<td>Top Fruit (150 ha, 75 % apple, 25 % pear)</td>
<td>5)</td>
</tr>
<tr>
<td>Germany</td>
<td>1735</td>
<td>Excluding standard tree production</td>
<td>5)</td>
</tr>
<tr>
<td>The Netherlands</td>
<td>180 + 115 in conversion</td>
<td>Apples, pears, strawberries</td>
<td>5)</td>
</tr>
<tr>
<td>United Kingdom</td>
<td>604</td>
<td>Top Fruit (estimated 514)</td>
<td>5)</td>
</tr>
<tr>
<td>Denmark</td>
<td>306</td>
<td>Black currants, strawberries, apples, sweet cherries</td>
<td>5)</td>
</tr>
<tr>
<td>Norway</td>
<td>57</td>
<td>Apples, pears, plums, diff. berries</td>
<td>7)</td>
</tr>
<tr>
<td>Sweden</td>
<td>189</td>
<td>Strawberries, apples, other berries</td>
<td>7)</td>
</tr>
</tbody>
</table>

Sources:
1) Organic-Europe Homepage
2) MOAM
3) Ministry of Agriculture, Fisheries and Food, Spain 2002
4) Ministero Politiche Italiana 2001
5) Weibel 2002, Poll among members of EUGROF
6) Bio-Suisse 2001
7) Lindhardt and Callesen 1999
1-MCP: One Ring to Rule Them All?
Randy Beaudry, Department of Horticulture
Michigan State University, East Lansing, MI

Background
The growth regulator, 1-methylcyclopropene (MCP), has been shown to have significant promise as an ethylene action inhibitor. Presently approved for use with ornamental crops under the trade name EthylBloc, MCP is not yet approved for application on other horticultural crops. However, MCP is presently being extensively evaluated for use on many crops and is undergoing Environmental Protection Agency registration processes. The commercial name for MCP on horticultural crops other than ornamentals is SmartFresh.

With apples, a single exposure to MCP can temporarily render the fruit insensitive to ethylene. MCP delays the onset of the rise in ethylene production and similarly delays the rise in respiration, aroma production, and softening. A single postharvest application can prevent ripening for an extended period (greater than 30 days) at ambient (75F) temperature relative to non-treated controls. MCP also dramatically inhibits aroma production in apple and can reduce the incidence of a common disorder called superficial scald.

The response of apple fruit (and ethylene sensitive floral crops) to MCP depends upon a number of variables. These variables include application technique, the exposure environment, the storage environment (if different from the exposure environment), cultivar sensitivity, and the physiological status of the crop. Control of these variables will be needed to achieve a consistent response from MCP, regardless of the crops being treated.

Response variables
Application technique refers to the concentration, duration and frequency of application. MCP concentrations required to saturate binding sites, and the extent and longevity of MCP action, are influenced greatly by species, organ, tissue, and mode of ethylene biosynthesis induction. A "time x concentration" effect is apparent, and the longer the exposure, the lower the required concentration.

Although MCP binding is thought to be essentially irreversible, inhibition of ethylene action may be overcome by the production of new receptor sites. For apple, it appears that the concentration of MCP needed to be effective is between 0.25 and 1 ppm in the airspace around the fruit. The time needed for effective treatment appears to be relatively short and is between 12 and 16 hours at 32-68F. It is thought that the treatment time needed to achieve maximum benefits decreases as treatment temperature increases.

Repeated treatment of apple fruit with MCP can improve the effectiveness of the material, especially at elevated temperatures. A weekly application of MCP prevented the softening of 'Redchief Delicious' apple fruit for over 120 days at 68F. However, decay, while reduced relative to untreated fruit, is not inhibited by MCP and can be a significant problem for fruit held at elevated temperatures.
The physiological status of the apple fruit is affected by a number of environmental, chemical and physiological factors. It appears that apple fruit tend to respond best when they are treated early in the ripening process in much the same way that less mature fruit tend to respond more favorably to controlled atmosphere storage (CA) application relative to more mature fruit. There is some evidence to suggest that the elevated levels of ethylene found during ripening in some fruit varieties, such as ‘McIntosh’, may be sufficient to reduce the effectiveness of MCP. Therefore, those factors that enable treatment of the fruit with MCP at an earlier stage of development should improve or enhance the response of the fruit.

If fruit are held in storage for a period prior to application of MCP, the effectiveness of the gas declines. This is likely due to the fact that the fruit are at a relatively advanced stage of ripening at the time of MCP application. However, depending on variety, fruit may still respond to MCP even after several months if they are maintained in a relatively young condition by CA storage.

The storage environment influences the physiology of the apple fruit and so too affects the response to MCP. As temperature increases, the duration of the effectiveness of a single pre-storage application of MCP declines. Ripening is delayed by roughly 30 to 40 days at room temperature, but the delay in ripening can be more than 100 to 200 days at 32F.

Physiological disorders of apple fruit (superficial scald, soft scald, coreflush, greasiness, and senescent breakdown) can be reduced by MCP application. MCP application has also been associated with the development of some forms of superficial lesions or disorders occasionally on some apple fruit cultivars. One concern is reports of increased susceptibility of MCP-treated fruit to carbon dioxide injury.

Beneficial or detrimental effects of MCP presumably depend on whether ethylene production, and associated ripening and senescence, is required for disorder development, e.g. scald and senescent breakdown, or whether normal ripening is required to prevent disorder development.

Factors to Consider Prior to Use
Ethylene is a natural hormone for the plant and, like other hormones, is required for, or participates in, a number of physiological processes. Apart from inducing ripening-related changes in flavor and texture in climacteric crops such as apple, ethylene is known to play a role in pigment formation, chlorophyll degradation, decay resistance, leaf/flower abscission, phenolic metabolism, and other processes in many tissues.

While some aspects of ripening are nearly completely arrested by timely MCP application, others not under complete control of ethylene may continue to change. The effect of MCP on ripening parameters such as starch degradation, sugar accumulation, and preservation of titratable acidity, is not as dramatic as its effect on firmness. This may have important implications on fruit quality. In the case of apple, acidity contributes a significant portion of taste quality. It is therefore possible that MCP treated fruit, despite their firmness, may not maintain the tartness (taste) typical of some cultivars after extended storage.

The impact of MCP on aroma has been measured. The compound induces a profound reduction in aroma production at concentrations greater than 1 ppm. Application of MCP immediately after harvest delays the recovery of the capacity to produce aromas. ‘Jonagold’ and ‘Red Delicious’ fruit treated with MCP after harvest required almost two months at room temperature to develop a
normal complement of aromas, whereas non-treated fruit required only about a week. The time to recovery of volatile production declined as the duration of refrigerated storage increased. MCP-treated fruit were producing low amounts of aromas immediately after removal from refrigerated storage after 5 to 6 months storage.

Decay has not been shown to increase in response to MCP, but when MCP-treated fruit are held at elevated temperature, an unacceptable level of decay can result. While there is no published literature that suggests that apple fruit in particular may be more susceptible to decay in response to the suppression of ethylene action by MCP, other plant species have exhibited increased susceptibility to some disease and decay causing pathogens. Some caution with regard to decay prevention is probably warranted even at the low temperatures of typical air or CA storage.

The advent of MCP as a commercial tool has tremendous potential to help fruit (and floral) industries maintain fruit (flower/plant) quality. However, the effects of MCP described thus far indicate that much remains to be learned before commercial success can be realized.
Risk Management for Specialty Crops in Michigan

Chris Shellenbarger, Agent for Spartan Insurance
11769 Bell Rd, Clarksville, MI  48815
tel: 616 693-3247 or email: cshell58@hotmail.com

The Agricultural Risk Protection Act (ARPA) of 2000 was signed into law by the President on June 20, 2000. This legislation allocated funds to reform the Federal crop insurance program to better serve the needs of all farmers. This includes, but is not limited to, producer education for risk management, and development of new programs for uninsured commodities.

Insurance for specialty crops has been limited to the NAP program and ad hoc disaster program payments. Although the NAP program has been improved to cover losses on an individual basis, the limitations still allow for only a catastrophic loss. And ad hoc disaster program payments are certainly not something to count on when a producer is considering how to manage risk in their farm operation.

Why is there no crop insurance available for asparagus in Michigan? Development of policies depends first of all upon the demand for them. Producers can, and do, have an influence on when and how a policy is developed. In fact, ARPA allows for grower organizations and other groups to develop new policies. Information will be provided for attendees of this workshop on how to get involved in developing or expanding a risk management tool for carrot producers.

An alternative to traditional crop insurance, Adjusted Gross Revenue (AGR) is a whole farm revenue insurance policy available to producers in limited counties in Michigan. AGR insures for a combination of weather and price related losses. Average past income is used to determine the amount of insurance coverage for the farm operation. Details of AGR insurance will be presented in this workshop.
Fusarium and the Asparagus Miner
In recent years, Fusarium incidence has been increasing in newly-planted or one-year-old fields of Michigan asparagus. These fields have often been associated with high populations of asparagus miner. Asparagus miner, an Agromyzid fly, lays eggs in the lower stem of asparagus in the fern stage. Larvae mine stems and pupate within them. Larvae, eggs, adults, and pupae can harbor Fusarium with infested pupae serving as an overwintering inoculum source.

During the 2002 growing season, adult asparagus miner flies were monitored in nine asparagus fields, three in each of the following categories: 1 year old fields, 4 to 5 year old fields, 10 years or older fields. Beginning 21 May, 3x5” yellow Stiky Strips™ insect traps (Olson Products), were set out and changed weekly. Nine traps were placed at ground level to which four additional traps were added at canopy height after the last harvest when the asparagus was going into fern. One exception to this was that in one of the 1 year old fields that had sparse growth, only ground traps were used. Figure 1 shows the average number of adult flies captured each week averaged over the number of traps in each field.

Each week, beginning 2 July, 60 stems were labeled and examined for mining damage above ground. Figure 2 shows the weekly percentages averaged over the three fields in each maturity category. There was a high incidence of mining early in the season in the 1 year old fields and corresponds to an early lay-by date. The fields that were in fern longer had more mining than...
fields that were harvested later into the season. It is on these above ground mines that *Fusarium* readily produces spores that may move on air currents to nearby healthy asparagus and cause infection and disease.

**Table 1.** Location and number of puparia, either emerged in 2002 or intact for overwintering, collected from 60 stems within fields of differing maturity.

<table>
<thead>
<tr>
<th></th>
<th>1 year</th>
<th>4-5 years</th>
<th>10+ years</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Emerged above ground</strong></td>
<td>42</td>
<td>9</td>
<td>4</td>
</tr>
<tr>
<td><strong>Intact above ground</strong></td>
<td>3</td>
<td>13</td>
<td>7</td>
</tr>
<tr>
<td><strong>Total above ground</strong></td>
<td>45</td>
<td>23</td>
<td>11</td>
</tr>
<tr>
<td><strong>Emerged below ground</strong></td>
<td>151</td>
<td>95</td>
<td>108</td>
</tr>
<tr>
<td><strong>Intact below ground</strong></td>
<td>25</td>
<td>70</td>
<td>141</td>
</tr>
<tr>
<td><strong>Total below ground</strong></td>
<td>176</td>
<td>165</td>
<td>250</td>
</tr>
<tr>
<td><strong>Total Puparia</strong></td>
<td>222</td>
<td>188</td>
<td>261</td>
</tr>
</tbody>
</table>

At the end of the season, the 60 stems that had been examined throughout the season in each field were broken away from the crowns by pulling and brought back to the lab for extraction of asparagus miner puparia. Pupa is the form in which the insect overwinters, and the puparium is the rigid outer shell that covers the pupa (Fig. 3).

Puparia were removed from both above ground and below ground on the stems, and were crushed to determine whether the insect had already emerged in 2002, or if the pupae were intact for overwintering. Table 1 shows the average over the three fields within each age group of the number of puparia collected from 60 stems and whether they were found above or below ground on the stems. The average number of puparia found per stem was 3 to 4 across the maturity ranges, however the 1 year old fields had more emerged asparagus miners and less overwintering pupae than either the 4 to 5 year old or 10 years or older fields. This corresponds to the fact that the 1 year old fields were in fern longer than the others, and the young fields provide early season ovipositioning sites for the asparagus miner. While *Fusarium* was found in association with puparia in 2001, results from 2002 are not yet complete.

**Rust**

Rust is a problem on ferns following harvest with symptoms including red or brown elongated spots, within which spores are produced. Severe infections can stunt or kill young shoots, and can defoliate plants. Currently, there is not a disease prediction system for rust but timing the start of a spray program by scouting may be helpful. A rust scouting trial tested the effectiveness of a 14-day program of Folicur 3.6SC alternated with Bravo Weather Stik 6SC, initiated at different disease levels based on scouting (Fig. 4). Using a rating scale where 1=healthy fern, the spray program was initiated at stubble (prior to fern emergence), at a trace of disease, at fully expanded fern, and at
rust ratings of 1, 2, 3, 4. This trial showed the effectiveness of scouting as a means to monitor disease and reduce fungicide sprays. For instance, when a spray program is initiated at stubble, six applications are needed. Delaying the initiation of a spray program until the first trace of disease eliminated one spray. A further delay of initiating programs until disease progressed to a rating of 1 or 2 resulted in a further decrease in sprays without compromising disease control. Overall, a 50% reduction in fungicide use was demonstrated by this trial, using scouting to begin a spray program.
This research was supported in part by the USDA CSREES Crops at Risk project, “Seeking alternatives to B2 fungicides and carbamate insecticides for asparagus production;” and the National Foundation for IPM Education and Environmental Protection Agency Pesticide Environmental Stewardship Program project, “Promoting pest forecasting and scouting as standard management tools in Michigan asparagus.”
Choosing the Right Raspberry Varieties for your Market Needs

Eric Hanson, Department of Horticulture, Michigan State University

Several new raspberry varieties have renewed interest in commercial production. Raspberry varieties offer a wide array of fruit characteristics and harvest seasons. Some are better adapted to U-Pick marketing whereas others are suitable for packing and off-farm sales. Harvest seasons for summer fruiting varieties extend from late June to late July in southern Michigan. Some primocane-fruiting or fall-fruiting varieties begin in early August, almost overlapping the latest summer raspberries, and the fall season can extend well into October if freezing weather is late to arrive. With support from the Michigan State Horticulture Society Trust Fund, we have been able to test a number of raspberry varieties at the Southwest Michigan Research and Extension Center in Benton Harbor and on the MSU campus in East Lansing.

Heritage is the standard for comparison for fall-fruiting raspberries because it produces reliable yields of firm, flavorful fruit. Heritage is the most planted raspberry worldwide, and accounts for a third of Michigan's acreage. A limitation of Heritage is that it begins fruiting relatively late (late August in southern Michigan, mid-September in northern lower Michigan), so early cold weather can end the season before much fruit is picked. Heritage also has relatively small fruit. Useful alternatives or additions to Heritage are Autumn Bliss and Autumn Britten, primarily because they begin fruiting 2-3 weeks before Heritage. Both produce larger but somewhat softer berries than Heritage. In southern areas, Bliss and Britten can lengthen the market season. In the north, they can provide a reasonable crop before cold weather arrives. I think the most promising new fall variety is Caroline. Caroline is extremely productive, and produces larger berries than Heritage. It is also a few days earlier than Heritage, and may be a good choice in northern areas where Heritage struggles to produce a crop. Polana, a recent release from Poland, is interesting because it is as early as Bliss and Britten. Fruit have an intense flavor and bright glossy appearance, but yields, berry size and plant vigor have been disappointing in early trials.

Summer raspberries produce berries on two year-old canes in mid-summer. Because the canes need to survive the winter, hardiness is the most important qualification for use in Michigan. Some varieties produce exceptional fruit quality but are not hardy enough for Michigan. Summer raspberries have a more condensed harvest season than fall-fruiting types; there may only be 7-10 days difference between the first picking of early varieties and late varieties.

The standard summer varieties for southern Michigan have been Boyne, Canby, and Latham. Canby has the best fruit quality of these, although it is occasionally injured during the winter. Boyne and Latham are extremely hardy and reliable producers, although the berries are small. Boyne has an outstanding flavor. Choices for northern areas are limited by winter injury potential. Boyne and Latham are the best choices.
There are a number of promising newer varieties that can be suggested for trial. The two new varieties from New York, Prelude (early) and Encore (late) may provide season extension and reasonable yields. Both are reported to be hardy and may be useful in northern Michigan. Nova is a very hardy variety that produces very firm, attractive berries that likely would ship well. Unfortunately, Nova is lacking in flavor. K81-6 is a promising, hardy selection from Nova Scotia. In our Benton Harbor trial, it has been very productive, with large, attractive fruit, though they tend to be somewhat soft. Reveille is another very productive variety that is moderately hardy. Reveille may be useful in PYO operations because berries are large but too soft to pack.

### Fall-fruiting Raspberry Varieties for Michigan

<table>
<thead>
<tr>
<th>Warmer Areas</th>
<th>Colder Areas</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Recommended</strong></td>
<td><strong>Suggested for Trial</strong></td>
</tr>
<tr>
<td>Heritage</td>
<td>Caroline</td>
</tr>
<tr>
<td>Autumn Bliss</td>
<td>Autumn Britten</td>
</tr>
</tbody>
</table>

### Summer-fruiting Raspberry Varieties for Michigan

<table>
<thead>
<tr>
<th>Warmer Areas</th>
<th>Colder Areas</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Recommended</strong></td>
<td><strong>Suggested for Trial</strong></td>
</tr>
<tr>
<td>Canby</td>
<td>Prelude</td>
</tr>
<tr>
<td>Boyne</td>
<td>Encore</td>
</tr>
<tr>
<td>Reveille</td>
<td>Latham</td>
</tr>
<tr>
<td>K 81-6</td>
<td></td>
</tr>
<tr>
<td><strong>Recommended</strong></td>
<td><strong>Suggested for Trial</strong></td>
</tr>
<tr>
<td>Boyne</td>
<td>Nova</td>
</tr>
<tr>
<td>Latham</td>
<td>Prelude</td>
</tr>
<tr>
<td>Encore</td>
<td>Encore</td>
</tr>
</tbody>
</table>
New Ideas on Managing Weeds in Strawberries
Leslie Huffman, Weed Management Specialist (Horticultural Crops)
Ontario Ministry of Agriculture and Food, Harrow, Ontario

For some people, the future for successful weed management in strawberries lies in winning "The Search for the Perfect Herbicide". In Ontario, we have identified these times in the production system when our current weed management systems fail, both in the planting year (the first month especially broadleaf weed escapes, and weed escapes within the row, not touched by cultivation) and the harvesting year (problem weeds: groundsel, dwarf snapdragon, field pansy, oxalis, replacement for Dacthal, replace/improve Sinbar, and options for summer grasses).

We submitted applications for year of planting to our Minor Use Registration program for these 6 herbicides: Dual Magnum, Frontier, Prowl, Reflex, Blazer and Goal. In 2002 we have had some success:
• Dual Magnum is now registered PPI or PRE for the year of planting
• Goal 2XL is now registered for fully dormant strawberries

Our plans are to continue to try for Frontier, Reflex & Blazer for strawberries in the planting year, and to proceed with these 5 products for bearing strawberries.

In the United States, potential herbicides for strawberries are also being tested in the IR-4 program. In the future, we hope to share data between IR-4 and our Minor Use program to improve the registration process in both countries. We plan to continue our search for new strawberry herbicides, but in general are not optimistic about finding new herbicides for strawberries in either country.

What if we lose the Search for the Perfect Herbicide? We need to change the way we approach weeds in strawberries. We need to focus on how we can change our growing systems to give advantage to the strawberry crop instead of the weeds.

I would like to suggest some different ways to think about managing weeds, and to challenge you to think how these techniques might be applied in strawberries.

In the weed science world, these concepts are known as Integrated Weed Management or IWM. Similar to IPM (Integrated Pest Management) which is familiar to many fruit growers, IWM uses many methods of weed control, including cultural, biological, physical and chemical techniques, to manage weeds.

Remember that your goal in managing weeds is not a weed-free field from start to finish. Instead we need to focus on the true reason to control weeds: To maximize yields, by reducing weed competition during critical periods of crop development.

Consider how these ideas will fit into growing strawberries:
1. **Lower the weed pressure:** Prevention of weeds establishing in your fields from field edges is critical. Clean and wash cultivation equipment between fields. Be adamant about using weed-free mulch. Starting with a field free of perennial weeds and with low weed pressure will make the job much easier.
Planting a **green manure or cover crop** to prepare your site in the year before planting is strongly recommended to suppress annual weeds (and their seed production). Use a systemic herbicide with glyphosate in the preplant year to **eliminate perennial weeds**.

2. **Use planting and growing systems that discourages weeds:** Minimum tillage planting systems have been used in field crops to reduce weed problems as well as improve soil. Research trials in Ontario have shown over the last 2 years that strawberries can also be successfully established in either no-till or reduced-till systems.

   We know that the largest flushes of weeds are in the spring, right after planting. Maybe we could **plant later** to avoid this weed pressure, with **higher plant populations**, so the rows would still be full by the time fruit buds start initiating in late summer.

   In bearing fields, the use of chemical renovation can drastically reduce weed germination that is common after renovation with tillage.

3. **Apply fertilizer to the crop, not the weeds:** We should consider **banding fertilizer** applications to prevent weeds from using the fertilizers destined for the crop. Perhaps we should consider **fertigation** through drip systems.

4. **Use cover crops to suppress weeds:** Some growers have used living mulches to provide weed-free winter protection grown right where you need it. To make it work, we need to **rethink** how to establish living mulches, adjusting fertility and planting times, and how to integrate herbicide use to avoid injury. Also, **preplant cover crops** may be manipulated to give more weed suppression. Marvin Pritts at Cornell showed a reduction of weed biomass of 70% following a cover crop of marigolds, in addition to nematode control.

5. **Use mulch for weed control:** Perhaps we should focus more on the **weed suppression** we can get from our mulch dollars. Of course, ensuring that mulch does not bring weeds into a field is very important. Some growers have developed systems to **grow weed-free mulch** for their own use.

6. **Adapt new cultivation equipment to strawberries:** New cultivation equipment is being developed for vegetables that may be useful in strawberries, with some modifications. Researchers have been able to achieve economic weed control with various cultivators. At Cornell, complete weed control in strawberries was achieved in the planting year with 3 passes of the **brush hoe** + 2 hand weedings. More modifications may make cultivators even more useful in strawberries.

7. **Control weeds only during the most important times:** Marvin Pritts found that weeds need to be controlled for at least the first 2 months of the planting year, preferably until August, to maximize runnering and yield in the 2nd year. He also found that a planting kept weed-free in the planting year had almost no weeds the 2nd year due to thick crop growth. By the 3rd year, weeds were able to establish and reduce yields. So your best bet is to **focus your weed control dollars** before bloom, during runnering and in late summer as fruit buds begin to form.
8. **Identify the pest:** Above all else, we need to continue to learn about the weeds we have, make sure we identify them correctly and to observe weed behaviour. Be sure you know if your weeds are annuals or perennials.

**Integrated Weed Management** in strawberries will require new ways of thinking about growing berries. We need to think about how our berry growing techniques may be giving weeds a head start. Then we need to think about how to turn the tables, and give the advantage to our crop, not the weeds. It's a big challenge as we relook at growing strawberries profitably yet sustainably. We need to use all aspects of Integrated Weed Management to win the battle against weeds in berries.
Getting to Know the Multi-colored Asian Lady Beetle
Rufus Isaacs, Department of Entomology, Michigan State University – email: isaacsr@msu.edu

The multicolored asian ladybeetle was a significant pest at some raspberry farms in the Fall of 2001, but was almost absent from crop fields in the fall of 2002. This presentation will bring growers up to date with the latest research on this insect, and will explain the positive and negative aspects of its biology, so they are prepared if populations become significant again in the future.

The multi-colored Asian lady beetle is a beneficial insect that has become established throughout the eastern United States. Originally introduced to help manage tree fruit pests, it has become a nuisance for homeowners and for some agricultural crops. In recent years, it has caused problems for growers of fall-ripening fruit, who find the beetles on and in their fruit during harvest. However, this insect also helps fruit growers during the summer months when adults and larvae provide biological control of many soft-bodied insects, including aphids and leafhoppers. During the fall when the adult lady beetles begin to search for energy and sheltered sites for overwintering, fruit crops can provide both of these resources and large numbers of beetles can infest fall-ripening fruit. Raspberry, blackberry, grape, and peach are particularly affected.

Identification
As their name suggests, adult Asian lady beetles can take on many different color forms, varying from yellow to orange and red. Their spots may be dark on the wing covers or they may be faded or absent. Even the number and size of the spots varies.

The adult beetles are approximately a quarter-inch long, with a domed, round to oval shape. They are similar to many of the native species of lady beetles that do not cause homeowners or fruit growers problems. Native lady beetle species typically overwinter in sheltered sites outdoors and do not seek homes during the fall.

Immatures (larvae) are covered with tiny, flexible spines that do not sting. Their body is alligator-shaped and they can rapidly move over leaves and branches, where they eat aphids and other soft-bodied insects. Eggs are yellow, oval-shaped, and occur in clusters of about 20, usually on the undersides of leaves.

Damage
Fruit growers and MSU Extension agents first reported direct feeding damage by adult Asian lady beetles in Michigan during fall 2001. The greatest number of reports was from fall raspberries and on over-ripe grapes in the southern half of the Lower Peninsula, though the beetle is present through much of Michigan. Beetles can start this damage themselves, but they are most attracted to fruit that is already punctured. Either way, their presence is most unwelcome at harvest.

A more serious issue for growers selling fresh berries is the potential for contamination with adult Asian lady beetles. If berries are picked with beetles and then placed in cold storage, the beetles seem to move away from the cold, and this typically means that they burrow deeper into the berry. Once out on the fruit stand, beetles may warm up and fly out of the container, but they could also be bought and eaten.
When disturbed, the adults release a noxious yellow-orange liquid from their legs. This is called reflex bleeding and is meant to prevent birds and other predators from eating the beetle. The defense secretion is extremely bitter and unpleasant tasting with a strong odor. Preventing beetles from being harvested is important to avoid contamination that can lead to customer complaints and off-flavors in juice or wine. Learning more about the biology of the Asian lady beetle can help in understanding how to prevent their infestation into a fruit planting, and this is briefly reviewed below.

**Management**

Growers that find their fruit infested with a few adult beetles immediately before picking can instruct hand pickers to carefully avoid them. This may not be economically feasible on a large planting, however, and growers may have to resort to other tactics. Camphor and menthol have recently been shown to repel adult beetles, but their activity lasted for only a short time and no commercial formulations are yet available.

Ladybeetles are efficient predators of pest insects for the majority of the growing season, and most chemical controls for this introduced beetle will also kill native predators. If beetles reach pest levels in a fruit planting before harvest, insecticides applied for other near-harvest pests may allow growers to achieve insect-free fruit during harvest. Pesticides applied for control of other beetle pests such as Japanese beetle are likely to control Asian lady beetle infestations. The waiting period restrictions will vary by crop, so the labels should be checked carefully before any product is used near to harvest, to allow pickers to re-enter and harvest to proceed.

Pesticides should be applied only to infested areas to minimize chemical exposure and to avoid causing outbreaks of other plant-infesting pests because these products also kill beneficial insects. Many pesticides are labeled for use only by certified, licensed applicators that have received specialized training on the use and disposal of pesticides. These pesticides should not be applied by unlicensed homeowners, and at all times, their use should be in accordance with the label.

More information on the Asian Ladybeetle is available at this MSUE website address: [http://www.msue.msu.edu/ipm/asianladybeetle.htm](http://www.msue.msu.edu/ipm/asianladybeetle.htm)
Phytophthora Fruit Rot: Lessons Learned
M.K. Hausbeck (517-355-4534, hausbec1@msu.edu) and B.D. Cortright
Michigan State University, Department of Plant Pathology, E. Lansing, MI 48824

Phytophthora capsici caused serious fruit rots problems in many Michigan fields this season. Several field studies were conducted, and are detailed below. To summarize, fungicides can be helpful if they are applied early and frequently with excellent coverage of the fruit.

In 2001, a study was conducted at a cooperator’s farm on a sandy loam soil with a history of *P. capsici*. Plots were 2,640 ft. long with 9 rows per plot, 30 in. between rows and 3 in. between plants. Additional fungicide treatments were applied with a conventional boom sprayer, an air-assisted sprayer, or according to standard grower practices. The conventional sprayer had 8003 nozzles spaced 20 in. apart, operated at 50 psi and delivered 20 gal/A. The air-assisted sprayer had four Proptec nozzles spaced 64 in. apart, and delivered 10 gal/A. Sprays were applied on 8, 13, and 15 Aug. Two large samples of fruit were taken on 17 Aug from each treatment strip and stored four days in bins at ambient conditions. After four days of storage, 200 fruit per bin were evaluated for *P. capsici* infection on 21 Aug. All of the treatments were better in protecting the fruit than the grower standard. The grower relied on Ridomil Gold/Bravo, which was not very effective in this field because resistance to this product had developed.

Table 1. Evaluation of fungicides and sprayers to manage *P. capsici* blight on pickles (2001).

<table>
<thead>
<tr>
<th>Spray regime, treatment and rate/A</th>
<th>Numbers of fruit</th>
<th>% infected <em>Phytophthora</em></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><em>Phytophthora</em></td>
<td>Healthy</td>
</tr>
<tr>
<td>Air-assisted sprayer</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Acrobat 50WP 6.4 oz + Kocide 2000 54WG 1.5 lb ...</td>
<td>4.5</td>
<td>184.0</td>
</tr>
<tr>
<td>Acrobat 50WP 6.4 oz + Kocide 2000 54WG 1.5 lb + Ridomil Gold Bravo 76.5WP 2.0 lb ............</td>
<td>3.5</td>
<td>191.5</td>
</tr>
<tr>
<td>Conventional boom sprayer</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Acrobat 50WP 6.4 oz + Kocide 2000 54WG 1.5 lb ...</td>
<td>15.0</td>
<td>173.0</td>
</tr>
<tr>
<td>Acrobat 50WP 6.4 oz + Kocide 2000 54WG 1.5 lb + Ridomil Gold Bravo 76.5WP 2.0 lb ............</td>
<td>19.0</td>
<td>173.0</td>
</tr>
<tr>
<td>Grower standard</td>
<td>59.5</td>
<td>133.0</td>
</tr>
</tbody>
</table>

In 2002, several studies were conducted at a cooperator’s farm on a sandy loam soil with a history of *P. capsici*. In the first trial, plots were 900 ft. long with 9 rows per plot, 30 in. between rows and 3 in. between plants. Fungicide treatments were applied with a conventional boom sprayer or an air...
assisted sprayer. The conventional sprayer had 8003 nozzles spaced 20 in. apart, operated at 60 psi and delivered 30 gal/A. The air-assisted sprayer had four Proptec nozzles spaced 60 in. apart and delivered 10 gal/A. Sprays were applied on 20, 26, and 29 Aug. These application dates corresponded to fruit sizes of 1, 3 and 5 inches. Three large samples of fruit were taken on 31 Aug from each treatment strip and stored four days in bins at ambient conditions. During harvest the number of infected fruit that came across the transfer belt of the harvester were recorded for a pass of 3 rows by 900 ft (6,750 ft$^2$). After four days of storage, 200 fruit per bin were evaluated for $P. \text{capsici}$ infection on 3 Sep. The results of this trial clearly indicate the need for good fruit coverage when applying fungicide to control fruit rot. While the fungicides helped to limit disease compared to the untreated, the least amount of disease was observed when an air-assisted sprayer was used. This is probably due to the ability of the air-assisted sprayer to more effectively force the fungicide through the plant canopy to cover the fruit.

Table 2. Evaluation of fungicides and sprayers to manage $P. \text{capsici}$ blight on pickles (2002).

<table>
<thead>
<tr>
<th>Trial 1</th>
<th>Spray regime, treatment and rate/A</th>
<th>Numbers of fruit</th>
<th>% infected $P. \text{capsici}$</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>$Phytophthora$ infected at harvest$^\dagger$</td>
<td>$Phytophthora$ infected after storage</td>
</tr>
<tr>
<td>Air assisted sprayer</td>
<td>Acrobat 50WP 6.4 oz + Kocide 2000 54WG 1.5 lb</td>
<td>16.3 a$^{*}$</td>
<td>11.7 a</td>
</tr>
<tr>
<td>Conventional boom sprayer</td>
<td>Acrobat 50WP 6.4 oz + Kocide 2000 54WG 1.5 lb</td>
<td>89.3 b</td>
<td>55.0 bc</td>
</tr>
<tr>
<td></td>
<td>Gavel 80WG 2.0 lb + Kocide 2000 54WG 1.5 lb</td>
<td>70.0 ab</td>
<td>54.7 bc</td>
</tr>
<tr>
<td>Untreated</td>
<td>................................</td>
<td>178.0 c</td>
<td>74.7 c</td>
</tr>
</tbody>
</table>

$^\dagger$Number of infected fruit that came across the harvest belt over a 3 row x 800 ft plot.

$^*$Column means with a letter in common are not significantly different (Student-Newman-Keuls; $P=0.05$).

In a second trial, plots were 2,640 ft. long with 9 rows per plot, 30 in. between rows and 3 in. between plants. Each spray treatment was replicated three times in a randomized block design. Fungicide treatments were applied with a conventional boom sprayer equipped with Tee Jet 8002 XR nozzles spaced 20 in. apart, operating at 66 psi and delivering 20 gal/A. Sprays were applied on 18, 22, and 24 Jul. These application dates corresponded to fruit sizes of 1, 3 and 5 inch. Three large samples of fruit were taken on 30 Jul from each treatment strip and stored four days in bins at ambient conditions. After four days of storage, 200 fruit per bin were evaluated for $P. \text{capsici}$ infection on 3 Aug. Overall, disease in this trial was severe because the weather was very favorable for $P. \text{capsici}$. Both Gavel and Acrobat were effective in reducing disease compared to the untreated. Kocide 2000 (copper hydroxide) was mixed with each of these fungicides because previous studies suggest that adding copper may improve disease control.
Table 3. Evaluation of Acrobat and Gavel to manage *P. capsici* blight on pickles (2002).

<table>
<thead>
<tr>
<th>Spray regime, treatment and rate/A</th>
<th>Numbers of fruit</th>
<th>% infected Phytophthora</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Phytophthora infected</td>
<td>Healthy*</td>
</tr>
<tr>
<td>Acrobat 50WP 6.4 oz + Kocide 2000 54WG 1.5 lb . .</td>
<td>19.3 a&quot;</td>
<td>141.3 a</td>
</tr>
<tr>
<td>Gavel 80WG 2.0 lb + Kocide 2000 54WG 1.5 lb . . .</td>
<td>21.3 a</td>
<td>152.7 a</td>
</tr>
<tr>
<td>Grower Standard . . . . . . . . . . . . . . . . . . .</td>
<td>65.0 b</td>
<td>113.0 b</td>
</tr>
</tbody>
</table>

*Number of fruit without Phytophthora or Pythium infection.

"Column means with a letter in common are not significantly different (Student-Newman-Keuls; P=0.05).

In a third trial, plots were 900 ft. long with 9 rows per plot, 30 in. between rows and 3 in. between plants. Each spray treatment was replicated three times in a randomized block design. Fungicide treatments were applied with a conventional boom sprayer equipped with Tee Jet 8003 XR nozzles spaced 20 in. apart, operating at 60 psi and delivering 30 gal/A. Sprays were applied on 11, 15, and 20 Aug. These application dates corresponded to fruit sizes of 1, 3 and 5 inch. Three large samples of fruit were taken on 22 Aug from each treatment strip and stored four days in bins at ambient conditions. After four days of storage, 200 fruit per bin were evaluated for *P. capsici* infection on 26 Aug. Disease in this trial was somewhat less severe, and the fungicides were able to limit *P. capsici* fruit rot fairly effectively.

Table 4. Evaluation of Acrobat and Gavel to manage *P. capsici* blight on pickles (2002).

<table>
<thead>
<tr>
<th>Spray regime, treatment and rate/A</th>
<th>Numbers of fruit</th>
<th>% infected Phytophthora</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Phytophthora infected</td>
<td>Healthy*</td>
</tr>
<tr>
<td>Acrobat 50WP 6.4 oz + Kocide 2000 54WG 1.5 lb . .</td>
<td>11.0&quot;</td>
<td>168.3</td>
</tr>
<tr>
<td>Gavel 80WG 2.0 lb + Kocide 2000 54WG 1.5 lb . . .</td>
<td>1.7</td>
<td>193.0</td>
</tr>
<tr>
<td>Untreated . . . . . . . . . . . . . . . . . . . . . .</td>
<td>39.0</td>
<td>150.3</td>
</tr>
</tbody>
</table>

*Number of fruit without Phytophthora or Pythium infection.

"There were no significant differences among treatments (Student-Newman-Keuls; P=0.05).

This research was supported in part by the Pickle Seed Research Fund, Pickle Packers International, Inc.; and the Pickle and Pepper Research Committee for Michigan State University.
Weed Control Strategies for Pickles
Bernard Zandstra and Mathieu Ngouajio, Michigan State University

In a field experiment during the summer of 2002, cucumbers were treated with various preemergence and postemergence herbicides. Curbit is the primary herbicide used in pickle production. A popular tank mix is a combination of 2 pints of Curbit and 2/3 pint of Command 3ME per acre applied after seeding.

A new herbicide, Strategy, from UAP, contains a premix of ethalfluralin (Curbit) plus clomazone (Command 3ME). It may be applied preemergence at 2-5 pints/acre. It gives good control of most annual broadleaves and grasses.

Sandea has been used on cucumbers in Michigan for several years under a 24c label. It should have a full federal label for 2003. Sandea can be used most effectively postemergence to kill emerged broadleaves and yellow nutsedge. Always include nonionic surfactant in the spray mix. It is especially effective against pigweeds and yellow nutsedge, which neither Curbit or Command control well. It is somewhat weak on common lambsquarters, common purslane, and eastern black nightshade. It gives very poor grass control, so include Poast or Select in the postemergence application.

With these new labels, growers should be able to obtain good weed control under many conditions by using the appropriate products. Please see Extension Bulletin E433 for current recommendations.
Development of an Improved Pickup Head For Tractor-Mounted
(Wilde/Raven) Pickling Cucumber Harvesters

James R. Adkins, University of Delaware

The tractor mounted pickling cucumber harvester was developed in the late 1960’s by Bernie Wilde in cooperation with Michigan State University. This “pinch roll fruit separation” type machine was first produced in the early 1970’s by Wilde manufacturing and is currently produced by Raven. Despite approximately 30 years of machine production, few design changes have been made to the original harvester. These machines have been the predominant choice among Delmarva growers with approximately 25 machines spread among 14 growers.

The recent development of a new pickle harvester designs (FMC, Pik Rite) with significantly higher recovery rates prompted the development of a new vine pickup header with improved recovery for use with the Wilde/Raven machines.

Figure 1. The University of Delaware Modified Harvester & and Standard Wilde Machine

The original pickup attachment used a reel consisting of 4 rows of cam-operated pickup fingers in a 12 in diameter rotating finger guard (Fig. 2). The cam extended the pickup fingers from the guard at the bottom of the reel rotation. The fingers pull the cucumber plants around the reel 120 degrees at which point the vines were transferred to the draper belt and the pickup fingers retracted inside the guard. The vines were then transported rearward until they reached the pinch rollers.

A rod chain over fingered chain pickup attachment was developed for the Wilde/Raven tractor mounted pickle harvester (Figs. 1,3). The objectives of the proposed design changes were to simplify pickup head construction, maintenance and improve the recovery of pickles. The design consists of a rubber fingered rodded chain with rods spaced every 1.5 in. and staggered 2 in. long rubber fingers spaced 4 in. apart on every third rod. The fingered chain contacts the ground, picks up the
entire severed cucumber plant and conveys the plants to the separation rolls. A similar fingerless rodded chain was mounted 3 in. above the fingered chain to assist in pulling the vines into the machine. The chains counter rotate at the same speed, which may vary from 82 – 154 ft/min. depending on the harvester’s forward travel speed. The operating parameters were tested by varying the pickup belt speed (82 ft/min, 100 ft/min, 120 ft/min, 137 ft/min, and 154 ft/min) and the harvester travel speed (1.6 mph, 1.8 mph, 2.1 mph, 2.4 mph.) over 16 – 30 ft. plots. The harvester loss was then recovered by hand, weighed and graded for size. This process was replicated 3 times per day over 4 testing days. The trials displayed optimal recovery rates at 116 ft/min pickup belt speed at 1.8 mph machine travel speed.

Once the operating parameters were determined a comparison of the cam-operated pickup design and the fingered chain system was performed. Tests were conducted by harvesting 4 – 500 ft. plots with one head, weighing the harvested yield and hand recovering loss for each plot. The pickup attachments were then changed and the process was repeated. The initial comparisons (3 tests) between the original cam operated pickup reel header and the new chain over fingered chain header demonstrated a 10% improvement in recovery with the new system. In average yielding pickles, this may result in 20 bu/ac. increase in recovery or approximately 70 dollars per acre.

The data collected demonstrates a significant improvement in crop recovery with the fingered chain pickup attachment over the tradition cam finger design. These results present the potential for significant increases in grower profits through reduced maintenance costs and improved recovery.

For more information contact: James R. Adkins, University of Delaware Research & Ed. Center, 16684 County Seat Hwy, Georgetown, DE 19947, Phone: 302-856-7303, Email: adkins@udel.edu
What Makes A Quality Tomato Transplant

Dr. Richard L. Hassell
Clemson University CREC, Charleston, South Carolina

Often times we think we are getting excellent tomato transplants only to have them set idle or die once they are placed in the field. Looks are often very misleading especially when it comes to tomato transplants. Many years ago tomato transplants used to come up from the south as bare root plants, packed in wooded crates. When transplanted into the field it looked a lot like green sticks throughout a field. However, you very seldom lost a plant and new plant growth seemed to appear overnight. Yet when they arrived in the wooden crate you wouldn’t think they would grow at all by their appearance. If you can’t tell by looking at them then what is going on!!

The biggest difference in the two types of transplants is the amount of carbohydrate reserves in the plant. What this means is the ability of the plant to produce new roots once they are transplanted into the field. The speed to which the plant recovers (transplant shock) the higher quality the transplant. If conditions are ideal for transplanting in the field the less you will witness this. In this session we will discuss ways to build up carbohydrates within a tomato plant. These will include: growing time, cell size, watering schedule, and fertilizer rates. All of these factors play a major role in developing a quality tomato transplant.
Fresh Market Tomato Production Trends in North Carolina and Adjacent States
R.G. Gardner, Dept. of Horticultural Science
NCSU, MHCREC, 455 Research Drive, Fletcher, NC, 28732
Email: randy_gardner@ncsu.edu Phone: 828-684-3562

North Carolina growers produce approximately 2500 acres of staked, vine-ripe tomatoes each summer. Combined production in the adjacent mountain areas of eastern TN, northern GA and AL probably equals or exceeds that in NC. Although much of the production in NC is concentrated in the mountains of western North Carolina (late July - early October harvest), early season plantings for June - July harvest are important in piedmont and eastern North Carolina. Limited plantings are also made for late season harvest (September - October) in the piedmont and eastern areas.

Most growers produce their own transplants in greenhouses or have them grown locally in greenhouses on a custom basis. Cell size for transplants ranges from 1½" to 4", with the larger cells being used to produce very early tomatoes (June and early July) for a premium in the local market. Determinate varieties from the North Carolina breeding program, primarily 'Mountain Spring' for early season and 'Mountain Fresh' for mid and late season, are grown. During recent years, there has been significant production of 'Florida 47' and increasing production of 'Floralina.' The heat tolerant variety, 'Sun Leaper,' is being used for late season production in the piedmont and eastern areas. Limited production of cherry, yellow, and plum (Roma) types occurs throughout the state. Primary varieties are 'Mountain Belle,' 'Carolina Gold,' and 'Plum Dandy.'

Most growers fumigate their soil with methyl bromide/chloropicrin (MC-33) and use plastic-covered beds with drip irrigation. Between-row spacings are usually 5-6 feet with in-row spacings of 18-24 inches and stakes between every two plants. A one-time pruning is done when suckers are 4-6 inches long. Severity of pruning depends on variety and in-row spacing. For 'Mountain Spring' and 'Floralina,' 2-3 suckers are left below the first flower cluster and for more vigorous varieties, such as 'Mountain Fresh' and 'Sun Leaper,' one sucker is usually left below the first flower cluster.

Early blight is prevalent every year, and for the past 10 years late blight has been a problem. Most growers spray on a 5-day schedule for control of fungal diseases. Bacterial diseases (canker, speck, and spot) can occur, and growers use copper formulations in early season for control. Unless bacterial diseases are a problem, most growers stop copper sprays a week or two prior to first harvest because of the possible adverse effects of copper on fruit finish. Fusarium wilt race 3 is an increasing problem in the area, and growers with this disease are using the resistant hybrid 'Floralina.' Tomato spotted wilt virus has increased in severity in recent years and is becoming a significant problem in the area.

Almost all of the tomatoes produced in NC and northern GA and AL are harvested vine-ripe at the breaker to light pink color stages and are place packed in 2-layer 20-lb. boxes or in 25 lb. boxes. Eastern TN has a significant acreage of tomatoes produced for mature green harvest in addition to vine-ripe production. At one time, most of the tomatoes were packed in larger packing houses (co-ops or private packers doing custom packs). In recent years there has been a strong trend toward
growers packing their own fruit, either in small packing operations or doing field packs. This trend has occurred because of increases in packing charges coupled with competition of low-priced tomatoes (primarily from California and the Baja area of Mexico) in many seasons. Tomatoes are shipped throughout the eastern United States, with much fruit going to more northern areas before those areas have local fruit and to Florida during their summer off-season period. Growth of production is limited by lack of land for expansion in the mountains and by competition from other production areas of the United States and Mexico, which reduces profitability.
New and Upcoming Variety Releases from the North Carolina Tomato Breeding Program
R. G. Gardner, Dept. of Horticultural Science, North Carolina State University
Email: randy_gardner@ncsu.edu       Phone: 828-684-3562

Two new tomato varieties were approved for release from the NCSU tomato breeding program in 2002. 'Plum Crimson', a fresh-market plum (Roma type) hybrid with the crimson gene for improved fruit color and increased lycopene content was released to Harris Moran Seed Co. for exclusive seed production and sales, with first seed sales scheduled to be in time for the 2003 production season. 'Plum' Crimson has the I-3 gene for resistance to race 3 of fusarium wilt and has moderate resistance to early blight. Fruit are similar in shape to those of 'Plum Dandy' but are larger in fruit size. In four years of replicated trials at Fletcher, NC, 'Plum Crimson' was equivalent in marketable yield to 'Plum Dandy' and consistently exceeded 'Peto 882' and 'Puebla' in marketable yield, primarily as a result of its superior resistance to fruit cracking and weather check. 'Plum Crimson' sets fruit moderately well under high temperature conditions and is well suited to both vine-ripe and mature-green production. 'Mountain Crest', a large-fruited tomato hybrid with extended shelf life for vine ripe production, is in the process of being released to Sunseeds for exclusive seed production and sales. 'Mountain Crest' has the ripening inhibitor gene (rin) in heterozygous condition, which slows fruit ripening and softening. It is similar in maturity season to 'Mountain Spring' with slightly smaller fruit size than 'Mountain Spring' and 'Mountain Fresh'. 'Mountain Crest' exceeded 'Mountain Spring' in yields of U. S. Combination grade fruit in four years of replicated trials at Fletcher and was equivalent in yield to 'Mountain Fresh'. First seed sales for 'Mountain Crest' will likely be for the 2003 production season.

With the increasing incidence of tomato spotted wilt virus in North Carolina and surrounding production areas, development of resistant varieties has become a major focus of the breeding program. In 2002, numerous inbred tomato lines and experimental hybrids with the Sw-5 gene for resistance to TSWV were tested in NC and SC in research station plots and in grower trial plantings. In two trials conducted in coastal SC under severe disease pressure from TSWV, inbred lines and hybrids developed for resistance expressed a high level of resistance compared to heavy infection in susceptible varieties. In replicated yield trials in SC and at Fletcher, NC in 2002, several of the TSWV resistant hybrids performed as well and in some instances superior to standard varieties in yield, fruit size, and quality. Several of the most promising resistant hybrids are being increased for wide-scale grower trials in 2003.

Breeding continues toward combined resistance to early blight and late blight in tomato. We have been successful in incorporating the Ph-3 gene for late blight resistance into large-fruited, early blight resistant lines with good fruit quality and yield. We have identified a single gene for resistance to late blight in 'Richter's Wild Tomato' and are well advanced in backcrossing this gene into our best early blight resistant lines. Also, the Ph-2 gene, obtained from 'Legend', a recent release from Oregon State Univ., is being backcrossed into early blight resistant lines. Additional sources of late blight resistance are being evaluated with the idea that two or more genes will need to be incorporated into a variety to provide stable resistance. Research results from field studies in 2002 indicated that hybrids combining Ph-3 with Ph-2 or the Richter's source of resistance provided superior late blight resistance compared to the single gene resistances used alone.
New Products for Disease Control
M.K. Hausbeck (517-355-4534, hausbec1@msu.edu) and B.D. Cortright
Michigan State University, Department of Plant Pathology, E. Lansing, MI 48824

Several new products have recently been registered for disease control on tomato. Table 1 lists new products, industry standard, and products not currently registered that were included in MSU trials in 2002.

Table 1. Fungicides tested for control of tomato diseases at MSU in 2002.

<table>
<thead>
<tr>
<th>Product</th>
<th>Active ingredient</th>
<th>Company</th>
<th>Registered</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acrobat 40WP 6.4 oz</td>
<td>dimethomorph</td>
<td>BASF Corp</td>
<td>yes</td>
</tr>
<tr>
<td>AEC 67 65.4WG</td>
<td>~</td>
<td>duPont &amp; Co, Inc</td>
<td>no</td>
</tr>
<tr>
<td>Bravo Ultrex 82.5WDG</td>
<td>chlorothalonil</td>
<td>Syngenta Crop Protection</td>
<td>yes</td>
</tr>
<tr>
<td>Bravo Weather Stik 6SC</td>
<td>chlorothalonil</td>
<td>Syngenta Crop Protection</td>
<td>yes</td>
</tr>
<tr>
<td>Cabrio 20WG 1.0 lb</td>
<td>pyraclostrobin</td>
<td>BASF Ag Products</td>
<td>yes</td>
</tr>
<tr>
<td>Cuprofix Dispers MZ</td>
<td>copper sulfate</td>
<td>Cerexagri, Inc</td>
<td>yes</td>
</tr>
<tr>
<td>Dithane DF Rainshield 75DF</td>
<td>mancozeb</td>
<td>Dow Agrosciences LLC</td>
<td>yes</td>
</tr>
<tr>
<td>Equus 720 6SC</td>
<td>chlorothalonil</td>
<td>Griffin LLC</td>
<td>yes</td>
</tr>
<tr>
<td>Gavel 75DF</td>
<td>mancozeb</td>
<td>Dow Agrosciences LLC</td>
<td>yes</td>
</tr>
<tr>
<td>Kocide DF 61.4DF</td>
<td>copper hydroxide</td>
<td>Griffin LLC</td>
<td>yes</td>
</tr>
<tr>
<td>KQ 667 68.8WG</td>
<td>~</td>
<td>duPont &amp; Co, Inc</td>
<td>no</td>
</tr>
<tr>
<td>Manzate 200 75DF</td>
<td>mancozeb</td>
<td>Griffin LLC</td>
<td>yes</td>
</tr>
<tr>
<td>Previcur N 6SC</td>
<td>propamocarb HCl</td>
<td>Aventis CropScience</td>
<td>no</td>
</tr>
<tr>
<td>Quadris 2.08SC</td>
<td>azoxyystrobin</td>
<td>Syngenta Crop Protection</td>
<td>yes</td>
</tr>
<tr>
<td>Ranman 4SC 2.0 fl oz</td>
<td>~</td>
<td>ISK Bioscience</td>
<td>no</td>
</tr>
<tr>
<td>Reason 4.17SC</td>
<td>~</td>
<td>Aventis CropScience</td>
<td>no</td>
</tr>
<tr>
<td>Ridomil Gold Bravo 76.5WP</td>
<td>mefenoxam + chlorothalonil</td>
<td>Syngenta Crop Protection</td>
<td>yes</td>
</tr>
<tr>
<td>Scala 3.33SC</td>
<td>pyrimethanil</td>
<td>Aventis CropScience</td>
<td>no</td>
</tr>
</tbody>
</table>
**Trial 1.** Fungicides play an important role in managing foliar blights and fruit rots caused by fungi such as *Alternaria* (early blight) and *Colletotrichum* (anthracnose). Each year, my program tests products that are newly registered and those that are not yet registered, and compares them to industry standards to see if they control disease (see table 2). Not all products were equally effective in preventing fruit rot. Bravo Weather Stik has been considered a standard for fruit rot control, and was effective in this trial. Equus 6SC also performed well, and was comparable to Bravo Weather Stik 6SC. Other effective programs included rotating Bravo Weather Stik 6SC with a strobilurin fungicide such as Quadris 2.08SC or Cabrio 20WG. Both Quadris 2.08SC and Cabrio 20WG were recently registered for use on tomatoes. Manzate 200 75DF + Kocide DF 61.4DF are commonly used fungicides and were effective in limiting fruit rot in this study. Other fungicides that are not yet registered may have a fit in managing tomato diseases and will be tested further.

**Table 2.** Control of diseases of fresh market tomato ‘Mountain Spring’ with fungicides.

<table>
<thead>
<tr>
<th>Treatment and rate/A, applied at 7-day intervals</th>
<th>Trial 1</th>
<th>Foliar early blight*</th>
<th>Diseased fruit (5 plants) (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Untreated .................................................</td>
<td>6.0 c**</td>
<td>22.2 d ..................</td>
<td></td>
</tr>
<tr>
<td>Bravo Weather Stik 6SC 12.0 fl oz, apps. 1-3</td>
<td>1.5 ab</td>
<td>18.4 cd .................</td>
<td></td>
</tr>
<tr>
<td>Reason 4.17SC 5.4 fl oz + Scala 3.33SC 10.2 fl oz, apps. 4-8</td>
<td>2.5 b</td>
<td>18.3 cd .................</td>
<td></td>
</tr>
<tr>
<td>Bravo Weather Stik 6SC 12.0 fl oz, apps. 1-8</td>
<td>1.3 a</td>
<td>12.2 abc ...............</td>
<td></td>
</tr>
<tr>
<td>Reason 4.17SC 2.7 fl oz + Bond 4.0 fl oz, apps. 4-8</td>
<td>1.5 ab</td>
<td>9.9 a ..................</td>
<td></td>
</tr>
<tr>
<td>Bravo Weather Stik 6SC 1.5 pt, alternated</td>
<td>2.3 ab</td>
<td>10.7 ab .................</td>
<td></td>
</tr>
<tr>
<td>Quadris 2.08SC 6.2 fl oz ................................</td>
<td>1.8 ab</td>
<td>11.0 ab ..................</td>
<td></td>
</tr>
<tr>
<td>KQ 667 68.8WG 1.5 lb, alternated</td>
<td>1.3 a</td>
<td>11.0 ab ..................</td>
<td></td>
</tr>
<tr>
<td>Manzate 200 75DF 2.0 lb + Kocide DF 61.4DF 2.0 lb</td>
<td>1.5 ab</td>
<td>9.9 a ..................</td>
<td></td>
</tr>
<tr>
<td>AEC 67 65.4WG 3.0 lb, apps. 1-9</td>
<td>1.3 a</td>
<td>11.0 ab ..................</td>
<td></td>
</tr>
<tr>
<td>Manzate 200 75DF 2.0 lb + Kocide DF 61.4DF 2.0 lb, apps. 2,4,6,8</td>
<td>2.5 b</td>
<td>11.3 ab ..................</td>
<td></td>
</tr>
</tbody>
</table>

*Based on a visual estimation of percentage of foliage affected.
**Column means with a letter in common or with no letter are not significantly different (Fisher LSD; \(P=0.05\)).
Trial 2. In a second trial, fungicides were evaluated when early and late blights were present (Table 3). While late blight has not been a problem in Michigan, it has the potential to occur whenever the disease is a problem on potatoes. As new fungicides are registered for tomatoes and others identified as potential tools, it is important to determine their range of activity. The standard fungicides, including Bravo Weather Stik 6SC, Equus 720 6SC, Dithane DF Rainshield 75DF, and Ridomil Gold Bravo 76.5WP, were all effective in limiting both early and late blight. Newly registered products, including Acrobat 50WP (specific for late blight), Gavel 75DF, and Cabrio 20WG, performed well in this trial. Other products not yet registered also looked good and will be tested further.

Table 3. Chemical control of early and late blights of tomato ‘Peto 822.’

<table>
<thead>
<tr>
<th>Treatment and rate/A, applied at 7-day intervals</th>
<th>Trial 2</th>
<th>Foliar blight (%)</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Late blight</td>
<td>Early blight</td>
<td></td>
</tr>
<tr>
<td>Untreated .........................................</td>
<td>7.5</td>
<td>d</td>
<td>4.8</td>
<td>c</td>
</tr>
<tr>
<td>Cabrio 20WG 1.0 lb .................................</td>
<td>1.0 a</td>
<td>1.0 a</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cabrio 20WG 1.0 lb, alternated Acrobat 50WP 6.4 oz + Bravo Ultrex 82.5WDG 1.8 lb ....</td>
<td>1.8 abc</td>
<td>1.3 a</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dithane DF Rainshield 75DF 3.0 lb, apps. 1-3 Ranman 4SC 2.0 fl oz + Silwet L-77 2.0 fl oz, apps. 4-6</td>
<td>1.0 a</td>
<td>1.8 ab</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cabrio 20WG 12.0 oz, apps. 7-8 .....................</td>
<td>1.0 a</td>
<td>1.3 a</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cuprofix Disperss MZ 42DF 5.0 lb ...................</td>
<td>2.0 abc</td>
<td>1.3 a</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bravo Ultrex 82.5WDG 1.8 lb, alternated Ridomil Gold Bravo 76.5WP 2.0 lb ................</td>
<td>2.0 abc</td>
<td>1.8 ab</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dithane DF Rainshield 75DF 3.0 lb ..................</td>
<td>1.3 ab</td>
<td>1.3 a</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bravo Weather Stik 6SC 2.0 pt .....................</td>
<td>2.8 bc</td>
<td>2.0 ab</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Equus 720 6SC 2.0 pt ................................</td>
<td>3.0 c</td>
<td>2.8 b</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gavel 75DF 2.0 lb ..................................</td>
<td>2.3 abc</td>
<td>1.3 a</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Based on a rating of 1 to 10 where 1=0% to trace of disease to 10=complete defoliation and death.
**Column means with a letter in common or with no letter are not significantly different (Fisher LSD; P=0.05).

This research was supported in part by the GREEEN project (www.greeen.msu.edu), “Reducing Fruit Defects Affecting Fresh Market Tomatoes.”
Nutrition and Soil Management in High Density Apple Orchards
Denise Neilsen, Research Scientist Soil and Water Management – neilsend@agr.gc.ca
Gerry Neilsen, Research Scientist Soil Fertility and Plant Nutrition – neilsen@agr.gc.ca
Agriculture and Agri-Food Canada, Pacific Agri-Food Research Centre,
Summerland, British Columbia, Canada

Uptake of nutrients by trees is determined by the interception by the roots, the availability of nutrients in the soil, and tree demand. Apple trees have low rooting density compared with the weedy species and grasses with which they are interplanted and this is exacerbated for dwarfing rootstocks (Neilsen et al., 1997). Availability of nutrients is affected by native soil fertility, a function of soil mineralogy, degree of soil development and organic matter content and by inputs of fertilizer and organic amendments. The mobility of nutrients within the soil is a key factor in determining availability. Mobile nutrients, such as nitrogen and boron, are found predominantly dissolved in soil solution, and although they are readily delivered to tree roots, a major difficulty arises in retaining them in the root zone long enough for interception to occur. Immobile nutrients, such as phosphorus, potassium and zinc are less readily transported to the root and thus direct interception is required which may be limited in the restricted root zone of apple trees.

Management of mobile nutrients
Good management of mobile nutrients requires that supply is matched to demand, both in terms of amount, timing and retention in the root zone. In addition, flexibility in the timing of demand requires flexibility in the methods of nutrient delivery. Fertigation (injection of nutrients in irrigation water) allows such flexibility and also greater precision than broadcast fertilizer application (Neilsen et al., 1998). The results of a series of experiments receiving daily drip irrigation and fertigation of N will be discussed (Neilsen and Neilsen, 2002).

Size and timing of N demand – We have used a variety of measurements to determine the nitrogen demand of apple trees including whole tree excavation and partitioning, the use of isotopically labeled N fertilizer, and assessment of annual removal of fruit and leaves. At tree densities of 1330 trees/acre, total tree N content ranged from 0.08 to 0.7 oz/tree (7-59 lb/acre between planting and 4 years after planting. Based on removal in fruit and senescent leaves, nitrogen requirements for apple trees on M.9 rootstock ranged from 8-40 lb/acre over the first six years after planting.

Annual growth is supported by N remobilized from woody tissues in the spring and by root uptake. In several studies, we have demonstrated that leaf growth before bloom is supported mainly by remobilized N and that root uptake is negligible until remobilization has ended and rapid shoot growth has begun (around full bloom/petal fall). This potentially renders early spring, (pre-bloom) applications of N fertilizer ineffective, particularly if followed by heavy rain or irrigation.

Effect of timing of N supply on fruit quality – Studies with labeled N have indicated that large scale N inflow into apple fruit does not begin until after cell division has ended, about 4-5 weeks after full bloom. In a trial with Gala apple where N was fertigated daily for 0-4, 4-8 or 8-12 weeks
after full bloom, bloom, yield and fruit size were higher for early applications in one of three years. Fruit maturity (determined by starch index) was accelerated by late applications of N in 3 successive years, while soluble solids content and fruit acidity were increased in 2 of 3 years.

Efficiency of N fertilizer use - Timing of N applications to periods of high tree demand is crucial for improving efficiency of N fertilizer use. Retention of added N in the root zone is equally important. Nitrogen in the nitrate form is highly soluble and thus method of application and water management are primary factors in preventing losses beneath the tree roots. Soil solution monitoring has indicated that a single application of broadcast fertilizer followed by sprinkler irrigation (similar to heavy rainfall) results in rapid removal of N beneath the root zone. Similar N uptake occurs with smaller amounts of N applied more frequently through fertigation. In irrigated systems, scheduling irrigation to meet plant water requirements rather than applying at a uniform rate through the growing season can reduce water and N inputs and movement out of the root zone resulting in high N fertilizer use efficiency.

Boron - Boron like N is very soluble tending to move readily with irrigation or precipitation. This means that it can readily be leached from sandy soils reaching deficient levels in low organic soils with low B inputs. Since plant B requirements are very low and the range between deficiency and toxicity small, B can be successfully fertigated at low rates of 0.18g/tree. This offers an effective method of applying B in addition to the traditional methods of foliar sprays.

Management of immobile nutrients
Phosphorus, potassium and zinc are examples of important fruit tree nutrients that can have more limited solubility and availability in many orchard soils.

Phosphorus (P) - Effective application of P fertilizer in the Pacific Northwest has included mixing with the planting hole or dissolution and application directly with irrigation water (fertigation). Recent studies have indicated improved initial growth of newly planted apple trees following application of high rates of especially monammonium phosphate fertilizer in the planting hole, especially on fumigated, replanted orchard sites (Neilsen and Yorston, 1991). Fertigating P (as ammonium polyphosphate or even phosphoric acid) can improve the downward movement of P through the soil profile since P moves with the irrigation waters after saturation of reaction sites near the zone of P application. Phosphorus-fertigated trees also often exhibit increased yield on the first fruiting season. Usually P-fertigation is less effective for mature fruiting trees although recent research is investigating the benefits of application of a pulse of P annually within 4 weeks of bloom.

Potassium (K) - Potassium fertilizers can be applied to prevent the development of K-deficiency in fruit orchards. Broadcast surface applications of several K-fertilizer forms can improve K-nutrition, particularly in coarse-textured sandy soils which have limited ability to absorb K. The mobility of fertigated-K is well documented, even for soils with a high capacity to ‘fix’ K, reducing its plant availability (Uriu et al., 1980). Recently, fertigation of small amounts of K (as potassium chloride) were effective at preventing the development of K-deficiency which frequently develops after 3 years of drip-irrigating N-fertilized apple trees on sandy soils in the Pacific Northwest (Neilsen et al., 1998).

Zinc - Zinc is a common nutrient deficiency of tree fruits in western North America. Its availability from the soil is limited since a high proportion of soil-applied Zn is chemically absorbed by soil
particles. Research to improve its availability to fruit trees by fertigation has not been particularly successful. As a result, foliar application, often during the dormant period to avoid toxicity to fruit, remains the standard method of application. Unfortunately foliar applications seem to have little residual effect and must be reapplied annually.

**Literature Cited**


Controlling Flowering and Cropping of Apple Trees with Growth Regulators

Martin J. Bukovac, Department of Horticulture
Michigan State University, East Lansing, MI 48824

Introduction
The regulation of flowering and fruiting in apples is essential to promote annual production of quality fruit. The failure to regulate these processes, within some acceptable range, leads to under or over cropping, often in both cases to production of poor quality fruit, and a long-term problem of alternate bearing. To manually control flowering and fruiting is labor intensive and may not be effective. With the discovery of native and synthetic plant growth regulators, a number of compounds are now available that can effectively modify the flowering and fruiting processes.

The objective of my presentation is to present an overview of selected plant growth regulators that can be used, and to stress factors that may affect their response. In this brief presentation it will not be possible to give detailed recommendations thus any suggestion of rates or timing by necessity will be of a general nature. For specific suggestions for your conditions, please contact your local extension representative.

Spray Application is Critical
The optimum response from a plant growth regulator is obtained only when the desired dose is delivered and deposited uniformly over the tree. This requires detailed attention not only to accurately preparing the growth regulator spray solution or tank mix, but also to the application equipment to ensure uniform and adequate coverage of the target. In addition, the plant response and consistency to a given plant growth regulator dose may be affected by the condition of the plant, stage of development and environmental factors at time of and immediately after spray application. Trees under stress, or suffering from a physiological or biotic problem, and environmental factors, primarily temperature and relative humidity, may increase or decrease the response to a given dose. Care must be taken to deliver the appropriate dose uniformly to the tree at the appropriate time for optimum results.

Excessive Fruiting in Young Trees
Excessive early cropping of newly planted trees (1 to 3-yr-old) may markedly reduce vegetative development and delay the establishment of a new orchard. This may be the case for cultivars on dwarfing or semi-dwarfing rootstocks planted on light soils. There are two options available for minimizing this problem.

6. Trees of a number of apple cultivars (esp. McIntosh, Jonagold, Gala, Jonathan) can be partially or completely defruited by applying NAA (15-20 ppm) and carbaryl (0.5 - 1.0 pound per 100 gal) soon after petal fall. The addition of an efficient surfactant (about 1 pt / 100 gal) generally improves the response.

7. Gibberellin (200-400 ppm) applied at 4 - 6 weeks after full bloom effectively inhibits flower initiation thus reducing bloom density the following spring. Gibberellin A4+7 is more effective than gibberellin A3.

Fruit Thinning
The merits of fruit thinning on improving the quality of the remaining fruit and on increasing return bloom are well documented. Several chemical options for post bloom thinning are available, but none are fully effective on all cultivars and often lack consistency.

**NAA** - NAA continues to be the most widely used chemical in Michigan. It is most frequently applied at a concentration of 7.5 - 15 ppm, and at 9 - 12 mm king fruit diameter. The optimum concentration varies with cultivar, fruit set, tree condition and environmental conditions near application time. Caution - NAA should not be used in combination with Accel on 'Delicious'. This combination may cause increased fruit set and production of small (< 2") fruit. Similarly, early application of NAA following Promalin may also reduce fruit size and increase the number of "pygmy" fruit on 'Delicious'.

**Carbaryl** - Carbaryl (0.25 - 1 pound / 100 gal) is generally not a sufficiently aggressive or consistent fruit thinning agent when used alone. Increasing concentration is not an effective option, since the concentration response curve is relatively flat. However, carbaryl is frequently combined with NAA or Accel to enhance their effectiveness. Carbaryl is also used in desperation as a late application when the response to NAA or Accel has been less than desired.

**Accel** - Extensive studies have shown that Accel induces fruit abscission, particularly at high rates. Generally when used alone it fails to remove sufficient fruit, but fruit size for a given crop load is increased and is consistently greater than with NAA or carbaryl. Thus, Accel merits consideration as a "fruit size enhancer", particularly on small fruited cultivars. If these results can be confirmed, this approach may be the basis for developing a useful cultural practice.

**Other Potential Practices**

**Gibberellin A4+7** - Some cultivars (e.g. 'Gala,' and 'Jonathan') initiate excessive numbers of flowers on 1-yr-old shoots. This results in a prolonged bloom (by 4-7 d) in the spring increasing exposure to fire blight infection, and in the production of smaller, poorer quality and later maturing fruit than on spurs. In general, this is considered undesirable and in some fruit growing areas these fruits are often removed by hand. Our current studies show promise in selectively inhibiting flowering on 1-yr-old shoots with gibberellin A4+7. We believe that with appropriate timing and concentration it may be possible to selectively suppress lateral flowering (1-yr-old shoots) with only a minimal effect on flowering on spurs.

**Ethephon** - There is considerable evidence that foliar applications of ethephon can promote flowering in a number of plants. Some cultivars of apple that fail to come into flowering for an extended period after planting can be induced to flower with repeated applications of ethephon. We have been able to demonstrate that 1 - 3 applications of ethephon applied at 3 - 6 weeks after full bloom at about 250 ppm in the "on-year" of Delicious increased return bloom the following spring when the trees were in the "off-year". These flowers were functional and the trees set significantly more fruit than controls. This added cropping in the "off-year" resulted in fewer flowers and fruit in the following "on-year" and the trees required less thinning. We are now in the third cycle of a long term study and are hopeful that these findings will provide the basis for minimizing the alternate bearing problem.
New Marketing Concepts to Commercialize Unknown (Resistant) Apple Varieties Successfully
Franco P. Weibel, Research Institute of Organic Agriculture (FiBL)
CH-5070 Frick, Switzerland
franco.weibel@fibl.ch – http://www.fibl.ch

Introduction
Despite the undisputed advantages of disease resistant cultivars for organic apple production, producers are faced with the problem that both retailers and consumers have limited knowledge of their eating, cooking and keeping qualities, not to mention the ecological advantages, of these cultivars. Additionally, the trend in the apple market towards globalization, with a limited number of globally-traded cultivars strongly counteracts efforts to introduce additional cultivars in generally small quantities. Currently-available disease-resistant cultivars are very short-lived as constantly new cultivars with improved eating, cooking and production characteristics are being bred and put on the market. In order to utilize the advantages of disease-resistant cultivars despite the difficult conditions prevailing in the marketplace, new marketing concepts have to be devised for them.

Grouping apple cultivars into "Archetypes" and "Flavour Groups"
The extensive and short-lived range of cultivars on offer provides a complexity of new information that both producers and the market are seeking to resolve. Our concept of consolidating and thus simplifying this complexity is to sort the cultivars into a few, defined groups (Table 1): at the retail level the groups are "Archetypes" which are then further simplified as "Flavour Groups" at the consumer level (Weibel, 1995; Weibel and Grab, 2000). The definition of the "Archetypes" is based on the flavour and appearance of well-known commercially important cultivars. For example, the "Golden archetype" combines all yellow, large, smooth-skinned, mild to sweet tasting cultivars. Grouping into flavour groups then combines the archetypes "Golden", "Jonagold" and "Idared" in the flavour group "Mild to Sweet". The "Cox archetype" and "Gravenstein archetype" are described as "spicy, slightly acidic" and finally the cultivars in the "Boskoop archetype" are grouped as "predominantly acidic, spicy". The cultivar name is of course stated at each level but the information on flavour becomes predominant. From the pomological point of view, for sure, there are borderline cases in this classification and they may have to be revised in step with experience. However, the main goal is to guide the apple buyer towards the apple of his or her preferred taste without having him or her irritated (and thus hesitating to buy) by new variety names.

The grouping of cultivars into archetypes and flavour groups gives the producer the necessary freedom to be flexible in choosing a suitable range of cultivars and therefore also to be consistent in his or her environmental efforts. Not only new disease-resistant cultivars but also old or local varieties, that may be attractive for the buyers for some of their characteristics, can be re-introduced to the market. It further creates a simple basis for communication with wholesalers or retailers. These in turn gain greater flexibility in selecting a range of cultivars that meet their customers' needs and in communicating effectively the cultivars' characteristics down the distribution chain (intermediaries, consumers). We consider it as essential for the success of the concept that all links of the chain gain an advantage from it.
Successful introduction
In Switzerland the "Flavour Group Concept", as conceived by FiBL, has been introduced by the supermarket chain "COOP" in 1996. An internal evaluation at COOP in 2000 showed that the concept was considered to be successful and that retailers prefer to work with the Flavour Groups directly (Weibel and Graf, 2000; since then we use Archetypes for training purposes, only). In 2001 COOP decided to apply the concept not only for organic but for conventional apples. In 2002 also the biggest supermarket chain in Switzerland, MIGROS, has introduced the Flavour Group Concept for apples (organic and conventional), however, with only two flavour groups ("sweet" and "tart"). Another sign of the concept's success is that it is applied also in the Netherlands and its introduction is currently evaluated for Northern Germany (Niederrheinbege). The future
In a certain way, the Flavour Group Concept is the opposite extreme to the increasing tendency where new cultivars are propagated by Variety Clubs. The Flavour Group Concept does not have the advantages that the production quantity and quality of a certain variety can be (in theory!) completely controlled. However, for sure, it is much cheaper and allows much more flexibility for all links of the fruit chain - advantages that may be trump cards for the future of eco-oriented apple production.

**Figure 1**: Simplifying cultivar information over the chain by grouping cultivars into Archetypes and Flavour Groups*
Table 1: Grouping of apple cultivars into six archetypes and three flavour groups * Current status in Switzerland on basis of organic cultivar testing, grower and marketing experiences

<table>
<thead>
<tr>
<th>Archetype (AT)</th>
<th>Definition</th>
<th>Cultivars suited to organic production*, (in order of ripening; underlined = scab resistant)</th>
<th>Additional cultivars</th>
<th>Flavour Group (Colour and text on packing label)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Golden AT</td>
<td>Yellow, big, smooth skin, low in acidity, predominantly sweet</td>
<td>Resista, Delbard Jubilé, Golden Orange, (Goldrush)</td>
<td>Golden Delicious, Maigold</td>
<td>YELLOW «mild to sweet»</td>
</tr>
<tr>
<td>Jonagold AT</td>
<td>Like &quot;Golden AT&quot;, but red</td>
<td>Rubinola, Delorina, Pinova</td>
<td>Delbard Estival, Gala, Arlet, Jonagold, Maigold, Braeburn, Fuji, Pink Lady</td>
<td></td>
</tr>
<tr>
<td>Idared AT</td>
<td>Medium sized to big, smooth skin, mild, taste-balanced in sugar and acidity</td>
<td>Ariva, Rajka, Santana, Idared, Florina</td>
<td>Saturn, Fiesta, McIntosh, Spartan, Berner Rosen, Rosana, Jonathan, Empire, Gloster</td>
<td></td>
</tr>
<tr>
<td>Cox AT</td>
<td>Medium sized to small, rustic appearance, spicy-aromatic, slightly acidic</td>
<td>Alkmene, Discovery, Kidd’s Orange, Resi, Topaz</td>
<td>Liberty, Berlepsch, Cox's Orange Pippin, Kanada Reinette, Elstar, Rubinette</td>
<td>RED «spicy, slightly acidic»</td>
</tr>
<tr>
<td>Gravenstein AT</td>
<td>Early, for fresh eating, juicy, crunchy, slightly acidic</td>
<td>Julia, Retina, Primerouge</td>
<td>Klarapfel, Vista Bella, Jerseymac, Summerred, Gravenstein, J. Grieve, Reglindis, Granny Smith</td>
<td></td>
</tr>
<tr>
<td>Boskoop AT</td>
<td>Pronounced acidity, also for cooking and baking</td>
<td>Boskoop, Otava, Ecolette</td>
<td>Iduna, Rewena Glockenapfel</td>
<td>GREEN «predominantly acidic, spicy»</td>
</tr>
</tbody>
</table>
Improving the Performance of Blossom Thinners (Trust Report)
Jim Flore and Abed Janoudi, Horticulture Department, Michigan State University

The mode of action of blossom thinners and their effectiveness will be reviewed. A major problem with blossom thinners is poor performance. Herein we report on studies that describe the nature of erratic results, and possible solutions that may decrease this variability.

Influence of washing on blossom thinning by ATS in JonaGoRed apples.
Ammonium thiosulfate was applied at concentrations of 5% and 10% to JonaGoRed apple trees at 80% of full bloom (May 15, 2002). ATS-treated trees were then either not washed or washed at 1, 2 or 4 hours following treatment using a power sprayer that delivered approximately 2 gallons of water in 30 seconds. The quantity of water used in washing the trees was sufficient to thoroughly rinse the leaves. Untreated control trees were washed with water only. In a second experiment, JonaGoRed apple trees were treated during the petal fall stage (May 21, 2002) using ATS at a concentration of 5%. Washing of trees was performed as in the first experiment.

Experiment 1: ATS, applied at 80% of full bloom, reduced the number of fruit set by 67 to 100% (Table 2). Washing had no significant effect on ATS activity, with fruit set percentages being similar in the various washing treatments. No fruit were set when ATS was applied at 10% and the trees were not washed, and only 0.2-0.4% of the flowers developed into fruits when trees were washed following the 10% ATS application. In comparison, 4% of flowers set fruit in the untreated control trees. The 10% ATS treatment also caused severe leaf burning and desiccation of branches. Trees treated with ATS at 5% also exhibited leaf burning and some desiccation, although the trees mostly recovered from this damage by the end of the season.

Table 2. Blossom thinning in JonaGoRed apples using ammonium thiosulfate at 80% bloom.

<table>
<thead>
<tr>
<th>ATS conc.</th>
<th>Time to wash</th>
<th>Percent fruit set</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>N.A.</td>
<td>4.0 a</td>
</tr>
<tr>
<td>5 %</td>
<td>1 h</td>
<td>0.8 bc</td>
</tr>
<tr>
<td>5 %</td>
<td>2 h</td>
<td>1.0 bc</td>
</tr>
<tr>
<td>5 %</td>
<td>4 h</td>
<td>1.3 b</td>
</tr>
<tr>
<td>5 %</td>
<td>No wash</td>
<td>0.2 cd</td>
</tr>
<tr>
<td>10 %</td>
<td>1 h</td>
<td>0.2 cd</td>
</tr>
<tr>
<td>10 %</td>
<td>2 h</td>
<td>0.4 cd</td>
</tr>
<tr>
<td>10 %</td>
<td>4 h</td>
<td>0.2 cd</td>
</tr>
<tr>
<td>10 %</td>
<td>No wash</td>
<td>0.0 d</td>
</tr>
</tbody>
</table>

a. Trees were washed with water at the times indicated following the application of ATS.
b. Flowers were counted at the time of ATS application on two branches per tree; the number of fruits on the same branches was counted 8 weeks later.
c. N.A. Not applicable. Control trees were not treated with ATS and were not washed.
**Experiment 2:** When ATS was applied at a concentration of 5% at petal fall, washing had a significant effect on the blossom thinning activity of ATS. In ATS-treated trees that were washed one or two hours following the ATS treatment, the percentage of flowers that set fruit was significantly higher than that observed in trees that were not washed (Table 3). All ATS-treatment resulted in significantly lower fruit set percentages, ranging between 0.2 and 2.4%, as compared to the untreated control where fruit set reached 7.4%.

**Table 3.** Blossom thinning in JonaGoRed apples using ammonium thiosulfate at petal fall.

<table>
<thead>
<tr>
<th>ATS conc.</th>
<th>Time to wash</th>
<th>Percent fruit set</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>N.A.</td>
<td>7.4 a</td>
</tr>
<tr>
<td>5%</td>
<td>1 h</td>
<td>2.4 b</td>
</tr>
<tr>
<td>5%</td>
<td>2 h</td>
<td>1.3 bc</td>
</tr>
<tr>
<td>5%</td>
<td>4 h</td>
<td>0.9 cd</td>
</tr>
<tr>
<td>5%</td>
<td>No wash</td>
<td>0.2 d</td>
</tr>
</tbody>
</table>

- a. Trees were washed with water at the times indicated following the application of ATS.
- b. Flowers were counted at the time of ATS application on two branches per tree; the number of fruits on the same branches was counted 8 weeks later.
- c. N.A. Not applicable. Control trees were not treated with ATS and were not washed.

**Influence of washing on the level of ATS-induced damage in Manchurian Crabapple**

Aqueous solutions of ATS at concentrations of 1, 2, 5 and 10% were applied to crabapple trees at 80% of full bloom stage. ATS-treated trees were then either not washed or washed at 30, 60, 120 or 240 minutes after the application of ATS. A hand-held sprayer was used to wash the trees at a rate of 400 ml of water per tree.

**Results:** There was a significant interaction between ATS concentration and the washing interval (time between ATS application and washing) for all parameters of damage assessment Table 1). Washing reduced the level of damage to open flowers that were treated with a 1% solution of ATS. The percentage of open flowers damaged by ATS at concentrations of 2% to 10% was not affected by washing, with 95% to 100% of the flowers being damaged by ATS. ATS applied at concentrations of 1 to 5% caused little damage to flowers that were closed at the time of treatment and washing had no significant effect on the level of flower damage at these concentrations. When ATS was applied at a concentration of 10%, washing significantly lowered the level of damage to the closed flowers. The 30 min. post-treatment wash decreased the incidence of damage in closed flowers to levels comparable to those observed in the 1% ATS treatment. Almost half of the closed flowers were damaged in unwashed trees treated with 10% ATS, as compared to only 7% flower damage in the 30 min. wash treatment. In the 2% and 5% ATS treatments, washing decreased leaf damage by 66 to 85% as compared to the damage observed in the unwashed trees. ATS at 1% damaged less than 1% of leaves in unwashed trees, which was not significantly different from the damage level in the washed trees. Washing had no significant effect on leaf damage when ATS was applied at a concentration of 10%. Trees treated with 10% ATS and then washed 30 min. later had 60% leaf damage, which was similar to the damage observed in the unwashed trees treated with 5% ATS. Most of the trees that were treated with 10% ATS eventually died as a result of the severe desiccation of leaves and branches.
Table 1. Influence of washing \(^z\) at various intervals on ATS damage in Manchurian Crabapple.

<table>
<thead>
<tr>
<th>ATS concentration</th>
<th>Damaged open flowers</th>
<th>Damaged closed flowers</th>
<th>Damaged leaves</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 %</td>
<td>***</td>
<td>N.S.</td>
<td>N.S.</td>
</tr>
<tr>
<td>2 %</td>
<td>N.S.</td>
<td>N.S.</td>
<td>***</td>
</tr>
<tr>
<td>5 %</td>
<td>N.S.</td>
<td>N.S.</td>
<td>***</td>
</tr>
<tr>
<td>10 %</td>
<td>N.S.</td>
<td>**</td>
<td>N.S.</td>
</tr>
</tbody>
</table>

\(^z\). Crabapple trees were treated with ATS at the indicated concentration at 80% of full bloom, and then were spray-washed with water 30, 60 or 120 min after the ATS treatment. Control trees were not washed.

\(^y\). There were significant ATS*Washing interval interactions for the damage parameters measured. Thus, an analysis of the simple main effects was performed using the slicing procedure in the SAS\(^®\) statistical analysis software. **: significant at the 2% level; ***: significant at the 1% level.

Effect of the ethylene inhibitor AVG (Retain\(^®\)) on ATS damage to flowers and leaves in crabapple

Two experiments were conducted to investigate the possibility that ATS thinning activity was related to increased production of ethylene in the tree. AVG, a potent inhibitor of ethylene production in plants, was applied to trees shortly after treatment with ATS. AVG had no effect on the level of damage to flowers and leaves that was caused by ATS application. Therefore, it appears unlikely that the thinning activity of ATS is a consequence of the production of ethylene.

Conclusions

1. The thinning activity of ATS is a consequence of its action as a caustic agent that destroys floral tissue. Ethylene does not appear to have a major role in the blossom thinning action of ATS.

2. ATS can be a very effective, and safe, thinning agent when applied at petal fall at a concentration of 5% and followed by tree washing within 1 hour of application. Delayed washing and higher concentrations of ATS cause excessive thinning and moderate to severe damage to trees.
Soil health is defined as: “the continued capacity of soil to: function as a vital living system within ecosystem and land-use boundaries; sustain biological productivity; promote the quality of air and water environments; and maintain plant, animal, and human health” (Pankhurst et al, 1997). Soil health is vital to crop production and agro-ecosystem function.

An often overlooked aspect of soil health is the ability of the soil to suppress plant diseases. One way to improve the soil’s potential to suppress plant diseases in field soils is through cover cropping and the addition of organic residues (e.g. manures, composts, or industrial organic wastes such as paper mill residues). Organic residue-amended field soils have been shown to suppress a variety of soil-borne diseases.

The addition of organic residues to field soils can reduce disease by increasing the numbers and activities of beneficial organisms (e.g. organisms with potential for biological control of pathogens). Beneficial soil microorganisms can directly inhibit the pathogen through competition for carbon and other nutrients (e.g. iron), competition for space, antibiotic production, and direct parasitism.

Composts have been shown to suppress root diseases caused by *Pythium* spp., *Rhizoctonia* spp., *Phytophthora* spp., and *Fusarium* spp. in a wide variety of plant species in containers (Hoitink et al, 1991). Organic matter-mediated suppression of these fungal diseases is potentially due to a variety of mechanisms: suppression of pathogen germination, destruction of pathogen resting structures and mycelia, competition for space and/or nutrients, and induction of systemic resistance in the host plant. There is also evidence that similar phenomena occur in organic matter-amended field soils. Manure additions and cover cropping suppressed Phytophthora root rot of avocado in commercial orchards in Australia (Malajczuk, 1983). Composted brewery waste applications have been shown to increase bean emergence, reduce snap bean root rot, and increase yield in New York field soils (Abawi and Widmer, 2000). Grapevines from vineyards employing cover cropping and composting have been shown to exhibit significantly less root damage (due to *Fusarium oxysporum* and *Cylindrocarpon* spp.) than grapevines grown in vineyards in which these practices are not employed (Lotter et al, 1999).

Cover crops have been shown to reduce, increase, or have no effect on disease incidence depending on the host crop, cover crop, pathogen, and other factors. A cover crop can act as a host for a pathogen, resulting in an increase in pathogen populations and disease incidence in subsequent host crops. In other cases, cover crops can increase the populations of beneficial organisms and reduce disease incidence. Potato growers in eastern Washington are growing white mustard cover crops for suppression of Verticillium wilt (http://grant-
Snap bean root rot severity was shown to be reduced in container trials (with field soils) by the incorporation of ryegrass, oats, Trudan 8, grain rye, wheat, crown vetch, and rapeseed (Abawi and Widmer, 2000).

Plants may change the composition of the soil microbial community through selection of the microbes associated with their plant tissues – roots, leaves and stems. Fusarium wilt of palm (caused by *Fusarium oxysporum*) has been shown to be suppressed by the growth of an understory leguminous cover crop. This is thought to be due to an increase in the numbers of non-pathogenic *Fusarium oxysporum* and other *Fusarium* spp. in the soil, which compete with the pathogen for space and nutrients. Suppression was much stronger after 230 days of cover crop growth than it was after 49 days (Abadie et al., 1998).

Sturz and Christie (1998) have shown that red clover harbors bacteria in its tissues that improve the growth of subsequent potato crops. When red clover is grown in rotation with potato, the growth and yield of potato is enhanced. Some of these red clover and potato–associated bacteria have also been shown to be active against potato tuber pathogens such as *Fusarium sambucinum* and *F. oxysporum* (Sturz et al., 1999).

Some crops, such as mustard family plants, can actually destroy pathogen propagules immediately after incorporation (Lewis and Papavizas, 1971; Muehlchen et al., 1990). These plants contain glucosinolates, which break down during soil incorporation into chemicals that have detrimental effects on the survival of fungal mycelia and resting structures such as sclerotia and chlamydospores.

A field trial was initiated in 1998 at the University of Wisconsin to determine the impact of organic amendment quality and quantity on the severity of common root rot of snap bean. Raw and composted paper mill sludge (PS) were applied because PS is a large volume industrial waste stream currently land-applied in WI on sandy soil processing vegetable acreage. Both raw and composted paper mill sludge strongly suppressed common root rot (Stone, unpublished data).

In recent work in Oregon, we have shown that fresh and composted dairy manure solids amended to field soils suppress root rot of sweet corn, and there is a strong relationship between disease suppression and microbial activity. However, suppressiveness only lasts for one growing season. We also have preliminary evidence that sudangrass cover crops may have potential to suppress root rot, while annual ryegrass and cereal rye may be hosts to some of the causal fungal pathogens (H. R. Darby and A. G. Stone, unpublished data).

References:
This presentation would more suitably be called “Building Fertility with Cover Crops and Manure: How to Know If It’s Profitable.” My focus is on how to evaluate the costs and benefits. Others in this room know far more than I about how to use cover crops and manure to build soil fertility. Cost and benefits can be evaluated with a long-term or a short-term perspective. The short-term perspective is a necessary first step for the long term, so it is a good place to begin.

The short-term, direct costs of cover crops are cover crop seed, added labor and added equipment use. Other items to complete the inventory of direct costs may include burn-down herbicides and supplementary tillage prior to planting the next crop. It is important not to overlook the indirect “opportunity cost” of any crop yield benefits that may be foregone due to the cover crop. If an interseeded cover crop competes with the marketed crop, the opportunity cost would be the value of yield or quality reduction in the marketed crop. If a cover crop replaces a marketable crop for a season, then the opportunity cost is the entire potential net revenue foregone by not growing that marketable crop. Sometimes a cover crop may have zero opportunity cost, as when fall-seeded into a standing crop and plowed down before planting the next spring.

The short-term benefits of cover crops and manure are harder to measure. They typically include reduced costs for mineral fertilizer and possibly reduced costs for herbicides if cover crops can offer good weed suppression. Ideally, they might also include revenue gains due to higher yields, perhaps due to more soil organic matter. The short-term profitability analysis of changing fertility management to rely more on cover crops or manure can be summarized in a partial budget that shows whether the benefits (increased revenues and reduced costs) overcome the costs (reduced revenues and increased costs).

A long-term perspective is really the most appropriate one for evaluating the profitability of greater reliance on cover crops and manure in fertility management. Green manures and livestock manure offer soil quality benefits that accumulate gradually over time. Repeated applications of organic matter gradually build the total stock of soil organic matter. So it takes years to see the full fertility benefits of cover crop and manure, both via nutrient delivery from the active fraction of soil organic matter and from the moisture-stabilizing effect of more total soil organic matter.

Investment analysis methods use the same short-term costs and benefits over multiple years to build a long-term profitability analysis. The big difference from the short-term partial budget is that the long-term analysis captures the rising benefits from improving soil quality over time. So while the annual costs remain the same, the benefits rise gradually over time. An investment analysis can
capture the present value of net benefits from cover crops and manure over a period of several years (Roberts and Swinton, 1995).

So far we have focused on profitability analysis alone. But managing soil fertility with cover crops and manure may bring two kinds of economic benefits other than changes in expected profitability. First, soil organic matter may improve soil water retention capability and reduce soil compaction. Apart from raising average crop yields, these may also reduce yield losses due to drought stress. To many growers, reduced risk of down-side yield variability has value for its own sake, quite apart from gains in average yields. Second, reliance on slow-release nitrogen mineralization from soil organic matter may reduce nitrate leaching when rains follow intense applications of mineral nitrogen fertilizer. If cover crops suppress weed competition (either in the current crop or in subsequent crops) leading to reduced herbicide use, that too could offer environmental benefits. Some growers value environmental benefits for their own sake. Environmental benefits may also attract government cost-share funding (e.g., via the Environmental Quality Incentives Program, EQIP), thereby lowering the costs of using cover crops and manure.

The profitability analysis ideas mentioned here are discussed with greater detail and illustrated with examples in the staff paper by Labarta et al. (2002).

References
New Generation of Cover Crops for Tomatoes

Dale R. Mutch, Sieglinde Snapp, Mary Hausbeck, Ron Goldy and Todd E. Martin
Michigan State University

Contact:Dale R. Mutch, MSU Kellogg Biological Station, 3700 E. Gull Lake Drive
Hickory Corners, MI 49060; 616-671-2412 ext. 224; mutchd@msue.msu.edu.

Eight cover crop treatments were seeded in August 2001 to evaluate their influence on yield, quality, nutrient update, disease and weed reduction in summer squash and tomatoes. Summer squash was grown with and without fumigation under plastic. Both rows of squash were planted across the eight cover crop seeding and were replicated three times in a Randomized Complete Block (RCB) design. Squash was harvested, graded and monitored for disease. Diseased plants were sampled and cultured to determine if they were infected by phytophthora.

Tomato plants were planted under plastic across the eight cover crop seedings with three replications in an RCB design. Six tomato treatments were being compared. Fumigant vs. non-fumigant, high nitrogen vs. low nitrogen non-fumigant, and high nitrogen vs. low nitrogen plus fumigant.

Both destructive and nondestructive measurements were conducted. Each cover crop treatment was compared for yield, quality and growth. The roots of tomato were evaluated for several cover crop treatments using a minirhizotron, which recorded tomato root growth.

No. 1 tomato yields indicated that cover crop systems that included hairy vetch provided sufficient fertility to support late season production with no additional fertilizer required beyond a starter dose. Overall, including treatments that were not fumigated, the highest performing tomato crops were after cover crops systems that included oats and oilseed radish. Vigorous, healthy root growth in tomato was also promoted by hairy vetch and oil seed radish, compared to a cereal rye cover crop.

These results are preliminary and need to be evaluated in the context of the differential costs of different cover crops, and depending on disease pressure that farmers experience. Further information is needed to develop improved cover crop systems. The experiment will be repeated in summer 2003.
Cover Crops in a Seed Corn and Vegetable Rotation

Henry Miller, Villa-Miller Farms (email villamil@net-link.net)

At Villa-Miller Farms we have tried to make the use of cover crops an integral part of our cropping plans. Our principle crops for the past 10 years have been seed corn, snap beans, and potatoes. Approximately one half of our acreage is planted to seed corn each year while one fourth is planted to double crop snap beans and the other one fourth is rented to potato producers in the area. This allows us to rotate to a different crop annually which provides many advantages such as improved weed control and avoidance of herbicide resistant weeds by varying the herbicides used. The relative long rotation between snap bean crops and potato crops (4 years) helps with the control of diseases and may help with the control of insects such as the Colorado potato beetle. We feel the rotation also helps maintain a better soil health as well as a more varied nutrient demand as we have sequential bio-diversity which may be the best we can do in avoiding mono-cultures and the problems associated with them.

Another way we introduce more bio-diversity into our cropping system is through the use of cover crops. Our goal is to have at least one crop growing on every acre as much of the growing season as is feasible. To accomplish this we have used turnips, rape, and oil seed radish as trap crops for scavenging and recycling nutrients which might otherwise be lost by leaching. We have taken advantage of these crops for winter pasture by renting the fields to a cooperating dairy. These crops need to be inter-seeded into corn in mid to late July to achieve the desired bulb and forage production. Other cover crops are normally seeded after harvesting our primary cash crops. Normally we seed oats following potato harvest. Some of these are grazed from October through December. Oats not grazed are winter killed but continue to provide good ground cover and nutrient cycling provided there is adequate growth. To be sure to get enough growth it is advisable to seed the oats before September 1. Those crops harvested later, usually double crop snap beans and seed corn, are followed with rye as a cover. We have successfully over-seeded rye into seed corn by air in August as well as spreading it after harvest and chisel plowing. It emerges through the chiseled ground very well.

This year we have begun looking at the potential a crop such as cow peas might have for inter-seeding in seed corn. It showed a great deal of promise for both weed suppression and fixing of nitrogen which potentially would be available for a succeeding crop. It also has some potential for post harvest grazing.

A healthier soil with improved soil structure, greater bio-diversity, and increased soil organic matter are some of benefits of using cover crops. Environmentally it helps protect our surface water from sediments, nutrients, chemicals and other contaminants caused by wind and water erosion and our ground water from leached nutrients and chemicals by absorbing and recycling nutrients as previous crop residues decompose.
Some considerations that one needs to take into account in planning a cover cropping plan are; the primary and secondary purposes for your cover crop, the seeding window available, time and labor constraints, equipment availability, cost of seed, management of cover crop residue, choice of plant species which do not promote diseases or pests, and species which do not become a weed or in other ways interfere with your cropping system.
Grape Berry Moth in Michigan Vineyards

Rufus Isaacs, Department of Entomology, Michigan State University – email: isaacsr@msu.edu

Looking back on the 2002 season, grape berry moth (GBM) caused the greatest insect-related problems in Michigan vineyards. This was particularly true in SW Michigan, but increased infestations were also seen in vineyards around Traverse City. Reports of similar problems in the Lake Erie region also show that this was a region-wide issue.

In this talk, some time will be spent looking back to help understand what happened this season, and why control programs were not as effective as usual. The focus of this talk, however, will be on effective IPM programs for grape berry moth and other grape insects.

The key to preventing outbreaks of grape berry moth late in the growing season is to have a regular vineyard scouting plan in place that can provide early warning of sites that require control. Methods for vineyard scouting will be described, along with techniques for deciding whether the level of pest infestation is high enough to warrant a spray.

Our laboratory is conducting research to determine the best time during the season to spray for grape berry moth, given that populations have been building in the period before harvest in recent years. The results of these trials show the high degree of pest pressure in 2002, but also point to the need for post-veraison management of GBM in vineyards with high pest pressure. Important considerations for effective pest management in this late-season period will be discussed, so that growers can get maximum activity from

The recent changes in insecticide options for grape growers will be described, including results from trials with newly registered compounds and changes in currently-available products. I will discuss the implications of these changes for insect control programs and for resistance management strategies in Michigan vineyards.
Efficient and Effective Fertilization Programs for Grapevines

Eric Hanson, Department of Horticulture, Michigan State University

The best fertilization program meets the nutritional needs of the vines with the minimum amount of fertilizer. Because fertilizer costs are low relative to the loss of income that could result if vines are inadequately fertilized, it is tempting to fertilize more heavily than might be needed. Here are some suggestions to help make sure the nutritional needs are met without applying excess fertilizer.

First, sample petioles periodically for nutrient analysis. The MSU Plant and Soil Nutrient Lab and several other labs analyze plant tissue samples. Analyses cost $18 to $25, but this is a good investment. One sample is adequate for 5 to 10 acres of vineyard, so the per acre cost for an accurate assessment of nutritional health is only $2 to $5. The sampling procedure consists of collecting 50 to 70 petioles (leaf stems) in August from as many different vines throughout the vineyard area. Select petioles from recently matured leaves in the middle of shoots. Let the petioles dry on a desktop for a couple days, then send them in. There are alternative times to sample, but the August veraison period is recommended for Michigan. We are testing whether an alternative time might yield more information.

I see little value in sampling vineyard soils more often than every 6 to 8 years. Soil nutrient levels do not reflect vine nutrient status with any certainty, so an occasional soil sampling to check pH is all that is needed.

The subject of soil pH continues to raise questions. Since most Michigan fruit crops benefit from a pH between 6.5 and 7, it is sometimes assumed that grapes do as well. Currant information indicates that American varieties such as Concord and Niagara have a wide tolerance to pH, and do well from 5 to 7. Some healthy, productive vineyards are even on soils with pH less than 5. It appears that the optimum pH for French hybrid and Vinifera varieties is higher. These types appear most healthy between perhaps 6 and 7.5.

Potassium (K) management is an issue in many Michigan vineyards. Grapes have a relatively high demand for K that is often not met by sandy vineyard soils. Petiole testing is an excellent way to judge if K levels are adequate. Annual applications of K may be needed in some vineyards. Excessive K applications waste money and can reduce the acidity and pH of juice, so monitor petiole levels rather than assume more K is needed.

Nitrogen (N) represents the greatest fertilizer cost because most vineyards require annual applications. Rates vary from 30-50 lb N per acre on heavy fertile soils to 70-100 lb on sandier sites. Split applications of N may increase uptake by vines; apply half at bud break and half at bloom. Vineyards on sandy soils where N can leach will benefit most from split applications.
What To Look For In A Quality Pepper Transplant
Dr. Richard L. Hassell, Clemson University CREC, Charleston, South Carolina

Did you know that the size and shape of the first pepper fruit has already been decided before the flower is visible? This makes treatment of a pepper transplant extremely important. Often times the shape of the first fruit will be pointed instead of lobed. This maybe due to condition of the transplant at the time it was set in the field. In addition, pepper transplants seems to always have a harder time getting established in the spring (transplant shock), compared to other crops, so what can a grower due to encourage the plant to continue growing? In this succession we will be focusing on such things as: transplant growing time, watering schedule as well as over watering effects, and fertilizer scheduling as well as rates. Pepper plants have the ability to self harden with the minimal amount of stress. Be careful not to over due it. Too much stress can have an adverse effect on a pepper plant. All these factors will effect how a pepper transplant takes off once it is placed in the field and also the quality of the fruit being produced.
Biodegradable Mulches in Pepper Production

John Zandstra, Ridgetown College, University of Guelph, Ridgetown ON N0P 2C0
jzandstr@ridgetownc.uoguelph.ca

John Warner, Agriculture & Agri-Food Canada
Greenhouse and Processing Crops Research Centre, Harrow ON N0R 1G0
warnerj@em.agr.ca

Fresh market vegetable growers use plastic mulches to warm the soil, retain soil moisture, and suppress weeds, often resulting in higher yields and advanced crop maturity. Presently there are in excess of 4000 acres of vegetables grown on plastic mulches in Ontario.

Plastic mulches, however, impact the environment in a negative manner. They are produced using non-renewable resources, and are often used only for a single season. Disposal usually involves bringing the material to a municipal landfill, but with increasing pressure on landfills to reduce intake levels, these materials may at some point not be allowed. In Ontario, municipal landfills are only required to accept residential waste; since agricultural plastic is considered an industrial waste it could be easily refused. Efforts are underway to recycle this material, but it is often difficult due to the dirt and moisture which accompanies it.

Recently, biodegradable materials have been developed which have the potential to be used as agricultural mulches. These products are available in dark and clear films, and could be used on a range of vegetable crops. These products are not like the photodegradable type of mulches, which came apart after exposure to the sun, but rather are degraded by microorganisms in the soil. They consist mainly of plant starches, and over time are supposed to completely degrade in the field, eliminating the need for pickup and disposal. The main use of this material at the present time is garbage and grocery bags.

Trials were conducted at 2 locations in Ontario (Ridgetown and Harrow) using several types of degradable mulches, which were compared to production on standard plastic mulch and no mulch. Initially 3 biodegradable mulches were evaluated at Ridgetown in 2001; however 2 of the mulches were brittle and tore within 2 weeks of being laid. Only the degradable mulch supplied by Polar Gruppen was evaluated for yield and fruit characteristics at both locations in 2001.

Fruit characteristics (average weight, wall thickness, length) of bell pepper (cv. Boynton Bell) grown on the biodegradable mulch did not differ from peppers grown on standard plastic or bare soil in 2001. All mulches improved marketable yields of peppers when compared to bare soil, and yields of peppers grown on the biodegradable mulch did not differ from those grown on standard black mulch (Table 1,2).

In 2001 the degradable Polar Gruppen mulch remained intact until early August; however, by late August only 50% of the ground was still covered. In 2002 it appeared to degrade quicker, with little mulch cover remaining by the end of August. A second degradable mulch which was
evaluated in 2002 (supplied by Recoltech) was more durable, and remained largely intact the entire season.

**Table 1.** Effect of mulch type on yield and fruit characteristics of bell pepper. Ridgetown College, University of Guelph. 2001.

<table>
<thead>
<tr>
<th>Mulch Type</th>
<th>Sunscald Yield (tons/acre)</th>
<th>Marketable Yield (tons/acre)</th>
<th>Fruit Size (g/fruit)</th>
<th>Fruit Length (cm)</th>
<th>Fruit Diameter (cm)</th>
<th>Wall Thickness</th>
</tr>
</thead>
<tbody>
<tr>
<td>Black plastic</td>
<td>2.1</td>
<td>16.8 a</td>
<td>226</td>
<td>8.3</td>
<td>9.2</td>
<td>6.3</td>
</tr>
<tr>
<td>Biodegradable</td>
<td>1</td>
<td>15.7 a</td>
<td>227</td>
<td>8.4</td>
<td>9.1</td>
<td>6.6</td>
</tr>
<tr>
<td>Bare ground</td>
<td>2</td>
<td>10.6 b</td>
<td>219</td>
<td>8.4</td>
<td>8.8</td>
<td>6.7</td>
</tr>
</tbody>
</table>

*Means followed by the same letter within each column do not differ significantly (P=0.05)*

**Table 2.** Effect of mulch type on yield and fruit characteristics of bell pepper. Agriculture and Agri-food Canada, Harrow, 2001.

<table>
<thead>
<tr>
<th>Mulch Type</th>
<th>Culls Yield (tons/acre)</th>
<th>Marketable Yield (tons/acre)</th>
<th>Fruit Size (g/fruit)</th>
<th>Fruit Length (cm)</th>
<th>Fruit Diameter (cm)</th>
<th>Wall Thickness</th>
</tr>
</thead>
<tbody>
<tr>
<td>Black plastic</td>
<td>3.5 a</td>
<td>17.2 a</td>
<td>162</td>
<td>8.4</td>
<td>8.3</td>
<td>6.1</td>
</tr>
<tr>
<td>Solar mulch</td>
<td>3.2 a</td>
<td>15.8 a</td>
<td>158</td>
<td>8.6</td>
<td>8.5</td>
<td>6</td>
</tr>
<tr>
<td>Biodegradable</td>
<td>2.8 a</td>
<td>16.3 a</td>
<td>153</td>
<td>8.5</td>
<td>8.3</td>
<td>6</td>
</tr>
<tr>
<td>Bare ground</td>
<td>1.7 b</td>
<td>10.6 b</td>
<td>162</td>
<td>9</td>
<td>8.1</td>
<td>6.3</td>
</tr>
</tbody>
</table>

*Means followed by the same letter within each column do not differ significantly (P=0.05)*
Plastic Or No Plastic: Using Enterprise Budgets for Decision Making

Barbara Dartt, DVM, MS, Business Consultant
Salisbury Management Services, Inc.
2487 S Michigan, PO Box 10, Eaton Rapids, MI 48827
bdartt@salisbury-management.com – tel: 517.663.5600

Management of commercial vegetable crops is becoming more and more intensive. One method that can decrease production risk and increase yields is the use of black plastic mulch and drip irrigation. However, these inputs are costly and can substantially affect the timing and intensity of other production decisions. Is plastic right for your operation?

Using the bell pepper enterprise budget developed with a grower focus group, this presentation will examine the management decision of plastic versus no plastic from a financial perspective. The discussion will illustrate how enterprise budgets can be customized for individual operations and how those budgets can be utilized to make management decisions.

The budget utilized represents the full cost of production including fixed costs and returns to owner labor and management. The information on green pepper cost structure and yields was developed using a focus group of growers with a good knowledge of the industry and good field, enterprise, and financial records. The budget is available as a Michigan State University Department of Agricultural Economics Staff Paper titled, “Cost of Fresh Market Sweet Bell Pepper Production in Macomb County, Michigan.” A paper copy can be requested from Tobin Mellberg at 517.432.0848 or can be found at http://www.aec.msu.edu/agecon/pubs.htm by clicking on the “Staff Papers” link. In addition, the spreadsheet underlying the budget and the one utilized to compare the plastic and no plastic production scenarios are available at http://www.msu.edu/user/blackj/
Producing and Marketing Peppers for Eastern European Customers
Paul Lapadat, Ontario, Canada
Ron Rodzos, Memphis, MI
Bob DeCock, Macomb, MI

Paul Lapadat farms with his wife, Elaine, and their two sons Justin & Jordan, in Rodney, Ontario, Canada, a small town located between London & Chatham, Ontario. They grow about 30 acres of peppers in addition to PYO strawberries and corn and soybeans. The Lapadats market the majority of their Peppers wholesale to ethnic buyers who sell to their ethnic customers- Italian, Hungarian, Yugoslavian, and East Indians to name a few. On farm Retail is to the eastern Europeans.

They strive for quality and freshness in their produce at both wholesale and retail levels. Peppers include 25 acres of ethnic varieties including 8 different types of hot & sweet varieties with the remainder of the acreage in green/red bell peppers. They produce their own plants in plug trays, seeded in early April and planted on bare soil (no plastic or irrigation) in late May. Harvest starts late July-early August. They employ offshore labour. European Corn borer is the primary pest problem, more significant on yellow peppers as compared to bells.

About 40 years ago Paul’s parents (also Yugoslavian) started retailing on the farm growing only 2-4 acres. The customers would just show up, and his parents would visit with them and let them pick their own. In 1986 Elaine & Paul, who both worked off the farm, started growing peppers and they continued the retail selling the same way. The differences were that they had 10 acres with 2 wholesale buyers. As the acres increased they both had to leave their jobs to concentrate on this crop. In addition they found that this type of retail was clearly not going to work out. As growers as well as marketers and retailers, time was becoming very valuable. They had hoped that in a couple of years they could get their retail customers to order their peppers at least 2 days in advance and that these orders would be picked up in the evening. While the majority of customers adopted this retail policy, some haven’t and still show up.

As a result, the wholesale business has been expanded from 2 buyers (1986) to 7 buyers at present. It included the Ontario Food Terminal in Toronto until 1993. It was built upon a reputation of quality and freshness (peppers are washed, packed and delivered from 24-72 hours after being picked). The market has become very competitive with expanding growers and new growers in the last 6-7 years and the demand has leveled off if not declined. The price has also declined 20-25% over the last 6-7 years. The market includes 2 types of wholesale buyers

- Price buyers- quality is less of an issue but freshness is maintained
- Quality buyers – same quality and freshness they have always received

Tips For The Ethnic Market
- Research the ethnic community or communities you are targeting (for example markets, stores, events)
• Research the type of pepper for those communities (for example: red, yellow, green, hot, sweet, early or late varieties

•
• Sell on quality
• Get to know your buyers
• Let them see your face as much as possible
• Be the first one marketing those peppers in different communities
• Keep your price high (high demand > high price)
• Success in ethnic markets takes a lot of dedicated years
• On the retail end of the eastern Europeans customers you have to be firm on your policy but at the same time remain flexible
• Always have extra on hand in the barn – you will definitely sell them

Bob DeCock farms in Macomb Township, in southeast Michigan, with his brothers, Larry and Ken, and with the help of their mother, Virginia. The operation grew over three generations from a wholesale vegetable operation to a retail greenhouse and produce business. The landscape has changed dramatically, as well, and the farm draws from a large local customer base living and working nearby as well as from the diverse population of Metropolitan Detroit.

Over the years, the family made a practice of producing a percentage of specialty crops such as hothouse rhubarb, horseradish and celery root as well as more traditional vegetables. Eighteen years ago, they began to respond to another customer base, immigrants from Eastern and Central Europe who had an avid desire for large quantities of specific varieties of hot and sweet peppers. These customers have become a significant element in their customer base with the annual purchase of 1000 bushels of peppers at an average price of $13.00. They also purchase a considerable amount of late cabbage. However, the business needed to learn to deal with cultural differences that, if handled poorly, can make the sales of the crop a harrowing experience.

Approximately 150 families purchase an average of 7-8 bushels of peppers apiece. Word of mouth has increased the customer base. The fruit are ordered by specific characteristics of shape, color and flavor, if not specific cultivars. While the DeCocks trial new cultivars every year, about 9-10 different varieties annually make up the mix. Production is on raised beds with trickle irrigation and fertigation. Harvest begins in September and continues as long as possible with overhead irrigation protecting the crop from frost. Word spreads quickly in the community when the crop is ready and it is vitally important that producers be prepared before customers begin to call or arrive at the stand.

A marketing system has evolved that includes a number of strategies. One employee is designated as the primary contact for this group of customers. He or she keeps a record of first and last names and phone numbers. Orders are placed on a first-come, first served basis. Customer orders are recorded and the customers are contacted individually by phone when orders are ready for pick-up. These records include the date when contact is made and when orders are confirmed. At pick-up, the names and phone numbers are matched to avoid confusion with family members with similar first or last names. As with any group of customers, there are individuals who are less than
courteous and may offend some employees. An employee is selected who can be firm when there is a dispute about the order, price, quality or related issue.

Bob DeCock and other growers in Southeastern Michigan have found a profitable niche in the production and marketing of peppers for the ethnic market. When handled well, this customer base will continue to grow and be a winning arrangement for both producer and customer.

The following article contains excerpts from The Michigan Farmer, A Farm Progress Publication. October 2002.

Peppered with Opportunity by Beth Stuever

Ron and Kelly Rodzos have nearly 1,200 acres of cropland on their St. Clair County farm. But the two acres right behind the house that keep them busiest. That’s where the couple grows 16,000 pepper plants to cater to their Eastern European neighbors. As the youngest in his family, Ron spent more time hanging out in the garden with his mom than on the tractors with his dad. “Converting some of our ground to vegetables seemed more natural to me,” he says.

When Mike Rebic was growing up in his native Yugoslavia, fresh vegetables were a part of his daily life. Potatoes and various kinds of peppers were staples that kept his family happy year round. “We grew the potatoes in our garden,” he says. “But I never even thought about where the peppers came from. You could buy then anywhere. They were just always around.” But when Rebic immigrated to United States with his parents Miroslav and Maria in 1978, the plentiful peppers he knew as a child were a scarce commodity. Two years ago, he mentioned his family’s predicament to one of his farmer neighbors.

“Ron got that look in his eyes”, Rebic laughs. “I knew there was something going on in that head.”

Ron Rodzos is a third generation St. Clair County farmer. When he and his wife, Kelly, took over the family farm in 1995, he knew that long-term success hinged on expansion. As farmland disappeared and houses sprung up around him, Ron watched the Detroit suburbs were getting closer and closer and closer. It didn’t take him long to realize that expansion would not involve buying more land to grow more corn and soybeans – the crops his parent’s traditionally raised. Instead, he began searching for ways to get more bang for the buck for every acre he already owned. That’s when Rebic laid the pepper idea on him.

The average Yugoslavian family processes 15 to 20 bushels of peppers every year. They make everything from pickled peppers and a pepper-based slaw to a pepper sauce that replaces American catsup. “I couldn’t even tell you how often we eat peppers,” Mike says. “They are a side dish or a part of so many meals that I don’t even think about it. There’s always an open jar of something in the ‘fridge.”

Mastering the learning curve

“We didn’t know anything about growing vegetables,” Ron says. “But we knew we could learn.” Ron and Kelly’s education started with a conversation with their local MSU Extension field representative and a trip to the Great Lakes Fruit, Vegetable and Farm Market Expo – an annual event held in Grand Rapids in December. At the Expo, they met a supplier who imported seed for
golden, red sweet Bulgarian, Italian longhorn and crimson chili peppers from Hungary. In 2001, the couple planted 5,000 plants on two acres using a transplanter that Ron built himself and installed irrigation with a low-cost drip tape machine. “We try to do everything as low tech as we can so we don’t have to invest in a lot of new equipment,” Ron says. “We found out that our row crop tractor didn’t go slow enough so we had to figure out another way to get the plants in the ground. You have to be willing to experiment.” Rodzos’ experiment paid off so well that they expanded to 16,000 plants in 2002. “The field was picked clean last year and we sold everything we had,” Ron says. “So we decided to keep on going.”

New marketing approaches
Sales success hinges on getting news of their crop to Eastern European transplants that now call the Detroit suburbs home. Knowing their market is concentrated in a small area, Rodzoses are quick to enlist their neighbors’ help. Kelly makes flyers with directions to the farm and U-pick hours. She hands them over to Rebic who distributes them to various Detroit-area industrial shops while making his rounds as a representative for Snap-on Tools and his sister who works for Chrysler Corporation. “We get a good response from that,” Kelly says. “But we also sell to farm markets in bulk.”
Avoiding an Invasion of the Rots and Blights

M.K. Hausbeck (517-355-4534, huisbec1@msu.edu)
Michigan State University, Department of Plant Pathology, E. Lansing, MI 48824

Phytophthora Blight
Michigan growers producing squash and pumpkins have reported significant losses due to Phytophthora blight in recent years. In most cases, the fungus *Phytophthora capsici* is responsible. Recognizing disease due to *P. capsici* is not always easy. Because the disease often occurs in the low areas of a field where water accumulates, many growers assume that when plant stunting occurs, it is due to the ‘water logging’ of the roots, but infection by *P. capsici* may be to blame. Squash and pumpkin plants often have more obvious symptoms, with plants wilting or collapsing prior to dying. Such plants often have brown to black discolored roots and crowns. The disease is easily seen on infected fruit, initially as dark, water-soaked lesions which develop a distinctive white ‘powdered sugar’ layer of spores on the surface of the fruit. Fruit infection is especially troublesome because the infection may occur days before the symptoms become visible. As a result, healthy-appearing fruit may be harvested, and the fruit breaking down during transit or on grocers’ shelves.

To control *P. capsici*, several control measures need to be used in a management program to reduce losses from this disease. Crop rotation may reduce the number of *P. capsici* spores remaining in a field. A minimum of 3 years crop rotation to hosts other than those listed in Table 1 is recommended to avoid build-up of *P. capsici*. There are many fields in Michigan where the *P. capsici* has become resistant to the commonly used fungicide, Ridomil Gold. Other registered fungicides have been tested on zucchini fruit and include Acrobat 50WP and Gavel 75DF. Both Acrobat 50WP and Gavel 75DF help to limit *P. capsici* even when the pathogen is resistant to Ridomil Gold (Table 2). Mixing copper hydroxide with Acrobat 50WP and Gavel 75DF may be helpful. Fungicides perform best when used early and frequently. Good coverage of the fruit with the fungicide is essential. Fungicides cannot be relied upon alone to prevent disease, but they can provide an extra degree of protection when used in combination with other management practices, such as crop rotation, raised beds, and water management.

Good drainage is important in managing this disease. Susceptible crops should be planted on well-drained sites and in raised beds. However, even plants growing on well-drained fields on raised beds may have severe disease if rainfall is heavy. Growers should avoid relying on a single fungicide, to delay development of fungicide resistance with *P. capsici*. Crop rotation may help to lower *Phytophthora* levels in a field, but planting any of the susceptible vegetable crops into a field with a history of *P. capsici* is risky.
Table 1. Common vegetable hosts affected by *Phytophthora capsici*.

<table>
<thead>
<tr>
<th>Cucumber</th>
<th>Bell pepper</th>
<th>Pumpkin</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hot pepper</td>
<td>Summer squash</td>
<td>Tomato</td>
</tr>
<tr>
<td>Winter squash</td>
<td>Gourds</td>
<td>Eggplant</td>
</tr>
<tr>
<td>Zucchini</td>
<td>Watermelon</td>
<td></td>
</tr>
</tbody>
</table>

Preplant Control Strategies
- Consider a pre-plant banded fungicide application for fields with known problems with *P. capsici*.
- Plant susceptible crops 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 *P. capsici* disease.

Production Control Strategies
- Monitor fields for disease, including damping off, plant stunting, root and crown rot.
- Irrigate conservatively and, if possible, do not irrigate prior to harvest.
- Plow under portions of the field with diseased plants, including healthy plants that border diseased areas.
- Remove diseased fruit from the field.
- Never dump culls or diseased fruit from other fields or farms into production fields. Once *Phytophthora capsici* is introduced, it may remain indefinitely.
- Apply fungicide preventively, especially for known problem fields.
- Rotate the types of fungicides used.

Postharvest Control Strategies
- Harvest fruit as soon as possible from problem fields.
- Keep harvested fruit dry and cool.

Table 2. Evaluation of fungicides for managing Phytophthora blight of zucchini fruits (trial 1).

<table>
<thead>
<tr>
<th>Trial 1 Treatment and rate/A</th>
<th>Lesion diameter (cm) from <em>Phytophthora</em> isolate sensitive to Ridomil Gold</th>
<th>Lesion diameter (cm) from <em>Phytophthora</em> isolate resistant to Ridomil Gold</th>
</tr>
</thead>
<tbody>
<tr>
<td>Untreated control</td>
<td>5</td>
<td>5.7</td>
</tr>
<tr>
<td>Kocide 2000 54WG 1.5 lb</td>
<td>4.7</td>
<td>4.1</td>
</tr>
<tr>
<td>Acrobat 50WP 6.4 oz</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Acrobat 50WP 6.4 oz + Kocide 2000 54WG 1.5 lb</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Ridomil Gold 4EC 8.0 fl oz</td>
<td>0</td>
<td>3.8</td>
</tr>
</tbody>
</table>
Table 2. Evaluation of fungicides for managing Phytophthora blight of zucchini fruits (trial 2).

<table>
<thead>
<tr>
<th>Trial 2</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Untreated control</td>
<td>2.9</td>
<td>5.1</td>
</tr>
<tr>
<td>Kocide 2000 54WG 1.5 lb</td>
<td>1</td>
<td>2.7</td>
</tr>
<tr>
<td>Gavel 80DF 3.0 lb</td>
<td>0</td>
<td>0.9</td>
</tr>
<tr>
<td>Ridomil Gold Copper 76.5WP 2.0 lb</td>
<td>0</td>
<td>1.9</td>
</tr>
<tr>
<td>Acrobat 50WG 6.4 oz + Kocide 2000 53.8DF 1.5 lb</td>
<td>0.5</td>
<td>0</td>
</tr>
<tr>
<td>Gavel 80DF 3.0 lb + Kocide 2000 53.8DF 1.5 lb</td>
<td>1.1</td>
<td>1.7</td>
</tr>
</tbody>
</table>

Powdery Mildew

Powdery mildew is perhaps one of the easiest diseases to identify because of the whitish, talcum-like, powdery growth that develops on both leaf surfaces, petioles, and stems. Infected leaves usually wither and die. Premature loss of foliage often reduces the size or number of fruit and the length of the harvest period. In addition, powdery mildew infection predisposes plants to other diseases such as gummy stem blight. Powdery mildew occurs each year, although the time of disease appearance is unpredictable. Propagules responsible for infection (conidia or spores) may be transported rapidly over long distances by air currents. Therefore, the disease may become established in a clean field from conidia blowing in from a field affected by the fungus. It is also possible that this disease may overwinter in a black, bead-like, weather resistant form. Although this has not been verified for Michigan, overwintering of the fungus responsible for powdery mildew has been documented in nearby states.

Once powdery mildew is present, the disease may increase rapidly. The fungus can multiply and spread quickly under favorable conditions because the length of time between infection and symptom appearance is usually only three to seven days. Also, a large number of conidia that can infect healthy tissue can be produced in a short time, and contribute to spread of the disease within a field.

Currently, fungicides are the primary control practice for this disease. Resistant cultivars are becoming more available. Many products were tested in 2002 for their ability to control powdery mildew (see table, below). To avoid the development of fungicide resistance, fungicides should be used in alternation. Since Flint, Quadris, and Cabrio affect the powdery mildew similarly, they should not be used in alternation with each other. Rather, they could be used in a program with Bravo or Nova. It is critical that a field be monitored closely for the first appearance of the disease. To monitor effectively, a grower must walk through a field once or twice a week to look for powdery mildew.
mildew, especially on the older, shaded leaves. Do not forget to look at the underside of the leaves! It is apparent from field observations that early control of powdery mildew is the most effective.
Table 3. Evaluation of fungicides for managing powdery mildew of pumpkin.

<table>
<thead>
<tr>
<th>Treatment and rate/A, applied at 7-day intervals</th>
<th>Currently registered</th>
<th>Foliar powdery mildew (^1) (%) 8/19</th>
<th>Handle rating (^2) 10/1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Untreated .........................................</td>
<td>~</td>
<td>8</td>
<td>h(^3) 6</td>
</tr>
<tr>
<td>Flint 50WG 2.0 oz</td>
<td>yes</td>
<td>3.5 abcde</td>
<td>2.3</td>
</tr>
<tr>
<td>alternated Bravo Weather Stik 6SC 2.0 pt</td>
<td>yes</td>
<td>3.3 abcde</td>
<td>4.8</td>
</tr>
<tr>
<td>Flint 50WG 2.0 oz</td>
<td>yes</td>
<td>3.3 abcde</td>
<td>2.3</td>
</tr>
<tr>
<td>Cabrio 20WG 1.0 lb</td>
<td>yes</td>
<td>3.3 abcde</td>
<td>2.3</td>
</tr>
<tr>
<td>BAS 510 70WG 4.0 oz</td>
<td>no</td>
<td>3 abcde</td>
<td>1.8</td>
</tr>
<tr>
<td>Cabrio 20WG 1.0 lb + BAS 510 70WG 4 oz</td>
<td>yes</td>
<td>1.8 a</td>
<td>3</td>
</tr>
<tr>
<td>Cinnamite 2.5SC 6.0 pt</td>
<td>yes</td>
<td>2.8 abc</td>
<td>5</td>
</tr>
<tr>
<td>alternated Flint 50WG 2.0 oz</td>
<td>yes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nova 40WP 5.0 oz</td>
<td>yes</td>
<td>4.8 def</td>
<td>2</td>
</tr>
<tr>
<td>Bravo WeatherStik 6SC 2.0 pt</td>
<td>yes</td>
<td>3.3 abcde</td>
<td>2.8</td>
</tr>
<tr>
<td>Quadris 2.08SC 15.4 fl oz</td>
<td>yes</td>
<td>4.3 cde</td>
<td>3.3</td>
</tr>
<tr>
<td>alternated Nova 40WP 5 oz</td>
<td>yes</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

\(^1\) Based on a rating of 1 to 10 where 1=0% to trace of disease to 10=complete defoliation and death.

\(^2\) Rated on a scale of 1 to 10, where 1=healthy to 10=rotted.

\(^3\) Column means with a letter in common or with no letter are not significantly different (Fisher LSD; P=0.05).

This research was supported in part by the GREEEN project (www.greeen.msu.edu), “Biological and Novel Cultural Control of Vine Crop Pests.”
Pumpkins and squash have had few herbicide choices for many years. Fortunately, the situation is improving with several new registrations and labels.

For 2003, Strategy 2.1SE is now labeled on most vine crops. It is a premix of ethalfluralin (Curbit) and clomazone (Command 3ME). It will be used at 2-5 pints per acre, depending on soil type. The lowest rate should be used on light sands, and the 4-5 pint rate should be used on loams and clay loams. It should be applied to the surface after seeding or as a directed spray to the soil between rows of plastic or transplants.

Sandea should be registered for pumpkins and squash in 2003. It can be applied preemergence or postemergence over the top of pumpkin or winter squash, but should only be applied postemergence directed to the soil on summer squash. Avoid spraying Sandea over transplants or on plastic. It is very effective on many broadleaves and yellow nutsedge.

With these new labels, growers should be able to obtain good weed control for most of the season. Please see Extension Bulletin E-433 for current weed control recommendations.
Fitting Pumpkins Into Your Computer

Hannah Stevens, Macomb County MSU Extension
21885 Dunham Rd. Ste 12, Clinton Twp. MI 48036
586-469-6440 – stevensh@msue.msu.edu

Many growers are discovering the vast information sources on the world-wide-web. In fact, there is so much information that it can be time consuming to sort out home gardening sites or those that may be far removed from the Great Lakes States. Below are some valuable sites that growers can bookmark now for easy access during the growing season.

http://www.ag.ohio-state.edu/~vegnet/
From The Ohio State University, this site will take you to the online edition of the 2002 Ohio Vegetable Production Guide, as well as your choice of color presentations of production topics in pumpkins, sweet corn and others.

A twelve-page pdf file from Kansas State University Extension. Full of guidance on all aspects of pumpkin production and marketing including a cost of production study.

http://www.hort.cornell.edu/extension/commercial/vegetables/index.html
Cornell University's vegetable website will link you to several sites that will give you guidance on production of pumpkins and other vegetable crops

http://www.msue.msu.edu/vegetable
The Michigan State University Vegetable team has assembled commercial vegetable information into this user-friendly website. It includes cost of production spreadsheets, annually updated pest control bulletins and other current information.
Cover Crop Mulches for Pumpkin Production
Christian A. Wyenandt, Graduate Student, Dept. of Plant Pathology, The Ohio State University

Cover crops have been used in high-input agronomic and vegetable production systems to help reduce soil erosion, fungicide use, plant disease, and weed pressure. Cover crops have also been shown to increase soil organic matter, nitrogen availability, and moisture. Traditional cover crops, such as hairy vetch (*Vicia villosa*) and winter rye (*Secale cereale*), that are killed and left on the soil surface have been used in pumpkin (*Cucurbita pepo*) production with limited success. These traditional fall-sown cover crops can be killed by herbicide applications or mowing prior to pumpkin planting. Fusarium fruit rot (FFR) is a major soil-borne disease in pumpkin production. Current recommendations for control of FFR are crop rotations of 4+ years. In small roadside farm operations where pumpkin rotations are grown continuously or rotated every one or two years FFR can cause serious yield loss. Because control of FFR with fungicides does not work, there is a need for an alternative production system which allow for shortened pumpkin rotations. Cover crops killed and left on the soil surface may play an important role in alternative pumpkin production systems, as well as, help reduce FFR. The objectives of this study are as follows:

**Objectives**
- Selection of spring-sown living, fall-sown (herbicide) killed, and spring-sown (herbicide) killed cover crop mulches for use in commercial pumpkin production.
- Determine the effects of these cover crop mulch systems on pumpkin yield and aesthetic fruit quality.
- Determine the effects of cover crop mulches on soil-borne fungal diseases such as fruit rot of pumpkin caused by *Fusarium spp*.
- Introduce these cover crop systems to growers for use in commercial pumpkin production.

**Methods**
In Oct. 2000 fall-sown cover crop treatments of winter rye ‘Wheeler’ (90 lb/A and 50 lb/A) were established at research branches in Columbus, Fremont, South Charleston, and Wooster, OH. In early May 2001 spring-sown cover crop treatments of spring oat ‘Armor’ (110 lb/A) and annual medic ‘Sephi’ and ‘Polygraze’ at 40 lb/A were established at same sites. In Sept. 2001 fall-sown cover crop treatments of winter rye ‘Wheeler’ (90 lb/A and 50 lb/A), hairy vetch (50 lb/A), hairy vetch + rye (50 lb/A ea) were established at research branches in Fremont, South Charleston, and Wooster, OH. In late April 2002 spring-sown cover crop treatments of spring oat ‘Armor’ (110 lb/A) and annual medic varieties ‘Sephi’, ‘Parabinga’ and ‘Polygraze’ at 40 lb/A were established at same sites. Plot sizes were 25’ by 25’. In late May of 2001 and 2002 fall-sown rye plots were killed with Round-up at 4 pt/A. In hairy vetch plots 2,4D (Lo Vol) at 2 pt/A was added. Planting strips (22” wide) on 10’ centers were prepared in each treatment by spraying Round-up (5%) with a backpack sprayer. Fall-sown rye and springsown oat were laid down with a 2’ wide walk-behind roller in June. In mid to late June Poast Plus (2 pt/A) + 24DB (2 pt/A) were sprayed on annual medic plots to control broadleaf weeds. Prior to pumpkin planting, planting strips were tilled with a roto-tiller. Pumpkin cv. ‘Magic Lantern’ was seeded into the cover crop treatments in early July by
hand. Two seeds were planted every 2 ft. to approximate standard production practices. Seeds were established with ~8 oz. water with (10-52-10) and Admire at 2.2 oz/1000 ft. Plots were maintained with rotated applications of Bravo Ultrex @ 2.7 lb/A and Quadris @ 12.3 oz/A beginning in August. Nova 40WP @ 3.0 oz/A or Benlate 1 lb ai/A was also added to the spray program to help control Powdery Mildew. Sulfur-coated urea (39-0-0) was broadcasted @ 50 lb/A over entire plots at planting and banded at 50 lb/A at vine-tip. Pumpkins were watered with 1” drip irrigation tape throughout the growing season when necessary. At harvest all fruit from each treatment were graded according to color (orange, green) and weighed. Percentages of marketable (orange) and clean fruit were also calculated. Pumpkins were harvested during the first 3 weeks of October.

Results and Discussion
Establishment, cover crop biomass and % ground cover production: In general, fall-sown rye (90 lb/A and 50 lb/A) produced enough biomass to provide season long ground cover. Early establishment (ie. prior to hard freezes) in the fall is critical to the success of winter rye and hairy vetch as cover crop mulches. Fall-sown oat and annual medic (winter-killed) do not produce enough biomass to last the following season. However, spring-sown oat at 110 lb/A planted in late April to early May provided excellent early to mid-season ground cover. Oat tends to breakdown much quicker than fall-sown rye and its ability to provide ground cover, suppress weeds, and conserve soil moisture decreased much quicker than rye during the growing season. Annual medics established well when planted in late April to early May. Springsown annual medic ‘Sephi’ provided excellent season long ground cover whereas, ‘Parabinga’ and ‘Polygraze’ provided early, but failed to provide season long ground cover due to early senescence from summer heat, spider mites, and powdery mildew.

Pumpkin yield and fruit quality: In 2001 and 2002 marketable yield (orange fruit) on fall-sown winter rye (90 and 50 lb/A), hairy vetch (50 lb/A), and winter rye (50 lb/A ea) and spring-sown oat (110 lb/A) were comparable to slightly higher than bare soil. In both years, yield of pumpkins grown in spring-sown living annual medic cover crops were reduced. In both years, fruit cleanliness was highest on fall-sown winter rye. Springsown oat and fall-sown hairy vetch provided intermediate fruit cleanliness. Fruit cleanliness in annual medic cover crops ranged from poor to excellent depending on variety and year.

Cover crop effect on development of Fusarium fruit rot: In 2002, research plots in Fremont, South Charleston and Wooster, OH were artificially inoculated with Fusarium fruit rot (FFR) by three different methods. Method of inoculation affected severity of FFR. In Wooster, 2002, average percent yield loss (PYL), based on weight, was highest in bare soil plots (43%). PYL in springsown annual medic ranged from 21 to 37% based on variety. In hairy vetch (50 lb/A) PYL was 27% and spring-sown oat PYL was 22%. PYL was lowest in fall-sown cover crops. PYL was 9% in rye (50 lb/A), 5% in rye (90 lb/A) and 4% in rye + hairy vetch (50 lb/A ea).

Conclusions
Overall, our findings show that fall-sown rye and hairy vetch can be successfully incorporated into pumpkin production in Ohio although integration and success will depend on fall-planting date, lbs/A planted, spring kill date, and method of pumpkin planting. We find that a strip tillage system may allow for easier pumpkin planting as well as offer some leeway in the window of opportunity for spring cover crop kill. Too much rye biomass and successful kill of hairy vetch has often been a
problem. Spring-oat when planted at a high rate (110 lb/A) can also be successfully incorporated into a strip-tillagge pumpkin production system. Planting a cover crop such as oat in the spring alleviates some of the problems of a fall-sown cover crop such as having a field free for planting and helps to avoid some of the weather contingencies necessary for a successful cover crop. Although oat will not produce as much biomass as a fall-sown rye, its growth habit makes it much easier to kill with herbicides, as well as, having a much greater window of opportunity for kill. Although cover crops such as rye can provide season long ground coverage, herbicide applications will be necessary. An herbicide over mulch (HOM) study will be undertaken in 2003. Spring-sown annual medics when left as living mulches in a strip-tillage system with drip irrigation cause reduced yields. Competition for water and available N and allelopathy may all play a role, future work still needs to be done. Fruit cleanliness and PYL due to FFR was lowest in fall-sown rye and rye + HV plots suggesting that these cover crops provided an excellent physical barrier between pumpkin fruit and the soil.
Effective Use of Sprinkler Systems for Blueberry Frost Control

Charles M. "Mike" Mainland, Department of Horticultural Science
Horticultural Crops Research Station, North Carolina State University, Castle Hayne, NC.
Phone: (910) 675-2314 Email: mainland@sprynet.com

Until about 1980 there was only one blueberry farm in North Carolina with overhead sprinkler irrigation. It was used for freeze protection as well as for providing soil moisture. In the early 1980s another farm put in an overhead system that was well designed and capable of providing good freeze protection. The following spring, temperatures dropped to the low 20s or upper teens in most fields in early April. Fields without freeze protection irrigation had almost no crop while the protected field had a full crop. One spot adjacent to the irrigation went down to 18°F. Seeing this full crop convinced many growers that freeze protection irrigation was essential if they were to remain in business. Now more than 2,000 acres, representing 70 to 80% of the production, have overhead sprinkler systems for freeze protection. Based on some rough calculations, a system in North Carolina will pay for itself in five years based on freeze protection and in 10 years for protection against drought. Severe freeze damage seems to be somewhat less frequent in the Michigan-Indiana blueberry production areas than in North Carolina and farther south.

The most devastating freezes in both North Carolina and Michigan-Indiana have occurred after all blossoms have opened on all cultivars. This is during the month of April in north Carolina and June in Michigan-Indiana. Freezes at these times when fruit is developing and a few blossoms remain are the radiation type with still condition and 100% relative humidity. Only once in 34 years has there been a freeze with wind and low humidity in late March that caused severe damage to early cultivars in North Carolina. As a result of this history, the overhead systems were designed for minimum cost and water requirements to provide protection from radiation freezes.

The System: There is very little difference from system to system in North Carolina. The design became quite universal in the 1980s because many lending institutions required that Dr. Ronald Sneed, the Irrigation Specialist at NCSU, approve the plans before they would provide financing. Following is this standard design:

- Size the pvc pipe for a maximum flow rate of 5'/second.
- A 5'/second design will usually keep nozzle pressure within 5% of pump pressure.
- Put pressure gauges in end risers on the longest laterals.
- Space sprinklers 60' x 60' (or 60' x 63' if rows are 9' apart).
- Provide pump capacity that will allow a pressure of 60 psi.
- Sprinklers that will wet a diameter of at least 95' at 60 psi with 5/32" nozzles.
- This gives an application rate of approximately 0.15"/hour.
- The Nelson F33 and the Weather-Tec 10-30 are the most common sprinklers used.
- Water is usually from dug ponds and attempts are usually made to recover runoff.
- Put shielded minimum thermometers in warm, medium and cold locations at bush height.
Since wind is not a major consideration, single nozzle sprinklers have proven to be adequate. However, the single nozzle sprinkler does give a "donut" pattern with more water at the outer edge where water from the range nozzle hits. A double nozzle sprinkler with range and spreader nozzles gives a more uniform pattern. North Carolina growers have begun planting more Florida cultivars in recent years. These tend to blossom earlier when there is more chance for freeze damage. Probably one of the easiest ways to get better freeze protection, should there be some wind, is to choose a low angle nozzle that keeps the water stream lower. Designing with enough water capacity to use sprinklers with a double nozzle will provide both more uniform coverage and more frequent wetting. With single nozzle sprinklers that cover a diameter of 101' at 60 psi and the standard 60' x 60' spacing, a large area only receives water from two sprinklers. If the rotation position becomes synchronized, a large area will only be wet once each rotation which may be as much as a minute. If sprinkler spacing is reduced to 50' x 50', the area that only receives water from two sprinklers is much smaller than at the 60' x 60' spacing and does not exist at the 40' x 40' spacing. At spacings closer than 60' x 60', the Rainbird 30EH has become popular. Depending on nozzle selection, application rates can extend from the minimum recommended of 0.15"/hour to more than 0.50"/hour. Double nozzle sprinklers around the edge of the field also improves freeze protection by providing double coverage to bushes that would otherwise only get coverage from a single nozzle.

**When Should Sprinkling Begin? End?** Many factors need to go into the decision:

**Available water** must always be the first consideration as the freeze protection season begins. How many nights protection do you have if you are pumping from a pond? Will the pond recharge naturally or can you fill from a well? Our recommendation in North Carolina has been to have 2.5 nights capacity or about 25 hours with the pump at 50-60 psi. Also, a well that will deliver 0.5 nights (5 hours) water for the third night if it is started when sprinkling begins the first night. If less water is available, it is important not to use a large portion when only a small percentage of the blossoms are open than not have enough left for late freezes that will destroy a high percentage of the crop.

**Wind** is always a consideration and especially in the early part of the blossoming period. Arctic outbreaks, with wind, are much more likely as blossoming is beginning. Late February protection has been attempted a number of times in North Carolina without success. There has been no protection and in many cases more damage from sprinkling when the wind is more than 7 to 8 mph. Sprinkler icing can also be severe. Later in the season there is often some wind early in the evening that tends to subside during the night. Weather forecasts, and the location of pressure systems will help decide if the wind will continue. Late in the season it is more prudent to begin sprinkling even if there is still some wind than earlier in the season.

**Minimum temperature possibilities** should always be estimated and reevaluated. Will the temperature drop to below 28°F on the shielded thermometer before the sun rises? We have not seen damage beyond some slight browning of corollas of highbush blueberries when temperatures stay above 28°F. A constantly recording hygrothermograph with a paper chart is convenient for predicting the minimum. As the temperature drops after sunset, project the line until the time of sunrise. If it projects to below 28°F, prepare to begin sprinkling. If the humidity is nearly 100%, as it usually is on radiation freeze nights, with no wind, start sprinkling when the coldest spots in the field get down to 33°F. If there is some wind and low humidity it is safer to start at 36-37°F.
Thoroughly wet the bushes (at least the 50 psi) after starting. With no wind and 100% relative humidity, the pressure can be cut back to 35-40 psi if water is limited. As the temperature continues to drop, increase the pressure. At 30°F the pressure should be 40-45 psi. Increase to 50 psi at 28°F and to 60 psi or whatever the system will safely deliver at 25°F and lower.

**Shutting down** can be done anytime there is no ice on the bushes and the temperature rises above freezing. When there is ice, continue sprinkling until the ice begins to melt. Select a branch in the shade and try cracking the ice. It should slip freely from the branch. This indicates there is a layer of water between the branch and the ice. There have been cases when the wind began shortly after sunrise and the humidity dropped. Although the ice had begun to melt, the evaporative cooling caused additional freezing that resulted in blossom or fruit damage.

**Flower and fruit tolerance to freezing temperatures** depends on the stage. As mentioned previously, damage begins as the temperature drops below 28°F. Between 27° and 28°F, berries and flowers, where the corolla has dropped, will be killed. Unopened flowers with corollas that have reached half of their full length will be killed between 25° and 26°F. If flowers are just beginning to protrude from the bud, those flowers will withstand about 20°. As buds swell and a few blossoms appear, there is a tendency to overestimate the stage of development and want to begin sprinkler protection before it is likely to do very much good.

**Good preparation** will go a long way toward insuring successful sprinkler freeze protection. Servicing and testing the pump and engine is especially important on a system that may not have run since the previous year. Weather forecasts several days ahead will indicate a possible threat. Knowing how much colder your field can be than the nearest reporting station can also help predict the low temperature.
Update on Highbush Blueberry Production Patterns
Jim Hancock and Eric Hanson, Department of Horticulture, Michigan State University

Over 225 million pounds of blueberries are now produced annually in the world; a little over 50% is sold fresh. About 80% of the total production comes from North America (~44% fresh), 10% from Europe (~97% fresh), 5% from South America (100% fresh), and 4% from the Pacific Rim (~56% fresh).

In North America, the leading production areas in 1999 were Michigan (65 million lbs ~ 40% fresh), New Jersey (36 million lbs ~ 72% fresh), British Columbia (31 million lbs ~ 39% fresh), Oregon (21 million lbs ~ 33% fresh), North Carolina (12.5 ~ 76% fresh) and Washington (10 million lbs ~ 15% fresh). About 13% of the fruit was produced in the southern US, and 87% in the North. Michigan’s annual production has averaged 66 million lbs over the last 5 years (49 - 77 million lbs).

Worldwide blueberry acreage has risen by about 60% over the last decade, from 42,500 to 68,500. The most substantial increases have occurred in North America (40,000 to 57,500), Chile (30 to 2,500), Germany (650 to 2500), Poland (350 to 1000) and Australia (225 to 925). Chile is expected to double its acreage over the next 5 years and a significant industry is emerging in Argentina. Of all the major production regions, only New Zealand has lost acreage (1000 to 750). In North America, the largest acreages in 1999 were in the Midwest (21,000), Northeast (13,500), South (12,500) and the Northwest (10,400). California is at about 500 acres, with much greater expansion expected. Michigan’s acreage over the last decade has increased from 16,400 to 18,000.

Worldwide, the most important varieties are Bluecrop, Jersey, Weymouth, Croatan, Blueray, Elliott, Rubel and Duke. Brigetta is very important in Australia, and O’Neal in Chile. Duke has been the most actively planted variety in the last five years. In Michigan, 39% of our acreage is Jersey, 27% Bluecrop, 10% Elliott, 9% Rubel. All other varieties are less than 2.7%.
Marketing Fresh Blueberries Around the Calendar

John Shelford, President, Global Berry Farms LLC (1)
2241 Trade Center Way, Naples FL 34109
Tel 239-591-1664; Mobile 239-293-4848; Fax 239-591-8133

Blueberries - Growing! Growing! Growing!

Overview: Blueberry plantings are increasing in many countries and districts.
• Where?
• How much?
• Why?
• What does it mean?

Blueberry demand has been excellent yielding profitable prices.
• Will demand continue to provide profitable returns for the increasing supplies?
• Are there other models?
(1) Global is the largest selling and marketing organization of fresh blueberries on the globe sourcing from the majority of growing districts in the world. John has over 25 years of experience in the blueberry industry.
This is what you want to hear. Where and how is your money being spent? What are the results? First let's review for newcomers and others who might have forgotten. All U.S. highbush blueberry growers voted in April of 2000 to assess themselves six-tenths of a cent per pound for promotion and research. The referendum passed with 73.2% of volume in favor.

Please note, we can only do promotion and research. We cannot do anything politically such as influencing decisions on school lunch and other government programs. Also we are prevented from soliciting governmental bodies about environmental and pesticide issues. That is why it is so important to keep the North American Blueberry Council strong and well funded. NABC handles these responsibilities for the industry. We would like all of you blueberry growers to support both organizations.

How much money is collected and where does it go? USHBC collected $1,112,130.00 on the 2001 crop. Imports are collected at the time of entry into the U.S. by customs at six-tenths of a cent per pound, the same as U.S. production. The first year USHBC budget for use in 2002 was

<table>
<thead>
<tr>
<th>Item</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>US Promotions</td>
<td>$555,300</td>
</tr>
<tr>
<td>Imports Research</td>
<td>$85,426</td>
</tr>
<tr>
<td>MAP funds Industrial Relations</td>
<td>$15,000</td>
</tr>
<tr>
<td>USDA Program Fees</td>
<td>$164,411</td>
</tr>
<tr>
<td>Administration Reserve</td>
<td>$265,868</td>
</tr>
<tr>
<td>Reserve</td>
<td>$125,095</td>
</tr>
</tbody>
</table>

The following programs were used to bring the wonderful blueberry story to everyone. Blueberries are easy to use, healthy and always available. They look and taste good and are traffic, image and profit builders.

**CONSUMER/FOOD SERVICE** – Print Media and Materials, Radio/TV placements, Web Site, Food Service, Retail, Professional Education. Through these media the following programs are being used: Blueberry Press kits, Spanish Language Press releases, Healthful Blueberry Recipe Leaflet, Taste for the Blues Info Folio, TV with Green Grocers, Spanish TV/Radio, Health Message radio tour, Teachers Guide, Professional Culinary School Mailings, 500 Supermarket Chain Produce Buyers, Managers, Ad Directors information, recipes, photo program.

**FOOD MANUFACTURES CAMPAIGN** – Blueberry Tech Center, USHBC Web Site, Trade Publicity and Shows, School Food Service/Military Promotion. Through these channels the following programs are used: Toll-free hot line for Manufacturers, Web Site up date/ expand
Spanish, Portuguese, French, Scandinavian sites, Health oriented blueberry stories in food Manufacturers' publications in U.S, Canada, Mexico. "Berry Latest" Newsletter to 7000 subscribers, Cereal Chemist Show- Montreal, ABASTUR Food Show- Mexico City,

**Food Technologist Shows** - Oakland May, Pennsauken November, Presentation "Blue Bar" high energy bar concept through mailings and School/Military food service meetings.

**MAP EXPORT PROGRAM-- JAPAN, TAIWAN, ICELAND**

Were using Web Sites, Trade Meetings, Trade Ads, In store Promotion , to reach the Customer. Market evaluation are use to measure programs progress and direct future actions.

**RESEARCH PROGRAMS** – (1). Localization of Fruit Polyphenolics In Vitro- Beneficial Biological Actions. Dr. Jim Joseph Tufts University; (2) 5 -A-Day Phytochemical Data Base. USDA(ORAC) Tufts Univ. USDA Lab (flavonoid) Beltsville; (3) Effect of Blueberries and Antioxidants on Suppression of Exercise and Heat Induced Oxidative Stress. Appalachian State University, North Carolina; (4) Mechanisms Involved in Beneficial Effect of Blueberries on Cognitive and Motor Behavior, USDA, Tufts Univ. Dr. Jim Joseph. The programs are strong, but are always under review to make certain that we anticipate the changes in the consumer, the industry and new every changing markets and technologies.

Based on best estimates income from the 2002 crop, with reserve and carry-over, plus increase Map funds income should be near 1,500,000, with 1,300,000 budget, 200,000 reserve for 2003. The 2003 program will continue to build on past success. Keeping the American consumer first, But directing strong efforts to the foreign customer. More direction will be given to trade show, food and manufacturers meetings.

What are the results of all this money and efforts? Let's look at markets and production. 2001 crop Highbush 227,300,000 Lowbush 175,000,000 Total 403,000,000. 2002 Estimated Highbush 223,000,000- Lowbush 146,000,000 Total 365,000,000. 2002 carry-in highest in many years. 2002 was a profitable year in the blueberry industry. Carry-into 2003 will be down.

Blueberries were the health talk of TV, Newspapers, Magazines and Doctors' offices. Everyone was talking about the No.1 fruit in Antioxidants and it's other health benefits.

Where can we go? It gets better. The British fed their the pilots in WW2 billberries,[a cousin to our Blueberries] because they help in night vision. The Japanese now claim blueberries help their eye problem. By the way blueberry sales to Japan have grown from 1,200,000 in 1993 to 16,700,000 in 2001. NABC was working on market development there in the 80's. It gets even better. Primary tests suggest that the Polyphenolics in blueberries may protect blood cells. There are other wonderful benefits that our blueberries contain.

Great things are ahead-- Good Crops-Good Markets-Good Profits--Great Promotions and Research. Be a working part of USHBC and the NABC. Please support your Blueberry and Agriculture Industries - on your farm, with your customer, at all times. Our food system is what keeps America strong.
Japanese Beetle Biology and Management Options

Rufus Isaacs, Department of Entomology, Michigan State University, East Lansing, MI 48824. email: isaacsr@msu.edu

This talk will cover the biology of Japanese beetle, with a focus on the aspects of its biology and typical blueberry production that contribute to its status as a leading pest of Midwest blueberries. In the past few years, a series of research projects have addressed the issues in the list below.

1. Density of Japanese beetle grubs in Michigan blueberry

2. Relative abundance of grubs in and around fields

3. Effect of clean cultivation

4. Potential of cover crops for suppressing Japanese beetle while retaining soil structure

5. Soil insecticides for control of grubs

6. Use of monitoring traps to intercept beetles and prevent them reaching bushes

7. Foliar insecticides for control of adults

8. Use of botanical insecticides with short PHI to prevent contamination of harvested fruit

In this talk, I will present the results from these experiments, and describe how growers can take an integrated approach to adopt these tactics on their farms for long-term suppression of Japanese beetle.
Strategies to Control Brown Rot on Stone Fruit

Guido Schnabel, Clemson University, Department of Plant Pathology and Physiology
218 Long Hall, Clemson, SC 29634; phone 864 656 6705; e-mail schnabe@clemson.edu

Brown rot of peach is caused by the fungus *Monilinia fructicola* and is probably the most destructive disease in stone fruits (1, 2). Estimates of disease losses during an epidemic in Georgia peach production areas for 2001 were $4.3 million in direct losses and $1.5 million in fungicide costs. Control of the brown rot disease usually starts with two bloom sprays to control blossom blight, followed by three preharvest applications to control fruit rot and one postharvest application for shipped peaches.

Inoculum production and possibilities for reducing sprays. For the development of disease the presence of inoculum is a prerequisite. Four important sources of the brown rot fungus have been identified. During bloom, spores originate from decaying fruits on the ground, either in peach orchards or under wild hosts such as wild plums near the orchard. Smaller numbers of spores also may arise from infected twigs or decaying fruits in trees. If these sources of inoculum can be eliminated, reducing or even omitting blossom sprays becomes possible. Reduction or even elimination of blossom sprays would save the cost of expensive material plus the cost of application because insecticides are not applied during bloom. After bloom, some developing fruits fail to mature, die, and remain attached to the twigs. That fruit becomes susceptible to brown rot. Also, when peaches are thinned those that lie on the ground may become infected, especially if thinned after pit hardening. All of these infected fruits may produce huge numbers of spores for infection of ripening peach fruits. In addition wild hosts are important for brown rot outbreaks as fruits ripen. Infection of immature fruits in the tree or on the ground can be prevented by (i) fungicide sprays, (ii) thinning fruits before pit-hardening, and (iii) elimination of sources of spores outside the orchard. The latter is especially important because these sources are active no matter how well the orchard is maintained. All such hosts near peach orchards must be destroyed if numbers of sprays are to be reduced.

Preharvest fungicide applications for brown rot control. There are several fungicides available for the control of preharvest brown rot. In our experience, the demethylation inhibitor fungicides (DMI fungicides) such as Indar and Orbit perform consistently well especially in years with high disease pressure (Table 1).

Do we have to worry about DMI fungicide resistance in *M. fructicola*? In 2001 and 2002 *M. fructicola* isolates were collected from commercial orchards in South Carolina (SC) and Georgia (GA), respectively. The isolates had been treated with DMI fungicides for more than a decade on a regular basis and were taken from sites where growers identified brown rot hot spots. Isolates were also obtained from an abandoned orchard (DL) in South Carolina that had never been sprayed with DMI fungicides before. All isolates were tested for sensitivity to propiconazole (the active ingredient of Orbit). The results show that all SC isolates and most of the GA isolates were just as sensitive to
propiconazole as the DL isolates with a few exceptions (Fig. 1). The reduced sensitivity to propiconazole of some isolates from GA was compared to the reduced sensitivity to propiconazole of isolates collected in 1995 and 1996 (3). It was concluded that the level of the observed reduced sensitivity has not increased over the last six
to seven years and should not cause control failures in commercial peach orchards (3). Therefore, DMI fungicides such as Indar, Orbit, and Elite are still safe to use for brown rot control in southeastern stone fruit production areas in coming years. However, monitoring *M. fructicola* populations on a regular basis is critical for making sound disease control recommendations.

**Table 1.** Brown rot incidence on nectarine fruit after 2 preharvest applications of test material.

<table>
<thead>
<tr>
<th>Control</th>
<th>Brown rot %</th>
<th>2001</th>
<th>2002</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>50 a</td>
<td>60 a</td>
<td>5.2 a</td>
</tr>
<tr>
<td>Indar 2 oz, 16 flozs</td>
<td>1.4 c</td>
<td>1.4 c</td>
<td>2.6 a</td>
</tr>
<tr>
<td>Orbit 4 flozs</td>
<td>2.4 c</td>
<td>2.8 c</td>
<td>1.0 a</td>
</tr>
<tr>
<td>Captain 8 lb</td>
<td>10.6 be</td>
<td>17.4 be</td>
<td>2.6 a</td>
</tr>
<tr>
<td>Captain 6 lbs/Indar 4 flozs</td>
<td>2.1 c</td>
<td>2.5 c</td>
<td>1.0 a</td>
</tr>
<tr>
<td>Abound 15.4 flozs</td>
<td>8 be</td>
<td>11.1 be</td>
<td>6.2 a</td>
</tr>
<tr>
<td>Elevate 1.5 lbs</td>
<td>17.3 b</td>
<td>21.9 b</td>
<td>3.6 a</td>
</tr>
<tr>
<td>BA 3 516 0.656 lbs</td>
<td>5.2 c</td>
<td>9 c</td>
<td>2.6 a</td>
</tr>
<tr>
<td>BA 3 516 0.92 lbs</td>
<td>5.6 c</td>
<td>8.3 c</td>
<td>2.1 a</td>
</tr>
</tbody>
</table>

**Figure 1.** Sensitivity of *M. fructicola* isolates to DMI fungicide propiconazole. DL isolates derived from an abandoned orchard in South Carolina and had never been treated with DMI fungicides. SC and GA isolates were collected from brown rot hot spots in South Carolina and Georgia, respectively.

**Literature**
### Promising Sweet Cherry Varieties for the Eastern US

Robert L. Andersen, Professor of Horticulture, Dept. of Horticultural Sciences  
Geneva Experiment Station, Cornell University, Geneva, NY 14456

<table>
<thead>
<tr>
<th>Varieties by Maturity Season</th>
<th>Key Evaluation Traits*</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Early</strong></td>
<td></td>
</tr>
<tr>
<td>Cavalier (d)</td>
<td>Shy</td>
</tr>
<tr>
<td>Cristalina (d)</td>
<td>Hardy?, New</td>
</tr>
<tr>
<td><em>(Unfortunately no early white processing variety available!)</em></td>
<td></td>
</tr>
<tr>
<td><strong>Mid-early</strong></td>
<td></td>
</tr>
<tr>
<td>Sam (d)</td>
<td>Q-, Soft</td>
</tr>
<tr>
<td>Columbia (d)</td>
<td>New</td>
</tr>
<tr>
<td>BlackYork™ (d)</td>
<td>Sz-</td>
</tr>
<tr>
<td>Emp. Francis (w)</td>
<td>Sz-</td>
</tr>
<tr>
<td>WhiteGold™ (w)</td>
<td>New</td>
</tr>
<tr>
<td><strong>Mid-late</strong></td>
<td></td>
</tr>
<tr>
<td>Attika (d)</td>
<td>OvS, Frost, Pit'</td>
</tr>
<tr>
<td>BlushingGold™ (w)</td>
<td>New</td>
</tr>
<tr>
<td><strong>Late</strong></td>
<td></td>
</tr>
<tr>
<td>Regina (d)</td>
<td>Shy, Pol?</td>
</tr>
<tr>
<td>Starks Gold (w)</td>
<td>Pol?, Sz-</td>
</tr>
<tr>
<td>Sweetheart (d)</td>
<td>OvS</td>
</tr>
</tbody>
</table>

*Abbreviations – Bob Andersen's professional opinions about positive and negative traits (as determined by at least 7 seasons' observations at Geneva)*

- **BCT+** = bacterial canker tolerance is above average at Geneva
- **(d)** = dark fleshed
- **Hardy** = wood hardiness above average at Geneva
- **Hardy?** = wood hardiness has shown signs of weakness @ GES
- **LoCrk** = low fruit cracking
- **New** = variety has been tested & proven to be very good at Geneva for 7 or more seasons but it has not yet been grower-tested in NY or similar climes
- **OvS** = over-sets causing reduced size, variable ripening, less Q
- **Pit?** = poor pit characteristics for processing uses
- **Pol** = pollinate other varieties well if same season bloom time
- **Pol?** = sometimes difficult to pollinate effectively
- **Pro** = processing-type, meaning heavy yielding, but fruit size medium or less
- **Q** = high quality (a combination of taste & texture)
- **Q -** = inferior quality for fresh use
- **Q+** = best quality fruit of varieties we have tested
- **Red** = red, not mahogany or black skin
- **Rel** = reliable, consistently crops very well @GES
- **Shy** = shy cropping, meaning slow to crop & needs extra pollenizer trees
- **Soft** = soft flesh
- **Sz-** = size is questionable for fresh uses
- **(w)** = white fleshed
Managing Water and Nutrition in High Density Sweet Cherry

Gerry Neilsen, Research Scientist, Soil Fertility and Plant Nutrition
Denise Neilsen, Soil and Water Management
Agriculture and Agri-Food Canada, Pacific Agri-Food Research Centre,
Summerland, British Columbia, Canada
E-mail: neilsen@agr.gc.ca or neilsend@agr.gc.ca

Introduction
The work to be reported grew out of a conviction that field trials to investigate the nutrition and water requirements of sweet cherry were limited compared with apple or peach. This is particularly true for the newer, dwarfing rootstocks. Gisela 5 (G.148/2) is one such promising cherry rootstock for which, however, reduced fruit size relative to fruit on F12/1 has been reported (Franken-Bembeck, 1998). Considerable recent research by our group has been undertaken on managing apple orchard nutrition by applying fertilizers directly with the irrigation water (fertigation) (Neilsen et al., 1999) and we were interested in extending this research to cherry.

This presentation will summarize results from the first 5 growing seasons of an experimental planting of Lapins/Gisela 5 planted in 1998 with their objectives of determining the effects of fertigation and irrigation management on nutrition, vigor, yield and fruit quality of the cherry trees.

Methods
Eight annual irrigation/nutrition treatments were established the year of planting. Fertigation treatments included (1-3) three concentrations of fertigated N (42, 84 and 168 ppm), generally applied 8 weeks past full bloom as calcium nitrate; the medium fertigated N rate was also applied with (4) P as ammonium polyphosphate in early spring or (5) with K as potassium chloride fertigated usually in June; (6) N, uniformly broadcast at 75 kg N per ha ammonium nitrate in a 1 m wide strip centered on the tree row; also (7) with broadcast N followed by the medium rate of fertigated N applied 4 weeks postharvest, usually in August; and (8) the medium N rate but drip-irrigated for 8 weeks, post full bloom.

Irrigation for treatments 1-7 was applied via Dan 2001 pressure compensating microsprinklers (PSI Irrigation, Fresno, CA) located between trees in the tree row. Irrigation was applied in treatment 8 via 4 x 4 litres/hour pressure compensating tree emitters located at 0.7 and 1.3 m on both sides of the trees within the tree row. Throughout the experiment, irrigation was scheduled according to evaporation as measured by an atmometer (ET Gage Co., Loveland, CO) with irrigation rates manually adjusted to account for the previous day’s estimated water use.

The experimental orchard was located on a gravelly, sandy loam, a common fruit-growing soil series located throughout the southern part of the Okanagan Valley. These soils generally drain rapidly, have low water-holding capacity, low organic matter, low N and P content, neutral pH and overlay coarse-textured subsoils ranging from gravelly loamy sands to loamy sands.

Results
Water application – Much less water was applied in the drip irrigation treatment relative to the treatments involving sprinkler irrigation. For example, in the 2001 growing season, irrigation via the drip system applied only 20% of the water applied by sprinklers. Thus a major difference between the two irrigation systems has been a marked decrease in soil moisture content toward the grassed tree alley in drip-irrigated plots. Reduced soil moisture content in the drip-irrigated treatments commenced about 1 ½ feet from the tree row and was particularly pronounced within the alleyway between the tree rows.

Tree and vigor yield – The predominant growth effect observed in the experimental block was a reduction in the size of the drip-fertigated trees. Smaller trees resulted from the restriction in volume of the optimally wetted portion of the soil for the drip-irrigation treatment. There were however, for the initial fruit harvests, no effect of reduced tree vigor on total tree yield, implying a higher yield efficiency for drip-irrigated trees. In 2001 (a heavy cropping year) fruit size was reduced by about 10% as N-fertigation rate increased from low to high and by about 20% for the drip fertigated trees.

Tree nutrition – Microsprinkler fertigation has been effective at augmenting tree N-nutrition but less effective for improving tree P and K nutrition. Leaf P and K concentration also tend to decline when high rates of N are fertigated. Leaf K also shows marked decreases over time for drip-fertigated trees, implying an orchardist should be alert to the possibility of the development of K-deficiency for drip-irrigated cherry grown on dwarfing rootstocks. Although few effects of treatments on the tree micronutrient nutrition were observed, attention to maintenance of adequate Zn nutrition should be a constant concern.

General comment – Specific data will be presented from this ongoing research trial in order to illustrate possible general strategies for improved nutrient and water management of high density sweet cherry planting systems.

Literature cited
Processor Viewpoint on the Tart Cherry Federal Marketing Order

Glenn Rogers, Director of Agriculture for Fruit, Agrilink Foods
Alternate Processor Representative, Cherry Industry Administrative Board.

My assignment today is to share a perspective of the FMO from a processor point of view.

First, keep in mind that all processors are not created equal, nor do they all have the same goals.
• Some cherry processors create an ingredient for someone else to create a product that will ultimately be sold to a consumer. Examples would be 5+1 or IQF for further manufacturing.
• Some processors create product for retail sale directly to consumers. Examples would be retail pie filling, retail packaged dried cherries, retail packaged IQF, and retail packaged juice or concentrate.
• Many processors create mix of these products.
• Also there processors for whom cherries are the only thing they produce, and processors for whom cherries are a very small part of what they produce.

None of this has changed since the advent of the Marketing Order.
• Prior to the marketing order some processors were not strong marketers. The order has not changed this.
• Prior to the marketing order some processors were not sound financially. The order has not changed this.

What has changed is that processors, who prior to the order sold the raw product that they packed each year, now have to handle restricted tonnage at a cost to them and their growers. This includes the practice of packing reserve inventory which is not available to the market, participating in less profitable markets than in the past in order to receive diversion credit, purchasing excess credits from another processor, or growers having to destroy fruit.

What also has changed is that processors who continually packed product they could not sell now have the ability to put that excess product in a reserve position and in many cases encourage their growers to finance this pack.

While all of this may sound negative, the FMO has bought the industry some survival time.

The question that continues to plague the industry and the Board I believe is how to make sure that everyone survives, which begs the question, should everyone survive in an oversupplied commodity?

One area in which the Order has not been effective is that of increasing demand. While we have increased grower and finished product returns, I feel that the numbers show that we have hit the ceiling in terms of the demand at current pricing.
When deciding whether to support the order, growers and processors are going to have to decide whether they can accept the last 5 years levels of returns, or are they willing to get bloody, watch some segments go by the wayside, and let the survivors prosper. I will leave this decision to those of you who will vote next spring.
Promotions: Sowing Excitement, Reaping Profits

Jane Eckert, Principal, Eckert AgriMarketing, 8054 Teasdale, St. Louis, MO 63105
Tel. 314-862-6288 – E-mail: jane@eckertagrimarketing.com
WWW: www.eckertagrimarketing.com

Now that you've expanded your farm and retail enterprise, how do you impact net profits? Grow beyond business as usual - and straight advertising - to special promotions that build excitement and increase sales.

Promotions are important because they attract new customers, create loyalty and increase average sales per person. Promotions can be either very simple or very complex, depending on the amount of budget you have and the resources of manpower. Either way, it is worth your while to create and implement promotions both at the farm and off the farm.

On-farm Promotions
- Contests and Giveaways
- Special Pricing and Discounts
- Featured Guests & Seminars
- Tastings & Recipes
- Drawings
- Loyalty Programs
- Liquidation
- Special Shopping Events for "VIP" Customers
- Early Bird Specials
- Seasonal Cross Promoting

Off-farm Promotions
- Sponsorships
- Cross-Promotion Partnerships
- Couponing
- Posters and Literature
- Charitable Donations
- Public Events and Shows
- Become a local expert

Publicizing Your Promotions
- Press Releases
- Web Site
- Advertising
- Newsletters
Whether it's in-store or in the community, these are special approaches to highlighting and selling your products that create new and loyal customers. Think outside the box - and outside the field - to jumpstart your season, keep your customers coming for more and increasing sales per customer.
Producing Onions in Oswego County, NY
Jan van der Heide, Cornell Cooperative Extension of Oswego County
3288 Main Street, Mexico, NY 13114
phone: 315-963-7286 – e-mail: jjv7@cornell.edu

Muck onion production in Oswego County probably bears a lot of similarity to muck onion production in other areas of the Northern US. There are several climatic conditions, however, that set Oswego County apart from other production areas in New York State, and probably onion production in other states.

Oswego County is located just north of the city of Syracuse, and most muck is located within a few miles of Lake Ontario. As in Michigan, the down-wind location from one of the great Lakes results in fearsome Lake Effect snowfall, blanketing most of the production areas in several feet of snow at a time, with annual snowfall exceeding 100 inches every year.

The heavy snow cover keeps fields cold and wet until late in the spring, and Oswego County growers are the last ones to plant their onions in the US, and only growers in Ontario plant later. At the same time, the proximity to a large body of water helps moderate summer temperatures. Moderate temperatures and adequate moisture usually result in even rates of crop development and reliable yields of 900 - 1000 bushels/A of excellent quality and acceptable size. The length of the growing season is relatively short, however, at about 115 days.

Acreage
In New York State, onions are produced on approx. 14,500 acres of muck, and a few hundred acres of upland soils. In Oswego County, we grow onions on about 2,300 acres of muck, and about 100 acres of upland soils. The majority of the acreage is planted to yellow storage onions, about 400 acres is planted with red onions, with an additional 300 acres planted in sweet spanish onions.

Soils
Muck in Oswego County is primarily of the woody type, with pH ranging between 5.2 and 5.8. The depth of muck deposits ranges from over 40 feet on the deepest mucks, to less than 2 ft on the older and shallower muck. The oldest fields have been in production for over 100 years, and the youngest muck is about 10 years old. Oswego County could expand production to at least 40,000 acres, but, as is the case anywhere in the USA, muck farmers in New York State can not clear any new muck as the result of the Wetland Protection Act. As a result, soil resources for onion production are depleting, and the acreage of productive muck is declining. Onion production on upland soils is increasing, but upland onion production is very difficult without adequate irrigation.

Planting
Onions are seeded between April 20 and May 10, and harvest begins in the middle of August with the early varieties and extends into early October. Onions are planted on both raised beds and "on
the flat”, with each farm using its own configuration of row spacing and bed width and height. Seeding is done with Stanhay belt seeders, using pelleted seed. Several farms are using film-coated seed and vacuum seeders, like Gaspardo or Monosem. All growers use a liquid drench system to deliver fungicides and insecticides, and other amendments to the seed furrow.

A significant portion of red onions and spanish onions is produced from bare root transplants. Transplants are produced in Florida or Arizona and are planted in the Oswego area in the early part of May. Transplanting is done with modified celery planters, or by hand.

**Pest Control**

Most seed is treated with ProGro for control of Onion Smut, and growers add fungicides to the liquid drench for control of damping-off organisms and Onion Smut (Mancozeb @ 3 lb/A) and Pythium (Ridomil Gold @ 0.5-1 pt/A).

Onion maggot is controlled with either Trigard as a seed treatment, or with Lorsban in the drench.

The most important foliar diseases include Botrytis Leaf Blight, Alternaria Purple Blotch, and Stemphylium. On cold and wet years we also have some problems with Downy Mildew. The usual fungicides (Mancozeb, Bravo, Quadris, etc.) are applied on a regular basis, starting by mid-June and continued trough harvest, with good succes.

Other fungal diseases that can cause losses are Botrytis Neck Rot and Fusarium Basal Plate Rot. These diseases are often limited to red onions, especially on years with a wet fall (Neck Rot) or on years with a hot and dry summer following a wet spring (Fusarium).

In addition to onion maggot, growers experience problems with onion thrips. The weather in Oswego County tends to be cool due to close proximity to Lake Ontario, and the build up of thrips populations is not nearly as rapid as in Orange County. Frequent rains help to suppress thrips as well. Insecticide sprays for thrips include Warrior and Lannate. In winter and early spring it is not difficult to find onion thrips in storage and grading facilities, or on cull piles.

The use of Trigard as seed treatments has made some onions vulnerable to seed corn maggot damage. The incorporation of green cover crops, or heavy weed populations, attracts seed corn maggot adults and encourages oviposition in these fields. Losses to seed corn maggot are sporadic, but can be devastating.

Losses to bacterial diseases are usually small, and include decay caused by Sour Skin bacteria and sometimes Slippery Skin. Soft Rot bacteria can cause minor storage losses, but are usually secondary pathogens.

**Harvest**

Storage onions are treated with sprout inhibitor and undercut in the field. After onion necks are dry onions are harvested with AirFlo harvesters and collected in 20 bushel bins. The bins are stacked and covered in the field, and onions are allowed to cure for several weeks.
Some growers harvest onions in bulk trucks and remove trash before onions are transferred to 20 bushel bins. In this case, onions are left to cure in bins on a separate gravel pad.

Most red onions and Spanish onions are harvested by hand, and Spanish onions are often cured in dryers using forced and heated air.

**Storage**
Onions are stored in common storage buildings, equipped with roof vents and side vents. Some storage buildings are equipped with automatic ventilation systems that help to regulate temperature and humidity levels in the storage, but in the majority of cases temperature and humidity levels are manipulated through opening and closing doors and operating ventilation fans by the grower himself.

In Oswego County, there is only one bulk storage building, and it is not in use this year because of the light crop.

**Marketing**
Onions are marketed from September through April, and are sold primarily to re-packers and brokers, either in 50 lb sacks or in 20 bushel bins. Onions from Oswego are sold through markets and chain stores from Maine to Florida, and on some years a sizeable portion of the crop is exported to the Caribbean Basin. As is the case everywhere, growers from Oswego are supplying a saturated onion market, and the availability of large volumes of onions from western production areas and Quebec, has depressed prices and is reducing farm profitability.
Weed Control in Onions
Bernard Zandstra and Michael Particka, Michigan State University

Preemergence and postemergence weed control trials were established at the MSU Muck Research Farm in Laingsburg, MI in 2002. Overall, weed control was good and there was very little crop injury with the warm, dry growing conditions. Preemergence application of Prowl 2 lb/acre followed by Outlook and/or Dual Magnum gave good season-long control of most weeds, including yellow nutsedge, and highest yields. Outlook 0.98 lb/a (21 fl oz) applied preemergence and at the 2-leaf stage may have reduced yields slightly. If Outlook was applied only after the 2-leaf state, there was no reduction in yield. Valor applied at the 2-leaf stage or later caused no injury and gave good yield. Spartan 0.1 lb reduced onion yield.

In the postemergence trial, Goal applied twice at 0.25 lb/a gave good weed control and good yield. Valor was safe postemergence at 0.032 - 0.047 lb ai (1-1.5 oz) per acre. A tank mix of Goal and either Poast or Select, plus NIS gave good broad-spectrum weed control and good yield.

We continue to anticipate a federal label for Outlook on dry bulb onions. Please see Extension Bulletin E-433 for current recommendations.
Thrips are a recurring nuisance for onion growers. Some years, however, thrips are especially abundant and their damage especially severe. Such was the case in the latter half of the 2002 growing season in Michigan. Where do thrips come from? Why do they sometimes appear in huge numbers? What can be done about them?

Thrips are very small insects with a unique mouth that enables them to scrape the outer surface of plants and then suck the juices. There are different kinds of thrips, some specific to certain plant species. Most thrips attacking onions in Michigan are onion thrips, *Thrips tabaci*. Notwithstanding their common name, onion thrips can be found on a variety of vegetable and non-vegetable crops, including corn, vine crops and cole crops. They occasion produce economic damage to cabbage and vine crops, but their most significant impact is on onions.

Thrips overwinter as eggs in weeds, small grains and cull onions and sometimes as adults on onions in storage. In the spring and early summer they are present on a many kinds of plants. Although they are probably present in low numbers on onions early in the season, they tend to become abundant in July and August. Thrips thrive in hot, dry weather conditions. High temperatures speed up their life cycle and abundant offspring are produced quickly. In addition, dry weather removes a major source of mortality; rain, especially heavy rainfall, may wash the majority of thrips off the plant and drown them.

A couple of factors complicate thrips control on onions. First, most of the thrips on a plant are found at the base within the leaf axils, safe from insecticide sprays. Second, if exposed to insecticides repeatedly, thrips populations can rapidly develop resistance.

Thrips management depends on early, regular and effective scouting to detect populations before they become unmanageable. Insecticide applications should be made to maximize coverage and to ensure that as much as possible of the pesticide reaches the base of the foliage. The risk of insecticide resistance can be minimized by alternating between different chemical classes of insecticides, such as Lannate alternated with one or more pyrethroids (Ammo, Warrior, Mustang, etc.). In the future, promising new insecticides that provide effective control with minimal disruption to natural enemies may become available.
Onion Variety Evaluation Trials and Nutrient Management Tips
Darryl D. Warncke, Department of Crop & Soil Sciences
Michigan State University, East Lansing, MI 48824-1325

Variety Evaluations
In 1999 the Michigan Onion Committee initiated an onion evaluation program for new and recently released onion varieties suitable for growing in Michigan. Seed companies provide seed of their entries for planting in commercial onion fields at three locations; the Byron Center area, the Grant area and the Eaton Rapids area. Throughout the growing season each variety is rated for vigor and growth habit, occurrence of pesticide injury, disease, and insects. Relative maturity is rated by estimation of percent tops-down 7 to 10 days apart as the onions approach maturity. Occurrence of pink root has also been evaluated at this time. Onion bulbs are harvested, hand-topped, graded by size and placed in storage for evaluation in early February. In 2002 the 15 varieties were grown near Bryon Center and 12 were grown near Marshall. Wind severely thinned the stands at the Byron Center site. Stands and growth were very good at the Marshall site. Samples of the evaluated varieties will be on display during the onion session.

Nutrient Management
Nitrogen, phosphorus, potassium, manganese and copper are the key nutrients to be managed in the production of onions. Soils used for growing onions generally contain adequate amounts of the other essential elements. Each 100 cwt of onion bulbs contains about 25 lb N, 12 lb P2O5, and 25 lb K2O. The soil system can supply a significant portion of the nutrient requirements of crops depending on its nutrient status. The nutrient status can be determined by collecting representative soil samples and having them analyzed. A soil test provides the information necessary to develop a cost effective nutrient management program. The first item to check is the soil pH. If it is below 5.3, apply lime at the recommended rate and incorporated into the rooting zone of the soil. Broadcast and incorporate prior to planting all the needed potassium and any phosphate needed above that applied in the planting time fertilizer. Placement of 40 to 50 pounds of nitrogen and phosphate 2 inches below the seed and no more than 2 inches to the side of the seed enhances early growth. Placement of single band midway between two lines of onions 4 inches apart is effective. A single band midway between lines more than 4 inches apart is less effective. This placement is important because there is limited early lateral root growth. Inclusion of manganese (1-2 lb/a), copper (0.5 lb/a) and sometimes zinc (0.5 lb/a) may also benefit early growth and ultimate crop quality. Sprays of manganese (Mn) to the onion foliage are very beneficial even when Mn is included in the soil-applied fertilizer because of its limited availability in organic soils. Foliar Mn sprays are most beneficial when applied early, prior to the 4 true leaf stage. Regular Mn sprays (0.5 to 2 lb/a) every two weeks up to bulb initiation will improve plant health and bulb size. Inclusion of molybdenum in the first two early sprays may also contribute to early plant vigor.

An onion crop will generally utilize 150 to 160 lb N/a. If 40 to 50 lb/a is applied at planting time this leaves 100 to 120 lb to be topdressed. Splitting the topdress nitrogen between two applications may more effective and reduce the risk of loss than a single large N topdress application.
Depending on the development of the onions make the first application between June 1 and 15, and the second between June 25 and July 5. Organic soils in which onions are grown can release significant amounts of nitrogen, over 100 lb N/a prior to July 1. Doing a soil nitrogen test prior to supplemental N application will indicate how much nitrogen is already present in the soil and how much additional nitrogen to apply. There have been years when the soil released sufficient N so that no additional N was needed, and investment in topdress N fertilizer was not necessary. In wet years where N loss was significant the N soil test may indicate the need for more N than normally applied.

When stress conditions occur foliar nutrient sprays may be beneficial in maintaining plant health. Nitrogen (up to 5 lb N/a) and manganese (1 lb/a) are the most beneficial. Some calcium, copper and zinc may also provide some benefit. In field studies foliar application of phosphorus and potassium have not proven beneficial when adequate levels are present in the soil.
Produce Branding: Can it Work for Onions?
Jan van der Heide, Cornell Cooperative Extension of Oswego County
3288 Main Street, Mexico, NY 13114
phone: 315-963-7286 – e-mail: jjv7@cornell.edu

Onion growers in New York, as well as anywhere else in the US, face a saturated onion market where onion prices have come under a lot of pressure. Stagnant prices and rising costs of production result in declining farm profitability.

To address declining profitability, business owners have to examine several strategies to increase profitability of a mature product in a mature market:

1. Increase production
2. Increase production efficiency and lower production cost
3. Increase demand

Increasing production in a mature market will lead to lower prices, and does not appear to offer relief without implementing other strategies first. Lowering production costs and increasing production efficiency have been the standard approach to improving farm profitability, but this strategy can only improve farm profitability if prices remain constant. Improving production efficiency, however, tends to lead to more overproduction, and tends to depress prices even further.

Stimulating sales of any mature product relies on the introduction of novel products, by building the perception in the consumer's mind of added value, and through consumer education.

The work of the National Onion Association provides generic information about onions, and the work of grower associations around the country have resulted in an increase of per capita onion consumption to over 18 lbs, up from about 10 lbs annually, over the last 25 years. Increasing consumption is surpassed by increasing production, however, and only the most productive land with its associated lowest cost of production remains profitable, while less productive land is breaking even or operating at a loss.

An essential part of increasing consumption, and sales, is communication with consumers. In produce commodities, producers can communicate with consumers effectively through Branding. Several well-known brand exist in the produce industry and have been used successfully to increase or maintain sales (Sunkist, DelMonte, Chiquita, Ocean Spray, etc.).

Branding, when done well, takes a lot of time and effort and money, but offers opportunities when increasing production and production efficiency have been exhausted as means of increasing farm income.

Theory of Branding
Branding is more that a name and a logo, and branding is more than just advertising. Branding is the combination of product differentiation and marketing. Product differentiation relies on a product's...
attributes (distinct qualities) and on consumer perception of these attributes. Marketing takes the product differentiation and establishes and supports a differential value (higher price than generic product). This differential value becomes the "Brand Equity".

All things (onions, for example) are equal until "Branding" occurs. Branding adds a premium value, and this "Brand Equity" is equal to the premium that consumers are willing to pay for your product vs. the competition. The "Pay" can mean money (higher prices) and loyalty (market share).

**Benefits of Branding**

To Consumers, branding provides familiarity and structure: it is easier for consumers to choose products they know and trust. Also, brands help reduce risks to consumers, because they trust that the product will work right, taste good, look better and last longer.

For companies, branding creates a unique identity and opportunities to extract a market place premium. In addition, branding helps to ward off competitive attacks and price pressure, and new product introductions and line extensions are supported by brand recognition. Overall, brand marketing is an additional source of revenue generation.

As stated earlier, branding will require a lot of effort and money, primarily in creating and managing a Brand Image. Organizations that successfully manage their brands focus on three key brand strategy principles: Clarity (Clear Identity, Who we are), Coherence (How we present ourselves) and Control (How we ensure consistency). Building a successful brand will require for your company to make an emotional connection with consumer to provide differentiation of your brand, to develop and use key messages, create a distinct identity (name, logo, etc), and to develop a communications plan.

**Branding Strategy**

In order for you to introduce a new brand successfully, you will need to find out what is most important to your target consumer, and how you can support that. You will need to differentiate your product in terms of consumer perceptions and product attributes. Finally, you will need to communicate what makes your product different in a clear and coherent manner.

A brand makes a promise to the customer, and this promise must have meaning to your target audience, or the brand will not be successful. Branding only makes sense if the category size is large enough to offer growth potential, and if a distribution system exists or can be built so that consumer can find the product easily, and when there are reasonable expectations for the gain or protection of market share. Finally, your branding effort will not be successful, unless your company has the discipline and determination to support the brand.

**Can it work for onions?**

When thinking of successful onion brands, the Vidalia onion comes to mind quickly. The Vidalia onion commission has done an excellent job of communicating their promise to consumers: "You can eat them like an apple!" And consumers agree that the Vidalia onion has a very mild flavor, and is excellent for raw consumption. The brand's promise is meaningful, and the brand delivers its promises!
After several years of brand building, Vidalia growers saw a tremendous increase in prices as opposed to prices paid for their "generic" onions prior to brand introduction. But as with any new product introduction, Vidalia onions by themselves have lost their novelty value as growers increased their acreage from 3,000 acres to over 16,000 acres, and other brands of sweet onions were introduced. The Vidalia brand is no longer commanding the super high prices that it used to. However, new product introductions under the Vidalia brand (relishes, salad dressings, soups, baby Vidalias, etc) and extension of the marketing season through the use of Controlled Atmosphere Storage, for instance, have helped to extend the brand and continue to offer opportunities for profitability to onion growers in Georgia.

Recently, the introduction of the New York Bold brand has attracted attention in the onion industry. The onion sold under the New York Bold brand are very pungent, have high sugar content and have great flavor development, and are considered a premium cooking onion. New York Bold onions are marketed through only one supermarket chain, and it appears that the promise of the New York Bold brand resonates with at least a portion of consumers. Colorful packaging, a distinctive logo, and a marketing strategy support the brand.

Less than 1% of New York onions are sold under the New York Bold brand and this is only the second marketing season for this premium cooking onion. The company consists of 14 grower members, and revenues have not yet exceeded investments and operating costs.
New Products and Strategies for Disease Control

M.K. Hausbeck (517-355-4534, hausbec1@msu.edu)
Michigan State University, Department of Plant Pathology, E. Lansing, MI 48824

Purple blotch is typically a yearly problem for Michigan onion growers. As new products become available to the vegetable industry, it is important to determine whether they are effective, and ensure that there are no negative side effects to plant growth and yields. Testing products that are not yet registered for onions can help determine whether they might have a fit in current disease programs. Eleven fungicides were included in the new product test that was conducted at the Michigan State University Muck Soils Experimental Farm (see table, below).

Table 1. Products included in 2002 onion trial.

<table>
<thead>
<tr>
<th>Chemical</th>
<th>Active ingredient</th>
<th>Company</th>
<th>Registered</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cabrio 20WG</td>
<td>pyraclostrobin</td>
<td>BASF Ag Products</td>
<td>yes</td>
</tr>
<tr>
<td>BAS 510 70WDG</td>
<td>-</td>
<td>BASF Ag Products</td>
<td>no</td>
</tr>
<tr>
<td>BAS 516 38WDG</td>
<td>pyraclostrobin + BAS 510</td>
<td>BASF Ag Products</td>
<td>no</td>
</tr>
<tr>
<td>Bravo Weather Stik 6SC</td>
<td>chlorothalonil</td>
<td>Syngenta Crop Protection</td>
<td>yes</td>
</tr>
<tr>
<td>Elevate 50WDG</td>
<td>fenhexamid</td>
<td>Arvesta Corp USA</td>
<td>no</td>
</tr>
<tr>
<td>Scholar 50WP</td>
<td>fludioxonil</td>
<td>Syngenta Crop Protection</td>
<td>no</td>
</tr>
<tr>
<td>Messenger 3WDG</td>
<td>harpin protein</td>
<td>Eden Bioscience Corp</td>
<td>yes</td>
</tr>
<tr>
<td>Quadris 2.08 SC</td>
<td>azoxystrobin</td>
<td>Syngenta Crop Protection</td>
<td>yes</td>
</tr>
<tr>
<td>Rovral 50WP</td>
<td>iprodione</td>
<td>BASF Ag Products</td>
<td>yes</td>
</tr>
<tr>
<td>Serenade 10WP</td>
<td><em>Bacillus subtilis</em> QST 713</td>
<td>AgraQuest, Inc</td>
<td>yes</td>
</tr>
<tr>
<td>Switch 62.5WDG</td>
<td>cypertodinil + fludioxonil</td>
<td>Syngenta Crop Protection</td>
<td>yes</td>
</tr>
</tbody>
</table>

In the 2002 new product study, when plants were not treated, they became severely diseased with the purple blotch pathogen, and received a rating of 7.5 (10=defoliation and death) (Table 2). While many of the fungicide programs limited purple blotch to a disease rating of #3.0, others allowed the disease to progress seemingly unchecked. Among the programs that appeared to be most effective were those using Quadris 2.08 SC, Switch, Scholar, Rovral 50WP, Cabrio 20WG, BAS 510 70WDG, and BAS 516 38WDG. While Bravo was an effective product when used in alternation, it was less effective when used alone. The Serenade 10WP and Elevate 50WG products were better than not doing anything, but they were not as effective as the other products tested. Some spray programs resulted in enhanced yields compared to the untreated control and included...
Quadris 2.08SC alternated with either Scholar or Switch. Yield was also enhanced when Cabrio was used in alternation with Bravo Weather Stik 6SC.

**Table 2.** Standard fungicides and new products for control of foliar blights on onion.

<table>
<thead>
<tr>
<th>Treatment and rate/A, applied at 7-day intervals except where noted</th>
<th>Foliar purple blotch rating</th>
<th>Bulb yield per 22’ of row</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Total (lb)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>&lt;2” (%)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2-3” (%)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>&gt;3” (%)</td>
</tr>
<tr>
<td>Untreated ................. 7.5 e**</td>
<td></td>
<td>45.8 cdef</td>
</tr>
<tr>
<td>Bravo Weather Stik 6SC 1.5 pt, alternated</td>
<td>1.6 a</td>
<td>51.5 abcd</td>
</tr>
<tr>
<td>Quadris 2.08SC 9.2 fl oz  ..........</td>
<td>2 ab</td>
<td>50.6 abcde</td>
</tr>
<tr>
<td>BAS 516 38WDG 1.2 lb  ..............</td>
<td>2.3 ab</td>
<td>55.4 a</td>
</tr>
<tr>
<td>Quadris 2.08SC 9.2 fl oz, apps. 1-3, 7-8</td>
<td>2 ab</td>
<td>46.2 bcdef</td>
</tr>
<tr>
<td>Scholar 50WP 7.0 oz  ................ 2 ab</td>
<td>4.2 a</td>
<td>79.7 9.6</td>
</tr>
<tr>
<td>Quadris 2.08SC 9.2 fl oz, apps. 1-3, 7-8</td>
<td>2.3 ab</td>
<td>47.8 abcdef</td>
</tr>
<tr>
<td>Scholar 50WP 5.4 oz  ................ 2.3 ab</td>
<td>54.2 a</td>
<td>8.2 78.3 13.5</td>
</tr>
<tr>
<td>Quadris 2.08SC 9.2 fl oz, alternated</td>
<td>2.3 ab</td>
<td>55.4 a</td>
</tr>
<tr>
<td>Switch 62.5WDG 11.0 oz  ..............</td>
<td>2.3 ab</td>
<td>54.2 a</td>
</tr>
<tr>
<td>BAS 510 70WDG 11.2 oz  ................ 2.3 ab</td>
<td>47.8 abcdef</td>
<td>8.2 78.3 13.5</td>
</tr>
<tr>
<td>Rovral 50WP 1.0 lb  + Bravo Weather Stik 6SC 1.0 pt ........ 2.4 ab</td>
<td>52.6 abc</td>
<td>10.6 79.7 9.6</td>
</tr>
<tr>
<td>Quadris 2.08SC 9.2 fl oz, apps. 1-3, 7-8</td>
<td>2.8 abc</td>
<td>52.9 abc</td>
</tr>
<tr>
<td>Switch 62.5WDG 14.0 oz, apps. 4-6 .... 2.8 abc</td>
<td>52.3 abc</td>
<td>9.3 81.5 9.2</td>
</tr>
<tr>
<td>Cabrio 20WG 1.0 lb, alternated</td>
<td>3 abc</td>
<td>3.5 bc</td>
</tr>
<tr>
<td>Bravo Weather Stik 6SC 1.5 pt  ............ 3 abc</td>
<td>53.5 ab</td>
<td>9.6 82.7 7.7</td>
</tr>
<tr>
<td>Quadris 2.08SC 9.2 fl oz, apps. 1-3, 7-8</td>
<td>3 abc</td>
<td>52.3 abc</td>
</tr>
<tr>
<td>Switch 62.5WDG 11.0 oz, apps. 4-6 .... 3 abc</td>
<td>43.9 ef</td>
<td>12.7 77.7 9.6</td>
</tr>
<tr>
<td>Bravo Weather Stik 6SC 1.5 pt  ............ 3.5 bc</td>
<td>44.6 def</td>
<td>9.5 78.4 12.1</td>
</tr>
<tr>
<td>Bravo Weather Stik 6SC 1.5 pt, Tom-Cast 15 DSV ................ 4.3 cd</td>
<td>44.1 def</td>
<td>10.8 80.3 8.9</td>
</tr>
<tr>
<td>Elevate 50WDG 1.0 lb ........................................... 5.8 d</td>
<td>40.4 f</td>
<td>10.3 81.2 8.5</td>
</tr>
<tr>
<td>Serenade 10WP 6.0 lb ............................................. 5.8 d</td>
<td>44.1 def</td>
<td>10.8 80.3 8.9</td>
</tr>
<tr>
<td>Messenger 3WDG 9.0 oz ........................................... 7.8 e</td>
<td>45.4 cdef</td>
<td>11.3 81.4 7.2</td>
</tr>
</tbody>
</table>

*Based on a rating of 1 to 10 where 1=0% to trace of disease to 10=defoliation and death.
**Column means with a letter in common or with no letter are not significantly different (Fisher LSD; P=0.05).

This research was supported in part by the Michigan Onion Committee.
Agricultural Water Use Research, 2002

Jeff Andresen, Tracy Aichele, Colin Nugent, and Aaron Pollyea
Michigan Climatological Resources Program/Dept. of Geography
Michigan State University

John Bartholic and Da Ooyang
Institute for Water Research
Michigan State University

Background: Lack of water is the most important environmental limitation to plant-based agriculture in Michigan. As a result, many growers within the state are reliant on supplemental application of water through irrigation to improve crop yields and production consistency. The amount of water used in irrigation and the timing of application can vary greatly across the state by locality, crop, growing season, and soil type. Similarly, the rate of ground water recharge, which is critical in determining the capacity of water resources in a given area, can vary as much as 10 fold in Michigan. Unfortunately, relatively little is known about irrigation for agriculture within the state other than coarse, state-level statistics. New laws and water use regulation passed without adequate information regarding the true nature of irrigation water use could result in severe and costly restrictions on the agricultural industry. Collectively, these factors underscore the need for new objective, integrated information regarding irrigation use by agriculture, a vital element for developing local and state management strategies for sustaining and protecting ground water resources.

Project Objectives: The Michigan Climatological Resources Program (MCRP) and Institute for Water Research is engaged in a 2-year project to investigate and better quantify the amount and timing of water use for agriculture in Michigan. The objectives of the project are: 1) Validation of a spatial, Geographic Information System (GIS)-based irrigation water use model using on-farm well and soil moisture monitoring during the 2002 and 2003 growing seasons; 2) Development of a spatial data resource describing the rate of groundwater aquifer recharge and the relative sustainability of groundwater use for a given area of the state; 3) Using the system validated in 1), develop statewide quantitative estimates of irrigation water use by crop and soil type at a 4km spatial resolution for five growing seasons (1999-2003); 4) Perform sensitivity analyses of irrigation water use by crop and soil type, and groundwater recharge characteristics for several individual locations throughout the state, and analyze estimated past historical and projected future irrigation water use; and 5) Publication of the results of 1), 3), and 4) in a suitable scientific journal and development of a project summary report suitable for the general public and for state regulators.

2002 Activities and Preliminary Results: Validation of the spatial irrigation simulation estimation system began in April, 2002. A key element of this validation is comparison of estimated soil moisture levels within the growing season versus those observed in the field. Throughout the 2002 growing season, moisture levels were monitored on 13 farms in 4 counties with 6 different irrigated
crop types. Data collection began July 5, 2002, and continued through September 17, 2002. Initial results show strong within-field variability of soil moisture and that the model simulation was able to replicate the major observed changes of within-season soil moisture at different levels.

Sensitivity analyses of the irrigation simulation scheme began during the fall of 2002, with tests on differing soils and crop types. Indications are that the model's STATSGO-based profile data may have to be modified to better fit the soils typically irrigated in Michigan (generally lighter, coarser-textured soils). The model appears to be sensitive to the planting date, harvest date, the date of the end of irrigation, irrigation management, acreage and crop planted, soil type, and weather. Based on this information, we will be investigating the ability to refine the model in these areas.

An analysis of temporal patterns in irrigation water usage also began during fall, 2002, in which long term (approx. 100-year) climatological time-series of climate data were input into the irrigation simulation scheme at a given location and crop type to determine their influence on irrigation water demand in a historical context. Preliminary analysis suggests that irrigation demand during the 20th century as a function of climate alone peaked during the 1930s (due to a relatively drier climate) and has slowly decreased since. Model simulations for other locations are currently being run.

Acknowledgements: We are grateful to the Generating Research for Extension and Environmental Needs (GREEEN) Initiative, the Michigan Dept. of Environmental Quality, the Michigan Potato Commission, and the Michigan Vegetable Council for sponsoring this project, and to anonymous growers across the state who have graciously provided data for our analysis.
Potato production in Michigan has become more intensive as urbanization and land values have increased. This has led to increased use of short two-year rotations, with potatoes alternated every year with corn, wheat, beans or vegetables. Exhaustion of organic matter in these rotations is a particular problem on well-drained sandy soils. Farmers widely use winter cereals as cover crops in Michigan to protect soil from wind erosion, and this helps maintain soil organic matter.

Farmers must actively plan how to use organic matter sources such as manure, compost and high tonnage cover crops to combat the intensive tillage and minimal residues associated with potato rotations that tend to deplete soil organic matter over time.

**Importance of soil organic matter.** Maintenance of soil organic matter is critical for successful long-term production. Depletion of soil organic matter results in:

- Reduction in soil water holding capacity: for every ~ 0.5% loss of organic matter, there is an associated loss of ~ 10% water holding capacity.
- Reduction in nutrient availability and nutrient buffering capacity. This increases fertilizer requirements.
- Deterioration of soil texture, structure, tilth
- Soil crusting problems and localized problems with flooding or ponding of water.
- Increased requirements for fumigation.

Effective methods for adding and improving soil organic matter are the regular application of livestock manure or compost, the use of cover crops between principle crops, use of green manure crops and by maximizing incorporation of available crop residues. Reducing tillage by growing winter wheat or no-till soybeans will also help maintain soil organic matter.

While building soil organic matter is critically important, it may take a few years to measure a detectable improvement in soil organic matter concentration. Findings are still preliminary, but it appears that a yield increase of approximately 50 cwt/acre may be associated with application of 5000 lb or more of manure. These benefits are independent of fertilizer rates applied, and also increase soil organic matter and water-holding capacity but it takes a number of years to detect these soil building benefits.

**Use of Manure.** Interest among potato growers in using liquid or composted livestock manure as a soil amendment has been on the rise. Application of manure is one way to replace organic matter quickly. Availability of livestock manure is dependent on proximity of potato acres to local animal facilities. Intensive livestock operations need to properly dispose of a steady supply of manure and are often open to the prospect of increasing the land base for such disposal. Costs involved in
transportation and application of animal manure depends on local variables such as proximity, manure quality and seasonal quantities available.

Once a source of manure or compost has been identified, nutrient composition of the manure must be determined before it can be applied. Livestock manure is highly variable with respect to:

- Water content
- pH and nutrient content
- Presence of sand, sawdust, straw or other ingredients

Thorough mixing manure is essential for accurate sampling and analysis. Most manure pits are equipped with a mixing system and adequate mixing time must be allowed to achieve uniformity. Sample manure periodically as it is unloaded or pumped into a spreader. Submit several of these samples for analysis. Manure application rates should then be calculated using manure composition and soil test results from each individual field.

To maximize manure organic matter and nutrient benefits, manure must be applied and managed properly. Timing of application is very important. Spring application of manure, before potatoes are planted, can result in less nutrient and organic matter loss. However, the estimation of availability of nutrients for the crop can be challenging. Spring application of compost is not as problematic. Fall application of manure often results in greater loss of nutrients during the winter months but estimation of subsequent nutrient release is more accurate. Whenever it is applied, manure should be injected directly into the soil or applied to the surface followed by immediate incorporation for optimum nutrient capture and to minimize potential losses from runoff. To minimize health and safety concerns, manure should never be side-dressed or applied to potatoes within 3 months from harvest unless it is first composted. Manure should also be stored for a minimum of 60 to 90 days before application whenever possible.

Use of Cover Crops. A cover crop is any unharvested crop which is grown to provide vegetative cover on the soil. Cover crops are usually killed and either left on the soil surface as a mulch or incorporated as a 'green manure.' This practice directly adds organic matter to the soil and reduces losses through minimizing wind and rain erosion and leaching, compared with bare soil. Leguminous cover crops can also add nitrogen to the soil. Cover crops also provide habitat for beneficial wildlife and insects between growing seasons. Killing and incorporation of the crop residue must be managed properly for optimal benefits.

Montcalm research farm trial for building organic matter in a short potato rotation.

A long-term trial was initiated in the spring of 2001 on the use of cover crops and manure to improve yields and soil quality in potato, snap bean and sweet corn rotations. A wheat rotation with potato was also tested, where red clover is frost seeded into the wheat and the red clover cover incorporated before potatoes are planted. Nitrogen fertilizer was applied at the recommended rate of 200 lb N/acre for the Snowden variety. A second research trial was conducted in large containers, using soil from the field trial. We found that an appropriate fertilizer nitrogen credit for the composted manure was 40 lb N/acre, thus the N fertilizer application was reduced to 160 lb N/acre (200 - 40 = 160) in the composted manure experiment.

Combined use of manure and cover crops. The most promising treatment in 2002 appeared to be the use of composted poultry manure applied at a rate of 5000 lb/acre to a snap bean/winter rye cover crop/potato rotation sequence. As shown in Figure 1, the application of poultry compost
consistently increased potato yields, and a combination of manure and cover crop had an additive effect for additional yield benefits. One of the most interesting findings in this experiment was that a rye cover crop released nitrogen very late in the growing season, while the combination of rye cover crop and poultry manure released nitrogen at an optimal time for potato production. The effect on soil characteristics will be presented at the Great Lakes Fruit, Vegetable & Farm Market Expo.

Additional information regarding manure application is available online from the Michigan Manure Resources Network (web2.msue.msu.edu/manure) and from the Michigan Agriculture Environmental Assurance Program (www.maeap.org). Cover crop information is available from the Kellogg Biological Station Cover Crops program (www.kbs.msu.edu/Extension/Covercrops/home.htm) and from the Sustainable Agriculture Network (www.sare.org/htdocs/pubs/mccp).

![Graph](image.png)

Figure 1. Chip potato yield with a spring application of 160 lb N/acre fertilizer plus 5000 lb/acre poultry compost, supplying ~ 40 lb N/acre. The soil was left bare in the winter, or a rye cover crop was used (J. Nyiraneza and S. Snapp, unpublished data).
Early Blight Management with Fungicides in Wisconsin
Walter R. Stevenson, University of Wisconsin, Department of Plant Pathology
Tel. No. 608-262-6291 – Email: wrs@plantpath.wisc.edu

There's hardly a location around the world where early blight does not appear on potatoes at some point during the growing season. In Wisconsin where the bulk of our main season crop grown for processing and fresh market is produced on irrigated sandy soil, early blight is observed every year in varying levels of severity. Depending on rainfall, these sandy areas may be irrigated three or more times per week. Production fields commonly receive up to 2 inches of irrigation per week to meet the needs of the crop. In each of the last several years, this sandy production area has received single event rainfalls in excess of 4 inches, leading to losses in nitrogen and water-soluble chemicals. During 2002, an intensive system moved across this sandy area in a 10-mile band (north to south) leaving up to 15 inches of rainfall. Rainfalls of even moderate intensity in mid to late June are contributing factors to early blight development since they lead to nitrogen loss and contribute to early season infection of the crop by Verticillium dahliae, one of the primary pathogens of early dying. Crops affected by early dying, nitrogen deficiency and other seasonal stresses are more susceptible to infection by the early blight pathogen than is a well-nourished crop grown in the absence of other stress factors. Early blight is less of a problem in other areas of the state where potatoes are grown on silt loam or muck soils.

Losses attributed to early blight depend to a large extent on the timing of leaf infection, disease progression and loss of productive leaf canopy. In Wisconsin, we commonly observe the first symptoms of early blight at the time of or just prior to flowering. This corresponds to roughly 300 P-Days (Physiological Days - ref: Sands, Hackett and Nix. 1979. Field Crops Research 2: 309-331) tabulated daily from crop emergence. Left untreated with fungicide, 100% of the foliage can exhibit early blight symptoms by early to mid August. Disease can progress rapidly when there are warm days, cool nights and abundant leaf moisture from fog, dew, irrigation and rainfall. Multiple cycles of infection, lesion development and spore production can occur through the growing season. When over 50% of the foliage is expressing symptoms of early blight by early to mid-August, yield losses often exceed 25%. If disease development is delayed because of weather conditions unfavorable to disease development, adequate crop fertility and careful application of fungicide sprays, losses in yield and quality are minimal.

Our program conducts an annual evaluation of a broad range of fungicides, registered and numbered products, for their efficacy in controlling both early and late blight. For the period of 1980 to 1995, the standards for early blight control included various formulations of chlorothalonil including chlorothalonil plus Zn, mancozeb and mancozeb plus triphenyltin hydroxide. Even with these standard and widely used products used at full label rates, we observed rapid disease progress during the last few weeks of the growing season. Disease progress over the entire growing season resembled a standard S-shaped curve with slow disease progress early in the season and rapid progress late in the season. Some treatments, application schedules and treatment rates served to help delay disease progress, but none were totally effective. Beginning in 1996, however we began
to evaluate a new class of fungicide belonging to the strobilurin group. The first of these exciting compounds was azoxystrobin (Quadris - ICI A5504) and this material was soon joined by trifloxystrobin (Gem - previously Flint) and pyraclostrobin (Headline - BAS500) in our evaluation program. The results of our 1996 and 1997 trials with azoxystrobin were very promising since this compound in a season-long program with chlorothalonil flattened the disease progress curve better than any compound previously tested in our field program. Based on field data from Wisconsin and other states, EPA allowed WI to use Quadris fungicide during 1998 in a closely supervised Experimental Use Permit (EUP) program on 2,000 acres representing 27 potato fields. In these fields, we observed that use of azoxystrobin significantly improved early blight control. Yield and tuber size were generally higher in fields with improved early blight control. In addition, growers participating in the EUP program observed a significant reduction in the amount of fungicide active ingredients (ai) needed for satisfactory early and late blight control. This significant ai reduction is a major contributing factor in the current eco-labeling project undertaken by the Wisconsin potato industry. These data provided significant momentum to obtaining a national label for Quadris use on potatoes in 1999. In subsequent field studies, the recently registered Headline and Gem as well as Quadris fungicides continue to provide excellent control of early blight.

Use of strobilurin fungicides has revolutionized the management of early blight, particularly those areas where early blight is a perennial threat. Users of these products must, however, pay special attention to the management of pathogen resistance because of the site specific mode of action. The current labels for Quadris, Headline and Gem indicate the need to follow a resistance management program that includes no more than 6 applications of strobilurin fungicides per season and alternation of strobilurin fungicides with fungicides having a different mode of action. In Wisconsin, we urge growers to use the full label rate when using strobilurin chemistry, to apply the strobilurin materials early in the season beginning at 300 P-Days in a strict alternation with chlorothalonil, mancozeb or metiram chemistries and to consider applying no more than three strobilurin sprays during the growing season.

We are currently monitoring isolates of *Alternaria solani* (early blight fungal pathogen) collected in 1998 from grower fields (statewide) prior to use of strobilurin fungicides, in 2001 from our field trials in central Wisconsin and in 2002 from our field trials and fields of growers who participated in the 1998 EUP project. We are concerned about elevated levels of early blight in field trials during the last two years where strobilurin fungicides were applied according to label directions. It is still too early to definitively say whether we are observing resistance to strobilurin fungicides, but evaluation of isolates from these plots is underway. We have literally hundreds of isolates that are being meticulously screened for sensitivity to strobilurin fungicide from research plots and grower fields. Preliminary data from this screening will be available prior to the 2003 growing season.

Early blight was more prevalent on commercial acreage and in our fungicide trials during 2002 than in the past four years. In part this was due to reduced use of strobilurin fungicides by the potato industry, untimely and excessive seasonal rains and crop stress related to heat and widespread early dying. Control of early blight continues to be one of the more important priorities on potato, one that requires a comprehensive management program.
Factors to Consider in Organic Potato Production

Dr. Matt Kleinhenz, Asst. Professor and Extension Vegetable Specialist
Department of Horticulture and Crop Science, OSU/OARDC - Wooster
Ph. 330-263-3810; FAX 330-263-3887; E-mail kleinhenz.1@osu.edu;
Internet http://www.oardc.ohio-state.edu/kleinhenz

Factors to Consider
As in other enterprises, many factors need to be considered when growing potatoes organically. This presentation will focus on:

1. Why farm organically?
2. Certification: certifying agency or body and time required.
3. Market – new versus familiar buyers and who are your competitors and partners?

Background Information

Why farm organically? There are a number of reasons why people farm organically. Some are motivated primarily by profit potential. Premiums for organic products – the price between what is paid for organically and conventionally-grown versions of the same commodity – are attractive. However, these premiums do not guarantee profitability. Others view organic production as a means to respond to changing social and other forces off the farm. For example, as populations increase near rural areas, new market options may develop. Finally, farming organically may be preferred by some with relatively limited resources (e.g., land, labor, equipment) or the belief that it is better for people and the environment. No matter the primary motivation for farming organically, good farming and business practices are required to be successful.

Certification – State, regional, and national certifying agencies currently exist, creating some confusion in the implementation and market identity of organic standards. Growers need to clearly understand various criteria for certification and buyer requirements. For information on certification in Michigan, contact Organic Growers of Michigan (ph. 616.875.8695; E-mail ogm@michiganorganic.org. Information can also be found on-line at:

http://www.ams.usda.gov/nop
http://www.ers.usda.gov
http://www.ofrf.org

There are many criteria for certification. If they are unfamiliar to you at this stage, the time required to become certified (often 3 years) is important to know. Crops are not properly labeled as organic until they are certified. The "transition" period creates unique opportunities and challenges. Proper planning is needed to farm organically.

Market – It is important to ask “Who will buy my product?” “New or familiar buyers?” “What are their labeling requirements?” “Is growing organically my idea, my buyer’s idea, or my banker’s idea?” Marketing organic products requires specific attention and hard work but it is currently assisted by a
generally favorable supply/demand ratio. If the ratio changes, however, “passive” marketing may be less effective. If currently growing conventionally, growing organically may add to your list of competitors. Develop a plan, start small and be open to partnerships and new approaches to growing and marketing.

**Major Production Issues – rotation, weeds, fertility, pests, and diseases** – Certified organic production often requires a 4-year rotation. The ramifications of a mandatory minimum 4-year rotation are large, if only because of what it suggests about land availability, price, and use.

Organic production is not necessarily chemical-free. However, it does call for significant changes in how weeds, fertility, pests, and diseases are often managed in conventional, large-scale potato production. There is no formula for success in organic potato production. In fact, many of the same factors, including ingenuity, required to be successful in conventional production are also required in organic production. However, here are some points to keep in mind about the challenges often encountered in growing potatoes organically.

In general, organic growers often cite weed and fertility management as their primary production-related challenges. Survey results suggest that, by comparison, pest and disease problems tend to be less frequent and/or severe. Obviously, however, pest and disease management in organic systems require careful attention and the use of new and familiar tools.

For weeds, exclusion, suppression, and eradication are key. Keep new weeds from invading the farm. Also, combine approaches to suppress and eradicate existing weed species. Adjustments in planting date, variety selection, tillage equipment, weed population thresholds, weed removal practices, and other factors may be needed. Regardless of the approach, purposeful combinations of machinery, timing, and attitude will be useful. The timeliness of operations is particularly important. For example, weed seedlings can be killed by disrupting the contact of their roots with the soil. This is easier to accomplish when seedlings are quite young. Likewise, removing mature weeds before they shed seed will reduce the return of weed seed to the soil.

As always, the question in nutrient management is “how much, when, and where?” Nutrient management in organic production is based on rotation and, if needed, organic amendments. Organic amendments include manures and composts. Plentiful supplies of inexpensive and uniform organic “fertilizers” for large-scale application are very limited. Research-based information on the optimal use of organic amendments is also lacking. However, nitrogen (N), in particular, can be in short supply in organic systems. Therefore, nutrient management plans for organic potato production can start with estimates of how much N the crop needs and what amount may be supplied by the breakdown of rotation crops. In Ohio, we have increased the yield of U.S.#1 and B-size certified organic, short-season red-skin potatoes by applying 3 ton/A of composted dairy manure in the spring of the potato year (to fields in a potato-soybean-clover-spelt rotation). Assuming that organic amendments will be needed, organic potato growers will benefit by working with other farmers, neighbors, business partners, the research-extension community, and others to identify sources and application rates of organic amendments.
Volunteer Potato Management
Chris Long, Potato Specialist, Dept. of Crop and Soil Sciences, Michigan State University

Volunteer potatoes harbor diseases, nematodes and insects that infest subsequent potato crops. Volunteer potatoes are very detrimental to the Michigan seed potato industry. Seed producers have higher production costs for early generation seed compared to commercial production. Furthermore the potential for crop mixtures and virus vectoring by insects poses a problem for seed certification. The need for control measures to reduce or eliminate volunteer potatoes in seed production fields is critical. A number of strategies to disrupt the life cycle of volunteer potatoes and stop the production of daughter tubers are discussed below.

The survival of potato tubers through the winter months depends on soil temperature and snow cover. The average low temperature during the winter months in central Michigan has increased over the past decade. Potato tubers require soil temperatures below 29 °F for 50 hours or more to be rendered nonviable (dead). Soil temperatures in Montcalm County during the past three winters were not below 29°F for a long enough period to freeze potato tubers. Soil temperatures at a 6 inch depth in Monroe County during the 2000-2001 winter were never below 32 °F.

Snow cover can protect tubers from freezing temperatures because snow acts as an insulating blanket over the soil and protects over-wintering potatoes. Snow accumulations cannot be controlled, but the depth at which tubers are buried can be managed. If tubers are close to the soil surface they have a better chance of freezing. If they are buried they have a better chance of survival. Therefore the environment the potato tubers are in over the winter ultimately dictates the need for management strategies to control volunteer potato the following year.

Managing volunteer potatoes requires multiple steps. No one step will eradicate volunteer potatoes. The goal for managing volunteer potatoes is to reduce tubers remaining in the field and disrupt the formation of daughter tubers. An evaluation of the past four to nine years of your crop production practices should be taken. This will show you how these production practices have influenced volunteer potatoes on your farm. Winter soil temperatures and snow cover amounts should be recorded. Cold winters with little snow cover reduce the potential for volunteer potatoes. Be prepared to manage volunteer potatoes in fields following a mild winter with substantial snow cover.

Growers should base field selection on cropping history. Commercial potatoes should be rotated with other crops, preferably on a three year or longer rotation to reduce the probability of volunteer potatoes. Seed growers should not plant high value potatoes in a field that has had potatoes planted in it within the last decade. Highly valuable mini-tubers should only be planted in virgin potato ground. Once a seed lot is contaminated in an early generation, the mix will be present until the lot is flushed out. Much expense will be incurred trying to rogue a contaminated seed lot and the lot could still face decertification.

Choose a variety that produces a large percentage of "A" sized tubers. Plant the variety at the proper seed spacing for optimum tuber set to reduce the potential number of "B" sized tubers.
Weed control plays an important role in reducing tubers remaining in the field. Poor weed control will reduce total tuber yield, increase the number of "B" sized potatoes, and cause a number of tubers to be carried across or fall through harvesting equipment and return to the ground to become volunteer potatoes in future years.

Commercial producers could apply a sprout inhibitor (MH-30) to reduce the sprouting potential of tubers that remain in the field.

Volunteer potatoes are generally derived from the smallest tubers that slip through digger chains. Harvesting an immature crop can increase the number of potatoes returned to the field. Many small tubers remain in the field if only 75 to 80% of the crop has reached a size to pass over the harvester. Small, immature tubers will be attached to stolons and vines. Heavy vine trash can carry potatoes out the back of harvesting equipment.

When harvest chains get worn a greater number of potatoes pass through them. Operate equipment at speeds which are conducive to steady flow through. Operating too fast will cause tubers to be pushed out the sides of the blades and too much volume prevents "Air-heads" from doing their job.

Shallow fall tillage is recommended. Plowing or tillage that rolls over the soil and buries tubers should be saved until the spring. Tubers will be more susceptible to freezing if they remain in the upper portion of the soil profile.

Fall planted cover crops such as winter wheat or rye are very competitive with volunteer potatoes. Light and moisture competition will reduce the emergence of volunteer potatoes.

Volunteer potatoes are seldom a problem in winter wheat. Winter wheat is very competitive and few volunteer potatoes will emerge. Herbicides such as Starane are registered to control volunteer potatoes in wheat. Wheat is harvested in early to mid July. Any volunteer potatoes in the wheat crop should be controlled by tillage. Volunteer potatoes need to be controlled in corn. Michigan State University evaluated the effectiveness of some postemergence herbicides for volunteer potato control in corn in 2002. Injury to volunteer potatoes was evaluated 7 and 28 days after herbicide application. Volunteer potato plants remaining in the field were 'harvested' in the fall and the number and size of the daughter tubers produced was determined. Callisto + atrazine and Distinct + atrazine provided the greatest volunteer potato control 7 days after application. By 28 days after application Callisto, Callisto + atrazine, and Distinct + atrazine provided the best control. These treatments (and Distinct, Starane, and Starane + atrazine) reduced daughter tuber production. Therefore Callisto or Distinct, with or without atrazine, would control volunteer potatoes in corn.
The Sweet Corn Buyer’s Perspective on Quality

Dr. Matt Kleinhenz, Asst. Professor and Extension Vegetable Specialist
Department of Horticulture and Crop Science, OSU/OARDC - Wooster
Ph. 330-263-3810; FAX 330-263-3887; E-mail kleinhenz.1@osu.edu;
Internet http://www.oardc.ohio-state.edu/kleinhenz

“Sweet corn was our family's weakness. We were prepared to resist atheistic communism, immoral Hollywood, hard liquor, gambling and dancing, smoking, fornication, but if Satan had come around with sweet corn we at least would have listened to what he had to sell.”
– Garrison Keillor in Leaving Home

Points to Consider

• Buyers and growers have different views on what “good” means when it comes to quality in sweet corn. So, if needed, review how buyers assess quality in sweet corn.
• Growers may not always get paid more for higher quality. However, delivering a high quality product is critical to being able to compete in the marketplace, especially with sweet corn often in ample supply.
• Growers need to find varieties and practices that result in high quality sweet corn for both them and their buyer.

Background Information

Sweet corn production is a major industry in many states. For example, approximately 12000 acres of fresh market sweet corn are planted annually in Michigan, with this crop having an estimated total farm-gate value exceeding 14 million dollars. Industry and research partnerships have been important to the success of many sweet corn industries. Such cooperation helped identify the components of quality and methods to achieve it. Criteria that consumers use to gauge the quality of sweet corn are well known. The primary genetic, production, and post-harvest influences on sweet corn eating quality are also known. What determines sweet corn eating quality, from the buyer’s perspective, is outlined in this summary.

The Buyer’s Perspective on Eating Quality. In general, the eating quality of whole-kernel sweet corn is determined by its unique combination of flavor, texture, and aroma. Typically, consumers focus on flavor more heavily than they do texture. Aroma impacts consumer ratings of quality but generally less so than taste or texture.

Sweetness is the major component of flavor while sweetness itself depends mostly on kernel sucrose content. Texture is determined primarily by pericarp tenderness, levels of water-soluble polysaccharides (phytoglycogen), and kernel moisture content. Factors that comprise flavor and texture, such as the levels of sucrose, starch, and kernel moisture, are often related. For example, kernel moisture levels often decline as starch levels increase. Aroma depends on the presence of
sulfur-containing compounds (e.g., dimethyl sulfide) that are detectable only when sweet corn is heated.

**Genetic and Production Factors which Influence Sweet Corn Eating Quality.** Genetic manipulation of kernel endosperm composition continues to have an enormous impact on the sweet corn industry. The endosperm is the primary storage tissue of the seed. Its physical and chemical makeup affects the kernel’s eating quality and ability to function as a seed. The types of sugars made by the plant and stored in the endosperm – and the rate at which they change into other compounds (e.g., starch) – are manipulated through genetics and breeding. So also are the factors that control kernel texture and, to a lesser extent, aroma. Breeding efforts focus on the fact that flavor and texture are most important to consumers and that consumers prefer corn that is sweet and tender with a creamy texture, low starch content, and pleasant “sweet corn”-like aroma. Over the years, varieties with different types and levels of sugars at maturity, rate of quality loss after maturity, and pericarp characteristics have been available. Compared to normal corn, standard sugary or “su” varieties accumulate more sugars and water-soluble polysaccharides (phytoglycogen) and less starch. However, su-type varieties rapidly convert sugars to starch after harvest maturity, leaving narrow harvest and market windows. As a result, su-type varieties are rarely grown in the U.S. Instead, sugary enhanced (se)- and shrunken2 (sh2)-type varieties dominate since they are more sweet and tender and have longer harvest and market windows than su-type varieties. Se-type varieties tend to bear the creamy texture provided by relatively high levels of phytoglycogen which are lacking in most sh2-type varieties. As a group, se- and sh2-type varieties have overlapping ranges of total endosperm sugar level at harvest maturity although the varieties with the absolutely highest sugar levels tend to be of the sh2 type. Rates of kernel sugar conversion to starch and dry-down also may be similar among se- and sh2-type varieties as a group but, as in kernel sugar levels, varieties with the slowest sugar-to-starch conversion and kernel dry-down rates tend to be of the sh2-type.

A variety’s genetic makeup impacts its potential eating quality. However, environmental factors and management also influence crop quality. For example, high temperature stress during pollination and kernel development can reduce the number and eating quality of kernels, partly through undesirable effects on texture. Likewise, low and high moisture stress are thought to reduce crop quality. Excessive nitrogen fertilization can also reduce the number and quality of sweet corn kernels.

**Other Traits important to Buyers.** A crop’s flavor, texture, and aroma (eating quality) are evaluated last by consumers. However, other traits related to crop appearance are evaluated first and influence whether the corn is bought at all. These traits include: husk and flag leaf color and length, tip fill, and row configuration. The genetic control of these traits is poorly understood. Variety, environment, and management appear to have comparable levels of control over these traits. Anecdotal evidence suggests that nitrogen fertilization and moisture stress may influence husk and flag leaf color and tip fill. High nitrogen availability is associated with dark green husks and flag leaves but excessive nitrogen fertilization and moisture stress (low, high) can lead to poor tip fill. Of course, it is important to keep in mind that good eating corn is less marketable if it fails to meet buyer expectations of appearance.

**Summary**
Fresh and processed sweet corn is very popular. The combined efforts of many people in different disciplines made it possible to identify the most important traits of kernels and crops, from the buyer’s perspective. Most consumers prefer sweet corn that is sweet and tender with a creamy texture, low starch content, and pleasant “sweet corn”-like aroma. Other traits related to the appearance of whole ears influence the likelihood that consumers will buy them to begin with. In general, consumers often prefer dark green husks and flag leaves and well-filled ears with straight rows. Some of the most desirable traits related to appearance or other factors may differ between fresh and processing markets. However, traits related to eating quality are similar in both markets. These traits continue to be incorporated into new varieties. Along with favorable environments and proper management, the use of improved varieties helps to ensure greater crop marketability and grower profit potential.

References


Influence of In-row Spacing Accuracy and Uniformity of Emergence on the Yield of Sweet Corn

John Zandstra, Ridgetown College, University of Guelph, Ridgetown ON N0P 2C0
jzandstr@ridgetown.uoguelph.ca

Crop plants established in rows compete among each other for light, nutrients, moisture and space. Uniform emergence of seeded crops encourages consistent competition by ensuring all plants in the row are at the same developmental stage. Research in Illinois has demonstrated that when emergence in field corn is not uniform, yields suffer (Nafziger et al, 1991) due to increased competition from the earlier emerging plants. Research on field corn at the University of Guelph has also found that plants whose emergence is delayed may be at a disadvantage in terms of yield (Stewart, 2001).

In general it is felt that sweet corn plants which are less than 2 leaves behind in development compared to the majority of the plants will still produce a marketable cob, while plants 4 leaves or more behind will not develop a useful cob. This however, appears to be an assumption and has not been tested. Information on how far behind in development sweet corn plants can be without negatively affecting yield is important, especially in years when emergence is erratic due to poor soil conditions and replant decisions must be made.

Consistent in-row spacing ensures uniform competition between plants within the row and provides a more uniform yielding and maturing crop. Research in Indiana has indicated that in-row variability in field corn has a negative impact on yield, to the extent that in a field survey, plantings with the greatest variability yielded 21 bushels/acre less than plantings with the lowest variability when plant populations were similar (Nielsen, 1991, 1997). This was felt due to increased competition between crowded plants resulting in lower productivity. Pioneer Hi-Bred International now promotes achieving “picket fence” stands in field corn, based on their research which shows improved yields when in-row variability is reduced (Doerge et al, 2002). While growers recognize that uniform emergence and “picket fence” stands of sweet corn are ideal, little is known about the impact of these 2 variables on sweet corn productivity.

Research evaluating the influence of delayed emergence on yields in sweet corn was initiated at Ridgetown College in 2002. Different portions of the plants in a plot were removed at emergence and replanted at a later date, resulting in stands with 25 and 50% of the plants either 4 or 8 leaves behind in development. Initial results indicate that in plots with plants 4 leaves behind in development, yields were reduced generally in proportion to the percentage of plants at the delayed development, but this trend was found in only 1 of the 2 varieties tested. Yields in plots where the plants were 8 leaves behind did not demonstrate significantly reduced yields; this is likely due in part to the development of a second marketable cob on the older plants.

In the summer of 2002, measurements were taken in seven commercial sweet corn fields in Ontario in order to determine the degree of in-row plant variability. All fields averaged 20,000 - 22,000
plants/acre. Overall, the variability, measured as a standard deviation, was 13.4 cm, or 5.3 inches. This means that on a 20,000 plant/acre population where on average plants will be spaced 10.6 inches apart in the row, the majority (68%) of the plants were spaced ± 5.3 inches of the mean, or between 5.3 and 15.9 inches. Individual fields ranged in standard deviations from 4.6 to 6.2 inches. From a field corn perspective, this is considered moderately variable. Standard deviations associated with individual planter units on the same planter ranged from 2.8 inches to 10.3 inches, indicating that improvements can be made.

References


Every sweet corn grower knows the frustration of opening ears of succulent corn, ready to harvest, and finding them loaded with well-fed caterpillars and their nasty mess. Most often these are corn earworm, which enter the ear though the silk channel and feed in the tip. This pest has been the major obstacle to production of organic sweet corn throughout the US. Conventional control of this pest relies on repeated applications of synthetic insecticides, which are prohibited in organic standards. A method that uses small quantities of vegetable oil applied directly to the silks to create a barrier inside the silk channel, gives organic growers a means to control this corn pest throughout the season. The Zea-later™ oil applicator, now commercially available, makes this method physically and economically feasible.

Larval behavior on corn ears. Three different caterpillars feed on corn ears. Two of the species of caterpillars that infest corn ears are the European corn borer (Ostrinia nubilalis) and fall armyworm (Spodoptora frugiperda). These caterpillars are most likely to enter the ear by chewing through the husk, making them susceptible to foliar sprays of Bacillus thuringiensis (an insect stomach poison). European corn borer will also enter ears through the silk channel. The corn earworm (Helicoverpa zea) caterpillars hatch from single, globe-shaped white eggs on the silks and move rapidly into the enclosed silk channel, avoiding the husk and feeding very little on the exposed silk, which explains why foliar sprays of Bt are not effective against this pest. Once inside the husk, larvae feed on silks and kernels, well-protected from predators and pesticides. Depending on the geographic location and the time of the season, corn may be infested with one, two or all three of these kinds of larvae.

Direct silk applications of oil. Vegetable oil that is applied directly to the tip of each ear coats all the silks down inside the silk channel and kills larvae as they enter. This technique was widely used by sweet corn growers in the 1940's, before the development of synthetic insecticides. Since 1992, when a group of sweet corn growers brought this to our attention, University of Massachusetts and Hampshire College researchers have been exploring how to make this method economical and effective.

Developing a delivery method. The first step was to find a way to deliver the oil to the silk with relative ease and speed. The Zea-later™ oil applicator, consisting of a hand-held applicator connected by a clear plastic tube to a 2-liter waist-belt tank, was specially designed for this use by researchers at the University of Massachusetts and Hampshire College. The applicator has a shell of strong molded plastic, with an internal pumping mechanism of stainless steel and plastic components which have been selected for durability, repeated use, and tolerance to corn oil. The molded handle has a "trigger" to release 0.5 ml of oil per stroke. By placing the pointed tip on the hollow at the center of the silk's ear or pushed slightly into the silk channel, the oil is dispensed.
where it will be drawn into the silk channel. It works best to walk down each row, treating the top ear of each corn plant; it takes about 8L (4 tank-fulls) to treat one acre. The Zea-later™ is available from Johnny's Selected Seeds.

**Research.** Trials using the oil method in late-season corn at the UMass Research Farm have shown significant control of the corn earworm pest and caterpillar feeding damage. Through field experiments we have determined the type of oil, dose, and timing for best control. We also found that control is improved when Bacillus thuringiensis is added to the oil. The best overall control of caterpillars in late-season corn was achieved through an integrated strategy, which combined foliar Bt sprays during tasseling, with a single oil dose on the silks. This strategy works best when pest pressure and crop growth are carefully monitored to determine when it is necessary to treat the crop.

**Type and dose of oil.** The only oils that should be used directly on the corn ears are corn or soy oil. Both of these oils are exempt by the EPA from food residue tolerance requirements and from the federal law regulating pesticides (FIFRA, the Federal Insecticide and Fungicide Reduction Act, section 25b). Adequate control was found when 0.5ml of oil or less was used; greater amounts of oil resulted in an oily residue on the corn ear at harvest. Control was also improved significantly when Bt was added to the oil.

**Timing.** The best time to apply oil is 5-6 days after silk growth starts. At this time, most of the pollination has taken place, and the exposed silks are wilting and beginning to turn brown. Earlier applications result in poor kernel fill due to oil interference with silk pollination in the last one-half inch of the tip. Oil applied later than 6 days after silk initiation results in poorer control. This is especially true when corn earworm pressure or temperatures are high and larvae have entered ears before oiling. One application to each block of corn is adequate.

**Controlling both tip and side damage.** The best overall control of caterpillar pests when European corn borer (ECB) or fall armyworm numbers are also high is achieved by combining the silk oiling with foliar Bt sprays. It was found, for instance, that a Bt spray made little difference in the number of clean ears of corn when ECB pressure was low: 89.5% clean in the oil only sample vs. 93.3% clean with the oil combined with a Bt foliar spray, compared to 57% untreated. However, when ECB pressure was high, the numbers of clean ears rose from 57% to 100%, compared to only 24% clean in the untreated sample.

**Monitoring Pest Pressure.** The most economic way to insure clean corn is to treat it only when pest pressure is over IPM thresholds. While corn earworm may be active for only part of the season, its activity may be unpredictable. This is especially true in northern areas, where migratory flights arrive suddenly. Flights can be monitored with the Scentry Heliothis net trap, baited with Hercon™ luretapes for corn earworm, placed at about ear height in freshly silking corn. Trap captures of two or more moths per week indicate damaging numbers; oil treatments are warranted when potential losses exceed the cost of treatment. ECB and FAW can be monitored by weekly inspecting 50-100 plants for larvae: if more than 15% have one or more larvae than damage may be > 5% at harvest, and foliar sprays are recommended. For more details refer to Extension recommendations for your region.
Healthy stands of sweet corn produced the best results. Corn that is full of tall weeds is difficult to maneuver in, and therefore, oil. Also, the more evenly aged the stand of corn, the easier it is to determine when to treat the block. This is best accomplished by planting when soils are warm enough for rapid germination. Further, we found that varieties with good tip cover seem to produce the best results as the oil only works as a barrier when it is enclosed inside the silk channel.

Farm trials. We are currently working with eight growers around New England to test the direct oil method using the oil application in commercial plantings. These include wholesale, retail (farmstand) and community supported agriculture operations. Each farm has several plantings, with oiled and non-oiled plots within each planting, and all are being scouted using IPM methods. The results from summer 2000 showed an average improvement in ear quality of 24% in the oiled treatment vs. no treatment. This reflected a decrease in ear tip damage by over half, from 41% down to 16%. The gain in undamaged tips resulting from oiling ranged from 8-44%, with the best improvement occurring on farms with the highest corn earworm pressure. Two growers had control in the 90-100% range. High ECB numbers on the other farms suggest that better results would be achieved with a foliar Bt spray in addition to the oil; indeed, many of the blocks that had the best results had been sprayed as well as oiled. All of the growers are eager to participate in the trials again this coming summer.

Is it worth the cost? At first glance, it hardly seems possible that treating every ear could be cost-effective. In fact, the cost is in the same range as conventional methods. The one-time oil treatment usually takes 8-10 hours per acre and can be done by any employee who is careful and reliable. Thus, labor cost ranges from $60-80/acre. Materials include about 2 gallons of oil (at $6 per gallon) and 1 pint Bt ($5-7) per acre. For a grower with 15 acres of sweet corn or less, each successive block is typically less than an acre, so it can be treated in one day or less. This can be done in windy conditions, on two successive days if necessary, and does not have to be re-applied after a rainstorm. And at harvest, having clean corn keeps customers coming.
Managing Frost/Freeze Damaged Sweet Corn Plantings

Mike Staton, MSU Extension ANR Agent, Berrien County MSU Extension
1737 Hillandale Road, Benton Harbor, MI 49022-9630
Phone: (269) 944-4126 – Email: staton@msue.msu.edu

One of the keys to success in direct marketing sweet corn is to produce an early crop. However, late spring frost or freeze events can damage early plantings. In many cases only the leaves are damaged and the plants have the ability to fully recover and produce a normal crop. Several factors determine if the frost/freeze damage will be lethal to a given sweet corn planting. The stage of development of the crop, the minimum air temperature near the soil surface and its duration, health of the plants prior to the event and the weather conditions occurring after the event, all control the extent of the damage.

Young corn plants are less likely to die from low temperature injury than more mature plants. In young corn plants the growing point is below the soil surface. Once the plants reach the V6 stage (six true leaves with collars), the growing point has emerged from the soil and is no longer protected by the insulating effects of the soil.

Temperatures of 32°F occurring for about an hour will severely damage leaf tissue and can be lethal to the growing point in plants that have six true leaves. If the growing point is below the soil, these conditions should not damage the growing point. However, if the temperature dips to 28°F for a brief period of time or remains at 32°F for several hours, the insulation provided by the soil may not be enough to protect the growing point.

No matter how much leaf tissue is lost, the plants should have the capacity to develop normally and produce a normal yield as long as the growing point is healthy. Several factors affect the damaged plant’s ability to recover. The dead leaf tissue may restrict new leaves from emerging from the whorl. Cool, damp weather conditions following the event can delay the growth of new leaf tissue and the plants may starve to death. Cool, wet conditions also favor disease development in the damaged tissue, which can invade the growing point.

After a sweet corn planting has been damaged by a frost/freeze event, the grower must choose between three management options: 1) Keep the existing stand and do nothing; 2) Replant the field; or 3) Keep the existing stand and remove the dead leaf tissue by mowing. Several researchers have studied the impact of mowing damaged corn. Mowing has not been shown to consistently improve yields and in many cases, it has caused yield losses compared to allowing the plants to recover on their own.

The first step to making an informed decision is to determine if the growing points are still alive and healthy. There are two ways to do this—looking for new leaf tissue emerging from the whorls and inspecting the growing points. With both methods, it’s best to evaluate the damage after three to five days of good growing conditions with daily high temperatures above 70°F. When looking for new leaf growth, strip away the dead tissue and check for lime green leaf growth inside the
whorl. Also cut the plants lengthwise and look for crinkled or rippled leaves. This condition is a sign that new leaf growth has occurred but the new tissue is restricted by the damaged tissue. To inspect the growing points you will need to cut the plants lengthwise. Look for the growing point at the top of the pyramid-shaped whitish stalk tissue near the base of the plant. Dark tissue is diseased or damaged and probably won’t recover. Plants with growing points that are firm and whitish should be able to recover from the damage.

If new leaf tissue is present and the growing points look healthy, keep the stand and do nothing. Mowing has not been shown to consistently improve plant recovery. If the growing point is discolored and no new leaf tissue has been produced after three to five days, the planting should be abandoned or replanted if possible.
What Three Years of Research Has Revealed About Stewart’s Wilt

Beth A. Bishop, Department of Entomology, Michigan State University
355-5154 – bishopb@msu.edu

Stewart’s Wilt bacterial disease is a sporadic, but potentially serious, disease of sweet corn, especially early season varieties. The disease is transmitted by the corn flea beetle, which feeds on corn and a variety of other wild and cultivated plants in the grass family. The bacterium overwinters in the gut of the flea beetle and the flea beetle overwinters as an adult in areas surrounding corn fields. Overwintering survival, as affected by winter temperatures, has been long considered to be a major determinant of the seriousness of the problem in the following season.

During the mid-to-late 1990’s, Stewart’s Wilt became an increasing problem in many Michigan counties. This was attributed to a series of mild winters. In 2000 we began a 3-year research project to help growers understand and control Stewart’s Wilt disease in sweet corn. Our objectives included developing a more accurate model for predicting the risk of Stewart’s wilt each year and developing a more useful and accurate technique for sampling for corn flea beetles in sweet corn.

We have developed a yellow sticky trap to effectively monitor corn flea beetle populations over time and space. We have found considerable variation in population abundance. Abundance of corn flea beetles, however, is not directly related to the risk of Stewart’s Wilt. Rather the proportion of flea beetles carrying the bacteria, which we have found to be highly variable, is a more important determinant of risk.
Michigan Apple Marketing Future: Fresh Apple Perspective
Barry L. Winkel, Greg Orchards & Produce Inc.

• Changes for the future are already happening and will continue at a pace faster than ever before.

• Growing areas will change both in acreage and types of produce raised. Consolidation will take place between small and medium sized shippers.

• Our customer base will slip as the smaller chains merge with the larger ones. Shippers will take on more responsibility to make sure the shelves have the right varieties and quality on them.

• Growers will become more dependent on a primary outlet.

• Growers and shippers will get more politically involved. As the world becomes more global, we will have to have a say in food safety, chemical usage, water usage, land use and preservation, and above all, trade pacts.

• How is the apple industry faring as compared to ten years ago? After looking back, some changes will not be easy to make. However, after some adjustments are made, the fruit business can still be profitable. I am even looking forward to it.
Michigan Apple Marketing Future: A Processing Perspective
Ken Guise, Knouse Foods

1. Is Bigger Still Better?

2. Re-Invention

3. Cash Flows

4. Understanding Change

5. Market Knowledge

6. Quality

7. Loyalty

8. Innovation

9. The Man in the Mirror
Fire Blight Management

George W. Sundin, Michigan State University, East Lansing, MI

Fire blight, caused by the bacterium *Erwinia amylovora*, is a significant disease problem on apple in Michigan. This disease is destructive to the current year's crop, and can also reduce subsequent production by killing fruit spurs and branches, and can kill whole trees planted on susceptible rootstocks. Control of the disease is not readily achieved and, at the least, involves an integrated approach incorporating measures aimed at reducing pathogen populations with measures designed to reduce the susceptibility of the host. In this report, I will discuss ongoing efforts to reduce disease incidence with antibiotic sprays, systemic acquired resistance (SAR) inducers, and a growth inhibitor. I will also discuss our current efforts to utilize biotechnology as a means to incorporate resistance genes into susceptible varieties and rootstocks.

The antibiotic streptomycin remains the most effective chemical control measure for the blossom blight phase of the fire blight disease. However, streptomycin resistance is prevalent in Southwest Michigan which can significantly affect efficacy. Oxytetracycline is recommended for use in combination with streptomycin in orchards where streptomycin resistance occurs. Field results in 2002 in Michigan and New York were also promising for the compound oxolinic acid. The integrated use of Apogee, a growth inhibitor that reduces the amount of vigorous susceptible shoots in orchards, with streptomycin also was effective in fire blight control in 2002, although disease pressure was light in the experimental orchard. SAR inducers show some effect in reduction of disease incidence, although the number of applications required indicates that this practice may not be economically feasible.

Attempts to understand the genetic interaction between *E. amylovora* and apple and the genetic basis for the differences in disease incidence on highly susceptible varieties (ex. Gala) and rootstocks (ex. M26) vs more resistant varieties (ex. Red Delicious) and rootstocks are long-term approaches aimed at developing methods to incorporate durable fire blight resistance into popular varieties and rootstocks. I will discuss some of the research directions that we are taking with a goals of controlling the fire blight disease.
Carrot weed control trials were conducted on sand in Oceana County and on muck soil at the MSU Muck Soils Research Farm in Laingsburg, MI. In the preemergence experiment on sand, only Lorox 0.5 lb/a, Domain (flufenacet plus metribuzin) 0.3 lb, and Command 0.25 lb were totally safe on carrot and gave sufficient weed control. Goal 0.1 or 0.2 was safe on carrot, but weeds emerged after one month and caused yield reduction. Valor caused carrot injury when applied preemergence at 0.005 or 0.01 lb at/acre.

In the postemergence trial on sand, Lorox 0.5 and Domain 0.45 or 0.6 lb gave good weed control and no crop injury. Valor, Goal, Callisto, and Spartan reduced carrot yield.

On muck, Lorox 1 lb postemergence was safe on carrot. Sandea, Valor, and Spartan applied postemergence caused serious crop injury. Sandea and Spartan gave good yellow nutsedge control.

Weed Control in Carrots

Bernard Zandstra and Jose Cisneros, Michigan State University
Improving The Tools For Carrot Disease Management

Walter R. Stevenson, University of Wisconsin, Department of Plant Pathology
Tel. No. 608-262-6291 – Email: wrs@plantpath.wisc.edu

The two most common diseases affecting the foliage of the Wisconsin carrot crop are Alternaria leaf blight (Alternaria dauci) and Cercospora leaf blight (Cercospora carotae). Both diseases commonly appear in the same production fields and if left uncontrolled they can lead to extensive defoliation, significant reductions in yield and quality and a weakening of the leaf petioles. While much of the Wisconsin carrot acreage is mechanically topped in the field and harvested with modified potato harvesters, some growers who do not mechanically top prior to harvest rely on strong petioles in the harvest operation to lift the carrots from the soil. Achieving the best possible control of both diseases is an important facet of the crop and pest management activities on the Wisconsin carrot acreage.

The tools available for disease management on carrots are few in number. Short of crop rotation with non-susceptible crops, precision seeding for uniform plant populations, bedding to aid in drainage of water away from the developing carrot, careful irrigation to avoid prolonged leaf wetness and fertility programs based on soil and plant testing programs, growers are left with a limited number of fungicides and host resistance. During the past few years, growers relied on the use of chlorothalonil (Bravo and Echo) and fixed copper materials (Champ and Kocide) to control foliar diseases. Iprodione (Rovral) fungicide is registered for use on carrots, but none of the WI growers have opted to use this product in recent years. Azoxystrobin (Quadris) was added to this toolbox in 2001 and in late 2002, pyraclostrobin (Cabrio = BAS 500) received a full label. Both Quadris and Cabrio belong to the strobilurin fungicide chemistry group and represent reduced-risk chemistries. We have evaluated both Quadris and Cabrio in field trials on disease susceptible carrot varieties as alternating applications with chlorothalonil. Both products in an alternating program with chlorothalonil provide excellent disease control comparable with control provided by the weekly application of chlorothalonil. Because of the low amount of fungicide active ingredient (ai) used when either Quadris or Cabrio is applied, there is a substantial reduction in the fungicide ai applied in a season-long program. The reduction of ai and the replacement of conventional fungicide chemistry with reduced risk alternatives are both attractive to processors and others interested in pesticide risk reduction. In contrast to potatoes where the application of strobilurin fungicides increases tuber size and yield, the application of Quadris or Cabrio to carrots does not appear to increase carrot yield or the size of individual carrot roots. Because both Quadris and Cabrio are currently more expensive on a per application basis, the Wisconsin carrot industry has thus far not adopted the use of these new products in their disease management programs. The registration of strobilurin fungicides and eventual use of Quadris and Cabrio by the carrot industry requires the entire grower community to carefully read and understand the label use directions. Because of concern for selecting resistant strains of fungal pathogens, label directions include statements on resistance management, a limitation of the number of strobilurin sprays allowed per growing season and a limitation on product use per growing season.
Host resistance is a critical ingredient in carrot disease management. Since 1992, our program has conducted a yearly evaluation of currently available carrot cultivars and breeding lines to determine their field resistance to the pathogens inciting Alternaria and Cercospora leaf blights. Included in this testing program are representatives of slicing, dicing and cut and peel type carrots. These data are useful to carrot breeders, seed companies, processors and growers. Over the years, we have observed WI growers incorporating information from these plots in their disease management programs. Five of nine growers surveyed in 2001 to determine how they manage carrot pests reported that they routinely block and spray their carrot cultivars according to disease tolerance characteristics identified in our trials. Susceptible cultivars receive the most intensive spray programs while those cultivars with substantial field resistance to foliar diseases are sprayed the least. This represents substantial savings to those growers using the blocking program. The processing industry has encouraged this grower practice and has also assisted our program in selecting cultivars and breeding lines for inclusion in our annual trials.

Combining host resistance with the use of reduced risk fungicide programs is a logical next step in designing an integrated disease management program. One approach is to change the interval between fungicide sprays according to cultivar susceptibility. This past summer our carrot program, with capable leadership provided by Peter Rogers, evaluated four cultivars, Gold King and Fontana (susceptible), Recoleta (moderate susceptibility) and Carson (tolerant) under four fungicide treatment protocols (no treatment, weekly sprays, spraying every 2 weeks and spraying every 3 weeks). Sprays were initiated when 1% of the foliage of Carson exhibited disease symptoms. For the most susceptible cultivars, weekly sprays were required to maintain crop health. It was clear, however, that fewer sprays were required for disease suppression on Recoleta and still fewer sprays for Carson. An additional field trial focused on the use of treatment thresholds for triggering the first and subsequent application of fungicide on Bolero (tolerant) and Fontana (susceptible). Sprays for each cultivar were independently initiated when 1% disease was observed on the foliage of each cultivar. Subsequent sprays were applied on the basis of a modified Tom-Cast 15 or 20 Disease Severity Value (DSV) schedule. In this trial, disease was optimally controlled on Fontana with weekly fungicide sprays. Increased disease was observed on this cultivar when the Tom-Cast schedules were used. Acceptable disease control on Bolero was observed with substantially fewer sprays applied according to Tom-Cast schedules. It is clear from these trials that disease resistance can be interfaced quite nicely in determining when to spray and the intensity of fungicide spraying needed to achieve a desirable level of disease control.

Adding disease management tools in the form of reduced risk fungicides and carrot cultivars with greatly improved disease resistance are important contributions to the carrot industry from the chemical industry and breeders. Learning how to best integrate these tools in an effective disease management program will provide tangible benefits to growers, processors and ultimately consumers.
How to Use Scouting and Forecasters for Blight Control

M.K. Hausbeck (517-355-4534, hausbec1@msu.edu), R. Bounds, and E. Webster
Michigan State University, Department of Plant Pathology, E. Lansing, MI 48824

Studies were conducted in 2002 to explore the use of field scouting and the disease forecaster Tom-Cast to time fungicide applications to control Alternaria and Cercospora blights on carrots. For each 24-hour period (11:00 AM to 11:00 AM), Tom-Cast uses the hours of leaf wetness and the average temperature during the wetness periods to calculate a Disease Severity Value (DSV) ranging from 0 to 4, corresponding to environmental conditions unfavorable to highly favorable for disease development. Daily DSV values are summed and accumulate until a threshold value is reached, a fungicide spray is applied, and the DSV total is reset to zero.

One study was located at the Michigan State University Muck Soils Experimental Farm. Carrot ‘Early Gold’ seeds were planted on 21 May (plant population of 169,476/A). Another study located in Fremont, MI was established with a grower cooperator using ‘Prime Cut’ seeds planted on 6 June 2002 (plant population of 508,522/A). Bravo Ultrex 80WG (1.4 lb/A) alternated with Quadris 2.08F (6.2 fl oz/A) were applied to all treatment plots, excluding the control. Initial sprays were applied before disease symptom development (0%), or when disease was evident on a trace amount, 5%, or 10% of the foliage. Subsequent sprays were applied every 7 days (commercial field only), 10 days or according to Tom-Cast with a threshold of 15, 20, or 25 DSVs.
Spray programs initiated when a trace amount of the foliage was diseased often provided control comparable to the program that started before blight developed (see graphs below). Prolonging the initial application until disease appeared on 5% or 10% of the foliage reduced the number of sprays but did not provide acceptable disease control. Results suggest that reducing carrot production costs can be achieved by utilizing Tom-Cast (15 DSV) coupled with field scouting to time fungicide sprays.

An additional study was conducted to determine whether Tom-Cast could be used to time sprays for foliar blight using Quadris 2.08SC, Bravo Ultrex 82.5WDG, and Kocide 2000. The cultivar Heritage was grown in a 3-row raised bed. Initial sprays were applied before disease symptoms and subsequent sprays were applied every 7 days or according to Tom-Cast with a threshold of 10, 15 or 20 DSVs. Disease pressure occurred early and progressed within the treatment blocks. When this same trial was conducted in 2001, disease occurred late in the season. In both years, using Tom-Cast 15 DSV with a 3-way alternation of Quadris 2.08SC, Bravo Ultrex 82.5WDG, and Kocide 2000 was as effective as the 7-day application while saving 6 sprays. In 2002, more disease developed on the petioles when using Tom-Cast 15 DSV compared to the same treatments in 2001. However, the petiole health rating indicated that most of the fungicide programs were effective enough to keep the tops intact for pulling. An exception to this was Kocide used alone every 15 DSVs where the health rating was 5 (1=healthy, 10=dead). Overall, Tom-Cast at 20DSV appeared to allow too much disease to develop.
<table>
<thead>
<tr>
<th>Treatment and rate/A</th>
<th>No. of sprays</th>
<th>Plants with infected petioles (%)</th>
<th>Health&lt;sup&gt;*&lt;/sup&gt;</th>
<th>Foliar evaluation (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Untreated</td>
<td>-</td>
<td>100</td>
<td>7.3</td>
<td>33</td>
</tr>
<tr>
<td>Kocide 2000 53.8 DF 1.5 lb</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7-day</td>
<td>13</td>
<td>44</td>
<td>2.8</td>
<td>5</td>
</tr>
<tr>
<td>10-DSV</td>
<td>10</td>
<td>47</td>
<td>3.5</td>
<td>9</td>
</tr>
<tr>
<td>15-DSV</td>
<td>7</td>
<td>77</td>
<td>5</td>
<td>23</td>
</tr>
<tr>
<td>20-DSV</td>
<td>5</td>
<td>79</td>
<td>6</td>
<td>25</td>
</tr>
<tr>
<td>Quadris 2.08SC 6.2 fl oz alternate Kocide 2000 53.8 DF 1.5 lb</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7-day</td>
<td>13</td>
<td>28</td>
<td>1.5</td>
<td>3</td>
</tr>
<tr>
<td>10-DSV</td>
<td>10</td>
<td>25</td>
<td>2.3</td>
<td>4</td>
</tr>
<tr>
<td>15-DSV</td>
<td>7</td>
<td>53</td>
<td>2.8</td>
<td>5</td>
</tr>
<tr>
<td>20-DSV</td>
<td>5</td>
<td>64</td>
<td>3.8</td>
<td>13</td>
</tr>
<tr>
<td>Bravo Ultrex 82.5WDG 1.8 lb alternate Kocide 2000 53.8 DF 1.5 lb</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7-day</td>
<td>13</td>
<td>30</td>
<td>1.8</td>
<td>6</td>
</tr>
<tr>
<td>10-DSV</td>
<td>10</td>
<td>44</td>
<td>2.3</td>
<td>4</td>
</tr>
<tr>
<td>15-DSV</td>
<td>7</td>
<td>69</td>
<td>4</td>
<td>14</td>
</tr>
<tr>
<td>20-DSV</td>
<td>5</td>
<td>68</td>
<td>4.3</td>
<td>10</td>
</tr>
<tr>
<td>Quadris 2.08SC 6.2 fl oz alternate Bravo Ultrex 82.5WDG 1.8 lb</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7-day</td>
<td>13</td>
<td>8</td>
<td>1.8</td>
<td>2</td>
</tr>
<tr>
<td>10-DSV</td>
<td>10</td>
<td>11</td>
<td>2.5</td>
<td>2</td>
</tr>
<tr>
<td>15-DSV</td>
<td>7</td>
<td>50</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>20-DSV</td>
<td>5</td>
<td>50</td>
<td>5.3</td>
<td>16</td>
</tr>
<tr>
<td>Bravo Ultrex 82.5WDG 1.8 lb</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7-day</td>
<td>13</td>
<td>18</td>
<td>1.8</td>
<td>3</td>
</tr>
<tr>
<td>10-DSV</td>
<td>10</td>
<td>12</td>
<td>1.3</td>
<td>1</td>
</tr>
<tr>
<td>15-DSV</td>
<td>7</td>
<td>32</td>
<td>2.8</td>
<td>11</td>
</tr>
<tr>
<td>20-DSV</td>
<td>5</td>
<td>64</td>
<td>4.8</td>
<td>30</td>
</tr>
<tr>
<td>Quadris 2.08SC 6.2 fl oz alternate Bravo Ultrex 82.5WDG 1.8 lb alternate Kocide 2000 53.8 DF 1.5 lb</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7-day</td>
<td>13</td>
<td>27</td>
<td>2.3</td>
<td>6</td>
</tr>
<tr>
<td>10-DSV</td>
<td>10</td>
<td>16</td>
<td>1.5</td>
<td>3</td>
</tr>
<tr>
<td>15-DSV</td>
<td>7</td>
<td>12</td>
<td>1.8</td>
<td>2</td>
</tr>
<tr>
<td>20-DSV</td>
<td>5</td>
<td>67</td>
<td>3.5</td>
<td>9</td>
</tr>
</tbody>
</table>

<sup>*</sup>Petioles rated on a scale of 1-10, where 1=healthy to 10=dead.

This research was supported in part by GREEEN (www.greeen.msu.edu), USDA CSREES Risk Avoidance and Mitigation Program project, and the Gerber Products Company.
The Agricultural Risk Protection Act (ARPA) of 2000 was signed into law by the President on June 20, 2000. This legislation allocated funds to reform the Federal crop insurance program to better serve the needs of all farmers. This includes, but is not limited to, producer education for risk management, and development of new programs for uninsured commodities.

Insurance for specialty crops has been limited to the NAP program and ad hoc disaster program payments. Although the NAP program has been improved to cover losses on an individual basis, the limitations still allow for only a catastrophic loss. And ad hoc disaster program payments are certainly not something to count on when a producer is considering how to manage risk in their farm operation.

Why is there no crop insurance available for carrots in Michigan? Development of policies depends first of all upon the demand for them. Producers can, and do, have an influence on when and how a policy is developed. In fact, ARPA allows for grower organizations and other groups to develop new policies. Information will be provided for attendees of this workshop on how to get involved in developing or expanding a risk management tool for carrot producers.

An alternative to traditional crop insurance, Adjusted Gross Revenue (AGR) is a whole farm revenue insurance policy available to producers in limited counties in Michigan. AGR insures for a combination of weather and price related losses. Average past income is used to determine the amount of insurance coverage for the farm operation. Details of AGR insurance will be presented in this workshop.
Risk Management For Specialty Crops in Michigan

Chris Shellenbarger, Agent for Spartan Insurance
11769 Bell Rd., Clarksville, MI 48815
616 693-3247 – cshell58@hotmail.com

The Agricultural Risk Protection Act (ARPA) of 2000 was signed into law by the President on June 20, 2000. This legislation allocated funds to reform the Federal crop insurance program to better serve the needs of all farmers. This includes, but is not limited to, producer education for risk management, and development of new programs for uninsured commodities.

Insurance for specialty crops has been limited to the NAP program and ad hoc disaster program payments. Although the NAP program has been improved to cover losses on an individual basis, the limitations still allow for only a catastrophic loss. And ad hoc disaster program payments are certainly not something to count on when a producer is considering how to manage risk in their farm operation.

Why is there no crop insurance available for celery in Michigan? Development of policies depends first of all upon the demand for them. Producers can, and do, have an influence on when and how a policy is developed. In fact, ARPA allows for grower organizations and other groups to develop new policies. Information will be provided for attendees of this workshop on how to get involved in developing or expanding a risk management tool for carrot producers.

An alternative to traditional crop insurance, Adjusted Gross Revenue (AGR) is a whole farm revenue insurance policy available to producers in limited counties in Michigan. AGR insure for a combination of weather and price related losses. Average past income is used to determine the amount of insurance coverage for the farm operation. Details of AGR insurance will be presented in this workshop.
Fusarium-tolerant Celery: Are We there Yet?

Dr. Matt Kleinhenz, Asst. Professor and Extension Vegetable Specialist
Department of Horticulture and Crop Science, OSU/OARDC - Wooster
Ph. 330-263-3810; FAX 330-263-3887; E-mail kleinhenz.1@osu.edu;
Internet http://www.oardc.ohio-state.edu/kleinhenz

Dr. Krishna V. Subbarao, Plant Pathologist and Specialist in Cooperative Extension
Department of Plant Pathology, University of California-Davis
Ph. 831-755-2890; FAX 831-755-2814; E-mail kvsubbarao@ucdavis.edu

This work was supported by University of California-Davis, The Ohio State University, and the California Celery Board. Dr. Ravi Bhat, Judy Hubbard, and Dr. Tom Gordon (Dept. of Plant Pathology, Univ. California-Davis), Steven Koike (U.C. Cooperative Extension, Salinas), and Brenda Schult (Dept. of Horticulture and Crop Science, The Ohio State Univ.) also contributed significantly to the project.

Presentation Summary
In 2000 and 2001, we set out to: 1) assess the role of other Fusarium spp. along with F. o. apii in Fusarium yellows of celery, and 2) screen varieties and experimental genotypes for resistance against F. o. apii in the greenhouse and field in Ohio. We also aimed to determine the effects of celery cultivars differing in Fusarium yellows resistance on the dynamics of soil and plant populations of a known F. o. apii genotype. Results from studies regarding Objectives 1 and 2 are outlined here.

For Objective 1, two isolates each of Fusarium equiseti, F. sambucinum, F. culmorum, and an unknown Fusarium spp. were inoculated either singly or in combination with F. o. apii to test their ability to cause Fusarium yellows in greenhouse-grown celery. Only F. o. apii caused Fusarium yellows when inoculated alone. Plants inoculated with species other than F. o. apii grew normally. However, disease occurred earlier and was more severe in plants inoculated with F. o. apii plus another species compared to F. o. apii alone. Several combinations also decreased plant height relative to inoculation with F. o. apii alone. These results strongly suggest that fields which lack F. o. apii are less conducive to Fusarium yellows despite the presence of other Fusarium species. However, if F. o. apii is present, these species may increase disease severity.

For Objective 2, reactions of celery varieties and experimental genotypes to F. o. apii isolates from Ohio and California were documented in plants grown in the field and greenhouse in Ohio. A total of 25 varieties and breeding lines were studied. The Ohio populations of F. o. apii were more virulent than the California isolate. Disease severity was also significantly greater in plants exposed to the Ohio populations of F. o. apii, compared to the California isolate, even in cultivars reported to be tolerant. These results suggest that more work is needed to develop varieties tolerant to the Ohio populations of F. o. apii.
Table 1. Comparison of disease severity in a total of five isolates of *F. o. apii* from Ohio (OH) and California (CA) in plants challenged with the isolates and grown in sand culture in the greenhouse.

<table>
<thead>
<tr>
<th>Isolate</th>
<th>Disease Severity (1-5, 5 = most severe)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2000</td>
</tr>
<tr>
<td>A (CA)</td>
<td>3.3</td>
</tr>
<tr>
<td>B (OH)</td>
<td>3.9</td>
</tr>
<tr>
<td>C (OH)</td>
<td>4.1</td>
</tr>
<tr>
<td>D (OH)</td>
<td>4.3</td>
</tr>
<tr>
<td>E (OH)</td>
<td>0.7</td>
</tr>
<tr>
<td>LSD (P &lt; 0.05)</td>
<td>0.21</td>
</tr>
</tbody>
</table>

Severity is the mean of 10 plants each from 25 celery lines screened.

Table 2. Reactions of genotypes to Ohio populations of *Fusarium oxysporum* f. sp. *apii* grown at The OSU Muck Crops Research Branch in Celeryville, OH in 2000 and 2001. Genotypes are listed in order of decreasing severity within each year.

<table>
<thead>
<tr>
<th>Genotype and Disease Severity (1-5, 5 = most severe)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Genotype and Disease Severity (1-5, 5 = most severe)</td>
</tr>
<tr>
<td>Genotype and Disease Severity (1-5, 5 = most severe)</td>
</tr>
<tr>
<td>Genotype and Disease Severity (1-5, 5 = most severe)</td>
</tr>
</tbody>
</table>
Background Information

In addition to *F. o. apii*, *F. equiseti*, *F. culmorum*, and *F. semitectum* isolates are frequently recovered from celery plants showing Fusarium yellows symptoms and from the rhizosphere soil of diseased plants. Just as important, the success of disease management techniques, especially those based on chemical application, probably will be species-specific. Therefore, it is important to determine the relative role of various *Fusarium* species in Fusarium yellows disease. For Objective 1, we tested the pathogenicity of two isolates of each species individually and with *F. o. apii*, using the susceptible line TU52-70R grown in sand culture in the greenhouse. Each species isolate was also co-inoculated with a virulent isolate of *F. o. apii* to determine if they can enhance the severity of the disease together. Each plant was monitored daily for symptoms of Fusarium yellows. Eight weeks after inoculation, plant height above the soil line was recorded for each plant. Fusarium yellows severity was then rated on a 0-5 scale (0 = no disease, 1 = lateral roots discolored, 2 = main root discolored, 3 = crown discolored, 4 = crown extensively discolored, and 5 = plant dead).

The high pathogenicity of *F. o. apii* isolates from Ohio is well documented. Therefore, these isolates and the soil in which they first appeared are ideal testing agents for breeding programs attempting to incorporate tolerance to Fusarium yellows in celery varieties. For Objective 2, a total of 25 genotypes were chosen in consultation with private breeders and Dr. Carlos Quiros. Separate groups of plants of each line (grown in sand and drip-irrigated) were challenged with four isolates of *F. o. apii* from Ohio and an isolate from California in a greenhouse at the OARDC in Wooster. The same 25 celery genotypes were planted in replicated plots arranged in a randomized block design at the OSU Muck Crops Research Branch in Celeryville, Ohio. Plant condition and Fusarium yellows severity were monitored regularly. Disease severity was recorded in both studies using the scale described earlier (8 weeks after inoculation in the greenhouse, approx. 10 weeks after field transplanting).
Development of Fusarium-resistant Celery Cultivars

Brian Cortright, Rebecca Grumet and Mary Hausbeck
Departments of Horticulture and Plant Pathology, Michigan State University

Fusarium yellows (causal agent: *Fusarium oxysporum* f.sp. *apii* race 2) is a limiting factor in celery production in Michigan and nationally. This disease cannot be controlled with chemicals or cultural practices and so it is imperative to have high quality, resistant cultivars. The Michigan State University celery breeding program has used a combination of somaclonal variation and recurrent selection to develop high yielding, highly fusarium-resistant celery breeding lines. These lines also exhibited desirable horticultural characteristics with the exception of short petioles. A crossing program was initiated in 2000 to increase height and determine whether the MSU ‘FL683’-derived somaclone lines have a different source of resistance than the celeriac-derived resistance present in current commercial cultivars.

Hybrid families were produced between three MSU somaclone lines and the commercial cultivar, ‘Greenbay’ (‘XP166’). The hybrid progeny all showed a high level of resistance and significantly greater height than the somaclone-derived parents. This past summer, 2002, trials were performed with F3 progeny families produced from 36 F2 individuals selected for disease resistance, yield, height, and horticultural qualities. The F2 selections represented four initial hybrid combinations and 10 F2 families. The F3 families were tested individually in single plots, and in bulks in a replicated trial (see Figure 1).

![Figure 1. Fusarium disease rating of commercial and somaclonal lines transplanted in a heavily infested site, Hudsonville, 2002.](image-url)
Once again, disease conditions in the test field were severe. The susceptible control, 'FL683' received a mean disease rating of 4.2 (rated on a scale of 1-5, where 1=no disease and 5=dead plant); none of the 'FL683' plants were marketable. On average the F3 progeny showed a high level of resistance, however, there was variability among the F3 families, as would be expected, if there is segregation for the disease resistance trait. Average ratings for the families ranged from 1.0 – 1.8 with an overall average of 1.2. The averages for the ten lines ranged from 1.0 – 1.5. The bulks ranged from 1.0 – 1.6 with a mean of 1.2. With the exception of two bulks, all of the others scored 1.0 or 1.1. These values compare favorably with the commercial cultivars, XP85, XP166, XP266 and Picador which gave values of 1.2, 1.1, 2.4, and 1.2, respectively. Surprisingly, XP266 did not perform well this year, the reason is not known. Yield of the F3 families measured as weight (lbs)/10 plants ranged from 12.5 – 23.4, with an overall mean of 17.0. Weights of the commercial cultivars were 18.8, 19.2, 12.6, and 17.0, respectively. The families were less variable for height than at the F2 stage, indicating success in selecting for this trait. Although not as tall as some of the commercial varieties, six of ten families had acceptable heights, greater than 9” to the first node.

F2 bulks corresponding to 6 of the F3 lines were tested in row trials on two grower-cooperators’ farms. F2 materials were used, as F3 seed were not available in time for the commercial plantings. Data were available from one farm. Plants in the row trial showed excellent disease resistance (all had ratings of 1.0). Yields (weight/10 plants) were slightly lower than the XP266 check variety, and the plants were more variable in size and height. This variability is consistent with an early generation (F2) bulk and should diminish as selection proceeds.

Selected individuals were dug from the F3 trial field and are currently in cold storage to induce flowering to allow for F4 seed production this winter.
The Challenge of Controlling Multiple Insect Pests in Celery

Beth A Bishop, Department of Entomology, Michigan State University
(517) 355-5154 – bishopb@msu.edu

Controlling insect pests on celery is challenging for several reasons. Celery has a low tolerance for damage, especially close to harvest. Celery is attacked by a diverse group of insect pests each requiring somewhat different tactics. Controlling one pest sometimes directly interferes with control of another pest.

A major migratory pest of celery is the aster leafhopper, which transmit aster yellows disease. Aster leafhoppers migrate into the Great Lakes region every year from the south. Aster leafhoppers are difficult to deal with because of their unpredictability: when they will show up, how many will come, and how many carry the aster yellows disease.

Tarnished plant bugs are also difficult to predict and detect. Although these insects are able to overwinter in Michigan, they are highly mobile and have a wide host range. Whether or not they will damage celery depends on the attractiveness of the celery crop relative to the other options (other crops, weeds) that the bugs have to feed on. Adults can and do regularly migrate into a celery crop, feed, then leave. The only evidence that they were there is the feeding damage they leave behind.

Several caterpillar (i.e., "worm") pests injure celery. Celery and cabbage loopers, celery leaf tiers and cutworms feed on various portions of the celery plant. Their occurrence is variable, as is their control. Some insecticides used to control other celery insect pests are not effective on worms and vice versa.

Aphids are challenging for several reasons. Aphid populations can appear suddenly, often late in the season. Effective insecticides with short preharvest intervals are needed to clean up these late infestations. Overuse of insecticides to control other celery pests, especially pyrethroids, can result in aphid build-up because of insecticide resistance and death of natural enemies.

The secret of effective insect pest control on celery is frequent, effective scouting to detect potential problems, knowledge of each particular pest's biology and control. Effective control involves balancing needs and priorities of several pests. Future research will fill in gaps in our knowledge and provide better, safer tools, but controlling insects on celery will always remain a challenge.
Weed Control in Celery
Bernard Zandstra and Michael Particka, Michigan State University

A celery weed control trial was conducted at the MSU Muck Soil Research Farm in Laingsburg, MI in 2002. Our objective is to find new herbicides that can be used in addition to Caparol, Lorox, and Dual Magnum. Caparol 1 lb applied after transplanting and again 4 weeks later either alone or plus Poast and COC gave control of all weeds except yellow nutsedge, and good yield. Caparol 2 lb applied twice was similar in weed control and crop injury to Caparol 1 lb applied twice. When weeds are small, Caparol 1 lb is as effective as Caparol 2 lb. Valor applied after transplanting or postemergence set celery back somewhat, but did not cause major crop injury. Yields were lower, but may have recovered if harvest was delayed. Spartan 0.1 lb appeared to be safe postemergence. Dual gave good yellow nutsedge control but may have delayed celery harvest slightly.

There should be no changes in celery weed control labels or recommendations for 2003. Please see Extension Bulletin E-433 for current recommendations.
A New Program for Disease Management

M.K. Hausbeck (517-355-4534, hausbec1@msu.edu)
Michigan State University, Department of Plant Pathology, E. Lansing, MI 48824

One of the trials conducted in 2002 emphasized a comparison between commonly used fungicides and new products for use on celery. The ability of the treatments to limit Septoria blight was evaluated by assessing the amount and severity of infection and the marketable yield.

**Trial 1.** Testing new products for control of Septoria blight of celery.

<table>
<thead>
<tr>
<th>Treatment and rate/A, applied at 7-day intervals</th>
<th>Currently registered</th>
<th>Active ingredient</th>
<th>Foliar infection’ (%)/10/1</th>
<th>Yield per 10 plants (lb)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Untreated inoculated ..........................</td>
<td>-</td>
<td>-</td>
<td>7 d”</td>
<td>6.1 c</td>
</tr>
<tr>
<td>Untreated natural infection .................</td>
<td>-</td>
<td>-</td>
<td>6.8 cd</td>
<td>28 ab</td>
</tr>
<tr>
<td>Cabrio 20WG 1.0 lb alternated</td>
<td>no</td>
<td>pyraclostrobin</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bravo Ultrex 82.5WDG 1.8 lb ...............</td>
<td>yes</td>
<td>chlorothalonil</td>
<td>1 a</td>
<td>29 a</td>
</tr>
<tr>
<td>BAS 516 38WG 10.5 oz .................</td>
<td>no</td>
<td>510</td>
<td>1.3 a</td>
<td>27 ab</td>
</tr>
<tr>
<td>Quadris 2.08SC 9.2 fl oz alternated</td>
<td>yes</td>
<td>azoxystrobin</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bravo Ultrex 82.5WDG 1.8 lb ...............</td>
<td>yes</td>
<td>chlorothalonil</td>
<td>1 a</td>
<td>27 ab</td>
</tr>
<tr>
<td>Quadris 2.08SC 15.0 fl oz alternated</td>
<td>yes</td>
<td>azoxystrobin</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bravo Ultrex 82.5WDG 1.8 lb ...............</td>
<td>yes</td>
<td>chlorothalonil</td>
<td>1 a</td>
<td>26 ab</td>
</tr>
<tr>
<td>Quadris 2.08SC 9.2 fl oz alternated</td>
<td>yes</td>
<td>azoxystrobin</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tilt 3.6EC 4.0 fl oz ........................</td>
<td>yes</td>
<td>propiconazole</td>
<td>3 b</td>
<td>28 ab</td>
</tr>
<tr>
<td>Quadris 2.08SC 15.0 fl oz alternated</td>
<td>yes</td>
<td>azoxystrobin</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tilt 3.6EC 4.0 fl oz ........................</td>
<td>yes</td>
<td>propiconazole</td>
<td>2 ab</td>
<td>27 ab</td>
</tr>
<tr>
<td>Bravo Ultrex 82.5WDG 1.8 lb ...............</td>
<td>yes</td>
<td>chlorothalonil</td>
<td>1 a</td>
<td>26 ab</td>
</tr>
<tr>
<td>Serenade 10WP 6.0 lb ......................</td>
<td>yes</td>
<td>Bacillus subtilis</td>
<td>5.8 c</td>
<td>24 ab</td>
</tr>
<tr>
<td>Messenger 3WDG 9.0 oz ......................</td>
<td>yes</td>
<td>harpin protein</td>
<td>6 cd</td>
<td>24 b</td>
</tr>
<tr>
<td>Equus DF 82.5DF 1.8 lb ........................</td>
<td>yes</td>
<td>chlorothalonil</td>
<td>1.5 a</td>
<td>28 ab</td>
</tr>
<tr>
<td>Kocide 2000 54WG 1.5 lb  ....................</td>
<td>yes</td>
<td>copper hydroxide</td>
<td>6.5 cd</td>
<td>24 ab</td>
</tr>
<tr>
<td>Actigard 50WG 1.0 oz ........................</td>
<td>no</td>
<td>acibenzolar-S-methyl</td>
<td>5.5 c</td>
<td>24 ab</td>
</tr>
</tbody>
</table>

* Based on a rating of 1 to 10 where 1=0% to trace of disease; 10=complete defoliation & death.
** Column means with a letter in common are not significantly different (Student-Newman-Keuls; P=0.05).
When plants were left untreated, they became severely diseased. Many of the products tested provided excellent disease control, and included Equus DF, or BAS 516 38WG, or Bravo Ultrex 82.5WDG alone or alternated with Quadris 2.08SC or Cabrio 20WG. Good control was also achieved with Quadris 2.08SC alternated with Tilt 3.6EC. When Quadris was used in alternation with Bravo, it appeared that the lower Quadris rate (9.2 fl oz) was as effective as the higher rate (15.0 fl oz).

The higher rate of Quadris did not negatively affect yield. The Serenade 10WP, Messenger 3WDG, Kocide 2000 54WG, and Actigard 50WG products did not provide adequate disease control. To avoid the development of resistance, fungicides should be alternated within each growing season.

Disease forecasting uses weather (temperature, leaf wetness, rainfall, and relative humidity) to determine whether disease is likely to develop. When the environment is favorable, the forecaster alerts the grower that a fungicide spray is needed. Disease forecasters can help time sprays so they are applied when they are most needed. Disease forecasters have been used successfully in vegetable crops, including tomatoes and asparagus. Recent research suggests that carrot blights can also be managed using disease forecasting. In a celery trial conducted during the 2002 growing season, three disease forecasters were compared with each other and to commonly used calendar-based spray programs.

**Trial 2. Using forecasters to control Septoria blight of celery.**

<table>
<thead>
<tr>
<th>Treatment and rate/A, application schedule</th>
<th>No. of appl.</th>
<th>Foliar infection(^\text{*}) (%) 10/1</th>
<th>Yield per 10 plants (lb)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Untreated inoculated ..........................</td>
<td>~</td>
<td>7  c</td>
<td>6.5  b</td>
</tr>
<tr>
<td>Untreated natural infection ....................</td>
<td>~</td>
<td>5.5  b</td>
<td>22.9  a</td>
</tr>
<tr>
<td>Quadris 2.08SC 9.2 fl oz alternated</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bravo Ultrex 82.5WDG 1.8 lb, 7 day ..........</td>
<td>12</td>
<td>1.3  a</td>
<td>23.1  a</td>
</tr>
<tr>
<td>Bravo Ultrex 82.5WDG 1.8 lb, 7 day ..........</td>
<td>12</td>
<td>1.3  a</td>
<td>26  a</td>
</tr>
<tr>
<td>Quadris 2.08SC 9.2 fl oz alternated</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bravo Ultrex 82.5WDG 1.8 lb, Septoria predictor ......</td>
<td>9</td>
<td>1.3  a</td>
<td>26.1  a</td>
</tr>
<tr>
<td>Bravo Ultrex 82.5WDG 1.8 lb, Septoria predictor ......</td>
<td>9</td>
<td>1  a</td>
<td>22.3  a</td>
</tr>
<tr>
<td>Quadris 2.08SC 9.2 fl oz alternated</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bravo Ultrex 82.5WDG 1.8 lb, Cercospora predictor ....</td>
<td>6</td>
<td>1.8  a</td>
<td>26.5  a</td>
</tr>
<tr>
<td>Bravo Ultrex 82.5WDG 1.8 lb, Cercospora predictor ....</td>
<td>6</td>
<td>1.8  a</td>
<td>23.7  a</td>
</tr>
<tr>
<td>Quadris 2.08SC 9.2 fl oz alternated</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bravo Ultrex 82.5WDG 1.8 lb, Tom-Cast 15 DSV ......</td>
<td>5</td>
<td>1.8  a</td>
<td>25.4  a</td>
</tr>
<tr>
<td>Bravo Ultrex 82.5WDG 1.8 lb, Tom-Cast 15 DSV ......</td>
<td>5</td>
<td>1.3  a</td>
<td>24.6  a</td>
</tr>
</tbody>
</table>

\(^*\)Based on a rating of 1 to 10 where 1=0% to trace of disease to 10=complete defoliation and death.

\(^\text{**}\)Column means with a letter in common are not significantly different (Student-Newman-Keuls; P=0.05).
When plants were left untreated, they became severely diseased. Spraying the plants every 7 days with either Bravo Ultrex 82.5WDG alone or Bravo Ultrex 82.5WDG alternated with Quadris 2.08SC provided excellent disease control and resulted in 12 applications. Using the Septoria disease predictor reduced the number of sprays needed to 9 without compromising disease control or yield. When fungicides were timed with the Cercospora (6 sprays) or Tom-Cast (5 sprays) disease predictor, the number of fungicide sprays needed dropped even further. Using Bravo Ultrex 82.5WDG alone was comparable to using an alternating program of Bravo Ultrex 82.5WDG and Quadris 2.08SC.

Further work is needed to determine whether forecasting systems can hold up under severe disease pressure, especially when lesions occur early in the season.

This research was supported in part by the GREEEN project (www.greeen.msu.edu), “Using Resistance and Reduced Risk Fungicides to Manage Fusarium Yellows and Foliar Diseases in Michigan Celery;” Celery Research, Inc.; and the USDA CSREES Risk Avoidance and Mitigation Program project, “A Strategy to Advance IPM for Celery Growers in Michigan, California and Florida.”
The South Carolina Peach Industry is doing well. Together with Georgia, we are number 2 in national peach production only behind California. We produce an average of 140 million pounds of fruit every year. This year’s prices for > 2 ¾” shipped peaches were $10-12 per ½ bushel and for roadside 2 ½” peaches $14 per ½ bushel.

Disease control is an important component of peach production. In the southeastern United States, where a warm, humid climate favors rapid growth and reproduction of insects and organisms that cause disease, chemicals to control these pests are applied at regular intervals from break of dormancy until fruits are harvested. Fifteen to twenty sprays may be applied on later-maturing peach varieties. That of course, constitutes a major cost factor in the production of peaches and poses a threat to the environment and fresh water supplies. One of our goals is to identify critical times for sprays to reduce the number of pesticide applications. In this report reduced fungicide/bactericide spray strategies are discussed for bacterial spot, peach scab and brown rot. Other diseases exist but most of them are usually controlled by the regular spray programs with the exception of oak root rot.

**Bacterial spot.** This disease is caused by the bacterium *Xanthomonas arboricola*. It is very unpredictable, meaning it occurs only in some years. Research at NC State University led by Dr. Dave Ritchie is underway to try to predict years of high disease pressure. For now, it seems that infection of fruit is most severe in years when frequent periods of rainfall occur 3 to 4 weeks following petal-fall (PF).

The current strategy for controlling bacterial spot is to reduce inoculum levels using copper starting at late dormant with 2 lb (a.i.) of metallic copper. Copper applications are continued up to (PF), but rates are significantly reduced to avoid phytotoxicity. After PF growers spray Mycoshield (oxytetracycline) in weekly intervals or rotate Mycoshield with copper applied at low rates throughout the season. Despite this very aggressive spray program, chemical sprays are not totally effective on highly susceptible cultivars in years when conditions for bacterial spot are very favorable. Timing of spray applications is critical, meaning that applications are most effective if applied prior to a rain but with enough time for drying. Clemson University scientists Dr. Dale Linvill and Dr. Walker Miller have developed a computer model to predict infection periods based on weather data. The model was tested three years in a row (99-02) in grower orchards from SC and GA under supervision of Dr. Phil Brannen, UGA. Based on his experience, the model seems to have merit especially early in the season but may need some adjustments in regard to forecasts later in the season.
**Peach scab.** You can count on this disease every year. The fungus (*Cladosporium carpophilum*) causes spots on developing fruit making the fruit unmarketable. The fungus begins producing conidia about two weeks before shuck split (SS) and continues to do so until 4 to 5 weeks after SS. Protection of the fruit tissue with fungicides is critical during this period. Several fungicides are registered for scab control, including Bravo, Abound, Captan, and Sulfur. The compounds differ in their efficacy against scab and market price. The grower has the choice to primarily use the cheaper but less effective Sulfur and risk some scab development in a high scab pressure season or the more expensive products with higher efficacy such as Bravo or Abound. Many growers know that the early scab sprays are the most important ones and usually do not hesitate to use Bravo or Abound at that time followed by the less expensive Sulfur in the cover sprays. This program is usually effective against scab if disease pressure is not too high and it is relatively inexpensive. Although scab pressure ceases four weeks after SS, many growers keep adding Sulfur to their spray tanks for “extra insurance”.

**Brown rot.** Brown rot of peach is caused by the fungus *Monilinia fructicola* and is probably the major pre and postharvest disease concern. When environmental conditions are conducive, the disease can spread quickly and may cause significant losses. Estimates of disease losses during an epidemic in Georgia for 2001 were $4.3 million in direct losses and $1.5 million in fungicide costs. The disease is particularly dangerous if blossom blight is allowed to produce high inoculum levels and if rainfall is prevalent during the growing season up to harvest. Other inoculum sources such as old cankers, peduncles, mummified fruit and green fruit rot may produce sufficient inoculum for epidemic levels of brown rot in any wet year. The prolific production of conidia, which are spread through wind and rain, allows for rapid epidemic development within an orchard or a region. Our research has shown that the demethylation inhibitor (DMI) fungicides such as Indar, Orbit, and Elite are still highly effective in controlling the disease although they have been used for almost three decades on a regular basis. Some DMI fungicides perform slightly better than others primarily due to the ability of the fungicides to bind to the fungal target enzyme. A shift of some *M. fructicola* populations towards reduced sensitivities has been documented, but recent research shows that this shift has not increased during the last six years.

**Oak root rot.** Prior to the widespread cultivation of cotton in many parts of the southeastern United States, the land was largely covered with hardwood forests. In this forested land, the oak root rot (ORR) fungus thrived and spread throughout the region. Today, the fungus can be found in the soil of most of the prominent peach growing areas - if not everywhere - should you just dig deep enough to find it. The ORR fungus can survive for up to a hundred years in root pieces deep down in the soil where degradation of organic material progresses very slowly. Many growers have a misconception that growing trees on ‘virgin’ peach land (i.e., land where peaches have never been grown before) is a solution to the problem of soil-borne pathogens that kill peach trees. Depending on the depth where the ORR is present and the amount of inoculum that exists in the soil, trees on virgin land can die from ORR well before they live out their productive lifespan. There is currently no rootstock commercially available that is resistant to ORR. Although Guardian™ rootstock is very helpful on sites with Peach Tree Short Life (PTSL), it is also very susceptible to ORR. Once living peach tree roots reach the infected root pieces remaining in the soil, they become infected. The fungus then migrates up the root system to the crown of the tree, which it essentially girdles and kills. The tree subsequently dies. On existing peach sites where trees have died from ORR previously, it is highly likely that the inoculum level in the soil is greater and closer to the soil.
surface than in ‘virgin’ land. Thus, one would expect trees on replant sites to die even sooner (Figure 1). We have actually excavated dying trees as young as in their second and third leaf where ORR was the cause of death on replant sites!

There is basically nothing the grower can do to rescue infected trees. The only control option is to prevent the spread of the disease by pulling out adjacent, healthy trees. Even this method has its limitations and there is a cost in terms of lost production. The fungus, once established, will infect neighboring trees by root to root contact. The earlier the grower recognizes the existence of this disease in the orchard, the less damaging and more successful will be your option of prevention provided there is not a tremendous amount of inoculum at the site and only a few isolated trees are infected. We have several projects underway currently to address the growing problem of ORR to peach production in the southeastern U.S. These include the use of biological control against ORR, the potential development of a resistant rootstock through genetic engineering, and future work involving various cultural practices.
Quarantine: Plum Pox Virus (PPV) raised its nasty, expensive head in the fall of 1999 in Adams County Pennsylvania orchards and in our Ontario neighbors’ orchards in 2000. Although first discovered in about 1915 in eastern Europe, the U.S. and Canada had thought that it had been excluded by using strict federal quarantine laws and regulations. Although the Pennsylvania outbreak has been nearly eradicated by pouring large sums of tax payer money into orchard a large, regional, orchard grubbing program, new positive (meaning infected) samples are still being found in PA backyards and neighboring orchards adjacent to the already grubbed, infected sites. In Ontario the decisions about orchard grubbing have been quite different from those in the U.S. They grub whole orchards only if a specified percentage of positive samples are found. Otherwise they just remove the positive trees and the trees immediately adjacent to them. This means that PPV is not eradicated in either the U.S. or Canada. It lurks as a nursery and stone fruit industry problem that requires knowledge and costly changes in nursery industry practices. Possibly of potentially greater significance, PPV has been designated in the U.S. as a bio-terrorism threat. I'll explain what each stone fruit farmer should know and what they should do relative to PPV. There are two rules of thumb: 1) don’t smuggle any propagating wood into the U.S. (put in a positive way – get a permit from the USDA in advance for any stone fruit propagating material that you anticipate acquiring from a foreign country); and 2) purchase stone fruit trees from reputable nurseries.

Other domestic pest examples: Cherry Rugose Mosaic virus is a "hot" strain of Prunus Necrotic Ringspot Virus (PNRSV, CRMs). It affects sweet cherries much more seriously than the common strains of PNRSV that we have wide spread throughout our U.S. cherry industry in every state. PNRSV is pollen born, and certified free of virus trees are readily available, newt orchards become infected quite thoroughly by age of due to pollinating bees bringing in "dirty" pollen. These common strains of PNRSV have minor affect (less than 5% reduction in vigor) on sweet cherries. Much more serious impact occurs on tart cherry trees when combined with infections of Prune Dwarf Virus, where the combination causes sour cherry yellows disease (SCY). But no widespread industry concern exists because gibberellin treatments reinvigorate tart cherry orchards when they became infected. So, why worry? Because the Rugose strain of PNRSV is still present in California sweet cherry orchards. It was essentially "fire-walled" off from movement into Oregon and Washington cherry orchards by some clever research. Knowing that Rugose was present in California orchards and that custom bees were being transported from California cherry orchards to NW cherry orchards, they simply required that all such bees had to be withheld from the NW orchards for several days after they had been moved out of the CA orchards. Bees clean up and use the pollen that is on the surfaces of their bodies within 48 hours when they are locked in their hives. Remember, I used Rugose as an example, new strains of PNRSV and of every other virus
disease occur through natural mutations. You could introduce "hot" strains if you smuggle or don't use reputable nurseries.

Brown Line Decline (BLD)/ Peach Stem-pitting (PSP) - The virus entity that causes both of them is Tomato Ringspot Virus (TmRSV). This virus is present in many weed species and annual vegetable crops common to our Nematodes that feed on the weeds are the vectors that move it into roots of stone fruit trees. Fortunately testing orchard sites for nematodes and subsequent fumigation and/or cover cropping is partially successful in reducing incidence of this disease. Common weeds are part of the (spread mechanism), orchards with susceptible trees don't stay clean if they don't also employ resistant rootstocks and weed control strategies that reduce the problem. Why bring this up here as if it were a major risk. As tree fruit orchardists attempt to diversify their crop mix due to the apple marketing dilemma, they need to be vigilant to ask about key diseases. They require education and application of knowledge. These are the watch-words of Integrated Pest Management. Practice them!
Growing Peaches in Ontario

John W Smith, Cherry Lane Frozen Fruits

A short description of the production areas in Ontario with the primary producing area in the Niagara Penninsula at about the same latitude as Grand Rapids, Michigan.

Fresh peach varieties that are recommended for general planting in the latest Ontario Ministry of Agriculture fact sheet of August 2002 will be presented along with limited and trial planting recommendations.

Processing clingstone recommended varieties featuring some of the latest varieties out of Vineland will also be detailed with slides to identify with.

Cultural practices that are in general use in Ontario will be outlined; these include pruning and thinning techniques as well as timing of these operations.

The presentation will describe the use of a sod/mulch environment for growing peaches and all fruit crops along with the need for a large water supply, and a reliable easy to use irrigation system and the need to start irrigating early.

Finally tree densities and tree styles will be covered from the old open centre 20'X20' tree spacing thru central leader trees up to spindle type orchards with tree densities of greater than 700 trees/Acre and yields beginning to approach those California crops we dream of.
What Are The Advantages And Disadvantages Of Using Tunnels?

Dr. Richard L. Hassell, Clemson University CREC, Charleston, South Carolina

The first question a grower needs to ask is what would be the advantage of having produce during a time when you would normally not have it. This means not only the spring but also the fall. Often extending the season may not be an advantage to you. Will it increase your consumer base? Is the price of the product during the time the low tunnels are needed high enough to justify the added costs involved? What is your labor force during the time of tunnel construction and removal? Tunnels are expensive and very time consuming.

Tunnels will provide you with an increase in temperature during the day. The extent of the increase will depend on the light intensity and the duration of the sunlight. Tunnels will hold in the heat at night. Tunnels will provide a slight frost protection. This is possible by delaying the escape of heat from the soil and air. This generally amounts to only a few degrees above outside air and only for a few hours, depending on the amount of heat generated during the day. So if you are expecting a hard freeze the covers won’t help! Tunnels provide wind protection, which can be a real plus. However, they also increase the humidity and encourage insect populations to build up. A constant monitoring of the conditions in the tunnels is a must to prevent disease and insect outbreaks that could devastate your crop.

The type of crop used will depend on the type of tunnel you chose. Vine crops such as cucumbers, melons, squash may require a different tunnel than due crops like tomatoes, peppers, and eggplant. How long and what size of plant do you need to protect, will also play a major role in the type of cover needed. In this session we will discuss these issues.
SWMREC Drip Irrigation Trial Results for 2002

Dr. Ron Goldy, Southwest Michigan Research and Extension Center
1791 Hillandale Road, Benton Harbor, MI 49022

Dr. Sieglinde Snapp, 440A Plant & Soil Science, Michigan State University

Dr. Jeff Andresen, 417 Natural Science, Michigan State University

Agricultural irrigation has become an important issue in Michigan. Legislation regulating water use in agriculture will no doubt be acted on in the 2003 legislative session. The Michigan Department of Agriculture is also presently cooperating with government and private agencies in developing Generally Accepted Agricultural Management Practices (GAAMPs) for agricultural water use. These GAAMPs help direct proper use and efficient application of water. They are scheduled to be available for the 2003 growing season.

Michigan’s fresh-market vegetable industry has benefited from irrigation water application. Irrigation is one way to assure higher yield and quality, thus reducing economic risks. In recent years, drip irrigation has played a significant role in water delivery to high-value vegetable crops. Growers also use their drip systems to deliver fertilizer in a more efficient manner.

Water application rate and delivery method through a drip system can vary depending on soil type, crop, growth stage, and weather. Vegetable drip irrigation trials were initiated at the Southwest Michigan Research and Extension Center in 2002. Two trials were established, one evaluated six delivery systems, the other evaluated six application rates. The delivery systems trial compared equal amounts of water applied through emitter spacings of 4, 12 and 16”, two tapes versus one, and low flow (0.25 gpm) versus high flow (0.50 gpm). The application rate trial investigated equal amounts of water applied in single or multiple applications.

Soil moisture levels were monitored at the 1, 2, and 3 foot levels using a capacitance probe. The probe was able to determine real-time soil moisture levels for each treatment. Capacitance readings were converted to actual soil moisture and then compared to the soil water holding capacity. Effect of each treatment was also determined on yield and quality of cucumber, eggplant, pepper, tomato and zucchini. For two of the irrigation treatments tomato root growth was also monitored using mini-rhizotrons.

In general irrigation treatments had little effect on fruit yield and quality. Results for each treatment will be presented. However, all data could not be analyzed and still meet the publication deadline for this document.
Plastic Mulch Films – Additives and Their Effects
Braionna M. Barber, Development Engineer
Ampacet Corporation, 3801 N. Fruitridge Avenue, Terre Haute, IN 47804

Abstract: There are many parameters to consider when designing plastic mulch films for agricultural applications. These include the type and level of ultraviolet stabilizer, the antioxidant package, the gauge of the mulch film, the polymer resins to be used for production, the opacity of the film, and the color of the mulch film. Some of the factors which will influence these various choices are the mulch film service lifetime, the geographic location for use, the soil type and condition, the mulch laying equipment, and the crops to be grown on the mulch film.

Ultraviolet Stabilizers
The choice of the ultraviolet inhibitor stabilization package for mulch film is important in designing a mulch film for several reasons. The type and level of the ultraviolet inhibitor (UVI) will determine the outdoor lifetime of the film, i.e. whether the film will last for six months, or one year, etc. In order to choose not only the correct UVI, but also the proper level, one must be familiar with the geographic location for which the mulch film will be used as well as the types and levels of agrochemical contact that will be involved. The level of UVI needed to properly stabilize a plastic mulch film will vary depending upon gauge, agricultural location, service lifetime, and mulch film color.

Antioxidants
Another important factor to be considered when designing a plastic mulch film is the choice of antioxidant additives. Antioxidants (AOs) are additives that interrupt the autoxidation (thermal decomposition) process of the polymer. This autoxidation of the polymer can lead to a loss of the film’s physical and optical properties similar to that experienced with UV degradation. Antioxidants are important to protect the polymer from degradation both during mulch film manufacture (Primary AO) as well as during field exposure (Secondary AO). Secondary AOs also help to protect the polymer and additives during the masterbatch manufacture. Masterbatch is the form that the additives and colorants come in that is used by the film manufacturer to produce the mulch film.

Polymer Choice
The selection of the polymer resins used to produce the mulch films is significant for determining the physical characteristics of the finished mulch film. Some of the most commonly selected types of polymers to produce mulch films include low density polyethylene (LDPE), linear low density polyethylene (LLDPE), high density polyethylene (HDPE), and metallocene LLDPE (mLLDPE). The resin blends used to produce a mulch film can impact such properties as the tear and puncture resistance of the film, the mechanical stretch of the film, the strength of the film, and the moisture and vapor permeability of the film. All of these variables are important to designing a mulch film; however, generally all resins cannot be used together to impart all the best properties. Therefore, it is necessary to design the polymer matrix to yield the properties necessary to suit the growers.
farming needs and mechanical mulch film laying capabilities. Ideally, the mulch film should have enough retained strength and elasticity to be easily removed from the field.

**Processing and Fabrication**

The processing of the resin blends is also a crucial factor affecting the physical properties. The film manufacturer must control the rate of film production, the cooling rate of extruded film, the tension of the film winding equipment, as well as the level of additives for each film. These factors can contribute to the crystallinity of the film, which can affect the strength and permeability of the film in addition to the tear and puncture properties. The thickness of the film (gauge) can also impact the physical properties as well as the service lifetime of the mulch film.

**Colored Mulch Film**

Black, white and clear plastic mulch films are standards in plasticulture with many other colors now being evaluated as well. Plastic mulch films now include such colors as silver, red, blue, yellow, green, olive and brown. These mulches are being evaluated not only for their effect upon plant growth and fruit yield; but also for their ability to suppress weed growth, control insect infestation, and warm/cool the soil as needed.

**White Mulch Film**

The choice of various pigments in order to make the colored mulch film is also important and can have an impact upon the type and level of UVI needed to sufficiently stabilize the plastic mulch film for its service lifetime. A good example of the effect of choosing the correct pigment is white mulch film. The pigment titanium dioxide (TiO$_2$) is used to color the film white. There are many different types and grades of TiO$_2$ available for a number of applications. It is important however, to choose a grade which is suitable for outdoor exposure when designing a plastic mulch film. Weatherable grades of TiO$_2$ are surface coated to make them more stable outdoors. Untreated grades of TiO$_2$ can actually accelerate the degradation of film outdoors even in the presence of UVI.

**Black Mulch Film**

Carbon black is another pigment that is available in a wide variety of grades and particle sizes for a multitude of applications. Smaller particle sized carbon blacks tend to perform better in outdoor applications than the larger particle size carbon blacks. All pigments used to make colored mulch films need to be outdoor stable to ensure that the color does not fade and that they do not contribute to premature film degradation.

**Conclusion**

In essence, there is a wide array of factors that must be taken into account when designing a plastic mulch film. Everything from thickness, geographic location, and film gauge to ultraviolet stabilizers, antioxidants, and resin blends must be considered to ensure a plastic mulch film that will perform well throughout the growing season. These variables make it almost impossible to produce one mulch film for all climates, geographic regions, crops, and service lifetimes.
Unusual Small Fruits as Additions to Farm Markets

Eric Hanson, Department of Horticulture, MSU

Many farm market operators are on the lookout for alternative crops that might increase sales and revenue or provide work for employees during slower periods. A number of seldom grown minor fruits may meet these needs for some farm markets.

Currants and gooseberries (Ribes species) may have a use. These can be productive, easy to grow plants that produce fruit in July (in southern Michigan) with a wide array of fruit characteristics. Fruit colors range from black to red to white in currants, and green to pink in gooseberries. Flavors also vary, but all types are most often consumed in baked goods, or as preserves or juices. They could potentially be sold fresh, frozen, or in preserves.

Planting currants and gooseberries is restricted in some areas of Michigan because these species are alternate hosts for the fungus causing white pine blister rust (WPBR). A permit is required from the Michigan Department of Agriculture to plant gooseberries or currants in the Upper Peninsula or counties in the northern half of the lower peninsula. Black currants cannot be grown anywhere in Michigan, although WPBR immune varieties may be allowed on a case by case basis. Again, contact the MDA for specifics.

Elderberries may also have use in some farm markets. These bushes are very vigorous and tolerant of poorer soils. Fruit mature in late August or September, and are typically used for jellies, pies and wine.

Juneberries or Saskatoons may also have a place in farm markets. These fruits grow on multi-stem bushes up to ten feet tall. They resemble blueberries in size and color, but have a mild, distinctly different flavor. Saskatoons tolerate severe winter weather and variable soils. Fruit mature in late June or early July, and are commonly consumed fresh or processed into jams or syrups.

You can find more detailed information on these and several other fruits in MSU Extension Bulletin E-2747, Unusual Fruit Plants for Gardens in the North Central Region, which can be obtained through county extension offices. This bulletin also contains an extensive list of additional information sources.
Rhubarb Production

Dr. Al Gaus, Berrien County Michigan State University Extension
Agricultural and Natural Resources Agent (Commercial Horticulture)
1737 Hillandale Road, Benton Harbor, MI 49022
Phone: (269) 944-4126  email: gaus@msu.edu

With the poor economic showing of the traditional production crops, individuals are looking at alternative crops. Rhubarb could be that crop for some. Rhubarb is a member of the buckwheat family. It is a vegetable that the edible portion of the plant is the leaf stalk. The leaves have calcium oxalate in them making them poisonous to humans; thus, leaves should never be eaten. It is a perennial that is normally propagated by root divisions, since the seed does not come true-to-type.

Most rhubarb grown in the U.S. is processed for use in pies. A small amount is sold fresh, mostly in roadside markets and local stores. This is where I see rhubarb fitting into most production schemes – as a roadside, small-acreage addition to an existing operation, well packaged and sold as a specialty item.

Varieties are generally classified as green-, pink-, or red-petiole types. The major varieties that have produced well in Michigan include Chipman (or Chipman’s Canada Red) (very red), Valentine (red), Strawberry (pink), Sutton (or Sutton’s Seedless or Red Right Through) (pink), and MacDonald (pink).

Rhubarb grows best on fertile, high organic matter, well-drained soils. It prefers a pH of 6.0 to 6.8, but will tolerate a pH as low as 5.0. Since it is a perennial plant, careful preparation of the ground the year prior to planting is essential, especially the clearing of perennial weeds. Most rhubarb plantings can last over 10 years. In Michigan, yields have varied from 8 to 18 tons per acre. Rhubarb responds to fertilizer and irrigation. Soil tests should be used to determine the amount of phosphorus and potassium needed. You can expect to need 200 pounds of actual nitrogen per acre on older plantings.

Planting with divisions from nurserymen should be planted in the fall; however, spring planting of your own crowns is acceptable. The divided crown should be planted so that the buds are just at or below the soil surface. Rows should be 4 feet apart and plants should be 4 feet apart in the row. If planted to a square design, the field can be cross cultivated. There are few herbicides labeled for rhubarb.

Harvesting of rhubarb should not be done the year of planting. All food from the leaves is needed to develop the crown and root system from which future crops will be grown. The year after planting, one light harvest can be taken. A full harvest can occur the second year and subsequent years after planting. The stalks can either be cut or pulled off. They can be all cut at once or selectively harvested over an extended period of time up to six weeks. After removing the stalks, the leaf should then be cut off. The date of harvest will depend on the variety, temperature, and location. Generally, harvest will be the end of May or early June. On vigorous sites, a second harvest
in August can occur. Care should be taken not to let stalks remain on the plant too long or they will become tough. The cut tops should not be exposed to moisture like rain or dew because they will "broom" or split. Fresh rhubarb can be stored at 32 degrees F and 95% relative humidity for up to four weeks.

Rhubarb is fairly pest free. Leafhoppers and Rhubarb Curculio may occasionally cause damage. The only major disease is crown rot (Phytophthora) that may occur on poorly-drained soils.

A good source of information on rhubarb is “The Rhubarb Compendium” located at www.rhubarbinfo.com

I would like to acknowledge James Neibauer, former MSUE District Vegetable Agent, for providing much of the above information and many of the slides used in the presentation.
Tree Fruits for Niche Markets
Bill Shane, SW Michigan Research and Extension Center, Michigan State University
1791 Hillandale Road, Benton Harbor, MI 49022
phone: (269) 944-1477 ext 205 – email: shane@msue.msu.edu

Michigan is blessed with abundant supplies of the major tree fruit types in Michigan in most years. One of the challenges faced by farm markets is to provide an array of produce not offered by conventional grocery stores. Farm markets have the opportunity to offer a better quality product than chain stores that have to contend with long-distance shipping and all its related problems. Farm markets, because of their one-on-one interaction with their clientele, have the opportunity to offer new products and build niche markets.

As with any new venture, important questions need to be answered before planting significant numbers of new varieties. Is my farm suited for growing this new fruit type? Do I have the expertise and time to cater to the needs of the new fruit candidate? What are the harvest season and the shelf life of the new fruit type? Can I obtain this new fruit type from other sources at a reasonable price so that I do not have to grow it myself? Are your potential customers looking for bargains or for new taste experiences? Am I willing to spend the time to acquaint my customers with the new product?

Flavor, aroma, appearance, pleasing texture, nostalgia, tradition, mystique, and price are reasons for the appeal of familiar and new fruit types. Taste and preference depends on the individual and is not always predictable. With this in mind, view this presentation as a collection of tree fruit options for farm markets.

**Apples** – This fruit has the advantage that it is relatively easy to grow and store, but the disadvantage to the farm marketer is that apples are readily available in all food stores year round. Farm markets need to offer top quality if selling one of the mainstream varieties or unusual varieties with some special appeal. Probably the safest approach is to watch the trends of the conventional chair stores and plant aggressively when a good candidate comes along. Honeycrisp is a prime example...growers who planted this variety after seeing the enthusiastic response when it first appeared four or more years ago would already have fruit production today. A new apple needs to be wonderful in some way. Most importantly, it has to have great flavor or aroma. In a chain store, the fruit has to have a classic apple beauty...in farm markets looks are also important – it has to look distinctive, not necessary beautiful.

1) Old favorites, becoming hard to get: red strain Jonathan, red strain Empire, Macoun, Northern Spy, Mutsu (also called Crispin)
2) Popular varieties that you should be able to produce better quality than mainstream suppliers: red strains of Fuji, red strains of Jonagold
3) Ones you may be better off buying from another grower, rather than grow yourself: Gala, Yellow Delicious, Braeburn, Red Delicious
4) Difficult to grow well in some sites, experiment for your site: Cameo, Honeycrisp
5) Gourmet apples that require time to build repeat customers, but are very tasty: Golden Russet, Swiss Gourmet, Tsugaru. A niche found by some farm markets is the retailing of heirloom/antique apples—too many types to list here.

**Peaches** – If you don’t have a peach site, develop a working relationship with established peach growers who can supply your needs. Flavor is always an important issue with peaches, especially with farm markets. Customer satisfaction correlates with sugar content—generally, the higher sugar, the better. When the weather is hot and dry, most peach varieties taste excellent...with rain, flavor is generally not as good. Traditional yellow flesh Michigan varieties such as Redhaven, Canadian Harmony, and Loring generally have good flavor but have lost favor with larger peach growers because production problems such as split pits, soft fruit, or poor skin color. The trend in the nursery industry has been toward varieties with redder skin color, better size. Some newer varieties, such as Flaming’ Fury PF-23 also have very nice slow softening characteristics—however, it is important not to extend storage too long because problems such as mealiness may show up in some years.

White flesh peach varieties have been around for many years. Most of these older varieties have major problems such as short shelf life (e.g. Carolina Belle), unattractive green background color (Champion), and serious bacterial spot problems (White Lady).

New white flesh peaches and nectarines with promise for the Michigan industry are Blushingstar and Southern Pearl. Two white flesh nectarines worthy of a test planting are Arctic Star and Arctic Sweet. Try slices of white peaches and nectarines in a glass of red wine for a dessert taste treat. At the SW Michigan Research and Extension Center we have been watching several new white peaches from California with some excellent flesh and size characteristics—Snow King, Snow Giant, Snow Bride, Sugar May—however, with these bacterial spot susceptibility appears to be a significant problem.

A unique peach to look into for Michigan farm markets is Saturn, a white flesh peento = flat doughnut peach variety. This variety is small and prone to brown rot, but has been commanding excellent prices. Look for new peento peach varieties coming from New Jersey.

Another new and unique niche for the peach/nectarine market are subacid/low acid types. These varieties have unique textures and flavors. Most of these have insufficient bacterial spot resistance because they were developed in California where the disease is not a problem. The Rutgers University breeding program is expected to release some of these shortly.

Another peach niche was opened up recently for farm markets by the introduction of new high quality non-melting yellow flesh varieties from the Vineland Ontario breeding program. These new varieties include Vulcan, Vinegold, Virgil, and Venture. Non-melting yellow flesh types are traditionally used as processing varieties—however, these types of varieties are also prized for their excellent fresh-eating qualities. Unlike the older processing types such as Babygold 5,7 and 8, the Vineland series have excellent bacterial spot resistance. All non-melting peaches are clingstone, which is not usually a problem to consumers.
Plums – The plum industry in Michigan has been in a slump because of the lack of competitive varieties suited to the Michigan climate. Competition from California Japanese type plums has been fierce. Japanese type plums such as Early Golden, Methley, Shiro, Elephant Heart, Simka, and Red Heart bloom relatively early in Michigan and are subject to spring frost problems.

European plums are more suited to the Michigan climate. Damson types, the #2 plum in Michigan, are small, have a tart flavor and are used mainly for processing. Stanley, the #1 plum, is not well suited for either processing or fresh market. Best opportunities for European plums in Michigan are the NY9, Castleton, Vanette, Victory, Vision, and Empress. Farmer marketers may need to give samples to convince buyers that, unlike Stanley, which was sour around the pit, these plums are sweet throughout.

Tart Cherries – Unusual tart cherry types to investigate for farm market niches include Balaton®, Jubellium®, and Danube™. These are morello types with red flesh and juice compared to the industry standard pie cherry Montmorency with yellow flesh and clear juice. There is some indication that they may be more prone to cropping problems than Montmorency. Another marketing niche is dried tart cherries, available from several processors in Michigan.

Sweet cherries – Probably the biggest recent opportunity for farm markets in the sweet cherry arena has been the introduction of the Gisela® dwarfing rootstock. These rootstocks allow growers to reduce tree size and greatly increase the early bearing of sweet cherry varieties. New sweet cherry varieties (e.g. Index, Tieton, Skeena, Columbia) have been recently introduced from Washington State and British Colombia, but it is too soon to tell if they have value for farm marketers.

Pears – The greatest challenge to the European pear industry has been the extreme susceptibility of Bartlett, Bosc, and D'Anjou to the bacterial disease fire blight. The new Canadian variety Harrow Sweet ripens two weeks after Bartlett and has extremely good fire blight resistance, excellent fruit quality, and very good storage life for an early pear. Harrow Sweet offers opportunities for Michigan growers to return to the local pear market.

Asian pears – are sometimes called "apple pears" because several of these varieties have round shapes and crisp, crunchy flesh. Fruits must be handled carefully to avoid bruising the delicate flesh. Of the many Asian pear varieties, only a few (New Century, Twentieth Century, and Chojuro) so far have proven to perform well under Michigan conditions although many varieties remain to be tested. The mild, unique flavor of Asian pears is quite variable from year to year. Like apples, they must be harvested when they are ready to eat and overripe fruit is sometimes unpleasant – experience with each variety is needed to determine the best timing. Both European and especially Asian pear varieties make excellent dried fruit slices.
Michigan Land Resources for the Future - Projections to 2040
Stuart H. Gage, Entomology Department, Michigan State University

A project was undertaken by a consortium of research personnel from Michigan State University, the University of Michigan and Michigan Technological University to project the changes in Michigan's land use base and to assess these changes and the resulting associated economic impacts. The project was funded by the Kellogg and Frey Foundations and was facilitated by Public Sector Consultants of Lansing, MI. An analysis of trends in regional population change and changes in built areas of the state was conducted to assess temporal patterns of change in population from 1800 to the current time.

A geographic simulation model was developed to project changes in Michigan's land use based on past and current distribution of land use patterns. The research team assessed the projected geographic changes to the year 2040 for agriculture, forests, build areas, other vegetation and wetlands. The most striking projected change was that build areas would increase by 178 percent at the expense of other land use types. Patterns of change and the economic consequences of the expected changes on the land based industries including agriculture, forestry; mining and tourism were assessed by economists in each of these sectors.

The resulting projected patterns of land use change provide a rather startling wake-up call to those who wish to preserve the character and value of Michigan's natural features and its land based industries. Although changes will occur throughout the state, specific regional changes in western and southeast Michigan are dramatic. Recent climatic events will affect the sale of agricultural land and the current economic situation is making the current land-grab in Michigan even more relevant. The results of the project were general in nature and not designed to address specific commodities. It will be up to the citizens of Michigan to design their future and this project was conducted to help inform the debate.
The Michigan Agricultural Preservation Fund
Richard Harlow, Michigan Department of Agriculture, Lansing, MI

In June of 2000 the Michigan Agricultural Preservation Fund and Fund Board were created by Public Act 262 of 2000. The purpose of the Agricultural Preservation Fund is to make grants to local units of government to assist in establishing Purchase of Development Rights Programs. The funding sources for the program are repayment money that is returned to the State when landowners come out of the PA 116 program and recapture authorized under Public Act 260 of 2000.

In order for local units of government to qualify for the funds they must 1) adopt a purchase of development rights ordinance, 2) update the local master plan within the last 10 years including a farmland preservation component and 3) provide matching funds to match with the State grant.

Matching funds for the State grants may come from the local unit of government, the landowner and/or other funding sources. The ordinance adopted by the local government must contain a scoring system to select parcels as well as other provisions required by State law.

The Agricultural Preservation Fund Board has recently completed the development of guidelines and scoring systems to review grant applications. It is expected that grant applications may be made to the Board sometime in 2004.
PA 116 Program (Farmland and Open Space Preservation)
Jon Mayes, Michigan Department of Agriculture, Lansing, MI

The Farmland and Open Space Preservation Program commonly known as PA 116 began in Michigan in 1974. Under the PA 116 program a farmland owner enters into a temporary restriction on their land where they agree not to develop their land for a minimum of 10 years. In exchange for entering into the restriction the landowner can receive a tax credit through their income tax and the land is exempt from various special assessments. The tax credit that can be received is equal to that portion of a landowners property taxes that exceeds 3.5% of their adjusted household income.

Currently in Michigan there are more than 50,000 farmland development rights agreements (PA 116 Agreements) covering more than 4.3 million acres of Michigan Farmland.

Farmland Agreements may be terminated prior to the expiration date based on 1) the death of the Agreement holder, 2) the disability of the Agreement holder, 3) if the land is not suited for farming, 4) if surrounding conditions changed restricting farming, 5) if a natural change occurred to the land limiting farming, 6) if a court order restricts farming or 7) if a public interest is served by the release of the land. When land comes out of the program prior to expiration or at the expiration of the Agreement it is required to repay a portion of the tax credits received by the landowner. These repayments go into the Agricultural Preservation Fund for use in grants to local governments for purchase of development rights programs.
The State Purchase of Development Rights Program
Meghan MacDougall, Michigan Department of Agriculture, Lansing, MI

The Farmland and Open Space Preservation (PA 116) program also includes the provision for the State to purchase the development rights on unique and critical farmland. The provision for doing the purchase of development rights has been in Michigan law since 1974; however, sufficient funds were not available until 1994 to begin purchasing the development rights of unique farms.

Under the program landowners make application to have their land considered for purchase. If the parcel is selected, an appraisal is done wherein the market value of the land is determined as well as the value of the land with the development rights removed. The landowner is offered the difference between the two appraised values. If the offer is accepted the landowner enters into a permanent conservation easement with the State wherein they restrict the development of their farmland.

Because of limited funding the State purchase of development rights program is very competitive. In the three years that applications have been accepted the State has received more than 1,300 applications from landowners. Limited funding has allowed the State to accept only 86 parcels from the 1,300 for further consideration.

Currently the State holds 59 conservation easements permanently protecting more than 13,900 acres of Michigan land. Of the 59 easements 53 were purchased and 6 were donated. The average price paid per acre has been approximately $2,000.
Federal Worker Protection Standards (WPS) From Education to Enforcement

Antonio Castro-Escobar, Michigan Department of Agriculture

Overview
The Federal Worker Protection Standard (WPS) was revised and issued by the Environmental Protection Agency (EPA) in 1992. The objective of the WPS is to reduce the risk of pesticide exposures among agricultural workers who may be exposed to pesticide residues during work activities and pesticide handlers who may be exposed to pesticides during handling and/or application operations. To accomplish this objective, the WPS contains requirements for personal protective equipment for pesticide handlers and early entry workers, pesticide safety training for both workers and pesticide handlers, decontamination supplies, notification of pesticide applications, emergency medical assistance, and directions to follow restricted entry intervals after pesticide applications. Agricultural employers must ensure that WPS protections are provided to their agricultural employees.

Brief Outlook of Michigan Agriculture
Agriculture in Michigan plays an important role in the state's economy. Michigan has a diverse agriculture comparable to California and Florida in the diversity of crops grown. There are approximately 46,600 farms, 1900 nurseries, and about 600 greenhouses (Michigan Agricultural Statistics). There are about 10,075 private certified applicators and about 1,287 commercial private applicators. There are about 96,000 agricultural employees employed by the agricultural industry (Michigan Agricultural Statistics). Out of these 96,000 employees, about 50,000 are migrant and or seasonal farm workers. The predominant number of this labor force is of Mexican origin. Some of these workers migrate from the State Texas, Florida and Georgia, and find their place of work through friendship networks. Others find their place of work through labor contractors. Most of these agricultural employees perform hand labor activities. There are about 180 labor contractors in the state of Michigan. Recently, the State has experienced a growing number of Hispanic growers. Most of these growers are of Mexican origin and are involved in blueberry and apple production. Looking at this picture, the impact of the Worker Protection Standard is vast and complex.

WPS Implementation
The Michigan Department of Agriculture (MDA), Pesticide and Plant Pest Management Division is the agency responsible for the implementation of the WPS. The main focus of the WPS implementation has been outreach and communication to provide compliance assistance to the agricultural community affected by the WPS. The compliance assistance is provided through MDA's participation at different commodity and grower associations' events. Another mechanism for providing compliance assistance at the establishment level is through WPS planned use inspections.
(PUIs). Planned use inspections are made by appointment, and are used to determine if pesticides are being used according to label directions and State and federal statutes.

**General Accounting Office (GAO) Report**
Recently, the General Accounting Office issued a report on the WPS implementation nationwide. The report indicated that the WPS was not adequately protecting children of agricultural families from pesticide exposures. The GAO also mentioned that implementation of the WPS was not being done consistently among states, and that the EPA needed to do more state oversight. As a result of this report and an EPA audit of the state's WPS implementation, the MDA will be conducting more through WPS inspections.

**WPS Non-Compliance Areas**
There are some areas of the WPS that the MDA consistently finds that are not complied with. These areas include pesticide safety training, information at a central location, decontamination supplies (water single-use towels, and soap), workers not being notified about pesticide treated areas (oral or posting notification), and leaving posting signs up for too long. Growers are encouraged to contact any MDA regional offices in their area for questions about the WPS or if they need compliance assistance. Growers may also contact Michigan State University Extension for assistance with the WPS.

For questions about this article, please contact Antonio Castro-Escobar at (517) 373-6350 or by e-mail at escobara@michigan.gov
Water Law in a Nutshell: Riparian Rights, The Public Trust Doctrine and Navigability

Chris A. Shafer, Associate Professor, Cooley Law School, Lansing, MI

I. Riparian Rights and the Riparian Doctrine
   A. The Riparian Doctrine governs surface water use in the states east of Mississippi River.
      - American riparian law evolved from English “natural flow” rule to “reasonable use” rule.
      - Riparian owner—a person who owns property on a lake or stream.

   B. There are four generally recognized riparian rights:
      1) Use of the water for domestic and other purposes;
      2) Access to navigable waters;
      3) To wharf out to navigability;
      4) The right to natural accretions.

      Note: Riparian rights are property rights and if taken, must be compensated, except for the federal government exercising its navigation servitude.

      Also, Michigan is a common law reasonable use state. Many other riparian states have enacted water use statutes.

   C. “Moveable freehold” concept on Great Lakes—as the shoreline erodes, state ownership increases; as the shoreline accretes, private ownership increases.
      - Boundary line between public bottomlands and private uplands is the Ordinary High Water Mark.
      - Public has no right of passage on exposed sand beach along Great Lakes—the riparian owner has exclusive right of access to the water’s edge.

II. The Public Trust Doctrine
   A. Certain common areas and resources, such as navigable lakes and streams, are held in trust for the benefit of the people.
      - Ancient and venerable doctrine—traces its roots to Roman Law, through English common law to the states by virtue of the revolution.
      - States are the sovereign—they step into the shoes of the King under equal footing doctrine.
B. Nature of the Trust - different in character from lands held by state in its proprietary capacity - i.e. state forests and state parks.
- It is a "high, solemn and perpetual trust, which it is the duty of the State to forever maintain". Collins v Gerhardt, 237 Mich 38, 49 (1926).
- Protected uses include navigation, commerce, fishing, boating and swimming.

C. Legal Basis for PTD
- Legal authority for PTD is abundant, including the famous Illinois Central RR Co. decision in 1892 and the 1988 decision in Phillips Petroleum.
- Michigan Supreme Court embraced PTD as early as 1901 and has repeatedly reaffirmed the doctrine.
- Great Lakes Submerged Lands Act (now Part 325) essentially codified PTD for Michigan’s Great Lakes waters and submerged lands. The Inland Lakes & Streams Act (now Part 301) did the same thing for inland waters.
- Riparian rights are subservient to the state’s public trust authority.

D. Evolving Doctrine - great potential for the future
- Other states have used PTD more creatively than Michigan.
- California - to protect non-navigable tributaries that may adversely affect public trust waters.
- New Jersey - to ensure fair and non-discriminatory beach access to coastal waters.

III. Navigability - Three Different Concepts
A. Navigability for title - determines ownership of the beds of lakes and rivers - actual commercial navigation at statehood is required. See Utah v United States, 403 US 9, 10 (1971).
B. Navigation in fact - used to determine scope of federal commerce power to regulate - waterway is potentially useable for commercial navigation. See The Daniel Ball, 77 US (10 Wall) 557, 536 (1870).
C. Navigability for Public Access - Boating & Fishing
- Michigan follows the “valuable floatage” test for determining which rivers and streams are publically navigable. See Moore v Sanborne, 2 Mich 519, 524 (1853).
- This test has become known as the “log flotation” test, which is still a commercially-based test.
- Rivers that meet this test are “qualifiedly navigable”, meaning that there is a public easement for boating & fishing.
- Thirteen other states use a “recreational boating” test, meaning that if the lake or stream can be used by a canoe, small boat or kayak, it is a navigable waterway.
- Unfortunately, Michigan Supreme Court refused to adopt the recreational boat test, deferring instead to the Legislature. See Bott v Natural Resources Comm’n, 415 Mich 45, 86 (1982).
Irrigation Gaamp Progress Report
Ted L. Loudon, Chair, Irrigation GAAMP Task Force

This presentation is a report of the progress of the task force that was appointed to develop a GAAMP on the subject of Agricultural Irrigation. This GAAMP will only cover water use for irrigation, not other agricultural or horticultural water uses. It is anticipated that it will be sufficient to provide a summary of generally accepted and recommended practices for all aspects of irrigation water use including field crops, turf, and nursery production. As of the date of this writing, November 1, 2002, the task force has been formed and a list of the members is attached. The task force has developed and adopted a list of five sections to be included in the GAAMP. These sections are:

1. An overview of irrigation water use in Michigan
2. Overview of existing GAAMPs and how irrigation water use relates to those GAAMPs.
3. A review of existing water law in Michigan related to irrigation water use and Riparian considerations
4. Planning and Preparing for Irrigation
   a. Estimating water needs
   b. Selecting a water source-surface or groundwater
   c. Determining adequacy of the source and potential impacts on other users.
5. Recommendations on irrigation water use and management issues
   a. Stewardship concepts
   b. Irrigation scheduling
   c. Record keeping
   d. Conservation measures
   e. Other uses of Irrigation
      i. Chemigation
      ii. Seed germination
      iii. Herbicide activation
      iv. Frost protection
      v. Cover crop establishment
      vi. Wind erosion control

Individuals on the task force volunteered to serve on subcommittees to draft each of the five sections. The task force is well along toward completion of the draft of the GAAMP. It is anticipated that by the time of the Great Lakes Expo, the final draft appropriate for distribution for public comment will be available.
Irrigation GAAMP Task Force

- Jeff Andresen, Department of Geography (climatological expertise)
- John Barclay, USDA-NRCS
- Tom Carey, West Michigan Environmental Action Council
- Steve Davis, USDA-NRCS (alternate)
- Amy Frankmann, Nursery and Landscape Industry
- Ron Goldy, Michigan Vegetable Growers
- Mike Gregg, Michigan Department of Agriculture (Mud Creek Irr. District)
- Don Gregory, Michigan Fruit Growers
- Fred Henningsen, Great Lakes and Water Resources Commission
- Lyndon Kelley, Michigan Groundwater Stewardship Program
- Ben Kudwa, Michigan Potato & Carrot Growers
- Ted Loudon, MSU Agricultural Engineering Dept. (Task Force Chair)
- Dave Lusch, MSU, Institute of Water Research
- Greg Lyman, Department of Crop and Soil Sciences (represents the turf grass industry)
- Jim Nicholas, United States Geological Survey
- Scott Piggott, Michigan Farm Bureau
- Ben Russell, Russell Farms, Inc. (Michiana Irrigation Assn.)
- Dean Smith, Mud Creek Irrigation District
- Don Smucker, MSU Extension Montcalm County (represents extension)
- Ron Van Til, Michigan Department of Environmental Quality
<table>
<thead>
<tr>
<th>Name</th>
<th>Affiliation</th>
<th>Address</th>
</tr>
</thead>
<tbody>
<tr>
<td>James Adkins</td>
<td>University of Delaware</td>
<td>16684 Co. Seat Hwy., Georgetown, DE 19947</td>
</tr>
<tr>
<td>Robert L. Andersen</td>
<td>Dept of Horticultural Sci.</td>
<td>61225 CR 388, South Haven, MI 49090</td>
</tr>
<tr>
<td>Rob Anderson</td>
<td>MI Farm Bureau</td>
<td>20555 23 Mile Rd., Macomb, MI 48042</td>
</tr>
<tr>
<td>Jeff Andresen</td>
<td>Michigan State University Geography Dept.</td>
<td>3001 North Fruitridge Ave, Terre Haute, IN 47804</td>
</tr>
<tr>
<td>Ms. Braionna Barber</td>
<td>Ampacet Corporation</td>
<td>350 Ottawa Ave NW, Grand Rapids, MI 49503</td>
</tr>
<tr>
<td>Bill Barton</td>
<td>Bellwether Hard Cider</td>
<td>1609 Trumansburg Road, Ithaca NY 14850</td>
</tr>
<tr>
<td>Randy Beaudry</td>
<td>Michigan State University A22 Plant and Soil Sciences</td>
<td>455 Research Drive, Fletcher, NC 28732</td>
</tr>
<tr>
<td>Roger Betz</td>
<td>Calhoun Co. MSU Extension</td>
<td>350 Ottawa Ave NW, Grand Rapids, MI 49503</td>
</tr>
<tr>
<td>John Biernbaum</td>
<td>Michigan State University Horticulture Dept.</td>
<td>455 Research Drive, Fletcher, NC 28732</td>
</tr>
<tr>
<td>Beth Bishop</td>
<td>Michigan State University Entomology Dept.</td>
<td>442 Natural Science, E. Lansing, MI 48824</td>
</tr>
<tr>
<td>Carrie Bongard</td>
<td>USDA/APHIS Animal Care</td>
<td>350 Ottawa Ave NW, Grand Rapids, MI 49503</td>
</tr>
<tr>
<td>Les Bourquin</td>
<td>Michigan State University Food Science Dept.</td>
<td>E. Lansing, MI 48824</td>
</tr>
<tr>
<td>John Bukovac</td>
<td>Michigan State University Horticulture Dept.</td>
<td>A390 Plant and Soil Science, East Lansing, MI 48824</td>
</tr>
<tr>
<td>Antonio Castro-Escobar</td>
<td>MDA WPS Program Manager</td>
<td>1054 Sherwood Rd., Williamston, MI 48895</td>
</tr>
<tr>
<td>Dave Ciolek</td>
<td>Dave Ciolek Construction</td>
<td>140 Plant Biology Bldg, E. Lansing, MI 48824</td>
</tr>
<tr>
<td>Brian Cortright</td>
<td>Michigan State University Plant Pathology Dept.</td>
<td>1737 Hillandale Road, Benton Harbor, MI 49022</td>
</tr>
<tr>
<td>Barbara Dartt</td>
<td>Salisbury Management Services</td>
<td>PO Box 10, Eaton Rapids, MI 48827</td>
</tr>
<tr>
<td>Bob DeCock</td>
<td>Michigan State University Horticulture Dept.</td>
<td>A34 Plant and Soil Sciences, East Lansing, MI 48824</td>
</tr>
<tr>
<td>David Dilley</td>
<td>Michigan State University</td>
<td>184 Foss Hill Rd., RR 1 Box 2580, Albion, Maine 04910-9731</td>
</tr>
<tr>
<td>Ken Fine</td>
<td>Johnny's Selected Seed</td>
<td>184 Foss Hill Rd., RR 1 Box 2580, Albion, Maine 04910-9731</td>
</tr>
<tr>
<td>Jim Flore</td>
<td>Michigan State University</td>
<td>184 Foss Hill Rd., RR 1 Box 2580, Albion, Maine 04910-9731</td>
</tr>
<tr>
<td>Stuart Gage</td>
<td>Michigan State University Entomology Dept.</td>
<td>235B Natural Science, East Lansing, MI 48824-1115</td>
</tr>
<tr>
<td>Randy Gardner</td>
<td>Mtn Hort Crops Res Ext</td>
<td>455 Research Drive, Fletcher, NC 28732</td>
</tr>
<tr>
<td>Al Gaus</td>
<td>Berrien Co. MSU Extension</td>
<td>1737 Hillandale Road, Benton Harbor, MI 49022</td>
</tr>
<tr>
<td>Name</td>
<td>Company/Department</td>
<td>Address/Nationality</td>
</tr>
<tr>
<td>---------------------</td>
<td>---------------------------------------------------------</td>
<td>---------------------</td>
</tr>
<tr>
<td>Eric Gibson</td>
<td>New World Publishing</td>
<td>11543 Quartz Dr., Auburn, CA 95602</td>
</tr>
<tr>
<td>Ron Goldy</td>
<td>SWMREC</td>
<td>1791 Hillandale Road, Benton Harbor, MI 49420</td>
</tr>
<tr>
<td>Ken Guise, CEO</td>
<td>Knouse Foods, Inc.</td>
<td>800 Peach Glen Road, Peach Glen, PA 17375</td>
</tr>
<tr>
<td>Larry Gut</td>
<td>Michigan State University</td>
<td>205B Pesticide Research Ctr., E. Lansing, MI 48824</td>
</tr>
<tr>
<td>Jim Hancock</td>
<td>Michigan State University</td>
<td>Horticulture Dept., 342 Plant and Soil Sciences, East Lansing, MI 48824</td>
</tr>
<tr>
<td>Eric Hanson</td>
<td>Michigan State University</td>
<td>Horticulture Dept., 338 Plant and Soil Sciences, East Lansing, MI 48824</td>
</tr>
<tr>
<td>Rich Harlow</td>
<td>MDA</td>
<td>PO Box 30017, Lansing, MI 48909</td>
</tr>
<tr>
<td>Richard Hassell</td>
<td>Coastal Research Station</td>
<td>2865 Savannah Highway, Charleston, SC 29414</td>
</tr>
<tr>
<td>Mary Hausbeck</td>
<td>Michigan State University</td>
<td>Plant Pathology Dept., 140 Plant Biology Bldg, E. Lansing, MI 48824</td>
</tr>
<tr>
<td>Tom Heffron</td>
<td>Exotic Farm Produce</td>
<td>S.A. Ruta 4, 4-26 Zona 4 Guatemala City, Guatemala</td>
</tr>
<tr>
<td>Richard Hentschel</td>
<td>Pickle Packers International</td>
<td>P.O. Box 606, St. Charles, IL 60174</td>
</tr>
<tr>
<td>Sandy Hill</td>
<td>MDA Constitution Hall</td>
<td>214 E. Center St., Ithaca, MI 48847</td>
</tr>
<tr>
<td>Rich Hodupp</td>
<td>Gratiot Co. MSU Extension</td>
<td>214 E. Center St., Ithaca, MI 48847</td>
</tr>
<tr>
<td>Dierdre Holcroft</td>
<td>Michigan State University</td>
<td>Horticulture Dept., E. Lansing, MI 48824</td>
</tr>
<tr>
<td>Leslie Huffman</td>
<td>Horticultural Crops Research</td>
<td>Harrow, Ontario N0R 1G0, Canada</td>
</tr>
<tr>
<td>Rufus Isaacs</td>
<td>Michigan State University</td>
<td>201 Integrated Plant Systems, East Lansing, MI 48824</td>
</tr>
<tr>
<td>Bill Kimball</td>
<td>Michigan State University</td>
<td>1226 N Foster Ave., Lansing, MI 48912</td>
</tr>
<tr>
<td>Willie Kirk</td>
<td>Michigan State University</td>
<td>35 Plant Biology Building, E. Lansing, MI 48824</td>
</tr>
<tr>
<td>Matt Kleinhenz</td>
<td>Horticulture &amp; Crop Sci. OARDC</td>
<td>1680 Madison Ave., Wooster, OH 44691</td>
</tr>
<tr>
<td>Wolfram Koeller</td>
<td>Plant Pathology Dept.</td>
<td>NY Agr. Experiment Station, Geneva, NY 14456</td>
</tr>
<tr>
<td>Paul Lapadat</td>
<td></td>
<td>22450 Thomson Line RR#3, Rodney, Ontario N0L 2CO, Canada</td>
</tr>
<tr>
<td>Don Lehman</td>
<td>Montcalm Co. MSU Extension</td>
<td>3030 S. Pere Marquette Hwy., Ludington, MI 49431</td>
</tr>
<tr>
<td>Art Lister Jr.</td>
<td></td>
<td>3030 S. Pere Marquette Hwy., Ludington, MI 49431</td>
</tr>
<tr>
<td>Chris Long</td>
<td>Michigan State University</td>
<td>Crop &amp; Soil Sciences Dept., 582 Plant &amp; Soil Sciences, E. Lansing, MI 48824</td>
</tr>
<tr>
<td>Theodore Loudon</td>
<td>Michigan State University</td>
<td>222 Farrall Hall, East Lansing, MI 48824</td>
</tr>
<tr>
<td>Renfru Lu</td>
<td>USDA-ARS</td>
<td>224 Farrall Hall, East Lansing, MI 48824</td>
</tr>
<tr>
<td>Mike Mainland</td>
<td>Hort Crops Research Station</td>
<td>224 Farrall Hall, East Lansing, MI 48824</td>
</tr>
<tr>
<td>Mike Mainland</td>
<td>Hort Crops Research Station</td>
<td>224 Farrall Hall, East Lansing, MI 48824</td>
</tr>
<tr>
<td>Mike Mainland</td>
<td>Hort Crops Research Station</td>
<td>224 Farrall Hall, East Lansing, MI 48824</td>
</tr>
<tr>
<td>Presenters at 2002 Great Lakes Fruit, Vegetable and Farm Market Expo</td>
<td></td>
<td></td>
</tr>
<tr>
<td>---------------------------------------------------------------</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kirsten Maue</td>
<td>Tom Oomen</td>
<td>Annemiek Schilder</td>
</tr>
<tr>
<td>Angelic Organics</td>
<td>Oomen Farms</td>
<td>Michigan State University</td>
</tr>
<tr>
<td>1547 Rockton Road</td>
<td>5182 N 136th Avenue</td>
<td>104 Pesticide Research Center</td>
</tr>
<tr>
<td>Caledonia, IL  61011</td>
<td>Hart, MI  49420</td>
<td>East Lansing, MI  48824</td>
</tr>
<tr>
<td>John Mayes</td>
<td>Chris Peterson</td>
<td>Guido Schnabel</td>
</tr>
<tr>
<td>MDA</td>
<td>Michigan State University</td>
<td>Plant Pathology &amp; Physiology</td>
</tr>
<tr>
<td>PO Box 30449</td>
<td>Agricultural Economics Dept.</td>
<td>218 Long Hall Box 340377</td>
</tr>
<tr>
<td>Lansing, MI  48909</td>
<td>E. Lansing, MI  48824</td>
<td>Clemson, SC 29634-0377</td>
</tr>
<tr>
<td>Bonnie and David McAfee</td>
<td>Joe Pirrone</td>
<td>Alan Schreiber</td>
</tr>
<tr>
<td>County Line Orchard</td>
<td>Mike Pirrone Produce</td>
<td>Washington State Asparagus</td>
</tr>
<tr>
<td>200 County Line Rd.</td>
<td>PO Box 100</td>
<td>2621 Ringold Rd.,</td>
</tr>
<tr>
<td>Hobart, IN 46342</td>
<td>Capac, MI  48014</td>
<td>Eltopia, WA 99330</td>
</tr>
<tr>
<td>Meghan McDougall</td>
<td>Ed Rasch</td>
<td>Mike Schrom</td>
</tr>
<tr>
<td>MDA</td>
<td>Rasch Farms</td>
<td>Honee Bear Canning Co.</td>
</tr>
<tr>
<td>PO Box 30449</td>
<td>14744 Peach Ridge Ave.</td>
<td>PO Box G</td>
</tr>
<tr>
<td>Lansing, MI  48909</td>
<td>Grand Rapids, MI  49330</td>
<td>Lawton, MI  49065</td>
</tr>
<tr>
<td>Tracy Meisterheim</td>
<td>Tom Reardon</td>
<td>Phil Schwallier</td>
</tr>
<tr>
<td>Wagbo Peace Center</td>
<td>Michigan State University</td>
<td>Clarksville MSU Extension</td>
</tr>
<tr>
<td>5745 North M-66</td>
<td>Agricultural Economics Dept.</td>
<td>9302 Portland Road</td>
</tr>
<tr>
<td>East Jordan, MI  49727</td>
<td>E. Lansing, MI  48824</td>
<td>Clarksville, MI  48815</td>
</tr>
<tr>
<td>Henry Miller</td>
<td>Ron Rodzos</td>
<td>Jeff Send</td>
</tr>
<tr>
<td>17613 Fairchild Rd</td>
<td>Riley Ridge Farms, Inc.</td>
<td>Cherry Lane Farms</td>
</tr>
<tr>
<td>Constantine MI  49042</td>
<td>1292 Riley Center Rd.</td>
<td>2866 S. Lee Point Rd.</td>
</tr>
<tr>
<td></td>
<td>Memphis, MI  48041</td>
<td>Suttons Bay, MI  49682</td>
</tr>
<tr>
<td>Dale Mutch</td>
<td>Glenn Rogers</td>
<td>Chris Shafer</td>
</tr>
<tr>
<td>Kellog Biological Station</td>
<td>Agri-Link</td>
<td>Cooley Law School</td>
</tr>
<tr>
<td>3700 E. Gull Lake Dr.</td>
<td>PO Box 1050</td>
<td>P.O. Box 13038</td>
</tr>
<tr>
<td>Hickory Corners, MI  49060</td>
<td>Fennville, MI  49408</td>
<td>Lansing MI 48901</td>
</tr>
<tr>
<td>Jim Neibauer</td>
<td>David J. Ropa</td>
<td>Bill Shane</td>
</tr>
<tr>
<td>5546 Alpine Ridge</td>
<td>TJP Market Development</td>
<td>Berrien Co. MSU Extension</td>
</tr>
<tr>
<td>Stevensville, MI  49127</td>
<td>321 N. Owen Dr.</td>
<td>1791 Hillandale Rd.</td>
</tr>
<tr>
<td>Denise Neilsen</td>
<td>Madison, WI  53705</td>
<td>Benton Harbor, MI  49022</td>
</tr>
<tr>
<td>Pacific Ag Food Research</td>
<td>Brian Rowe</td>
<td>John Shelford</td>
</tr>
<tr>
<td>Summerland, B.C. V0H 1Z0</td>
<td>MDA Plant &amp; Pesticide Div.</td>
<td>Global Berry Farms</td>
</tr>
<tr>
<td></td>
<td>PO Box 30017</td>
<td>2241 Trade Center Way</td>
</tr>
<tr>
<td></td>
<td>Lansing, MI  48909</td>
<td>Naples, FL  34109</td>
</tr>
<tr>
<td>Presenter Name</td>
<td>Organization</td>
<td>Address/Location</td>
</tr>
<tr>
<td>---------------</td>
<td>--------------</td>
<td>------------------</td>
</tr>
<tr>
<td>Chris Shellenbarger</td>
<td>Spartan Insurance Agency</td>
<td>11769 Bell Road, Clarksville, MI 48815</td>
</tr>
<tr>
<td>David Skjaerlund</td>
<td>Rural Partners of MI</td>
<td>821 E. Kalamazoo St Ste E-1, Lansing, MI 48912</td>
</tr>
<tr>
<td>John Smith</td>
<td>Cherry Lane Farms</td>
<td>4230 Victoria Ave., Vineland Station, ON L0R 2E0, Canada</td>
</tr>
<tr>
<td>Walt Stevenson</td>
<td>University of Wisconsin Plant Pathology Dept.</td>
<td>285B Russell Laboratories, Madison, WI 53706</td>
</tr>
<tr>
<td>Alexandra Stone</td>
<td>Oregon State University Horticulture Extension</td>
<td>4135 Ag Life Sciences Bldg, Corvallis, OR 97331</td>
</tr>
<tr>
<td>Susan Smalley</td>
<td>Michigan State University Crop &amp; Soil Sciences Dept.</td>
<td>582 Plant &amp; Soil Sciences Bldg, E. Lansing, MI 48824</td>
</tr>
<tr>
<td>Sieg Snapp</td>
<td>Michigan State University Horticulture Dept.</td>
<td>440A Plant and Soil Sciences, E. Lansing, MI 48824</td>
</tr>
<tr>
<td>Michael Staton</td>
<td>Berrien Co. MSU Extension</td>
<td>1737 Hillandale Rd., Benton Harbor, MI 49022</td>
</tr>
<tr>
<td>Hannah Stevens</td>
<td>Macomb Co. MSU Extension</td>
<td>21885 Dunham Rd. Suite 12, Clinton Twp. MI 48036</td>
</tr>
<tr>
<td>Peggy &amp; Sam Stitt</td>
<td>Great Lakes Barn Preservation</td>
<td>6611 One Mile Rd., Hesperia, MI 49422</td>
</tr>
<tr>
<td>George Sundin</td>
<td>Michigan State University 103 Integrated Plant Systems</td>
<td>East Lansing, MI 48824</td>
</tr>
<tr>
<td>Scott Swinton</td>
<td>Michigan State University Agricultural Economics</td>
<td>E. Lansing, MI 48824</td>
</tr>
<tr>
<td>Bob Tritten</td>
<td>Genesee Co. MSU Extension G-4215 West Pasadena Ave</td>
<td>Flint, MI 48504</td>
</tr>
<tr>
<td>Jan J. Vanderheide</td>
<td>Oswego Co. Cornell Ext.</td>
<td>3288 Main Street, Mexico, NY 13114</td>
</tr>
<tr>
<td>Darryl Warncke</td>
<td>Michigan State University Crop &amp; Soil Sciences Dept.</td>
<td>582 Plant &amp; Soil Sciences Bldg, E. Lansing, MI 48824</td>
</tr>
<tr>
<td>Franco Weibel</td>
<td>Research Institute of Organic Agriculture (FiBL)</td>
<td>CH-5070 Frick, Switzerland</td>
</tr>
<tr>
<td>Barry Winkel</td>
<td>Greg Orchards</td>
<td>10 Lakeshore Dr., South Haven, MI 49090</td>
</tr>
<tr>
<td>John Wise</td>
<td>Michigan State University 205 Integrated Plant Systems</td>
<td>East Lansing, MI 48824</td>
</tr>
<tr>
<td>Andy Wyenandt</td>
<td>Ohio State University Plant Pathology Dept.</td>
<td>2021 Coffey Rd., Columbus, OH 43210</td>
</tr>
<tr>
<td>Tom Zabadal</td>
<td>SWREC</td>
<td>1791 Hillandale Road, Benton Harbor, MI 49022</td>
</tr>
<tr>
<td>Bernard Zandstra</td>
<td>Michigan State University Horticulture Dept.</td>
<td>440 Plant and Soil Science Bldg, E. Lansing, MI 48824</td>
</tr>
<tr>
<td>John Zandstra</td>
<td>University of Guelph</td>
<td>Ridgetown College 120 Main Street East, Ridgetown ON N0P 2C0, Canada</td>
</tr>
</tbody>
</table>