Managing the Uncertainties in Growing and Marketing Fruits and Vegetables

Education Session Abstracts
December 10 - 12, 2002

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Risk Management for Specialty Crops in Michigan

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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>Emerged above ground</td>
<td>42</td>
<td>9</td>
<td>4</td>
</tr>
<tr>
<td>Intact above ground</td>
<td>3</td>
<td>13</td>
<td>7</td>
</tr>
<tr>
<td>Total above ground</td>
<td>45</td>
<td>23</td>
<td>11</td>
</tr>
<tr>
<td>Emerged below ground</td>
<td>151</td>
<td>95</td>
<td>108</td>
</tr>
<tr>
<td>Intact below ground</td>
<td>25</td>
<td>70</td>
<td>141</td>
</tr>
<tr>
<td>Total below ground</td>
<td>176</td>
<td>165</td>
<td>250</td>
</tr>
<tr>
<td>Total puparia</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 Folincur 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.”
Phytophthora Fruit Rot: Lessons Learned

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Michigan State University, Department of Plant Pathology, E. Lansing, MI 48824

Phytophthora capsici caused serious fruit rot 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 Phytophthora</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Phytophthora</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>4.5 184.0</td>
<td>2.2</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>3.5 191.5</td>
<td>1.8</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>15.0 173.0</td>
<td>7.5</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>19.0 173.0</td>
<td>9.5</td>
</tr>
<tr>
<td>Grower standard</td>
<td>59.5 133.0</td>
<td>29.8</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 $P. capsici$ 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 $P. capsici$ blight on pickles (2002).

<table>
<thead>
<tr>
<th>Trial 1</th>
<th>Numbers of fruit</th>
<th>% infected Phytophthora</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Phytophthora infected at harvest$^*$</td>
<td>Phytophthora infected after storage</td>
</tr>
<tr>
<td><strong>Air assisted sprayer</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<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><strong>Conventional boom sprayer</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<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>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><strong>Untreated</strong></td>
<td>178.0 c</td>
<td>74.7 c</td>
</tr>
</tbody>
</table>

$^*$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 $P. capsici$ infection on 3 Aug. Overall, disease in this trial was severe because the weather was very favorable for $P. capsici$. 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>Trial 2</th>
<th>Spray regime, treatment and rate/A</th>
<th>Numbers of fruit</th>
<th>% infected Phytophthora</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Phytophthora infected</td>
<td>Healthy*</td>
</tr>
<tr>
<td></td>
<td></td>
<td>19.3 a**</td>
<td>141.3 a</td>
</tr>
<tr>
<td>Acrobat 50WP 6.4 oz + Kocide 2000 54WG 1.5 lb</td>
<td></td>
<td></td>
<td>9.7 a</td>
</tr>
<tr>
<td>Gavel 80WG 2.0 lb + Kocide 2000 54WG 1.5 lb</td>
<td></td>
<td></td>
<td>21.3 a</td>
</tr>
<tr>
<td>Grower Standard</td>
<td></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>Trial 3</th>
<th>Spray regime, treatment and rate/A</th>
<th>Numbers of fruit</th>
<th>% infected Phytophthora</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Phytophthora infected</td>
<td>Healthy*</td>
</tr>
<tr>
<td></td>
<td></td>
<td>11.0”</td>
<td>168.3</td>
</tr>
<tr>
<td>Acrobat 50WP 6.4 oz + Kocide 2000 54WG 1.5 lb</td>
<td></td>
<td></td>
<td>5.5</td>
</tr>
<tr>
<td>Gavel 80WG 2.0 lb + Kocide 2000 54WG 1.5 lb</td>
<td></td>
<td>1.7</td>
<td>193.0</td>
</tr>
<tr>
<td>Untreated</td>
<td></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

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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

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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

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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 Disperss 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>azoxystrobin</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>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>
</tr>
<tr>
<td>Bravo Weather Stik 6SC 12.0 fl oz, apps. 1-3</td>
<td></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>1.5 ab</td>
<td>18.4 cd</td>
</tr>
<tr>
<td>Bravo Weather Stik 6SC 12.0 fl oz, apps. 1-8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>+ Reason 4.17SC 2.7 fl oz + Bond 4.0 fl oz, apps. 4-8</td>
<td>2.5 b</td>
<td>18.3 cd</td>
</tr>
<tr>
<td>Bravo Weather Stik 6SC 12.0 fl oz, apps. 1-3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reason 4.17SC 2.7 fl oz + Bond 4.0 fl oz, apps. 4-8</td>
<td>1.3 a</td>
<td>12.2 abc</td>
</tr>
<tr>
<td>Manzate 200 75DF 2.0 lb + Kocide DF 61.4DF 2.0 lb, apps. 2,4,6,8</td>
<td>1.8 ab</td>
<td>11.0 ab</td>
</tr>
<tr>
<td>AEC 67 65.4WG 3.0 lb, apps. 1-9</td>
<td></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>1.3 ab</td>
<td>11.0 ab</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>
</tr>
<tr>
<td>Bravo Weather Stik 6SC 1.5 pt</td>
<td>1.5 ab</td>
<td>8.0 a</td>
</tr>
<tr>
<td>Cabrio 20WG 1.0 lb, alternated</td>
<td>1.5 ab</td>
<td>11.3 ab</td>
</tr>
<tr>
<td>Equus 720 6SC 2.0 pt</td>
<td>2.5 b</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>
<thead>
<tr>
<th>Treatment and rate/A, applied at 7-day intervals</th>
<th>Trial 2</th>
<th>Foliar blight (%)*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Untreated .....................................</td>
<td>7.5 d*</td>
<td>4.8 c</td>
</tr>
<tr>
<td>Cabrio 20WG 1.0 lb ................................</td>
<td>1.0 a</td>
<td>1.0 a</td>
</tr>
<tr>
<td>Cabrio 20WG 1.0 lb, alternated</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Acrobat 50WP 6.4 oz + Bravo Ultrex 82.5WDG 1.8 lb</td>
<td>1.8 abc</td>
<td>1.3 a</td>
</tr>
<tr>
<td>Dithane DF Rainshield 75DF 3.0 lb, apps. 1-3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ranman 4SC 2.0 fl oz + Silwet L-77 2.0 fl oz, apps. 4-6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cabrio 20WG 12.0 oz, apps. 7-8 ..................</td>
<td>1.0 a</td>
<td>1.8 ab</td>
</tr>
<tr>
<td>Cuprofix Disperss MZ 42DF 5.0 lb .................</td>
<td>2.0 abc</td>
<td>1.3 a</td>
</tr>
<tr>
<td>Bravo Ultrex 82.5WDG 1.8 lb, alternated</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ridomil Gold Bravo 76.5WP 2.0 lb .................</td>
<td>2.0 abc</td>
<td>1.8 ab</td>
</tr>
<tr>
<td>Dithane DF Rainshield 75DF 3.0 lb ...............</td>
<td>1.3 ab</td>
<td>1.3 a</td>
</tr>
<tr>
<td>Bravo Weather Stik 6SC 2.0 pt ....................</td>
<td>2.8 bc</td>
<td>2.0 ab</td>
</tr>
<tr>
<td>Equus 720 6SC 2.0 pt ................................</td>
<td>3.0 c</td>
<td>2.8 b</td>
</tr>
<tr>
<td>Gavel 75DF 2.0 lb ..................................</td>
<td>2.3 abc</td>
<td>1.8 ab</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.”
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-adams.wsu.edu/agriculture/covercrops/green_manures/index.htm). 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:**


Building Fertility with Cover Crops and Manure: What it Takes to Get Profitable

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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

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Michigan State University

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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 phytophora.

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.
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

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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 (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 (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

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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 them 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 to his doorstep. 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

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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>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>0</th>
<th>2.7</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, 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&lt;sup&gt;1&lt;/sup&gt; (%) 8/19</th>
<th>Handle rating&lt;sup&gt;2&lt;/sup&gt;</th>
</tr>
</thead>
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<tr>
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<td>3.5 abcd</td>
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<td>3 abcd</td>
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<td>1.8 a</td>
<td>3</td>
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<td>Nova 40WP 5.0 oz</td>
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<td>Quadris 2.08SC 15.4 fl oz alternated Nova 40WP 5 oz</td>
<td>yes</td>
<td>4.3 cde</td>
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</tr>
</tbody>
</table>

<sup>1</sup> Based on a rating of 1 to 10 where 1=0% to trace of disease to 10=complete defoliation and death.

<sup>2</sup> Rated on a scale of 1 to 10, where 1=healthy to 10=rotted.

<sup>3</sup> 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.”
Putting Weed Control Chemicals to Work for you On Pumpkins and Squash

Bernard Zandstra and Mathieu Ngouajio, Michigan State University

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

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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 book mark 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 spring-sown annual medic ranged from 21 to 37% based on variety. In hairy vetch (50 lb/A) PYL was 27% and springsown 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-tillage 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.
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, Thrips and more Thrips
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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
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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?
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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 and 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>cyprodinil + 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 botch 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 2.08SC, 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&lt;sup&gt;1&lt;/sup&gt;</th>
<th>Bulb yield per 22' of row</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Total (lb)</td>
</tr>
<tr>
<td>Untreated ..........................................................</td>
<td>7.5</td>
<td>e”</td>
</tr>
<tr>
<td>Bravo Weather Stik 6SC 1.5 pt, alternated ..........................</td>
<td>1.6 a</td>
<td>51.5 abcde</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 ab</td>
<td>46.2 bcdef</td>
</tr>
<tr>
<td>Quadris 2.08SC 9.2 fl oz, apps. 1-3, 7-8 ...........................</td>
<td>2 ab</td>
<td>55.4 a</td>
</tr>
<tr>
<td>Scholar 50WP 7.0 oz ...........................................</td>
<td>2.3 ab</td>
<td>47.8 abcdef</td>
</tr>
<tr>
<td>Quadris 2.08SC 9.2 fl oz, alternated 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 .........................................</td>
<td>2.3 ab</td>
<td>47.8 abcdef</td>
</tr>
<tr>
<td>Rovral 50WP 1.0 lb + Bravo Weather Stik 6SC 1.0 pt ..............</td>
<td>2.4 ab</td>
<td>52.6 abc</td>
</tr>
<tr>
<td>Quadris 2.08SC 9.2 fl oz, apps. 1-3, 7-8 Switch 62.5WDG 14.0 oz, apps. 4-6 ......</td>
<td>2.8 abc</td>
<td>52.9 abc</td>
</tr>
<tr>
<td>Cabrio 20WG 1.0 lb, alternated Bravo Weather Stik 6SC 1.5 pt ..........</td>
<td>3 abc</td>
<td>53.5 ab</td>
</tr>
<tr>
<td>Quadris 2.08SC 9.2 fl oz, apps. 1-3, 7-8 Switch 62.5WDG 11.0 oz, apps. 4-6 ......</td>
<td>3 abc</td>
<td>52.3 abc</td>
</tr>
<tr>
<td>Bravo Weather Stik 6SC 1.5 pt ................................</td>
<td>3.5 bc</td>
<td>43.9 ef</td>
</tr>
<tr>
<td>Bravo Weather Stik 6SC 1.5 pt, Tom-Cast 15 DSV .....................</td>
<td>4.3 cd</td>
<td>44.6 def</td>
</tr>
<tr>
<td>Elevate 50WDG 1.0 lb .........................................</td>
<td>5.8 d</td>
<td>44.1 def</td>
</tr>
<tr>
<td>Serenade 10WP 6.0 lb .........................................</td>
<td>5.8 d</td>
<td>40.4 f</td>
</tr>
<tr>
<td>Messenger 3WDG 9.0 oz .........................................</td>
<td>7.8 e</td>
<td>45.4 cdef</td>
</tr>
</tbody>
</table>

<sup>1</sup>Based on a rating of 1 to 10 where 1=0% to trace of disease to 10=defoliation and death.

<sup>2</sup>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

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**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).
Early Blight Management with Fungicides in Wisconsin
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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
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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
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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 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 ºF 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 ºF.

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

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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


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


Organic Pest Control in Sweet Corn

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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 through 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 (Spodoptera 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

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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.
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.
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 ai/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.
Improving The Tools For Carrot Disease Management

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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

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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.

![Graphs showing the effects of scouting and forecasting on blight control]
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: Treatment and rate/A, No. of sprays, Plants with infected petioles (%), Health, Foliar evaluation (%)

<table>
<thead>
<tr>
<th>Treatment and rate/A</th>
<th>No. of sprays</th>
<th>Plants with infected petioles (%)</th>
<th>Health</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>
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<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>
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<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>
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<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>
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<td></td>
<td></td>
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</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>
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<td>50</td>
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<td>Bravo Ultrex 82.5WDG 1.8 lb</td>
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<td>3</td>
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</tr>
<tr>
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<td>32</td>
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<td>64</td>
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<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>
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<td></td>
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<td>13</td>
<td>27</td>
<td>2.3</td>
<td>6</td>
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<td>10</td>
<td>16</td>
<td>1.5</td>
<td>3</td>
</tr>
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<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>

*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.
Risk Management for Specialty Crops in Michigan

Chris Shellenbarger, Agent for Spartan Insurance
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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.
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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.

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Fusarium-tolerant Celery: Are We there Yet?

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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>2000</td>
</tr>
<tr>
<td>GSB</td>
</tr>
<tr>
<td>UC Fus Hyb #1</td>
</tr>
<tr>
<td>P1252-0889-5</td>
</tr>
<tr>
<td>UC 494</td>
</tr>
<tr>
<td>TU 52-70RI</td>
</tr>
<tr>
<td>Ponderosa</td>
</tr>
<tr>
<td>Promise</td>
</tr>
<tr>
<td>P1264-1088 BS 3</td>
</tr>
<tr>
<td>Affina</td>
</tr>
<tr>
<td>UC 390S</td>
</tr>
<tr>
<td>UC 1</td>
</tr>
<tr>
<td>UC Fus Hyb #2</td>
</tr>
<tr>
<td>XP 85</td>
</tr>
<tr>
<td>UC 10-1</td>
</tr>
<tr>
<td>Matador</td>
</tr>
<tr>
<td>XP 266</td>
</tr>
<tr>
<td>VTR 1330</td>
</tr>
<tr>
<td>P1252-0889-14</td>
</tr>
<tr>
<td>P1264-1133-6</td>
</tr>
<tr>
<td>Picador</td>
</tr>
<tr>
<td>Challenger</td>
</tr>
<tr>
<td>UC 509</td>
</tr>
<tr>
<td>A 112</td>
</tr>
<tr>
<td>Pybas 465R</td>
</tr>
<tr>
<td>Green Bay</td>
</tr>
</tbody>
</table>

LSD (P < 0.05) 0.39
Severities are mean of 10 plants each in 4 replications in the field and 10 plants each inoculated with five isolates in the greenhouse.

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**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).

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.
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∗ 6.1 c</td>
<td></td>
</tr>
<tr>
<td>Untreated natural infection ......................</td>
<td>-</td>
<td>-</td>
<td>6.8 cd 28 ab</td>
<td></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 29 a</td>
<td></td>
</tr>
<tr>
<td>BAS 516 38WG 10.5 oz ............................</td>
<td>no</td>
<td>510</td>
<td>1.3 a 27 ab</td>
<td></td>
</tr>
<tr>
<td>Quadris 2.08SC 9.2 fl oz alternated</td>
<td>yes</td>
<td>azoxystrobin</td>
<td>1 a 27 ab</td>
<td></td>
</tr>
<tr>
<td>Bravo Ultrex 82.5WDG 1.8 lb ......</td>
<td>yes</td>
<td>chlorothalonil</td>
<td>1 a 26 ab</td>
<td></td>
</tr>
<tr>
<td>Quadris 2.08SC 15.0 fl oz alternated</td>
<td>yes</td>
<td>azoxystrobin</td>
<td>1 a 26 ab</td>
<td></td>
</tr>
<tr>
<td>Bravo Ultrex 82.5WDG 1.8 lb ......</td>
<td>yes</td>
<td>chlorothalonil</td>
<td>1 a 26 ab</td>
<td></td>
</tr>
<tr>
<td>Quadris 2.08SC 9.2 fl oz alternated</td>
<td>yes</td>
<td>azoxystrobin</td>
<td>1 a 26 ab</td>
<td></td>
</tr>
<tr>
<td>Tilt 3.6EC 4.0 fl oz ............................</td>
<td>yes</td>
<td>propiconazole</td>
<td>3 b 28 ab</td>
<td></td>
</tr>
<tr>
<td>Quadris 2.08SC 15.0 fl oz alternated</td>
<td>yes</td>
<td>azoxystrobin</td>
<td>2 ab 27 ab</td>
<td></td>
</tr>
<tr>
<td>Tilt 3.6EC 4.0 fl oz ............................</td>
<td>yes</td>
<td>propiconazole</td>
<td>2 ab 27 ab</td>
<td></td>
</tr>
<tr>
<td>Bravo Ultrex 82.5WDG 1.8 lb ......</td>
<td>yes</td>
<td>chlorothalonil</td>
<td>1 a 26 ab</td>
<td></td>
</tr>
<tr>
<td>Serenade 10WP 6.0 lb ............................</td>
<td>yes</td>
<td>Bacillus subtilis</td>
<td>5.8 c 24 ab</td>
<td></td>
</tr>
<tr>
<td>Messenger 3WDG 9.0 oz ...........................</td>
<td>yes</td>
<td>harpin protein</td>
<td>6 cd 24 b</td>
<td></td>
</tr>
<tr>
<td>Equus DF 82.5DF 1.8 lb ..........................</td>
<td>yes</td>
<td>chlorothalonil</td>
<td>1.5 a 28 ab</td>
<td></td>
</tr>
<tr>
<td>Kocide 2000 54WG 1.5 lb ..........................</td>
<td>yes</td>
<td>copper hydroxide</td>
<td>6.5 cd 24 ab</td>
<td></td>
</tr>
<tr>
<td>Actigard 50WG 1.0 oz ............................</td>
<td>no</td>
<td>acibenzolar-S-methyl</td>
<td>5.5 c 24 ab</td>
<td></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* (%) 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>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 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 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 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.
**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.”
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
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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

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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 form 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 ($\text{TiO}_2$) is used to color the film white. There are many different types and grades of $\text{TiO}_2$ 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 $\text{TiO}_2$ are surface coated to make them more stable outdoors. Untreated grades of $\text{TiO}_2$ 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.