PENNSTATE

College of Agricultural Sciences • Cooperative Extension

# 2004 Vegetable and Small Fruit

# Research Report

# Department of Horticulture

## Department of Horticulture Personnel with Applied Research Programs

**Faculty** working at the Horticulture Farm:
Dr. Richard Marini – Department Head, Fruit Crops
Dr. Robert Crassweller – Tree Fruits
Dr. David Eissenstat – Tree Physiology
Kathy Demchak – Small fruits and Grapes Extension Associate
Dr. Majid Foolad – Plant Breeding/Genetics
Dr. Peter Ferretti – Vegetable Crops
Dr. William Lamont – Potatoes & Vegetable Crops
Dr. Michael Orzolek – Vegetable Crops
Dr. Elsa Sanchez - Horticultural Systems Management

**Technical Support:**
Don Smith – Tree Fruit
Bruce Dye – Potatoes/High Tunnels
Guoyang Lin – Plant Breeding/Genetics
Lisa White – Manager, High Tunnel Research and Education Facility

**Graduate Students:**
Adam Montri
Dru Bernthal
Hamid Asharfi-Nasrabadi

**Summer Help:**
Kimberly Hassler
Cindy Doliana
Shannon Robbins
Catherine Rasmussen
Daniel Wagner
Kevin Lamont
Jenna Batt
Thomas Plummer
Jim Lettiere
Rob Cushman
Kelly Dezura
Steve Gleason
Ellen Lovelidge
Dan Saniski
Ann Schroeck
Retha Sellmer

**Farm Crew:**
Robert Oberheim – Farm Manager
Ron Shuey – Group Leader
Craig Kreider – Machinery operator/mechanic
Albert Dreibelbus – Machinery operator

# Table of Contents

Company Support and Contributions

Weather data – Rock Springs – Horticulture Research Farm

Onion Variety Trial

Pumpkin Demonstration  Trial

Squash Variety Trial

Tomato Variety Trial

Biodegradable Mulch Study

Low Tunnel Study

Onion Plug Size Transplant Study

Pumpkin Tillage Study

Renaldo Tray Study

Tomato Fertigation Study

High Tunnel Research and Demonstration Summary

Heating Greenhouses With Plastic: Clean Heat From Dirty Wastes

# Company Support and Contributions

The following companies and individuals are acknowledged for their support and contributions to the Department of Horticulture Research Farm, Rock Springs, PA for our vegetable and small fruit research and demonstration programs.

ABR LLC

American Takii, Inc.

Amoco Fabrics and Fiber Co.

Bdi Machinery

Bejo Seeds

DaniMer Scientific

Emerald Seed Co.

Alan Erb, Cornell Cooperative Extension

Harris-Moran Seed

Integrated Packaging Americas

Johnny's Selected Seeds

Kietzer Farms, Hartford MI

Meyer Seed International

Novamont

PGI International

The PA Vegetable Research and Marketing Board

Pliant Plastics

PlastiTech Inc.

Renaldo Sales and Service Inc.

Rupp Seeds Inc.

SeedWay

Seminis Seeds

Syngenta Seeds, Inc.

Toro Agricultural

T-Systems International

# Weather Data – Rock Springs, PA

2004 Monthly Rainfall and Average Temperatures at the Horticulture Research Farm, Russell E. Larson Research Center, Rock Springs, PA.

| | Rainfall inches | Avg.Temp (°F) | | Absolute Temp (°F) | |
|---|---|---|---|---|---|
| Month | | Max | Min | Max | Min |
| January | 1.6 | 28 | 15 | 44 | -5 |
| February | …... | 36 | 14 | 51 | -8 |
| March | 2.6 | 48 | 29 | 70 | 16 |
| April | 4.8 | 57 | 39 | 82 | 24 |
| May | 3.9 | 75 | 51 | 95 | 29 |
| June | 3.8 | 74 | 55 | 86 | 42 |
| July | 9.4 | 77 | 60 | 86 | 50 |
| August | 4.8 | 76 | 57 | 84 | 45 |
| September | 9.1 | 73 | 52 | 80 | 35 |
| October | 1.4 | 59 | 38 | 72 | 26 |
| November | 3.9 | 50 | 36 | 68 | 18 |
| December | 3.8 | 39 | 23 | 53 | 2 |
| Total rainfall | 49.1 | | | | |

# 2004 Sweet Spanish Onion Variety Trial

M. D Orzolek
The Pennsylvania State University
University Park, PA  16802

**Plot size**:  Four rows/bed 7.5’ long x  6”apart – 60 plants/rep.

**Transplanting Date**: April 29, 2004

**Production system**: raised bed with IRT green plastic mulch and 2 rows of drip tape – high flow 0.45 gal./min./100 ft at 12 orifice spacing.

**Herbicide Application**: One post-emergence applications of Goal at 3.0 oz./A.

**Fungicide**: Two applications of Bravo at 2.5 pt./A.

**Insecticide**: One application of Warrior at 3.0 oz./A.

**Fertility**:  Broadcast and incorporated 60 lbs./A-N, 60 lbs./A-P, and 120 lbs./A-K and two applications of calcium nitrate injected in the drip system for a total of 14 lbs./A N.

**Harvest Date**: August 18, 2003

**Drying**:  Bulbs from individual plots were placed in potato 100 lb. Burlap bags and placed on the Horticulture Farm greenhouse benches for 7 days.

**Date Graded**: September 8, 2004

**Design**:  Randomized Complete Block with 3 replications

| **Varieties** | **Seed Source** | **Bulb color** |
|---|---|---|
| 1. Eagle* | American Takii | yellow |
| 2. EM 398* | Emerald | yellow |
| 3. EM 680* | Emerald | yellow |
| 4. EM 984* | Emerald | yellow |
| 5. Candy* | Seedway | yellow |
| 6. BGS 178 | Bejo | pink |
| 7. Exhibition | Bejo | yellow |
| 8. Expression* | Bejo | yellow |
| 9. Hildago* | Bejo | yellow |
| 10. Milaga* | Bejo | yellow |
| 11. Recorra* | Bejo | yellow |
| 12. Sharon* | Bejo | yellow |
| 13. Red Beauty* | Bejo | red |

| | | |
|---|---|---|
| 14. Robin | Bejo | red |

* - Indicates Hybrid variety.

**Results**:
Growing conditions in 2004 were less than ideal even for sweet Spanish onions grown on raised beds with plastic mulch and two rows of drip tape, but better than the 2003 growing season. It was fortunate to find a period of time in mid-April when the soil was dry enough to make beds and lay plastic mulch plus the drip tape. We were also fortunate in 2004 to be able to broadcast the 10-10-20 prior to making the raised beds with plastic mulch. Fourteen pounds of nitrogen was injected into the drip irrigation tape over a 7-8 week period after transplanting. Use of greenhouse grown plug plants helped to accelerate the transplanting of the onion varieties in 2004 compared to 2003. Transplanting the tray or greenhouse grown transplants was much quicker, efficient and uniform compared to the field grown transplants. While weed control was good to excellent the first 4 weeks after transplanting, continued rain resulted in significant weed populations (both grass and broadleaf weeds) in and between the onion rows. The single application of Goal and Poast significantly reduced weeds and increased harvesting efficiency. The highest marketable onion bulb yield was obtained from Expression, EM 398, Hidalgo and Milaga compared to Candy (current sweet Spanish onion standard Table 1). The marketable yield of Eagle was slightly lower than Candy, but has a larger average bulb size and higher soluble solids level than Candy (Tables 1 and 2). Expression produced 80.5% of bulbs that were 3.0 in diameter or larger that was similar to Candy. Both Robin and Red Beauty had a higher percentage of double centers compared to BGS 178 and overall appearance of the red onion varieties was best exemplified by the variety BGS 178.

Table 1. The marketable yield of fourteen onion varieties evaluated at the Horticulture Research Farm, Rock Springs, PA – 2004.

| Variety | Percent MKT Harvest $^{X}$ | Total MKT$^{Y}$ Yield T/A | Avg. bulb.$^{Z}$ wt. lbs. | % non- |
|---|---|---|---|---|
| EM 398 | 79.0 | 16.9 | 0.97 | 6.3 |
| EM 680 | 82.0 | 11.2 | 0.77 | 4.1 |
| EM 984 | 77.0 | 9.5 | 0.92 | 25.9 |
| Sharon | 81.0 | 11.4 | 0.81 | 5.5 |
| Exhibition | 81.0 | 9.8 | 0.97 | 46.5 |
| Milaga | 83.0 | 16.4 | 0.93 | 8.7 |
| Candy | 81.0 | 15.7 | 0.90 | 9.7 |
| Eagle | 77.0 | 15.1 | 0.98 | 10.8 |
| Expression | 74.0 | 18.2 | 1.13 | 6.8 |
| Recorra | 82.0 | 15.8 | 0.92 | 4.1 |
| Hildago | 80.0 | 16.7 | 1.03 | 15.3 |
| Red Beauty | 76.0 | 13.3 | 0.84 | 4.4 |

| | | | | |
|---|---|---|---|---|
| Robin | 73.0 | 10.0 | 0.82 | 18.9 |
| BGS 178 | 69.0 | 14.8 | 1.12 | 12.1 |

X – Percent of onion bulbs that were harvested from the established transplants.
Y – The total marketable yield is based on an onion population of 50,000 plants/A including jumbo and collosal bulb sizes.
Z – Average weight of bulbs in pounds based on jumbo bulb size and larger.

Table 2. The size distribution and soluble solids of fourteen onion varieties evaluated at the Horticulture Research Farm, Rock Springs, PA – 2004.

| Variety | Percent bulbs 3.0 inch in diameter or larger | % soluble[Z] solids |
|---|---|---|
| EM 398 | 78.2 | 8.0 |
| EM 680 | 36.1 | 9.6 |
| EM 984 | 34.6 | 7.1 |
| Sharon | 26.2 | 11.4 |
| Exhibition | 45.2 | 6.7 |
| Milaga | 75.8 | 8.3 |
| Candy | 79.4 | 7.2 |
| Eagle | 64.1 | 9.5 |
| Expression | 80.5 | 6.4 |
| Recorra | 63.9 | 10.4 |
| Hildago | 73.6 | 6.2 |
| Red Beauty | 59.0 | |
| Robin | 40.2 | |
| BGS 178 | 66.2 | |

Z – Soluble solids of onions was obtained by cutting a wedge from 5 onion bulbs; with wedges placed in a commercial juicer and pooled onion juice collected in a beaker. The soluble solids were measured with a digital refractometer on October 7, 2004.

## 2004 Pumpkin Variety Demonstration

Scott Guiser, Bucks County
Penn State Cooperative Extension
Penn Vermont Farm, Bedminster, PA

**Planted** June 10, 2004;
**Plot size**: 21’ x 9’ plots = 1/230th of an acre. Plants thinned to 3 feet apart in the row in late June; rows 9 feet apart; 27 square feet per plant; 1 rep harvested
**Weed Control**: Command applied pre-plant; Sandea applied at 3-5 leaf stage
**Pest Management**: Standard fungicide and insecticide sprays applied. Good foliage cover all season.
**Harvested** September 27, 2004.

Table 1. The marketable yield of pumpkin varieties evaluated at the Penn Vermont Farm, Bedminster, Bucks County, PA – 2004.

| Variety Name | Seed Source | Marketable Fruit Yield/plot No. | Lbs. | T/A or fruit/A | Avg fruit Wt. –lbs. |
|---|---|---|---|---|---|
| Gold Dust F1 | R | 58 | | 13,367 | 0.5 |
| Harvest Princess | M S I. | 56 | 112 | 12,906 | 2.0 |
| Bumpkin | M S I | 110 | | 25,352 | 1.0 |
| Apprentice | HM | 72 | | 16,594 | 1.0 |
| HMX 2690 | HM | 29 | | 6,683 | 3.5 |
| Munchkin | HM | 98 | | 22,586 | 0.8 |
| | | | | | |
| Gold Bullion | R | 14 | 189 | 21.7 | 13.5 |
| Gold Gem F1 | R | 14 | 265 | 30.5 | 18.9 |
| RPX 1003 | R | 11 | 220 | 24.4 | 20.0 |
| RPX 1006 | R | 14 | 230 | 26.5 | 16.4 |
| RPX 763 | R | 14 | 205 | 23.6 | 14.6 |
| RP 3515 | R | 12 | 165 | 19.0 | 12.7 |
| RP 3516 | R | 10 | 130 | 15.0 | 13.0 |
| MSX 6009 F1 | M S I. | 14 | 180 | 20.7 | 12.9 |
| MSX 6074 F1 | M S I. | 11 | 155 | 17.9 | 14.1 |
| MSX 6075 F1 | M S I. | 27 | 108 | 12.4 | 4.0 |
| MSX 6078 F1 | M S I | 14 | 160 | 18.4 | 11.4 |
| Magician (0683) | HM | 13 | 170 | 19.6 | 13.0 |
| Magic Lantern | HM | 12 | 155 | 17.8 | 12.9 |
| | | | | | |
| Autumn King F1 | R | 14 | 286 | 32.9 | 20.4 |
| Gold Medal F1 | R | 13 | 340 | 39.2 | 26.2 |
| RPX 1002 | R | 17 | 240 | 27.7 | 14.1 |
| RPX 764 | R | 16 | 280 | 32.3 | 17.5 |
| Harvest King | M S I | 11 | 250 | 28.8 | 22.7 |
| Golden Condor | M S I | 10 | 220 | 25.4 | 22.0 |
| Aladdin | HM | 8 | 135 | 15.6 | 16.9 |

Seed source code: R = Rupp Seed
MSI = Meyer Seed International
HM = Harris Moran

Table 2. The marketable yield of pumpkin varieties evaluated at the Penn Vermont Farm, Bedminster, Bucks County, PA – 2004 - Observations.

| Variety Name | Seed Source | Observations |
|---|---|---|
| Gold Dust F1 | R | Uniform fruit, green speckling. |
| Harvest Princess | M S I. | |
| Bumpkin | M S I | Uniform, excellent fruit and stem color, unique shape. |
| Apprentice | HM | Uniform fruit with softball shape. |
| HMX 2690 | HM | Uniform fruit with exceptionally hard rind. |
| Munchkin | HM | Uniform fruit with orange/yellow color. |
| | | |
| Gold Bullion | R | Uniform fruit with excellent color |
| Gold Gem F1 | R | Excellent fruit color, but variable size. |
| RPX 1003 | R | |
| RPX 1006 | R | Variable fruit shape. |
| RPX 763 | R | Uniform, upright fruit with excellent color. |
| RP 3515 | R | |
| RP 3516 | R | Uniform fruit (size and shape). |
| MSX 6009 F1 | M S I. | |
| MSX 6074 F1 | M S I. | Variable fruit size and shape. |
| MSX 6075 F1 | M S I. | Uniform fruit with excellent color. |
| MSX 6078 F1 | M S I | Extremely variable in fruit shape and size. |
| Magician (0683) | HM | Uniform fruit with basketball shape. |
| Magic Lantern | HM | Uniform fruit with excellent color. |
| | | |
| Autumn King F1 | R | |
| Gold Medal F1 | R | Excellent fruit color with high yield. |
| RPX 1002 | R | Elongated fruit. |
| RPX 764 | R | Very impressive, uniform fruit with dark stems – best variety in trial for the medium size entries. |
| Harvest King | M S I | Variable fruit size with excellent color. |
| Golden Condor | M S I | Large, upright fruit. |
| Aladdin | HM | Upright fruit. |

Seed source code: R = Rupp Seed
MSI = Meyer Seed International
HM = Harris Moran

## 2004 Summer Squash Variety Trial

M. D Orzolek
The Pennsylvania State University
University Park, PA  16802

**Transplanting Date**: May 27, 2004

**Plot size**:  Single row 30’ long x 5’ between rows.

**Spacing**: 15 plants/rep – 3’ between plants in-row.

**Production system**: 4” high raised bed with blue 3’ wide plastic mulch and drip tape – high flow 0.45 gal./min./100 ft at 12 orifice spacing.

**Row Cover with Hoops Placed Over Zucchini Varieties:** May 27, 2004

**Row Cover Removed from Zucchini Varieties:** June 16, 2004

**Herbicide Application**: Broadcast application prior to making raised beds of Goal at 5.0 oz./A. and Dual Magnum II at 1.0 pt./A.

**Fungicide**: One application of Ridomil Gold Copper at 2.0 lbs./A on July 29.

**Insecticide**: Three applications of Asana at 6.0 oz./A on June 9, July 16 and July 29.  One application of Pounce at 6.0 oz./A on June 24.

**Fertility**:  Broadcast and incorporated 60 lbs./A-N, 150 lbs./A-P, and 150 lbs./A-K and two applications of calcium nitrate injected in the drip system for a total of 14 lbs./A N.

**Harvest Dates**: June 28 through August 6, 2004.

**Design**:  Randomized Complete Block with 2 replications

| **Varieties** | **Seed Source** | **Disease Resistance** |
|---|---|---|
| Zucchini types | | |
| 1. Cashflow | Syngenta | ZYMV and WMV |
| 2. Golden Dawn (yellow) | Syngenta | None |
| 3. Spineless Beauty | Syngenta | None |
| 4. Senator | Seminis | Check - None |
| 5. Independence II | Seminis | ZYMV and WMV II |
| 6. Justice III | Seminis | ZYMV , WMV II and CMV |
| 7. EXT 04629728 | Seminis | ZYMV , WMV II and CMV |
| Straightneck/Crookneck Types | | |
| 8. Gentry | Syngenta | None |
| 9. Sunray | Seminis | Check - None |
| 10. Conqueror III | Seminis | ZYMV , WMV II and CMV and conventional resistance to PRSV |
| 11. Patriot II | Seminis | ZYMV and WMV II |
| 12. Liberator III | Seminis | ZYMV , WMV II and CMV |
| 13. General Patton | Seminis | Check - None |
| 14. XPHT 1832 | Seminis | ZYMV , WMV II and CMV |

* - Indicates Hybrid variety.

**Results**:
Fifteen plants of each variety were transplanted on May 27, 2004. A row cover from Amoco Fiber and Fabrics (7.0 oz) was placed only over the zucchini varieties in both replications immediately after planting. There were 15 zucchini plants per variety in the row, so the first 9 plants were covered with the row cover and the last 6 plants had no row cover (check). The row cover was removed from all zucchini varieties/reps on June 16, 2004. After removing the row cover from the field, the squash plants under the row cover were twice the size of the no cover or check zucchini plants. Earliest yield was consistently harvested from the zucchini plants under the row cover (Table 1). All zucchini plants of the 7 varieties in the trial that had the row cover placed over them had an increase in marketable fruit yield between 20% and 30%.
The highest marketable zucchini yield was harvested from Spineless Beauty followed by Cashflow and then Justice(Table 2). The high marketable yield of Spineless Beauty was the result of a larger fruit size compared to the other varieties and a relatively high number of fruit harvested from each plant. The variety with the lowest yield, Golden Dawn, was the only yellow fruited variety in the trial which had excellent color and taste compared to previous yellow zucchini varieties developed in the past. Because of it's lower yield and higher fruit quality, I believe Golden Dawn needs to be marketed as a specialty summer squash to make it economical to grow compared to the green fruited zucchini varieties.
The highest marketable straightneck/crookneck yield was harvested from Patriot II followed by Gentry and then Conqueror II (Table 3). The high marketable yield of Patriot II was the result of a slightly larger fruit size compared to the other varieties and a relatively high number of fruit harvested from each plant. Fruit harvested from Patriot were very attractive and had a nice light yellow color. The variety with the lowest yield, Liberator III, also produced the fewest fruit per plant compared with the other straightneck/crookneck varieties in this trial.

Table 1. The marketable yield of seven zucchini varieties evaluated with and without row cover at the Horticulture Research Farm, Rock Springs, PA – 2004.

| Variety | Total Marketable Yield[Y] | | Total Marketable Variety Yield | |
|---|---|---|---|---|
| | # fruit | Wt. – lbs. | # fruit | Wt. – lbs. |
| Cashflow –RC | 202.5 | 121.1 | 312.0 | 176.4 |
| Cashflow - NRC | 109.5 | 55.3 | | |
| Golden Dawn -RC | 125.0 | 55.6 | 196.5 | 84.4 |
| Golden Dawn -NRC | 71.5 | 28.8 | | |
| Spineless Beauty-RC | 185.0 | 121.7 | 290.5 | 187.0 |
| Spineless Bty-NRC | 105.5 | 65.3 | | |
| Senator-RC | 152.0 | 89.1 | 238.5 | 134.0 |
| Senator-NRC | 86.5 | 44.9 | | |
| Independence-RC | 142.0 | 96.2 | 226.0 | 137.6 |
| Independence-NRC | 84.0 | 41.4 | | |

| | | | | |
|---|---|---|---|---|
| Justice-RC | 193.0 | 105.8 | 291.5 | 157.8 |
| Justice-NRC | 98.5 | 52.0 | | |
| | | | | |
| EXT 4629-RC | 174.0 | 100.8 | 255.0 | 149.4 |
| EXT 4629-RC | 81.0 | 48.6 | | |
| | | | | |
| X – RC all varieties | 167.6 | 98.6 | | |
| X – NRC all varieties | 136.4 | 72.0 | | |

Y – The total marketable yield of individual row cover and no row cover plots.
RC – Row cover placed over #9 wire hoops over the first 9 zucchini transplants.
NRC – No row cover over the last 6 zucchini transplants.

Table 2. The marketable yield of seven zucchini varieties evaluated at the Horticulture Research Farm, Rock Springs, PA – 2004.

| Variety | Total Marketable Yield T/A. | Average fruit Wt. - ounces | Average fruit No./plant. |
|---|---|---|---|
| Cashflow | 25.6 | 9.0 | 20.8 |
| Golden Dawn | 12.3 | 6.9 | 13.1 |
| Spineless Beauty | 27.2 | 10.3 | 19.4 |
| Senator | 19.5 | 9.0 | 15.9 |
| Independence | 20.0 | 7.6 | 15.1 |
| Justice | 22.9 | 8.7 | 19.4 |
| EXT 4629 | 21.7 | 9.4 | 17.0 |

Table 3. The marketable yield of seven straightneck/crookneck varieties evaluated at the Horticulture Research Farm, Rock Springs, PA – 2004.

| Variety | Total Marketable Yield T/A. | Average fruit Wt. - ounces | Average fruit No./plant. |
|---|---|---|---|
| Gentry | 22.8 | 6.7 | 24.9 |
| Sunray | 20.9 | 6.2 | 24.6 |
| Conqueror II | 21.1 | 6.7 | 23.3 |
| Patriot II | 24.5 | 7.0 | 25.7 |
| Liberator III | 17.0 | 6.4 | 19.4 |
| General Patton | 19.3 | 5.1 | 27.5 |
| XPH 1832 | 17.4 | 5.3 | 24.1 |

# 2004 PA Fresh Market Tomato Variety Trial

M. D. Orzolek
Horticulture Research Farm
Rock Springs, PA

**Date transplanted in Field**: May 24, 2004

**Design**: Randomized Complete Block with 3 replications.

**Production system**: Raised bed with black plastic mulch and drip irrigation.

**Fungicide Application**: Two Bravo applications

**Insecticide Application:** None

**Weed Control**: Cultivation and hand hoeing between beds.

**Fertility:** Broadcast and incorporated prior to making raised beds 60 N- 100 P- 150 K. Injection of 20-10-20 (7.0 lbs./application) through drip tape four times during the growing season**.**

**Harvest Dates**: Aug. 10 + 24 and September 3, 2004 for a total of 3 harvests.

| **Variety** | Seed Company | Maturity | Comments |
|---|---|---|---|
| Florida 47 | Seminis Seed | Full season | Round red |
| SVR 0176 (Applause) | Seminis Seed | Ist early | Round red |
| SVR 0140 | Seminis Seed | Full season | Round red |
| Biltmore | Seminis | Full season | Round red |
| Tygress | Seminis | Mid-season | Round red |
| Sunsation | Seminis | Mid-season | Round red |
| Mt. Fresh Plus | Seedway | Full season | Round red |
| Seedway 10250 | Seedway | Mid-season | Round red |
| Mt. Spring | Rogers | Mid-season | Round red |
| Mt Crest | Rupp Seeds | Mid-season | Round red |
| Forida 7514 | Rupp Seeds | Full season | Round red |
| Charm | Bejo | $2^{nd}$ early | Plum/pear |

Table 1. The marketable yield and quality of 12 tomato varieties grown at Horticulture Research Farm, Rock Springs, PA – 2004.

| Variety | Total Marketable Yield | | | % No.1 | Percent | Avg. fruit |
|---|---|---|---|---|---|---|
| | # | Wt. (lbs) | T/A | % | cull | Wt. (oz) |
| Florida 47 | 108.7 | 75.0 | 12.6 | 74.6 | 27.2 | 11.0 |
| Applause | 122.4 | 79.6 | 13.3 | 70.8 | 24.5 | 10.4 |
| SVR 0140 | 118.3 | 87.6 | 14.7 | 86.0 | 22.7 | 11.8 |
| Biltmore | 116.0 | 90.2 | 15.1 | 85.6 | 33.8 | 12.4 |
| Tygress | 118.0 | 82.6 | 13.8 | 86.8 | 19.8 | 11.2 |
| Sunsation | 96.7 | 66.8 | 11.2 | 77.5 | 33.3 | 11.1 |
| Mt. Fresh + | 125.0 | 90.1 | 15.1 | 83.7 | 8.2 | 11.5 |
| Sway 10250 | 119.3 | 78.3 | 13.1 | 77.4 | 48.8 | 10.5 |
| Mt. Spring | 103.7 | 80.5 | 13.5 | 91.2 | 33.9 | 12.4 |
| Mt Crest | 129.7 | 93.1 | 15.6 | 88.6 | 18.3 | 11.5 |
| Forida 7514 | 81.6 | 46.3 | 7.8 | 63.2 | 45.1 | 9.1 |
| Charm | 1,288.0 | 225.4 | 37.7 | | 6.6 | 2.8 |

Cull – tomato fruit were considered cull when they were misshapen, had blossom end rot, blotchy ripening and other fruit disease. Some tomato varieties in the trial were heavily infected with early blight and lost a majority of their canopy.

**Notes:**

Seedway 10250 was observed to have large blossom scars and a large number of misshapen fruit.

Applause (SVR 0176) had large, firm fruit, moderate blotchy ripening, medium-small plants with moderate to severe early blight symptoms on foliage. This was the earliest variety in the tomato trial that was harvested in early August.

Charm was a plum/pear shaped tomato fruit, 1.8 to 3.0 ounces in size, jointless fruit, minimum fruit cracking, some blotchy ripening, and fruit firm even when harvested red.

Table 2. The average marketable tomato fruit number of 10 tomato varieties grown in Southeast PA Tomato Variety Demonstration at two commercial growers farms – 2004.

| Variety | Marketable Yield # of fruit | # of plants | Avg. # fruit/plant |
|---|---|---|---|
| Florida 47 | 483 | 30 | 16.1 |
| Applause | 304 | 30 | 10.1 |
| SVR 0140 | 428 | 28 | 15.3 |
| Biltmore | 391 | 30 | 13.0 |
| Tygress | 465 | 28 | 16.6 |
| Sunsation | 384 | 28 | 13.7 |
| Mt. Fresh + | 459 | 30 | 15.3 |
| Seedway 10250 | 507 | 24 | 21.1 |
| Mt Crest | 506 | 22 | 23.0 |
| Forida 7514 | 639 | 30 | 21.3 |

There were 10 transplants of each tomato variety planted at the Andrew Frankenfield Farm on May 16, 2004 and tomato fruit harvested on Aug. 16, 2004. There were 20 transplants of each tomato variety planted at the Kohler Farm, Ambler , PA on May 29, 2004 and tomato fruit harvested on Aug. 24, 2004.

## Biodegradable Plastic Mulch Evaluation Study

M. D. Orzolek and B. Dye
Dept. of Horticulture
The Pennsylvania State University

**Crops**: Watermelon – Seedless "Imagination" with Super pollenizer.
Bell Pepper – "Revolution"

**Plot size**: 30' long x 28" wide raised bed.

**Plant spacing**: 2.0' in-the-row for watermelon and 1.5' in-the-row for bell pepper - 7' between rows.

**Design**: Randomized Complete Block with 3 Replications.

**Plastic Applicator**: Rain-Flo 4' raised bed/mulch layer with drip tape dispenser.

**Fertilizer Application**: 150 lbs./A of 34-0-0 and 750 lbs./A of 0-20-20.

**Herbicide Application**: None, hand weeding.

**Date Planted**: June 9, 2004.

**Dates Harvested**: Watermelon - September 7, 2004.
Bell Pepper – August 26, September 23, and October 12, 2004.

**Treatments**:

1 – Black – Pliant (standard)
2 – Mater-Bi black biodegradable – Novamont
3 – Blue – Pliant/Ampacet
4 – IRT green- Pliant
5 – Clear – Pliant/Ampacet

Table 1. The marketable fruit yield of watermelon (cv. Imagination) from plants grown on different colored and type of polyethylene mulch at the Horticulture Research Farm, Rock Springs, PA.-2004

| Mulch color/type | No. of fruit | Wt. of fruit (lbs.) | T/A | Avg. fruit Wt. (lbs) |
|---|---|---|---|---|
| Black – ND | 15.3 | 81.3 | 14.8 | 5.3 |
| Black – BD | 16.0 | 75.5 | 13.7 | 4.7 |
| Blue – ND | 15.0 | 91.9 | 16.7 | 6.1 |
| IRT Green – ND | 13.7 | 90.3 | 16.4 | 6.6 |
| Clear – PD | 19.3 | 116.9 | 21.2 | 6.1 |

ND – Non degradable
BD – Biodegradable
PD – Photodegradable

Table 2. The marketable fruit yield of bell pepper (cv. Revolution) from plants grown on different colored and type of polyethylene mulch at the Horticulture Research Farm, Rock Springs, PA.-2004

| Mulch color/type | No. of fruit | Wt. of fruit (lbs.) | T/A | Avg. fruit Wt. (oz.) |
|---|---|---|---|---|
| Black – ND | 120.7 | 56.7 | 10.3 | 7.5 |
| Black – BD | 117.7 | 51.0 | 9.3 | 6.9 |
| Blue – ND | 132.0 | 56.5 | 10.2 | 6.8 |
| IRT Green – ND | 115.3 | 51.1 | 9.3 | 7.1 |
| Clear – PD | 61.7 | 34.2 | 6.2 | 8.9 |

ND – Non degradable
BD – Biodegradable
PD – Photodegradable

**Comments:**
The clear mulch film row was material from 2002, but stored in a dark room. All mulch films were applied in the field with the Rain-Flo raised bed/mulch layer and drip tape dispenser without any problems. There were basically three types of mulch film used in this study: non-degradable (black, blue and IRT from Pliant), photo degradable (clear from Pliant/Ampacet) and biodegradable (black from Novamont). After being in the field for 60 days, the clear mulch film began to breakdown, become brittle and break-off into large shards in all replicates. The biodegradable black mulch film from Novamont did not start to degrade until 80 days after application in the field. The biodegradable mulch become brittle, broke-up into smaller pieces that adhered to the soil and did not move off site of application.

The highest watermelon yield was harvested from plants growing on the clear photodegradable mulch film (Table 1). The lowest yield was harvested from plants grown on the black degradable plastic film which was not significantly different from the check or standard non-degradable black mulch. All other mulch treatments produced watermelons which were in between the watermelon yield from the standard (check) and biodegradable black film mulch. Interestingly, the largest fruit size was harvested from plants grown on the IRT green mulch film and the smallest fruit from watermelon plants grown on the black degradable plastic film. It was also observed that there were very few weed seed that had germinated and was growing underneath the clear plastic mulch.

Pepper plants that were grown on the different mulch film treatments produced similar pepper fruit yield except from plants grown on the clear photodegradable mulch film (Table 2). While plants growing on the clear photodegradable mulch film produced the lowest yield of bell pepper fruit, they also produced the largest pepper fruit size compared to the other treatments.

The difference in crop yield when grown on the clear plastic mulch film can be explained by the growth characteristics of the two different crops. Watermelon are tropical crops with prostrate growth habit; so that the increase in soil temperature from the clear film accelerated canopy development of the fast growing watermelon crop thereby reducing the amount of UV light that was shining on the plastic film. However in bell pepper, the plants are slow to develop and have an upright growth habit, therefore there was slow development of a pepper leaf canopy and the plastic film mulch was exposed the entire growing season to the UV rays of the sun. When the photodegradable clear mulch film degraded, many weed seed germinated on the top of the beds and competed with the developing pepper plants thus reducing the marketable yield of bell peppers.

After harvesting the crop in October, the non-degradable mulch films were retrieved from the field. However, the biodegradable and photodegradable mulch films were disced into the soil and the soil will be checked in the spring of 2005 for any mulch film residue.

**Conclusions:**

1 - Based on the crop yield of both watermelon and bell pepper, the biodegradable mulch film performed as effectively as the non-degradable and photodegradable mulch films in 2004.

2 – Mulch films which warm the soil earlier and to a higher temperature (namely blue, IRT green and clear) produced the higher yields of watermelon fruit in 2004.

3 – Vegetable crops with an upright growth habit such as tomato and pepper do poorly when grown on photodegradable mulch film if that film degrades before the fruit mature because of weed competition.

## Effect of Row Cover Low Tunnels on Pepper Growth and Yield

M. D. Orzolek and B. Dye

Dept. of Horticulture, The Pennsylvania State University

**Crop**: Bell Pepper – "HMX 2643"

**Plot size**: 25' long x 18" wide raised bed.

**Plant spacing**: 1.5' in-the-row - 5' between rows.

**Design**: Randomized Complete Block with 3 Replications.

**Plastic Applicator**: Nolt's Supply 3' raised bed/mulch layer with drip tape dispenser.

**Fertilizer Application**: 150 lbs./A of 34-0-0 and 750 lbs./A of 0-20-20.

**Herbicide Application**: None, hand weeding.

**Date Transplanted**: July 29, 2004.

**Date Row Cover/Low Tunnels Placed in Field**: September 28 and 29, 2004. All row covers materials were placed over #9 wire hoops spaced 5' apart in the row and fabric/plastic sides placed under 3/8" nylon rope that was stretched along the sides of the row. The rope/material was then anchored to the soil with 6" metal clips.

**Date Temperature Data Loggers placed in low tunnels**: October 5, 2004. Five HOBO H8 Pro Series external temperature and three HOBO Outdoor Industrial Loggers – 4 channel external for soil temperature. Data loggers product of Onset Corp., P. O. Box 3450, Pocasset, MA 02559-3450. Phone (800) 564-4377.

**Dates Harvested**: November 2, 2004.
**Treatments**:
1 – Check – no row cover
2 – Amoco 0.55 oz/ sq. yd. polypropylene fabric
3 – Amoco 0.9 oz/ sq. yd. polypropylene fabric
4 – PlastiTech 8 mil clear polyethylene film with 405 holes (3/8" diam.)/sq. yd.
5 – Check – no treatment
6 – Agribon AG 50 spunbonded polyethylene (1.5 oz./sq. yd.)
7 - Agribon AG 15 spunbonded polyethylene (0.45 oz./sq. yd.)
8 - Agribon AG 50 spunbonded polyethylene (0.55 oz./sq. yd.

**Comments**:
The peppers in this study were transplanted in late July (small plants) with the expectation that they would produce mature fruit before frost. The plants were not sprayed with any pesticides, and no significant pest problems were observed on the peppers prior to placing the low tunnels over the plants. In retrospect, more peppers would have been harvested if the low tunnels were placed over the pepper plants within 7 to 10 days after transplanting on the plastic mulch. As presented in Table 3, the ambient air temperature during the last half of October was not very conducive for active plant growth of peppers but any immature pepper fruit on the plant was able to reach marketable maturity. Row covers that maintained more uniform temperatures for active plant growth and higher marketable fruit yields were: Amoco 0.55 and 0.9 oz. material and

Agribon AG 19 and AG 50 (Table 20). Both the AG15 and PlastiTech clear poly film over pepper plants produced the lowest marketable fruit yields. The lower yields of pepper fruit from the AG 15 and clear poly treatments appeared to be related to the thickness of the material and their inability to retain heat during the night (Table 3). Plant appearance ratings based on frost damage were lowest for the PlastiTech and AG 15 treatments (Table 1). Ambient air temperatures inside the low tunnels varied by material. The PlastiTech treatment consistently had higher daytime temperatures compared to the other treatments; while it also had the lowest nighttime temperatures of all the low tunnel treatments. Less fluctuating diurnal temperatures were observed in low tunnels covered with either the AG 50 or Amoco 0.9 oz fabrics.

**Conclusions:**

Pepper plants with no low tunnel over them (check) were killed by cold temperature prior to harvest.

Low tunnels can extend the growing season foe many vegetable crops especially if the low tunnel material is placed over the crop row within 7 days of seeding or transplanting on raised beds with plastic mulch.

Plants growing in low tunnels covered with the PlastiTech clear poly material were growing in tunnels with high daytime temperatures which would hasten crop maturity more than no low tunnel by a factor of two. On the other hand, the clear poly film over the hoop wires does not retain nighttime heat as well as the other materials and thus consistently had the lowest ambient nighttime temperature.

Both AG 50 and Amoco 0.9 oz. fabric treatments appear to be good choices for late season extension production of vegetables because of their heat retention properties.

Table 1. The marketable fruit yield of bell peppers (cv. HMX 2643) from plants grown on black polyethylene mulch and raised beds under different low tunnel materials at the Horticulture Research Farm, Rock Springs, PA.-2004.

| Treatments | Average number of plants/plot | Plant Appearance[Z] Rating |
|---|---|---|
| Check | 13.7 | 1.0 |
| Amoco – 0.55 oz | 15.0 | 4.0 |
| Amoco – 0.9 oz. | 14.3 | 4.3 |
| PlastiTech | 10.7 | 3.3 |
| AG 50 | 14.0 | 5.5 |
| AG 15 | 12.0 | 3.8 |
| AG 19 | 14.7 | 4.3 |

Z – Plant appearance rating was taken on November 2, 2004 and based on the following scale: 1 – dead plants to 10 – actively growing green plants with no frost damage.

Table 2. The marketable fruit yield of bell peppers (cv. HMX 2643) from plants grown on black polyethylene mulch and raised beds under different low tunnel materials at the Horticulture Research Farm, Rock Springs, PA.-2004.

| Treatments | Marketable Fruit Yield No. | Wt.(lbs.) | Average Fruit Weight (oz.)Rating |
|---|---|---|---|
| Check | 0.0 | 0.0 | 0.0 |
| Amoco – 0.55 | 29.5 | 11.5 | 6.2 |
| Amoco – 0.9 | 24.7 | 9.7 | 6.3 |
| PlastiTech | 15.3 | 5.9 | 6.2 |
| AG 50 | 27.7 | 12.4 | 7.2 |
| AG 15 | 15.5 | 6.3 | 6.5 |
| AG 19 | 25.0 | 9.8 | 6.3 |

Table 3. The ambient air temperature under several low tunnel materials covering bell pepper plants (cv. HMX 2643) growing on raised beds with plastic mulch at the Horticulture Research Farm, Rock Springs, PA –2004 for the first and last 7 days of the study

| Date | Control | AG-50 | Clear Poly °F | Amoco 0.9 oz | AG-15 |
|---|---|---|---|---|---|
| 10/6 H | 73.8 | 81.0 | 95.7 | 85.3 | 80.2 |
| L | 29.3 | 35.6 | 34.8 | 35.2 | 35.3 |
| 10/7 H | 83.2 | 87.9 | 104.0 | 93.7 | 88.9 |
| L | 34.6 | 39.2 | 38.9 | 39.1 | 39.3 |
| 10/8 H | 83.1 | 84.4 | 99.4 | 88.8 | 84.8 |
| L | 39.7 | 43.7 | 43.9 | 44.0 | 43.7 |
| 10/9 H | 72.0 | 74.9 | 85.8 | 78.0 | 73.9 |
| L | 44.0 | 50.4 | 49.0 | 49.7 | 49.7 |
| 10/10 H | 68.0 | 57.4 | 63.2 | 58.3 | 55.8 |
| L | 36.0 | 41.7 | 41.5 | 41.5 | 41.4 |
| 10/11 H | 53.0 | 77.5 | 94.1 | 81.4 | 76.3 |
| L | 37.0 | 38.4 | 36.8 | 36.7 | 37.3 |
| 10/12 H | 60.0 | 79.4 | 96.2 | 83.4 | 79.3 |
| L | 29.0 | 33.9 | 32.4 | 33.0 | 33.5 |
| 10/27 H | 60.0 | 79.0 | 87.1 | 79.2 | 81.0 |
| L | 40.0 | 44.3 | 44.2 | 44.0 | 43.8 |
| 10/28 H | | 80.8 | 89.0 | 79.9 | 81.8 |
| L | | 39.6 | 39.0 | 38.9 | 39.0 |
| 10/29 H | 62.0 | 57.6 | 60.5 | 57.6 | 57.6 |
| L | 33.0 | 49.8 | 49.6 | 50.4 | 49.8 |
| 10/30 H | 64.0 | 68.4 | 72.2 | 69.0 | 68.4 |
| L | 50.0 | 53.2 | 53.4 | 53.2 | 52.9 |
| 10/31 H | 56.0 | 72.7 | 78.0 | 72.8 | 72.1 |
| L | 40.0 | 47.3 | 46.2 | 47.6 | 47.1 |
| 11/1 H | 65.0 | 69.8 | 75.6 | 70.1 | 70.0 |
| L | 35.0 | 39.3 | 36.8 | 38.1 | 37.9 |
| 11/2 H | 58.0 | 72.0 | 72.3 | 72.0 | 71.9 |
| L | 49.0 | 48.8 | 48.5 | 49.5 | 49.0 |

Table 4. The ambient soil temperature under several low tunnel materials covering bell pepper plants (cv. HMX 2643) growing on raised beds with plastic mulch at the Horticulture Research Farm, Rock Springs, PA –2004 for the first and last 7 days of the study

| Date | Control | Clear | AG-15 |
|---|---|---|---|

| | | Poly °F | |
|---|---|---|---|
| 10/6 H | 59.9 | 67.6 | 65.3 |
| L | 52.2 | 40.2 | 49.0 |
| 10/7 H | 61.8 | 71.3 | 68.6 |
| L | 53.1 | 54.6 | 50.6 |
| 10/8 H | 62.5 | 71.8 | 69.3 |
| L | 54.8 | 58.3 | 53.3 |
| 10/9 H | 62.0 | 67.8 | 66.2 |
| L | 57.4 | 58.3 | 56.7 |
| 10/10 H | 57.8 | 62.0 | 58.9 |
| L | 55.5 | 57.0 | 53.8 |
| 10/11 H | 59.9 | 67.9 | 63.3 |
| L | 52.2 | 52.5 | 49.3 |
| 10/12 H | 59.2 | 67.6 | 62.5 |
| L | 50.7 | 51.5 | 47.4 |
| 10/27 H | 57.1 | 59.5 | 56.8 |
| L | 49.8 | 51.4 | 50.9 |
| 10/28 H | 56.9 | 55.4 | 57.9 |
| L | 49.3 | 51.2 | 51.2 |
| 10/29 H | 53.9 | 54.7 | 55.4 |
| L | 52.4 | 49.7 | 52.9 |
| 10/30 H | 58.0 | 59.2 | 57.4 |
| L | 53.2 | 51.8 | 53.2 |
| 10/31 H | 60.0 | 61.3 | 59.3 |
| L | 55.1 | 52.5 | 55.6 |
| 11/1 H | 56.8 | 57.5 | 56.3 |
| L | 50.5 | 50.6 | 52.2 |
| 11/2 H | 68.0 | 70.4 | 69.0 |
| L | 53.2 | 53.4 | 53.2 |

## 2004 Onion Plug Size Transplant Study

M.D. Orzolek, Dept. of Horticulture
The Pennsylvania State University
Cooperator: Rock Keitzer, Grower

Kietzer Farms, Hartford MI  49057

Plug Size Treatments

1- 288 cells/tray
2- 338 cells/tray
3- 406 cells/tray

Sweet Spanish Onion Variety: Expression

Date transplants received: May 7, 2004

Date planted in Field: May 10, 2004

Statistical Design: Randomized Complete Block with 4 replications

Production system: 6" raised beds (28" wide) with IRT mulch (4' wide) and 2 drip tapes per bed (0.45 gpm)

Plant spacing: 6" x 6" – 4 rows/bed (60 plants/plot)

After transplanting in Field: watered in onion transplants with 1.0 ounce/gallon of LCF (liquid compost factor).

Date harvested onions: August 18, 2004

Drying conditions: Placed onion bulbs per treatment per rep in potato burlap bags and placed in greenhouse bench for 5-7 days.

Table 1. Yield of the Sweet Spanish Onion variety "Expression" from different cell-size transplant plugs planted at the Horticulture Research Farm, Rock Springs, PA- 2004

| Treatments Cells/tray | Total no. of bulbs harvested/plot | Bulbs greater than 3" diam. | | Bulbs less than 3" diameter | |
|---|---|---|---|---|---|
| | # | # | Wt.(lbs.) | # | Wt. (lbs.) |
| 288 | 56.0 | 34.0 | 30.0 | 16.8 | 8.3 |
| 338 | 54.8 | 28.5 | 23.6 | 22.8 | 12.9 |
| 406 | 56.5 | 23.8 | 19.0 | 23.0 | 10.8 |

Table 2. Marketable yield, non-marketable yield, and average bulb weight of the Sweet Spanish Onion variety "Expression" grown in different cell-size transplant plugs planted at the Horticulture Research Farm, Rock Springs, PA- 2004

| Treatments Cells/tray | Non-marketable bulbs/plot | Marketable bulb yield T/A.[Z] | Average bulb 3" diameter |
|---|---|---|---|

| | # | Wt. (lbs) | | Wt. (lbs.) |
|---|---|---|---|---|
| | | | | |
| 288 | 5.3 | 2.8 | 16.0 | 0.88 |
| 338 | 3.8 | 2.1 | 15.2 | 0.83 |
| 406 | 7.5 | 4.2 | 12.4 | 0.80 |

Z – Marketable yield in T/A based on a 50,000 plants/acre population.

**Comments:**
Based on the yield data, the maximum number of cells to seed onions in plug trays would be 338 cells/tray. Planting onion seeds in plug trays with more than 338 cells/tray appears to reduce total marketable bulb yield, a lower percentage of jumbo and collosal bulbs and somewhat smaller bulb size. Cell number/tray did not appear to effect onion bulb maturity.

## Pumpkin Tillage Evaluation Study

M. D. Orzolek and R.L. Oberheim
Department of Horticulture, The Pennsylvania State University
Horticulture Research Farm, Rocksprings, PA

**Tillage Treatments:**
Primary tillage in this field was with a spadding machine (late March) and a moldboard plow (early-May). Secondary tillage on the spaded soil was with a rototiller, while a s-tine was used as a secondary tillage implement on the moldboard plowed section of the field. Also on the south end of the field, about 0.25 acres were planted with a no-till transplanter.

**Variety:** Gold Standard

**Transplanting Date**: June 2, 2004

**Fertility**: Applied 300 lbs./A of 0-20-20 and 800 lbs./A 0f 10-10-10 on April 20. 2004.

**Weed Management:**
Weed management on the tilled sections of this pumpkin field was with an application of Dual Magnum (2.0 pts./A) and Alanap(4.0 qts./A) pre-transplant (May 27), while the no-till section of the field received Command 4EC (5.8 oz/A), Prefar (6.0 qts./A) and Touchdown (2.5 qts./A) pre-transplant (May 10) and the entire pumpkin field (1.0 acre) received an application of Sandea (0.5 oz/A) on June 23, 2004.

**Insect Control:**
Asana XL was applied at the rate of 6.0 oz/A on the following dates: June 15, July 22, July 29, August 11, August 16, August 23, and September 10, 2004.

**Disease Control**:
BravoWS was applied at the rate of 1.5 to 2.0 pts./A on July 7, July 16, July 22, August 4, August 16, and September 17, 2004. Ridomil Gold Copper was applied at the rate of 2.0 lbs./A on July 2, July 29, August 11, August 23, and September 17, 2004. A single application of Quadris at 0.75 pts./A was made on September 10, 2004.

**Design**: Randomized Complete Block with 4 replications.

**Sample size**: 144 sq ft.

**Table 1**. The marketable yield of "Gold Standard" pumpkins grown in various tillage treatments at the Horticulture Research Farm, Rock Springs, PA. – 2004.

| Treatment | No of Fruit/A | Wt. fruit T/A | Avg. fruit wt. (lbs.) | % brown stem | Range of fruit size (lbs.) |
|---|---|---|---|---|---|
| Tillage – Spading | 3,328 | 25.4 | 15.3 | 43.0 | 5.0 to 28.0 |
| Tillage-Moldboard | 2,813 | 21.5 | 15.3 | 43.0 | 5.3 to 26.9 |
| No-till | 2,360 | 10.7 | 9.1 | 0.0 | 3.9 to 17.9 |

**Comments**:
This study was conducted to evaluate the value of optimum tillage practices for the production of pumpkins. There have been many growers who have adopted to no-till pumpkin production in

the last 5 years in Pennsylvania; but limited work has been done regarding tillage practices prior to transplanting pumpkin plants in the field.
The use of the spadding machine allowed us to till earlier in the year (March vs May) under wetter soil conditions compared to moldboard plowing. In addition, spading will breakup plow pans and compacted areas of the soil to a depth of 12 inches.
The highest yield of marketable pumpkins was harvested from the spading followed by rototiller treatments. Surprisingly, the lowest yield was harvested from the no-till treatment. It was also observed that in the no-till treatments, there were more immature green fruit with shorter stems compared to the other two tillage treatments. It appeared as if the growth of the pumpkin plants was 2 weeks later in no-till compared to the other treatments.
Fruit size was also affected by tillage treatment, largest fruit harvested from the spaded or moldboard plots and smallest fruit from the no-till plot.

# Evaluation of Plug Tray Type and Color on Pepper, Tomato, and Cabbage Transplants

M. D. Orzolek[1], B. Dye[1] and A. Erb[2]
[1]Dept. of Horticulture, The Pennsylvania State University, University Park, PA
[2]Cornell Cooperative Extension-Lake Plains Region, East Aurora, NY

**Crops**: Cabbage – “Bronco”
Tomato – “Royal Mountie”
Bell Pepper – “Paladin”

**Date Crops Seeded in Greenhouse**: April 14 and 15, 2004

**Tray types**: Standard 200-cell tray with inverted pyramid soil cube (1.5” square), plants removed from top.
Renaldo 200-cell tray with square, shallow soil cube (1.5” square), plants removed from bottom.

**Plot size**: 15’ long x 3.5’ wide.

**Plant spacing**: 12” in-the-row and 42” between rows; 15 plants per plot.

**Design**: Randomized Complete Block with 3 Replications.

**Date Transplanted**: July 28, 2003

**Date Harvested**: November 10, 2003

**Plot size**: Tomato and Pepper - 25’ long x 6’ wide on raised 18” wide beds 4” high and black plastic mulch.
Cabbage – 30’ long x 3’ wide on bare ground.

**Plant spacing**: Tomato and pepper –2.0 ft. in-the-row and cabbage 1.5 ft in-the row.

**Date Transplanted**: Tomato and pepper – June 28, 2004.
Cabbage – June 30, 2004

**Date Harvested**: Tomato and pepper – September 16 and October 5, 2004
Cabbage – October 6 and 7, 2004

Table 1. The affect of transplant plug tray type on the marketable yield of tomato (cv. Royal Mountie) from plants grown on raised beds with black plastic mulch and drip irrigation tape at the Horticulture Research Farm, Rock Springs, PA – 2004

.

| Plug tray type | Marketable yield | | Avg, fruit |
|---|---|---|---|
| | No. fruit | Wt. fruit (lbs.) | Wt. (oz) |
| Renaldo black | 198.3 | 105.5 | 8.5 |
| Renaldo white | 176.0 | 97.1 | 8.8 |
| Standard black | 171.3 | 91.6 | 8.6 |
| Standard white | 176.3 | 98.2 | 8.9 |
| | | | |
| Renaldo | 187.2 | 101.3 | 8.7 |
| Standard | 173.8 | 94.9 | 8.8 |
| | | | |
| Black | 184.8 | 98.6 | 8.5 |
| White | 176.2 | 97.7 | 8.9 |

Table 2. The affect of transplant plug tray type on the marketable yield of bell pepper (cv. Paladin) from plants grown on raised beds with black plastic mulch and drip irrigation tape at the Horticulture Research Farm, Rock Springs, PA – 2004

.

| Plug tray type | Marketable yield | | Avg., fruit |
|---|---|---|---|
| | No. fruit | Wt. fruit (lbs.) | Wt. (oz) |
| Renaldo black | 47.0 | 22.2 | 7.6 |
| Renaldo white | 48.7 | 23.6 | 7.8 |
| Standard black | 28.3 | 11.1 | 6.3 |
| Standard white | 47.3 | 21.2 | 7.2 |
| | | | |
| Renaldo | 47.9 | 22.9 | 7.6 |
| Standard | 37.8 | 16.2 | 6.8 |
| | | | |
| Black | 37.7 | 16.7 | 7.1 |
| White | 48.0 | 22.4 | 7.5 |

Table 3. The affect of transplant plug tray type on the marketable yield of cabbage (cv. Bronco) from plants grown on raised beds with black plastic mulch and drip irrigation tape at the Horticulture Research Farm, Rock Springs, PA – 2004
.

| Plug tray type | Marketable yield | | Avg, head |
|---|---|---|---|
| | No. heads | Wt. heads (lbs.) | Wt. (lbs.) |
| Renaldo black | 16.3 | 124.6 | 7.6 |
| Renaldo white | 18.3 | 130.3 | 7.1 |
| Standard black | 17.3 | 148.5 | 8.6 |
| Standard white | 19.3 | 131.3 | 6.8 |
| | | | |
| Renaldo | 17.2 | 127.5 | 7.4 |
| Standard | 18.3 | 139.9 | 7.6 |
| | | | |
| Black | 16.8 | 136.6 | 8.1 |
| White | 18.8 | 130.8 | 7.0 |

**Comments**:
All crops were planted as Randomized Complete Block designs with 3 replications. Transplants from the Renaldo trays were pushed through the bottom and had a very vigorous root system. Transplants grown in the standard plug-trays were pulled from the top and had a vigorous root system. Only the trays with the tallest tomato, pepper and cabbage plants were used in this study.
Generally speaking, transplants produced in the Renaldo tray compared to the standard plug tray produced higher yields of tomato and pepper (Tables 1 and 2). However, there was no difference in cabbage yield from transplants grown in the Renaldo trays compared to the standard plug tray

## Tomato Fertigation and Plant Spacing Study

M.D.Orzolek, W.J. Lamont and B. Dye
Department of Horticulture
The Pennsylvania State University

**This research was supported by a grant from the PA Vegetable Research and Marketing Program in 2003.**

**Fertility Treatments**: Target nutrition level for tomato: 100N-100P-100K.
1 - 100% of all nutrients broadcast and incorporated prior to making raised beds.
2. – 50% of all nutrients broadcast and incorporated prior to making raised beds and 50% of nutrients injected in the drip system during the growing season.
3. - 100% of nutrients injected in the drip system during the growing season.

**Plant Spacing**: In-row-spacing of 1.5', 2.0', and 2.5 with twelve feet between rows. A total of 25 plants/plot.

**Statistical Design**: Split plot with 3 replications. Main variable – tomato fertility and split variable – plant population.

**Variety**: Mountain Spring

**Date transplanted**: June 25, 2004.

**Production System**: Raised beds (28" wide X 6" high), with black plastic mulch and a single row of drip tape – No Staking.

**Tissue sampling date**: August 20, 2004

**Harvesting dates**: September 15 + 16, and October 1 + 4, 2004.

**Results and Discussion**:
Even thou we received more rainfall in 2004 and the tomato plants were transplanted in late June compared to 2003, growth and production of tomato plants and fruit were higher than average. Also, use of raised beds with plastic mulch helped to maintain a more uniform soil moisture level throughout the growing season.
The results of the tissue test taken on August 20 are presented in Table 1. The concentration of N, P, K, and Ca were higher in tomato tissue where tomato plants were grown on beds with 50% of total nutrient application made prior to making the beds and the other 50% of nutrients injected into the drip tape compared to 100% of all nutrients applied prior to making the beds and 100% of all nutrients injected into the drip system. For the stage of tomato development when this sample was taken, macro nutrient levels were in the optimum range. The concentration of Mn, Cu, B, and Zn were higher in tomato plants grown on beds with 100% of all nutrients injected into the drip system compared to 50% of total nutrient application made prior to making the beds and the other 50% of nutrients injected into the drip system and 100% of all nutrients applied prior to making the beds (Table 1).
Although the 50% of total nutrient application made prior to making the beds and the other 50% of nutrients injected into the drip system treatment had the highest macro nutrient tissue concentration, ironically this treatment produced the lowest marketable fruit yield compared to the other two treatments (Table 2). There was basically no difference in average fruit weight (oz.) or percent fruit greater than 3.0 inches between the different fertility treatments. Since similar marketable yields were harvested from tomato plants that were grown on beds with 100% of all nutrients applied prior to making the beds or 100% of all nutrients injected into the drip system, one would think that leaf tissue concentrations were higher in these two treatments than the 50% broadcast and 50 % injected treatment. Ironically, these two treatments had lower nutrient concentrations in the leaf tissue compared to the 50% of total nutrient application made

prior to making the beds and the other 50% of nutrients injected into the drip system. Did nutrient application affect the marketable tomato fruit yield of "Mt. Spring" tomato in 2004? From the data presented in Tables 1 and 2, nutrient application in 2004 did not appear to have a significant affect on marketable fruit yield. Too much rain, too late a planting date, soil with high clay content, or variety with minimum fertility response; very difficult to single out, but there were several factors that affected tomato yields in 2004.

Tomato plant population had a definite affect on marketable fruit yield in 2004 (Table3). The higher the plant population of tomatoes, the higher the fruit yield, smaller the average fruit weight, and a smaller percentage of tomato fruit 3.0 inch diameter or larger (Table 3). Even thou the tomato plants were not staked in this study, the yield difference due to higher tomato plant populations would not be affected whether plants were staked or not.

The interaction of fertility and plant spacing on "Mt. Spring" tomato is presented in Table 5. The lowest tomato marketable fruit yield was harvested from plants that were grown on beds with 50% of total nutrient application made prior to making the beds and the other 50% of nutrients injected into the drip system at the farthest spacing of 2.5 feet (39.8 total pounds) and the highest tomato marketable fruit yield was harvested from plants that were grown on beds with 100% of all nutrients applied prior to making the beds and closest spacing of 1.5 feet (63.7 total pounds).

**Conclusions**
In 2004, the following conclusion can be drawn from the tomato fertility trial:

1) Broadcast and incorporating all required nutrients for optimum tomato yields prior to making raised beds covered with plastic mulch and drip irrigation tape is comparable to injecting all required nutrients through the drip irrigation tape during the growing season. The only disadvantage of broadcast and incorporating nutrients prior to making raised beds is that continual rain after broadcasting, but before incorporating the nutrients could leach significant N and K from the soil profile to ground water and be unavailable for use by tomato plants.
2) Increasing the in-row-spacing of tomato plants (reducing plant population) reduced total marketable yield and percent of fruit greater than 3.0 inches in diameter while increasing average fruit weight ( from 7.6 to 8.4 ounces/fruit).

Table 1. The tissue analysis of “Mountain Spring” tomato plants grown under different fertility treatments at the Horticulture Research Farm, Rock Springs, PA - 2004.

| Fertility Treatments | N | P | K | Ca | Mg |
|---|---|---|---|---|---|
| | | | % dry weight | | |
| 100 % BC | 3.54 | 0.34 | 2.77 | 2.37 | 0.35 |
| 50% BC + 50% Inj. | 3.98 | 0.42 | 2.86 | 2.60 | 0.37 |
| 100& Inj. | 3.26 | 0.37 | 2.60 | 2.40 | 0.32 |
| | Mn | Fe | Cu | B | Zn |
| | | | PPM | | |
| 100% BC | 457 | 98 | 11.7 | 25 | 62 |
| 50% BC + 50% Inj. | 574 | 119 | 12.0 | 29 | 81 |
| 100% Inj. | 681 | 94 | 15.7 | 31 | 90 |

BC - broadcast
Inj - injected

Table 2. The total marketable fruit yield of “Mountain Spring” tomato plants grown under different fertility treatments at the Horticulture Research Farm, Rock Springs, PA - 2004.

| Fertility Treatments | Total Marketable Yield | | | Average | Percent fruit greater |
|---|---|---|---|---|---|
| | Fruit # | Fruit Wt (lbs.) | T/A | Wt. (oz) | than 3.0” diameter |
| 100% BC | 335.6 | 169.9 | 15.3 | 8.1 | 34.3 |
| 50% BC + 50% Injected | 259.6 | 128.5 | 11.6 | 7.9 | 33.7 |
| 100% Injected | 330.3 | 165.1 | 14.9 | 8.0 | 34.3 |

BC - broadcast
Inj - injected

Table 3. The total marketable fruit yield of “Mountain Spring” tomato plants grown under different plant populations (in-row-spacings) at the Horticulture Research Farm, Rock Springs, PA - 2004.

| Plant population Treatments (In-row-spacing) | Total Marketable Yield Fruit # | Fruit Wt (lbs.) | T/A | Average Wt. (oz) | Percent fruit greater than 3.0” diameter |
|---|---|---|---|---|---|
| 1.5 feet | 351.9 | 168.0 | 15.1 | 7.6 | 27.0 |
| 2.0 feet | 305.6 | 153.6 | 13.8 | 8.0 | 34.3 |
| 2.5 feet | 268.0 | 141.9 | 12.8 | 8.5 | 41.0 |

Table 4. The marketable fruit yield of “Mountain Spring” tomato plants grown under different fertility treatments at the Horticulture Research Farm, Rock Springs, PA - 2004.

| Fertility Treatments | Plant Spacing | Marketable Fruit Yield: Fruit 3.0” diam. or larger # | Wt (lbs.) | Fruit less than 3.0” diam. # | Wt (lbs.) |
|---|---|---|---|---|---|
| 100% BC | 1.5 feet | 35.3 | 23.8 | 96.3 | 39.9 |
| | 2.0 feet | 37.3 | 25.7 | 63.0 | 25.5 |
| | 2.5 feet | 40.7 | 27.8 | 63.0 | 27.2 |
| 50% BC + 50% Injected | 1.5 feet | 28.0 | 18.4 | 67.3 | 27.6 |
| | 2.0 feet | 27.3 | 17.9 | 61.0 | 24.8 |
| | 2.5 feet | 31.3 | 21.0 | 44.7 | 18.8 |
| 100% Injected | 1.5 feet | 31.3 | 20.5 | 93.7 | 37.7 |
| | 2.0 feet | 40.7 | 27.6 | 76.3 | 32.1 |
| | 2.5 feet | 38.0 | 25.7 | 50.3 | 21.4 |

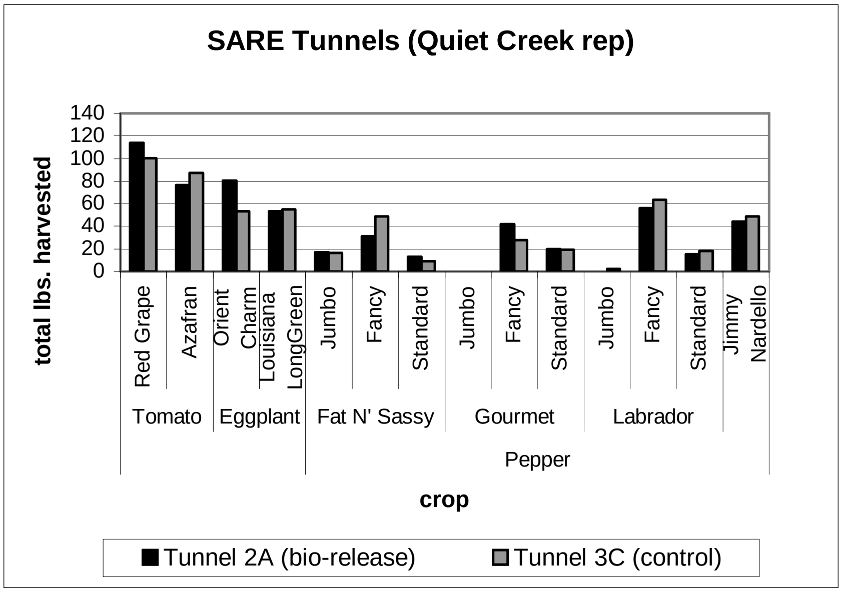
BC - broadcast
Inj - injected

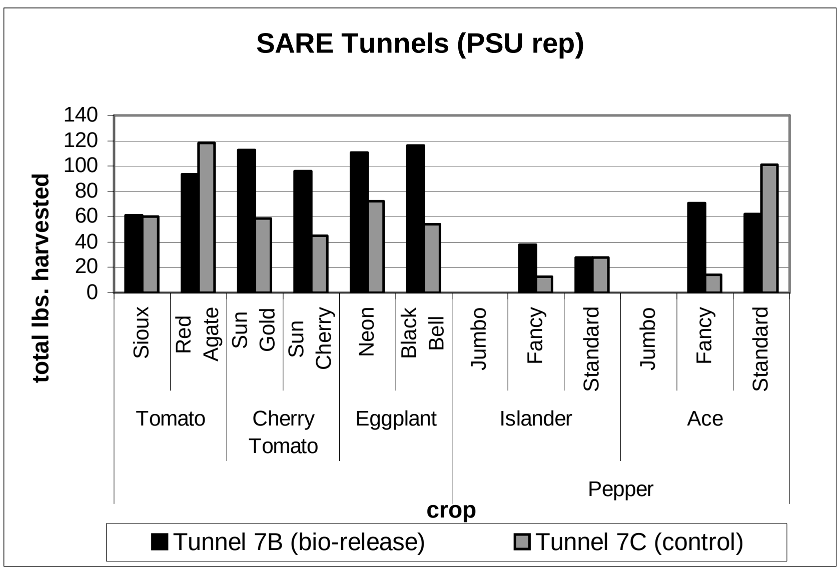
Table 5. The total marketable fruit yield of "Mountain Spring" tomato plants grown under different fertility treatments at the Horticulture Research Farm, Rock Springs, PA - 2004.

| Fertility Treatments | Plant Spacing | Total Marketable Yield Fruit # # | Fruit Wt (lbs.) | Percent fruit greater than 3.0" diameter |
|---|---|---|---|---|
| 100% BC | 1.5 feet | 131.6 | 63.7 | 27.0 |
| | 2.0 feet | 100.3 | 51.2 | 37.0 |
| | 2.5 feet | 103.7 | 55.0 | 39.0 |
| 50% BC + | 1.5 feet | 95.3 | 46.0 | 29.0 |
| 50% Injected | 2.0 feet | 88.3 | 42.7 | 31.0 |
| | 2.5 feet | 76.0 | 39.8 | 41.0 |
| 100% Injected | 1.5 feet | 125.0 | 58.3 | 25.0 |
| | 2.0 feet | 117.0 | 59.7 | 35.0 |
| | 2.5 feet | 88.3 | 47.1 | 43.0 |

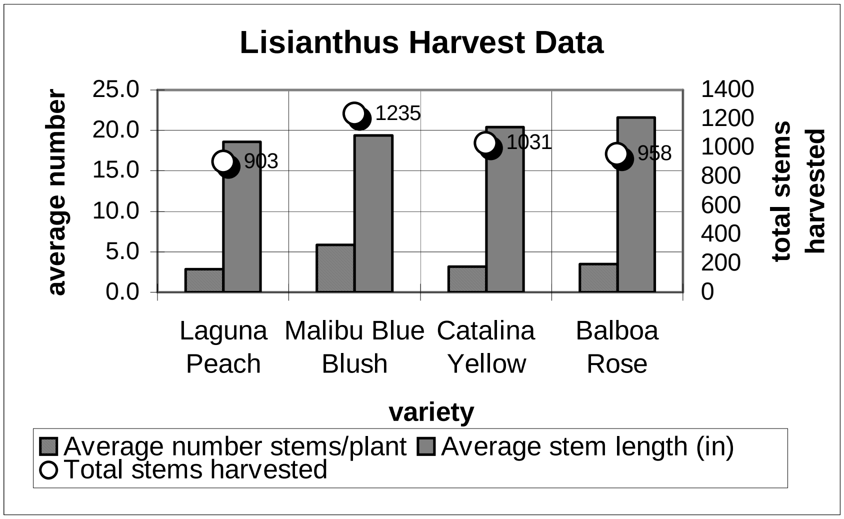
BC - broadcast
Inj - injected

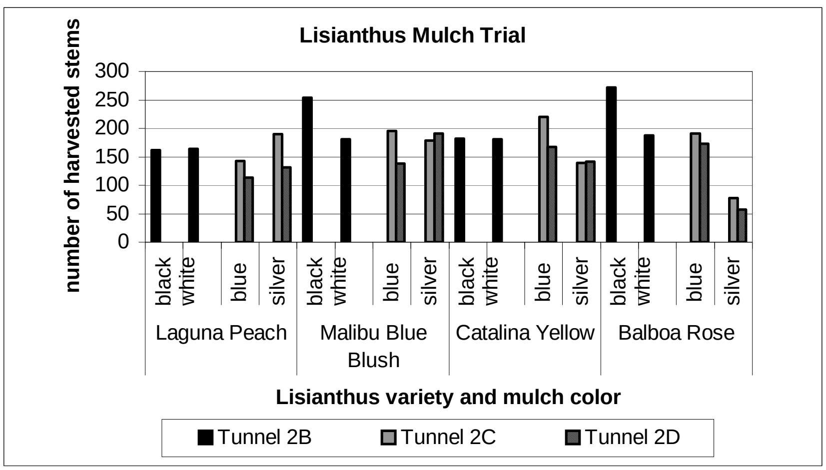
# High Tunnel Research and Demonstration Summary



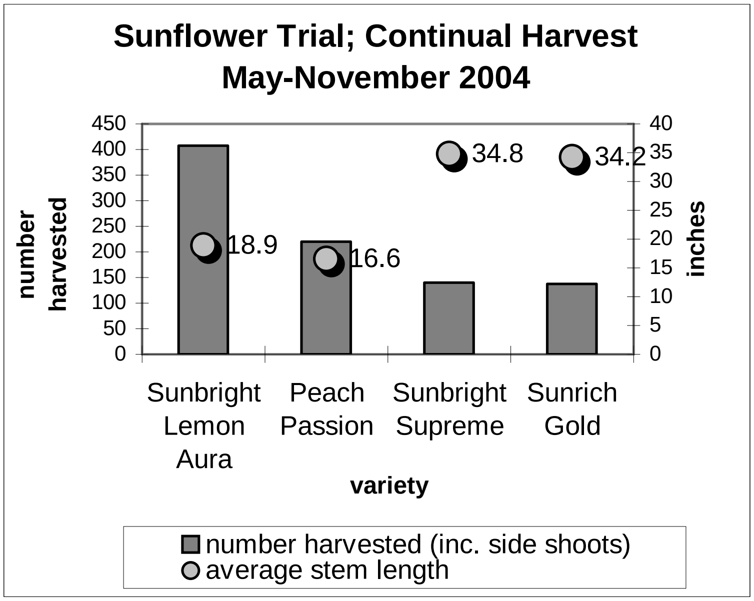

One of the main factors studied in our 3 year SARE Project was the effectiveness of releasing beneficial insects to control pest populations as part of an Integrated Pest Management (IPM) system (for more detailed info about this study email Catie at cmm244@psu.edu).
The data shown above reflects the total pounds of marketable fruit harvested from each of the high tunnels used in the IPM study. In each pair of high tunnels, one received beneficial insect releases throughout the season, and the other did not. If and when pest populations became too high in the "control" tunnels, insecticidal soap or horticultural oil was sprayed. The 2004 growing season was a bad pest year; we observed extremely high populations of spider mites (mostly on eggplant and peppers) and thrips, and more moderate populations of aphids and whitefly.

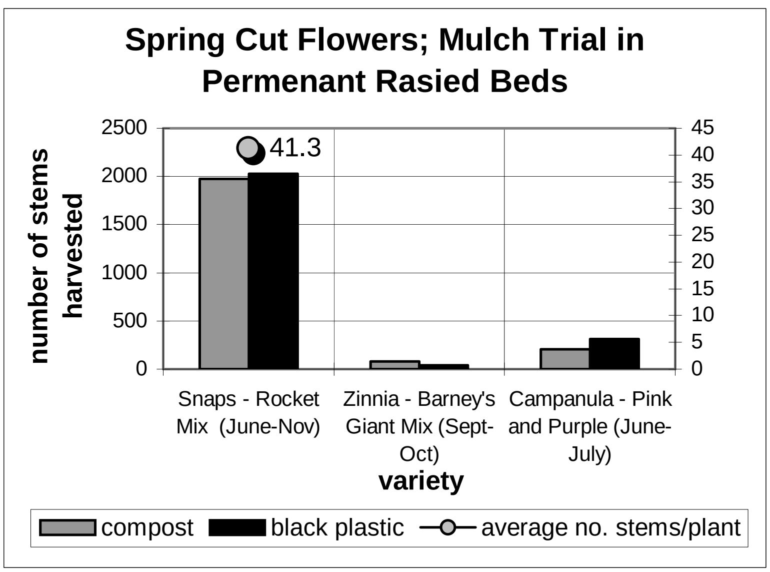



<u>Total Flowers (stems) per Tunnel</u>:
2B (black and white mulch) -- 1680
2C (blue and silver mulch) -- 1335
2D (blue and silver mulch) -- 1112
Average 3.8 stems/plant

This is the second year that we have grown Lisianthus and they continue to do very well in the high tunnel environment. Stem length, excellent flower quality and extended harvest season are the main benefits to high tunnel production. Our field comparison plots where not worth harvesting compared to the beautiful appearance of the lisianthus produced in the high tunnels. For the most part, lisianthus seems to prefer either black or blue plastic mulch. The 2005 trial will compare Avila Deep Rose, Balboa Purple, Balboa Yellow and Ventura Peach grown on black and blue plastic mulch. Only one high tunnel will be dedicated to this year's study. Favorite Lisi out of this group; Balboa Rose (also one of the *Association of Specialty Cut Flower Growers* nominees for "2005 Fresh Cut Flower of the Year")!



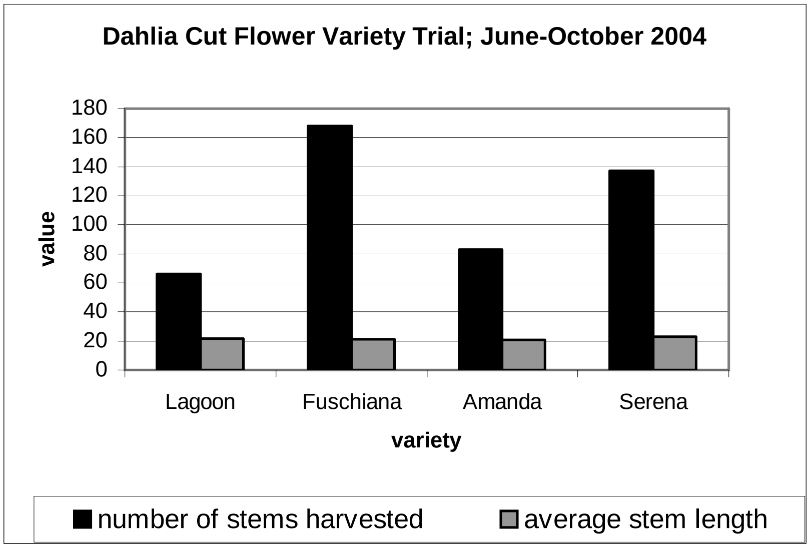




Once again, cut flowers of all types do very well in high tunnels. Along with variety trials of different common cut flowers, we simultaneously test their mulch preference (whether it be plastic or other materials). In the 'Spring Cut Flower' trial, there seemed to be a slight preference for black plastic mulch in relation to yield. The other major benefit of plastic mulch is weed suppression throughout the season. This spring we will be planting a wide assortment of flowers including Bupleurum, Yarrow, Zinnia, Snapdragons, Delphinium, Sea Holly, Sweet William and Calendula.

Sunflowers also seem to love the high heat of the tunnels. The extended season achieved is great for the out-of-season sunflowers price point (which always sell well!) Floating row cover may be needed in the early or last season, especially for the cold sensitive sunflowers. The 2005

Sunflower trial will look at my two "favorites", plus Autumn Beauty and Sunrich Yellow. Favorite Sunflowers; Sunbright Supreme and Sunrich Gold!

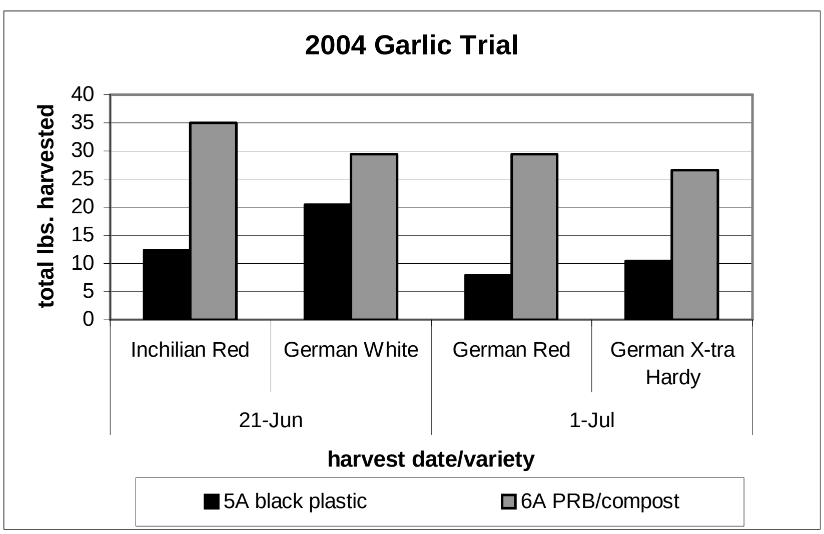
---




This year was the first year growing bulbs. The Dahlias did very well in the tunnels (and are hopefully over-wintering well as we speak). They where grown in raised beds with no mulch. Lagoon and Fuschiana sold very well as individual stems. Serena (white) did not last as long as the others with its tips turning brown rather quickly. Favorite Dahlia; Fuschiana!

---

**Garlic Trial**




While some crops thrive on black plastic mulch, garlic is not one of them! Over the past few years we have observed continued preference and response of garlic to compost mulch as opposed to black plastic mulch. One theory is that the moisture level remains too high under the plastic mulch. This year none of our garlic production is under plastic mulch, rather we are looking at the difference between PRB (permanent raised beds), annual raised beds and flat culture production in the high tunnels.

Other noteworthy (but not graphworthy) high tunnel crops that we have successfully grown are;Cucumbers, Hot and Specialty Peppers, Beets, Turnips, Kale, Collards, Kohlrabi, Salad and Asian Greens, Culinary and Medicinal Herbs, Broccoli, Summer and Winter Squash, Celery , New Potatoes, and Onions.

---

## HEATING GREENHOUSES WITH PLASTIC: CLEAN HEAT FROM DIRTY WASTES

James W. Garthe
Agricultural Engineer and Instructor
Dept. of Agricultural and Biological Engineering
Pennsylvania State University
University Park, PA 16802

Recovering valuable energy from most types of plastic wastes may soon become reality. Dirty, used or non-recycled plastics can be converted to heat for greenhouses and agricultural operations, commercial buildings, light industrial facilities, or other buildings requiring an environmentally clean, yet safe, fuel. Here are two technologies being worked on at Penn State University.

The First Technology: Plastofuel

A simple process has been invented to densify waste plastics into a fuel, called Plastofuel. This process was developed in the Department of Agricultural and Biological Engineering at Penn State University, with the goal of reducing waste plastic buildup on farms around the world. The process works by forcing rigid or film plastic items through a heated die, thus melting a thin jacket which encapsulates the pieces of plastic and dirt within the extruded material exiting the die. A hot knife cuts the extrudate into dense fuel nuggets that can be easily conveyed, stored and shipped.


**Figure 1.** Shown are very dirty plastic drip irrigation tubing and mulch film being fed by hand into the prototype Plastofuel machine. A hydraulic cylinder forces the plastic items through a heated die, shown on the lower right. The extruded material is then cut with a hot knife to form Plastofuel, shown in Figure 2.

**Figure 2**. These Plastofuel fuel nuggets were made from all sorts of dirty plastics mixed together. The process works well using either discarded films, rigid plastic items, or both.

The nuggets were originally designed to be co-fired 5-10 percent with coal in existing boilers, allowing the high temperature of coal (around 2000 $^{o}$F) to sustain clean combustion, free of noxious smoke. The end-use is for agricultural boilers or small community boilers designed to burn coal. Plastofuel can be made either on the farm or in small industrial settings, thereby consuming the energy close to the source. The benefit of the system is that it converts an annoying waste into a valuable fuel, with a minimum of energy expended in the process. Non-recycled consumer plastic food and beverage containers can also be used in the process.

Beginning in 2005, the Penn State team will scale-up the prototype Plastofuel process to produce 227 kg (500 lbs.) per hour. This system will be instrumented to measure energy expenditures, which will better define the economics of the process compared with competing fuels. It will also provide Plastofuel in quantity for pilot-scale testing.

The Second Technology: Korean High Temperature Combustion

Although blending used plastic with coal continues to be an important way to recover energy from waste plastic, a new Korean technology is being investigated by researchers at Penn State. Manufactured by GR Technologies Company, Ltd., this hot water boiler heating system burns pea-sized pellets made from waste plastics. The systems preheats a series of combustion chambers to 1650-2000 $^{o}$F (900-1100 $^{o}$C) for 10-15 minutes using fuel oil or kerosene, then automatically switches to the plastic pellets. Field testing of a 396, 850 Btu/hr. (100,000 kcal/hr.) unit for heating high tunnels began at the Horticulture Research Farm in 2004. Eventually, the pellet-fueled unit will be modified to burn the larger and more energy efficient Plastofuel nuggets.

**Figure 3.** Shown is the GR Technologies boiler at the factory in Korea. The rectangular tank in the foreground stores the fuel oil for pre-heating. The boiler is the cylindrical piece on the left behind the fuel tank. The high-temperature burner is shown on the right, fueled by plastic pellets conveyed by a vacuum feed device to the hopper atop the burner. The electronic control box is partially visible behind the burner.


**Figure 4.** This is the hot water boiler housed in the boiler building at the Horticulture Research Farm. Hot water heated by the unit is used to heat high tunnels nearby. Here, the burner (right) has been pulled out of the boiler (left) for demonstration purposes to show the flame while burning plastic fuel.

Testing by the Korea Test Laboratory showed this system meets Korean and US Environmental Protection Agency (EPA) emissions standards. To verify EPA test results in a field setting, in 2005 researchers will investigate combustion characteristics and efficiencies, air emissions, and overall system heat transfer using a wide array of waste plastic fuels.