29th Annual Horticulture Industries Show

Local Growers—Local Cooperation

January 8 & 9, 2010
2010 Horticulture Industries Show Proceedings
Tulsa Community College Northeast Campus
3727 E. Apache
Tulsa, OK
WE SAVVY IRRIGATION

Typical Drip System Layout

Plastic Mulch Film

Plasticsculture Equipment

Tomato Stakes & Twine

Garden & Orchard Kits

Sprinklers

Rain Bird

1-800-SAY-RAIN

We are a full service Irrigation, DRAINAGE, & Tractor Dealership. Certified Designers / Professional Engineers. We offer the Complete System. Call for a FREE Buyers Guide 800-SAY-RAIN (729-7246). Visit us on the Web www.Irrigation-Mart.com
PROCEEDINGS of the

29th ANNUAL
HORTICULTURE INDUSTRIES SHOW*

January 8 & 9, 2010

Tulsa Community College
Northeast Campus

Edited by:
Donna Dollins
Department of Horticulture and Landscape Architecture
Oklahoma State University
Stillwater, OK

Show Sponsors:

Arkansas Agriculture Department
Arkansas Cooperative Extension Service
Arkansas State Horticulture Society
The Kerr Center for Sustainable Agriculture
Oklahoma Cooperative Extension Service
Oklahoma Department of Agriculture, Food & Forestry
Oklahoma State University, Stillwater
Tulsa Community College
University of Arkansas

*Formerly the Oklahoma Horticulture Industries Show from 1981 through 1997
A special thanks to the following for their support of the Horticulture Industries Show

Tulsa Community College

The Kerr Center for Sustainable Agriculture

Oklahoma State University Cooperative Extension Service, Stillwater, OK

The Horticulture and Landscape Architecture Department, Oklahoma State University, Stillwater, OK

Oklahoma Botanical Garden & Arboretum

Oklahoma Christmas Tree Association

Oklahoma Department of Agriculture, Food & Forestry

Oklahoma Herb Growers and Marketers Association

Oklahoma Vegetable Association

Oklahoma & Arkansas Farmers’ Markets Associations

The Samuel Roberts Noble Foundation

Arkansas State Horticulture Society

University of Arkansas Cooperative Extension Service
# Table of Contents

2009-2010 BOARD OF DIRECTORS ............................................................................................................ 7
Trade Show Donor ..................................................................................................................................... 9
Trade Show Exhibitors ............................................................................................................................... 9
Local Foods on Friday ................................................................................................................................ 12
Local Foods on Saturday ........................................................................................................................... 13

**Keynote Speaker** ................................................................................................................................ 14
Overview of Locally Based-Greenhouse Tomato Production ................................................................. 15

**Christmas Tree Sessions** .................................................................................................................... 26
Christmas Tree Sales Report – 2009 Season ............................................................................................ 27
Marketing Real Christmas Trees in Today’s Economy ............................................................................. 31
Christmas Tree Seedling Selection and Culturing .................................................................................... 34

**Farmers’ Markets/Sustainable Agriculture Sessions** ....................................................................... 40
Federal Food Safety Policy: Impacts on Local Hort Producers ............................................................. 41
New Programs to Improve Access to Farmers Markets ........................................................................ 42
An Introduction to Accepting Federal Food Benefits at Farmers’ Markets in Oklahoma ..................... 43
Oklahoma Senior Farmers’ Market Program ............................................................................................. 45
Selling Your Agricultural Products Using a Green Distributor ................................................................ 47
"Are We Organic Yet!?” NOP Compliance for Non-certified Organic Growers .................................... 49
Diverting yard and City Waste from Landfills to Farms ....................................................................... 52

**Fruit Sessions** .................................................................................................................................... 56
Farming a Few Acres of Specialty Crops ................................................................................................. 57
New Fruit Crop Establishment for a Value-added Processing Business ............................................... 61
Helping Growers Capture “Local” Retail Market Opportunities ............................................................. 66
Economic Analysis for Raspberries and Blackberries Production Using Interactive Enterprise Budgeting ............................................................................................................................... 67
Opportunities and Challenges for High Tunnel Fruit Production in the Arkansas-Oklahoma Region .... 68
Virus diseases of blackberry and blueberry in the South .................................................................... 72
Management of Green June Beetles and Japanese beetles in Fruit ......................................................... 73
Problems and Solutions with Peach Crops ............................................................................................. 78
Early Performance of an Organic Apple Orchard as affected by Nutrient Source and Ground Cover Management .................................................................................................................. 80
Rock Creek Vineyard – An Oklahoma Experiment ............................................................................... 84
<table>
<thead>
<tr>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Development of an Integrated Approach for Managing Black Rot of Grape in Oklahoma</td>
<td>86</td>
</tr>
<tr>
<td>Elderberry Research and Production in Missouri</td>
<td>89</td>
</tr>
<tr>
<td>Hot Topics in Pecans</td>
<td>94</td>
</tr>
<tr>
<td>Cultural Problems Facing the Blueberry Industry in Arkansas</td>
<td>97</td>
</tr>
<tr>
<td><strong>Public Garden/Master Gardener Sessions</strong></td>
<td>99</td>
</tr>
<tr>
<td>Native vs. Non-native Plants: Finding a Balance</td>
<td>100</td>
</tr>
<tr>
<td>Introduction to the Junior Master Gardener Program</td>
<td>102</td>
</tr>
<tr>
<td>Jr. Plant Scientist</td>
<td>104</td>
</tr>
<tr>
<td>Japanese Landscape Design</td>
<td>108</td>
</tr>
<tr>
<td>Vines – What’s the Deal?</td>
<td>109</td>
</tr>
<tr>
<td>Entomology Up Close and Personal</td>
<td>112</td>
</tr>
<tr>
<td>Managing Turf in Shady Areas</td>
<td>115</td>
</tr>
<tr>
<td>Xeriscape Demonstration Landscape at Bickham-Rudkin Park, Edmond</td>
<td>118</td>
</tr>
<tr>
<td><strong>Vegetable Sessions</strong></td>
<td>120</td>
</tr>
<tr>
<td>Problems, Solutions and Troubleshooting of Greenhouse Tomato Production</td>
<td>121</td>
</tr>
<tr>
<td>New Food Safety Factsheets for Fresh Produce</td>
<td>129</td>
</tr>
<tr>
<td>Developing a Food Safety Plan for Your Farm</td>
<td>132</td>
</tr>
<tr>
<td>Snap Beans...A Tender Warm Season Crop</td>
<td>137</td>
</tr>
<tr>
<td>The Pepper – Colorful, Frightening and Savored the World Over</td>
<td>140</td>
</tr>
<tr>
<td>Research Update on Pepper Production Systems</td>
<td>142</td>
</tr>
<tr>
<td>Low and High Input Organic Mulching Trial</td>
<td>145</td>
</tr>
<tr>
<td>Cover Crops and Vegetable Rotations</td>
<td>148</td>
</tr>
<tr>
<td>Soil Testing and Fertilizer Recommendations for Vegetable Crops</td>
<td>152</td>
</tr>
<tr>
<td>Soil Improvement Studies for Oklahoma Vegetables</td>
<td>156</td>
</tr>
<tr>
<td>Irrigation Timing and Fertilizer Rate in Peppers</td>
<td>157</td>
</tr>
<tr>
<td><strong>Posters</strong></td>
<td>159</td>
</tr>
<tr>
<td>Micronized Compost as an Organic Amendment for Soil Media</td>
<td>160</td>
</tr>
<tr>
<td>Organic Greenhouse Soil Media + Supplemental Fertilizer = Better Organic Tomato Transplants</td>
<td>163</td>
</tr>
<tr>
<td>Certified Organic Herb Mulching Demonstration</td>
<td>165</td>
</tr>
<tr>
<td>Horticulture Industries Show Sponsors</td>
<td>168</td>
</tr>
</tbody>
</table>
# HORTICULTURE INDUSTRIES SHOW
## 2009-2010 BOARD OF DIRECTORS AND SUPPORTING PERSONNEL
### OFFICERS

<table>
<thead>
<tr>
<th>Position</th>
<th>Arkansas Representative</th>
<th>Oklahoma Representative</th>
</tr>
</thead>
<tbody>
<tr>
<td>President</td>
<td>Jim Shrefler</td>
<td>Heather Friedrich</td>
</tr>
<tr>
<td>President-elect</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sec/Treasurer</td>
<td>Jim Shrefler</td>
<td>Heather Friedrich</td>
</tr>
</tbody>
</table>

**WWAREC**
PO Box 128
Lane, OK 74555
580-889-7343
Jim Shrefler@okstate.edu

**Arkansas Representative**
PO Box 128
Lane, OK 74555
580-889-7343
Jim Shrefler@okstate.edu

**Oklahoma Representative**
PO Box 128
Lane, OK 74555
580-889-7343
Jim Shrefler@okstate.edu

**BOARD OF DIRECTORS**

<table>
<thead>
<tr>
<th>Commodity Area</th>
<th>Arkansas Representative</th>
<th>Oklahoma Representative</th>
</tr>
</thead>
<tbody>
<tr>
<td>Christmas Tree</td>
<td>Don Wickersham</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Farmers Market</td>
<td>Jim McGuire</td>
<td>Doug Walton</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fruit</td>
<td>Richard Collins</td>
<td>John L. Mikelson</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Herb</td>
<td>Kathie Webb</td>
<td></td>
</tr>
<tr>
<td>Master Gardener/Public</td>
<td>Janet Carson</td>
<td>David Hillock</td>
</tr>
<tr>
<td>Garden</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nonproducer (Industry)</td>
<td>Bruce Tencleve</td>
<td>Robert DeWitt</td>
</tr>
<tr>
<td>Sustainable Agriculture</td>
<td>Heather Friedrich</td>
<td></td>
</tr>
</tbody>
</table>

**Contact Information**

- **Don Wickersham**
  - 4215 S. 257 E. Ave.
  - Broken Arrow, OK 74014
  - 918-266-6001
  - donwickersham@aol.com

- **Doug Walton**
  - 1441 W. 46th St. South
  - Muskogee, OK 74401
  - 918-686-6939 / cell 360-2012
  - doug.walton@suddenlink.net

- **Richard Collins**
  - 14 Deerwood
  - Conway, AR 72032
  - 501-372-0333
  - rcollins@conwaycorp.net

- **Kathie Webb**
  - 1403 Glen Oaks Ct. #3
  - Norman, OK 73071
  - 405-206-2729
  - ntvgrdnr@yahoo.com

- **Janet Carson**
  - Univ of Arkansas Ext. Service
  - PO Box 391
  - Little Rock, AR 72203
  - 501-671-2174
  - 501-671-2303 (fax)
  - jcarson@uaex.edu

- **David Hillock**
  - OSU Horticulture & LA
  - 360 Agricultural Hall
  - Stillwater, OK 74078-6027
  - 405-744-5158
  - 405-744-9709 (Fax)
  - david.hillock@okstate.edu

- **Bruce Tencleve**
  - Arkansas Farm Bureau
  - P.O. Box 31
  - Little Rock, AR 72203-0031
  - 501-228-1856
  - tencleve@arf.com

- **Robert DeWitt**
  - P.O. Box 5556
  - Norman, OK 73070
  - 405-364-0908
  - 405-364-0908 (FAX)
  - dewittco@swbell.net

- **Heather Friedrich**
  - Univ of Arkansas
  - 316 PTSC
  - Fayetteville, AR 72701
  - 479-575-2798
  - 479-466-9667 (cell)
  - heatherf@uark.edu
Commodity Area

Vegetable

Arkansas Representative
Craig R. Andersen
Dept. of Horticulture
University of Arkansas
Hinton, OK 72047
316 Plant Science Bldg.
Fayetteville, AR 72701-1201
479-575-2639 or 479-575-8619 (FAX)
crander@uark.edu

Oklahoma Representative
Glen Price
PO Box 508
405-542-3920

Arkansas Tech University
Jim Collins
Arkansas Tech University
Department of Agriculture
Dean Hall 123
Russellville, AR 72801
479-968-0632
479-964-0139 (Fax)
james.collins@mail.atu.edu

University of Arkansas
Teddy Morelock
University of Arkansas
Department of Horticulture
316 Plant Science Building
Fayetteville, AR 72701-1201
479-575-2603
479-575-8619 (FAX)
teddy.morelock@uark.edu

Tulsa Community College
John Kahre
TCC Northeast Campus
3727 E. Apache
Tulsa, OK 74115
918-595-8433
918-595-8412 (Fax)
jkahre@tulsacc.edu

Arkansas State University
Dale Maronek
OSU Horticulture & LA
360 Agricultural Hall
Stillwater, OK 74078-6027
405-744-5415
405-744-9709 (Fax)
dale.maronek@okstate.edu

SUPPORTING PERSONNEL

Dennis Voss
TCC Northeast Campus
3727 E. Apache
Tulsa, OK 74115
918-595-7554
918-625-8159 (Cell)
918-595-8434 (Fax)
dvoss@tulsacc.edu

Lynn Brandenberger
OSU Horticulture & LA
360 Agricultural Hall
Stillwater, OK 74078-6027
405-744-5408
lynn.brandenberger@okstate.edu

Ray Campbell
2616 Shinnery Court
Stillwater, OK 74074
405-377-8948
405-747-0953 cell
raycampbelliddabel@sbcglobal.net

Dan Chapman
1749 State Hwy 818
Clarksville, AR 72830
479-754-2406
479-979-7600 (Cell)
479-754-7529 (Fax)
dichapma@uark.edu

M. Elena Garcia
316 Plant Sci Bldg.
U of A-Horticulture Dept.
Fayetteville, AR 72701
479-575-2790
479-871-0350 cell
megarcia@uark.edu

Sue Gray
Tulsa County Extension Office
4116 E. 15
Tulsa, OK 74112
918-746-3717
sgray@tulsacounty.org

Rogers Co. Ext Office
219 S. Missouri, Rm B 115
Claremore, OK 74017-7863
918-341-2736
918-636-6557 cell
john.haase@okstate.edu

David Hensley
Dept. of Horticulture
University of Arkansas
316 Plant Science Bldg.
Fayetteville, AR 72701-1201
479-575-7319
479-575-8619 (Fax)
dhensley@uark.edu

Berni Kurz, Staff Chair
Washington Co. Extension Office
2536 North McConnell Avenue
Fayetteville, AR 72704
479-444-1755
hkurz@uaex.edu

Dean McCraw
4416 West 44th Street
Stillwater, OK 74074
405-377-7862
mccraw.d@brightok.net

James E. Motes
2819 E. Richmond Rd.
Stillwater, OK 74075-1766
405-372-4634 (Home & Fax)
jememotes@gmail.com

Warren Roberts
WWAREC
P. O. Box 128
Lane, OK 74555
580-889-7343
wroberts@lane-ag.org

Mike Schnelle
OSU Horticulture & LA
360 Agricultural Hall
Stillwater, OK 74078-6027
405-744-5409
mike.schnelle@okstate.edu

Ron Rainey
University of Arkansas
Agr Economics & Agribusiness
P.O. Box 391
Little Rock, AR 72203
501-671-2175
501-671-2297 (Fax)
rrainey@uaex.edu

Eric Stafne
OSU Horticulture & LA
360 AG Hall
Stillwater, OK 74078-6027
405-744-5409
eric.t.stafne@okstate.edu

Al Sutherland
OSU Extension
828 Choctaw
Chickasha, OK 73018-2310
405-224-2216
sutherland-aj@onenet.net

Steve Upson
Noble Foundation
P.O. Box 2180
Ardmore, OK 73401
580-223-5810
sdupson@noble.org
Trade Show Donor

We extend our appreciation to the following exhibitor for their donation to help cover expenses for the HIS reception.

DeWitt Seed Company
Robert DeWitt
PO Box 5556
Norman, OK  73076
405-364-0908

Trade Show Exhibitors

American Plant Products
Delores Whatley
9200 NW 10th
Oklahoma City, OK  73127
405-787-4833
appas@americanplant.com

Arkansas Women in Agriculture
Carrie Hirmer
1323 MC 62
Texarkana, AR 71854
carriehirmer@yahoo.com
www.arkansaswomeninag.com

Cedar Farm – BCS Tractors
Jim Shaw
6336 S. 209 W. Ave.
Sand Springs, OK 74063
TNJSShaw@hotmail.com
www.cedarfarmok.ok

Decade Products
Arlin Plender
24 Cedar Lance
Sand Springs, OK 74063
plendera@DecadeProducts.com
www.DecadeProducts.com
918-865-3001

Department of Horticulture
University of Arkansas
David Hensley, dhensley@uark.edu
316 Plant Science
Fayetteville, AR  72701
479-575-7319
www.uark.edu

Department of Horticulture and Landscape Architecture
Oklahoma State University
Dale Maronek 358 Ag Hall
Stillwater, OK  74078-6027
405-744-5414
www.hortla.okstate.edu

DeWitt Seed Company
Robert DeWitt
PO Box 5556
Norman, OK  73070
405-364-0908
dewittco@swbell.net

Food & Ag Products Center
Erin Early
140 FAPC
Stillwater, OK  74078-6055
405-744-7300
erin.joy.early@okstate.edu
http://fapc.biz/
H.E. Anderson Company
Doug Olinger
2100 Anderson Drive
(PO Box 1006, 74402)
Muskogee. PL 74403
doug@heanderson.com
www.heanderson.com
800-331-9620

Hillside Orchard Farms
Lynn McDaniel
105 Mitcham Circle
Tiger, GA 30576
Lynn@hillsideorchard.com
706-782-4995

Irrigation-Mart
Jackie Robbins
300 South Service Road East
Ruston, LA 71270
318-255-1832
jwdr@irrigation-mart.com
www.irrigation-mart.com

Kerr Center for Sustainable Ag
Maura McDermott
PO Box 588
Poteau, OK 74953
918-231-0328
www.kerrcenter.com

Krohne Plant Farms, Inc.
Bill Krohne
65295 CR 342
Hartford, MI 49057
269-424-5423
www.krohneplantfarms.com
info@krohneplantfarms.com

Lane Ag Center
Box 128
Lane, OK 74555-0128
580-889-7343
www.lane-ag.org/

National Center for Appropriate Technology
Katherine Adam
PO Box 3657
Fayetteville, AR 72702
kadam@ncat.org
www.attra.ncat.org

Oklahoma AgrAbility Project
Amanda Erichsen
211 Agricultural Hall
Stillwater, OK 74078
Amanda.erichsen@okstate.edu
www.agrability.okstate.edu
405-744-2398

Oklahoma Agriculture Mediation Program, Attn: Alan Ware
1514 West Hall of Fame
Stillwater, OK 74078-2026
405-744-3011
alan.ware@okstate.edu
www.mediation.okstate.edu

Oklahoma Department of Agriculture, Food & Forestry
Chris Kirby
2800 N. Lincoln Blvd.
Oklahoma City, OK 73105
405-522-2106
www.oda.state.ok.us

OSU—OKC Horticulture
David Gerken
400 N. Portland Ave.
Oklahoma City, OK 73107
405-945-3358
www.osuokc.edu

Stay Tuff Fence
Denise Demoin
924 S. West Street
Stillwater, OK 74074
denise@staytuff.com
Staytuff.com
Sustainable Green Country/Buy Fresh Buy Local
Rita Scott
16523 E. 171st S.
Bixby, OK 74008
rejuvrita@olp.net
www.BuyFreshBuyLocalOK.com

USDA/NASS/Oklahoma Field Office
Wilbert Hundl Jr.
PO Box 528804
Oklahoma City, OK 73152
Wil_hundl@nass.usda.gov
www.nass.usda.gov
405-522-6190
Friday, January 8—Lunch

**Beef Daube with Mushroom Marinade**  
Sirloin from Blakley Family Farms  
Rae and Lyle Blakley, Oologah, OK

Bell Peppers  
Peach Crest Farm  
Susan Bergen, Stratford, OK

Cabernet Sauvignon  
Tidal School Vineyards, Drumright, OK

**Handmade Egg Noodles and Mushroom Medley**  
Amish Style Homemade Noodles  
The Noodle Shoppe, Inola, OK

Organic Shiitake, Oyster and Maitake  
Mushrooms  
Mushroom Planet  
Sharon & Richard Hewitt, Tulsa, OK

Om Gardens  
Jaclyn & Steve Morton, Norman, OK

**Baked Winter Squash with Molasses Butter**  
Butternut Squash  
Peach Crest Farm  
Susan Bergen, Stratford, OK

**Mixed lettuce Salad**  
Organic Salad Mix and Watermelon Radishes  
Peach Crest Farm  
Susan Bergen, Stratford, OK

**Wheat Rolls**

**Carrot Cake**

Friday, January 8—Reception

**Teriyaki Hotwings**  
Chicken  
Downing Family Farm  
Wes & Kathy Downing, Grove, OK

**Meatballs in Marinara**  
Sirloin  
Blakley Family Farms  
Rae & Lyle Blakley, Oologah, OK

**Sauteed Mushrooms with White Wine and Rosemary**  
Mushrooms  
Mushroom Planet  
Sharon & Richard Hewitt, Tulsa, OK

Om Gardens  
Jaclyn & Steve Morton, Norman, OK

**Rosemary**  
Waltons Farm  
Kim & Doug Walton, Muskogee, OK

**Cheese Tray**  
Christian Cheese  
George & La Wanna Christian, Kingfisher, OK

**Honey Sweet Peanuts**  
Snider Farms  
Jamie & Stephanie Snider, Hollis, OK

**Rice Salad**  
Brown Basmati Rice  
Southern Brown Rice Co., Weiner, AR

**Pickled Turnips**

**Spinach Artichoke Dip**
Saturday, January 9—Lunch

_Baked Grassfed Chicken with Rosemary And Wine Sauce_
- Chicken
- Downing Family Farm
- Wes & Kathy Downing, Grove, OK

- Rosemary
- Waltons Farm
- Kim & Doug Walton, Muskogee, OK

- Chardonnay Wine
- Tidal School Vineyards, Drumright, OK

_Herbed Basmati Rice_
- Brown Basmati Rice
- Southern Brown Rice Co., Weiner, AR

_Roasted Sweet Potatoes with Collards and Pecans_
- Sweet Potatoes
- Sunrise Acres
- Robert & Barbara Stelle, Blanchard, OK

- Collards
- Peach Crest Farm
- Susan Bergen, Stratford, OK

_Julienne Beets and Carrots_
- Beets
- Peach Crest Farm
- Susan Bergen, Stratford, OK

_Spinach Salad with Microgreens_
- Spinach
- Peach Crest Farm
- Susan Bergen, Stratford, OK

- Microgreens
- High Tides and Green Fields
- Dev Vallencourt, Blanchard, OK

_Wheat Rolls_

_Chocolate Cake_
Keynote Speaker

Rick Snyder
Mississippi State University
Crystal Springs, MS

January 8, 2010
Greenhouses are for Environmental Modification
- temperature
- light
- insects, diseases, and weeds
- air pollutants
- water

Why Modify the Environment?
- allow crop production at a time when it would otherwise be impossible.
- example - we raise cold sensitive plants in the winter months in a greenhouse, which we could not do in the field at the same time of year.

Structures for Modifying The Environment
- Greenhouses
- High Tunnels
- Row Covers
- Plastic Mulch

Greenhouse Tomatoes
Higher Quality & Value
- locally grown
- vine ripened
- not breakers or gassed

higher quality ——> higher value

Looks easy? Lot to learn

Cost
Crop Value
Village Farms of Virginia

42 acres under one roof

Eurofresh Farms
Willcox, AZ
318 acres total

Almeria, Spain

Huge, multi-acre range.

Small, family-run business.

Same Concepts.

#1 Grow, then Sell Tomatoes
- Don't even think about growing greenhouse tomatoes unless you have a market to sell them.
- Small grower?
  - Sell locally.
  - Have alternative buyers.

Overview of Locally Based-Greenhouse Tomato Production
#2 Get Educated
- Conferences and Workshops like this one
- Greenhouse Tomato Short Course
- Extension publications
- Books
- Newsletters
- Visit growers
- Internet

#3 Get a Greenhouse
- See vendor list in Greenhouse Tomato Handbook.
- Determine size.
- Site location.
- Sales on site?
- Plan for drainage.
  - 1-2% slope.

#4 Learn The Language
- See the Greenhouse Tomato Growers’ Glossary.
- Learn the terminology.
- Feel free to suggest words to add if you find other terms you don’t know.

#5 Start Small
- 1 or 2 bays
- Not 6
- Not 12
- Not 5 acres

“Well you said start small…”

#6 Who will do all the work?
- Labor – yes there is work to do.
- Average 20 hours per week per bay over the life of the crop.
  - Do it all by yourself?
  - Family labor?
  - Hire part-time labor?
  - Hire full time labor?
  - Be sure labor is available when you need it.

#7 Good Quality Water
- Get your water tested
  - In Mississippi – Mississippi State Chemical Laboratory
  - 1 Gallon in CLEAN jug (not from milk or orange juice!)
    i.e. from bottled water
  - Not all water is created equal
  - Water quality can change over time
    - Especially community water
#8 Temperature Control
- Heaters (64°F min)
- Fans (keep it under 90°F)
- Vents
- HAF
- Shade Materials?
- Pad & Fan system?
- Fogging?

#9 How Many Plants?
- Plant Population
  - 5 square feet per plant
  - Length X width / 5 = number of plants
  - 24 X 96 → 460 plants
- 3 or 4 plants for 2 cubic foot lay-flat bag
- 2 plants per 5 or
- 7 ½ gallon upright bag or
- 5 gallon nursery bucket

#10 Variety
- Choose a good variety.
- Pick a greenhouse variety.
- Look for
  - Good yield & size
  - Red color
  - Excellent disease resistance
  - Free of disorders

#11 Choose a good growing medium
- Pine bark (composted fines)
- Perlite
- Coconut coir
- Rockwool
- Peat-lite mixes
- Soil
- Sand
- Newer Alternatives

#12 Have the right tools of the trade
- Pollinator or bumblebee hive
  - (Class A, B, C)
- pH meter
- EC meter
- High/low thermometer

#13 Design A Good Irrigation System
- Not as simple as it sounds.
- Get help from an irrigation engineer.
- Choose proper emitters.
- Use filters.
- Plan for fertigation.
  - Bulk tank
  - Injector
Overview of Locally Based-Greenhouse Tomato Production

#14 Fertility & Nutrition
- Use a greenhouse hydroponic tomato fertilizer.
- Use correct pH (5.6-5.8).
- Get regular tissue analysis.

#15 Have A Support System*
- Wire Height
  - Average – 7 feet above ground.
  - Higher for the taller grower.
  - Lower for the shorter grower.
- Be sure it has good support.
  - 600 plants can weigh 3 to 4 tons!
  - 3 feet apart in V-formation over row.
  - Tie strings to wire and clip to base of plant.

  *Note: this does not refer to group therapy, but that may be useful as well.

#16 Be prepared for Insects and Diseases.
- They happen.
- Insects do not know if you are organic.
- Prevention works best.
- Greenhouse structure does not prevent insects and diseases from getting in.
- Consider a double door entry.
- Consult with your Pest Management Specialists.

#17 Do Not Use Herbicides In The Greenhouse.
- Do not use Roundup in the greenhouse.
- Do not use Roundup outside the greenhouse when plants are inside the greenhouse.
- Do not use any herbicides in the greenhouse.
- Do not use any herbicides outside the greenhouse when plants are inside the greenhouse.
- Quiz – Which Herbicide is OK to use in GH?

#18 Maintain your equipment
- Heaters
  - Should be ready in advance of need.
- Fans
- Vents
- Emitters
- Injectors
- Pumps

#19 Use a Vented Heater ONLY.
- Heaters must be vented to the outside with a stack.
- Do not use any space heaters in the greenhouse which exhaust into the greenhouse.
- Do not use so-called “100% efficient heaters”.
- Ventless heaters may be ok for chickens, but NOT for tomatoes.
- Ethylene and carbon monoxide in exhaust gas will kill flowers, severely reducing yield.
#20 Worry!
- Check your work.
- Use pH and EC meter to check nutrient solution daily and after mixing.
- Use a gallon jug to check volume per day.
- Walk the greenhouse every day.
  - Look for wilting plants.
  - Look for critters.

#21 Use Diagnostics Resources When Needed.
- Local County Agent or Area Horticulture Agent.
- Extension Vegetable Specialist.
- Digital diagnostics.
- Diagnostics laboratory.
- Email list.
- Friends in the business.

Marketing
- the total of activities involved in the transfer of goods from the producer or seller to the consumer or buyer, including advertising, shipping, storing, and selling
- creating demand for purchase of your product

Know Your Role
- Grower
- Seller
- Marketer
- Promoter
- Industry Representative

Know Your Product – What’s So Good About It?
- Vine ripened
- Good red color
- Great flavor
- Locally grown
- Not breakers or gassed
- Uniform size and shape
- High nutrition value & other health benefits
- Excellent quality

Tomato Nutrition

<table>
<thead>
<tr>
<th>Nutritional Information</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Serving Size: 1 medium sized tomato (140 grams)</td>
<td></td>
</tr>
<tr>
<td>Amount per Serving</td>
<td></td>
</tr>
<tr>
<td>Calories: 15</td>
<td></td>
</tr>
<tr>
<td>Calories from Fat: 0%</td>
<td></td>
</tr>
<tr>
<td>Total Fat: 5 g</td>
<td></td>
</tr>
<tr>
<td>Saturated Fat: 0 g</td>
<td></td>
</tr>
<tr>
<td>Cholesterol: 0 mg</td>
<td></td>
</tr>
<tr>
<td>Sodium: 0 mg</td>
<td></td>
</tr>
<tr>
<td>Total Carbohydrate: 7 g</td>
<td></td>
</tr>
<tr>
<td>Dietary Fiber: 1 g</td>
<td></td>
</tr>
<tr>
<td>Protein: 1 g</td>
<td></td>
</tr>
<tr>
<td>Vitamin A: 20%</td>
<td></td>
</tr>
<tr>
<td>Vitamin C: 40%</td>
<td></td>
</tr>
<tr>
<td>Calcium: 2%</td>
<td></td>
</tr>
<tr>
<td>Iron: 2%</td>
<td></td>
</tr>
</tbody>
</table>

* Percent Daily Values are based on a 2,000 calorie diet.
Tell People How Good Tomatoes Are For You

- vitamin C/100 grams 19 mg
- vitamin C/average slice 23 mg
- Recommended RDA 60 mg/day
- No saturated fat
- No cholesterol
- Lycopene – fight cancer

Benefits of Lycopene

- Lycopene have been shown to lower the risk of prostate cancer; powerful antioxidant
  - 28% reduction of early stage
  - 35% reduction advanced stage
- Cooked tomatoes better
- Tomato sauce – 2 servings per week
- Also tomatoes, pizza, tomato juice, tomato-based condiments, watermelon, pink grapefruit

Sources of Lycopene

Sell Quality

- Grade your fruit well.
- Do not sell cull or #2 and #1 fruit to same buyer.
- Build your reputation for high quality.
- Keep your customers happy.
- Aim for repeat business!
- Develop a brand name customers associate with high quality.
- Logo

Know When to Harvest

- Red - same day retail
- Light red - retail and close wholesale
- Pink - wholesale close and mid range
- Turning - wholesale long range
- Breaker - never
- Green - NEVER EVER
  - Well, maybe for fried green tomatoes.

Develop A Brand

- Catchy business name
- Use the brand
  - stickers on fruit
  - boxes
  - signs
- Communicate a message
Brand Loyalty
- Quality counts
- Consistency
- Company name / logo
- Labeling
- Make your product stand out

Communication
- Pesticide Free
  - insecticide free
  - herbicide free?
- Organic
- Food Safety
- Nutritive Value
- Excellent Flavor
- Vine Ripened (red!)
- High Quality

Point Of Sale Materials
- Recipes
- Nutrition guides
- Signs
- Show them your logo

Public Relations - Paid
- Paid advertising
  - newspaper
  - radio
  - television
- Evaluate the costs

Public Relations – Free
- Free promotion
  - Newspaper
  - Radio
  - Magazines
  - News “stories”
- Need a unique angle

Promotion
- Make up a “spec sheet” for reporters
- List the basics of your operation
- Makes it easier for them to do a story
- Keeps things accurate!
Public Relations – Web site
- Create a Web site
- Easier than you think
- Easy to find help

Marketing
- For the smaller grower --
  - Sell locally
  - Avoid competition with the big guys

Self Serve Sales

Use Stickers for Promotion
Cost per sticker
- For round 3/4 inch label
  - 3000 stickers per roll
  - $7.15 per roll for 10 rolls
  - $50 one time plate charge
  - 0.18 cents per sticker (i.e. 5 for a penny; includes plate charge)
**PLU Numbers - Tomatoes**

For Greenhouse / Hydroponic:
- 4798 Small (6X6 or smaller)
- 4799 Large (5X6 or larger)

Greenhouse or Other
- 4664 Cluster (TOV)
- 4796 Cherry

---

**Publication Resources**

- **Greenhouse Tomato Handbook**
- **Greenhouse Tomato Growers' Glossary**
- **Environmental Control for Greenhouse Tomatoes**
- **Greenhouse Tomatoes - Pest Management in Mississippi**
- **Budget For Greenhouse Tomatoes**
- **A Spreadsheet Approach to Fertilization Management for Greenhouse Tomatoes**

*All are on the web site.*

---

**Internet Resources**

- **Greenhouse Tomato FAQ:**
  [www.msucares.com/crops/comhort/greenhouse.html](http://www.msucares.com/crops/comhort/greenhouse.html)
- **Greenhouse Tomato Short Course:**
  [www.greenhousetomatosc.com](http://www.greenhousetomatosc.com)

---

**Is the Market Saturated?**

- North America has about 75% of population of Europe
- Greenhouse industry in North America is less than 2% of that in Europe
- Plus in the U.S. we have
  - more sunlight
  - lower energy costs
  - lower labor costs
  - cheaper land costs

---

**Overview of Locally Based-Greenhouse Tomato Production**

Dr. Richard G. Snyder
Christmas Tree Sessions
Introduction:
In December, 2009 a total of 28 survey questionnaires were mailed to Oklahoma Christmas tree growers. Of the surveys mailed, 18 were returned by growers. Two growers indicated that they sold no trees in 2009. Ten growers did not respond in time for inclusion in this report, could not be contacted, or declined to be interviewed.

Oklahoma-Grown Tree Sales

Table 1 provides a summary of survey results from 1989 through 2009 for trees grown in Oklahoma.

<table>
<thead>
<tr>
<th>Year</th>
<th>Number of Growers</th>
<th>Total Trees Sold (Oklahoma Grown)</th>
<th>Trees Sold per Grower Total (CC trees)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1989</td>
<td>NA</td>
<td>8,769</td>
<td>NA</td>
</tr>
<tr>
<td>1990</td>
<td>42</td>
<td>11,527</td>
<td>274 (197)</td>
</tr>
<tr>
<td>1991</td>
<td>48</td>
<td>11,989</td>
<td>250 (186)</td>
</tr>
<tr>
<td>1992</td>
<td>54</td>
<td>14,145</td>
<td>262 (185)</td>
</tr>
<tr>
<td>1993</td>
<td>55</td>
<td>18,002</td>
<td>327 (230)</td>
</tr>
<tr>
<td>1994</td>
<td>63</td>
<td>20,102</td>
<td>319 (223)</td>
</tr>
<tr>
<td>1995</td>
<td>64</td>
<td>21,071</td>
<td>329 (234)</td>
</tr>
<tr>
<td>1996</td>
<td>59</td>
<td>20,795</td>
<td>352 (248)</td>
</tr>
<tr>
<td>1997</td>
<td>55</td>
<td>18,982</td>
<td>344 (224)</td>
</tr>
<tr>
<td>1998</td>
<td>34</td>
<td>13,131</td>
<td>386 (237)</td>
</tr>
<tr>
<td>1999</td>
<td>41</td>
<td>14,564</td>
<td>355 (242)</td>
</tr>
<tr>
<td>2000</td>
<td>44*</td>
<td>15,699</td>
<td>356 (226)</td>
</tr>
<tr>
<td>2001</td>
<td>28*</td>
<td>7,590**</td>
<td>NA (271)</td>
</tr>
<tr>
<td>2002</td>
<td>35*</td>
<td>8,591</td>
<td>245 (251)</td>
</tr>
<tr>
<td>2004</td>
<td>25*</td>
<td>8,496</td>
<td>340 (319)</td>
</tr>
<tr>
<td>2005</td>
<td>19*</td>
<td>6,863</td>
<td>361 (347)</td>
</tr>
<tr>
<td>2006</td>
<td>18*</td>
<td>7,543</td>
<td>419 (402)</td>
</tr>
<tr>
<td>2007</td>
<td>19*</td>
<td>6,714</td>
<td>353 (342)</td>
</tr>
<tr>
<td>2008</td>
<td>20*</td>
<td>8,680</td>
<td>434 (417)</td>
</tr>
<tr>
<td>2009</td>
<td>16*</td>
<td>7,988</td>
<td>499 (480)</td>
</tr>
</tbody>
</table>

Notes for Table 1. * Does not include growers who responded, but had no sales, who did not market trees, or who did not report exact figures. ** Choose-and-cut (CC) only - other years are all methods for Oklahoma-grown trees.
In 2009, reported sales for Oklahoma-grown trees were approximately 8 percent lower than in 2008. Conversely, total sales including cut-tree imports showed an increase over 2008 (13,168 vs. 12,154).

**Sales Methods**

The primary sales method for Oklahoma-grown trees is choose-and-cut (Table 2). Virginia pine continues to be the dominant choose-and-cut species offered by Oklahoma growers, comprising approximately 88 percent of the trees sold. Scots pine held about 6 percent of the choose-and-cut market. Other species included Leyland cypress and a few Austrian pine and eastern white pine.

**Table 2. Oklahoma-grown harvested tree sales by sales method 1989 – 2009*.**

<table>
<thead>
<tr>
<th>Year</th>
<th>Choose-and-Cut</th>
<th>Wholesale</th>
<th>Retail</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1989</td>
<td>6,662</td>
<td>1,625</td>
<td>482</td>
<td>8,769</td>
</tr>
<tr>
<td>1990</td>
<td>8,111</td>
<td>2,641</td>
<td>775</td>
<td>11,527</td>
</tr>
<tr>
<td>1991</td>
<td>8,762</td>
<td>1,969</td>
<td>1,228</td>
<td>11,989</td>
</tr>
<tr>
<td>1992</td>
<td>9,852</td>
<td>3,294</td>
<td>999</td>
<td>14,145</td>
</tr>
<tr>
<td>1993</td>
<td>12,459</td>
<td>4,586</td>
<td>957</td>
<td>18,002</td>
</tr>
<tr>
<td>1994</td>
<td>13,848</td>
<td>5,460</td>
<td>796</td>
<td>20,104</td>
</tr>
<tr>
<td>1995</td>
<td>14,766</td>
<td>4,893</td>
<td>1,432</td>
<td>21,071</td>
</tr>
<tr>
<td>1996</td>
<td>14,394</td>
<td>4,270</td>
<td>2,131</td>
<td>20,795</td>
</tr>
<tr>
<td>1997</td>
<td>12,103</td>
<td>5,483</td>
<td>1,342</td>
<td>18,928</td>
</tr>
<tr>
<td>1998*</td>
<td>7,833</td>
<td>3,383</td>
<td>193</td>
<td>11,409</td>
</tr>
<tr>
<td>1999*</td>
<td>9,697</td>
<td>3,080</td>
<td>521</td>
<td>13,298</td>
</tr>
<tr>
<td>2000*</td>
<td>9,736</td>
<td>4,931</td>
<td>None**</td>
<td>14,667</td>
</tr>
<tr>
<td>2001*</td>
<td>7,590</td>
<td>Not available</td>
<td>None**</td>
<td>7,590</td>
</tr>
<tr>
<td>2002*</td>
<td>7,448</td>
<td>426</td>
<td>265</td>
<td>8,139</td>
</tr>
<tr>
<td>2004*</td>
<td>7,969</td>
<td>120</td>
<td>None**</td>
<td>8,089</td>
</tr>
<tr>
<td>2005*</td>
<td>6,468</td>
<td>123</td>
<td>None**</td>
<td>6,591</td>
</tr>
<tr>
<td>2006*</td>
<td>7,228</td>
<td>Not available</td>
<td>None**</td>
<td>7,228</td>
</tr>
<tr>
<td>2007*</td>
<td>6,500</td>
<td>Not available</td>
<td>None**</td>
<td>6,500</td>
</tr>
<tr>
<td>2008*</td>
<td>8,336</td>
<td>None</td>
<td>None**</td>
<td>8,336</td>
</tr>
<tr>
<td>2009*</td>
<td>7,688</td>
<td>None</td>
<td>None**</td>
<td>7,688</td>
</tr>
</tbody>
</table>

* Only cut trees, live trees not included.

** Does not include retail sales of imported trees at growers’ farms.

**Live Tree Sales**

Live trees decreased as a percentage of total tree sales (Table 3) in 2009 continuing a general trend over the past several years. Major live trees species were Austrian pine, Scots pine, white pine, Leyland cypress, and spruces.
Table 3. Live trees sold from 1990 – 2009.

<table>
<thead>
<tr>
<th>Year</th>
<th>Live Trees Sold</th>
<th>Percent of Total Sales</th>
</tr>
</thead>
<tbody>
<tr>
<td>1990</td>
<td>1,177</td>
<td>10.2</td>
</tr>
<tr>
<td>1991</td>
<td>2,030</td>
<td>16.9</td>
</tr>
<tr>
<td>1992</td>
<td>1,825</td>
<td>12.9</td>
</tr>
<tr>
<td>1993</td>
<td>2,810</td>
<td>15.6</td>
</tr>
<tr>
<td>1994</td>
<td>2,247</td>
<td>11.2</td>
</tr>
<tr>
<td>1995</td>
<td>1,251</td>
<td>13.2</td>
</tr>
<tr>
<td>1996</td>
<td>4,038</td>
<td>19.4</td>
</tr>
<tr>
<td>1997</td>
<td>3,001</td>
<td>15.9</td>
</tr>
<tr>
<td>1998</td>
<td>1,722</td>
<td>13.1</td>
</tr>
<tr>
<td>1999</td>
<td>1,266</td>
<td>8.7</td>
</tr>
<tr>
<td>2000</td>
<td>1,184</td>
<td>7.6</td>
</tr>
<tr>
<td>2001</td>
<td>541</td>
<td>NA</td>
</tr>
<tr>
<td>2002</td>
<td>456</td>
<td>NA</td>
</tr>
<tr>
<td>2004</td>
<td>407</td>
<td>3.5</td>
</tr>
<tr>
<td>2005</td>
<td>272</td>
<td>2.7</td>
</tr>
<tr>
<td>2006</td>
<td>227</td>
<td>2.1</td>
</tr>
<tr>
<td>2007</td>
<td>139</td>
<td>1.5</td>
</tr>
<tr>
<td>2008</td>
<td>334</td>
<td>2.8</td>
</tr>
<tr>
<td>2009</td>
<td>300</td>
<td>2.2</td>
</tr>
</tbody>
</table>

Sales of Imported Trees

Approximately 56 percent of growers sold pre-cut, imported trees from other states. Imported tree sales of 5,180 in 2009 equated to 40 percent of total tree sales for the state. Imported tree sales were almost 10 percentage points above the 2008 results. True firs comprised over 85 percent of imported sales. Noble fir and Fraser fir were the most popular imported tree species (34 percent each). Grand fir, Douglas-fir and Nordmann fir made up the remaining sales.

Sales of Christmas-Related Products

Ninety-four percent of the growers reported sales of wreaths, memorial blankets and other greenery products, both from Oklahoma-grown and imported materials. Estimated total for sales of these products exceeded $65,000. About 30 percent of greenery products were Oklahoma-grown. Over 90 percent of survey respondents reported sales of other holiday items such as ornaments, toys and tree stands. Total sales of non-greenery items were reported at $41,051. Almost half of the growers reported producing non-Christmas tree crops such as you-pick berries, pumpkins and hay.
Tree Prices

Tree prices reported in 2009 appeared to be about the same as those reported in 2008. The majority of growers who price by the foot for choose-and-cut trees charged $6 to $7 per foot. Those who sell on a per-tree basis generally charged from $40 to $60. Virginia pine choose-and-cut trees tended to occupy the lower end of the price range, with Austrian and Scots pines usually selling for higher prices.

Imported, pre-cut trees generally sold from $40 to $80 per tree, or from $6 to $11 per foot. Live trees generally sold from $60 to $90 per tree.

Discussion

Growers responding to the survey indicated that fewer production difficulties were encountered in 2009 as opposed to 2008. Growers reported losses due to drought, deer, and insect/disease damage. Residual damage from the 2007 ice storm was also listed as a cause for fewer marketable large trees. Growers quantified 2009 losses as approximately $4,500.

Overall, growers reported having a good sales year, due in large part to good weather during the selling season. Some farms closed briefly for bad weather, but those closings were on weekdays when sales are often less than on weekends.

Acknowledgements

Results from 1989-1997 were compiled by Dr. Steven Anderson, Extension Forestry Specialist, and Champe Greene, Renewable Resources Extension Specialist. Bill Ross, Extension Forestry Specialist and Clark Perry, Senior Secretary at OSU Extension Forestry and Wildlife, collected data and prepared the report in 1998 thru 2002. No data was collected in 2003.

Thanks to the Oklahoma Christmas Tree Association and all growers who took part in this survey.
As we move into the year 2010, most individuals are painfully aware of the recent downturn in the nation’s economy. In one way or another, we have all been affected by the overall economic slide. However, a quick scan of the more significant economic indicators suggests that some improvement may be occurring. For example, in the most recent reporting period, retail sales are showing movement in a positive direction, unemployment rate is decreasing, and the stock market is slowly recovering from last year’s lows. We certainly have not fully recovered from the downturn, but these indicators do offer reason to approach the future in a positive mode.

While the improvement in broad scale economic indicators is encouraging, the sale of Christmas trees nationwide has not yet approached the recent high of about 33 million trees in 2005. The positive news from 2008 (the latest national data available) is that more trees than ever are being purchased from choose-and-cut farms. About 30 percent of all real trees were purchased from these farms in 2008, up from about 20 percent in 2005.

So, how do we maintain or increase our Christmas tree sales given today’s economic environment? As a start, we can address the issue by 1) thinking like a customer, 2) utilizing aggressive sales promotions, and 3) adding value at the farm.

Thinking Like a Customer

We are all customers of a number of goods and services. To know how Christmas tree customers think is to look at ourselves and note how we think. For example, is price always the overriding factor, how about service, distance from home, or even ease of parking? These factors and others impact our purchasing decisions. In a general sense, our decision as to what and when to make a purchase revolves around meeting some personal need, be it a necessity or for personal satisfaction.

Maslow (1954) placed human needs into a formalized ‘hierarchy’ that expresses how individuals respond to their environments. At the lower level of the hierarchy are physiological needs such as food, sleep, stimulation, activity, etc. Christmas tree customers have such needs and, to a degree, growers can address these items by providing snacks, water, etc. Even just the customers’ perception that growers can provide physiological benefits leads to more enjoyable experiences.

The second level of Maslow’s hierarchy involves security and freedom from harm. Do customers at your farm feel safe, can they park their car without fear of damage, are there holes in the field that can cause injury that are not marked, and how about attractive nuisances (ponds, tractors, mowers, etc) on which someone can be injured?
Again, well-lit, clean parking areas, signs of potential danger, etc. give the perception that these needs are being considered by the grower.

Humans need to have a sense of belonging. This sense of belonging is generally accomplished through friendships, comradeships, and being with others of similar interests. The Christmas tree farm is an ideal place to foster this feeling. As a grower you can also add to this atmosphere by showing appreciation to the customer as a person who has similar interests to yours. You are all interested in Christmas trees, right?

One of Maslow’s higher needs is that of self esteem. Everyone wishes to have self respect that comes from the feeling of personal worth and right of autonomy in our actions. Customers at the tree farm can feel that they are ‘in charge’ of their lives, by examining, selecting, and cutting (if they desire) their own tree. Nothing destroys a Christmas tree outing more than having someone tell you which tree to cut!

At the top of Maslow’s hierarchy is the concept of reaching one’s full potential. As the customer drives away, that individual needs to believe that he/she has had an enjoyable time at the farm, picked just the right tree - at just the right price, and was treated with the best service possible. What more could anyone ask?

Sales Promotions

There are a number of sales promotion methods that can be applied to Christmas trees. These methods include, but are not limited to; 1) Price promotions. Special prices can be placed on specific items that draw the customer's attention, 2) Coupons. Those customers returning from last year receive a coupon for a discounted purchase, or perhaps coupons can be made available through local merchants to attract new customers, 3) Gifts provided with purchases. If gifts are to be provided, they should be advertised in order to effectively attract customers to the farm, and 4) Point-of-sale displays. Studies have shown that these displays may increase sales as much as two to three times more than when the items are in regular locations.

Point-of-sale displays are those product displays that are near the physical location where goods are sold, such as the cash register, gift shop, etc. These displays should be something that gets the customer’s attention, while not being too cluttered. Point-of-sale displays generally fall into one of the following categories; 1) floor displays, commonly called dumps. Dumps are most effective when placed at the front of the store, such that customers view the display immediately upon entering, 2) counter displays are usually placed very near the selling area and consist of low-priced items for impulse buying, and 3) smaller displays, called shelf talkers, can be placed on shelves alongside of the items. To be most effective, these displays should not be too large and use a short, brief text.

Adding Value at the Farm
The concept of adding value is focused on the promotion and enhancement of the on-farm experience. Pre-season farm tours, hay rides, petting zoos, and having crafts for sale are but a few of the ways to enhance the customers' visits. In addition, the grower should consider offering other or unique products and services to make the visitor's experience more complete.

Summary

The current economic environment raises concern as to the feasibility of growing Christmas trees as a business. However, Christmas is a tradition that has the strongest tradition of any of our holidays. Likewise, economic conditions appear to be improving, leading to an increased customer willingness to make discretionary purchases, which include real trees.

To maximize marketing efforts, growers should thoroughly analyze customer needs, as well as consider creative methods to promote products and services offered. These efforts, when applied in concert with other production and marketing activities, can greatly enhance the customers' visits to the farm, and hopefully increase sales over years.

Reference

VIRGINIA PINE:
The Virginia Pine continues to be the biggest seller in our fields by a margin of three to one. This tree, which has its natural stands in Middle Eastern America, is by nature a timber tree that will grow aggressively against the shear. It will grow in most soils with or without ground breaking, but, as with most pine trees, does not like to have continuous wet feet. As a one-year seedling from the bed, it will transplant well with the dibble bar or a small augured hole. We are able to rotate this tree in our fields every three to four years from one-year seedlings in the bed to one-gallon containers, or planted in a controlled area for one growing season and then planted in early fall or late winter. This process will vary from farm to farm depending on the soil and culturing practices. The Virginia Pine seed source is very important, especially when early fall freezes are experienced prior to the new growth hardening off. The trees that are acclimated to colder weather, such as the ones from our state tree nursery, tend to be better selections over the coastal or southern-grown seedlings.

Before the end of the selling season, the stumps are removed from our fields to allow a few months of ground settlement prior to planting back where the previous tree was grown. This is also beneficial for our irrigation layout, which allows us to interplant in the fields without making adjustments to our Toro irrigation system.

If the transplanted seedlings are rapidly growing at shearing time, they are lightly sheared at the first spring shearing in our fields and then aggressively sheared at the second shearing of their first year in the field. We continue to maintain bamboo stakes on the trees for at least two years. Even then it is impossible for all the trunks to be straight, as the Virginia pine seems to have a mind of its own and will grow against all your efforts to culture a quality tree. Eight-inch leaders are maintained between whorls, and considerable top staking and interior pruning are done in our efforts to grow a quality tree. Each tree on our farm is visited with hand pruners twice a year prior to shearing. Even though the Virginia Pine presents many challenges to the grower, it can be a stunning Christmas tree and is well worth the effort when sold for six to nine dollars a foot.

As soon as the seedlings are received from the nursery, we immediately cull them. The genetics of a Virginia Pine tree are recognizable at this stage, and culling is easy. We strive to select only the seedlings that have set good four- or five- branch whorls, with nice straight and preferably large diameter trunks. If we have a shortage of seedlings held over from the previous growing season, we will plant only the largest and best received from the nursery and either containerize or line out the remainder in a controlled area for fall planting.

The Nantucket Pine-tip moths are the biggest predator problem encountered and must be monitored closely during the growing season. If allowed to go uncontrolled, this little
monster can cause havoc in your fields. Another big problem can be needle cast and scale, which we have been able to keep at minimum by coloring all our trees at selling time. The pigment seals the trees and helps them to deter the airborne fungus and scale. Also, prior to removing stumps, we thoroughly clean and remove all the needles left by the previous tree occupying the spot. I believe that removing the stump and needles provides a much cleaner and disease-free location for the next tree to grow.

In my early days of growing Christmas trees, fertilizer tablets were placed under each seedling and some above-ground fertilization was performed. Because the above-ground fertilization caused more grass and weed problems, we have stopped using both methods and now rely on the green manure that is created from the tree shearings. This seems to work just as well, does not generate increased weed growth, and produces a soil condition that is conducive for tree growth.

At harvest time the Virginia Pine normally has considerable needle build up under the tree, which in some cases will cover several inches of the trunk. At Sorghum Mill, we encourage our customers to clean this area well prior to harvesting the tree; it gives them more tree and a better handle for placing presents. Before sending home with the customer, the Virginia Pine can be quite difficult to clean and can require considerable time on the shaker and a little hand work. Although the Virginia Pine is a very soft-needle tree, the interior branches can be quite prickly. Therefore, it is recommended to wear gloves when going into the interior of the tree. The Virginia Pine also bales nicely and is easy to cut. All in all, it is a remarkable tree, and I plan to continue growing it for the remainder of my tree career.

SCOTCH PINE:
The Scotch Pine is our number two seller in the field. The culturing process for this tree is much the same as with the Virginia Pine; however, the leaders are stretched to 10 inches. In the past we purchased our seedling from the state tree nursery but now obtain them in the fall from out-of-state nurseries in one-gallon rooted containers. Although most varieties will grow well in our area, my preferences are the Spanish, French Blue, and Belgian Scotch. At our farm, it takes five to seven years to produce the Scotch Pines into choose and cut and live trees for sale.

The Scotch Pine is fairly easy to culture but does present problems maintaining a good leader. It can require considerable thinning of branches in each whorl in order to maintain balance in the tree. Normally we start shearing the Scotch Pine after its second year in the field. Prior to that, we stake and do a little hand work with pruners. The Scotch Pine flushes only once per year; therefore, it requires a later shearing than the Virginia Pine.

Although the Scotch Pine can be quite stunning as a Christmas tree, its needles are more course, making it less desirable for many. It is also more difficult to clean and a little harder to bale than its rival the Virginia Pine. This tree has exceptional tolerance to cold weather.
The Nantucket pine-tip moth prefers other species but will attack the Scotch Pine, especially during times of heavy flights. Coloring does seem to help with control of fungus and scale. While I like to grow the Scotch Pine, a faster rotation is necessary for our area. Therefore, we are planting less each year.

LEYLAND CYPRESS:
Taking over the number three spot on our farm is the hybrid Leyland Cypress, which is a cross between the Alaskan Cedar and the Monterey Cypress. Although this tree has been around for a long time, we only started growing it a few years ago on our farm. Because the Leyland produces no seed or pollen, it is a popular tree for families with allergies. While my first experiences with this tree were not good, I have learned a lot from those failures.

The Leyland Cypress is a very fast-growing tree, if not exposed to extreme cold. Our seedlings are purchased from out-of-state nurseries in one-gallon rooted containers, and we never plant them until all the harsh weather has ended (spring and fall).

Culturing this tree is not difficult. Other than the basal pruning prior to planting, it requires very little hand pruning. It is important to note that basal pruning must be accomplished in the early stages to produce an acceptable tree for the customer. We also stake this tree at the time it is planted. Leyland’s are easy to shake, clean, and bale. We start shearing the Leyland Cypress in the fall of the first year in the field, and then twice a year thereafter, performing the last shearing a little later than the other varieties. Even though we color this tree at the same time as the other species, it could be sold uncolored just as well. The Leyland Cypress is the fastest growing tree on our farm, allowing for three- to four-year rotations.

I am not aware of any predators which might interfere with the growth of the Leyland Cypress. It does, however, have a host of fungus problems and will freeze quickly in cold north winds, especially when planted in low areas. The only location on my farm where I can successfully grow this tree is on the upper hillsides.

I like the Leyland Cypress and will continue growing it, even though we are a little too far north for it. From my experience, I have found that the Murray-X Cypress is better adapted to our colder weather than the Leyland Cypress.

AUSTRIAN PINE:
Austrian Pine is now in forth place on our farm. It is a majestic tree that requires a lot of spraying for the prevention of needle cast. Although the Austrian Pine is slow growing, flushes only once per year, has prickly-needles and stiff branches, it is sought after by customers, with most preferring the sheared over the non-sheared.

Our seedlings are purchased from out-of-state nurseries in one- or two-gallon rooted containers. It is convenient to ship them in with our cut Christmas trees when space allows.
Normally we place the containers on a pad with mulch around them and plant in late February. Most nurseries will stake these liners prior to shipping. To create a straight trunk, we leave the nurseries’ stake and add a taller stake at planting and maintain it for a couple of years. Shearing is done with a knife in the third year, with a little hand pruning accomplished up to that age. Basal pruning at an early age is very important on this tree. After the first shearing, which sets a skeleton, most of the pruning is accomplished with hand pruners until the tree is rotated out as a cut or landscape tree.

The Austrian Pine will experience very little predator damage during its growth; however, its susceptibility to needle cast and vulnerability to nematodes are the growers’ greatest challenges. A good spraying program must be implemented to successfully grow a sellable tree. The Austrian Pine seems to set a balanced whorl if you maintain 10 to 12 inch leaders with four- or five-branch whorls. The biggest problem I encounter in working with this tree is the large amount of sap secretion as you make your cuts. Rotation of the Austrian Pine on our farm is six to eight years.

Although this tree has a bad reputation in the landscaping industry because of its needle cast problems it can be cultured into a very impressive Christmas tree. I am planting fewer every year in favor of the faster growing varieties.

LOBLOLLY PINE:
The Loblolly Pine is now our number one landscape tree, and, at one time, held the number two spot as a choose and cut. However, its inability to hold up in the stand without severe needle drop is a big problem. No doubt this long, soft-needled tree can be cultured into a gorgeous Christmas tree. It will also tolerate wet feet better than any other pine species.

We purchase our seedling from out-of-state nurseries either as bare root (which we plant into one-gallon containers and grow for one season prior to planting in the field) or as three-gallon six to eight foot transplants (which we plant into the field and stake for one year with a good fiberglass stake). The Loblolly Pine has rapid growth and requires continual pruning of the leader to approximately 10 to 12 inches. We normally shear this tree twice a year, except the year of harvest when it is sheared only once in late July.

An ineffective spray program will allow pine-tip moth and needle cast damage; however, I am unaware of any nematode problems with this species. The Loblolly Pine is grown to 25 feet for some of our big-tree customers. In selling, however, we stress its short stand life and encourage harvesting closer to the holiday. We will continue to grow the Loblolly Pine for landscape sales but grow fewer for Christmas trees.

BLUE ICE AND CAROLINA SAPPHIRE:
The newest Christmas and landscape tree on our farm is the Blue Ice and Carolina Sapphire, with the Blue Ice being our choice for cultivation.

While these species are not your traditional Christmas tree, they show real promise as our customers continue to bring them out of the field. Personally I’m not fond of the
fragrance of these trees or the sticky sap they produce; however, I have been told by customers they are good trees and some actually comment on the good smell.

These two species are both hybrids that grow well in poor arid soils, require very little irrigation, and are tolerant to cold weather. We have not experienced any fungus or predator problems with this tree.

We purchase the Blue Ice and Carolina Sapphire as plugs from an out-of-state nursery in the spring, pot into one-gallon containers, grow them until fall, and then plant in our fields. They provide a nice contrast to the green trees and make any field brighten up.

We culture and protect these trees much the same way as the Leyland Cypress. They are very fast growing trees, with rotation about the same as the Leyland Cypress. We only planted a few hundred in the beginning to test customer acceptance, but, now that we are certain of the trees, we are planting several hundred each year and look forward to them playing a much bigger role on our farm.

**EASTERN WHITE PINE:**
Because it is well adapted to our area and transplants very well, I started growing the Eastern White Pine many years ago for live tree sales. Although we tried a few cut trees, it is about like the Loblolly Pine in its inability to hold up in the stand for extended periods. Therefore we only sell them as cut trees upon customers' requests and try to discourage it.

The Eastern White Pine is easy to grow but requires irrigation in the early years while a good root structure is being established. I have not experienced any problems with fungus or predators in the White Pine but occasionally have had a slight scale problem. We culture the leader to 10 inches with four to five branches on each whorl. It does require considerable thinning of crossover and turned-back branches. Shearing is done at the same time as the Virginia Pine; however, we normally just do light hand pruning on the second shearing. Rotation for this tree is four to six years.

Of the live trees we sell for Christmas trees, the Eastern White Pine is by far the most sought-after.

**NORWAY SPRUCE AND COLORADO BLUE SPRUCE:**
Norway Spruce and Colorado Blue Spruce are very slow growers and require considerable care. We grow these for landscape and living Christmas trees, with very few making it to the cutting stage. Culturing either of these trees is relatively simple requiring very little, if any hand work. It seems they just grow like a Christmas tree. The only problem is it can take 6 to 10 years for a sellable product.

Most of the predators and fungus to which these trees are susceptible are easily controlled with a good spray program. Monitoring for and providing corrective spraying for red spiders are very important in the cultivation of spruce trees.
Seedlings are purchased from out-of-state nurseries in either one- or three-gallon containers and transplanted in February. We do not stake in the beginning, and, after the second year, light hand pruning is done once a year after the tree flushes in the spring.

In my opinion it is not profitable to grow the Norway Spruce and Colorado Blue Spruce, as they can be purchased out of state at reasonable prices. They are very difficult to grow here, and I do so only because I like a challenge, and, believe me, they are that.
Farmers’ Markets/Sustainable Agriculture Sessions
Federal Food Safety Policy: Impacts on Local Hort Producers

Garrett King
Rep Frank D. Lucas support staff, OK U.S. House District 3

Congressman Lucas is of the strong opinion that America has the safest food supply on earth. He also believes that we must continually examine our food production and regulatory system and look for ways to improve food safety. So it was that he was disappointed in the flawed process that produced H.R. 2749. Congressman Lucas stood ready and willing to work on this important legislation—an opportunity he and many other members were denied by the congressional leadership who did not permit the House Agriculture Committee to conduct hearings on the measure’s provisions and to make improvements. This flawed process was a stunning failure on the part of the congressional leadership to fulfill basic legislative responsibility.

Food safety reform is a relatively complex, controversial matter competing for attention with an ever-growing list of other domestic priorities. On the other hand, though, there has been a growing consensus that changes are needed. Congressman Lucas believes that we have the safest food supply in the world. And he knows that anyone following current events is aware that our food production system faces ongoing food safety challenges. Congressman Lucas stands ready to work with his colleagues to address those challenges in a thoughtful, transparent way, which is the only manner worthy of America’s producing public.

Congressman Lucas greatly appreciates the work of our nation’s horticulturalists—the tree, turf, and shrub farmers, the flower and landscape plant growers, and of course the vegetable and fruit producers who comprise an important and ever-expanding component of our national production. Congressman Lucas is keenly aware of the vital role horticulturalists can and will play in the challenges facing us as the Twenty-First Century unfolds. How will we meet the food and resource demands of an increasing global population? How can we best ensure environmentally-conscious economic development while avoiding the dangers of regulatory overreach and innovation-stifling mandates? The urgently needed best practices, sustainable production methods, and innovative marketing strategies that will help move American production forward will undoubtedly draw greatly on the horticulture industries. Of course, future challenges and opportunities will also be shaped in part by the way horticulturalists face industry issues in the present. Congressman Lucas believes that one such major issue today is that of food safety policy—it is his hope that you will work with him to improve the system and benefit producers from all walks of life and enterprise.
New Programs to Improve Access to Farmers Markets

Jerry Davidson
SNAP-ECC Program Manager
Electronic Payment Services Unit
Finance Division, Oklahoma Department of Human Services.

What is EBT?

SNAP, CHILD CARE, Debit Cards (TANF, Child Support, AABD, Adoption Subsidy)

Issuances of over $850,000,000.00 per year handled are by the Electronic Payment Services Unit.

EBT in Oklahoma

SNAP (formerly food stamps)

October 1997—Food Stamp pilot began in Oklahoma County.

Jan-March 1998—Food Stamp EBT was rolled out state wide.

Currently---2,878-participating retailers.

$75,000,000.00 issued per month.

Farmers Market Program

February 2009—Planning began for SNAP and SFMNP.

July 2009-First SNAP Transaction was completed.

August 2009-First SFMNP Transaction was completed.

OKLAHOMA was the First State in the Nation to implement SFMNP via EBT.

439-Seniors participated in the six week application process

Three Markets Participated (Ardmore, Muskogee and Tahlequah.)

Eleven (11) weeks of activity

Total Transactions---603

Total value of transactions----$12,086.00
An Introduction to Accepting Federal Food Benefits at Farmers’ Markets in Oklahoma

The Supplemental Nutritional Assistance Program (SNAP), formerly called the federal Food Stamp Program, provides over 400,000 low-income Oklahomans with financial assistance each month to help buy the food they need for good health. As of November 2009 the number of households receiving SNAP assistance was 243,588 with a total of 563,360 persons. SNAP recipients receive electronic benefits for purchasing fruits, vegetable, breads, grains, meat, fish, poultry, dairy products, seeds and food-bearing plants at approved retailers (see resources at bottom for a complete list of eligible items). These items are purchased with the Oklahoma Access EBT (Electronic Balance Transfer) card, which works like a typical “debit card.” One barrier to the acceptance of food benefits at farmers’ markets is the need for retailers to utilize an electronic Point-of-Sale (POS) terminal for processing an EBT transaction.

The Oklahoma Dept. of Human Services, who administers SNAP throughout the state is working with the OK Dept. of Agriculture, Food and Forestry and other key partners (Three Springs Farm, Newsome Community Farms, Kerr Center for Sustainable Agriculture, OSU Cooperative Extension, USDA Food and Nutrition Service (FNS), and the OK Farmers’ Market Alliance) to explore ways for expanding the acceptance of food stamps at farmers’ markets in Oklahoma.

As of December 2009 there were a total of 8 markets who had been approved. Seven were approved prior to the season ending, but only six completed the entire process to get their POS machines and actually participated during the season. As of December there are two additional markets who requested applications and plan to participate during the 2010 market season. This will give us a total of 10 markets where SNAP clients can shop for fresh food items.

These partners have evaluated various options and identified the following method as most likely to work best for accepting federal food benefits at farmers’ markets in Oklahoma.

**Tokens** - SNAP customer swipes their card at a central Point of Sale (POS) terminal at the market, in exchange for tokens of assigned dollar value(s) to be spent on eligible products from approved vendors.

- **Pros:**
  - Used when one central POS device is utilized at the market.
  - Each farmer does not have to complete an FNS retailer application – only one application submitted by the market; easy transactions for customer and vendor; allows acceptance of other forms of electronic payment besides EBT card, such as debit or credit cards.
cons: requires someone to tend the POS device throughout market hours; requires market to match-up terminal sales with token inventory; cost for wireless device, service and transactions.


Other Resources:

For step-by-step guidance in completing the Food Stamp Application for Stores, see Guidance for Farmers’ Markets in Oklahoma Applying to Accept Food Stamps, Kerr Center, 2009. For a more complete description of the token process, see Accepting Food Stamps at Farmers’ Markets in Oklahoma, Kerr Center, 2009.

USDA, Food and Nutrition Services:


OK Dept. of Human Services, SNAP:

To obtain copies of the first two publications above; for assistance completing a Retailer Application; or for general questions about food benefit acceptance at farmers’ markets in Oklahoma, contact Leola Anderson, leola.anderson@okdhs.org, 405-521-3445.

Oklahoma Senior Farmers’ Market Program

Zach Root

BIO:
Zach Root has worked at the Oklahoma Department of Human Services since 2001 in the Office of Planning, Research and Statistics and most recently in the Aging Services Division. In his current capacity, Mr. Root responds to requests for grant proposals and manages grant projects for the Aging Services Division.

What is it?:
The Oklahoma SFMNP will promote nutritionally healthier lifestyles for eligible senior participants and their families by supplementing their household food purchases with fresh produce available through local farmers markets.

The SFMNP:
1. Provides resources in the form of fresh, nutritious, unprepared, locally grown fruits, vegetables, honey and herbs from farmers' markets to low-income seniors;
2. Increases the domestic consumption of agricultural commodities by expanding or aiding in the expansion of domestic farmers' markets; and,
3. Develops or aids in the development of new and additional farmers' markets.

Who is eligible?:
1. Oklahoma resident
2. 60 + years of age
3. Meet income guidelines (at or below 185% of federal poverty level)

How to apply?:
1. Contact local AAAs
2. Meet eligibility requirements
3. Fill out SFMNP application

How to purchase produce under SFMNP?:
1. Apply for benefits
2. Upon approval, SFMNP card will be mailed to you
3. Go to FMNP-approved farmers’ market
4. Use card to receive SFMNP tokens valid only at the specific SFMNP-approved farmers’ market
5. Exchange tokens for produce

When can I use SFMNP card?:
1. Contact local AAAs for starting dates of SFMNP-approved farmers' markets
2. Each market has its own schedule (most start around May and run through October)
3. SFMNP cards will be redeemable through 8/30/10
4. SFMNP cards only valid for one growing season

How much can I buy? :

1. $25 worth of produce during the season

What agencies/organizations are participating? :

1. Oklahoma Department of Human Services
2. Oklahoma Depart of Agriculture, Food and Forestry
3. Area Agencies on Aging (EODD and SODA)

How is it funded? :

1. USDA FNS
2. OKDHS
3. ODAFF
4. AAAs
5. OSU-Ext
6. Farmers’ Markets
Selling Your Agricultural Products Using a Green Distributor

Presentation by Matthew Burch at Horticultural Industries Show January 9, 2010

How to sell product with Urban Agrarian:

1. Contact Urban Agrarian at info@uaoklahoma.com with crop growth or product information. Biographical information is requested but not required.
   - Your farm or business is mapped for route determination and product information, including variety and availability, are logged.
   - Crop availability predictions are compiled and communicated to buyers.
   - Planting requests can be submitted to growers.
   - Collaborations are available for photo, video, audio library of your production for outreach and branding use.
   - Delivery and terms are negotiable on a case by case basis. Anything from we-pick to you deliver to our central Oklahoma City distribution center. This process is led by a value assessment by both parties.

2. Regular updates on crop stand, environmental conditions, and other variables help in the communication flow to end-users. These updates can be handled by email or phone.

3. Delivery begins and currently net 30 payment terms are standard. There is a strong possibility that Urban Agrarian will be able to purchase products up front in the near future. Checks are mailed to your preferred address and made out to your agricultural enterprise.

4. Unless there is an issue during delivery or handling, product quality is the producers responsibility.

Why to sell product with Urban Agrarian:

1. Urban Agrarian has established connections to a growing audience of direct consumers and bulk purchasers of Oklahoma agricultural products.

2. The economics of 1 distributor as compared to 10-20 grower/distributors have been proven out in other areas.

3. You will have a partner in marketing, customer relations, communication, and outreach.

4. Fuel experiments with waste vegetable oil fuels show promise in keeping costs under control and environmental pollutants to a minimum.

5. A combination of growers allows local food to work on a larger scale.

6. Obligations will be reasonable for both sides and won’t extend beyond specific plantings.

7. Web technology, proper bookkeeping with Quickbooks reports, professional marketing, and the availability of multimedia technicians get the word out about Urban Agrarian and your enterprise.

8. Urban Agrarian maintains a strong relationship with a local food processor, Earth Elements Market and Bakery for seconds and excess. This brings more value to your harvests.
9. A direct access to schools and restaurants (over 40 in 2009) as well as direct consumers and retail stores (thousands of individuals and nearly 10 stores in 2009).

10. Cross marketing opportunities with other institutions and organizations.

11. Urban Agrarian consults with and receives mentorship and assistance from OSU’s Robert M. Kerr Food and Agricultural Product Center, The Kerr Center for Sustainable Agriculture, UCO’s Small Business Development Center, and others. We are creating a workable system and gathering all the resources we can to succeed.

12. Urban Agrarian is one of the few involved with the logistical framework of the local food system. It is an early stage development (1.5 years). Begin now sharing and participating in the establishment of this system.

Immediate Needs:

1. Product to fulfill a large purchase order from OSU.
2. Information about anticipated plantings for 2010.

Comments, concerns or questions should be directed to

info@uaoklahoma.com

Or

Matthew Burch, founder, Urban Agrarian (405)615-5797

Check out UAOklahoma.com
"Are We Organic Yet!?" NOP Compliance for Non-certified Organic Growers

George Kuepper
Sustainable Agriculture Specialist
Kerr Center for Sustainable Agriculture
Poteau, OK 74953

Prior to joining the Kerr Center for Sustainable Agriculture, I spent close to 11 years working for the National Center for Appropriate Technology (NCAT), which operates the ATTRA Project. For much of that time, I was responsible for developing educational materials about organic compliance, certification, and regulation. Most of this was done with funding provided by the National Organic Program.

In 2005, several of us were in Little Rock doing a special training of University of Arkansas Extension Educators. I began a routine presentation on organic regulation as it applies to certified farmers. Things went fairly well up to the point where my presentation was “hijacked” by Educators who wanted to focus on another group of organic farmers—those who are not certified. Non-certified organic growers, it seems, had become a controversial issue at many of the farmer’s markets in the State. I subsequently learned that the problem was not confined to Arkansas, and not just to farmer’s markets.

The circumstances are these: The National Organic Standard (i.e. USDA’s Organic Regulation) requires that all farms selling their produce as organic to be certified by an accredited agent. However, §205.101(a) provides an exemption for anyone selling less than $5,000 of organic product annually. Many small market growers—particularly market gardeners—take appropriate advantage of this exemption. They call themselves and their wares “organic,” but forego the costs and process of certification.

These growers—non-certified organic growers—are still expected to comply with all the relevant regulation. The Organic Standard requires certain practices and it also prohibits many conventional agricultural inputs, particularly synthetic pesticides, standard chemical fertilizers, sewage sludge, and genetically engineered crops. However, because they are not subject to the same review and inspection process undergone by certified growers, exempt growers do not get the same level of guidance that ensure that they’re really compliant...that they’re really “organic.” This situation puts consumers at risk of buying misrepresented goods. No matter your opinion of the quality of organic food, if a buyer is willing to pay more for products grown to a particular standard, they should not be defrauded.

It is also an issue for other growers. Those who do comply with the Regulations, especially those that undertake certification, become irate when forced to compete with growers who misrepresent themselves, whether through ignorance or greed.
Solutions to this problem don't promise to be simple. It is unlikely that there will be any changes in the National Organic Standard. The less-than-$5000 exemption is not merely part of the Regulation, but is required by §6505(d) of the Organic Food Production Act of 1990—the legislation that originally mandated the writing and implementation of a National Organic Standard.

At Kerr Center, we’ve tried to contribute to the solution by developing an assessment tool for exempt growers that we’ve entitled Small Scale Organics: A Guidebook for the Non-certified Organic Grower. What we’ve tried to do with this tool is strip away those portions of the Organic regulations that do not apply to the small exempt grower. We’ve then re-organized and simplified what remains. We’ve tried to get to the big issues, particularly those that concern the buyers of organic food.

Salient features of the Small Scale Organics tool include the following:

1) Background on Organic Legislation and Regulation. This includes details on how to recognize a fully certified organic operation.

2) Production Requirements. There are several things certified and exempt organic growers must address to ensure compliance with the National Standard, as well as meet the expectations of their customers. We broke this down into seven main topics:
   a. Land or Site Requirements. This is mainly about the requirement that a production site be free of prohibited inputs for the three preceding years.
   b. Growing Practices. Organic growing is centered on building a healthy, fertile soil and supporting biodiversity. This is accomplished using strategies and practices modeled from natural systems. Unfortunately, the popular focus on excluding synthetic pesticides and fertilizers in organic growing often disregards these fundamental principles. As a result, there is less emphasis on the basic practices that allow organic growers to produce excellent food without conventional inputs. This section outlines those basic growing practices.
   c. Fertilizers and Soil Amendments. Lists of prohibited fertilizers are provided. Several products incorrectly believed to be organically acceptable are highlighted. There are instructions on how to read a fertilizer label and recognize allowed products.
   d. Manure and Compost. Limitations on the use of manure and manure-based compost are related mostly to food safety. We explain this and go on to discuss the status of commercial bagged manure products and compost tea.
   e. Pest Control Agents. Lists of prohibited pesticides—including their chemical and trade names—are provided. There are a number of natural pesticides that have been ruled too toxic for organic use. These are discussed as well. There are instructions on how to read and interpret a pesticide label, and recognize allowed products.
   f. Seeds and Planting Stock. Basically, fungicide- or insecticide-treated seeds are prohibited; also genetically-engineered varieties.
g. Preventing Contamination. We address issues of spray drift, contaminated containers, treated wood and related matters.

3) Marketing Issues. Exempt growers may use the word organic, but they may not display the USDA Organic Seal.

4) Special Products. This includes transplants grown for sale, wild harvested foods, sprouts, etc. There are some things growers must know if they plan to market these as organic.

5) Paperwork. Paperwork is sometimes considered the bane of certified organic production. Many growers cite it as the reason they choose not to be certified. There are basically two stages of paperwork facing the organic grower. First is the Organic System Plan (OSP)—the written plan that explains what the grower will do to comply with the National Organic Standard. (Certified growers complete an OSP as part of the application process.) The second stage involves the records required to document that the grower’s OSP is being followed. Exempt growers are also supposed to have a written OSP and to keep certain records. However, they need not be near as extensive as those required for certified production. Small Scale Organics features both a blank OSP document and update forms stripped of extraneous details information requirements. Check boxes are used as much as possible. The record keeping forms are also minimalist. There are really only a few things that exempt growers really need to track.

We tried to design Small Scale Organics for broad use.

- We see it as usable by small growers, themselves, as a self-assessment tool.
- Extension Educators can use it as an educational tool.
- Market managers and produce buyers can use it by requiring sellers to complete and sign the OSP document. It is structured as a declaration and could be modified further into a legal affidavit, if desired. This does not preclude fraud, of course, but most of us are reluctant to sign our names to statements that are not true.

Copies of Small Scale Organics are available on the Kerr Center Web site at: http://www.kerrcenter.com/publications/small-scale-organics.pdf. Print copies are available by contacting: Kerr Center, P.O. Box 588, Poteau, OK 74953; Tel: 918-647-9123
Diverting yard and City Waste from Landfills to Farms

Kathy Moore
Anichini-Moore Ranch & Farm
1302 17th Street, Woodward, OK  73801
Farm Address: RR 1, Box 171, Woodward, Ok 73801
Phones: 580-256-0657 or 405-823-8295 cell

Websites: www.anichinimoore.com & www.okcompostingcouncil.org
Email: Kathy@anichinimoore.com

Introduction:
• Parents and grandparents lived during the depression and dust bowl and were life long recyclers. Compost mulch and use green manures

• Prior to owning a farm was a backyard and front yard gardener with edible landscaping

• Brought a highly eroded 160 acre farm in 1995 with all sand and 22 acres of trees in a region of the state known for vast rangelands and commodity crops

• Planned to rebuild the soil and water holding capacity

• Planned to create an old fashioned highly diversified farm with heritage animals, fruit trees, vineyard, herbs, vegetables and flowers

• Plan was to fill a niche with local pastured meats and produce with direct marketing to local customers.

Goals:
• Rebuild soil – organic matter and water holding capacity
• Eliminate erosion from wind and rainfall
• Restore wildlife habitat and ecosystem
• Growing food organically that enhanced all of the above.

Plan:
• Rebuild soil by accessing enormous amounts of yard waste from city
• Access feed lot and auction manure and possibly paper and food wastes

Waste from municipal and institutional sources can enable composting, mulching and soil building on your farm, but it’s not always as simple as it seems.
• Cultural and governmental policies may not coincide with goals and plans

Requirements:
• Start by building relationships with landfill board, city, county, contractors, yard contractors, neighbors
• Plan to pick up yard and other wastes as part of your routine
Start small

- Try to recruit volunteers or collaborators
- Inquire at Coffee shops to pick up coffee grounds and filters
- Inquire at restaurants to access their coffee grounds, vegetable trimmings, rolls, etc
- Cruise the alleys for bags of leaves, grass, pumpkins, straw, cardboard, newspapers
- Recycle your junk mail from home cross shredded & bagged for farm use (no staples, metal or plastics)
- Yard Service people – ask them to deliver their waste to you and save a tipping fee or to call you for pick up
- Farmers Market – ask customers to bring you any of the above to market or farm

Relationship building and networking:

- Neighbors – ask permission and/or help
- Phone contacts – always keep your promise to be there to pick up or receive materials
- Talk about what you do at the Farmers Market, Roadside Stand, on Farm Store, etc – educate
- Seek media coverage – builds interest and educates
- Offer to teach composting with local conservation district or assist in other ways
- Join composting councils such as U.S. Composting Council or OK Composting Council (www.okcompostingcouncil.org) for support and assistance
- Join Recycling Associations such as OK Recycling Association (www.okrecycle.org)

Communication:

- Consider advertising for donations of yard and other wastes
- Use less expensive weekly papers like Penny news & Shoppers Edge in Oklahoma
- Make and distribute flyers about farm recycling for Farmers Markets, and Stores
- Tell your story to everyone and anyone who will listen
- Post your activities/story on your website or blog
- Use other forms of social media if you know how
- Offer to speak to groups about what you do and why
- Keep talking, educating and building relationships

What are the advantages and challenges of using local “waste” on your farm?

- Lots of challenges and advantages
- Is recycling and reuse the norm or not performed at all where you live?
- Local and state policies may be barriers
- Status quo or apathy may be the local norm
- Depending on your location may involve culture shifting or more time and patience to educate and change beliefs and/or practices
• Hard work to picking up heavy bags, or making daily visits to coffee shops and restaurants
• Advantages are materials are abundant and free
• Can be used as mulch or to make compost
• Builds community and develops more relationships
• Builds public interest or support for your farm or ranch
• Observable changes over time – less erosion, more biodiversity, reduced water usage, more birds and other wildlife; dung beetles, horned toads, toads and beneficial insects and worms appearing

What materials are easiest to compost and where can you get them?
• Leaves
• Grass clippings
• Straw
• Newspapers (black and white is preferable)
• Junk mail (no metal, plastic, colored ink unless soy ink)
• Cardboard including toilet paper and paper towel rolls
• Coffee grounds and filters
• Food wastes (vegetable and fruit waste and other items)
• Old hay
• Manure
• Resources for materials to compost or mulch can be obtained from alley ways, curbside, restaurants, coffee shops, farmers, etc.

How do you avoid both contaminants and expensive equipment costs?
• Involves common sense and observation
• If picking up yard waste for mulching- know your providers whether they use chemicals or not
• Ask questions
• Composting kills most pathogens and eliminates most contaminants
• Test your compost – try growing radish seeds, if they germinate the compost is stable
• If there are concerns about contamination place or use materials in a “safe” location until determined stable for use on crops.
• Equipment can be as simple as a pickup or car and involves mostly manual labor

My farm does not have any equipment. It takes longer, but it can be done.

Ideal equipment – trailer, chipper/shredder, small tractor with affront end loader and possible a wind row turner

Equipment possibilities: collaborate and share equipment with neighboring farms or work with conservation districts, NRCS, etc and rentals

Findings of farm research using composted yard waste on garden plots from years of composting and mulching practices.
• Observable changes over time – less erosion, more biodiversity, reduced water usage, more birds and other wildlife; more water holding capacity; dung beetles, horned toads, toads, beneficial insects, song birds and worms appear.
• Biodiversity reduces insect and suppresses disease
• Produce and fruit crops endure heat, drought, and wind better
• Plants and animals are healthier
• Plan to have future farm demonstrations or field days to relate more formal research results of using waste to rebuild soil and water holding capacity related to a grant with Kerr Center

Expectations from research based on observations to date
• Reduced water use from soils with greater organic matter and carbon
• Reduces energy use of less need to pump water
• Reduced insects and costs for organic insect control products or measures
• Reduced cost for organic soil and plant amendments

Expectations from Research based on Measurements
• Measurable increase in organic matter
• Measureable increase in bricks or sugar content of produce

Conclusion
• Study and observations continue
• Reduction of land filled materials also reduces air and water pollution, saves energy, lengthens life of landfills and saves money
• Preliminary analyses – well worth all the work to divert organic debris from landfills to farms to hasten soil rebuilding for development of vibrant local food systems, food security, and biodiversity on farms!

Thank You!
Please contact Kathy for more information.
Fruit Sessions
Steve Upson, a native of Tulsa, Oklahoma, received a bachelor’s degree in horticulture from Oklahoma State University and a master’s degree in horticulture from Kansas State University. Past employment includes serving as a county and district horticulture agent with the Oklahoma Cooperative Extension Service and as manager of a commercial market garden operation east of Kansas City, Missouri. For the past 21 years, Steve has lived in Ardmore, Oklahoma where he is employed as a horticulture consultant with the Noble Foundation. Steve’s current area of specialization involves researching and demonstrating the benefits of modified environment ‘hoop house’ high value crop production.

A question that I’m often asked is, “I recently purchased a small acreage and I’d appreciate some guidance as to what I can do with it.” My response is usually “it depends”. All too often people purchase property without first having developed goals and a plan of action for the property. Purchasing a place prior to planning is a risky proposition.

Before purchasing a place or before making decisions on how to use an existing piece of property, you will need to set goals; take inventory of farm resources, family resources and skills; and decide on an enterprise(s). Keep in mind that these factors are not independent but frequently interact and influence each other. For example, the quality and quantity of irrigation water is a huge determining factor on the kinds of crops that can be grown and the scale of production.

At the Noble Foundation, we require individuals applying to become producer cooperators, complete a goals questionnaire. We believe that careful consideration of financial, production and quality of life goals is requisite for success. Individuals who do not complete the goals document are not accepted into our consultation program.

When formulating goals, consider these questions: Do you view the farm as a way to achieve quality of life for the family? Do you want the farm to produce a supplemental or a full income for your family? Do you need the farm to provide food and/or energy independence?

Keep in mind the goals you set must realistically consider the feelings of family members, your financial situation and the farm or business related skills of family members.

To be useable, goals should be S.M.A.R.T, i.e. specific, measurable, achievable, realistic and timely;

- **Specific.** A specific goal has a much greater chance of being accomplished than a general goal. Ask yourself who, what (do I want to accomplish), where, when and why?

- **Measurable.** For example, how much income do you want to generate and by when? How many family members will be employed?
• **Achievable.** What is the level of difficulty associated with each goal? A goal too easy is not energized. A goal too difficult seems hopeless. Set the level of challenge somewhere in between.

• **Realistic.** Do you have the knowledge, skill set and competency to reach your goals?

• **Timely.** Goals should have a time factor involved. A time frame instills a sense of urgency.

Not all rural properties are created equal. They vary widely in the types of crops they can grow. A farm’s capability to grow various crops is determined by its land, water and climate resources. Land resources include soil type, slope, elevation, exposure, location and access. Well drained, loamy soils can support a wide range of specialty crops whereas poorly drained, finer textured clay soils will not support stone fruit and root crops without extensive modification. Excessively sloped property is susceptible to erosion when cultivated and is best suited for perennial crops such as fruit. Early flowering crops, such as the stone fruit, require an elevated site not prone to forming frost pockets on cold spring nights. Excessively sheltered sites that block airflow are not good candidates for hoop house production because breezes are required for ventilation. Wind pollinated crops such as tomato and crops susceptible to powdery mildew such as cucurbits grown in hoop houses will perform poorly without sufficient airflow to facilitate pollination and exhaust humid air. Farms located far from populated areas are at a disadvantage from a marketing standpoint. Consumers are less likely to travel long distances to pick or purchase produce and will choose closer options all things being equal. The further your farm is located from markets, the more expenses you will incur for fuel and labor. Property located on poorly maintained dirt roads will, in all probability, not be accessible during certain times of the year. This condition is unacceptable if your goal is to establish an agri-tourism enterprise.

Water is another critical resource that determines crop options for your farm. In the southern Great Plains, it is considered too risky to grow specialty crops without irrigation. Prior to establishing cropping goals, you will want to determine the quantity and quality of water available for irrigation. Your water source needs to have the capacity to supply a minimum of one acre inch per week. One acre inch is equivalent to 27,000 gallons. This volume must be available throughout the summer months. Sources of irrigation water include ponds, streams, wells and municipal. If your irrigation water source is a pond, keep in mind that you will need to compensate for the water lost from the pond due to evaporation. Municipal (rural) water should only be counted on for emergency use as it is too expensive for commercial use and is often unavailable during periods of drought due to rationing. If you plan on irrigating from a stream you will first need to obtain a water use permit from the state agency charged with water use oversight. In Oklahoma, this agency is the Oklahoma Water Resources Board, [http://www.owrb.ok.gov](http://www.owrb.ok.gov). Wells are used extensively in Oklahoma as a source of irrigation water. In some areas, sufficient quantities of water are located too deep to be economical. As a rule of thumb, a well needs to yield a minimum of 7gpm/acre. Surface water will need to be filtered to remove biological matter before use in micro-irrigation systems. Well water requires filtration to remove inorganic debris such as silt and sand.
Some aquifers contain excessive levels of salts and cannot be used for irrigation, so be sure to have the water tested prior to use.

Climate is important to farming. Rainfall, growing season (frost free days), temperature, wind speed and probability of hail storms vary throughout the state. If you are searching for a piece of property with the primary goal of producing for early, local markets, you would necessarily confine your search to the southern parts of the state. Before committing to a hobby or for-profit farm, do an assessment of your family resources including finances, labor, business and farm related skills.

All crops require you to spend money in advance to establish the crop. Some crops, such as tree fruits, require several years before any income is realized. Knowing in advance where you stand financially and your capacity for risk taking will influence the types of choices that best fit your situation. Consider these questions: What can you invest in startup and operating costs without putting your family in financial risk? How long can you wait for the crop to begin to create some cash flow? Profit? Can you deal with fluctuations in the market? How much time and money can you allocate toward marketing your crop? What other financial obligations are you taking on with the farm?

Specialty crops are very labor intensive. Access to reliable and productive labor can mean the difference between success and failure. Ask yourself these questions: Do you have access to reliable and productive labor? Are you comfortable managing labor? Are you willing and able to do the additional paperwork involved with having employees? Can you pay for labor before you are paid for your crop? Don’t choose a farming enterprise based solely on financial and labor considerations.

To be successful, you must also take into account your family’s skill set, work ethic and desires. Consider these questions: What do you love to do? A real passion for the work will help you get through hard times. What do you know how to do? Many skills, including production and business, are needed to be a successful farmer. What do you do well? Some folks have a knack for growing, some for operating and maintaining equipment, and others for marketing and record keeping. Assign responsibilities based on a person’s strengths. Accentuate the positive! How many hours and what months do you want to work on the farm? During harvest season, it’s easy to put in 12-14 hour days. Hot, humid weather can make liars out of people having the best of intentions.

Choosing specific crops to grow requires some thought and planning. When selecting a crop, keep in mind the market is ultimately consumer driven. Growing something simply because you enjoy growing it will not guarantee a return on investment. Conduct a survey of local markets to determine supply and demand for various crops. Currently, Oklahoma farmers markets do not have the volume and kinds of fruit to meet consumer demand.

Growing a diversity of crops can spread the risk of changes in the growing environment and market price in a given year. However, trying to grow too many crops presents a risk in itself because of the different management requirements associated with each crop.
Before investing any significant amount of your time and money in a crop, you should thoroughly research the crop and talk to as many growers, consultants and extension specialists as possible. Once you choose a crop(s), resist the temptation to make changes in the traditional production system until you become an experienced grower. For more information, check out the following:

- What Can I Do with My Small Farm?  
  http://extension.oregonstate.edu/catalog/html/ec/ec1529
- California Small Farm Center http://www.sfc.ucdavis.edu/default.asp
New Fruit Crop Establishment for a Value-added Processing Business

Richard A. Ortez

My name is Dick Ortez and I own and operate El Sueno Enterprises, a small vertically structured “Food Processing” business. On my farm, I grow several vegetables, which I process into value-added products. By choice, each of my dozen or more products (sold at a local Farmers’ Market) contains at least one ingredient which I have grown. Wishing to expand my product line to include jams and jellies, I recently put in a small fruit orchard. The purpose of this report is to describe that orchard and the process by which it was established.

Business Description. El Sueno Enterprises, established in 1994, operates on 74 acres located about thirteen miles east and north of Stillwater, Oklahoma. The bulk of the land is either unimproved or devoted to pasture for a small herd of beef cattle. However, about five acres are available for horticultural use. Over the years, the size of the gardens has varied from as little as ¼ acre to as much as 3 acres; the larger area including land used for “dry bean” and “small grain” production. The vegetable patches themselves average around ¼ to ½ acre. Once more diverse, I now tend to grow only those crops for which I have value-added products: onions, garlic, beets, cabbage, and peppers. I do not sell fresh produce.

On the farm is a mobile home which has been converted into a fully licensed “Commercial Kitchen;” on which I currently carry two “Oklahoma State Department of Health” licenses: “Food Service” (45F) and “Manufacturing” (45P). As crops mature, they are transported to the kitchen and processed into one or more value-added products. Examples of these are: Sauerkraut from cabbage; Pickled Beets from beets; Bean Salad from dry and green beans; and Chili Verde, Salsa, Pickled Peppers, Hot Sauce, & Chili Powder from peppers. I also produce several “low water activity” products such as: Bread and other baked items, Dry Beans, Small Grains, Dried Herbs and Granola. So, the addition of an orchard (with the jams & jellies it will yield) represents a logical expansion of my operation.

Orchard Description. Currently the orchard covers one acre, but will be expanded to about 1 ½ acres in the next year or two as berries currently planted between trees are relocated. There are a total of 60 trees representing 9 species (pear, apple, fig, apricot, nectarine, peach, plumb, cherry, and persimmon) with 3-4 varieties of each species and 2 trees of each variety. There are also five species of small fruit (blackberries, raspberries, gooseberries, currents, and blueberries) as well as grapes: with 2-4 varieties of each. Varieties were selected based on the recommendations of Dr. Eric Stafne, Oklahoma State University Fruit and Nut Specialist, as those most likely to succeed in my region. Table 1 provides a breakdown of the species and varieties. Essentially I have planted any fruit which has even a remote chance of making a crop in North Central Oklahoma. Because of the manner in which I will market the fruit (jams & jellies), I need neither pretty fruit nor a crop every year. For example, apricots may make a crop in my area only once in seven years. However, if it is a good crop it may generate enough jam (which is a shelf stable product) to last several years.
The trees are planted on two 800-ft long earth berms running along the west side of a large garden area where they will also serve as a wind break – protecting the garden from wind damage. In fact, that was the initial problem for which the orchard became the solution. The total cost of establishing this orchard was $6,880.29 (Table 2).

At maturity the orchard is estimated to yield $22,250.00 annual gross revenues, about half of which should represent net revenues. There will be no fruit production, and therefore no income, during the first year. After that, income is expected to climb from a low of around $1,050.00 in the second year to $22,250.00 by year eight. Table 3 breaks the fruits into four categories based on time to maturity, with conservative estimates of yield (berries = 10 pounds of fruit/plant; grapes = 15 pounds of fruit/plant; Early Tree Fruits = 2 bushel/plant; Late Tree Fruits = 4 bushed/plant) providing the projected income values.
TABLE 3: Estimated Gross Revenues from Orchard

<table>
<thead>
<tr>
<th>Year</th>
<th>Berries</th>
<th>Grapes</th>
<th>Early Tree</th>
<th>Late Tree</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>2</td>
<td>1,050</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1,050</td>
</tr>
<tr>
<td>3</td>
<td>2,625</td>
<td>225</td>
<td>1,800</td>
<td>0</td>
<td>4,650</td>
</tr>
<tr>
<td>4</td>
<td>3,150</td>
<td>563</td>
<td>4,500</td>
<td>1,200</td>
<td>9,413</td>
</tr>
<tr>
<td>5</td>
<td>3,500</td>
<td>675</td>
<td>5,400</td>
<td>3,600</td>
<td>13,175</td>
</tr>
<tr>
<td>6</td>
<td>3,500</td>
<td>750</td>
<td>6,000</td>
<td>9,000</td>
<td>19,250</td>
</tr>
<tr>
<td>7</td>
<td>3,500</td>
<td>750</td>
<td>6,000</td>
<td>10,800</td>
<td>21,050</td>
</tr>
<tr>
<td>8</td>
<td>3,500</td>
<td>750</td>
<td>6,000</td>
<td>12,000</td>
<td>22,250</td>
</tr>
<tr>
<td>9</td>
<td>3,500</td>
<td>750</td>
<td>6,000</td>
<td>12,000</td>
<td>22,250</td>
</tr>
</tbody>
</table>

- Early Tree Fruits include peaches, nectarines, plumbs, jujube, paw paw and fig.
- Late Tree Fruits include apple, apricot, pear, and persimmon.

**Establishing the Orchard.** Table 4 shows the timeline for establishing the orchard. The whole process began four years before it was actually planted. The idea grew out of a desire to provide wind protection for a prime garden area. Thinking a row or two of pecan trees might work, I consulted with Dr. Dean McGraw (the pecan specialist with Oklahoma State University at the time); he suggested fruit. The next couple of years were spent pondering such a venture and looking at alternative sites on the property. Then, in 2007, I learned about the Oklahoma Department of Agriculture’s “Farm Diversification Grant” program and the planning took on new vigor. An application was submitted on March 18, 2008; word of its approval arrived on July 8, 2008; and a starting date of August 11, 2008 was established.

**TABLE 4: Timeline for Establishing the Orchard**

<table>
<thead>
<tr>
<th>Time</th>
<th>Activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>4 years prior</td>
<td>Idea began to develop, some planning, site selection</td>
</tr>
<tr>
<td>18 months prior</td>
<td>Began year of intense study, consultation, grant writing</td>
</tr>
<tr>
<td>6 months prior</td>
<td>Cleared trees, ordered plants</td>
</tr>
<tr>
<td>2 months prior</td>
<td>Soil preparation, berm construction, hole excavation</td>
</tr>
<tr>
<td>Planting Day</td>
<td>Field Day, March 21, 2009</td>
</tr>
<tr>
<td>1 month post</td>
<td>Installed anti-deep fence</td>
</tr>
<tr>
<td>3 months post</td>
<td>Installed irrigation</td>
</tr>
<tr>
<td>4-6 months post</td>
<td>Maintained: watered, weeded</td>
</tr>
</tbody>
</table>

Work began in September of 2008 with the clearing of some cedar trees. During that fall I also made the species and variety selections, and ordered the plants. Because of the diversity of plants involved, they ended up coming from five different nurseries. Arrangements were made for them to be shipped on March 16, 2009. This
shipping date was critical as it would have the trees arriving just in time for a “Field Day” scheduled for March 21st. As a retired educator, I could not pass up the opportunity to use this project as a teaching tool.

In the early spring of 2009, I began preparing the seedbed. The ground was first cleared of trash left from the tree removal, and then plowed and disked to smooth and level. Then two 800-ft long earth berms were constructed twenty feet apart. These were built by repeated blowing, disk ing and grading of the earth towards the center of each; it took four such cycles to build the 12-14 inch high berms. During the final cycle fertilizer (as indicated by an OSU soil test) and wheat seed (to provide ground cover and minimize soil erosion) were incorporated.

On March 21, 2009 a “Field Day” on “Orchard Establishment and Maintenance” was conducted. It began in the Payne County Expo Center, where about 70 persons gathered to hear presentations on “Fruit Tree Basics” by Dr. Eric Stafne; “Insect Management” by Dr. Phil Mulder; and “Disease Management” by Dr. Damon Smith. After a lunch featuring items grown and processed by El Sueno Enterprises, we caravanned to the farm. Following a presentation by Dr. Hailin Zhang on “Soil and fertility,” and a demonstration on proper planting techniques, the participants broke into small groups (each under the direction of a Payne County Master Gardener) to plant of the trees. The final presentation of the day was by Dr. Mike Kizer on “Irrigation Systems for Fruit Trees.” Everyone had a good and profitable time; and the trees were in. A few days later I planted the small fruits, and a couple weeks after that the grapes. Everything was in the ground by mid April.

Within days of planting the trees I discovered deer tracks, and quickly installed a six-foot high, seven-wire, portable electric fence around the orchard. This is a fence system I had already developed for the gardens; and it does a good job if managed properly. There are a large number of deer in my area, and they seem to prefer garden produce to prairie grass; so fencing the gardens has been essential to getting vegetable crops. Having to place it around the orchard was expected, and I was ready for it.

The spring of 2009 was unusually wet, and the orchard did not need to be irrigated. Finally it dried out enough that by mid June I could install the irrigation system. Water is obtained from a 1 ½ -acre pond about 200 ft from the orchard site. The pump, sand filter, and electricity to run the pump were already in place. What we added were: 1) 200 foot of 1 ¼ inch black plastic to reach the orchard, 2) a screen filter for additional trash removal, 3) a 1 inch header line across the two rows, 4) two ½ inch lateral lines, and 5) a single 2.0 gallon per hour emitter at each tree. Eventually, as the trees grow, a second lateral line and a total of four emitters per tree will be required.

Through the remainder of 2009 the orchard was watered and weeded as needed; but no other major projects were undertaken.

Problems and Lessons. I did encounter some problems – both expected and unexpected. The first of these happened a couple weeks before the March 21st Field Day. One of the nurseries had erroneously shipped the trees several months
premature. After some nervous exchanges, I returned the trees and we re-set shipping for its original March 16th date. Well, guess what, on March 3rd, and quite unexpected by me, that re-order arrived at my door. I was not prepared for holding trees nearly three weeks, I did the best I could, but it was apparently not good enough. Later that spring several trees failed to leaf out; and the vast majority of them were from that shipment. I suspect I kept them too wet and drowned them. The nursery is going to replace them, but I could have avoided the extra hassle had I been better prepared to receive trees early.

Another problem I encountered relates to the anti-deer fence. I had never used it adjacent to a cattle pasture before; and it turns out that it will not keep cows out (especially small calves). I will need to install a regular barbed wire fence on that side of the orchard; and extend its height so that it continues to exclude deer. I’ve also learned that you cannot discontinue the charge on the fence for a prolonged time. I was away for two weeks in May and elected to turn the power off during my absence. Upon return I discovered that a deer buck had gotten in and damaged several trees. So the fence system needs some adjustments.

Two problems arose with the irrigation system. After it had been installed and used for several weeks, I began noticing that some trees were not getting watered; the emitters had become plugged, and replacing them restored flow. However, this was not an occasional or even spotty problem and eventually the whole system shut down. I finally determined that the screen filter placed between the sand filter and emitters was plugging with a slimy substance, and that cleaning it restored flow. Unfortunately, cleaning it was very difficult and it didn’t stay clean very long. I have discussed this problem with the company from which I purchased the equipment; and they have suggested replacing the screen filter with something called a “disk” filter, which has much more surface area. I will try that next year.

The second problem with the irrigation system has to do with the fact that I simply laid it out on the ground, much as I do in the gardens. However, the first time I went to mow the area, I realized that it will need to be raised off the ground 12-18 inches. Otherwise it must be pulled away every time I try to work around the trees, a very time and energy consuming process.

I want to end by commenting on what I consider perhaps the most significant lesson I have learned from this whole experience. It is that an orchard differs from a garden in one very fundamental way: the plants are long lived. In the past, it was not uncommon for me to “let a crop go” when a problem became extreme. I could do that because it could be replanted the next year (or even yet that same year as a fall planting); and because to do so was relatively inexpensive. That is clearly not the case with trees, berry bushes, and grapevines. I now realize I must stay much more “on top” of problems as they develop in the orchard because these plants are not expendable.
Locally and regionally produced food products are demanded by consumers across the United States at unprecedented levels. This demand is driven by consumers' desire to support local economies, reduce food miles, encourage sustainable agricultural practices, and have greater access to healthier and fresher produce. Historical direct marketing channels such as farmers' markets, produce stands, community supported agriculture have always relied on this product attribute to promote sales but retailers are increasingly targeting local sourcing to expand their sales, creating new opportunities for growers to engage retail buyers.

Electronic marketing networks are gaining popularity. They gather information from producers and potential customers to help connect farmers directly with consumers. Large retail chains are now exploring electronic markets to increase consumer market share by meeting customer demands for fresher, local grown foods. Before producers can realize the full potential of these new marketing avenues, several barriers must be overcome. Our program focuses on identifying the needs of producers interested in these emerging markets and developing tools and educational programs to address those needs.

Our project provides risk management assessment and curriculum development for Southern region specialty crop growers interested in direct marketing of their products. Currently including 21 lessons, our goal is to continuously update and expand the direct marketing curriculum covering marketing, legal, business and finance topics. Lessons available at: www.manageyourrisk.net

As part of our evaluation of producer needs, we are seeking producers nationwide to take our survey. Our objective is to gauge the interests of producers in marketing directly to large retailers and other institutions. Producers are encouraged to complete the survey to help guide the development of these marketing tools. The survey can be accessed in English and Spanish at: www.manageyourrisk.net
Economic Analysis for Raspberries and Blackberries Production
Using Interactive Enterprise Budgeting

Jennie Popp, Héctor Germán Rodríguez, Brittany Haywood, Heather Friedrich, Curt Rom

Production of raspberries and blackberries in Arkansas is growing as more consumers demand a local supply of fresh, high quality fruit. Demand for these fresh berries still typically exceeds supply in much of the state particularly early and late in the production season. Producers could benefit from out-of-season production by sustaining cash flow throughout the year and expanding markets.

Commercial production with high tunnels offers promise for those producers willing to make the necessary capital investment for early and/or late season production. Consequently, tools that help producers in estimating the costs of production and in conducting what-if analyses around costs, revenues and production levels are important components for planning and for financial management of berry fruit production in Arkansas. The objective of this study was to develop a tool that allows producers to make better planning and financial decisions.

To fulfill this objective, interactive budgets for raspberry and blackberry production were created in Microsoft Excel®. These budgets allow producers to compare costs, revenues and net returns among different cultivars. Given the recent interest in out-of-season production the budgets allow also allow producers to evaluate their operations with and without the costs associated with high tunnel production.

In these budgets, sample costs for labor, materials, equipments and custom services were based on figures gathered at the University of Arkansas experimental farm. Once producers select interest rate, inflation rate, planting density, expected prices, marketing plan and production practices (including high tunnel dimensions if any), the budget is calculated automatically.

Those familiar with the Windows® computer environment should find the budgets easy to navigate. These budgets are both easy to use and highly customizable. Producers can estimate several budgets by using default cost values, by entering their own farm values or by combining both. Anytime producers modify an activity, the budgets automatically calculate total cost per year, a breakeven analysis for yield and price and a sensitivity analysis for total cost.

A breakeven analysis suggests what prices a producer will need to receive in order to cover new costs of production. A sensitivity analysis supports decision making by providing a range of total cost values for a specific combination of production practices. Graphics options provide visual explanations of costs, revenues and net returns under different scenarios chosen by the producer. Producers can review information for any given production year or for the expected life of the orchard.

High tunnels show potential in Arkansas to extend the production season for raspberries and blackberries. Extended season could assist producers in capturing a larger market share, especially early and late season when premium prices are paid. Consequently, producers could use these interactive budgets to estimate operating costs, fixed costs, total costs and expected total returns by modifying an important production practice, cost or return value. Allowing comparisons among different cultivars and high tunnel dimensions would assist berry producers to make better investment decisions.
Opportunities and Challenges for High Tunnel Fruit Production in the
Arkansas-Oklahoma Region

Curt R. Rom, Professor of Horticulture
Heather Friedrich, Program Technician
Jason McAfee, Program Technician
Donn Johnson, Professor of Entomology
Elena Garcia, Fruit Extension Specialist
Jennie Popp, Associate Professor of Agricultural Economics
Agricultural Experiment Station, Division of Agriculture, University of Arkansas,
Fayetteville, AR
Contact: C.R. Rom (crom@uark.edu); phone: 479.575.7434

Speaker Biography
C.R. Rom grew up on a fruit farm in Northwest Arkansas. He attained a BS of
Agriculture studying Horticulture and Business from the University of AR and earned his
MS and PHD degrees from The Ohio State University. He was a horticulturist at the
Washington State University prior to becoming a professor at the University of Arkansas
in 1989. He has broad responsibilities for horticulture education, and research on fruit
crop physiology and management, and organic and ecologically-based production
systems.

Introduction
High tunnels are minimally structured, and typically unheated or electrified
hoophouse greenhouses. These structures, tunnels, have been demonstrated in many
regions of the world to provide opportunities for horticulture and specialty crop
producers. We believe they have potential as a tool for fruit producers in this region to
extend the harvest season of berries advancing the season into the spring by two to
four weeks and by extending the fall season, thereby extending the normal six-week
summer harvest season to approximately three to four months. The high tunnels are
not meant to replace field production but rather as a component of the farm production
strategy to extend the production and market season and therefore increase farm cash-
flow. Further, producing fruit out of season generally increases the value of the fruit.
High tunnels also have the potential of reducing environmental damage to the
plants and crops from frosts, wind, hail and rain, and work and harvest in tunnels is not
interfered by rain. Lastly, because of the exclusion of rain and therefore rain-induced
diseases, and the exclusion of pests, tunnels provide a unique opportunity to produce
fruit organically.

High Tunnel Research in Arkansas
Our hypotheses are that high tunnels can be used to produce fruit organically
and the increase in value will justify the cost of the structure, and the high tunnels will
allow for season extension and out-of-season fruit production to further increase product
value. To test these hypotheses we established a series of test for production of
blackberries and raspberries in high tunnels. The trial lasted three years. We
compared high tunnel (HT) to field (FD) production, not for the intent of demonstrating
as superior to the other, but as a means of frame of reference. We hypothesize that HT
and FD production are compatible and should be used on the farm to extend the
There were two studies planted. 1) A study of standard floricane genotypes using HT to advance the summer season. 2) A study of new autumn-bearing primocane genotypes using HT to extend the autumn harvest season. In both studies, three genotypes of blackberries and three genotypes of raspberries were used.

**Key Summary of Findings**

**Spring and Summer Production of Floricane Berries**
- Across the first two harvest seasons HT produced approximately 70% more fruit than the FD for both floricane blackberries and raspberries. There was only a small difference in blackberry yield in the first harvest due to HT, but more than a double in yield increase in year 2 as FD fruit were damaged by frost and rain.
- Raspberries, although not as productive as blackberries, produced better in HT than FD in both years and the HT resulted in a 3-fold yield increase across two years.
- Tunnels without supplemental heat shifted harvest dates approximately 15 days earlier.
- HT berries were larger and more fruit were of marketable quality.

**Autumn Production of Primocane Genotypes**
- Flowering in both cases can be delayed by pruning so that flowering and fruiting occurs during late August – October when temperatures are cooler.
- Across three harvest seasons, HT produced more fruit than FD. This was especially true for raspberries where the HT yield was approximately 45% greater than FD. Some primocane blackberry genotypes produced better in the FD than HT; there is genotype interaction and so not all genotypes may be adapted to HT production.
- Across three years, the season was extended by an average of three weeks by HT compared to FD before severe freezes ended fruiting.
- Berry size and marketable fruit yield was increased in tunnels in every case.

**Steps in managing high tunnel for spring production of blackberries and raspberries**
- For HT, select early ripening cultivars (e.g. Natchez, Arapaho; Prelude, Autumn Bliss, Caroline); select mid to late season cultivars for the field.
- Close tunnels in late January to early February.
- Cover plants with a spun polyester fabric row cover blanket to conserve heat.
- Add supplemental heat if freeze damaging temperatures occur after budbreak (temperatures below 26F for foliage, below 33F for flowers and fruit).
- Open tunnels during the day when temperatures exceed 50F and there are clear, sunny skies.
- Keep tunnel closed when temperatures are below 65F and it is cloudy.
• Close tunnels at night when temperatures go below 50F. Tunnels have 0-2F night time heat conservation.
• After budbreak and early growth, remove row covers
• Cover the plants with row covers during flowering and fruiting if temperatures go below 33F
• Add supplemental heat during flowering and fruiting if temperatures go below 33F; start supplemental heat at 34-35F prior to frosts.
• During bloom, supply pollinating insects; Bumblebees in boxes have worked well.
• Open tunnels once threat of frosts is past and nightly temperatures are greater than 40F.
• Minimize weeds in the tunnels with mowing or mulches.
• Spray plants at budbreak and first flower with lime-sulfur to prevent disease. Use alternative control methods to control cane borers. Sanitation and removal of floricanes after cropping is important.
• HT need more frequent harvest than FD; harvest every 2-3 days.
• Plants in HT will be 25-30% taller and require a trellis; plants should be allowed to grow 5-6 ft height. Follow standard pruning systems as in the FD.

Steps in managing autumn-bearing primocane fruiting genotypes of berries in high tunnels
• Select late season bearing cultivars for HT (ex; Prime-Jim; Prime-Ark; Nantahala, Caroline, Dinkum); select early to mid season bearing cultivars for the FD (ex; Prime-Jan; Nova, Heritage, Autumn Bliss).
• Prune primocanes to delay and synchronize bloom to occur 15-Aug to 15-Sept. Mow canes to ground approximately 1-June and head at 2-3 ft height 1-July.
• Apply lime sulfur after pruning, at first flower, and at first berry color; scout for insects.
• Control weeds with mowing, mulch, and removal after pruning and until cropping.
• Open tunnels during the day and/or leave open when temperatures exceed 50F and there are clear, sunny skies.
• Keep tunnel closed when temperatures are below 65F and it is cloudy.
• Close tunnels at night when temperatures go below 40F and/or daytime temps are below 50F.
• During flowering and fruiting periods, protect from frosts with row covers and supplemental heat.
• Continue harvest until frosts/freezes kill flowers and fruit.
• 1-December, prune or mow to the soil surface all canes; remove or mulch to control overwintering insects.
• Open tunnels for overwintering.
Concluding thoughts and notes

- In our trials, raspberries generally responded in all situations with all cultivars to HT compared to the FD relative to blackberries.
- Generally 65-75% of harvested fruit in HT were marketable as a fresh product. A use for non-fresh market fruit may enhance economic returns.
- Plants in HT grow taller and require trellising or some support system.
- There is minimal advantage of small tunnels. Larger tunnels provide a better modified HT environment.
- HT production is more intense and higher risk (high investment, earlier spring and later autumnal flowering and fruiting which may make them more susceptible to frosts and freezes.

Important Tunnel Resources:
Penn State High Tunnel Manual: http://plasticulture.cas.psu.edu/manual.htm
Blackberry and blueberry production in the southern states has grown exponentially in the last decade. With the expanded acreage new virus diseases have emerged in both crops. These diseases have the potential to significantly impact yield and fruit quality. For example in blackberry where fields are normally replanted every 20 or more years, disease problems have led to 5-7 year rotation. This has a major impact in profitability given the high cost of replanting and the reduced yield the first year(s) after replanting.

Blackberry is primarily affected by blackberry yellow vein (BYV), a widespread disease in the Southern and Midsouth States. The disease is caused by the synergistic effect of several viruses when they co-infect blackberries. In the last few years there are more than 10 viruses associated with the disease, most of which are new to science and are only known to infect blackberry. To our knowledge none of the new viruses cause disease when found alone in plants. Several virus combinations can lead to decline and it is not uncommon to have plants exhibiting the same symptoms whereas the complexes detected can consist of completely different viruses. To add to the complexity of the disease the potential vectors of the new viruses identified in BYV plants include whiteflies, aphids, eriophyid mites, thrips, nematodes and hoppers among others. Until we are able to identify the vectors in the field and the major viruses in our area it is recommended that growers plant material that has gone through thermotherapy and meristem culture followed by rigorous testing for all viruses known to affect blackberry to minimize the possibility to introduce virus-infected material in the field.

In blueberry there are several diseases that were identified in the last few years. In the Southeast Xylella bacterial leaf scorch has become a significant problem. The bacterium is transmitted by sharpshooters. The disease has not been observed in Arkansas or Oklahoma but is important not to introduce it to our area through propagation material from affected areas. Many cultivars develop necrosis symptoms but there are some that remain asymptomatic and can serve as means for dispersal to fields planted with susceptible plants. Testing for this pathogen is straight-forward and it is important to plant only material that is certified free of the bacterium.

Necrotic ring blotch disease cause very distinct symptoms. Red to grey ring spots develop on both leaf sides that can merge to cover a large portion of the leaf but ring centers always remain green. This disease is associated with a new virus and at this point there is no information on varieties that may carry symptomless infections and serve as medium for virus movement within and between states.

Mosaic is a disease that thought to be present in northern latitudes but last year it was found in two farms in Arkansas. Symptoms are very distinct with yellow, green or purple mosaic developing in few leaves or branches. In rare case the whole plant develops symptoms. A virus is associated with the disease and we are working in developing detection protocols for this pathogen. Information on the disease is limited but there are reports that claim 70% yield reduction. Given that mosaic is not widespread in our area it is suggested that infected plants are removed from the field and destroyed to avoid further dispersal to neighboring plants.
Management of Green June Beetles and Japanese beetles in Fruit

Donn T. Johnson¹, Barbara Lewis¹, Allen Knutson² and Fran Pontasch³

¹AGRI 320 Department of Entomology, Division of Agriculture, University of Arkansas, Fayetteville, AR 72701; dtjohnso@uark.edu
²Extension Entomologist, Texas A & M Research & Extension Center, Dallas, TX
³North Texas Viticulture Advisor, Texas AgriLife Research & Extension Center, Stephenville, TX

Biography: Dr. Donn Johnson has been a Professor since 1978. He teaches courses in Insect Pest Management and Insect Behavior/Chemical ecology. His job appointment is 12% teaching, 25% extension and 60% research in fruit. He develops and implements fruit pest scouting programs and more ecologically-based fruit pest management practices. He updates fruit pest alerts and recommendations as needed on the University of Arkansas Fruit IPM web site: http://comp.uark.edu/~dtjohnso/. His research and extension projects include: developing pest scouting and management practices for organic apples and field grown and high tunnel bramble production systems; testing insecticide efficacy against rednecked cane borer, raspberry crown borer, grape phylloxera, grape berry moth, green June beetles and Japanese beetles (JB); showing growers how to use mating disruption against fruit moths; attracting plum curculio adults to baited trees for spot sprays of insecticide; and finding tactics to reduce local populations of JBs.

Abstract: The green June beetle (GJB) and Japanese beetle (JB) are related beetles that both cause damage in eastern Oklahoma and Arkansas. Thousands of GJB adults were mass captured in 20 or more baited traps placed in trap lines adjacent to several vineyards in AR and TX. The bait inside each trap was a lure of 91% isopropanol evaporated from a cotton wicked-bottle. Similarly, JB traps baited with the dual-lure (floral lure and sex pheromone) around a vineyard perimeter mass trapped hundreds of thousands of JBs. Mass trapped vineyards still had fruit damaged by GJ Bs and were defoliated by JBs so growers applied weekly insecticide sprays. Four rows of a ‘Norton’ vineyard and all of an organic apple block were kept white-washed with three or four applications of Surround WP kaolin clay, respectively, resulting in minimal foliar damage by JBs comparable to multiple foliar sprays of recommended insecticides.

The green June beetle (GJB), Cotinis nitida L., is native to the southeastern United States and causes significant fruit damage to fruit cultivars maturing from mid-July to late-August and can damage turf or row crops fertilized by composted manure (Flanders and Cobb 2000, Jackson 2009, Johnson et al. 2009). Hand removal of fruit feeding GJBs or application of Sevin insecticide to foliage and fruit are the only recommended management tactics against the GJBs. We need alternative tactics developed against GJ Bs including additional insecticides labeled that have different modes of action and a preharvest interval (PHI) of 7 days or less. Johnson and Lewis (2009) reported the following insecticides as effective against GJBs: Actara, Admire, Altacor, Battalion, Baythroid, Clutch, Danitol and Mustang Max all killed 100%; whereas Ecotrol and Aza-Direct, respectively, killed only 70% and 50%). So far, only the Aza-Direct label
mentions a registered use against beetles (such as JB). We will request that EPA modify labels of these other compounds for use against GJBs on fruit.

**Mass Trapping Experiment:** We are also improving a lure and trap placement system either to mass trap or to attract-and-kill GJBs outside fruit plantings in order to minimize both fruit damage and use of insecticides. The present reusable GJB trap (Fig. 1 A, B) cost $12.50 and includes a 3/8” rebar stand 3ft long, recycled 20 fl oz bottle that evaporates $3 of 70% or 91% isopropanol bait per season from a $0.50 cotton-wick (½ inch diameter) inside a $4 plastic box (2-5 gal. capacity) that accumulates GJBs attracted to and funneled through the yellow Xpando trap top ($5 from Great Lakes IPM, Vestaburg, MI). In 2009, traps were set 100 ft apart in trap lines positioned 100 to 200 ft outside fruit plantings in six locations (Fig. 1 C): Altus, Eureka Springs, University of Arkansas Agricultural Research and Extension Center (AAREC) in Fayetteville, AR; and Purdy, MO; and in Bridgeport and Springtown, TX.

Fruit cultivars that ripen in late July and August could be susceptible to GJB and JB feeding damage (Hammons et al. 2008). The peak flight of GJBs differed between states as follows: late July or early August in AR and MO; and mid to late August in TX (Table 1). Totals of 22,195; 70,181; 3,240 and 9,170 GJBs were trapped and killed at the AR, MO and two TX vineyards, respectively. One TX grower hand collected 4,181 and 918 GJBs from grape clusters and traps, respectively, which indicated that the trap line captured only a portion of the GJBs entering the vineyard. The cluster damage due to GJBs ranged from 28% to 75% in these two TX vineyards despite mass trapping GJBs and application of two treatments of Sevin XLR at a rate of 2 quarts per acre ($22 per acre). Recommend placement of one or two alcohol-baited GJB traps near cultivars that mature in late July or early August to monitored for and alert growers when GJBs begin to disperse into that fruit planting so as to improve timing of protective insecticide sprays.

The Japanese beetle (JB), *Popillia japonica* Newman, was accidently introduced to New Jersey from Japan in 1916. In 2001, it became established and is spreading in NW Arkansas, eastern Oklahoma and Missouri where it causes economic damage to fruit, ornamental plants and turf. Fruit growers in Arkansas and Missouri have recently added three to four weekly sprays of insecticide per season to prevent JB damage for a seasonal cost greater than $36/acre. In Michigan, in order to ship blueberries free of JBs, they increased annual insecticide use by $72 per acre (Szendrei and Isaacs 2006). The carbamate, Sevin, is labeled for use against JBs. In 2007, the EPA approved three pyrethroid insecticides for control of JB on fruit: Mustang Max (zeta-cypermethrin, pyrethroid), Danitol (Fenpropathrin), and Brigade (bifenthrin).

**Mass Trapping:** Multiple years of mass trapping JB adults in yellow funnel traps baited with a dual-lure (floral lure and sex pheromone) and spaced 100 ft apart in Fayetteville, AR and Purdy, MO did not appear to reduce potential for defoliation of susceptible fruit plantings by JBs or significantly reduce local populations. In 2007 and 2008 in Purdy, MO, we had a trap line north of a susceptible ‘Vignoles’ vineyard that captured a season total of 281,785 (18 traps) and 1,039,732 (17 traps) JBs, respectively. This grower still applied three to four weekly insecticide sprays to prevent defoliation by JBs. In 2006 to
2009 at the AAREC in Fayetteville, AR, 14 to 18 baited traps captured season totals of 484,867; 146,218; 493,706; and 629,314 JBs, respectively. In 2008 and 2009, there was only slight JB feeding damage to foliage and flowers in the adjacent blackberry plants grown organically.

Surround WP Protectant: Surround WP (a kaolin clay formulation by Engelhard Corp., Iselin, NJ) may be used as an alternative to recommended insecticides. A couple trips through a JB-susceptible planting with a conventional sprayer is required to white-wash the leaves, stems, and fruit with a protective film of clay (Fig. 2 A, B). The clay deters insects in several ways. Tiny particles of clay attach to the insects when they contact the foliage causing insects to either clean themselves of clay instead of feeding or to leave the treated foliage (repelled). In addition, the highly reflective white coating makes the treated plants less recognizable as a host. Surround is generally compatible with other pesticides but you should check a pre-mixed slurry for curdling, precipitation, lack of film formation, or changes in viscosity as signs of incompatibility. Do not tank-mix Surround with sulfur or Bordeaux mixture fungicides.

In 2009, the first JBs were observed flying on 15 June and caused significant foliar damage from 24 June to early August. Danitol and Mustang Max insecticides provided adequate protection of foliage against JB feeding for about a week. In July 2009, the grower in Purdy, MO helped us set up an experiment. Rows 5 and 6 of a ‘Norton’ block were unsprayed. Rows 7 to 40 were sprayed on 22 June with Danitol 2.4EC insecticide at a rate of 10.5 fl oz and on 30 June and 9 July with Mustang Max EC at a rate of 4 fl oz. Rows 1 to 4 were white-washed with Surround at a rate of 25 lbs/acre on 26 June (Fig. 2 B) and re-applied on 28 June after residue was washed off by a total of 0.86” rain from 27 to 28 June. For the next two weeks, rain totaled 0.3” and did not wash off the clay residue. However, the grower re-applied Surround on 5 and 13 July when he saw JB feeding on new, unprotected terminal leaves. In Fayetteville, AR, Surround was applied to the organic apple block on 2, 9, 22 July and 12 August (Fig. 2 A). As a result, the apples or vines white-washed with Surround or vines sprayed with insecticide (Table 2) had minimal leaf defoliation. However, JBs defoliated the understory of weeds in the apple orchard (Fig. 2 A). The grower said that Surround would only have application in a backyard or organic vineyard since Surround is the most expensive JB treatment (> $30 per 25 lb bag/acre), washed off by rainfall, and difficult to get foliage white-washed with one trip of sprayer through the vineyard.

Currently, there are no effective natural enemies to suppress this JB population. Drs. Donn Johnson and Don Steinkraus and graduate student Bryan Petty have recently acquired funding from the Arkansas Agriculture Department USDA Specialty Crop Block Program titled, Classical biological control of the JB in Arkansas. This project will allow us to collect protozoan-infected and bacteria-infected JB grubs from Michigan, release these into JB-infested areas of NW Arkansas and annually assess if they start to reduce the JB population and lessen the usage of insecticides.

Disclaimer: All chemical information is given with the understanding that no endorsement of named products is intended, nor is criticism implied of similar products
that are not mentioned. Before purchasing or using any pesticide, always read the label and follow the directions.

**Acknowledgements:** This work was funded in part by the Missouri Wine and Grape Board, USDA Viticulture Consortium-East, Southern Region Small Fruit Consortium and the IR-4 Program. We thank the growers for allowing use of their vineyards, and our technical assistants: Erin Walters, Sandra Sleezer, and Emili Slamons.

**References Cited:**

Table 1. Estimated number of green June beetles (GJBs) captured in yellow funnel traps (N = number of traps) baited with 91% isopropanol in Arkansas, Missouri and Texas (2009)

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Purdy, MO</td>
<td>26</td>
<td>10,095</td>
<td>18,398</td>
<td>41,688</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>70,181</td>
</tr>
<tr>
<td>Altus, AR</td>
<td>14</td>
<td>311</td>
<td>3,452</td>
<td>1,200</td>
<td>3,983</td>
<td></td>
<td></td>
<td></td>
<td>8,946</td>
</tr>
<tr>
<td>Eureka Springs, AR</td>
<td>16</td>
<td>1,462</td>
<td></td>
<td>5,130</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>6,592</td>
</tr>
<tr>
<td>Fayetteville, AR</td>
<td>18</td>
<td>391</td>
<td>2,112</td>
<td>1,827</td>
<td>1,732</td>
<td></td>
<td></td>
<td></td>
<td>6,062</td>
</tr>
<tr>
<td>Bridgeport, TX</td>
<td>29</td>
<td>43</td>
<td>44</td>
<td>40</td>
<td>31</td>
<td>7,628</td>
<td>466</td>
<td>9,170</td>
<td></td>
</tr>
<tr>
<td>Springtown, TX</td>
<td>32</td>
<td>2</td>
<td>10</td>
<td>17</td>
<td>50</td>
<td>1,204</td>
<td>1,541</td>
<td>416</td>
<td>3,240</td>
</tr>
<tr>
<td>Sample date totals</td>
<td>--</td>
<td>1,757</td>
<td>8,920</td>
<td>7,253</td>
<td>10,926</td>
<td>2,122</td>
<td>9,169</td>
<td>882</td>
<td>104,191</td>
</tr>
</tbody>
</table>
Table 2. Mean number of Japanese beetles (± SE) per vine (N = number of vines) for each management treatment applied in Purdy, MO (2009)

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Mean No. Japanese beetles/vine</th>
<th>N</th>
<th>July 6</th>
<th>July 15</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surround WP (kaolin clay)*</td>
<td></td>
<td>21</td>
<td>0.4 ± 0.16 b</td>
<td>0.5 ± 0.11 b</td>
</tr>
<tr>
<td>Insecticide sprays*</td>
<td></td>
<td>10</td>
<td>4.8 ± 1.02 b</td>
<td>7.4 ± 0.83 a</td>
</tr>
<tr>
<td>Unsprayed</td>
<td></td>
<td>10</td>
<td>48.0 ± 3.37 a</td>
<td>5.0 ± 0.96 a</td>
</tr>
</tbody>
</table>

* Spray dates: Surround on 26, 28 June, 5 and 13 July; Danitol on 22 June followed by Mustang Max on 30 June and 9 July

Means followed by a different letter are significantly different in Tukey’s Studentized Range (HSD) test (P < 0.05)

Figure 1. (A) Cotton-wick dispenser being (B) filled with 91% isopropanol and green June beetle (C) traps set 100 ft apart in a trap line 100-200 ft outside a vineyard in Purdy, MO (2009)

Figure 2. Japanese beetle defoliation of (A) ‘Enterprise’ apples in Fayetteville, AR or (B) ‘Norton’ vines in Purdy, MO white-washed with Surround clay versus (C) vines sprayed with insecticides (Danitol on 22 June + Mustang Max on 30 June and 9 July); or (D) untreated (2009)
Problems and Solutions with Peach Crops

Tim Ray – General Manager, Deep Fork Peach Orchard, Harrah Oklahoma

There are many problems associated with peach crops but what are the solutions to those problems? Your solutions to your problems, from planning to planting to harvesting to selling, may be different than the grower down the road. This is a general discussion about peach crops and some of the adversity that we’ve had personally and what we did to solve the issues we were faced with.

When we took over the orchard in 2008, we were faced with a lot of ice damage from the December, 2007 ice storm. The first thing we had to do in the following months was clean everything up. We had a LOT of broken limbs, broken down trees, etc. The clean up resulted in a loss of 1000 trees out of 4000 so approximately a 25% loss in production before we even got started. We could have kept a few trees with a limb or two hanging off of them but we wanted everything to look as nice as possible. Aesthetics is NOT a big issue when it comes to many growers, after all a tree in production is making money, but we wanted everything to look as good as possible. We’ve had a lot of customers tell us how good everything looks and that’s important to us. After the cleanup, we knew we had to replant so from a planning and planting standpoint, the question was “Where do we go from here?” or “What is our main goal?” Our main goal obviously is making money. We wanted to plant more trees while at the same time, increase the number of trees. The problem we had was we were limited on space, no extra land available. The solution for us was simple, we were going to change the way we planted our trees.

We are changing to the Quad V pruning system to make up for the land limitation. The Quad V pruning system results in 4 (quad) scaffold limbs as opposed to the Open Center system where you might have anywhere from 5 to 7 or more scaffold limbs. The trees in the Quad V system are planted every 9-10 feet apart as opposed to 18-20 feet apart in the Open Center system. This saves money on chemical costs per acre, less chemical waste, and increases production.

After the ice storm clean up, we had a lot of stumps removed which left a lot of open areas where we needed to plant new trees. We used a tree spade to transplant various varieties and condensed them to full rows to make room for our new plantings. We did this so the few remaining trees in a variety would not be in the way of soil preparation and allowed us to keep young trees that are still producing. We had around a 95% success rate with our transplanting. A few of the larger trees did not make it.

As with every crop, we were faced with insect and disease problems. Identification and timing is critical! What do I mean by that? As with every crop, it is important to know the insects and diseases associated with them and in most cases, prevention is the most important aspect of management. Peach crops are definitely no exception. Waiting until you see damage may be too late in some cases.
When I first started managing this orchard, the previous owner was kind enough to show me some damage caused by the Peach Tree borer. To be honest, due to the amount of rainfall the previous year, he didn’t get a chance to do his borer spray so we had quite a bit of damage to many of the trees. The greater peach tree borer larvae will eat around the base of the tree usually at the soil line cutting off water and nutrient availability and the lesser will be found on scaffold limbs. We should get better control now that we are on a continuous spray program.

Besides the borer, two other insects, the Plum Curculio and Stink Bug, can do more damage than anything else it seems. And these are definitely two that we had problems with. The damage from both is easily distinguishable from any other insects. The plum curculio bites into the skin and lays their eggs. The larvae will then eat its way out. Stink bugs cause “cat facing”. These are areas that just don’t grow once they have been bitten.

Bacterial Spot is one of the diseases we had. It actually affected about 4 or 5 of our varieties with Summer Pearl having the worst damage. Summer Pearl is one of the more susceptible varieties there are. Once it has bacterial spot, there’s nothing you can do. I’m going to incorporate a bacteriacide, such as Oxytetracycline, in my spray program starting in early spring to see if we can get some control. Proper pruning is the Key to a successful harvest. When we took over the orchard not much pruning had been done previously so we had minimal time to prune what we could due to clean up efforts. Needless to say, we couldn’t prune enough the first year. The result was too many limbs left which allowed for poor insect and disease control when spraying. We were basically covering the outside limbs and leaves and not much getting to the inside.

Having good fruiting wood on the scaffolds is important. On our Lorings, we have too many limbs up top and not much fruiting wood down the scaffold limbs. We are preparing to plant 870 new Lorings so these will be removed once the others come into production.

Thinning is another area we had problems. Too many peaches close together resulted in poor fruit sizing. A gentleman gave me some advice before we started thinning. He said, “don’t look down because it will make you sick”. Another thing he told me was “when you think you’ve thinned enough, thin some more.” Well, he was right on both accounts. We ended up having some “ok” sized fruit but there’s no doubt we could have thinned more and gotten a lot bigger and better crop than what we ended up with.

A good distance between two peaches should be about 10-12 inches apart. 2009 started off very normal. Everything was blooming or had been in bloom and now with many small peaches on the trees and then……we were hit with a late freeze and we lost our entire crop over night. The temperatures got down to around 23-24 degrees. We had had a couple of freezes earlier but the temperatures had only gotten down to around 28 which is ok but anything below that and you really start having problems. Hopefully, we’ve learned our lessons from past experiences and have a better year in 2010.
Early Performance of an Organic Apple Orchard as affected by Nutrient Source and Ground Cover Management

Curt R. Rom, Professor of Horticulture
Jason McAfee, Program Technician
Heather Friedrich, Program Technician
Donn Johnson, Professor of Entomology
Elena Garcia, Fruit Extension Specialist
Jennie Popp, Associate Professor of Agricultural Economics
Mary Savin, Associate Professor of Crops, Soils, and Environmental Sciences
Agricultural Experiment Station, Division of Agriculture, University of Arkansas, Fayetteville, AR
Contact: C.R. Rom (crom@uark.edu); phone: 479.575.7434

Speaker Biography
C.R. Rom grew up on a fruit farm in Northwest Arkansas. He attained a BS of Agriculture studying Horticulture and Business from the University of AR and earned his MS and PHD degrees from The Ohio State University. He was a horticulturist at the Washington State University prior to becoming a professor at the University of Arkansas in 1989. He has broad responsibilities for horticulture education, and research on fruit crop physiology and management, and organic and ecologically-based production systems.

Introduction
A goal of the research, outreach and education programs of the Horticulture department of the University of Arkansas is to develop sustainable and organic production systems in order that producers can capture high value markets and meet the needs of consumers. Organic produce consumption in the US has been steadily increasing at almost a 10% rate for more than the last decade. This clearly demonstrates a demand for organic fruit. However, the number of organic certified farms in our region is small, especially relative to other places in the US. Most notably, there is a lack of organic fruit production. A survey of producers and extension works indicated that production may be limited by a lack of regionally and locally developed, adapted, tested, and demonstrated scientifically-based technologies for organic fruit production. There is a limited knowledge, expertise and experience. A project at the University of Arkansas was developed to develop organic production system for apples in the Arkansas-Oklahoma region.

Two key issues for organic horticultural research identified by growers and extension workers were how to manage nutrition in an organic orchard, and how to manage competitive vegetation under the tree. It is obvious that those two issues are inter-related and as applied nutrient sources may stimulate competitive vegetation, and the competitive vegetation may utilize all applied nutrition and thereby cause lack of tree performance. The research project was established to specifically study the inter-relationships of applied nutrient sources and under-tree competitive vegetation management systems and their affects on tree growth and performance. This paper presents summary findings of the early performance of the organic orchard project.
An organic orchard was planted in April 2006 at the University of Arkansas Main Agricultural Experiment Station, Fayetteville, AR, following 6 months of land preparation. Prior to planting, the field had been vacant for two to three years. Land was leveled and contoured for drainage. Preplanting soil assessment indicated the soil pH was unacceptably low and soil had very low organic matter. In September, the year prior to planting, the appropriate amount of agricultural lime was applied and cultivated-in to raise soil pH to approximately 6.2. Semi-composted horse manure was applied and cultivated-in at a rate of approximately 3 tons/acre in order to build soil organic matter and nutrition. After cultivation, Kentucky-31 fescue and white clover were planted with a winter cover crop of winter wheat. During the winter season, rows were laid, tree holes were dug, a 2-wire, 10-foot tall trellis system was installed, and an irrigation system was installed.

Trees of ‘Enterprise’/M26 were planted at 6 ft by 12 ft (605 trees/acre) in early April, 2006. ‘Enterprise’ was selected because of strong performance in previous tests; it has multiple disease resistances, is has a September harvest season, and is a vigorous tree producing large, red apples of adequate texture and flavor. It was our strategy to use a unique cultivar for the organic system and base that system on genetics that confer disease and/or insect resistance, as well as adaptability to the region. A vigorous tree was selected to withstand challenges from low nutrition and from competitive vegetation. Trees were trained to a vertical axis system; a tall narrow conical shape with trees achieving a height of approximately 12 feet.

Two interactive sets of treatments were applied to the trees approximately 1 month after planting and annually each March or April. Trees received one of the following nutrient source treatments: 1) a control where the ground cover management system provides nutrition (NF) (see below), 2) composted poultry litter from a local source (PL), and 3) a certified commercial pelletized nutrient source based from poultry products (CF). Trees then received one of the following ground cover management treatments being: 1) urban green compost (GC), 2) wood chips (WC), 3) shredded institutional white paper (SP), and 4) a mow and blow treatment where vegetation was allowed to grow under the trees and all vegetation under and between trees was frequently mowed and blown under the tree. With the interaction of treatments, there were a total of 12 treatments for this study. However, in this preliminary report, on the main effect of nutrient sources and ground cover management will be presented.

**Summary Findings**

- Trees grown with the GC and WC ground cover management treatments achieved growth targets of trunk cross-sectional area (>15 cm²) and tree height (>10 ft) within two growing seasons in order to carry a crop in the third season. Trees grown in SP and MB did not achieve growth targets and were not allowed to crop in the third season.
- Trees with CF, PL and NF nutrient source treatments were similar in trunk cross-sectional area after two seasons. However, only trees with PL had achieved target heights.
- Trees with GC and WC had 3-5 times more flower clusters and 3-4 times the fruit set in the third growing season than trees with SP or MP ground cover.
management. Trees with GC and WC produced an estimated 185 and 143 bushels per acre in the third season while trees with SP and MB did not carry a crop to harvest and had no yield.

- In the 4th growing season, trees with GC and WC had 80% more flowers and 5-times the fruit set compared to SP and MB treated trees. However, due to a frost at bloom and poor fruit set, the differences in yield were small with trees using GC, WC, SP and MB producing 73, 136, 90 and 94 bushels per acre, respectively. Cumulative yields were greatest for the WC plots producing 280 bushels cumulative yield per acre in the 4th year.
- Trees with no additional nutrient sources (NF) had fewer flower clusters and lower fruit set than CF or PL treatments in the first two cropping seasons. After two cropping seasons, trees with PL and CF produced cumulative yields of approximately 294 and 263 bushels per acre, respectively.
- Trees with MB had significant mouse damage during the winter after the second growing season while trees with WC had the least damage.
- SP and WC had the least competitive vegetation under the trees in the first 4 growing seasons.
- Trees with MB had smaller leaves and lower foliar N in the second and 4th seasons. All trees were in the lower range of adequate for foliar nutrition in years 3 and 4. Trees with NF in combination with MB or SP were near deficient for N. Trees with GC had excessive foliar N in year 4 and grew vigorously.

**General Conclusions**

- Management of the undertree competitive ground cover was adequate with WC and SP, although SP treated trees were smaller, weaker, had lower nutrient status, and produced fewer fruit. MB alone did not control undertree competitive vegetation and had negative impacts on growth and productivity.
- Trees using GC for ground cover management were larger and produced adequate yields in the first two seasons. However, the GC supported significant vegetation under the trees and introduced new plant species that were competitive. The GC provided more nutrition to the trees than was needed and resulted in excessive tree vigor with light cropping after a frost in the 4th season.
- Trees not receiving supplemental nutrition, although similar in size, did not produce as many flowers and had lower fruit set in the first two cropping seasons. After 4 season’s growth, trees without supplemental nutrition were smaller.
- The source of nutrients (CF, PL, or from GC) was not as important as having an additional nutrient source.
- Not controlling undertree vegetation or controlling with mowing (MB) and not supplying additional nutrition resulted in smaller trees with lower cropping capacity.
Undertree competitive vegetation can be controlled with organic mulches and those organic mulches can provide additional nutrition to the trees. The addition of light surface cultivation under the trees reduced vegetative competition. Supplying nutrition from organic sources can provide sufficient nutrient levels to sustain cropping and growth in an organic system.

This study is planned as a 10-15 year study and only 4 years are complete. It is expected the trees should enter their mature productive capacity in years 5-6.
My father was a career Army officer. During the period from 1956 to 1959, he was stationed at a small US Army base, Camp Bussac, located in southern France approximately 50 km north of Bordeaux. Because there was no staff housing on base, we lived in rented house in the small village of Marcillac. Our landlord, Roland Magister, owned a machine shop in our village and tended a 1-1/4 acre vineyard behind his house. During our life in Marcillac, Monsieur Magister let this young American teenager into his shop and vineyard. His love of making and fixing things rubbed off on me – as did his love for raising grapes and making and enjoying wine.

When my wife and I retired to Norman, Oklahoma, in August 2001, after my career of 35 years as a petroleum geophysicist, we purchased our home on a 5-acre tract of land on a hilltop east of Norman in central Cleveland County. We had beautiful view – and room behind the house for that small vineyard that I had had in the back of my mind for years. My wife hardly flinched when I mentioned it to her.

We had taken the Cleveland County Master Gardener course soon after we arrived in Norman, so I knew how to take soil and water samples and have them processed. I obtained a copy of the *Soil Survey of Cleveland County, Oklahoma*. I located our home tract in the survey. The soil was clay loam on silty clay, medium in natural fertility, and low in organic matter. The soil sample came back from the OSU laboratory slightly alkaline and low in nitrogen and phosphorous. The water sample was moderately alkaline and classified as very hard due to dissolved minerals. There seemed to be no situation that we could not deal with.

We attended the HIS meeting and the *Oklahoma Grape Growers and Wine Makers Association* (OGGWMA) meeting in early 2002. We visited with several winery owners to ask the question, “What grapes should we grow in Central Oklahoma?” We did not get any answer with which we were satisfied, so we decided to plant varieties that could produce wines that our family liked: Zinfandel, Chardonnay, and Merlot, with Cabernet franc as a blending grape.

We ordered grape plants and did some basic chemical and fertilizer calculations. In February 2002, I hopped aboard my small Ford 1110 diesel tractor, attached the 4-ft PTO tiller, and began to work the soil in *Rock Creek Vineyard*. We started attending the OSU *2002 Grape Management Course*. Over the next three months, we installed end posts, wires for VSP trellising, drip irrigation. We planted our vines and protected them with grow-tubes. By September, it actually looked like a vineyard; no grape clusters, of course, but it looked great. It looked so great, in fact, that we decided that we could actually have a second vineyard on the east side of the property. During 2003-4, we developed and planted the second vineyard, now called the east vineyard. We attended the OSU *2003 Grape Management Course* just for good measure.
We still could not get an answer to the question, “What should we plant?” We decided to plant more assorted grapes: wine varieties Chardonel, Orange Muscat, White Riesling, and Black Corinth along with additional Zinfandel. We also planted five varieties of University of Arkansas table grapes: Mars, Reliance, Neptune, Jupiter, and Venus. Such a variety would not only provide us with useful information but also an opportunity to train our personal sensory abilities. Along with our ‘learn-by-doing’ methods, in 2005 we took viticulture and enology courses at Grayson Community College in Sherman, Texas, and on-line through Vesta.

By 2006, both vineyards were producing. We were learning the practical side of fungicide applications and timing, insect detection and control, weather variability, storm damage, and irrigation. We were selling a portion of the crop to a commercial winery. We were selling table grapes at the Norman Farmers’ Market. We were in the grape business.

As well as grape production, Rock Creek Vineyard has served as a base for other experimental observation. Dr. Damon Smith of OSU has conducted two years of black rot field studies on four of the rows. The Natural Products Discovery Group at OSU uses Rock Creek Vineyard vine cuttings in an attempt to isolate vinifera-related chemical compounds. The Oklahoma Department of Agriculture, Food, and Forestry (ODAFF) has used Rock Creek Vineyard as an insect trapping and observation site.

Since 2003, we have collected production data for 13 varieties of grapes as well as temperature and rainfall data. We know of varieties that are tolerant to our spring frosts and which varieties are not. We know which varieties come to full sugar and which do not. We look forward to the time ahead as we observe and learn more about which varieties do well in our central Oklahoma 7a climate. The experiment will continue and change. Will Pierce’s Disease affect us now that it has been discovered in Oklahoma? Will vine decline accelerate? Time and observation will tell.
Development of an Integrated Approach for Managing Black Rot of Grape in Oklahoma

PRINCIPAL INVESTIGATOR: Smith, Damon L., Assistant Professor, Oklahoma State University, Department of Entomology and Plant Pathology, Turfgrass and Horticulture Crops Pathology, 127 Noble Research Center, Stillwater

CO-PRINCIPAL INVESTIGATOR: Stafne, Eric T., Assistant Professor, Oklahoma State University, Department of Horticulture and Landscape Architecture, Fruit and Nut Crops, 340 Ag Hall, Stillwater

PROJECT SITUATION AND JUSTIFICATION:
In the State of Oklahoma grape production has become a lucrative alternative to conventional row crop farms. In 2001, only four wineries were licensed in Oklahoma. In 2007, this number has approached 50. There are over 500 acres of grapes grown in Oklahoma, however, the demand for Oklahoma-grown grapes by wineries in Oklahoma is greater than the vineyards can supply. The expansion of vineyards in Oklahoma is currently limited by the lack of information about cultivars that perform well in the state and by insects and disease pressure. Currently, nearly 80% of Oklahoma’s grape crop is comprised of well known European cultivars and hybrids derived from Vitis vinifera including ‘Chardonnay’, ‘Cabernet Sauvignon’, ‘Merlot’, ‘Zinfandel’, ‘Chardonel’, and ‘Traminette’. Most of these cultivars are also highly susceptible to black rot (a foliar and fruit disease caused by the fungus Guignardia bidwellii) the most serious grape disease in Oklahoma and other grape growing regions of the Southern and Eastern U.S. While foliar infections are typically first observed, the economic loss from the disease is a result of fruit infection that quickly rots berries and results in the diagnostic shriveled black ‘mummies’ for which the disease gets its name (2). The disease is polycyclic, therefore, spores generated from leaf lesions can be released to infect berries or cause more leaf lesions.

Management recommendations focus on reducing leaf infections by removing mummies from the trellis when grapes are dormant, good canopy pruning practices, and preventative or curative fungicide application (2, 3, 4). Depending on the mode of action for various fungicides labeled to control black rot, timing of fungicide application is critical. Host phenology also plays a significant role when developing a black rot management plan. Previous research has demonstrated that once berries reach veraison (berries begin to change color and sugar content increases) they are highly resistant (2, 3). Fungicide programs that focus on preventative applications of fungicide to limit leaf infection and reduce the amount of available inoculum when fruit are susceptible, have the greatest potential for sustainably managing the disease (2). A relatively simple disease model has been developed and evaluated in the Northeastern U.S. for recommendation of preventative and curative fungicide sprays (1, 5).

The black rot disease model has great potential for use in Oklahoma grape production. Weather in Oklahoma can vary tremendously resulting in periods highly conducive for disease development or extended periods that weather is not favorable for disease. A
Black rot disease model can help eliminate unnecessary fungicide sprays. Reducing or eliminating fungicide applications through the use of disease advisories is profitable for the grower, and is a positive step toward sustainability in 21st century agriculture. Several valuable disease advisories and forecasting systems have already been developed for other crops in conjunction with the Oklahoma Mesonet weather service. The implementation and validation of a grape black rot advisory is a natural fit for the Oklahoma disease prevention arsenal.

RESEARCH GOALS AND OBJECTIVES:

Long-term goal: To generate an interactive tool for growers that provides a free, site-specific, weather-based, internet accessed advisory to better predict epidemics of black rot. The accuracy of fungicide applications on grapes across regions with black rot pressure will be improved by providing accurate predictions of disease based on epidemiologically significant weather events. This will enable better control of black rot and reduce unnecessary applications of fungicide.

Objectives of this project:
Validate the currently available black rot model in conjunction with Oklahoma Mesonet for recommending protective and curative fungicide applications in Oklahoma.

BRIEF DESCRIPTION OF METHODOLOGY:
The objective of this project was accomplished using three grower demonstration plots located in diverse grape growing regions in close proximity to Oklahoma Mesonet weather stations. Replicated (5 replicates) treatments (3 treatments) were applied to two cultivars with differential levels of resistance. The spray treatments included the black rot model (1, 5) in conjunction with Oklahoma Mesonet, a calendar/physiological based model (2, 4), or not sprayed. On-site weather stations were included to monitor the performance of the Mesonet weather output and to augment the validation process.

SUMMARY OF COMPLETED TASKS, AND DATA, 2008:
Replicated research trials were established in the 2008 growing season at Stone Bluff Cellars (Stone bluff, OK), Parson’s Vineyard and Winery (Shawnee, OK), and Rock Creek Vineyards (Norman, OK). At each location two blocks of plants (black rot resistant cultivar and black rot susceptible cultivar) were split into five replicates with three treatments per replicate. Treatments included calendar-based application of fungicides, application of fungicides using the Mesonet weather inputs in the advisory as described above, or not treated with fungicide. All fungicide programs were used until the beginning of veraison (fruit ripening). Further fungicide application was applied by the grower on an “as needed” basis to control pre-harvest diseases. On-site weather stations were located at each site to record hourly weather data for correlation analyses with Mesonet data.

Due to cooler dry weather early on, disease levels were low across all sites, with no incidence of black rot recorded at Rock Creek Vineyards. At Stone Bluff Cellars, disease levels were low relative to Parson’s Vineyard and Winery. For Calendar-based applications of fungicide at Stone Bluff Cellars, nine and eight sprays were applied to the susceptible (’Chardonel’) and resistant (’Cynthiana’) cultivars, respectively.
Parson’s Vineyard eight sprays were applied to the black rot resistant (‘Vignoles’) and susceptible (‘Cabernet Franc’) cultivars for the calendar-based fungicide applications. At both locations use of the advisory-based application of fungicide reduced the number of fungicide applications by an average of approximately 45%. At Parson’s Vineyard and Winery a significant ($P < 0.05$) interaction of cultivar and treatment was evident for fruit disease incidence. Level of fruit disease was very low for the susceptible cultivar (Fig. 1). Treatment protocols for the susceptible cultivar were not significantly different ($P > 0.05$). For the resistant cultivar, levels of fruit incidence were not significantly different for the advisory and calendar-based applications of fungicide, while the non-treated plots had significantly higher levels of fruit disease (Fig. 1). Yield was significantly lower for plots sprayed according to the advisory versus plots sprayed according to calendar-based applications (Fig. 2). Non-treated plots were not significantly different from the calendar-based or advisory application of fungicide (Fig. 2). There were no other significant responses to treatments at Stone Bluff Cellars, due to the extremely low levels of disease throughout the season (data not shown). Overall, using the advisory reduced the numbers of sprays in all locations by almost half with limited or no adverse affects on disease levels or yield in 2008.

**Figure 1.** Standardized area under the disease progress curve (AUDPC) of fruit disease incidence for two grape cultivars (‘Cabernet Franc’ and ‘Vignoles’) sprayed using three different spray protocols. Data are from Parson’s Vineyard and Winery located in Shawnee OK. Mean separations on the resistant cultivar were performed using Fisher’s protected LSD; $R^2 = 0.70$; $CV = 126$; $P < 0.01$

**Figure 2.** Yield for grapes sprayed using three different spray protocols. Yield data from the resistant cultivar (‘Vignoles’) located at Parson’s Vineyard and Winery located in Shawnee OK. Mean separations were performed using Fisher’s protected LSD; $R^2 = 0.67$; $CV = 31$; $P = 0.04$.

**Literature Cited**

Elderberry Research and Production in Missouri
Patrick Byers, Cooperative Extension, University of Missouri
Andrew Thomas, Southwest Research and Education Center, University of Missouri

Introduction

The Elderberry (Sambucus nigra L. ssp. canadensis (L.) R. Boll) is native to much of North America. The plant is a medium to large shrub or small tree. Foliage is pinnately compound, and the stems are noted for large, raised lenticels. Flowers are borne in flattened panicles, usually in May, and fruit ripens in July, August, and September. Flowers and fruit are produced on both current season’s shoots and on older wood.

Elderberries were undoubtedly utilized by Native Americans, and were harvested from the wild by European settlers. Organized efforts to improve the native elderberry, however, began in the 20th century. The cultivars Adams 1 and Adams 2 were selected from the wild by William W. Adams in New York in 1926. Ezyoff, of unknown parentage, was introduced by Samuel H. Graham of Ithaca, New York, in 1938. More recent breeding efforts at the Kentville, Nova Scotia experiment station have resulted in Johns (1954), and Nova, Scotia, Kent, and Victoria, all released in 1960. The Nova Scotia releases are all seedlings of either Adams 1 or Adams 2. The latest release, York (1964), is a cross of Ezyoff and Adams 2 and was developed by the New York Agricultural Experiment Station.

A review of the elderberry literature reveals studies at Pennsylvania State University on elderberry culture, and at the University of Illinois on fertilization and cultivar evaluation. Recent work has focused on elderberry juice composition and the use of elderberry juice as a colorant. Reported elderberry investigations in Missouri prior to 1997 were limited to cultivar testing at the State Fruit Experiment Station of then Southwest Missouri State University.

The elderberry is a native, adapted plant in Missouri, and there is a demonstrated, growing demand for elderberry fruit and flowers from winemakers, jelly processors, and producers of various nutraceutical preparations. Commercially available cultivars were developed elsewhere, in New York and Canada, and native midwestern germplasm has not been utilized to any extent in the development of adapted cultivars. Research-based information on suitable cultural practices is lacking; numerous possibilities for cultural studies are available.

The Elderberry Improvement Project

The Elderberry Development Program, established in 1997, is a multi-institutional research and development project with collaborators at the University of Missouri, Missouri State University, USDA-ARS, North Carolina State University, and Lincoln University. The program has three phases: evaluation of elderberry germplasm and development of superior elderberry cultivars, investigations into elderberry culture, and investigations into the biochemical and genetic characteristics of elderberry. Progress
to date in phase 1 includes the collection and characterization of 68 elderberry selections and cultivars; replicated testing at multiple sites of 22 superior selections; initial preparations to name and release two cultivars; and a multilocational genotype by environment study that compared Missouri and Oregon grown plants. Phase 2 investigations include a multi-year study at two sites that compared four pruning treatments; a study to evaluate foliar nutrient content of old shoots vs new shoots during 3 collection periods; and plant performance under three levels of nitrogen fertilization. Phase 3 studies include three years of measurement of juice characteristics from 12 selections and cultivars, including measurements of antioxidant activity; investigations into antioxidant activity in non-fruit plant tissue; and investigations into the genetic relationships among selections of *S. canadensis* and other *Sambucus* species in our germplasm collection using the Target Region Amplification Polymorphism genotyping technique.

**Elderberry Culture**

The information presented here is gathered from several sources (see references), including our experiences in Missouri with the Elderberry Improvement Project.

**Cultivars**

Several elderberry cultivars are available commercially, including Adams 1, Adams 2, York, Nova, Scotia, Kent, and Johns. Recommendations from other regions include all these cultivars. Two cultivars developed in the Elderberry Improvement Project, 'Wyldewood' and 'Bob Gordon,' have performed well in our trials. A large portion of the commercial fruit crop, especially in the Midwest, is harvested from wild plants.

**Propagation**

Elderberries are easy to propagate. Root cuttings (pencil diameter or slightly smaller, 4-6 inches long) may be dug in early March before growth begins. The cuttings are placed horizontally in a flat or pot, covered with .75 to 1 inch of a light soil or soiless medium, and kept warm and moist. Often a single root cutting will produce 2-3 plants. Dormant hardwood cuttings root easily. Collect 3-4 node cuttings before growth begins in the spring, and place the basal 2 nodes below the surface of a well drained soil or medium. Be sure that the cutting wood is not cold damaged. A dip of the basal end of the cutting in an IBA rooting powder may increase rooting. Sprouted hardwood cuttings and softwood cuttings are also easily rooted, provided provision is made to maintain high humidity around the cuttings until rooted. An intermittent mist system works well. A rooting hormone dip may be beneficial. Cuttings of 2-3 nodes root well. Remove a portion of the foliage from softwood cuttings (we usually leave only the 2 basal leaflets of each leaf). Softwood cuttings typically root well until about July 1; rooting percentage drops as the summer progresses.

**Establishment**

Bare root 1 year plants dug from a nursery work well for planting establishment. Recently propagated container-grown plants may be used to establish plantings during the same season. Our plantings are on raised ridges (berms) that are spaced 12 feet apart. Plants are spaced 4 feet apart in the planting row.
Pruning
Elderberries produce fruit on shoots older than one year, and also produce suckers from
the crown or root system which will bear fruit the first year. Several references
recommend a selective removal of older shoots when pruning. Initial results from the
Mountain Grove pruning study suggest little difference among the 4 pruning treatments
in either panicle yield or berry yield. We have learned that the average size of panicles
when shoots are renewed annually is significantly larger, suggesting that current season
suckers produce larger though fewer panicles. Most of the panicles on these plants
were harvested in two harvests, over a period of two weeks.

Fertilization and irrigation
We apply nitrogen annually to the elderberry plantings. Mature plantings receive 60-80
pounds of nitrogen, applied at budbreak in late March – early April. We apply other
nutrients every second year if needed based on a soil test (using blackberry
recommendations), using a complete fertilizer as the nitrogen source. Elderberries are
not drought tolerant, and we irrigate the plantings during dry periods. We use trickle
irrigation. The plantings are also mulched, to help conserve soil moisture.

Elderberry pests
While elderberries are relatively pest resistant, we have noted several potential
problems in our plantings. An unidentified stem borer causes wilting and dieback of
new shoots in April and May in the Mountain Grove plantings. Larva of a sawfly have
defoliated plants at the Mount Vernon site. The adult elder borer, also known as the
elderberry longhorned beetle, has been collected at both the Mount Vernon and
Mountain Grove sites. The larva of this spectacular beetle bores into the woody parts of
the plant. Stink bugs are routinely noted on ripe panicles, but the amount of damage is
unknown. A potentially damaging pest is the eriophyid mite, present at both the
Mountain Grove and the Mount Vernon sites. This mite causes a cupping and crinkling
of the foliage, and can cause abortion of florets and young fruit. The economic impact
of this pest is unknown. Fall webworms were also noted in the Mount Vernon planting.
An unidentified leaf spot disease, which usually is noted in midsummer, can cause
premature leaf drop and occasionally defoliation. Birds of several species will feed on
everderry fruit; those selections with pendulous panicles appear to be less attractive to
birds.

Elderberry harvest, yields, and juice parameters
Elderberry harvest takes place in late July, August, and early September. Entire
panicles are clipped and harvested when all berries are fully colored. The panicles on
current season’s shoots ripen later than panicles on older wood. A bush with shoots of
mixed age will ripen fruit over a 3 week period. We harvest plants at weekly intervals.
Berries may be removed from the panicle by freezing the entire panicle and shaking off
the fruit. The berries may be refrozen and processed as needed.

In the early 1970’s Dr. Skirvin of the University of Illinois reported on yields from an
everderry trial that included Adams 1 and Adams 2. Average yields over the two
cultivars were 1214 lb/acre in the first year, 8677 lb/acre in the second year, and 8582
lb/acre in year 3. Maximum yields (for Adams 2) were 3735 lb/acre in the first year, 13495 lb/acre in year 2, and 13846 lb/acre in year 3. The average yields for Adams 2 and the selection Gordon B from the pruning trial at Mountain Grove were 1226 lb/acre in the first year, 3338 lb/acre in year 2, and 5621 lb/acre in year 3. Gordon B had the highest yields in this trial - 1842 lb/acre in the first year, 4868 lb/acre in year 2, and 7572 lb/acre in year 3. In the first harvest year (2004) of the replicated selection/cultivar trial at Mountain Grove, the highest yield, 11352 lb/acre, was reported for the selection Wyldwood 1.

The following table includes juice parameters from the 2002 harvest:

Means of juice characteristics from 2002 elderberry harvest at two locations (Mountain Grove and Mount Vernon):

<table>
<thead>
<tr>
<th>Site</th>
<th># Samples</th>
<th>°Brix</th>
<th>pH</th>
<th>TA (ml)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mt. Vernon</td>
<td>34</td>
<td>11.44</td>
<td>4.72</td>
<td>0.85</td>
</tr>
<tr>
<td>Mtn. Grove</td>
<td>26</td>
<td>12.59</td>
<td>4.56</td>
<td>0.92</td>
</tr>
<tr>
<td>Combined</td>
<td>60</td>
<td>11.94</td>
<td>4.65</td>
<td>0.88</td>
</tr>
</tbody>
</table>

Uses and markets for elderberry fruit and flowers
At present, most of the elderberries grown in the Midwest are harvested for processing markets. Several wineries produce elderberry wines from the fruit, and the flower panicles are used to flavor wines. Jelly and jam are produced from elderberry juice or blends of elderberry and other fruits. Elderberries contain high levels of antioxidants, and elderberry juice and concentrate are marketed as nutraceuticals. The pigments in elderberry juice are suitable for colorant use.

A recent development of interest to elderberry enthusiasts is the formation of the North American Elderberry Alliance. While still under development, information on the Alliance is found at [http://www.elderberryalliance.org/](http://www.elderberryalliance.org/).

References


*Responses of Cultivated Elderberry Varieties to Fertilizer and Mulch Treatments*. 1958. Pennsylvania State University Agriculture Experiment Station.


Pecan acreage in Oklahoma has increased by nearly 65% over the last five years due to new plantings of improved varieties and increased management of natives. In fact over the past 20 years, Oklahoma has had the greatest increase in pecan acreage among the top five producing states (Georgia, New Mexico, Texas, Oklahoma and Arizona). There has also been an increase in number of operations in New Mexico and Oklahoma. However, Georgia, Texas and Arizona have declined in number of operations over the past 20 years. The majority of these new operations are small scale operations, less than 40 acres. This increase has ultimately led many questions from producers specifically concerning the hot topics in the pecan industry. One of the main topics for Oklahoma has been the overall change in the industry. Over the past several years there has been an increased interest in pecans which has resulted in several new plantings, both commercial and homeowner. There has also been an increase in management of natives.

With this increased interest it is important to educate potential producers about proper establishment methods in pecan orchards. When I begin working with an individual that is considering planting pecan trees, whether it is a couple of trees for their own use or if it is several thousand trees in a commercial operation, the first questions I ask is, “what are your goals for this planting?”. The goals may influence site selection, varieties and number of trees that will be planted. The other important area to discuss is management strategies for the planting. If a producer is looking for enough nuts for their family and a few friends the management strategies are quite different than for someone who wants to produce 2000 pounds per acre. There are five areas that should be considered before planting:

1) **Financial** – a producer must understand that starting and maintaining an orchard is an expensive investment with little return for several years.
2) **Land** - perhaps one of the most important resources that is often over looked.
   How much land is needed and will the desired location work for pecan production.
3) **Water** – availability is critical for pecan production
4) **Labor** – a producer can not just plant a tree and wait for it to produce.
   Successful pecan plantings require hard work and commitment. Work on the pecan orchard is different than that of vegetables or berry production, available labor must be considered.
5) **Marketing** - Is there a marketing plan? Marketing plans directly influence what varieties should be planted and the management strategies that will be required.

**Water**

Many times I will visit a grower that has planted pecans and they are disappointed in the performance of their orchard. Most of the time the actual planting site is the problem affecting performance. Many times, individuals think that because native pecans grow
in bottomlands, that this is the best sites for pecans. However, this is not always true. Trees that are growing in these areas have adapted to these areas or may not be as productive as compared to being planted in a better area. For example, water availability may be lacking in these areas. Pecans require a large volume of water (around 55 inches/ac), however it is critical to remember that too much water can be worse than not enough. I have also had producers ask about planting in an area with a high water table so the tap root will grow down to the water thus eliminating irrigation. This is common myth that I come across frequently. Most of the water uptake by the trees is from the small lateral roots growing in the top 30 inches of the soil. If the water table is too high, then the water will kill the root system. Therefore, you need to make sure that the water table is at least 7 ft below the surface. Even though pecans need a lot of water, water drainage is important as well. Surface drainage if not adequate is normally easy to correct, however internal drainage is often overlooked. Water drainage from the soil (internal drainage) can be checked by doing a perk test. A perk test can be done by the producer by digging a hole the depth of the rooting zone, filling the hole with water, letting it drain and refill. Monitor the length of time it takes the hole to drain the second fill. For pecans we would like to see it drain within 48 hours. If it does not drain out completely, a reduction in the production will be seen. A simple perk test will help determine the importance of irrigation and which type of irrigation should be used. If the water drains out within a hour then irrigation will be very important and a sprinkler type system would be best, if the water takes over 24 hours to drain then there is good water holding capacity in the soil and irrigation may not be as important (depending on goal) and a slow low volume irrigation system like drip would be best.

When you look at available water be sure that you have the volume of water needed for irrigation. Water should be tested to ensure that sufficient quality exists for pecans. I strongly recommend that producers contact an irrigation specialist to help design a proper system.

**Pecan Varieties**

Another common topic of interest is variety selection. Variety selection depends on goals and management strategies. It is crucial to remember that there are several good varieties to select from, while keeping in mind that there is not a perfect variety. Selection should be based upon individual situations. Some of the newest varieties that have been released are Lakota (59 nuts/lb; 62% kernel; early nut mature; strong tree structure; very resistant to scab), Mandan (50 nuts/lb; 60% kernel; early nut mature; strong tree structure; resistant to scab), and Apalachee (84 nuts/lb; 54% kernel; heavy early producer; strong tree structure; very resistant to scab).

After purchasing the desired trees, it is very important to remember to plant the trees at the same level that they were planted at the nursery, or a little higher. Trees that have been planted too deep do not grow roots in the area from the original soil line to the planted soil line, which creates a weak anchored tree. These trees are not very productive and are prone to blow over.

Some producers choose to clear out native pecan groves instead of planting improved varieties. When clearing groves it is critical to remove enough trees to reduce competition for essential nutrients. The proper spacing of the trees is very important to
the potential production of the grove. Proper tree spacing can be determined by maintaining no more than 50% shade under the trees during noon in July. If more shade is under the trees then more trees need to be removed. In areas that are being cleared out leave some of the small seedlings that can be grafted to a known variety. By grafting a known variety in a native grove, you can increase the production and quality of the grove.

**Fertilization**

Over the past couple of years, new research has revealed phenomenal information concerning the fertilization of pecan trees. Research indicates that pecan trees have very low absorption efficiency of nitrogen. In studies from New Mexico State and Oklahoma State nitrogen absorption is between 19 and 27% of applied nitrogen. The nitrogen that is absorbed is rapidly taken up and transported to actively developing tissues. Most of the nitrogen in foliage and fruit originates from storage pools. Pecan production depends on annual fertilization that replenishes storage pools however trees are relatively insensitive to nitrogen application time.

**Wildlife**

Another issue that I am often questioned about is wildlife control in the orchard. A study conducted by the Noble Foundation in a native pecan grove revealed that wildlife harvested sufficiently more pecans than the farm staff. Therefore, wildlife control is important for a successful productive orchard. The two predators responsible for the most significant damage are squirrels and birds (crows and blue jays). Squirrel damage starts early, about the time that the shell starts to harden, through harvest. Bird damage begins after the kernel is developed through harvest. So, the earlier pecans are harvested the less likely losses will be seen from wildlife. These two predators are not the only wildlife concerns. Losses from the feral hog are increasing. Hogs do not only eat and damage your crop, but they can damage the trees and damage the orchard floor. Other wildlife that can cause damage are deer, flying squirrels and gophers.

**Food Safety**

Food Safety became the hot topic for 2009 after the peanut recall which changed the risk level of nuts for food borne pathogens. During this outbreak, the recall was attributed to Salmonella contamination. Food recalls seriously impacted sales and consumer confidence. The pecan industry is quickly putting standards into place to ensure that pecans are as safe as possible. Fortunately, at this time the pecan industry has not suffered a blow due to food safety issues. However, Pecan Grower’s Associations have created a crisis communication plan in the event of a food crisis event.
Cultural Problems Facing the Blueberry Industry in Arkansas

M. Elena Garcia, Associate Professor - Horticulture Dept. University of Arkansas

Collaborators:
D. T. Johnson, Professor - Entomology Dept. University of Arkansas
I. E. Tzanetakis, Assistant Professor - Dept. of Plant Pathology- University of Arkansas
T. Kirkpatrick, Professor – Dept of Plant Pathology – University of Arkansas
C. I. Vincent, Program Technician – Horticulture Dept.- Horticulture Dept.

Introduction
According to USDA statistics, there are 530 acres of blueberries planted in Arkansas. Blueberry plantings generally consist of small acreage (1 to 5 acres) as part of a larger diversified farming operation. Eighty percent of the Arkansas blueberry crop is sold as fresh market with an estimated cash value of $2,500,000.00. Most blueberry acreage is concentrated in northern and central Arkansas. Significant production is located in Benton, Carroll, Stone, and Washington counties in northern Arkansas and Crawford, Faulkner, Franklin, Johnson, and White counties in central Arkansas. Blueberry production has been increasing in the U.S. in the last few years, with dramatic 45 percent increase in utilized value of production from 2005 to 2006. Although Arkansas climate allows for production of the three commercial types (northern highbush, southern highbush and rabitteye), acreage has not increased in the previous five years. We can attribute the lack of growth in this industry to various factors such as loss of agricultural land to urban development, but growers are also facing cultural problems such as general plant and yield declines. These problems are extensive and widespread throughout the industry and appear to be both abiotic and biotic in nature.

Methods
We conducted a survey of the industry to attempt to determine cause(s) for these problems facing the industry. We selected fourteen blueberry farms located throughout the state growing the three types of blueberries. These farms were visited four times during the growing season and the following activities were conducted:

- An assessment tool, developed to ascertain cultural practices, was given to the grower.
- Insect traps were set to determine presence or absence of the following insects: Blueberry maggot, Plum curculio, Cherry fruitworm, Cranberry fruitworm, Sharpnosed leaf hopper.
- Throughout the season, foliar samples showing disease symptoms were collected and sent to the plant diagnostic clinic to determine the casual organism. Disease management recommendations were attached to the diagnosis.
- Samples showing virus infection symptoms were sent to U of A laboratory for diagnosis.
- Soil samples were collected for nematode assays.
- Foliar samples were collected at each farm to determine nutritional status.
- Soil samples were collected at these farms to determine soil conditions.
Results

Assessment tool

- Demographics
  - Most of the farms are less than 3 acres.
  - The average age of the plantings is 20 years.
  - Average grower’s experience in growing blueberries is 20.5 years.

- Cultural practices:
  - The main cultivar planted is ‘Bluecrop’ followed by ‘Bluejay’.
  - Growers are punning and mulching, on average, every other year.
  - Grower reported weed problems as their main problem followed by disease and insect problems.
  - Growers did not report plant nutrition as a major problem.

Insect traps:

- Insects do not appear to be a major problem in these plantings.
- Blueberry maggot, a serious blueberry pest was not found in any of the plantings.
- Insect pest found in small numbers include: Cranberry fruitworm, Cherry fruitworm, Japanese beetle, and Green June beetle.

Diseases:

- Botryosphaeria stem canker and Phomopsis were two diseases common in these plantings.
- Mummyberry (*Monilinia vaccinii-corymbosi*), a disease not previously reported in Arkansas, was found in several plantings.
- Blueberry mosaic and Red Ring Spot virus were found in several plantings.

Nematodes:

- Parasitic nematodes do not appear to be a problem in these plantings.

Soil and foliar analysis

- The soil pH of these plantings was found to be within the range for blueberries in most of the plantings.
- Most of the foliar analysis showed deficiency problems, particularly with the minor elements such as iron, zinc, boron, and copper.

Conclusions

Results from this assessment indicate that changes need to be made to our UACES pest management recommendations. Cultural practices such as mulching and pruning on a yearly basis need to be implemented by growers. The problem with plant nutrition, not recognized by growers as serious, appears to be prevalent throughout all the plantings surveyed. In 2010, we plan to conduct fertilization and disease management studies in five of the farms to determine cultural practices that will help growers solve this problem.
Public Garden/Master Gardener Sessions
Residents in the State of Oklahoma are very fortunate to enjoy the biodiversity that exists in terms of plant materials and animal life as well. Within a day’s drive, one could start in the Panhandle to enjoy Rocky Mountain juniper (Juniperus) and Apache plume (Fallugia paradoxa) and then head diagonally towards Southeastern Oklahoma to see our native Spider lily (Hymenocallis spp.) and palmetto (Sabal minor). Suffice it to say that between plant materials found growing wild in Oklahoma and then the balance of the Lower 48, a person could easily spend a lifetime just growing and enjoying American plant materials. In fact, there are almost too many natives alone to ever “get on top” of the myriad of U.S. herbaceous and woody taxa. However, if plantspeople are open to flora outside the U.S., suddenly unique plant materials with nothing comparable in our woods are now available for us to landscape with and perhaps use for other purposes too such as breeding programs and other meaningful endeavors. Today’s lecture is comprised of both native and non-native plant materials that should be considered for Oklahoma and surrounding states. With time constraints, only a few of many superior plants can be mentioned. It is important to keep in mind that the vast majority of plants that have been introduced to the U.S. have proven to be harmless to the environment. Still, it is critical that we research non-native (exotic) plant materials before using them in the Oklahoma landscape. Horticulturists should be certain that they are not confusing species that occasionally germinate/reproduce in a local flower bed, for example, vs. a plant that truly can spread and ultimately displace native flora and/or fauna. Attendees that want to get a better handle as to where we stand with potentially invasive plants should get involved with the newly-formed Oklahoma Invasive Plant Council.

**Examples of natives:**
- Mahonia trifoliata
- Fallugia paradoxa
- Fothergilla Blue Shadow
- Cladastris kentukea
- Taxodium Peve Minaret
- Cotinus obovatus
- Amelanchier Cole’s Select
- Viburnum molle
- Nyssa sylvatica
- Sophora affinis
- Quercus imbricaria
- Frangula caroliniana
- Thuja Fire Chief
**A few non-natives:**
Cercis siliquastrum
Caragana spp.
Acer tegmentosum
Rhamnella franguloides
Genista tinctoria
Zelkova serrata Wireless
Cephaolotaxus Duke Gardens
Abelia Twist of Lime
Parrotia persica
Acer miyabei
Introduction to the Junior Master Gardener Program

Shelley Mitchell, Youth Programs Coordinator
OSU Department of Horticulture and Landscape Architecture

Suck-A-Bug. Gas Gobblers. Plant Parts Rap. Pinwheel Plants. Intrigued? These are all activities from Junior Master Gardener℠, a youth gardening curriculum developed at Texas A&M University and administered through the cooperative extension network. If you want to incorporate fun, inexpensive, environmental education activities into your child’s schooling, look no further than Junior Master Gardener℠. JMG℠ is a gardening curriculum designed for grades 3 – 5 (Level 1) and 6 – 8 (Level 2), but the activities are suitable for K-12. JMG℠ incorporates hands-on, project-based learning; leadership development; and community service. It is a flexible curriculum appropriate for families, camps, scout groups, after-school programs, schools, and public gardens. Access to a garden or plot of land is preferable, but not required.

The Level 1 curriculum encompasses eight areas: plant growth and development, soil and water, insects and diseases, environmental horticulture and ecology, vegetables and herbs, fruits and nuts, landscape horticulture, and life skills and career exploration. Each chapter has a selection of group and individual activities. Activities include arts and crafts, games, field trips, backyard explorations, experiments, cooking, and more. Many activities use items found in nature or around the house (film canisters, coat hangers, cookie cutters, paper plates, newspapers, window screens, etc.). Activities vary from ‘quick and simple’ (no supplies required) to more involved -- requiring more supplies and time (days, weeks). Do one activity or do them all-- it’s your choice; the curriculum is flexible. The Level 2 curriculum has two different units: Operation Thistle℠: Seeds of Despair, which covers plant growth and development, and Operation W.A.T.E.R.℠: Dr. Thistle Goes Underground, which covers soils and water.

In addition to the core curricula, there are several supplemental curricula at Level 1: Literature in the Garden℠, Health and Nutrition in the Garden℠, and Wildlife Gardener℠.

Literature in the Garden℠ engages youth through activities based on garden- and ecology-themed children’s books. The goal of the curriculum is to enhance understanding of the messages behind the stories. Health and Nutrition in the Garden℠ has chapters in thrifty gardens, basic gardening, growing techniques, food safety, ABCs of healthy eating, and healthy snacks. The activities aim to teach youth health, nutrition, food safety and decision-making skills. Wildlife Gardener℠ helps youth understand wildlife and their needs, their contribution to the garden, and their aesthetic value. Chapters in Wildlife Gardener℠ include habitat gardening basics, essential elements, birds, mammals, insects, reptiles and amphibians, wildlife habitat sites, and life skills and career exploration.

It only takes 5 youth to form a registered JMG℠ group! Registered groups get a certificate recognizing their group, a free page on the JMG℠ website, and are entered into monthly drawings for garden-related prizes. In addition, registered youth can work toward various levels of certification in the curriculum. JMG℠ registration is free, and the curriculum is inexpensive. Visit www.jmgkids.us for more information, to register a group, or to order curriculum. Whether you are looking for activities to fill weeks, months, a whole summer, or even just one hour (or less), JMG℠ is sure to have...
something that will fit your needs. The Oklahoma state coordinator for the Junior Master GardenerSM program is Shelley Mitchell, 4H and Youth Development, OSU Department of Horticulture and Landscape Architecture. Contact information is shelley.mitchell@okstate.edu, (405) 744-5755.
When you arrive at the site, you can click on any of the navigation items (left column) and it will give you a brief description of the Discovery. It will show the questions we are trying to answer and the activities that kids will do.

To get any further or to be able to do anything, requires that you Sign Up.

JR. PLANT SCIENTIST – Structure of the program

There are 10 explorations and the Plant Records activity in the Jr. Plant Scientist program. When a student has completed all the activities, she/he will receive a Jr. Plant Scientist certificate signed by plant scientists from the United States Botanic Garden, the Michigan 4-H Children's Gardens and the American Horticultural Society.

Each Jr. Plant Scientist exploration has three components:

In-garden:
The explorations will have you visit a botanical garden, school garden, nature park or participating Garden Center where you will complete several activities, discovering some of the wonders of plants. Participating gardens will work with you if you need help.

At-home:
Each exploration will have activities for you to complete at home. These will include making observations of your yard or neighborhood, trying to discover even more of the wonders of plants. You may be asked to make observations, take some pictures or even interview someone.

On-line:
Each exploration will have some online activities as well. These may involve doing research, investigating online resources, and reporting on your activities.

How do I become a Jr. Plant Scientist?

Becoming a Jr. Plant Scientist is fun and free.
- Sign up for the program by clicking the Sign up button
- Complete the ten plant explorations
- "Discover" a new plant and add your information to the Jr. Plant Scientist Plant Records
- Explore with an adult who will be your transportation and your assistant
- Report on your Jr. Plant Scientist explorations and activities
- Receive your Jr. Plant Scientist certificate!
TO SIGN UP:

To Sign Up as **individual students**: (this will require that each student has an email address)

1. Go to the site: http://jrplantscientist.ath.cx
2. Click on Sign Up (in left hand navigation panel)
3. Fill in the information and click Sign Up
4. You will receive an email message that gives you your log in information

If you are planning to work with a **class or group** of kids:

Groups will be set up through the teacher / group leader. This way students do not need an email address to participate in the Jr. Plant Scientist program. We have this tested and working, but do not have the user friendly interface ready yet. So, for the time being, we will set this up for you.

Go to http://jrplantscientist.ath.cx/teacher/

**NOTE**: You will have to click on this link or type it in. We are not making it public in order to prevent unauthorized folks from having access.

Log in or create an account

To import your class list:

- Go to http://jrplantscientist.ath.cx/teacher/
- Click the "upload class list" link
- Copy and paste your class list into the text box. Follow directions under text box.
- Click "Preview". If the class list looks correct in the preview box, click "Submit"
- Uploading a second or alternate version of a class list WILL NOT overwrite the previous class list. If a student was left out of a class list, simply upload them in their own class list and you will not lose the previously saved class data. However, care should be taken to assure all names are spelled correctly, as names cannot be changed or deleted once the class list is uploaded.

To group students:

- Go to http://jrplantscientist.ath.cx/teacher/
- Click the "Group Students" link
- Group students from the class list. Click the "New Group" or "Delete" buttons to add and remove groups
- Drag and drop the students’ names into the groups.
- Once you have grouped the students, click "Save Groups"
- Students can be regrouped and new groups can be made at any time.

TO LOG IN: (after you have signed up)

1. Go to the site: http://jrplantscientist.ath.cx
2. Click on Log In
3. Enter your email address and password
4. Click on Log In
5. Once you are logged in you can click on User and change your password and other information

TO GET GOING: (once you are logged in)
Click on Plant Discovery (in left side navigation column)
This will bring up the menu of Activities

- Background - gives some background information about this particular discovery

- In-garden - All the details and instructions for your in-garden activities. Be sure to print the In-garden Plant Discovery sheet. This will be your guide and where you will take notes. Later you will put this information on-line when you do your Report.

- At-home - All the details and instructions for you at-home activities. Be sure to print the At-home Plant Discovery sheet. This will be your guide and where you will take notes. Later you will put this information on-line when you do your Report.

- On-line - All the details and instructions for your on-line activities. Note that when you are asked to find information there will be a link to selected web pages. When you open the link a remote editor window will also open so you can type or cut and paste information. The information you add here will automatically be saved as part of your Report.

- Report - This opens a list of reports. Click on any one of these to transfer the information you have collected In-garden, At-home and On-line to your Plant Discovery Report. For each question, click on the Edit button to add your information. You can add photos and links to web sites... The Report sections for Plant Discovery are:
  - Plant Observations: Information from your in-garden and at-home activities
  - Plants in Common Places: Information from your in-garden and at-home activities
  - Plants in Curious Places: Information from your in-garden and at-home activities
  - Microclimates: Information from your in-garden, at-home and on-line activities
  - Plants and Culture: Information from your in-garden and at-home activities
  - Plant Explorers: Information from your in-garden and at-home activities
  - Biogeography: Information from your on-line activities
  - Wondercast – Microclimate: Information from your on-line activities
  - Lewis and Clark: Information from your on-line activities

- Wonder Wall - a link to the Wonder Wall where you can ask questions, post comments, draw and even upload photos
Further Investigations: (for kids (and adults) that just want to do more!)

- Experiment – here you will find an experiment based on this Discovery that you can do.
- More explorations – suggestions for further exploration of this topic. There are some great ideas here that you may want to incorporate into what you do.

Wrap Up

Provides a way for you to make sure you have completed and reported on all the activities in each discovery. Click the boxes to show you have completed the activities and then you will be ready to move on to the next discovery.

Contact Us – opens an email client so you can send us a message.

Home – Takes you back to the list of Discoveries

For further information, contact:

Norm Lownds
Associate Professor
Curator, Michigan 4-H Children's Gardens
lownds@msu.edu
517-355-5191 ext. 1-349
Japanese Landscape Design

Kim Rebek, Oklahoma Gardening Host
The Department of Horticulture and Landscape Architecture
Oklahoma State University, Stillwater

Japanese Landscape Design Powerpoint
See note section in powerpoint for information on slides.
See Powerpoint for more information.

**Slide 14 & 15: Basics of Vines – Vines serve many useful landscaping purposes**
- Dividers and Barriers
- Screen unsightly views/give privacy
- Break up monotony of long wall or fence
- Soften harsh structural lines
- Blend the structural lines with other plantings
- Use on steep banks and other areas where grass is difficult to establish and maintain
- Vines can be used as groundcovers
- Many varieties of woody vines will tolerate full shade

**Slide 16: Vines are/can be used as**
- Drought tolerant
- Shelters for birds and small wildlife
- Provide berries and seed for food
- Able to be shaped as a topiary
- Conversation pieces
- Provide shade when grown on an arbor or lattice structure

**Slide 17: Vine Selection**
- Select vines for intended use
- For screening-dense, coarse foliage is best
- For adding interest or color to a stone or brick wall-varieties are fine textured and slower growing works better

**Slide 18-21: How Vines Climb**
There are three main types of how vines climb
- Some vines have tendrils that wrap around any type of support
- Some vines climb by twining around any available means of support
- The third type of how vines climb is with aerial roots with tendril pads
- Vines attach with aerial roots without tendril pads

**Slide 22: Learn to tell the difference**
As there is one type with plain aerial roots that most of us need to stay away from (Posion Ivy)

**Slide 23: What do vines need to grow?**
- Fairly well-drained soil (some more than others)
• Full Sun for some, Not much sunlight for others
• Something to grow on (hopefully that you choose)
• Some stay upright with training
• That’s about it.

**Slide 24: Invasive Vine Plants**
As a general rule, there is a larger percentage of invasive vines, when compared to other vascular plants. The following selection of invasive vines are only 14 of over 120 species of vines that are listed on the federal invasive/noxious plant list.

**Slides 25-31 : Invasive Plant list for vines**
Fiveleaf Akebia, Chocolate Vine, *Akebia quinata*
Porcelain-berry – *Ampelopsis brevipedunculata*
Oriental Bittersweet, *Celastrus orbiculatus*
Black Swallow-wort, *Cynanchum louiseae*
Pale Swallow-wort, *Cynanchum rossicum*
Climbing Euonymus Wintercreeper, *Euonymus fortunei*
English Ivy, *Hedera helix*
Japanese Honeysuckle, *Lonicera japonica*
Japanese Hop, *Humulus japonicas*
Mile-A-Minute Weed, *Persicaria perfoliata*
Chinexe Wisteria, *Wisteria sinensis*
Japanese Wisteria, *Wisteria floribunda*
Kudzu, *Pueraria Montana* var. lobata
Bur cucumber, *Sicyos angulatus* L.

**Slide 32: Selection of Native Vines**
Arctic-hardy Kiwi: 20’, The male plants have showier foliage. The female plants have edible yellow fruits. Rated hardy to Zone 5.

**Slide 33: Native Wisteria**
*Wisteria frutescens* ‘Amethyst Falls’
Native wisteria with fragrant 4-6” long clusters of blue flowers. Blooms after foliage buds. Flowers from June through August. 20-30’ in length.

**Slide 34: Lady Banks Rose**
*Rosa baksiae*: Height 20-30’; Slender nearly thornless canes can be trained on trellis, fence or other support. 1” yellow flowers in spring. It is usually not hardy in Oklahoma.

**Slide 35: Crossvine, *Bignonia capreolata***
A vigorous semi-evergreen climbing vine that can be used as a wall or ground cover. Dense, lush foliage with bright orange-rose tubular flowers arrive mid-spring.

**Slide 36: Trumpet creeper, *Campsis radicans***
Very showy self clinging vine that produces dazzling display of trumpet shaped salmon-red flowers all summer. Vigorous climber to 30’. Great for summer accent.

**Slide 37: Sweet Autumn Clematis, *Clematis maximowicziana***
Very showy very fragrant display of small white blooms literally covering the bright-green foliage like snow. Very prolific. Great for late summer/early fall flowering accent. 20-30’ height. Hardy and can be invasive.

**Slide 38: American Bittersweet, *Celastrus scandens***
Twining climbing vine, capable of 20’. Fruit are produced July- October. Twining nature provides excellent wildlife cover and provide food for wildlife species including pheasant, quail, rabbit and squirrel.
Dr. Shufran has been coordinating the Insect Adventure for nearly 7 years. She graduated with her doctorate in Entomology from OSU in 2008 and got married to another entomologist a month after graduation. She obtained an MS in Agricultural Biology from New Mexico State University and a BS in Horticulture and Entomology from Texas A&M University. She enjoys many hobbies but especially loves her job where she gets to work with both people and bugs and gets to be a kid who never grows up every day of the year.

As the state land-grant institution, Oklahoma State University’s “mission triangle” consists of research, teaching and extension. With insects outnumbering humans more than a billion to one, Entomology must function in this mission to explore the human-arthropod interface, educate people on this invaluable group of animals, and answer their many questions regarding this alien neighbor of ours. The Department of Entomology and Plant Pathology is committed to an educational outreach program that strives to enlighten and excite students and adults regarding the impact of entomology on their daily lives through cooperative extension and direct hands-on interaction.

The Oklahoma State University Insectary has been in existence for nearly 20 years. However, until recently, it has operated without a coordinator or a facility and on a shoestring budget. With recent renovations and a newly created logo and identity, a 1500 square-foot educational facility on the OSU campus had been opened that can accommodate groups of up to 40 for outreach presentations. In addition, funds were made available to hire a full-time professional and the old Insectary was transformed into an entertaining Cooperative Extension program called the OSU Insect Adventure. There is currently a tremendous demand for services on science education and arthropods across the state of Oklahoma and the OSU Insect Adventure comes into contact with more than 300,000 persons annually.

The primary attractant for visitors to the OSU Insect Adventure is the “Insect Zoo.” Currently, the OSU Insect Adventure houses around 40 species of arthropods. The facility at OSU is the only facility to specifically and comprehensively target insect science through hands-on exploration in the state of Oklahoma. It provides an exciting and provocative look at insects with a unique hands-on experience. This opportunity represents a once-in-a-lifetime chance for many young people and gives them a level of appreciation for the many contributions and connections that insects and related
organisms have to science, the environment, ecology, agriculture, medicine, and literally any area we wish to explore.

Future plans for the OSU Insect Adventure program include the restoration of a retrofitted school bus to take entomology experiences on the road to a greater extent, the construction of a butterfly garden on the premises, and the renovation of a defunct greenhouse into an outdoor classroom. Furthermore, there are plans to increase the pinned insect exhibits at the OSU Insect Adventure, as well as to install apiculture and forensics entomology exploration stations on-site.

The OSU Insect Adventure's current list of entomological educational opportunities include:

- Insect Petting Zoo—Get to meet live insects and their relatives up close and personal! Discover what a 10-inch millipede feels like and look a tarantula right in its 8 eyes. Experience the beauty and fascination of arthropods and learn about their importance to our daily lives and even our existence on the planet! Get answers to all those questions that have been "bugging" you about the world's most numerous and diverse group of animals from a professional entomologist. A hands-on activity you'll be sure to remember and discuss for a long time.
- Insect Study (Boy Scouts of America merit badge adaptation)
- Junior Master Gardeners—Level 1 Insect Pin
- Making an Entomology Collection—Start to Finish
- Arthropod Classification and Identification
- Insect Growth and Development (including “Pasta Metamorphosis”)
- The Importance of Pollinators
- Earth -- The insect-ruled planet
- Insect Cuisine
- Venomous and Stinging Arthropods of Oklahoma
- Integrated Pest Management
- Insect Husbandry
- Careers in Entomology
- Arthropods and Humans—the good, bad, and the bugly
- Grasshopper “Dynamite” Dissection
- Bug Bowl
- Aquatic Entomology
- Entomology Nature Journaling

Entomology projects offer special benefits over many other kinds of projects:

- Inexpensive
- Can be conducted anywhere
- No special equipment or space required
- People of all ages, types, and abilities can participate
The OSU Insect Adventure Educational Outreach Program

On-Campus Facility
- 3003 W. Virginia (same road as OSU Botanical Garden and Arboretum)
- 1500 sq. ft. educational center
- Safe live arthropod zoo (25+ species)
- Showy collection of pinned insects
- Many insect identification reference materials
- Entomology videos and books
- Bus accessible / parking lot
- Presentations free of charge with appointment

Off-Campus presentations
- Adaptable to nearly any group, event, or situation
- $200 fee for 1-day (up to 5 hours) presentation
- Additional long-distance travel charges
Managing Turf in Shady Areas

Justin Quetone Moss, Turfgrass Specialist

Turfgrasses can be difficult to grow in shady areas and proper management strategies are needed for success. The following is a list of tips for growing turfgrass in the shade in Oklahoma.

1. **Right plant, right place.** Select the most shade tolerant species and/or cultivar available according to site usage.

2. **Remove or selectively prune trees and shrubs** if feasible. The north side of buildings, homes, and other non-moveable structures may not be conducive to turfgrass growth. Perform a sunlight site assessment by estimating the daily length of full sunlight over the area during the growing season. If the average is at least 8 hours of sunlight, bermudagrass may work, if at least 6 hours, zoysiagrass may work, if less than 6 hours, then tall fescue or alternative landscape planting materials may be the best option. Remember, trees and shrubs can be selectively pruned to improve light penetration to the lawn surface without destroying the growth habit of the plant. Remove tree limbs within 10 feet of the ground and clear brush, plants, or structures that block air movement and/or sunlight. For information on proper pruning practices, see Oklahoma State University (OSU) Cooperative Extension Service (CES) Fact Sheet HLA-6409.

3. **Increase the mowing height** to at least 3 inches for tall fescue (or other cool-season grasses) and at least 2 inches for bermudagrass, zoysiagrass, or St. Augustinegrass. In addition, it is likely that these areas can be mowed less frequently than full sun areas. This would also help to reduce traffic stress to the area. If you are managing warm-season grass in the full-sun and cool-season grass in shade, mowing equipment should be adjusted based upon recommended heights-of-cut by species for shady versus sunny areas.

4. **Fertilize lightly and frequently** as opposed to heavy and infrequent. Shaded turfgrass areas can survive with half of the nitrogen needed to maintain turfgrass in the full sun. In the shade, bermudagrass may need no more than 3 lbs of nitrogen per 1,000 sq. ft. per year. Zoysiagrass, St. Augustine, or tall fescue may need no more than 2 to 3 lbs of nitrogen per 1,000 sq. ft. per year. If possible, apply fertilizer at the rate of 0.5 lbs N per 1,000 sq. ft. per application, making 3-4 applications over the season. For warm-season grasses, only fertilize during the warm summer months. For cool-season grasses, only fertilize during the spring and fall. If possible, use blended fertilizers containing both a quickly available and a slow-release nitrogen fertilizer source to avoid a quick flush of growth. Always apply fertilizers based on yearly soil test results. For more information on proper soil testing procedures and analysis, see OSU CES Fact Sheets F-2207 and F-2225.
5. **Avoid excessive foot and/or equipment traffic.** Instead of mowing shady areas every time you mow full-sun areas, mow every other time. Rope-off or otherwise protect turf in shady areas, especially if laying new sod or re-seeding. Try not to use heavy lawnmowers or tractors in shady areas or at least try not to repeatedly mow or drive over the same tire tracks every time.

6. **Reduce irrigation amount and frequency when compared to full-sun areas.** Shade areas take longer to dry out than full-sun areas. If shady areas are constantly wet, there is a significant increase in the probability of disease development, especially for cool-season grasses such as tall fescue. Allow the area to sufficiently dry between watering. If you have an automatic irrigation system, put shady turf areas on a separate zone from full-sun areas. At the same time, note that turfgrasses, trees, and shrubs that are grown in the same immediate area all compete for the same resources to survive. Turfgrasses in the shade that are directly competing with large trees may need more frequent watering than turfgrasses under building or structural shade.

7. **Remove weeds either by hand or with herbicides.** In a home lawn situation, it may be feasible to remove weeds in shady areas by hand rather than using herbicides. Herbicides can often have a phytotoxic effect on desirable turfgrass plants. Herbicide phytotoxicity to desirable turf plants may be exacerbated by shady conditions. Also, many turfgrass herbicides can be phytotoxic to trees, shrubs, or other desirable landscape plants. Always read the entire label before applying any pesticide to any part of your lawn.

8. **Remove debris and leaves**, especially in the fall and spring. Tree leaves and other debris only serve to block precious light to the turfgrass plant. Raking and removal is necessary and can often make a nice compost/mulch pile for other landscape beds. For tips on composting and mulching, see OSU Fact Sheets BAE-1744 and L-251.

9. **Overseed, re-seed, or sod.** If the turfgrass plant does not receive adequate light and/or management, yearly or bi-yearly overseeding, re-seeding, or sodding may be necessary. If so, follow the same basic lawn establishment instructions found in OSU Fact Sheet HLA-6419. For warm-season grasses, complete this task in the late spring/early summer. If using zoysiagrass in a shaded site it will usually need to be installed as solid sod since development from seed will be extremely slow. For best results with cool-season grasses, seed or sod in the fall. If turfgrass repair in the shade is necessary, incorporate the most shade tolerant turfgrass species and cultivars.

10. **Be prepared with other planting options if necessary.** If you have tried to use tall fescue and or Kentucky bluegrass combinations and they have repeatedly failed in the shade over a 3 year period even after selective tree pruning and modified management for shade, it is time to move to an alternative shaded landscape strategy that can include shade tolerant ground covers, ornamentals and hardscape elements. Many other ornamental plants can be utilized in shady...
areas and many of these can tolerate shade much better than turfgrass plants. Sometimes, a nicely designed ornamental bed can be more aesthetically pleasing and easier to maintain than a thinned out turfgrass area in the shade. Hardscape elements such as mulch, pavers, and other interest elements can be welcomed additions to shaded landscapes.

If you have further questions about managing turfgrass in shady areas in Oklahoma, please consult OSU CES Fact Sheet HLA-6608 “Managing turfgrass in the shade in Oklahoma” or contact your local OSU CES Extension Educator.
Xeriscape Demonstration Landscape at Bickham-Rudkin Park, Edmond

David Hillock, Assistant Extension Specialist, Consumer Horticulture
Michael Holmes, Assistant Professor, Landscape Architecture

The need for water conservation is no stranger to the City of Edmond. In past summers the phrase “involuntary water rationing” has become a commonly heard term. This call to action did not come about because people were using too much water to bathe, clean, and drink. It became necessary because water pressure was being drained from the system by turf grass and landscape watering during dry summer months.

Needless to say this policy was not a popular one and the public did not appreciate being told not to use their water. The public outcry over water rationing was heard by the City of Edmond, and it resulted in the funding and construction of new water pump stations to increase water pressure throughout the system. However this solution is costly and has its limitations in lifespan. System expansion is only a solution so long as the population increases in Edmond don’t exceed the new system’s capacity.

A better solution to water pressure and water quality issues is to utilize landscaping systems that require less water. One of these systems is called xeriscaping.

The term xeriscaping has its origins in Denver, Colorado where water is an extremely limited and valuable resource. The definition of xeriscaping is not a yard full of rocks and cacti, nor is it a yard void of grass. Xeriscaping provides a diversity of seasonal colors and textures while reducing outdoor water use by 30 to 50 percent. Homeowners who xeriscape find their yards look better, need less maintenance, and their homes sell faster and bring higher returns.

The project at Bickham-Rudkin park is designed to help the citizens of Edmond understand that they have options for their landscaping other than water-needy landscapes, and that through the use of xeriscaping, they can have a beautiful landscape, and save water for Edmond’s future at the same time.

This project is a collaborative effort between Oklahoma State University Horticultural Extension and the City of Edmond. Oklahoma State is looking to generate interest in water conservation landscaping designs in the state by doing an example xeriscape garden project which incorporates educational signs and trails.

Hundreds of these gardens have been done in Colorado, Utah, California, Arizona, and Florida. These states have experienced severe pressures on their water supply systems and are taking proactive measures to educate their communities about their landscape options.

David Hillock, OSU Extension Consumer Horticulturist, was very familiar with the concept and approached Carrie Tomlinson, former Urban Forester with the City of Edmond, with the idea. David selected Edmond because of his knowledge of our water
pressure issues and also because he knew Edmond could set a great example. Carrie and David brainstormed and researched location ideas in Edmond. The house/shelter at Bickham-Rudkin Park presented some great qualities that could be incorporated into a demonstration project. The house/shelter currently gives the area a residential feel that citizens could translate to their own home. Also the site is new and very accessible.

Construction on the site began in 2008 beginning with renovations to the building by the City of Edmond. Planting beds were designated and prepared by killing weeds, removing debris, grading and incorporating organic matter into the soil. New walkways were installed in some areas of the garden. Planting occurred in late summer of 2009. Over 100 species of plants were installed and placed in beds based on their relative need for water. A drip irrigation system was installed using various components such as spaghetti tubing, in-line, and low pressure/volume spray heads.

Turf areas were also planted with three different turf species, buffalograss, zoysiagrass, and a tall fescue/Kentucky bluegrass mix (in a semi-shady area). Surrounding turf areas in the park are bermudagrass.

The garden will be well watered during the first growing season to help the plants become well established, after which they will be acclimated to lower irrigation schedules based on the watering zones they are located in. Watering zones are designated as very low, low and moderate. Very low means plants will be expected to survive on natural precipitation and watered only during very dry periods, if at all. The low water zone will be irrigated only once a month after establishment and the moderate water zone will be irrigated approximately every two weeks, but only as necessary to maintain the vigorous growth we are accustomed to seeing. Volume of water used in each zone will be monitored.

The Xeriscape Demonstration Garden also includes a rain garden. A rain water capturing system was also installed to capture water off the east end of the structure and will be used to irrigate the garden first, before using city water. Two (2), 1,200 gallon tanks will be installed.

The Xeriscape Demonstration Garden at Bickham-Rudkin Park in Edmond will be a living example of the principles emphasized in the xeriscape program and will demonstrate to Oklahoma residents that they can have a beautiful landscape and still conserve water and protect the environment. Educational programming will include interpretive signage throughout the gardens, workshops and tours, and publications such as brochures and fact sheets.
Vegetable Sessions
Problems, Solutions, and Troubleshooting of Greenhouse Tomatoes

What is the Goal of the Grower?
- Improve yield and quality through proper greenhouse management
- Prevent problems
- Diagnose & solve problems

Avoid Problems – Get the Essential Equipment
- EC Meter (electroconductivity)
- pH Meter
- pollinator

Avoid Clogged Emitters
- Dissolve Fertilizer Completely
- Use Strainer at end
- Do Not let siphon rest on bottom of concentrate tank
- Remove scum and precipitates
- Remix as needed

Fertility & Nutrition
- Use a greenhouse hydroponic tomato fertilizer.
- Use correct pH (5.6-5.8).
- Get regular tissue analysis.

Tissue Analysis How to Take Sample
- Snap off 10 to 12 leaves total
- Not more than 1 per plant
- Randomly selected from throughout greenhouse
- Choose leaf just above golf ball sized fruit
- Send to laboratory for analysis
Problems, Solutions, and Troubleshooting of Greenhouse Tomatoes

**Problems With Tomatoes**

- **Whiteflies**
  - Numerous dark spots
  - Begins on younger leaves
  - Leaves droop (wilt)
  - Fruit with ring spots
  - Plants eventually die

- **Leaf miners**

- **Botrytis – Gray Mold**

- **Tomato Spotted Wilt Virus**
  - Numerous dark spots
  - Begins on younger leaves
  - Leaves droop (wilt)
  - Fruit with ring spots
  - Plants eventually die
Problems, Solutions, and Troubleshooting of Greenhouse Tomatoes

Dr. Richard G. Snyder 12/17/2009

**Target Spot / Early Blight**
- Leaf lesions appear like a target.
- Starts on lower leaves.

**Blossom-End Rot**
- Blossom-end brown to black, dry, sunken, leathery
- Lack of calcium *in the fruit*
- Keep calcium level up in soil
- Avoid uneven water (dry periods)
- Don’t let plants wilt.
- Need young, actively growing roots for calcium uptake.

**Fruit Cracking/Splitting**
- Radial cracking.
- Concentric cracking.
- Avoid sharp changes in water.
- Avoid wilting.
- Splitting is only skin deep.
**Catfacing**
- Irregular, malformed fruit, especially on the bottom; crevices, scars, etc.
- Caused mainly by cool temperature (early fruit especially); can be caused by very high temperature, too.
- Some varieties more susceptible
- Fruit still tastes fine.

**Leaf Roll**
- Often starts at the bottom and moves up.
- This is *not* a disease; it is physiological.
- Usually occurs with wet soils, high fertility.
- Looks bad, but does not reduce yield or fruit quality.

**What is it?**
- Flowers fall off → reduces yield.
- Temperature too high or too low.
  - Day temp above 90˚ or night temp above 75˚F interferes with fruit set.
  - Night temp above 64˚F is ideal in greenhouse.
- High humidity.
- Too much or too little nitrogen.
- Any stress can cause flower drop.

**Why So Small?**
- Fertility?
- Water?
- Poor Pollination?
  - Slice fruit transversely.
  - Check for seed numbers.
  - Other symptoms: angular, flat-sided fruit.

**Small Tomatoes**
What is it?

Leaf Yellowing – Intervenal
- Upper Leaves
  - Iron deficiency - starts at base of leaflets.
  - Manganese deficiency - starts at tips of leaflets.
- Lower Leaves (or mid range)
  - Magnesium deficiency is most common culprit, especially at or after 4th cluster set.

Leaf Yellowing – Not Intervenal
- Nitrogen deficiency – general yellowing.
- Senescence – bottom leaves turn yellow.
- Natural death, promoted by aging and shade.
- Disease
  - Most often Early Blight / Target Spot.
    - First, small brown circles on lower leaves.
    - Then, larger brown circles.
    - Then, yellow leaves.
    - Leaf drop.
    - Finally, it progresses up the plant.

Uneven Ripening
- Green stripes, streaks, blotches, stars, shoulders, etc.
- May be caused by high fertility (N), low potassium, high temperature (lycopene killed), viruses, white flies.
- Maintain correct fertilizer.

Russetting
- Many, very fine cracks on fruit surface.
- Causes water loss; poor shelf life.
- Believed to be due to
  - Moisture on fruit surface.
  - Topping plant along with all suckers.
  - Use HAF fans.
- Leave 2 leaves above highest cluster at topping.
Sun Scald
- White blistered area on fruit.
- Can turn leathery, can be invaded.
- From fruit exposed to the sun.
- Keep good leaf cover.
- Do not prune too heavily.
- When topping, leave 2 leaves at top.

Wilting – several possible causes
- Abiotic
- Biotic

Carbon Monoxide / Ethylene

Cold Damage--Oedema

Spray Injury

What is it?
**Herbicide Damage**

- Do not use Roundup in the greenhouse.
- Do not use Roundup outside the greenhouse when plants are inside the greenhouse.
- Do not use any herbicides in the greenhouse.
- Do not use any herbicides outside the greenhouse when plants are inside the greenhouse.

**A Few Subtle Suggestions...**

A good way to preserve pests.

One possible wiring technique.

**Publication Resources**

- Greenhouse Tomato Handbook (Guía del cultivo del tomate en invernaderos)
- Greenhouse Tomato Growers’ Glossary
- Environmental Control for Greenhouse Tomatoes
- Greenhouse Tomatoes - Pest Management in Mississippi
- Budget For Greenhouse Tomatoes
- A Spreadsheet Approach to Fertilization Management for Greenhouse Tomatoes

All are on the internet.

**Internet Resources**

- **Greenhouse Tomato FAQ:**
  [www.msucares.com/crops/comhort/greenhouse.html](http://www.msucares.com/crops/comhort/greenhouse.html)
- **Greenhouse Tomato Short Course:**
  [www.greenhousetomatosc.com](http://www.greenhousetomatosc.com)

**Greenhouse Tomato Short Course**

- [www.greenhousetomatosc.com](http://www.greenhousetomatosc.com)
- Jackson, Mississippi area
- March 9 - 10, 2010
- Expert Speakers
- Educational Materials
- Growers from 20+ states
- Most Meals Included
- Exhibitors

Just 1 more ...

What is it?
Thanks for coming.
New Food Safety Factsheets for Fresh Produce

William McGlynn, Horticultural Food Scientist
&
Lynn Brandenberger, Vegetable Crop Specialist
Oklahoma State University Department of Horticulture and Landscape Architecture

Food Safety and Fresh Produce – a growing issue.
Consumption of fresh produce has been growing dramatically in the United States in recent decades. Unfortunately, incidents of food-borne illness associated with fresh produce have been growing as well. There are a number of possible reasons why this has occurred. One reason is likely to be the general increase in consumption – more product consumed means that more opportunities for food-borne illness occur as well. This increase ties into the fact that there are a number of minimally-processed fruit and vegetable products on the market that simply didn’t exist twenty or thirty years ago. In addition, production of these products, such as bagged fresh salad mixes, often takes place in large, centralized processing facilities from which product is distributed over relatively large geographic regions. This doesn’t necessarily imply that such products are less safe, but it does mean that if a given lot of product happens to become contaminated with disease-causing microorganisms, the resulting outbreak of illness can affect many more people than would’ve been the case in years past. Another factor driving the observed increase is our ability to detect and identify related cases caused by the same microorganism, which is much more advanced than it was in the past. Thus, we are better able to identify and trace outbreaks than we were even twenty years ago.

Whatever the reasons, the fact that we’ve identified greater numbers of people who are becoming ill after eating fresh produce has changed the perception of risk associated with fresh produce both among the general public and among those charged with helping to ensure the safety of our food supply. Bills have been introduced in both houses of the U.S. Congress that would, among other provisions, require many fresh produce growers and packer to create and maintain a written food safety plan. Whether or not any of these bills pass into law, many retailers and distributors are beginning to require their suppliers to create and adopt a written food safety plan and submit to periodic food safety audits as a condition of entering into a sales contract. Going forward it seems likely that many fresh produce growers and/or packers will want or need to have at least a basic written food safety plan for their operation. At first blush this may strike some as an unmitigated burden. But it is important to keep in mind that a robust food safety plan can help a grower/processor not only to produce safer products but also to open new markets limit legal liability. There may be pain in adopting a food safety plan, but there can also be gain.

In general, a written food safety plan should address the following topics:
1. Pre-planting issues:
   ◦ Land history & site selection.
1. Field sanitation practices, especially manure handling.

2. Irrigation/processing water testing plan.

Essentials of a written food safety plan:
Based on the general topics described above, we have identified seven issues that every written food safety plan should address. Note that these issues represent a starting point; any effective plan will need to be a living document, one that is subject to revision as circumstances require. But these are the essentials:

1. Field sanitation practices, especially manure handling.

2. Irrigation/processing water testing plan.
3. Produce washing/sanitation practices.
4. Employee hygiene practices/training.
5. Packing shed operations:
   cleaning/sanitizing, pest control,
   produce storage.
6. Transportation cleaning / sanitizing
   routine (if applicable).
7. Production / sales records.

With these essential issues in mind, we have created two new fact sheets. The first
explains the basic principles involved – why these issues are important and how they
should be addressed in a written food safety plan. The second fact sheet provides
basic templates for creating forms to document the activities described in a food safety
plan. They provide a starting point for capturing and documenting important
information. As such, they are designed to be general and we expect that sooner or
later most operators will find it beneficial to modify or expand upon the templates
provided.  

We would like to acknowledge that these worksheets were adapted from
documents originally developed by Robert B. Gravani, Ph.D., Elizabeth A. Bihn, M.S.,
and others at the Cornell University Department of Food Science.

Both fact sheets are available online at the following URLs:

FAPC 168 -- Developing a Food Safety Plan for Your Fresh Produce Operation
FAPC 167 -- Fresh Produce Production Food Safety Plan Logs and Worksheets

Food safety is an increasingly pressing issue for growers and packers/processors of
fresh produce these days, especially for those dealing with crops identified as high risk.
These crops include leafy greens, melons, tomatoes, green onions, fresh herbs, and
sprouts. A written food safety plan is a tool that can help mitigate risk and in so doing
help to boost profits as well as help prevent food-borne illness. The process of creating
such a plan may appear daunting at first glance, but it need not be a huge burden. The
two new OSU fact sheets described above are designed to provide growers, packers,
and processors alike with a simple, straightforward way to begin the process and create
a basic written food safety plan that can grow as their business grows.
As a first step we recommend obtaining copies of the following two OSU fact sheets:

**FAPC 168 -- Developing a Food Safety Plan for Your Fresh Produce Operation**  

**FAPC 167 -- Fresh Produce Production Food Safety Plan Logs and Worksheets**  

These fact sheets outline the principles described below and also provide templates for documenting important food safety activities. The worksheets referenced in the steps below are those found in fact sheet FAPC 167.

**Step 1: Addressing pre-plant issues**

**Land history and site selection.** Prevention should begin with proper site selection. A proper land history record will include the entire relevant history of a site’s use, including past crops, applications of pesticides or other chemicals, human or animal waste applications, etc. If the site’s history includes equipment and/or chemical storage, animal confinement, or other possible avenues of contamination, this information is relevant as well. The goal of a land history survey is to determine whether or not the soil has potential for causing crop contamination or has potential for crop damage from previous land use. Proper site selection involves assessing the risks for both pre-planting and post-planting contamination. Therefore, property surrounding the site should be checked to evaluate the chances that contaminants may enter the field from dust, runoff, or animals. See site selection worksheet.

**Water.** Water for irrigation should be tested annually or more often for fecal coliforms (2.2 fecal coliforms per 100 ml is the EPA limit for non-drinking (non-potable) uses. Overhead irrigation water should be treated if fecal coliforms exceed the limit mentioned above. See worksheet for irrigation and spray water.

**Wildlife and domestic animals.** Animals have serious potential for contaminating crops with feces. Scout the field for game trails and adjacent areas for the potential of harboring wildlife or domestic animals that could enter the field. If concern exists you will need to develop a plan to reduce these risks. See site selection worksheet.

**Crop selection.** Different crops vary in their potential for being contaminated. Root and leafy crops have a much greater potential for contamination than crops that flower and fruit (i.e. tomato, tree fruits, brambles, snapbeans), grain, or forage crops. Be
aware of this as part of creating a safety plan and making decisions about site selection, water use, etc.

Other potential risks. These might include contamination by pets, workers, visitors, field machinery, etc. Be aware of these risks and address them in a plan as necessary.

Step 2: Addressing production issues

Irrigation / spray water. Water is the most likely way of spreading contamination to fresh produce. During production pay special attention to monitoring irrigation water safety and using only drinkable (potable) water for crop sprays. Irrigating using drip or furrow irrigation is less likely to spread contamination to produce than overhead or flood irrigation. Water supplies should be tested at least annually and more often if well sites have experienced flooding or are uncapped. See worksheet for irrigation and spray water.

Field worker hygiene. Field worker hygiene is an important part of keeping fresh produce safe during production. Provide not only convenient, clean restroom and hand washing facilities, but also training to insure that workers understand the importance of personal hygiene for keeping fresh produce safe to eat. Worker training materials and videos are available at Cornell University’s National GAPs training website\(^3\). See worksheet on worker training.

Fertilizer use. Fertilizers vary in their potential to harbor microbial contaminants. Synthetic fertilizers have low potential for contamination while un-composted and improperly composted manure has a high potential. Sidedressing during the growing season should use only well-composted manure or synthetic fertilizers. See worksheet on fertilizer, compost, and manure application.

Animal control. Controlling access to the field will reduce the risk of contamination from people, livestock and wildlife. Exclude livestock, including pets and poultry, from the field with fencing or other means. Develop and implement a plan to manage wildlife access through appropriate methods. Workers and visitors access to the field should be controlled to limit access when wet field conditions exist. See worksheets on animal control.

Step 3: Addressing harvest issues

Harvest worker hygiene. Worker and U-Pick customer health and hygiene is a key component of the overall program to guard the safety of fresh produce during harvest. Workers will need to be trained in their responsibilities and well maintained facilities will need to be provided to allow them to carry these out. U-Pick customers will need convenient well maintained restroom facilities and signage to encourage them to follow good sanitary practices. See worksheets for worker training and field and packing shed restroom cleaning and service.
**Harvest equipment cleaning.** Harvest equipment must be maintained in a clean and sanitary condition. Pressure wash, rinse, and sanitize all harvest bins, harvest aids, and machinery. Cover washed and sanitized bins to prevent recontamination by wildlife. Maintain harvest equipment to minimize abrasion and wounding of fresh produce. See worksheets for worker training, field harvest / processing / packing / cleaning and the field and packing shed restroom cleaning and service log.

**Avoid damaging produce.** A wound or other damage provides an entry point for harmful microorganisms into fresh produce. And once inside, these microorganisms cannot be removed or killed by washing or sanitizing agents. Therefore, it is very important to avoid damaging produce before or after harvest. Be aware of equipment or contact surfaces that may cut, bruise, or compress produce. Minimize operations that transfer produce from one container to another. Also, beware of damage to produce that may occur during harvest from improper use of equipment, untrimmed fingernails, and so on.

**Holding / transport equipment cleaning.** Transportation and holding equipment including bins, trailers, trucks, etc. should be checked on at least a daily basis and maintained in a clean and sanitary condition. Follow a checklist for inspection of vehicles that will be carrying fresh produce. See worksheets for truck checklist and processing, packing line, facility cleaning.

**Fresh produce cleaning.** Safe produce handling should include removing soil from produce as it may be a source of contamination. Clean equipment and produce before it enters the packing shed. Consider using a sanitizing agent as part of the cleaning process. Damaged or diseased produce should be culled in the field to avoid contamination. Note that culled produce should be transported to a remote cull pile as soon as possible in order to avoid attracting pests or creating a reservoir for both human and plant pathogens.

**Step 4: Addressing post harvest issues**

**Packing shed cleaning.** The packing shed should receive a general cleanup to remove dirt, debris, and culled produce at least once a day. Produce-handling equipment and any surface that comes in contact with produce should be cleaned and sanitized daily. Bathrooms, sinks, waste receptacles, and floor drains should also be cleaned and sanitized daily, or more often if needed. Frequent inspections of the facility should be performed throughout the day to insure that sanitary conditions are maintained. Cold rooms should be cleaned and sanitized once a month or as operations allow. Rodent and insect traps and other pest control aids should be inspected and renewed as necessary – generally at least once a month. See worksheets on field, packing shed restroom cleaning and service, processing packing line facility cleaning, and pest / rodent control. Note that high-pressure hoses are not recommended for general cleaning when produce is being packed because high-pressure water sprays can create aerosols that may transport harmful microorganisms over long distances. A 200 PPM chlorine solution (1 tbsp household bleach / gallon water) makes an effective sanitizing solution when applied with a contact time of at least two minutes. Prior cleaning is important to insure that the sanitizer is effective. Note
that surfaces sanitized with 200 PPM or stronger chlorine should be rinsed with clean water or allowed to air dry before coming into contact with produce. See Table 2 for further information on sanitizer options and recommendations.

**Cooling or wash water sanitation.** Water used for cooling or washing must be clean and drinkable (potable). If water is being sanitized by adding chlorine, then the strength of the chlorine solution must be checked at least daily, more often if required, or whenever a fresh tank of water is prepared. See Washing / Cooling / Sanitizing Water Treatment worksheet.

**Cooling water temperatures.** If a water tank is being used to hydrocool fresh produce, insure that the cooling water is no more than 10°F cooler than the incoming produce to minimize the risk that produce will absorb or imbibe water during cooling.

**Strength of sanitizing washes.** Table 1 gives basic recommendations for chlorine-based sanitizing solutions that can be used to help ensure the safety of fresh produce. If a sanitizing wash is appropriate, the strength of the chlorine solution should be monitored at least once a day, more often if required, or whenever a fresh tank of solution is prepared. Be aware that the strength of the chlorine will dissipate over time and the more soil is present on the produce, the more quickly the strength of a chlorine-based sanitizing solution will be lost. See Washing / Cooling / Sanitizing Water Treatment worksheet.

**Proper storage of packed produce.** Hold and store produce away from possible hazards e.g. cleaning agents, pesticides, etc. Hold and store produce off the floor, away from walls, and in such a way as to avoid damage. If the produce is stored in a cold room, be sure to monitor and record temperatures. See cooler temperature worksheet.

**Transportation of packed produce.** Trucks used to transport produce should be cleaned and sanitized prior to loading. If trucks are not used exclusively to transport produce, then be aware of what other items may have been previously transported and clean accordingly. If refrigerated transportation is being employed, consider using temperature monitoring systems to help insure that proper refrigeration temperatures are being maintained during shipping. See truck checklist worksheet.

**Step 5: Addressing important record keeping issues**

First and foremost obtain a copy of FAPC-167 Fresh Produce Production Food Safety Plan Logs and Worksheets to create the forms that will help you keep records for your operation. This factsheet is available along with other food safety-related factsheets at: [http://fapc.biz/news/factsheets.html](http://fapc.biz/news/factsheets.html).

Create and maintain records for all employee trainings (see worker training log).

Create and maintain records of facility cleaning and sanitizing (see processing / packing line / facility cleaning and field / packing shed restroom cleaning and service worksheets).
Create and maintain records of produce sanitizing, if applicable (see washing / cooling / sanitizing water treatment worksheet).

Develop a traceback system for your farm that will allow you to trace produce to the field that it was harvested from, including harvest date (see produce tracing and recall traceback worksheets).

Consider developing a HACCP-like program for your farm (Hazard Analysis Critical Control Points). This system will identify where contamination problems are likely to occur (Critical Control Points) and will provide ways to address these potential hazards.

Records of all produce leaving your farm should be maintained to assist you in traceback and in any other problems that may occur. Remember if you don’t record it, you didn’t do it (see produce tracing worksheet).
Snap beans are among the top vegetables that people seek at farmers' markets. They know how to cook with them and green beans are a routine part of our diets year-round. Growers’ approaches to snap bean production vary with how they are marketed. For this reason, I interviewed four growers in wide-ranging parts of Northeast Oklahoma to seek their experiences and opinions. I would also like to thank Lynn Brandenberger, Extension Vegetable Specialist at Oklahoma State University and John Damicone, O.S.U. Extension Plant Pathology Specialist, for their advice and input. Snap beans are Native to Central and South America, yet are grown and consumed worldwide. Common names for them in the marketplace are green beans, snap beans, string beans and French beans. Names in other languages are: Latin: Phaseolus vulgaris, French, haricot vert; Spanish: ejote; Italian: fagiolino; Chinese: cai dao; and German: gartenbohne. U.S. per capita consumption of green beans has more than doubled from 1991 to 2006. There is more consumption in the Eastern U.S. than in other parts and white and Asian populations are the largest consumers. Leading states for fresh production are Florida, California and Georgia with Wisconsin, Oregon and Illinois leading the way with fresh and frozen beans. Bush snap beans predominate with a shorter, concentrated harvest for 45-60 days until picking. Pole beans take 50 to 70 days from seed to harvest, yield more per foot of row, are easier to harvest, but cost more to grow due to trellising requirements. Common commercial varieties are ‘Ambra’, ‘Brio’, ‘Bronco’, ‘Diplomat’, ‘Hayden’, ‘Roma II’, ‘Titan’ and ‘Ulysses’. Heat tolerant varieties tested at the Bixby, planted May 16 of 2006 and harvested in July are: ‘Ambra’(Harris Moran); ‘Gold Rush’(Pureline); ‘SB4285’, (Syngenta); ‘Titan’ (Asgrow/Seminis)’ and ‘Ulysses’ (Asgrow/Seminis). Favorite grower varieties are Bush Beans: ‘Tema’, ‘Jade’ and ‘Bronco’ with pole beans: ‘Fortex’ (round pod type) and ‘Hilda’, (flat pod type) Seed coat color varies from black to brown to white favored by processors. Brown and black seeded beans tolerate colder wet soils. Crop rotation suggestions: do NOT follow other legumes, onions, garlic, or brassicas (broccoli, cabbage, etc.) A compatible rotation is with small grains or corn. Handle seed carefully, do not drop and crack seed coats, store cool and dry and watch planter plates to avoid cracked seed coats. The result can be seedlings that never become mature plants.(bald headed seedlings). Ideal soil temperature is 60-85 degrees F. with germination ideal at 80 degrees F, meaning fall planting can be done beginning in mid-July. Ideal planting times for bush beans in Oklahoma: April 10-30 & Aug 10-20; pole beans: April 10-30 and July 15-30. Allow 1/8 pound per person or plant 80 lbs per acre. There are 1600 to 2000 seeds per pound. Spacing follows equipment with large scale at 2-4 inches between seed on 18-36 inch rows. Market garden scale is 3 inch by 12 inch spacing or 4 plants per square foot.
Protect from early season pests and seasonal frost using floating row covers. Rye strips between groups of rows can be an effective wind break and increase temperatures by 10%.

Irrigate to insure good pod set, providing 1.25 inches of water per week. Critical times for moisture are at planting, establishment, bloom and pod set.

Beans are generally self-pollinating, but blossoms drop at 85 degrees F. and above. Pods can also be hollow/barren in high temperatures. Cold wet soils can also result in blossom drop.

Average yield is 4800 lbs. per acre or 2.4 tons of beans. Machine harvest of bush beans is 3-20 man hours per acre from harvest to pack-out. Pole beans, picked by hand up to 5 times, 3 to 5 days apart, takes up to 300 hours per acre to pick and pack.

Post-harvest, remove field heat with forced air, store cool and moist at 40-50 degrees F. Below 40 degrees results in damaged pods.

Problems in the field to anticipate can be bean leaf beetles and diseases such as cottony leak causing rot on pods, seed rots in cold wet soils and bald heads due to cracked seed coats.

Cottony leak is worse in high nitrogen soils and in bare soils with mud splashing on foliage. Planting into small grain stubble or mulching prevents the disease. Varieties most resistant to pod rot in OSU tests during 2006-2008 are ‘Romano 942’ and ‘Igloo’.

**Grower comments about their experiences growing and marketing green beans:**

- “Handle seed gently. Seed coats can break if you drop the sack”.
- “We succession plant starting in late march and then every two weeks, with a mid-summer break”.
- “We sell yard-long/asparagus beans for mid-summer. They are in the black-eyed pea family and are heat tolerant”.
- “We plant more beans as soon as the first planting is germinating.”
- “We find that picking bush beans is easier and quicker due to concentrated harvest”.
- “Picking pole beans is easier for us and they last longer after planting”.
- “Don’t extend harvest too long on a single planting. Quality goes way down. Do succession planting to keep picking levels high per foot of row for more efficient harvest labor”.
- “We must have green beans at the market to get people to our stall. They, they buy other more profitable items.”
- “Pick beans small (as a French filet type) for higher demand and price. We have to charge more for the time it takes to pick them.”
- “Romano/flat types are harder to sell, but I think they taste better.”
- “Plain, round green beans sell best. Others are interesting for me to grow, but are not in demand.”
- “Green beans are the last thing we pick before going to bed before market day so they will be very fresh”.

**Information Sources:**

- “Sustainable Vegetable Production from Start-Up to Market”, by Vernon Grubinger
- One-on-one interviews with vegetable growers about how they grow their crops from start to finish: Mike Appel, Vernon Conrad, Jeff Marsh, Emily Oakley.
- “Knott’s Handbook for Vegetable Growers”, by Maynard and Hochmuth
- “Insect Pollination of Cultivated Crop Plants”. Agriculture Handbook No. 496
An announcement for the 2009 Pepper Research conference pointed out several aspects of U.S. pepper consumption trends. Current consumption is at an all time high and the demand for this vegetable, while always good, is increasing. This may be partly due to the word getting out about the nutritional value of peppers. Part of the interest in peppers is the American “hot food craze” that is accompanying an 8% increase in pepper consumption over the period of 2001 to 2007, raising consumption to 13 lbs per person annually. Peppers are common in many Oklahoma gardens. The can be found growing in traditional plot gardens, in hoop houses and in container gardens. In such gardens, peppers can be found being grown using a diversity of production practice technologies from simple to complex. In many gardens the crop is grown using plastic and other mulches and drip irrigation technology.

One place to observe the diversity of pepper types grown in Oklahoma gardens is at the county fairs. For example, in 2009, vegetable contest entries in Pontotoc and Marshall Counties included many entries of attractive peppers. Entries varied greatly in color, size, type and flavor (hot or sweet). Due to this last attribute, there is an element of mystery for many of the entries. Unless the entry is a common type, such as a bell or jalapeño, a casual observer cannot tell whether a given entry is something they would want to bite into. For many combinations of pepper shape, size and color, there can be much variation in the degree of pungency or “heat” in the fruits of the pepper variety.

What make peppers “hot”? Surprisingly, the heat or pungency of peppers is not something we sense with our taste buds. Heat is a result of a group of compounds called “capsaicins” that are not only unique to peppers but are also colorless, odorless and tasteless. So, why do some peppers send us running for something soothing to drink. To explain briefly, there is something called substance “P” at our nerve endings that, upon release, gives us a sensation of pain. Capsaicin results in an increased release of substance “P”, thus giving a sensation of pain. There is not an endless supply of substance “P” and once it is depleted the sensation of pain goes away. For this reason, capsaicin can be used to alleviate pain in medications such as topical creams.

Plant classification depends on the information that is available to distinguish different organisms. Early pepper classification depended greatly on fruit characteristics. As the science of genetics developed, plant breeding compatibility became more important as a means of determining how closely plants are related. With peppers there is a complicating factor to the geographical relationships of peppers. While peppers originated primarily from the Americas, some were taken by humans to places such as Asia. Here they were cultivated and bred to result in lines that were different from their relatives in the Americas. One example of this is peppers having scientific names that suggest the plant originated in China, when in reality, the particular pepper was transported to Asia where it was then cultivated.
<table>
<thead>
<tr>
<th>Company Name</th>
<th>Address</th>
<th>City</th>
<th>State</th>
<th>Zip</th>
<th>Phone</th>
<th>Website</th>
</tr>
</thead>
<tbody>
<tr>
<td>DeWitt Seeds</td>
<td>P O Box 5556</td>
<td>Norman</td>
<td>OK</td>
<td>73070</td>
<td>(405) 364-0908</td>
<td><a href="mailto:info@dewittseed.com">info@dewittseed.com</a></td>
</tr>
<tr>
<td>Enchanted Seeds</td>
<td>140 Haasville Rd.</td>
<td>Anthony</td>
<td>NM</td>
<td>88021</td>
<td>(575)-571-2247</td>
<td><a href="http://www.enchantedseeds.com">www.enchantedseeds.com</a></td>
</tr>
<tr>
<td>Gardener's Supply Co.</td>
<td>128 Intervale Rd.</td>
<td>Burlington</td>
<td>VT</td>
<td>05401</td>
<td>(888)-833-1412</td>
<td><a href="http://www.gardeners.com">www.gardeners.com</a></td>
</tr>
<tr>
<td>Garden's Alive</td>
<td>5100 Schenley Place</td>
<td>Lawrenceburg</td>
<td>IN</td>
<td>47025</td>
<td>(513)-354-1482</td>
<td><a href="http://www.gardensalive.com">www.gardensalive.com</a></td>
</tr>
<tr>
<td>Gurney Seed &amp; Nursery Co.</td>
<td>P.O. Box 4178</td>
<td>Greendale</td>
<td>IN</td>
<td>47025</td>
<td>(513)-354-1491</td>
<td><a href="http://gurneys.com">http://gurneys.com</a></td>
</tr>
<tr>
<td>Harris Seeds</td>
<td>355 Paul Rd.</td>
<td>Rochester</td>
<td>NY</td>
<td>14624</td>
<td>(800)-544-7938</td>
<td><a href="http://www.harrisseeds.com">www.harrisseeds.com</a></td>
</tr>
<tr>
<td>Henry Field's Seed &amp; Nursery Co.</td>
<td>P.O. Box 397</td>
<td>Aurora</td>
<td>IN</td>
<td>47001</td>
<td>(513)-354-1494</td>
<td><a href="http://www.henryfields.com">www.henryfields.com</a></td>
</tr>
<tr>
<td>Hummert International</td>
<td>4500 Earth City Exppressway</td>
<td>Earth City</td>
<td>MO</td>
<td>63045</td>
<td>(800)-325-3055</td>
<td><a href="http://www.hummertseed.com">www.hummertseed.com</a></td>
</tr>
<tr>
<td>Johnny's Selected Seeds</td>
<td>955 Benton Avenue</td>
<td>Winslow</td>
<td>ME</td>
<td>04901</td>
<td>(877)-564-6597</td>
<td><a href="http://www.johnnyseedseeds.com">www.johnnyseedseeds.com</a></td>
</tr>
<tr>
<td>Native Seeds/SEARCH</td>
<td>Tuscon</td>
<td>AZ</td>
<td></td>
<td>85705</td>
<td>(520)-622-5561</td>
<td><a href="http://www.nativeseeds.com">www.nativeseeds.com</a></td>
</tr>
<tr>
<td>New Earth Garden Center</td>
<td>9805 Taylorsville Rd.</td>
<td>Louisville</td>
<td>KY</td>
<td>40299</td>
<td>(800)-462-5953</td>
<td><a href="http://www.newearth.com">www.newearth.com</a></td>
</tr>
<tr>
<td>Nichols Garden Nursery</td>
<td>1190 Old Salem Rd. NE</td>
<td>Albany</td>
<td>OR</td>
<td>97321</td>
<td>(800)-422-3985</td>
<td><a href="http://www.nicholsgardennursery.com">www.nicholsgardennursery.com</a></td>
</tr>
<tr>
<td>Park Seed</td>
<td>1 Parkton Avenue</td>
<td>Greenwood</td>
<td>SC</td>
<td>29647</td>
<td>(800)-213-0076</td>
<td><a href="http://www.parkseed.com">www.parkseed.com</a></td>
</tr>
<tr>
<td>Pinetree Garden Seeds</td>
<td>P.O. Box 300</td>
<td>New Gloucester</td>
<td>ME</td>
<td>04260</td>
<td>(207)-926-3400</td>
<td><a href="http://www.superseseeds.com">www.superseseeds.com</a></td>
</tr>
<tr>
<td>Plants of the Southwest</td>
<td>3095 Agua Fria Rd.</td>
<td>Santa Fe</td>
<td>NM</td>
<td>87507</td>
<td>(505)-438-8888</td>
<td><a href="http://www.plantsofthesouthwest.com">www.plantsofthesouthwest.com</a></td>
</tr>
<tr>
<td>Rocky Mountain Seed Co.</td>
<td>6541 N. Washington St.</td>
<td>Denver</td>
<td>CO</td>
<td>80229</td>
<td>(303)-623-6223</td>
<td><a href="http://www.rockymountainseedco.com">www.rockymountainseedco.com</a></td>
</tr>
<tr>
<td>Seed Savers Exchange</td>
<td>3094 N. Winn Rd.</td>
<td>Decorah</td>
<td>IA</td>
<td>52101</td>
<td>(563)-382-5990</td>
<td><a href="http://www.seed">www.seed</a> savers.org</td>
</tr>
<tr>
<td>Seeds of Change</td>
<td>P.O. Box 15700</td>
<td>Santa Fe</td>
<td>NM</td>
<td>87507</td>
<td>(888)-762-7333</td>
<td><a href="http://www.seeds">www.seeds</a> of change</td>
</tr>
<tr>
<td>Territorial Seed Co.</td>
<td>P.O. Box 158</td>
<td>Cottage Grove</td>
<td>OR</td>
<td>97421</td>
<td>(800)-626-0866</td>
<td><a href="http://www.territorialseed.com">www.territorialseed.com</a></td>
</tr>
<tr>
<td>The Cook's Garden</td>
<td>P.O. Box C5030</td>
<td>Warminster</td>
<td>PA</td>
<td>18974</td>
<td>(800)-457-9703</td>
<td><a href="http://www.cooksgarden.com">www.cooksgarden.com</a></td>
</tr>
<tr>
<td>The Pepper Gal</td>
<td>P.O. Box 23006</td>
<td>Ft. Lauderdale</td>
<td>FL</td>
<td>33307</td>
<td>(954)-537-5540</td>
<td><a href="http://www.peppergal.com">www.peppergal.com</a></td>
</tr>
<tr>
<td>Tomato Grower's Supply Co.</td>
<td>P.O. Box 60015</td>
<td>Ft. Myers</td>
<td>FL</td>
<td>33906</td>
<td>(888)-478-7333</td>
<td><a href="http://www.tomatogrowers.com">www.tomatogrowers.com</a></td>
</tr>
<tr>
<td>Twilley Seed Co.</td>
<td>121 Gary Rd.</td>
<td>Hodges</td>
<td>SC</td>
<td>29653</td>
<td>(800)-622-7333</td>
<td><a href="http://www.twilleyseed.com">www.twilleyseed.com</a></td>
</tr>
<tr>
<td>W. Atlee Burpee Co.</td>
<td>300 Park Avenue</td>
<td>Warminster</td>
<td>PA</td>
<td>18974</td>
<td>(800)-333-5808</td>
<td><a href="http://www.burpee.com">www.burpee.com</a></td>
</tr>
<tr>
<td>Worm's Way</td>
<td>7850 N SR 37</td>
<td>Bloomington</td>
<td>IN</td>
<td>47404</td>
<td>(800)-274-9678</td>
<td><a href="http://www.wormaway.com">www.wormaway.com</a></td>
</tr>
</tbody>
</table>

Adapted from DeWitt & Bosland, 1993
Research Update on Pepper Production Systems

Brian A. Kahn

Dept. of Horticulture and Landscape Architecture,
Oklahoma State University, Stillwater, OK 74078

This paper summarizes current global research on certain aspects of field production systems for peppers (Capsicum spp.). A more complete treatment, with citations, will be available as part of a forthcoming monograph on peppers to be published by CABI.

Soil Preparation: Use of Raised Beds

While peppers often are produced on raised beds, relatively few studies have actually compared planting on raised beds versus growing on the flat. Growers should consider factors like soil type and drainage when deciding on the use of raised beds. Bed width and bed orientation (east-west versus north-south) appear to be relatively unimportant. For dry peppers (like paprika) intended for harvest with a stripper-type machine, either hilling or sustaining raised beds should improve plant anchorage.

Soil Preparation: Mulching

Black plastic mulch usually improves yield compared to bare soil, except when temperatures are high. Clear plastic gives more variable results, and may heat the soil too much for most Oklahoma applications other than solarization. Commercial growers who direct-seed and who are looking for the earliest possible production may consider a covered trench planting system. This system, involving raised beds and slitted clear plastic mulch, is described by Dainello and Heineman (1987). Colored plastic mulches, including red, have not been widely tested on peppers. Reflective mulches (including white, white-on-black, and silver-on-black) can provide insect control and may benefit yield when soil warming is not desired or is unnecessary. These reflective mulches could be the best bet for Oklahoma growers desiring to produce peppers on film-covered beds if early production is not essential.

Alternatives to plastic mulch are being studied. Mulching with killed plant materials (e.g., wheat straw or hairy vetch) often delays pepper maturity and may increase insect pests such as cutworms and fire ants. Total yields from peppers mulched with killed plant materials usually are comparable to, or lower than, yields from peppers mulched with black plastic or grown on bare soil. “Living mulches” usually reduce yield. Degradable film mulches can be hard to lay (paper) and/or costly. Promising results were obtained with a biodegradable paper/cured vegetable oil mulch (Shogren and David, 2006), although it is more expensive than plastic.

Row Covers / Low Tunnels

Row covers typically are used in conjunction with plastic mulches to encourage early production. Tunnels use hoops about 15-20 inches tall and are covered with clear,
perforated polyethylene or spunbonded polyester. “Floating” covers (no hoops) are made of spunbonded polyester. Results have usually been positive if temperatures do not get too high before cover removal. Removal is recommended after a heat unit accumulation of about 650 units (with a base temperature of 50°F) inside the tunnels.

Plant Population and Plant Arrangement

Recommendations for optimal plant population density vary with location and the type of pepper. Between-row spacing is often governed by the footprint of tillage and pest control equipment; rows 3 feet apart are common in Oklahoma. Fruit number and weight decrease per plant but increase per acre down to a within-row spacing of 2 inches in some pepper types (like paprika). Few studies have examined plant arrangements for peppers. OSU Cooperative Extension Fact Sheet HLA-6030 (Motes et al., 2007) recommends single rows 3 feet apart with plants 14 to 16 inches apart within rows for bell peppers, or about 1 plant every 3.75 ft². However, closer spacings are possible with intensive management practices like drip irrigation. A Canadian study found maximum bell pepper fruit yield per ft² at a density of 1 plant per 1 ft² (Gaye et al., 1992). Double-row beds are common, but net spacing between plants must be considered. In a study carried out in Oklahoma and Texas, single rows of bell peppers out-yielded double rows at the same plant population density (1 plant every 3.1 ft²), mainly due to more U.S. No. 1 fruit weight produced with single rows (Kahn and Leskovar, 2006).

Pruning, Training, and Plant Support Systems

Pruning and training are used in greenhouse production of peppers, but seldom in the field. Plant support in the field can be the same as for tomatoes (for example, the stake-and-weave system), but use of support systems for peppers is much less common than for tomatoes. Lodging can interfere with pepper harvest, whether by hand or by machine. Reduce lodging by selecting upright cultivars; using direct seeding, or setting transplants in the soil at least to the depth of the cotyledon leaves; practicing hilling or sustaining raised beds; and using windbreaks.

Plant Growth Regulators

The only common plant growth regulator used on peppers is ethephon, and it typically is used when red fruits are desired. The effectiveness of ethephon varies with cultivar, rate, number of applications, and temperature. Ethephon was tested on paprika peppers in Oklahoma, and was found to be of most value as a controlled abscission agent to increase the percentage of harvested red fruit (Kahn et al., 1997).

Specialized Cropping Systems

No-tillage systems have had limited success for peppers; stand establishment and weed control are issues. Strip-tillage has more potential, but management factors are still being studied. Tilled strips need to be at least 3 to 4 feet wide.
Intercropping has limited commercial use in the United States; it can complicate chemical pest control, and it is a labor-intensive practice. Intercropping is widely used in developing countries, and peppers are often one crop in the mix. No one intercrop combination is likely to work consistently in all locations.

Ratoon cropping is a possible system to improve fall pepper production in the southwestern United States, including Oklahoma. This involves mowing spring-transplanted plants during the summer at a height of about 9 inches. The alternative is to carry over spring-transplanted plants without pruning, and this may ultimately give the highest total marketable fruit production. However, by comparison the ratoon system results in plants that are easier to manage; reduces cull fruit production; and may increase premium fruit production in the fall (Kahn and Leskovar, 2001). The ratoon system is being used on some commercial pepper farms in Texas.

Of course, there are many other aspects of pepper production in the field, but these specific areas were the focus of the author’s review.

Literature Cited

Low and High Input Organic Mulching Trial

Angela R. Davis¹, Charles L. Webber III¹, James Shrefler², and Merritt Taylor²

¹USDA, ARS, South Central Agriculture Research Laboratory, P.O. Box 159, Lane, OK 74555 U.S.A.
²Wes Watkins Agricultural Research and Extension Center of OSU P. O. Box 128, Lane, Oklahoma 74555

SCARL, together with WWAREC have developed a center of excellence for vegetable and specialty crop research and organic production research.

Introduction

Many consumers consider organically grown produce a healthier and safer option over conventionally grown crops. Because of this consumers are often willing to pay more for organically grown produce. However, production of organic fruits, vegetables, and herbs can be challenging, especially in climates where weed, insect and disease incidence is prevalent. Knowing which organic production methods works best for our region is imperative for a good harvest. Unfortunately, there is limited information on specific organic production methods that do well in Oklahoma and Arkansas. To address this need, production characteristics of four mulching schemes were tested in Southeastern Oklahoma in 2009. Comparisons were made to determine which mulches perform best on multiple herbs and vegetables.

Materials and Methods

Four rows were prepared as three foot wide raised beds with three foot spacing. Mulch was laid on all but the control row (bare ground). Three treatments were tested, 1) high input with plastic mulch with bare ground between rows, 2) low input with three inches of non-treated rye (Secale cereale L.) straw on the bed and between rows, and 3) low input with shredded paper placed on the row prior to application of three inches non-treated rye straw. The control was a bare ground (no-mulch) row on the bed or between rows. In the third treatment we utilized shredded white paper on the soil before the addition of straw as a potential barrier against allelopathic effects from the rye.

Seeds were direct seeded through the mulch on June 5th in weed-free rows. Established, potted herbs were transplanted through the mulch on the same day. Hoeing and hand weeding were performed once per week. Time needed to weed each treatment was recorded. Transplants were watered in by hand with Neptune’s Harvest Fish & Seaweed fertilizer (2-3-1) (Earthly Goods), and plants were watered depending on each treatment’s moisture needs throughout the growing season using drip irrigation under the mulch. This was a non-replicated study.

Included in this study were eight crops: [one] rosemary (Rosmarinus officinalis L.), [one] ‘German Winter Thyme’ (Thymus vulgaris L.), [fifteen] garlic chives (Allium tuberosum Rottler), [three] garden chives (Allium schoenoprasum L.), [six] ‘Bronze and Green Tip Fennel’ (Foeniculum vulgare Mill), six ‘Genovese Basil’ (Ocimum basilicum
L., [ten] ‘Royal Burgundy Beans’ (*Phaseolus vulgaris* L.), [~30] ‘Roquette Arugula (*Eruca vesicaria sativa*)}. Numbers in square brackets denote how many plants or seed were planted for each variety in each replication. One to thirty plants of each of the eight crops were planted per replication. The four replications were in separate rows, three feet apart with six foot centers.

The soil (Bernow fine-loamy, siliceous, thermic, glossic palendalf soil) was pretreated using recommended rates of chicken litter for organic production (Roberts, 2002), and plants were fertilized every 12 to 15 days by hand with four applications of Neptune’s Harvest Fish & Seaweed fertilizer (2-3-1).

Beans were harvested throughout the growing season to keep plants productive and healthy. The rest of the crops were harvested at the end of the growing season. Dry and wet weights of plants were measured.

**Results and Discussion**

General observations were paper plus straw and straw mulches were more difficult to apply than the plastic mulch. However, the plastic required removal and disposal whereas the straw and paper plus straw mulch could be incorporated into the soil to add organic matter.

All three mulches gave good weed suppression (data not shown). The results of the weed control is presented in this issue (Webber et al., 2010).

Dry and wet weight data indicated similar trends, so plant weight will be used in the discussion and combines both the wet and dry weight results.

Bare ground and plastic mulch had the highest plant weight for all crops except garlic chives, which did best in the rye straw mulch. Arugula did well under all treatments. Bare ground and plastic mulch plant weights were similar, and for most crops, the difference between the two treatments was small. Average plant weight was reduced about 10% in the rye and roughly 80% in the rye plus paper treatment (Figure 1).

All mulches decreased the amount of irrigation and weeding needed (data not shown). In addition, the mulches kept leaves and beans cleaner than the bare ground control. However, 2009 was much wetter than average, and the heavily mulched rows, rye straw and paper plus rye straw, stayed wet most of the season. Conditions were probably too moist for optimum plant health. In a normal year or in a dry year, there may be a considerable advantage for the cooling and moisture retaining characteristics of the rye and paper plus rye mulch. However, it can not be ruled out that the rye straw decomposition could have utilized available nitrogen and phosphorus, which stunted plant growth, or the rye’s allelopathic effects stunted plant growth. We will repeat the study several more years to test this possibility.

Mention of trade names or commercial products in this article is solely for the purpose of providing specific information and does not imply recommendation or endorsement by the U.S. Department of Agriculture. All programs and services of the
U.S. Department of Agriculture are offered on a nondiscriminatory basis without regard to race, color, national origin, religion, sex, age, marital status, or handicap. The article cited was prepared by a USDA employee as part of his/her official duties. Copyright protection under U.S. copyright law is not available for such works. Accordingly, there is no copyright to transfer. The fact that the private publication in which the article appears is itself copyrighted does not affect the material of the U.S. Government, which can be freely reproduced by the public.

Acknowledgments
We would like to thank Amy Helms, Buddy Faulkenberry, Cody Sheffield, and William Baze for technical assistance.

References

Figure 1: Normalized average of all crops weight per row cover treatment. All values are compared to the no mulch control which was given a 100% weight rating. WT = weight. PAP = paper.
Cover Crops and Vegetable Rotations

Warren Roberts, Jim Shrefler, Merritt Taylor, and Chuck Webber

The authors are located at the Lane Agricultural Center at Lane, Oklahoma. For several years, work has been conducted at the agricultural center to support conventional, organic, and sustainable farming systems. Part of the recent effort has included selection of cover crops which could be used to prevent soil erosion, add organic matter to the soil, and in some cases add nitrogen to the soil.

For centuries, farmers have known that a cover crop planted in the fall could prevent soil erosion during the winter months, and could provide organic matter to the soil. Winter cover crops and summer green manure crops have been used extensively for decades, but although their benefits are well known, they are not always used on farm fields. The cost of seed, the labor required for planting, and unfavorable weather conditions at the time of planting are all factors that may prevent farmers from using cover crops. Another reason is that information concerning the best cover crop for a particular location and a particular planting season is not always available. While anecdotal information does exist concerning the best cover crops for a region, this information is not necessarily based on replicated scientific research work.

Materials and Methods: In the fall of 2008, we began a cover crop/vegetable crop rotation at the Lane Agricultural Center in southeastern Oklahoma. A total of eight cover crops were planted in September. These crops included four legumes ( crimson clover, arrowleaf clover, yellow sweet clover, and hairy vetch) along with four grasses (oats, rye, wheat, and ryegrass). Plots were 50 feet wide by 90 feet long. There were four replications of each plot. The crops germinated in the fall, and were allowed to grow during the late fall, winter, and early spring.

In April of 2009, half of each plot was mowed, while the cover crops continued growing on the remainder of the plot. The mowed half of each plot was then divided into three equally sized sections, and each section was planted to either sweet corn, southern peas, or sweet potatoes. Before the vegetables were planted, poultry litter was applied at the rate of one ton per acre to the surface of the soil, and was then tilled into the soil. The poultry litter contained approximately 40 pounds per acre of N, P\textsubscript{2}O\textsubscript{5}, and K\textsubscript{2}O.

Cover Crop Growth: On June 16, foliage samples were taken from the un-mowed half of the plots. The samples from each plot were air dried and weighed. At that time, there was more bio-mass with the arrowleaf clover (4.7 tons per acre) than with any of the other crops. The other crops weighed 3.3 tons (rye), 3.0 tons (ryegrass), 2.4 tons (wheat), 1.9 tons (oats), 1.9 tons (yellow sweet clover), 1.6 tons (crimson clover), and 1.4 tons per acre (hairy vetch). It should be pointed out that the crimson clover and hairy vetch were early maturing crops, and were already decaying when the samples were taken. If samples had been taken earlier, it is likely that the crimson clover and hairy vetch would have weighed more, and the later maturing arrowleaf clover and cereal grasses would have weighed less.
Weed and Grass Control: On August 7, it was noted that certain plots contained much more annual grass such as crabgrass and goosegrass than did other plots. On August 19, ratings were taken to determine the percentage of each plot that was covered by each of living grass, yellow nutsedge, clover, other broadleaf plants, or bare soil. Bare soil was defined to include both bare soil and dead organic plant materials.

With the crimson clover, hairy vetch, yellow sweet clover, oats, and wheat, there was more surface area covered with grass than with any of the other categories. Sixty-nine percent of the crimson clover plot, 67% of the hairy vetch plot, 53% of the yellow sweet clover plot, 52% of the oats plot, and 43% of the wheat plot was covered with grass. The remaining three plots (arrowleaf clover, rye, and ryegrass) had very little living grass. Arrowleaf had only 2% of the surface area covered with living grass, while ryegrass had 3%, and rye had 9% of the surface covered with grass. Most of the surface area of arrowleaf clover plots, rye plots, and ryegrass plots was covered with either bare soil or dead plant material.
Yellow nutsedge occurred more in the wheat plots than in any other plot. The wheat plots had 20% of the surface area covered with nutsedge, while the other plots ranged from 10% to 0%. There was no nutsedge in either the crimson clover or arrowleaf clover plots.

Crop Yield: On August 7, yield was taken from southern peas that had been grown in the different cover crop plots. The highest yielding plot was ryegrass, and the lowest yielding plot was rye. The other six cover crop plots produced yields that were nearly identical.

On August 17, yield was taken from the sweet corn that had been grown in the different cover crop plots. The four legumes (crimson clover, arrow leaf clover, yellow sweet clover, and hairy vetch) all yielded more than did the four non-legume cover crops. The highest yielding cover crop, hairy vetch, produced about 7 tons per acre, as opposed to the lowest yielding cover crop, oats, which only produced about 3 tons per acre.

Sweet potatoes were not harvested. Excessive rainfall and saturated soils during the fall of 2009 made it impossible to harvest or remove the sweet potatoes from the field.
**Conclusions:** Very good stands and very good growth were obtained with all eight cover crops. We anticipated that the legumes would provide substantial nitrogen to the subsequent vegetable crops. Poultry litter was applied at a marginal low rate to all plots to ensure that at least some nitrogen was available for the vegetable crops, but at such a rate (40 lbs N per acre) that crops were likely to be deficient unless nitrogen was obtained from the legumes. Sweet corn produced better yields with each of the four legume crops than with the non-legumes. Sweet corn is known to have a high requirement for nitrogen, and it is likely that the nitrogen from the legumes supplemented the nitrogen from the poultry litter and thus increased corn yield.

With the southern peas, yields were similar with all cover crops. This could be because southern peas themselves are legumes, and would have been expected to fix some nitrogen from the atmosphere. Thus, the nitrogen supplied from the poultry litter in combination with the nitrogen from the atmosphere appeared to be sufficient for crop growth.

Crimson clover and hairy vetch were early maturing crops, and grew well during the late winter and early spring months. These crops appear to be well suited for cropping systems that would require early plowing of the cover crops for an early spring vegetable crop. Arrowleaf clover and yellow sweet clover produced high quantities of biomass, but at a later time than did the other legumes. Thus, arrowleaf and yellow sweet clover might not be appropriate for an early plow down cropping system in the early spring, but might be well suited to a cropping system where the subsequent vegetable crops are not planted until later spring or summer, such as okra, cucumbers, and pumpkins.

Substantial interactions did occur between the various cover crops and subsequent grass and nutsedge weeds. Although this experiment has only been conducted for one year, there are indications that selection of an appropriate cover crop could be a valuable tool in reducing grass and nutsedge populations in following vegetable cropping systems.
Vegetable production is an important sector of our economy. In order to achieve the optimum yields, soils need to be tested and fertilizers should be applied based on soil nutrient supplying capacity. Soil fertility and fertilizer management is critical for a successful vegetable production. Soil testing is the first step in developing an effective nutrient management program. The nutrient needs of vegetables are similar but various among different species.

Soil test interpretation is an important part of nutrient management for crop production. This presentation will highlight strategies to take a representative soil sample, and how to make lime, nitrogen (N), phosphorus (P), and potassium (K) recommendations for vegetable crops based on soil test results. More details can be found in OSU factsheet HLA-6036 Soil Test Interpretations for Vegetable Crops.

**Nitrogen (N) Requirement:** The amount of N needed is directly related to the yield goal. Yield goals should be greater than long-term average yields to ensure nitrogen will not be the factor limiting crop production during years with better than average growing conditions. The nitrogen fertilizer rate is calculated by subtracting the soil test N value from the nitrogen requirement listed in Table 1.

Total fertilizer N requirement for vegetables can be calculated using the following equation if soil is tested:

\[
N \text{ (lbs/acre)} = \text{Total N from Table 1 (lbs/A)} - \text{soil test N (lbs/A)}
\]

### Table 1. The amount and timing of nitrogen fertilization for vegetable crops.

<table>
<thead>
<tr>
<th>Crop</th>
<th>Total N lbs/acre*</th>
<th>N preplant lbs/acre</th>
<th>1st N side/topdress lbs/acre</th>
<th>2nd N side/topdress lbs/acre</th>
<th>3rd N side/topdress lbs/acre</th>
</tr>
</thead>
<tbody>
<tr>
<td>Asparagus**</td>
<td>70-80</td>
<td>50</td>
<td>30-70</td>
<td>NA***</td>
<td>NA</td>
</tr>
<tr>
<td>Bean</td>
<td>75</td>
<td>25</td>
<td>50</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Beet</td>
<td>120</td>
<td>55</td>
<td>65</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Broccoli</td>
<td>175</td>
<td>40</td>
<td>65</td>
<td>70</td>
<td>NA</td>
</tr>
<tr>
<td>Brussels sprout</td>
<td>175</td>
<td>40</td>
<td>65</td>
<td>70</td>
<td>NA</td>
</tr>
<tr>
<td>Cabbage</td>
<td>175</td>
<td>40</td>
<td>65</td>
<td>70</td>
<td>NA</td>
</tr>
<tr>
<td>Carrot</td>
<td>175</td>
<td>50</td>
<td>65</td>
<td>60</td>
<td>NA</td>
</tr>
<tr>
<td>Cauliflower</td>
<td>175</td>
<td>40</td>
<td>65</td>
<td>70</td>
<td>NA</td>
</tr>
<tr>
<td>Cilantro</td>
<td>120</td>
<td>70</td>
<td>50</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Collard</td>
<td>120</td>
<td>70</td>
<td>50</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Cowpea</td>
<td>50</td>
<td>30</td>
<td>20</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Cucumber</td>
<td>150</td>
<td>50</td>
<td>50</td>
<td>50</td>
<td>NA</td>
</tr>
<tr>
<td>Eggplant</td>
<td>100</td>
<td>25</td>
<td>25</td>
<td>25</td>
<td>25</td>
</tr>
<tr>
<td>Garden pea</td>
<td>60</td>
<td>30</td>
<td>30</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Garlic</td>
<td>175</td>
<td>50</td>
<td>65</td>
<td>60</td>
<td>NA</td>
</tr>
<tr>
<td>Kale</td>
<td>120</td>
<td>70</td>
<td>50</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Lettuce</td>
<td>120</td>
<td>70</td>
<td>50</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Melons</td>
<td>125</td>
<td>50</td>
<td>50</td>
<td>25</td>
<td>NA</td>
</tr>
<tr>
<td></td>
<td>120</td>
<td>70</td>
<td>50</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>----------------</td>
<td>-----</td>
<td>-----</td>
<td>-----</td>
<td>-----</td>
<td>-----</td>
</tr>
<tr>
<td>Mustard</td>
<td>120</td>
<td>70</td>
<td>50</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Okra</td>
<td>80</td>
<td>40</td>
<td>20</td>
<td>20</td>
<td>NA</td>
</tr>
<tr>
<td>Onion</td>
<td>150</td>
<td>50</td>
<td>55</td>
<td>45</td>
<td>NA</td>
</tr>
<tr>
<td>Pepper</td>
<td>100</td>
<td>25</td>
<td>25</td>
<td>25</td>
<td>25</td>
</tr>
<tr>
<td>Potato</td>
<td>200</td>
<td>55</td>
<td>75</td>
<td>70</td>
<td>NA</td>
</tr>
<tr>
<td>Pumpkin</td>
<td>150</td>
<td>50</td>
<td>60</td>
<td>40</td>
<td>NA</td>
</tr>
<tr>
<td>Radish</td>
<td>80</td>
<td>40</td>
<td>40</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Spinach</td>
<td>120</td>
<td>70</td>
<td>50</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Squash</td>
<td>150</td>
<td>50</td>
<td>60</td>
<td>40</td>
<td>NA</td>
</tr>
<tr>
<td>Sweet corn</td>
<td>200</td>
<td>40</td>
<td>80</td>
<td>80</td>
<td>NA</td>
</tr>
<tr>
<td>Sweet potato</td>
<td>60</td>
<td>30</td>
<td>30</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Tomato</td>
<td>100</td>
<td>25</td>
<td>25</td>
<td>25</td>
<td>25</td>
</tr>
<tr>
<td>Turnip (roots)</td>
<td>80</td>
<td>40</td>
<td>40</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Turnip (tops)</td>
<td>120</td>
<td>70</td>
<td>50</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Watermelon</td>
<td>150</td>
<td>50</td>
<td>60</td>
<td>40</td>
<td>NA</td>
</tr>
</tbody>
</table>

*Attention should be paid to nitrogen applications in light of the fact that nitrogen is easily leached from soil by excessive rainfall.

**Asparagus is a perennial crop and fertility rates will vary according to establishment year vs. years following establishment. Establishment year apply 50 lbs N preplant and 30 lbs N as a sidedress 2 months after establishment. Years following establishment apply 70 lbs N near end of harvest season.

***NA = Not Applicable.

**Phosphorus (P) and Potassium (K) Recommendations:** Examples of P and K requirement based on soil test indices are shown in Table 2 and 3. See HLA-6036 if a crop is not listed in the tables below. Both P and K are considered relative immobile nutrients, therefore, fertilizers should be applied before or at planting so that they are mixed into the soil. Experiments have shown that when soil test P and K are over 65 and 250, respectively, crops had little or no response to additional fertilizer inputs.

**Table 2.** Phosphorus requirement for vegetable crops in Oklahoma using Mehlich 3 extraction.

<table>
<thead>
<tr>
<th>P Soil Test Index</th>
<th>P₂O₅ (lbs/A)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Asparagus</td>
</tr>
<tr>
<td>0</td>
<td>200</td>
</tr>
<tr>
<td>10</td>
<td>170</td>
</tr>
<tr>
<td>20</td>
<td>140</td>
</tr>
<tr>
<td>40</td>
<td>80</td>
</tr>
<tr>
<td>&gt;65</td>
<td>0</td>
</tr>
</tbody>
</table>
Table 3. Potassium requirement for vegetable crops production in Oklahoma using Mehlich 3 extraction.

<table>
<thead>
<tr>
<th>K Soil Test Index</th>
<th>P₂O₅ (lbs/A)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Asparagus</td>
</tr>
<tr>
<td>0</td>
<td>200</td>
</tr>
<tr>
<td>75</td>
<td>155</td>
</tr>
<tr>
<td>125</td>
<td>120</td>
</tr>
<tr>
<td>200</td>
<td>50</td>
</tr>
<tr>
<td>&gt;250</td>
<td>0</td>
</tr>
</tbody>
</table>

Other Nutrient Requirements: Vegetables also need other macro- and micro-nutrients in addition to N, P and K discussed above. However, those recommendations are under development in Oklahoma.

Lime Recommendation for vegetable crops is based on the pH and the buffer index of the soil sample. Although different vegetables have slightly different tolerance to soil acidity, most of them do well between pH 6.0 and 7.0. Therefore, lime is recommended if soil pH falls below 6. The amount of lime need to bring soil pH to 6.8 is listed in Table 4.

Table 4. Lime rates for vegetable production in Oklahoma. No lime is recommended when soil pH is 6.0 and higher no matter what the buffer index is.

<table>
<thead>
<tr>
<th>Soil Buffer Index</th>
<th>ECCE* Lime (tons/A)</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.2</td>
<td>4.2</td>
</tr>
<tr>
<td>6.3</td>
<td>3.7</td>
</tr>
<tr>
<td>6.4</td>
<td>3.1</td>
</tr>
<tr>
<td>6.5</td>
<td>2.5</td>
</tr>
<tr>
<td>6.6</td>
<td>1.9</td>
</tr>
<tr>
<td>6.7</td>
<td>1.4</td>
</tr>
<tr>
<td>6.8</td>
<td>1.2</td>
</tr>
<tr>
<td>6.9</td>
<td>1.0</td>
</tr>
<tr>
<td>7.0</td>
<td>0.7</td>
</tr>
<tr>
<td>7.1</td>
<td>0.5</td>
</tr>
<tr>
<td>7.2+</td>
<td>0.0</td>
</tr>
</tbody>
</table>

*ECCE (Effective Calcium Carbonate Equivalent): pure calcium carbonate ground fine enough to be 100% effective.

The rate of ag-lime to apply can be determined from the ECCE requirement using

[154]
the following formula:

\[
\text{Tons of ag-lime/A} = \frac{\text{Tons ECCE lime required}}{\%\text{ECCE of the ag-lime}}
\]

For example, a soil has a pH of 5.5 and buffer index of 6.6. It asks for 1.9 tons of ECCE, but the lime only has 80% ECCE. Therefore, the actual amount of this lime needed is: 2.4 tons (1.9/0.8).
Soil Improvement Studies for Oklahoma Vegetables

Lynn Brandenberger, Hailin Zhang, and Lynda Carrier
Departments of Horticulture and Plant and Soil Science, Oklahoma State University

Growers in the southern U.S. face serious problems due to low levels of organic matter in production soils. Organic matter levels in agricultural soils of Oklahoma commonly are less than 1%. Low organic matter can have serious effects upon production including poor stands, poor retention of water and plant nutrients, and generally poor tilth of production soils. The objectives of this study are to compare different means of increasing soil organic matter and the effects that increased organic matter may have on crop establishment and growth over a four year period.

Plots were arranged in a randomized block design with five replications. Treatments included a clean fallow check, cowpea (Victor) cover crop, sorghum/sudan cover crop (Hay Grazer BMR 6), sorghum/sudan + cowpea cover crop combination, and clean fallow + compost. Study treatments were initiated on 6/26/09 by direct seeding all cover crops in plots that were 12’ x 26’ which included 18 rows on six inch row centers. Plant populations are given in Table one. All cowpea seed were inoculated prior to planting with *Bradyrhizobium* species at a rate of 2.5 oz of inoculum per 50 lbs of seed. Clean fallow and compost plots were rototilled during the summer growth period on 7/24/09 and 8/6/09. Sorghum/sudan cover crop plots were mown with a rotary mower at a height of 4-6 inches on 8/06/09 and the entire study was mown on 8/25/09. On 9/01/09 all plots were rototilled once to a depth of 6-8 inches and this was repeated twice on 9/28/09 in preparation for planting on 9/29/09. Compost was applied on 9/29/09 to the clean fallow + compost plots at a rate of 8 tons of compost per acre and then rototilled to a depth of 3-4 inches for incorporation. All plots were direct seeded to the spinach cultivar ‘Padre’ on 9/29/09, eight rows per plot on one foot row centers at a seeding rate of 12 seed per foot row. All plots received 0.65 lbs ai/acre of Dual Magnum (S-metolachlor) as a preemergence herbicide application following direct seeding on 9/29/09. All plots received a total of 100 lbs of nitrogen per acre applied as a split application of 50 lbs per acre on two different dates (11/04/09 and 11/17/09). Emergence and stand coverage were rated on a 0 to 100 scale where 0% would indicate no emerged plants or coverage of the soil surface by crop plants in the plots and 100% would indicate a full stand and complete coverage of the soil surface by plants in the plots.

No differences were observed for emergence on 10/19/09 with emergence ranging from 46% for the fallow check to 53% for the sorghum x sudan + cowpea cover crop and the compost treatments (Table 1). Stand coverage was rated on 12/01/09 and differences between treatments were observed. The fallow check had 46% stand coverage while the compost treatment had 79% coverage, all other treatments did not vary from the lowest or highest ratings. In conclusion, the study was established during 2009 and although there were few differences between treatments observed, the authors are looking forward to continued efforts on the study and the potential improvement of soil conditions and related crop responses.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>% Emergence 10/19/09</th>
<th>% Stand coverage 12/1/09</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fallow check</td>
<td>46 a</td>
<td>46 b</td>
</tr>
<tr>
<td>Cowpea cover crop</td>
<td>46 a</td>
<td>57 a-b</td>
</tr>
<tr>
<td>Sorghum x sudan cover crop</td>
<td>50 a</td>
<td>63 a-b</td>
</tr>
<tr>
<td>Sorghum x sudan + cowpea cover crop</td>
<td>53 a</td>
<td>66 a-b</td>
</tr>
<tr>
<td>Compost at 8 tons/acre rate x</td>
<td>53 a</td>
<td>79 a</td>
</tr>
</tbody>
</table>

x All plots were tilled and planted to ‘Padre’ spinach on 9/29/09
y Numbers in a column followed by the same letter exhibited no significant differences based on Duncan’s Multiple Range Test where P=0.05.

Table 1. 2009 Soil improvement study, Bixby, OK.
Irrigation Timing and Fertilizer Rate in Peppers

Vincent M. Russo
U.S.D.A., A.R.S., South Central Agricultural Research Laboratory, POB 159, 911 Hwy. 3W, Lane, Okla. 74555
email: vrusso-usda@lane-ag.org

Weather patterns seem to be changing with wetter than expected summers occurring during the 2008 and 2009 growing seasons. Soils remained saturated and it was difficult to establish and maintain vegetable crops. If this is to be the norm then producers will need to adapt to these changes. In 2009 there were heavy rains prior to establishment of mid-April transplanted crops and rain began again shortly after that point. A question that could arise is whether, when rain events are frequent and/or heavy, will it be necessary to irrigate crops, or whether moisture stored in the soil will be sufficient to support plants so that desired yield levels are obtained. The amount of precipitation can change how quickly soil nutrients can be leached which removes them from use by plants and can affect yield. Precipitation amounts that began accumulating shortly after stand establishment, and eventually totaling ~16.7" during the growing season, provided an opportunity to determine if supplemental water would be needed to influence pepper (*Capsicum annuum* L.) yields. The project was undertaken to determine if supplemental timed irrigation and fertilizer rate affected yield of two types of pepper.

The Bernow, fine-loamy, thermic, Glossic, Paleudalf soil was supplied with either 150 or 300 lbs/acre of triple-17 NPK fertilizer broadcast-applied. The soil was formed into beds on 3 ft centers with a tractor mounted tilovator and bed shaper. Eight-week-old transplants of the bell pepper, cv. Jupiter, and the non-pungent Jalapeño pepper, cv. Pace 105, both *C. annuum*, were established with a tractor driven transplanter at an 18" in-row spacing on 15 April. Plots were replicated three times. Irrigation was supplied with overhead sprinklers. Plants were watered at 10AM or 2PM, either once or twice a week. If irrigation occurred once a week, on Monday, plants received 3" of water, and if irrigation occurred twice a week, plants received 1.5" of water on Monday and Thursday. Controls did not receive any irrigation.

Bell peppers were harvested once on 14 July 2009 and non-pungent Jalapeño peppers were harvested once on 22 July 2009. Bell pepper fruit were determined to be marketable based on USDA/AMS (1994) criteria. The non-pungent Jalapeños were graded based on criteria supplied by a processor of this type of peppers. Fruit were generally considered to be unmarketable due to size or blemishes. Irrigation timing and irrigation frequency, but not fertilizer rate, or any interactions, affected marketable yield; treatments did not affect cull yields (Table 1). For both types of peppers time of irrigation, 10AM or 2PM, produced similar values, 35,900 fruit/acre and 5 T/acre for bell pepper; 320,000 fruit/acre and 7.3 T/acre for non-pungent Jalapeño pepper. For both types of pepper irrigation twice/week produced higher yields than did irrigation once/week, or no irrigation. Numbers and yield of cull fruit were not affected by treatment. For ‘Jupiter’ numbers of cull fruit averaged 19,300/ac and yield averaged 1.7
For the ‘Pace’ numbers of cull fruit averaged 158,800/ac and yield averaged 3.5 T/ac.
Fertilizer rate did not affect results. For ‘Jupiter’, over fertilizer rates, numbers and yield of marketable fruit were 26,240/ac and 3.5 T/ac, respectively, and numbers and yield of cull fruit were 19,300/ac and 1.7 T/ac, respectively. For ‘Pace’, over fertilizer rates, numbers and yield of marketable fruit were 264,200/ac and 5.5 T/ac, respectively, and numbers and yield of cull fruit were 158,800/ac and 3.5 T/ac, respectively.

Even with greater than normal amounts of rain it was necessary to apply irrigation to improve yields. The amount of water stored in the root-zone of the soil was insufficient to support crop development and/or maximize yield. It may be that roots need refreshment of moisture to maintain the availability of dissolved nutrients delivered to plants. Irrigating twice/week may have stabilized water loss since the soil likely maintained a more stable water capacity then if watered once/week.

### Table 1. Affects of irrigation frequency on yields of bell or non-pungent Jalapeño peppers.

<table>
<thead>
<tr>
<th>Irrigation frequency</th>
<th>Bell Marketable</th>
<th>Non-pungent Jalapeño Marketable</th>
</tr>
</thead>
<tbody>
<tr>
<td>None</td>
<td>6940c 0.7c</td>
<td>152500c 2.0c</td>
</tr>
<tr>
<td>Once/week</td>
<td>22260b 2.8b</td>
<td>274100b 5.2b</td>
</tr>
<tr>
<td>Twice/week</td>
<td>49500a 7.1a</td>
<td>366000a 9.3a</td>
</tr>
</tbody>
</table>

Z values in a column followed by the same letter are not significantly different, \( P<0.05 \), Ryan-Gabriel-Einot-Welsch multiple range test; there was not a significant interaction.

Reference

Posters
Micronized Compost as an Organic Amendment for Soil Media

Charles L. Webber III\textsuperscript{a}, B. Warren Roberts\textsuperscript{b}, Merritt J. Taylor\textsuperscript{b}, and James W. Shrefler\textsuperscript{b}

\textsuperscript{a}USDA, ARS, SCARL and \textsuperscript{b}Oklahoma State University
Lane, OK

Introduction

There is a growing belief among consumers that organic foods are safer, provide superior nutrition, and their production is more environmentally friendly than conventionally grown foods. Increasing consumer demand and standardization of labeling of organic foods resulting from the establishment and implementation of the National Organic Program (NOP) standards has “opened new market opportunities for producers and is leading to a transformation in the organic foods industry” (Dimitri and Greene, 2002).

All components entering into the organic crop production system must be approved for organic use, including the seed, growth medium, and fertilizer used in transplant production. It is important to have access to organically approved fertilizers that can be used to produce healthy seedlings. The pharmaceutical industry has used micronization to reduce the average size diameter of materials to a few micrometers or the nanometer range to increase effectiveness on products. Greenhouse research was conducted to determine the impact on seedling growth as a result of adding a micronized compost to a growth medium for organic tomato (\textit{Solanum lycopersicon} L.) transplant production.

Methods and Materials

Tomato seeds (‘Florida 47’) were planted in an organic potting medium\textsuperscript{1} and grown in a glass-covered greenhouse at Lane, OK. At one week after seeding, tomato seedlings were thinned to 1 seedling per 3 inch by 3 inch container. Micronized compost\textsuperscript{2} (MC), organic\textsuperscript{3} fertilizer (OM), and synthetic fertilizer\textsuperscript{4} (SF) were applied at 4 rates (50, 100, 150, and 200 ppm) and a control which did not receive any fertilizer. The fertility treatments (MC, OM, and SF) were based on the nitrogen level on the product label and applied as a soil drench to established (3 week old) tomato seedlings. The tomato seedlings were harvested at 7 weeks and top weights and heights were determined. The experimental design was a randomized complete block with 4 replications. All data were subjected to ANOVA and mean separation using LSD with \textit{P}=0.05 (SAS Inc., SAS, Ver. 9.1, Cary, NC).

1 Sunshine Organic Planting Mix, Sun-Gro Horticulture Canada Ltd., Vancouver, British Columbia, Canada.
2 Natures Creation, Micronized Compost (5-5-5), Par 5 LLC, P.O. Box 108, Bartlesville, OK 74005
3 Neptune’s Harvest Fish and Seaweed Fertilizer (2-3-1), Neptune’s Harvest, P.O. Box 1183, Gloucester, MA 01931-1183
Figure 1. Influence of type of fertilizer and application rate on tomato seedling plant weight and height 7 weeks after planting.

<table>
<thead>
<tr>
<th>Fertilizer Material</th>
<th>Fertilizer Rate (ppm)</th>
<th>Plant Top Weight (g)</th>
<th>Plant Height (cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water Only</td>
<td>0</td>
<td>3.71 g</td>
<td>5.75 f</td>
</tr>
<tr>
<td>Micronized(^a)</td>
<td>50</td>
<td>17.25 def</td>
<td>10.22 cde</td>
</tr>
<tr>
<td>Organic(^b)</td>
<td>50</td>
<td>9.41 f</td>
<td>7.70 e</td>
</tr>
<tr>
<td>Synthetic(^c)</td>
<td>50</td>
<td>22.38 cd</td>
<td>11.18 bcd</td>
</tr>
<tr>
<td>Micronized</td>
<td>100</td>
<td>15.34 edf</td>
<td>9.43 de</td>
</tr>
<tr>
<td>Organic</td>
<td>100</td>
<td>11.54 ef</td>
<td>8.05 e</td>
</tr>
<tr>
<td>Synthetic</td>
<td>100</td>
<td>29.33 bc</td>
<td>12.45 bc</td>
</tr>
<tr>
<td>Micronized</td>
<td>150</td>
<td>20.49 cde</td>
<td>11.30 bcd</td>
</tr>
<tr>
<td>Organic</td>
<td>150</td>
<td>16.76 def</td>
<td>9.90 cde</td>
</tr>
<tr>
<td>Synthetic</td>
<td>150</td>
<td>34.20 b</td>
<td>13.05 ab</td>
</tr>
<tr>
<td>Micronized</td>
<td>200</td>
<td>22.66 cd</td>
<td>10.85 bcd</td>
</tr>
<tr>
<td>Organic</td>
<td>200</td>
<td>22.47 cd</td>
<td>10.10 cde</td>
</tr>
<tr>
<td>Synthetic</td>
<td>200</td>
<td>48.86 a</td>
<td>15.38 a</td>
</tr>
</tbody>
</table>

\(^a\)Natures Creation, Micronized Compost (5-5-5), Par 5 LLC, P.O. Box 108, Bartlesville, OK 74005
\(^b\)Neptune’s Harvest Fish and Seaweed Fertilizer (2-3-1), Neptune’s Harvest, P.O. Box 1183, Gloucester, MA 01931-1183
\(^d\)Values in columns followed by the same letter are not significantly different at P< 0.05, SAS Inc., SAS, Ver. 9.1, Cary, NC.

Results and Discussions

All fertilizer treatments were significantly greater than the control (water only) treatment for both plant weight and height at harvest. Increasing the application rate of the micronized compost did not significantly increase either the tomato seedling plant weights or heights. The micronized compost did not produce significantly greater seedling plant weights and heights compared to the organic fertilizer applications. The synthetic fertilizer produced significantly greater plant weights and heights at the 100, 150, and 200 rates than the micronized and organic fertilizer applications at the same rates.

The plant growth differences between the synthetic fertilizer and the micronized compost, and the organic fertilizer may be a result of a number of factors, including inaccurate prescription labeling of the micronized compost and/or the organic fertilizer or the relative solubility of the materials. It is important to note that regardless of the reason for low performance of the micronized compost and the organic fertilizer, additional material would need to be added in an attempt to produce equivalent tomato seedlings as the synthetic fertilizer. A producer would be wise to conduct their own small scale fertility trial when using the micronized compost or organic fertilizers for greenhouse seedling production.

References

Acknowledgements

We would like to thank Buddy Faulkenberry (USDA, ARS Technician) for his outstanding technical assistance. Special thanks go to Dave Davenport, Par 5 LLC, for supplying the micronized compost.

Disclaimer

Mention of trade names or commercial products in this article is solely for the purpose of providing specific information and does not imply recommendation or endorsement by the U.S. Department of Agriculture. All programs and services of the U.S. Department of Agriculture are offered on a nondiscriminatory basis without regard to race, color, national origin, religion, sex, age, marital status, or handicap. The article cited was prepared by a USDA employee as part of his/her official duties. Copyright protection under U.S. copyright law is not available for such works. Accordingly, there is no copyright to transfer. The fact that the private publication in which the article appears is itself copyrighted does not affect the material of the U.S. Government, which can be freely reproduced by the public.
Organic Greenhouse Soil Media + Supplemental Fertilizer = Better Organic Tomato Transplants

Charles L. Webber IIIa and B. Warren Robertsb

aUSDA, ARS, SCARL and bOklahoma State University
Lane, OK

Introduction

Consumer perceptions that organic food tastes better and is healthier are two major factors driving the increasing demand for organically produced crops in the U.S. It was necessary to develop organic certification to provide consistent standards across the U.S. for the benefit of producers, processors, wholesalers, retailers, and consumers. All components entering into the organic crop production system must be approved for organic use, including the seed, soil medium, and fertilizer used in transplant production.

Research was conducted to determine whether the addition of supplemental fertilizer to an organic soil media enhance seedling growth.

Material and Methods

The factorial experiment included 4 pre-planting fertilizer5,6 rates (5-4-4, 6-2-2, 7-3-7, and a 0-0-0 N-P-K control) added to a commercial organic soil medium7 prior to planting tomato (Solanum lycopersicon L.) seeds (‘Florida 47’) and two levels (2-3-1 N-P-K and a 0-0-0 control) of liquid fertilizer8 applied at 3 weeks after planting (3 WAP) with 6 replications and 6 plants per replication. All components (potting medium, seed, and fertilizer were from organic sources).

Each dry pre-planting fertilizer was mixed thoroughly into 1.5 ft³ of organic medium at the rate of 1% by weight. The 4 fertilized soil mixtures (5-4-4, 6-2-2, 7-3-7, and 0-0-0 N-P-K) were placed in 128-cell Speedling9 trays and planted, June 17, with tomato seeds and placed in the greenhouse. The seedlings were watered as needed, usually twice a day, and grown without artificial lighting. The tomato seedlings were thinned to 1 seedling per cell at 1 WAP. Plant heights were collected at 3 WAP.

Following the 3 WAP data collection, each pre-fertilized treatment received either an application of liquid fertilizer (0.4% v:v) or no additional fertilizer (control) (see Table 1). At 5 WAP, July 22, plant heights were collected. All data were subjected to ANOVA and mean separation using LSD with P=0.05 (SAS Inc., SAS, Ver. 9.1, Cary, NC).

5 The mention of trade names or commercial products in this publication is solely for the purpose of providing specific information and does not imply recommendation or endorsement by the U.S. Department of Agriculture.
6 Barton Isle Fertilizer Company, LLC, 27415 Fairfax St., Southfield, MI 48076
7 Organic Planting Mix, Sun Gro Horticulture Inc., 15831 N.E. 8th Street, Suite 100
Bellevue, WA 98008
8 Neptune’s Harvest, Fish and Seaweed Fertilizer (2-3-1), P.O. Box 1183, Gloucester, MA 01931-1183
9 Speedling Inc., P. O. Box 7220, Sun City, FL 33586-7220
Results and Discussion

Compared to the control (0-0-0), adding fertilizer prior to planting produced significantly greater plant heights at 3 and 5 weeks (WAP) (Table 1). Although there were few height differences among 3 fertilizer treatments at 3 WAP, addition of 0.4% solution of a fish and seaweed fertilizer at 3 WAP resulted in a significant height increase at 5 WAP for the 6-2-2 fertilizer treatment. To produce suitable tomato transplants supplemental fertilizer was required at a level of 1% by weight of a 6-2-2 N-P-K organic fertilizer, which was further enhanced by applying a 0.4% solution of a fish and seaweed fertilizer at 3 WAP. Further research should investigate additional organic soil media, fertilizer sources and rates, and crops.

Table 1. Influence of pre-planting fertilizer and supplemental fertilizers on tomato plant heights (cm) at 3 weeks after planting (WAP) and 5 WAP.

<table>
<thead>
<tr>
<th>Pre-Planting Fertilizer(^z)</th>
<th>Seaweed(^y)</th>
<th>3 DAP Plant Height (cm)</th>
<th>5 DAP Plant Height (cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1% by Weight N-P-K</td>
<td>0.4% v:v</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0-0-0 (Control) No</td>
<td>No</td>
<td>2.64 d(^x)</td>
<td>3.80 g</td>
</tr>
<tr>
<td></td>
<td>Yes</td>
<td>2.76 d</td>
<td>4.67 f</td>
</tr>
<tr>
<td>5-4-4 No</td>
<td>Yes</td>
<td>4.06 b</td>
<td>5.73 e</td>
</tr>
<tr>
<td>6-2-2 No</td>
<td>Yes</td>
<td>3.79 c</td>
<td>7.10 cd</td>
</tr>
<tr>
<td>7-3-7 No</td>
<td>Yes</td>
<td>4.66 a</td>
<td>9.77 a</td>
</tr>
<tr>
<td></td>
<td>No</td>
<td>4.03 b</td>
<td>6.80 d</td>
</tr>
<tr>
<td></td>
<td>Yes</td>
<td>4.18 b</td>
<td>7.13 c</td>
</tr>
</tbody>
</table>

\(^z\)Barton Isle Fertilizer Company, LLC, 27415 Fairfax St., Southfield, MI 48076
\(^y\)Neptune’s Harvest, Fish and Seaweed Fertilizer (2-3-1), P.O. Box 1183, Gloucester, MA 01931-1183
\(^x\)Values in columns followed by the same letter are not significantly different at P\(<\) 0.05.

Acknowledgements

We would like to thank Buddy Faulkenberry (USDA, ARS Technician) and Will Baze (USDA Summer Worker) for technical assistance. Special thanks go to Wendell Minott, Barton Isle Fertilizer Company, LLC, for supplying the pre-plant organic fertilizers.

Disclaimer

Mention of trade names or commercial products in this article is solely for the purpose of providing specific information and does not imply recommendation or endorsement by the U.S. Department of Agriculture. All programs and services of the U.S. Department of Agriculture are offered on a nondiscriminatory basis without regard to race, color, national origin, religion, sex, age, marital status, or handicap. The article cited was prepared by a USDA employee as part of his/her official duties. Copyright protection under U.S. copyright law is not available for such works. Accordingly, there is no copyright to transfer. The fact that the private publication in which the article appears is itself copyrighted does not affect the material of the U.S. Government, which can be freely reproduced by the public.
Certified Organic Herb Mulching Demonstration

Charles L. Webber III1, Angela R. Davis1, James W. Shrefler2, Merritt J. Taylor2, Joseph L. Townsend3, and Victoria M. Townsend3

1USDA, ARS, South Central Agriculture Research Laboratory, P.O. Box 159, Lane, OK, 74555
2OSU Wes Watkins Agricultural Research & Extension Center, P.O. Box 128, Lane, OK 74555
3The Farm, Center Point, OK, 1280 S. Center Point, Atoka, OK 74525

Introduction

The objective of organo-pestiphytology (the study of organic weed control) is to investigate and develop weed control strategies that are fundamental to the cropping system rather than afterthoughts to a production system. Conventional production systems are increasingly dependent on herbicides to control weeds. The scarcity of approved organic herbicides reinforces the necessity for organic crop producers to consider the entire spectrum of weed control options rather than placing their hopes solely on herbicide applications. Weed control in conventional and organic herb production present additional challenges because herbs are often slower growing and less competitive than are typical crops. An organo-pestiphytological demonstration project was conducted on certified organic land to determine the impact of mulching systems on herb production and weed control.

Materials and Methods

Raised beds, 3 ft wide on 6 ft centers, were prepared on certified organic land at Lane, OK. Drip irrigation line was placed on the top of each bed just off the bed’s center line. Beds were prepared using as mulches, plastic mulch, rye (Secale cereale L.) straw mulch, rye straw over shredded paper mulch, and a control with no mulch.

Eight herbs and two vegetables were planted, June 5, 2009, into each mulching system and all crops were irrigated as needed. The herbs included rosemary (Rosmarinus officinalis L.), German winter thyme (Thymus vulgaris L.), garlic chives (Allium tuberosum Rottler), garden chives (Allium tuberosum Rottler), bronze and green tip fennel (Foeniculum vulgare Mill.), genovese basil (Ocimum basilicum L.), roquette arugula (Eruca vesicaria L.), and bouquet dill (Anethum graveolens L.). The two vegetables were royal burgundy beans (Phaseolus vulgaris L.) and rhubarb chard (Beta vulgaris L.).

Weeds were removed once a week by hoeing or hand pulling, and the time required for each crop and mulching system were recorded. At harvest, September 1, 2009 (88 days after planting), the herbs’ plant height, width, fresh weight, and dry weights were determined. The plant yield data is reported in Davis et al. (2010).

Results and Discussion

Weed Removal

The absence of any mulch (bare soil) resulted in the greatest time required to remove weeds compared to treatment with mulches (Figure 1). The rye straw over shredded
Paper mulch inhibited weeds to the greatest extent, reducing weeding time by 80%. The plastic mulch and rye straw mulch reduced weeding by 49% and 40%, respectively, compared to the no mulch (bare soil) control.

Figure 1. Influence of mulching system on percentage of weed removal time compared to the no mulch (bare soil) control.

Herb Yields (Data Not Shown, information in this section found in this volume, Davis et al.)
Although the rye straw over shredded paper mulch resulted in the greatest reduction in weeding, this mulch treatment also reduced herb yields. Bare ground and plastic mulch had the highest plant weight for all crops except garlic chives, which did best in the rye mulch. Bare ground and plastic mulch plant weights were similar and for most crops the difference between the two treatments was not significant. The average plant weight difference for all crops indicated about a 10% decrease in the rye and roughly an 80% decrease in the rye plus paper rows. Arugula did well under all treatments.

Conclusions
Although the weed removal time decreased with the rye straw and rye straw/shredded paper mulches, the crop yields, in general, were also reduced. Reduction in weed and crop growth may of resulted from the allelopathic impact of rye straw and/or the increase carbon nitrogen ratio in the surface soil that may have reduced nitrogen availability for plant growth.

Acknowledgements
We would like to thank Buddy Faulkenberry, Amy Helms, William Baze, and Cody Sheffield for technical assistance.