30th Annual Horticulture Industries Show

Local Growers—Local Cooperation

January 14 & 15, 2011

2011 Horticulture Industries Show Proceedings

Holiday Inn City Center
700 Rogers Avenue
Fort Smith, AR

PROCEEDINGS of the

30th ANNUAL HORTICULTURE INDUSTRIES SHOW*

January 14 & 15, 2011

Holiday Inn City Center
700 Rogers Ave.
Fort Smith, AR

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 Vegetable Association

Oklahoma & Arkansas Farmers' Markets Associations

The Samuel Roberts Noble Foundation

Arkansas State Horticulture Society

University of Arkansas Cooperative Extension Service

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

Table of Contents

HORTICULTURE INDUSTRIES SHOW
2010-2011 BOARD OF DIRECTORS AND SUPPORTING PERSONNEL

OFFICERS

President	President-elect	Sec/Treasurer
Heather Friedrich	Doug Walton	Donna Dollins
Univ. of Arkansas	1441 W. 46th St. South	OSU Horticulture & LA
316 PTSC	Muskogee, OK 74401	358 Agricultural Hall
Fayetteville, AR 72701	918-686-6939	Stillwater, OK 74078-6027
479-575-2798	918-360-2012 cell	405-744-6460/405-377-6071
479-283-5357 cell	doug.walton@suddenlink.net	405-744-9709 (Fax) 405-612-0959 (cell)
heatherf@uark.edu		donna.dollins@okstate.edu

BOARD OF DIRECTORS

Commodity Area	Arkansas Representative	Oklahoma Representative
Christmas Tree		Don Wickersham 4215 S. 257 E. Ave. Broken Arrow, OK 74014 918-266-6001 donwickersham@aol.com
Farmers Market	Jim McGuire 2325 Reed Ave. Springdale, AR 72764 479751-3352 or 479-530-0806 cell jbmcguire3352@cox.net	Doug Walton 1441 W. 46th St. South Muskogee, OK 74401 918-686-6939 / cell 360-2012 doug.walton@suddenlink.net
Fruit	Richard Collins 14 Deerwood Conway, AR 72032 501-372-0333 rcollins@conwaycorp.net	John L. Mikelson 7831 E. 123 St. S. Muskogee, OK 74403 918-989-5009 918-557-3868
Herb		Kathie Webb 1403 Glen Oaks Ct. #3 Norman, OK 73071 405-206-2729 ntvgrdnr@yahoo.com
Master Gardener/Public Garden	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
Nonproducer (Industry)	Bruce Tencleve Arkansas Farm Bureau P.O. Box 31 Little Rock, AR 72203-0031 501-228-1856 tencleve@arfb.com	Robert DeWitt P.O. Box 5556 Norman, OK 73070 405-364-0908 405-364-0908 (FAX) dewittco@swbell.net
Sustainable Agriculture	Heather Friedrich Univ of Arkansas 316 PTSC Fayetteville, AR 72701 479-575-2798 479-466-9667 (cell) heatherf@uark.edu	

Commodity Area	Arkansas Representative	Oklahoma Representative
Vegetable	Craig R. Andersen Dept. of Horticulture University of Arkansas 316 Plant Science Bldg. Fayetteville, AR 72701-1201 479-575-2639 or 479-575-8619 (FAX) crander@uark.edu	Glen Price PO Box 508 Hinton, OK 73047 405-542-3920

Arkansas Tech University
Jim Collins
Arkansas Tech University
Department of Agriculture
Dean Hall 123
Russellville, AR 72801
479-968-0632
479-968-3944 (Home)
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
morelock@uark.edu
479-575-8619 (FAX)

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

Oklahoma 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
raycampbellidabel@sbcglobal.net

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

John Haase, Ext. Educ.
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
bkurz@uaex.edu

James E. Motes
2819 E. Richmond Rd.
Stillwater, OK 74075-1766
405-372-4634 (Home & Fax)
jimemotes@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
405-744-7361
mike.schnelle@okstate.edu

Jim Shrefler
WWAREC
P.O. Box 128
Lane, OK 74555
580-889-7343
jim.shrefler@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

Alan Ware
OAMP, Inc.
2800 N. Lincoln Blvd.
Oklahoma City, OK 73105
405-521-3934
Cell 918-658-5267
Alan.ware@oda.state.ok.us

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
carrie@arkansaswomeninag.com
www.arkansaswomeninag.com

Buy Fresh Buy Local—Oklahoma
Rita Scott
PO Box 162
Leonard, OK 74043-0162
rejuvrita@olp.net

H.E. Anderson Company
Doug Olinger
2100 Anderson Drive (74403)
PO Box 1006
Muskogee, OK 74402
918-687-4426
Fax: 918-682-3342
sales@heanderson.com
www.heanderson.com

Farming for Humanity Foundation
Danny L. Turrel
PO Box 582
Vinita, OK 74301
918-341-4441
Fax: 918-786-2498
dan@farmingforhumanity.org
www.farmingForHumanity.org

Fertrell – Troque Farms
Frank Kuhnert
1227 W. 25th Street
Independence, MO 64052
819-215-9925
Troquefarms@aol.com

Green Bag Packaging
Diana Warden & Jory Gromer
1800 Charles Allen Ddrive
Chickasha, OK 73018
405-222-2306
Fax: 405-222-2367
dwarden@gbp.com
www.gbp.com

Department of Horticulture and Landscape Architecture
Oklahoma State University
Dale Maronek 358 Ag Hall
Stillwater, OK 74078-6027

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

Irrigation-Mart
Jackie Robbins
300 South Service Road East
Ruston, LA 71270
318-255-1832
Fax: 318-255-7572
jwdr@irrigation-mart.com
www.irrigation-mart.com

Johnny's Selected Seeds
Howard Anderson
955 Benton Avenue
Winslow, ME 04901
800-854-2580
Fax: 207-861-8354
handerson@johnnyseeds.com
http://johnyseeds.com/

Kerr Center for Sustainable Ag
Maura McDermott
PO Box 588
Poteau, OK 74953
918-647-9123
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
Guy Ames
PO Box 3657
Fayetteville, AR 72701
guya@ncat.org
www.attra.ncat.org

Oklahoma Agriculture Mediation Program, Attn: Alan Ware
2800 North Lincoln Blvd., 2nd floor
Oklahoma City, OK 73105
405-521-3934/800-248-5465
mediation@oda.state.ok.us

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

Oklahoma Department of Agriculture, Food & Forestry, Organic Section
Jeff Stearns
2800 N. Lincoln Blvd.
Oklahoma City, OK 73152
405-501-3955/405-522-6119
jeff.stearns@oda.state.ok.us
www.oda.state.ok.us

OSU—OKC Horticulture
Julia Laughlin
400 N. Portland Ave.
Oklahoma City, OK 73020
405-945-3348
jlaugh@osuokc.edu
www.osuokc.edu

Stay Tuff Fence
Denise Demoin
924 S. West Street
Stillwater, OK 74074
denise@staytuff.com
Staytuff.com

USDA/NASS/Arkansas Field Office
Becky Cross, Director
10800 Financial Centre Pkwy,
Suite 110
Little Rock, AR 72211
501-228-9926
nass-ar@nass.usda.gov
www.nass.usda.gov

USDA, Natural Resource Conservation Service
John Lee & Alvin Peer
1100 W. Capital Avenue
Room 3416
Little Rock, AR 72201
501-301-3173
John.lee@ar.usda.gov

2010 Horticulture Industries Show
Local Foods on Friday

Friday, January 14—Lunch

Garlic Herb-Roasted Chicken
Chicken
Richard Ims
Monestary Farm at Little Portion
Berryville, AR

Rice Pilaf
Brown Basmati Rice
Southern Brown Rice Co.
Weiner, AR

Black-eyed Peas with Bok Choi
Peas
Allen Cannery
Siloam Springs, AR

Bok Choi
Patrice Gros
Foundation Farm
Eureka Springs, AR

Baked Winter Squash with Sorghum Butter
Australian Butter Squash
David and Deana Dickey
Dickey Farms
Tonititown, AR

Mixed Green Salad
Organic Spinach, Red Oak and Baby Leaf Lettuce
Mark Cain & Michael Crane
Dripping Springs Garden
Huntsville, AR

Bran Rolls
Chris & Agatha Ranalli
Ranalli Farms
Tontitown, AR

Pecan Pie Bars
Desirable var. Pecans
Randy Hardin
Hardin Farms, Grady, AR

Friday, January 14—Reception

BBQ Hotwings
Chicken
Monestary Farm at Little Portion
Richard Ims, Berryville, AR

Swedish Meatballs
Meatballs and Marinara
Beef
Ozark Pasture Beef Cooperative
Ron Morrow, Fayetteville, AR

Bruschette
Tomatoes
Matt Newton
Newton Sons Farm, Ft. Smith, AR

Baguettes
Little Bread Company
Fayetteville, AR

Pickle Tray
Old South
Bryant Preserving Co., Alma, AR

Cheese Tray
Honeysuckle Lane Raw Milk Cheese
Daley Dairy, Rose Bud, AR

Veggie Tray
Turnips
Patrice Gros
Foundation Farm, Eureka Springs, AR

Fruit Tray
AR Black, Golden Delicious and "Old-time" Red Delicious Apples
Fred Vanzant
Vanzant Fruit Farms, Lowell, AR

Stella Apples
John and Beth Aselage
A & A Orchard, Green Forest, AR

2011 Horticulture Industries Show
Local Foods on Saturday

Saturday, January 15—Breakfast

Mini Bagels, Muffins and Cream Cheese
Little Bread Company
Fayetteville, AR

Organic Bolivian Coffee
Global Beans
Roasted in Fayetteville, AR

Saturday, January 15—Lunch

Braised Beef Toast with Winter Vegetables
Sirloin Tip Roast from Ozark Pasture Beef Cooperative
Ron Morrow, Fayetteville, AR

Carrots from Foundation Farm
Patrice Gros
Eureka Springs, AR

Turnips
Mark Priest
Fayetteville, AR

Whipped Sweet Potatoes
Sweet Potatoes
Horn Farms—Fay Horn
Springdale, AR

Sauteed Cabbage with Pecans
Cabbage
Ranalli Farms—Chris & Agatha Ranalli
Tontitown, AR

Desirable variety Pecans
Hardin Farms—Randy Hardin
Grady, AR

Tomato and Mozzarella Salad
Tomatoes
Newton Sons Farms—Matt Newton
Ft. Smith, AR

Aged Caciocavera Cheese, hand formed
Lovera's Market
Krebs, OK

Mixed Green Salad
Organic Spinach, Red Oak and Baby Leaf Lettuce
Dripping Springs Garden
Mark Cain & Michael Crane
Huntsville, AR

Wheat Rolls
Ranalli Farms—Chris & Agatha Ranalli
Tontitown, AR

Black Apple Cobbler
Arkansas -Black Apples
Vanzant Fruit Farms—Fred Vanzant
Lowell, AR

Keynote Speakers

Paul & Alison Wiediger
Au Naturel Farm

John Lee
U.S. Department of Agriculture

Jon T. Biermacher
The Samuel Roberts Noble Foundation, Inc.

Farming for Locavores 52 Weeks a Year

Paul and Alison Wiediger
Au Naturel Farm
Friday, January 14, 2011

Local food has become a national, and even international “cause”. We see articles about sourcing food locally in many publications on a regular basis. Even in the heartland, more and more consumers are looking for sources of local food for their families. This is a wonderful opportunity for farmers to expand their offerings, both in variety and in months of production.

At Au Naturel Farm, we have always grown without the use of synthetic fertilizers, herbicides and pesticides. We believe that more and more consumers are interested in food that has been “grown naturally”, so this enhances our marketing. We also provide pastured eggs, broilers and pork to complement our vegetables. And, to be able to serve our customers year-round, we utilize high tunnels for winter growing as well as season extension.

We market at a producer only farmers market from mid-April through October that we helped develop and continue to help run. During the winter season, we utilize email to inform our customers what is available each week. They reply with orders, we harvest to those orders, and deliver to their doors on Saturday mornings. This allows us to maintain a relationship with our customers all year, and improves farm cash flow.

This is an exciting time of growing opportunities for farmers. We believe that it is a “win win” for farmers and consumers, and encourage farmers to explore the possibilities in their communities.

Meeting Off-Season Demand for Local Food

Paul and Alison Wiediger
Au Naturel Farm
Saturday, January 15, 2011

"Truck farming" and its more current name "market growing" have long provided consumers with a wonderful variety of locally grown fruits and vegetables during spring/summer/fall. In some parts of the United states, that can be many months, even year-round for the far south. And, in other areas, maybe only 60-90 days. In the mid-south, however, it usually means May through October for most growers. So, for the other six months of the year, customers may have to depend on the supermarket for fresh food. Increasingly, that food may, and often does, come from outside the US.

In many of our communities, consumers are demanding local food and want it year-round. To help meet that demand, more and more growers are utilizing high tunnels. With high tunnels, a grower can supply a nice variety of fresh vegetables through the winter months, satisfying consumer demand and increasing farm cash flow.

Paul and Alison Wiediger are pioneers in the use of high tunnels for year-round production and have been growing in them since 1995. Combined, they have over 70 years growing experience using organic methods. Au Naturel Farm is a diversified farm, including pastured broilers, layers and pigs, greenhouse plant production and cut flowers along with their 10000 square feet of covered and 2.5 acres of outdoor vegetable production. Their markets include a producer only farmers' market that they helped to develop along with email for the "off" season. They are also authors of the book, Walking To Spring, about their experiences in high tunnel growing.

Know Your Farmer, Know Your Food

John Lee
State Conservation Agronomist/State Water Quality Specialist
USDA/NRCS-AR

John received his B.S, in Agronomy and a minor in Chemistry from the University of Arkansas Pine Bluff and his M.S. in Soil and Environmental Science from North Carolina A&T State University. John Lee has recently joined the Natural Resource Conservation Service staff in Arkansas to serve as the State Conservation Agronomist / State Water Quality Specialist.

John's primary responsibilities are to address environmental issues that impact row crop agriculture, specialty crop production, and animal feeding operations. John focus areas are: nutrient management, animal waste management, pest management, water quality, and soil quality. Within these focus areas John provides technical guidance for conservation planning through the implementation of best management practices (BMP's) that protection of natural resources. These BMPs are in turn used to support the various initiatives of the United States Department of Agriculture such as: Organic Farming, High Tunnel Cropping Systems, and The Peoples Gardens.

Economic Potential of Using High Tunnel Hoop Houses to Produce Fruits and Vegetables

Jon T. Biermacher, Jeri Donnell, and Steve Upson
The Samuel Roberts Noble Foundation, Inc.

Abstract
Hoop house plasticulture has been promoted as a production technology that allows fruit and vegetable crops to be grown in the cool season months in early spring and late fall. At this time little information regarding the economics of hoop house plasticulture is available. Two fruit and vegetable production systems were developed for growing conditions in south-central Oklahoma. The first system has a spinach crop followed by field tomato, and the second system has annually produced strawberry followed by yellow and zucchini squash. Crop production data were collected in a three-year randomized and replicated experiment. The objectives were (1) to determine the expected cost of production for each crop and systems, (2) to determine the breakeven price for each crop in each system, and (3) to determine how robust breakeven prices are to a number of yield, expense and marketing scenarios. The expected total cost of production were $1,968 and $1,652 per house for spinach and tomato crops, respectively, and $2,749, $359 and $353 per house for yellow and zucchini squash crops, respectively. Breakeven prices for spinach and tomato were $3.32 and $0.83 per pound, respectively, and $6.16, $0.92, and $1.40 per pound for strawberry and yellow and zucchini squash, respectively. Breakeven prices for spinach and strawberry crops were most sensitive to assumptions about quantity of marketable yield sold and/or quantity of yield consumed by grower household.

Keywords: breakeven prices, economics, fruits and vegetables, hoop houses, plasticulture

Christmas Tree Sessions

Christmas Tree Sales Report – 2010 Season

Craig McKinley
Extension Forestry Specialist
Oklahoma State University

Introduction

In December, 2010 a total of 36 survey questionnaires were mailed to Oklahoma Christmas tree growers regarding the current selling season. Of the surveys mailed, 18 were returned by growers. Four growers indicated that they sold no trees in 2010. The remaining 18 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 2010 for trees grown in Oklahoma.

Table 1. Oklahoma-grown tree sales (live trees included), 1989 - 2010.

Year	Number of Growers	Total Trees Sold (Oklahoma Grown)	Trees Sold per Grower Total (CC trees)
1989	NA	8,769	NA
1990	42	11,527	274 (197)
1991	48	11,989	250 (186)
1992	54	14,145	262 (185)
1993	55	18,0 02	327 (230)
1994	63	20,102	319 (223)
1995	64	21,071	329 (234)
1996	59	20,795	352 (248)
1997	55	18,982	344 (224)
1998	34	13,131	386 (237)
1999	41	14,564	355 (242)
2000	44*	15,699	356 (226)
2001	28*	7,590**	NA (271)
2002	35*	8,591	245 (251)
2004	25*	8,496	340 (319)
2005	19*	6,863	361 (347)
2006	18*	7,543	419 (402)
2007	19*	6,714	353 (342)
2008	20*	8,680	434 (417)
2009	16*	7,988	499 (480)
2010	14	7,731	552 (542)

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 2010, reported sales for Oklahoma-grown trees were approximately 3 percent lower than in 2009. Total sales including cut-tree imports showed a slight decrease from 2009 (12,565 *vs.*13,168).

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 84 percent of the trees sold. Leyland cypress held about 6 percent of the choose-and-cut market. Minor species include Scots pine, Austrian pine, eastern white pine, Arizona cypress and others.

Table 2. Oklahoma-grown harvested tree sales by sales method 1989 – 2010*.

Year	Choose-and-Cut	Wholesale	Retail	Total
1989	6,662	1,625	482	8,769
1990	8,111	2,641	775	11,527
1991	8,762	1,969	1,228	11,989
1992	9,852	3,294	999	14,145
1993	12,459	4,586	957	18,002
1994	13,848	5,460	796	20,104
1995	14,766	4,893	1,432	21,071
1996	14,394	4,270	2,131	20,795
1997	12,103	5,483	1,342	18,928
1998*	7,833	3,383	193	11,409
1999*	9,697	3,080	521	13,298
2000*	9,736	4,931	None **	14,667
2001*	7,590	Not available	None **	7,590
2002*	7,448	426	265	8,139
2004*	7,969	120	None**	8,089
2005*	6,468	123	None**	6,591
2006*	7,228	Not available	None**	7,228
2007*	6,500	Not available	None**	6,500
2008*	8,336	None	None**	8,336
2009*	7,688	None	None**	7,688
2010*	7,601	Not Available	Not Available	7,601

* Only cut trees, live trees not included.
** Does not include retail sales of imported trees at growers' farms.

Live Trees Sales

Live trees sales decreased as a percentage of total tree sales in 2010 (Table 3), 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 – 2010.

Year	Live Trees Sold	Percent of Total Sales
1990	1,177	10.2
1991	2,030	16.9
1992	1,825	12.9
1993	2.810	15.6
1994	2,247	11.2
1995	1,251	13.2
1996	4,038	19.4
1997	3,001	15.9
1998	1,722	13.1
1999	1,266	8.7
2000	1,184	7.6
2001	541	NA
2002	456	NA
2004	407	3.5
2005	272	2.7
2006	227	2.1
2007	139	1.5
2008	334	2.8
2009	300	2.2
2010	130	1.0

Sales of Imported Trees

Approximately 57 percent of growers sold pre-cut, imported trees from other states. Imported tree sales of 4,384 in 2010 equated to 35 percent of total tree sales for the state. Imported tree sales were about 5 percentage points below the 2009 results. True firs comprised over 85 percent of imported sales. Noble fir and Fraser fir were the most popular imported tree species, with 39 and 26 percent, respectively. Grand fir, Douglas-fir and Nordmann fir made up the remaining sales.

Sales of Christmas-Related Products

Fifty 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 $68,000. About 8 percent of greenery products were Oklahoma-grown. Over 85 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 close to $45,000. About one-third of the growers reported producing non-Christmas tree crops such as you-pick berries, pumpkins, hay and flowers.

Tree Prices

Tree prices reported in 2010 appeared to be about the same as those reported in 2009. 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 significant production problems in 2010 as opposed to 2009. Growers reported losses due to drought, deer, and insect/disease damage. Growers quantified 2010 losses as approximately $32,700.

Overall, growers reported having a good sales year, due in large part to good weather during the selling season. The national trend of more people choosing real trees may also have been a contributing fact to a good 2010 sales season.

Acknowledgements

Results from 1989-1997 were compiled by Dr. Steven Anderson, Extension Forestry Specialist, and Champe Greene, Renewable Resources Extension Specialist. Dr. 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.

Marketing Choose and Cut Christmas Trees: Yesterday, Today and Tomorrow

Craig McKinley
Extension Forestry Specialist
Oklahoma State University

History of Christmas Trees

Greenery and Christmas trees have a long tradition. Ancient Egyptians filled rooms with green palms. Later, the Romans marked the winter solstice by decorating homes and temples with evergreens. Druids, priests of the ancient Celts, decorated temples with evergreens.

Germany is credited with starting the Christmas tree tradition during the 16th century, when Christians brought trees into their homes. The town of Riga, Latvia claims to have set up the first decorated Christmas tree in 1510. Martin Luther, the 16th century reformer is credited with adding candles to trees. In the United States, German settlements had trees as early as 1747, although early U.S. founders attempted to eliminate Christmas trees as "pagan". But, in 1846 Queen Victoria was depicted standing next to a tree, and Christmas trees became fashionable in short order.

Christmas Trees in the United States

Christmas tree retail sales began in the U. S. in the 1850's in New York City. Trees gained popularity on a national basis when President Franklin Pierce (1853-1857) displayed the first White House tree. By the 1890's Christmas ornaments were arriving from Germany and tree popularity was increasing dramatically. Shortly thereafter, in 1901, the first Christmas tree farm was begun. In 1908, trees were selling at retail for as much as a $1.00 each.

By 1947, some 21.5 million Christmas trees were sold in the United States. Nearly all of these trees were harvested from natural stands and sold at retail. The most popular species were balsam fir, Douglas-fir and spruce. By 1988, total sales had risen to about 40 million trees, with both retail and chose and cut sales. Christmas trees were now being harvested from farms establish for that purpose. The more popular species at that time were Scots pine, Douglas-fir, and various pines. The 2009 Christmas tree sales reached almost 30 million trees with Fraser fir, noble fir and Douglas-fir being the more popular. Of the 2009 sales, approximately 32 percent were purchased at a tree farm.

Currently, close to 100 million households in the United States have some form of Christmas tree, yet less than a third of those households have a real tree. Past surveys have indicated that the more common reasons given for not having a real tree are; 1) don't wish to clean up after Christmas, 2) selecting and displaying take too much time, 3) will not be at home during Christmas, and 4) the kids are gone. Unfortunately,

negative media publicity also results in some people not using real trees due to the perceived fire hazard.

The U. S. Population

In looking at both current conditions and projected population trends in the United, States, it becomes readily apparent that significant changes are occurring. The most notable trend is that of population growth. The U.S. population currently is about 310 million people. By the year 2035, that number is estimated to be near 400 million.

On the surface, that growth would appear to bode well for the Christmas tree industry, as a greater population should buy more trees. However, a closer look is necessary relative to the structure of the population. First, approximately 25 percent of the current population is age 55 and over. That percentage is projected to increase to over 30 percent by the year 2035. This increase in age by the population is significant in that individuals aged 55 and over buy Christmas trees at a rate of about half of those younger than 55. This older group is the age range that the so-called 'Baby Boomers' are moving into now.

Population total and age are not the only factors to consider. Changes in the number of minority individuals should also be noted. By 2035 Hispanics are anticipated to make up some 25 percent of the population, with Blacks increasing to almost 15 percent. Together that is some 40 percent of the total U. S. population.

The demographics of choose and cut customers should also be examined relative to who purchases trees at farms. A recent study in North Carolina suggested that 79 percent of choose and cut customers were over age 30 and 75 percent were married. Approximately 19 percent had one child in the family, while 29 percent had two children. Approximately 34 percent of the customers had no children. The most common time of purchase was two weeks before Christmas.

Marketing to Consumers

In simplest terms, marketing has two parts. One, making a product the customer wants, picket fences, fast hamburgers, or whatever. Two, making the customers want your product. For a successful business there has to be a supply and demand. The demand needs to be there; you're going to have the supply, but make sure that demand wants <u>your</u> product, <u>your</u> supply.

Those individuals who have taken a first course in marketing know the 4 P's: product, price, placement, and promotion. Let's look at each one of these factors:

Product - The product is what you have for sale. And before any product is sold, and this applies to service as well, the seller needs to know everything about it. Whether selling Christmas trees or pumpkins, you need to know everything about the product that you possibly can.

Price - Number two of our 4 P's is price. How is the price set? It's a good idea to know what the competition is selling the product for. But that only gives a start. You need to know how much you've got in the product in order to set a realistic price.

Are there quantity discounts? If the customer buys one or a few Christmas tree stands or whatever is for sale, there is probably a set price price per unit. What if they buy 5,000? What are the competitors charging? Perhaps a quantity discount is in order.

Timing; often prices change over the course of the selling. The market is certainly time-sensitive for Christmas trees. So it is important to think, when is the product wanted, when is it not wanted?

What form of payments can be expected? Will credit cards be accepted? This goes back to the business plan - how are you going to run the business?

Placement - Placement, better known as distribution, is our third P. There are options of direct sales, mail order, retail, wholesale, through agents, regional *vs.* national, seasonal. Any and all of those will work, but before you commit, I challenge you to look at them closely. How does it fit your business? How does it market your product, your service?

Promotion - The fourth P is promotion. This is where the focus is going to be on advertising.

Advertising is nothing more than disseminating information about your product. It's not just trying to make a sale, but rather, getting the information out. Advertising involves public and personal selling, sales promotions, publicities, public relations, and on and on. How much to advertise depends upon the audience, the size of the market, and the size of the advertising budget.

Let's look at some of the ways to advertise. Here is just a quick list: yellow pages, television, radio, newspapers, magazines, posters, billboards, leaflets, telephone, and websites. If a grower does all those, the day will be filled up in short order! So it is necessary to better pick the one is best for you; your product, your budget, your audience, etc.

Websites:

One of the more common questions today is "Is this going to be on a website? Websites provide a whole new system of marketing and advertising - highly visual, very interactive. Such messages as "Do you want to buy this?"or "Put it in your shopping cart". Push a button and you've bought it. Interactive capability is important. It allows an individual to purchase instantly if he/she wishes.

A recently-developed term for websites is that of search engine optimization (SEO). The idea is to build a website so one of the common search engines finds you by using keywords like "Christmas Trees", "Choose and Cut", "Family Outing", etc. To take

advantage of this technique, keywords need to be in the right place, like in titles and headlines. Keywords should relate directly to the content. Keywords should make sense and be those that you want the search engine to grab hold of. Keywords should not be used randomly - only about 5-6% of the text should contain keywords.

Selling Christmas Trees in the Future

As we look forward to the future, we should consider several factors:

Population demographics – The population is changing. How do we market to take advantage of these changes?

Production techniques – Will the same tools, pesticides etc., that we use today be available for use in the future.

Business management – Good business management will always be critical to the success of any venture. Will government policies, laws, etc. be different as we move forward in time?

Marketing – Basic marketing will remain somewhat the same, but new technologies, such as social networking will need to be included.

Technology – Past experience has shown that significant changes in technology will occur. It is important that we, as producers, keep up with these changes and use new technologies in our production and marketing efforts.

In selling trees, we can take satisfaction in some good news. First, there will always be a Christmas. Second, we have a desirable product. And third, there will be a demand for quality which can be met at a 'Choose and Cut' Christmas tree farm.

Summary

Christmas trees have been a significant part of the American way of life for several centuries, and this tradition is not expected to diminish in the future. To maximize the advantages of real chose and cut Christmas trees requires a consistent and planned approach. Both a business plan and a marketing plan are needed to be fully successful. Attention to the 4 P's of marketing is only the first step in developing a market, but a step that should not be overlooked.

Marketing trees in the future will continue to require 1) recognizing the changes in customer base, knowing what the customer wants, 3) adapting to new technologies, 4) recognizing potential threats and opportunities as they arise and 5) providing outstanding service to the customers who visit our farms.

Farmers' Markets/Sustainable Agriculture Sessions

Developing New Markets in Arkansas

Jody Hardin
President, Certified Arkansas Farmers Market and
Arkansas Farmers Market Association

One of the first building blocks of the local food system is to build or develop a network of 'fair trade' local markets for locally grown farm fresh foods. To do this, Arkansas farmers must be aware of dumping practices by commercial wholesalers, and produce resellers who are out to make a buck at the farmer's expense, using his or her farmers market to skim profits from unsuspecting consumers who assume everyone selling under the Farmer's Market sign is a real farm producer. In many states, this problem has long been corrected, but in Arkansas we have yet to take a firm stand on protecting local farmers markets from the unscrupulous vendors often disguised as farmers. My basic premise as a small farmer: Every dollar that comes into a farmers market should go in the pocket of a farmer. Period.

The Certified Arkansas Farmers Market, a (501 C6) member owned non-profit, was created in 2008 in central Arkansas to build producer only farmers markets, for the farmers and consumers who were frustrated by the unfair trade practices at the states largest open air public market in Little Rock- that calls itself a farmers market.
The Arkansas Farmers Market Association and Certified Arkansas Farmers Market represents dozens of local growers and small community based farmers markets who wish to clean up our states outdoor farmers markets, and make a clear designation to those communities who support a "local" only approach to their farmers market. These communities need 'branding' to signify its dedication to the local economy and the purity of its offerings at each vendors booth.

Possibilities and Opportunities for Arkansas Producers/Processors

Jody Hardin, President Certified Arkansas
Farmers Market and Arkansas Farmers Market Assoc.

Reprinted From ATTRA/NCAT Article: http://attra.ncat.org/interviews/hardin.html

Jody Hardin of the Certified Arkansas Farmers Market (CAFM) network, in Little Rock
Jody Hardin is a farmer, economist and activist. In 2005, he and five other Arkansas farmers founded the Certified Arkansas Farmers Market network (CAFM), a farmer-owned and -managed network of outdoor and online markets. Hardin now serves as executive director of the 501(c)6 corporation. CAFM has grown from a group of 25 farmers in 2008 to a group of over 40 farmers in 2009**. Their mission is to build a producer-only, source-verified and united network of Arkansas farmers.** CAFM plans to open and operate a distribution and aggregation system for Arkansas. This system, also called a hub-and-spoke system, will link central, or hub, aggregation centers with local spokes in all parts of the state. This means Arkansans throughout the state will be connected to Arkansas-produced food.

Q. What is CAFM proposing?

A. Our idea is to create an aggregation center for small-scale farmers, as well as mid tier farmers, that will serve as a packer, repacker, warehouse and cold storage and eventually get to the most important part, which is processing. I could see this going as far as a commercial kitchen that produces ready-to-eat foods for schools.


Jody Hardin of the Certified Arkansas Farmers Market Network

Q. What are the goals of the proposed CAFM hub-and-spoke distribution system?

A. To solve more than just one problem, like the farm-to-school issue, where crops are grown in the summer, when school is out. We have to find a way, if the schools legitimately want to serve local food, to preserve some of those summer crops and extend the season into the school year. So our goal is to build infrastructure. We can do this through our rural communities and farmers if we can aggregate and have a market maker to buy, process and store food for the Arkansas Hunger Relief Alliance, the food banks, the restaurants, the schools and the institutions.

Q. What other cities or towns around the state have you identified as possible spokes or aggregation centers?

A. The foodshed concept really makes the most sense. We really need a food assessment to do in-depth research into where our food is coming from and look at different foodsheds around the state to see what is grown where, or what is ready for market, or what is potentially ready for market, and then in each region we will build a specialty processor. If it

is in the Delta [eastern Arkansas] and they have a million acres of pecans — that's one of the products coming out of that foodshed. So we might, through economies of scale, locate a cracking and shelling plant there, but we would aggregate it at a central facility that is geographically located close to the buyers.

Q. Who will set the prices for products distributed through the hub-and-spoke system?

A. It depends on who the buyer is. The idea is to be farmer-driven (and have) fair-trade pricing. We are going to cooperate, together, if we're going to do anything. For instance, this aggregation center will work with large, national retailers as long as they don't isolate individual farmers and drive their prices down. We will collectively negotiate what our prices are. The national retailers have to understand that we're creating fair-trade markets. That's something different, something they've never dealt with, because we're going to ask for premium, fair-trade prices.

Q. Is this a system that encourages cooperation or competition?

A. It starts as cooperation, through coordinated development of new markets. Once these markets have been penetrated, and begin expanding, we will need to bring in more farmers to fill a growing demand. I'm looking at other successful models in California, Missouri and Kansas, as well as Amish auction markets, which I think is one of the keys to having fair competition among producers.

The Argenta Market, in the CAFM network.

Q. Will this system create profits, and for whom?

A. I would love for this to generate profits that are paid back to the farmers as a dividend, or as stock that can be sold when farmers retire.

Q. What has been the reaction from Arkansas farmers? What has been the reaction from Arkansas consumers?

A. Everyone I get time to explain this to seems to understand the logic of aggregation, especially the folks who are interested in an aggressive farm-to-school plan that would turn the existing system on its head. School is out in the summer when the bulk of Arkansas crops come off. I always say, “If you want this food to go into your school, how do we get it processed and stored until the school year?” This part is simple for most people to understand. The farmers who need new or bigger markets think the idea of a central buyer and aggregator with cold storage is a great idea.

Q. What difficulties have you encountered?

A. I'm a volunteer, and I have too many hats to wear to put this together. It will require some focused professionals to sit down with me and hash this out. I think we have a good, simple plan in place for 2010 with Sysco (a food distributor), who owns a warehouse in Little Rock and has a distribution system in place. They have recently returned with a counter proposal that is getting very specific on what we need to do: organize five gap audited farms; form a cooperative (for profit or nonprofit); buy custom boxes with the CAFM brand custom printed for squash, watermelon, peppers and tomatoes; and get group liability insurance for $5 million. All of this adds up to some pretty big money, and I'm still working as a volunteer to get this off the ground.

Arkansas-grown tomatoes at a CAFM market

Q. Are there other states that you are modeling, or will this program serve as a model for other states?

A. Each state seems to have its own issues. I've heard that Florida, Alabama and Mississippi have very well-coordinated local food systems that actually do get local food into their schools, and have centralized, state-sanctioned farmers markets that serve mid-tier, production-oriented family farms. Our project could become a national model, provided we get some funding to do it right, with ample amount of time to get it organized properly.

Q. How can farmers and communities around Arkansas get involved?

A. I need farmers to connect with our website (www.CAFM.locallygrown.net) and post their business description as well as the products they have for sale. This is one of the foundation tools we have been developing that will eventually drive a new, totally revolutionary local food system.

Proposed aggregation center in Little Rock, Ark.

Q. What is your advice to entrepreneurs in other states that want to start something similar?

A. Get busy organizing and coordinating your farmers, (and learn) what they grow and where they are located. Then start connecting the dots with those who want, and most importantly, need local foods.

Jody Hardin can be reached at certifiedarkansas@yahoo.com. You can visit CAFM's website at www.arkansasfood.net.

Southern SARE Funding Opportunities for Growers and Communities

David Redhage
Kerr Center

Slide 1: Today, I'd like to tell you about SARE--the Sustainable Agriculture Research and Education Program—a different type of grants program.

Slide 2: SARE is a national grants program, but it is administered regionally to recognize the differences and diversity of American agriculture. USDA funds about $19 million per year through the four SARE regions. Since its inception in 1988, SARE has funded more than 3000 projects.

SARE is participatory. This means that farmers are involved in all facets of SARE as advisors, evaluators and cooperators, designing and conducting on-farm research

SARE is inclusive: This means that SARE addresses the needs of limited-resource farmers and farmers of small holdings, who are often overlooked in traditional grants programs

SARE encourages a systems research method. Systems research is problem-focused and takes into account the dynamic nature of agriculture: no part of a farm or agricultural enterprise exists in isolation.

Slide 3: Thirteen states, Puerto Rico and the U.S. Virgin Islands make up the Southern Region.

Slide 4: The SARE structure consists of regional Administrative Councils which determine policy and Technical Review Committees that evaluate proposals. The management entity for Southern Region SARE is co-located at the University of Georgia and Fort Valley State University.

The Administrative Council has 24 members, including 1862 and 1890 land grant representatives, researchers, government agency representatives, extension agents, farmers, non-government agencies and ag business professionals. Basically they are peers of the people who submit proposals and the constituency that benefits from SARE research.

The Technical Review Committee is a similarly diverse group of specialists. The Administrative Council and Technical Review Committee help insure that SARE projects are applicable to farming problems in the region.

Slide 5: SARE was authorized by Congress in the 1985 Farm Bill to promote research that expands knowledge about agricultural practices that are: economically viable, environmentally sound and socially acceptable.

This translates into agricultural that is good for the farm family, their natural resources and their community.

Slide 6: SARE-funded projects have ranged from crop production to pest management to economics and marketing to community development. That range demonstrates the

diversity of subjects that can be addressed to advance sustainable agriculture research and education.

Southern SARE accommodates that diversity with 6 different grant opportunities.

Slide 7: Research and Education Grants – This was the original type of grant funded when SARE started in 1988. Generally, these encompass whole-systems research. Proposals are encouraged to have multi-institutional collaboration, especially between 1862 and 18980 institutions.

Slide 8: Graduate Student Grants are for researchers working on a masters or doctorate in sustainable agriculture. Up to $10,000 per project is awarded directly to the university to cover project expenses such as supplies including software, equipment for field or laboratory, special text books not readily available and travel related to the project.

Graduate students have researched such topics as velvet bean as a biological weed control in Georgia, streambank erosion associated with grazing in Kentucky and carcass quality of pasture raised poultry.

Slide 9: Professional Development Program trains ag information providers in sustainable techniques and concepts who then take their knowledge to farmer clients. To accomplish this training the PDP program administers a competitive grants program as well as providing funds directly to each state for sustainable ag training events.

Some recent PDP projects included training in sustainable fire ant management and the making of videos about sustainable greenhouse vegetable production.

Slide 10: The Producer Grants take advantage of producers' experience and knowledge. The projects are designed and conducted by producers and are funded for up to $10,000 for individuals or $15,000 for a group of producers doing the research as a team.

These very practical projects examine farm enterprises such as using woodlot waste for growing gourmet mushrooms and the feasibility of making farmstead cheese for the Latino Food market.

Slide 11: The On-Farm Research Grant allows up to $15,000 for extension agents, NRCS agents and other professionals who work with producers to conduct their own research using cooperators' farms.

Slide 12: The Sustainable Community Innovation Grant is for individuals or organizations to conduct activities that link the farm to non-farm parts of a community for the benefit of both, particularly for economic development. The SCI grants are administered jointly by southern SARE and the Southern Rural Development Center. With a project maximum of $10,000, SCI grants have been used to start farmers' markets, survey consumers about producer buying habits, provide education about local foods, produce maps to area farms, launch a local food festival and start community kitchens.

Slide 13: The most challenging aspect of writing a successful SCI proposal is establishing a solid link between the farm and non-farm community. According to

proposal reviewers they see a lot of great rural development proposals that don't have a link to sustainable agriculture and a lot of good sustainable agriculture proposals that don't address rural development.

Slide 14: The All Ozark Meals project headed up by Julia Sampson of ATTRA coordinated a series of 11 meals served at venues as widely different as a white napkin restaurant and a church fellowship hall. Chefs with established reputations in the area designed menus around local products for the year-long series in Fayetteville, Arkansas. A total of 1000 diners bought tickets to the meals. The purpose of the project was to create relationships between local chefs and growers. The series of meals also created consumer demand for more fresh foods in local restaurants. This project's connections among consumers, chefs and farmers were just the kind of links proposal reviewers look for in Sustainable Community Grants.

Slide 15: Another good example of linkage between sustainable agriculture and rural development is found in Alabama's Taylor Community. Its location halfway between Selma and Mississippi makes it a metaphor for hard economic times. Fortunately Taylor also has a place in the heart of three small local churches that formed The United Christian Community Association (TUCCA) dedicated to rural development around a 44-acre demonstration site for sustainable agriculture.

Using a SARE SCI grant and working with both Heifer Project International and NRCS, the project paid experienced farmers in the community to teach beginner adult and youth farmers to grow the full range of southern produce. Other teachers were brought in to instruct them in raising high-value products like cut flowers and pastured poultry. Together they learned to direct market for higher profits, eventually forming the Black Belt Farmers Cooperative and selling at the upscale Pepper Place Market in Birmingham. While times are still hard around Taylor, the farm and non-farm residents are working together to make them better.

Slide 16: Where the other two projects we've looked at benefited a particular community, some SCI projects target an entire state. For example a community specialist at Kentucky State University proposed a training to strengthen the state's sustainable agriculture through policy and legislative avenues by preparing women in agriculture for new leadership roles.

Through a network of women in agriculture, women's organizations, and sustainable agriculture groups, this training will provide information on how policy and legislative priorities are established, how to lobby on agriculture issues, what makes an effective public statement, and ways to work with the media to get the message out to the consumer as well as policy makers. Institute participants will then use these new tools and information to teach others how to make their voices heard-and make a difference for Kentucky's rural communities.

Slide 17: So, to sum up, what does SARE do for farmers and communities?

The most obvious support SARE offers is grant money.

Browse through the national database at www.sare.org to read summaries of more than 3000 projects that address every conceivable topic in sustainable agriculture.

Training in Value-Added Syrup Crops was a PDP project at Alcorn led by William Patton. He invented a portable Mill on Wheels to train sugar cane farmers to add value by making syrup. More than 2 million people attended demonstrations of syrup making at fairs and festivals and 155 beginning and seasoned syrup processors were trained in value-added methods. Since 1999 value adding has quadrupled the price of Mississippi syrup in quarts.

At Ft. Valley State University, Young Park used a research and education grant to evaluate the feasibility of using frozen goat milk for providing a year round supply of goat cheese.

Third Thursday, headed up by Marion Simon at KSU, is a popular hands-on training event funded by a PDP grant. It has branched out into another SARE grant in the neighboring state of Tennessee.

Gourmet pork raised in the woodlots and pastures of small farms was the subject of Chuck Talbott's Research and Education project at NCA&T University. Working with heirloom swine breeds for old time flavor and tenderness, producers are also experimenting with persimmons, acorns and other natural forages to produce a unique pork product.

Slide 18: National and regional SARE displays and materials are available for workshops or conferences. Shipped directly to the conference center with shipping paid both ways by SARE. Beautiful full color bulletins on specific sustainable ag topics can be ordered in any amount from SAN. They are all listed on the web site www.sare.org or in the free catalog Resources from the Sustainable Agriculture Network.

Southern Region SARE's newsletter Common Ground, published twice a year, keeps readers up to date on current projects and calls for proposals. The Southern SARE Annual Index of projects has phone number and email contacts for every current Southern Region project.

Summaries of all SARE projects ever funded are available from the SARE national and regional web sites.

Slide 19: Southern SARE is always looking for even more ways to invest in the future of agriculture

Fruit Sessions

Disease Control in Organic Fruit Production Systems

Mike Ellis
Department of Plant Pathology
The Ohio State University

Disease management strategies are very similar for both organic and conventional small fruit production systems in the Midwest. In both systems it is important to develop and use an integrated disease management program that integrates as many disease control methods as possible, the more the better. Major components of the disease management program include: use of specific cultural practices; developing knowledge of the pathogen and disease biology, use of disease resistant cultivars, and timely application of organically approved fungicides or biological control agents or products when needed. I have prepared written guidelines for disease management in the organic production of caneberries (raspberry and blackberry), strawberry, blueberry, grape and apple. These guidelines can be viewed on-line and/or printed off my web site at: http://www.oardc.ohio-state.edu/fruitpathology/

Specific information is provided for each crop in its respective chapter and color photos of disease symptoms are also provided.

Most disease control methods or strategies are identical for both conventional and organic production systems. Perhaps the greatest difference between organic and conventional production systems is that organic growers are not permitted to use synthetic “conventional” fungicides. If disease control materials are required in the organic system, growers are limited to the use of “inorganic” fungicides such as sulfur (elemental sulfur and lime-sulfur) or copper fungicides (Bordeaux mixture and fixed copper products). In addition, there are several new “alternative” disease control materials and biological control products that are currently available and are cleared for use in organic production.

There are several problems associated with the use of these inorganic fungicides and “alternative” products in small fruit disease control programs. Among the most important are 1) Phytoxicity, which is the potential to cause damage to foliage, fruit set and fruit finish (this is a concern primarily with copper and sulfur fungicides); and 2) their limited spectrum of fungicide activity, which means they may not be capable of providing simultaneous control of the wide range of fungal pathogens that can cause economic damage to the crop. For example, sulfur is highly effective for controlling powdery mildew on most fruit crops, but provides little or no control of most other diseases.

In a climate like the Midwest, environmental conditions during the growing season are generally very conducive (warm and wet) to the development of several important diseases, insect pests and weeds. Limitations in relation to which pesticides may or may not be used, present the organic grower with some unique and very demanding challenges. Whereas the use of various cultural practices and disease resistance will be the “back bone” of the organic disease management program, the limited use of

organically approved pesticides or biocontrol agents will probably be required at times. I have provided a handout to be distributed at the meeting describing most of the currently available fungicides and biocontrol agents for use in organic production systems. This information is also available on my web site.

Organic Apple Production Using Interactive Budgets

Hector Rodriguez
University of Arkansas
Department of Agriculture Economics and Agribusiness
Fayetteville, AR

Organic apple budgets are an important tool for orchards planning and for financial management. Although many apple producers develop their own budgets, some prefer to begin with existing budgets and adjust them according to their specific situation. The budgets developed in this project serve as a starting point for the latest group.

Sample costs and revenues to produce one acre of organic apples in Washington County, Arkansas are presented in this study. Information was placed into an Excel spreadsheet to create a baseline budget. Producers select interest rate, inflation rate, planting density, expected prices, marketing plan and production practices; the budget is calculated automatically.

The budget has six main components. The first component allows the producers to enter basic information about his/her orchard. The second component is a graphically representation of the total costs, total revenues and total net returns of four different ground covers and three fertilization levels. The third component is a comparison of cumulative total costs, cumulative total revenues, and total net returns above cumulative total costs for a 15-year period. The fourth component is a highly detailed budget. A net present value is calculated automatically helping the producer decide whether or not to undertake the project under his/her own specific conditions. The fifth component provides the producer with a total costs sensitivity analysis for the life time of the project. The final component is the price and the yield break-even points for all twelve budgets.

The budget allows comparison among variable operating costs, fixed costs, total costs and expected total returns for four different ground cover treatments and three fertilization levels. Up to twelve organic budgets can be compared simultaneously. What-if analyses are possible by selecting different costs, yields or market prices.

For all the operations and input prices outlined in this budget, it was assumed that the organic apple orchard management would be near to optimal and that all recommended practices would be followed. The costs were calculated as if the grower started with a bare field and followed the budgeted pattern. In general, projects start to be profitable after year five of production. However, this situation is limited by the management practices selected.

Contact Information

Dr. Germán Rodríguez, Research Program Associate, Department of Agricultural Economics and Agribusiness, 217 Agriculture Building 1 University of Arkansas, Fayetteville, AR; hrodrig@uark.edu, 479-575-2259 (Presenter)

Dr. Jennie Popp, Professor, Department of Agricultural Economics and Agribusiness

Ms. Heather Friedrich, Program Technician II, Horticultural Department, University of Arkansas.

Dr. Rom Curt, Horticultural Department, University of Arkansas.

Lessons in Organic Fruit Pest Management

Donn T. Johnson[1], Soo-Hoon Sam Kim[1], Bryan Petty[1], Curt Rom[2], Don Steinkraus[1], Barbara Lewis[1], Jason McAfee[2] and Heather Friedrich[2]
[1]AGRI 320 Department of entomology, Division of Agriculture, University of Arkansas,
[2]PLSC 316 Department of Horticulture, Division of Agriculture, University of Arkansas,
Fayetteville, AR 72701; dtjohnso@uark.edu

Biography: Dr. Donn T. Johnson is a professor at the University of Arkansas. He received a B.S. in biology from the University of Minnesota-Duluth, and a M.S. and Ph.D. (1978) in entomology from Michigan State University. He teaches Insect Pest Management and Insect Behavior. He develops and implements fruit pest management programs for conventional, organic and high tunnel systems; monitors fruit insect vectors; evaluates effectiveness of insecticides and biopesticides; and is developing kill station for green June beetles.

Abstract: Several terms are defined and agencies listed that deal with organic production and reviewed lessons from pest management tactics evaluated for organic fruit production.

Definitions or Agencies
Integrated Pest Management (IPM) was best defined during a Pest Management Stakeholder Forum in Washington D.C. in 2002 and reported by USDA and EPA (2003) as: a science-based, decision-making process that identifies and reduces risks from pests and IPM related strategies. It coordinates pest biology, environmental information and available technology to prevent unacceptable levels of pest damage by the most economical means, while posing the least possible risk to people, property, resources, and the environment.

United State Department of Agriculture (USDA) oversees the **National Organic Program** (NOP) whose mission is to establish standards governing the marketing of certain agricultural products as organically produced.

National Organic Standards Board (NOSB) publishes a National List of Organic Substances approved for use in organic production.

Organic Materials Review Institute (OMRI) independently reviews products for inclusion in the NOSB list of organic products. They review products using the following criteria: 1) Is it compatible with sustainable agriculture? 2) Is it historically used in organic production? 3) Can substance be replaced by safer alternative? 4) Is it non-synthetic (earth or plant derived)? 5) Does it have minimal detrimental effect on human health or agroecosystem? 6) Does it have a low potential for contamination? 7) Does it have low toxicity and safe mode of action? and 8) Does it have short environmental persistence?

Cultural tactics include: plant resistant cultivars; make sure transplants are free of pests or diseases; use cover crops to support natural enemies.

Mechanical tactics include: exclude insects and diseases by bagging fruit or use screens on high tunnels; repel insects or camouflage plants from insects by whitewashing plants with Surround (kaolin clay); use reemay row cover for small plantings; remove and destroy disease-infected and insect-infested plants or parts; wash off aphids; attract and trap or kill insects.

Bagging fruit requires thinning fruit to one tree fruit per six to eight inch limb. Then bag fruit when ½ in dia. or soon after petal fall. Bags remain on fruits until 3 wks before harvest, and then remove to allow coloration. Bagged (B) and unbagged (U) apple fruit differed in damage by codling moth (19% B and 69% U), stink bug (1% B and 7% U), cedar apple rust (16% B and 25% U), and sooty blotch (19% B and 88% U) (Bessin and Hartman 2003, Scott 2010).

Surround (kaolin clay) was applied to foliage and reapplied once or twice from late June to late July to maintain a whitewashed appearance of both apple and grape plants. Whitewashing significantly reduced the number of Japanese beetles observed on treated grapevines compared to vines treated with Danitol or Mustang Max and Surround prevented Japanese beetle defoliation of both apple and grape. Growers start applying Surround or make weekly insecticide sprays the last week of June and end in late July. The synthetic insecticides registered against Japanese beetle are: Actara; Assail; Brigade; Clutch; Danitol; Imidan; Mustang Max EC; Sevin; and Warrior. Two biopesticides are OMRI approved against Japanese beetle: Aza-Direct; and Pyganic. Recent surveys have found Japanese beetle causing defoliation in these states (ordered past to recent invasion): TN, KY, IL, MO, AR, MS, OK, KS, IA, NE, MN, WI, SD, and ND.

Biological control agents could reduce abundance of Japanese beetle. In 2010, we assessed the prevalence of various natural enemies and pathogens in Japanese beetle populations in NW Arkansas. Japanese beetle adults and grubs were collected from 11 sites in NW Arkansas and found to have the following natural enemies: 5 of 11 sites had 33 to 76% of the grubs infected with a pathogen called *Stictospora villain*; two sites had 3.6 to 5.9% nematode infection; but none of the specimens contained parasitoids or milky spore bacteria. The protozoan, *Ovavesicula popilliae*, occurred in only 0.2% of JB dissected from NW Arkansas (Johnson et al. 2010). In August 2010, Dr. David Smitley (Michigan State University) mailed 6,000 frozen JB adults infected with *O*. *popilliae*. Bryan Petty dissected a subsample of these beetles and determined 13% were infected with *O. popilliae*. They released these pathogen-infected JB cadavers in 4 locations: parks, nurseries and golf courses.

Japanese Beetle: Japanese Beetle Distribution JB Recommendations By 1 July or when JB appear: Reemay row cover Whitewash foliage with Surround (kaolin clay) Japanese Beetle Flight/Sprays Biological Control of Japanese Beetle 2010 survey of 11 sites in NW Arkansas for JB natural enemies: No parasitoids or milky spore 2 sites with 3.6 to 5.9% nematode infection 5 of 11 sites had 33 to 76% of JB grubs infected with

one pathogen called *Stictospora villain* Biological Control of Japanese Beetle. In Aug 2010, Dr. David Smitley (Michigan State University) mailed 6,000 frozen JB adults infected with *Ovavesicula popilliae*. Bryan Petty dissected a subsample to determine 13% *O. popilliae* infection and released pathogen-infected JB cadavers in 4 locations: parks, nurseries and golf courses. *O. popilliae* has a low occurrence in NW Arkansas (0.2%). We will monitor local JB population sites to determine if the pathogen is established and spreading. We hope this release will lead to Japanese beetle population reduction through larval mortality and reduced adult oviposition. Animal and Plant Health Inspection Service (APHIS) is proposing to issue permits for the release of a bacterium, *Bacillus thuringiensis japonensis*, into the continental United States for the biological control of the larval stage of Japanese beetle (better than milky spore bacteria)

Green June beetle: Synthetic insecticides that caused 100% green June beetle mortality include: Sevin labeled against GJB; whereas those not labeled but effective are Actara, Admire, Altacor, Battalion, Baythroid, Clutch, Danitol and Mustang Max. Biopesticides of Ecotrol (may be a repellent), Aza-Direct, Azera (Pyganic + azadirachtin) all caused < 70% mortality.

Organic Apple Program used several sampling techniques: April 1, set out pyramid trap + bait for plum curculio (PC) at the perimeter of the apple or peach orchard; late March set out Pherocon IV trap baited with L2 pheromone lure (long life 2 month) to attract Oriental fruit moth (OFM) and by April 1 set out traps baited with L2 lures for codling moth (CM). On May 14 we set out 200 Isomate CM/OFM TT dispensers for mating disruption (MD) of CM and OFM. Also set out Trece CM10X lure baited delta sticky traps to attract CM males and CM/DA lure in traps to attract both males and females. On June 3, we set out tufted apple bud moth (TABM) baited traps. For Arkansas, we recorded the first TABM and saw surface fruit feeding damage on fruit.

Push-Pull-Kill: In 2010, the UA-Fayetteville Organic Apple Project evaluated a push-pull-kill strategy against plum curculio (PC). The PC were “pushed” from the orchard interior by whitewashing trees with 75 lb Surround (kaolin clay) per acre on 19, 28 April against PC, and 25 lb per acre. These trees were whitewashed on 30 June, 16, 26 July to prevent defoliation by Japanese beetle (JB). The apple trees in Berryville were whitewashed with only 25 lbs Surround per acre in April and 50 lbs per acre in July. Trees in a commercial apple orchard in Fayetteville had no Surround applied. The PC were “pulled” to every 5th perimeter tree that was baited with dispensers containing: PE = plum essence or BA = benzaldehyde or GA = grandisoic acid. Lures combinations includes: 2 PE + 2 BA or 1 GA + 4 BA or unsprayed trees. Baited trees were sprayed twice weekly with Pyganic from 200 to 600 DD (17 Apr. - 9 May) to “kill” PC.

Successes: CM/OFM damage < 2% using Bt, Cyd-X, spinosad and Isomate CM/OFM TT; and observed 1st and 2nd summer PC adults emerged after 750 and 1750 DD, respectively.

Challenges: The PC push-pull-kill strategy allowed < 20% PC fruit damage to ‘Enterprise’ trees on the UA-Farm (organic), 50% at Berryville (moderate whitewash)

and 100% in the commercial Fayetteville orchard (no whitewash). The Berryville grower applied low-risk synthetic Actara insecticide in July to achieve less PC damage in the rest of his orchard. San Jose scale tree infestations increased to 23% when using only dormant oil sprays and Surround. There was 30 to 40% fruit drop due to summer rots. In conclusion, we need to conduct efficacy studies of other biopesticides against PC and the causal organisms of summer rots.

Invasive pests alert: The first new pests to look for are the brown marmorated stink bug (BMSB), an invasive species from Far East Asia. It has two generations per year. A recent article in the American Fruit Grower (Nov. /Dec. 2010) describes the damage potential of brown marmorated stink bug: "Stink Bug: a grower's nightmare." The BMSB initially is a nuisance to homeowners by invading poorly caulked homes to overwinter in large numbers inside. Fruit damage includes: corky spots in 60% to 80% apple or peach fruit in PA, MD, and WV. Other hosts include: apple, blackberry, cherry, figs, grape, mulberry, peach, pear, persimmon, raspberry, peppers, sweet corn, tomatoes, soybean, and beans.
Spotted Winged Drosophila (SWD) is another potential invasive pest of the United States. The SWD infest thin-skinned fruit by laying eggs inside ripening fruit before harvest so legless larvae (< 1/16 inch) contaminate fruit at harvest causing fruit to become soft and unmarketable (http://comp.uark.edu/~dtjohnso/New_Articles_and_PM_talks.html).

Acknowledgments: Funding from UG/USDA/SARE/PDP No: 0104-23573-31-7700; USDA-NIFA-Organic Research Extension Initiative No.: 2008-51300-04819; USDA/Southern Region IPM and Small Fruit Consortium and IR-4: 2009-08; USDA NIFA Small Business Initiative Research No: 2010-00204; Arkansas Agriculture Department Specialty Crop Block Grant; and an Agricultural Experiment Station Research Incentive Grant. The apprentice for the organic apple program was Stephen Steward. Suppliers included: Dr. Mark Whalon (PC baits); Certis USA (Deliver and Cyd-X), Dow AgroSciences (Entrust, Success, Intrepid, Delegate); Engelhard Corp. (Surround WP); and McGlaughlin Gormley King Co. (Pyganic).

References:
Bessin, R. and J. Hartman. 2003. Bagging apples: alternative pest management for hobbyists. Univ. of Kentucky Coop. Ext. Serv. ENTFACT-218.

Petty, B., D. Johnson and D. Steinkraus. 2010. Classical biological control of the Japanese beetle in Arkansas. Final Report to Arkansas Agriculture Department Specialty Crop Block Grant Program.

Scott, 2010. 2010. Organic apple production. Univ. of Kentucky. Online: http://organic.kysu.edu/OrganicApple.pdf

Fruit Breeding Update

John R. Clark
Department of Horticulture, University of Arkansas
Fayetteville, AR 72701

The University of Arkansas peach and nectarine breeding program continues with its emphasis on fresh market peaches and nectarines with high levels of bacterial spot resistance. Flesh types include many white selections along with yellow-flesh types. Firm fruits with low acid and standard acid flavors are included in the program.

Two new white peach varieties were released in 2009, White Diamond and White Cloud. White Diamond is a white, freestone, low-acid peach that ripens about August 1 at Clarksville. White Cloud is a non-melting, white, standard acid peach. It ripens usually July 6. Both of these new releases allow a wider selection of white peaches for the region. The overall order of ripening of the Arkansas white peaches are as follows:

White Rock: average first ripe date June 25
White Cloud: average first ripe date July 6
White County average first ripe date July 14
White River: average first ripe date July 20
White Diamond: average first ripe date August 1
Redhaven peach: July 2

The blackberry breeding program continues to focus on improved-quality floricane- and primocane-fruiting variety development. The advances coming along are exciting and are showing substantial progress in fruit quality, thornlessness attractive and large berries, and high yields.

The program released the first shipping-quality primocane-fruiting blackberry in 2009, Prime-Ark® 45. It has large berries (up to 10 g) with good soluble solids (10% commonly) that stay black in storage along with good firmness retention. The floricane crop ripens June 5 in Arkansas, and the primocane crop in mid-August. However, the primocane crop ripe date depends on location. Along the Central Coast of California, first ripe is usually Sept. 1, and in Oregon's Willamette Valley mid-September. Primocane-fruiting types are limited in the summer heat of Arkansas as the heat in July to September often hinders fruit development, quality, and size. Therefore only trials of the variety are suggested at this time in our region

A release from 2007, and the newest Arkansas thornless blackberry, Natchez ripens about June 5 in Arkansas. It has large, long berries, and is eye catching on the vine or in the clamshell. It averages about 9.5% soluble solids, and berries can be tart if crop load is excessive as has been reported in some southern US and California plantings. It is highly recommended for planting in Arkansas, and is intended to replace the prior early thornless variety Arapaho.

Although not a new variety, as it was released in 2003, Ouachita continues be successful in Arkansas and coast to coast in the US. Ouachita produces high yields of high quality berries (6-7 g) with soluble solids of 10-11%. It has erect canes, and ripens about June 10. It has shown broad adaptation, and has been a major variety in expansion of the domestic shipping blackberry industry.

Table grape improvement continues, and four selections are under consideration for release. Two of these are black-fruited, the other white/green in color. All are non-slipskin types ranging from moderately fruity to rather neutral flavors. These are being propagated for potential release and going through virus testing currently.

Of the past releases, Jupiter is the hottest of the Arkansas varieties currently, and is increasing in planting and consumer popularity. Its main attribute is flavor, with a muscat flavor blended with some American flavors. It is also non-slipskin and is accepted by consumers almost universally. It is dark red to purple when ripe. It is generally crack resistant, has medium clusters of medium fill, and moderate yields. It needs a good downy mildew control program.

Although not as popular as Jupiter, Neptune is a consideration from for a green (white) grape from the Arkansas program. It is fruity-flavored and non-slipskin. It has large, beautiful clusters, non-cracking berries, but only moderate yields. Like Jupiter, it needs careful downy mildew control.

Muscadine grape breeding was begun in 2005, and the program is off to a good start. It will be some years before varieties or released, but as of the end of 2010, 45 selections have been made and several thousand seedlings are in place for evaluation in 2011. The major traits being focused on in this fresh-market muscadine improvement program are:

Large fruit size
Crisper texture
Excellent flavor
Edible skin
Dry stem scar
Perfect (self-fruitful) flowers
Productivity
Winter hardiness
Disease resistance

All muscadine selections are being tested at the Southwest Research and Extension Center at Hope to provide a broader testing of their potential for Arkansas growers.

It was exciting to have a supporting grant by the Arkansas Agriculture Department funded for the muscadine program in 2010. A part of the Specialty Crop Block Grants program of the USDA-Ag. Marketing Service, this partnership in funding between the UA Division of Agriculture and the Department is a very positive step for the Arkansas fruit industry.

Plant Disease Management for Fruit Crops in High Tunnels

Mike Ellis
Department of Plant Pathology
The Ohio State University

High tunnels are large hoop houses that are covered in plastic. The plastic on the side and end walls can be raised (rolled up) and lowered in order to open the tunnel. Opening the tunnel allows for "at least some" regulation of temperature and air movement (ventilation) within the tunnel. High tunnels are usually not heated although supplemental heat can be provided. Unlike greenhouses, high tunnels usually do not have electric service or automated heating or ventilation systems. Proper ventilation is an extremely important component of the disease management program. Some sort of irrigation system is usually required because the plastic cover prevents irrigation from rain fall.

In general, disease pressure in high tunnels is much lower compared to field conditions. This is primarily due to the differences in the environment within the tunnel compared to outside. In order to develop an effective disease management program for high tunnels (or any other production system), it is important to understand a basic principle in plant pathology called the disease triangle. The disease triangle states "that in order to have a plant disease develop, you need to have a **susceptible host**, the **plant pathogen** and an **environment favorable for infection**". If any one of these three components (host, pathogen or environment) is missing, a plant disease cannot develop. The key component of the disease triangle that needs to be emphasized in high tunnels or green houses is the "ENVIRONMENT". The primary difference between inside the tunnel and the field is the absence of free water from rain or overhead irrigation. Free water on the surface of plant parts is usually required for a plant pathogen (fungi and bacteria) to infect. In addition, many fungal pathogens are disseminated from infected to healthy plants by splashing water. Thus, the absence of free water greatly reduces disease pressure. Careful ventilation in order to keep relative humidity low and foliage and fruit dry is also a key component for disease control in high tunnels and green houses. The importance of the environment within the high tunnel for effective disease control will be emphasized in my presentation.

The fruit crops that are most commonly grown in high tunnels are raspberry and strawberry. Recently, there has been quite a bit of interest in blackberry as well. The disease of primary concern for both raspberry and strawberry is powdery mildew. Unlike most other diseases caused by fungi, the powdery mildew fungus does not require free water on the plant surface in order to infect. In fact, it does not like free water and free water can actually prevent it from causing infections under certain situations. The powdery mildew pathogen requires conditions of high relative humidity in order to infect and reproduce. Thus, conditions that allow for high relative humidity in the tunnel or green house are ideal for powdery mildew development. When you combine ideal conditions for disease development with varieties that are highly susceptible to powdery mildew, damaging levels of disease can be expected.

The major components of the disease management program include: use of specific cultural practices; developing knowledge of the pathogen and disease biology, use of disease resistant cultivars, and timely application of organically approved fungicides or biological control agents or other products when needed. Growers should always try to select varieties with the highest level of disease resistance possible. Attention to cultural practices that maintain good air circulation, decrease relative humidity, promote good soil drainage and reduce levels of disease causing innoculum must always be emphasized. When resistance and cultural practices do not provide a sufficient level of disease control, the use of fungicides or other plant disease control chemicals must be considered. Fortunately, we have a good arsenal of fungicides for controlling most disease you would encounter in high tunnels. At least in Ohio, as long as a fungicide is registered for use on the crop, it can be used in a high tunnel or green house unless the label specifically state that it cannot be used in tunnels or greenhouses. Probably the biggest problem in using fungicides is how to apply them effectively and safely in the tunnel. Growers need to check with the regulatory agencies in their own states regarding the use of pesticides in high tunnels.

I have looked at the literature and consulted with colleagues that have experience working in high tunnels. Relatively few plant diseases other than powdery mildew have been reported to be a problem. As with many things in biology, this is always subject to change.

The following are the diseases I am aware of that may be a concern or have been observed to be problems in high tunnels.

Raspberry:
Powdery mildew
Late leaf rust (reds only)
Orange rust (blacks only)
Botrytis fruit rot (gray mold)
Phytophthora root rot

Strawberry:
Powdery mildew
Anthracnose fruit rot
Phythophtora root rot
Botrytis fruit rot
Salt Damage

I will briefly discuss these diseases and methods for their control in my presentation.

Fungicides for Use in Organic Production Systems

Mike Ellis
Department of Plant Pathology
The Ohio State University

The following is a brief description of some disease control materials that are commonly or traditionally used in organic production systems. Copper fungicides, elemental sulfur and liquid lime sulfur are the old “standard” fungicides, and have been used for many years in organic production systems.
Note: Prior to using any material in the organic system, it is important that the grower consult his/her organic certification agency or program to be positive that use of the material is permitted.

Copper Fungicides

When different formulations of copper are dissolved in water, copper ions are released into solution. These copper ions are toxic to fungi and bacteria because of their ability to destroy proteins in plant tissues. However, because copper can kill all types of plant tissues, the use of copper fungicides carries the risk of injuring foliage and fruit of most crops. Factors promoting this injury include: 1) the amount of actual copper applied, and 2) cold, wet weather (slow drying conditions) that apparently increases the availability of copper ions and, thus, increases the risk of plant injury. Because of the potential to injure plants and to accumulate in soil, the use of copper fungicides in conventional production systems has largely been replaced with conventional fungicides that are generally safer to plant tissues and often more effective. Several terms are used when discussing copper as a fungicide. The original material used was copper sulfate (also known as blue vitriol or bluestone). When this material was combined with lime in the French vineyards, the combination became known as Bordeaux mixture.

Bordeaux Mixture

Bordeaux mixture is a mixture of copper sulfate and hydrated lime in water. It has long residual action and has been used for years to control many diseases, including downy mildew and powdery mildew of grape. It can be made (mixed) on site by combining copper sulfate with spray grade lime. It is also commercially available as a dry wettable powder.

Fixed Copper Fungicides

Following the discovery and use of Bordeaux mixture, several relatively insoluble copper
compounds or fixed coppers were developed. Fixed copper formulations release less copper ions and are generally less injurious to plant tissues (safer to use) than Bordeaux mixture, but their use
is still limited because of their potential to injure plants and lack of compatibility with other pesticides. Some of the more common commercial formulations of fixed copper include C-O-CS, Kocide 101, Tribasic Copper sulfate, Champ, and Tenn-Copp 5E. There are several fixed copper fungicides registered for use on small fruit.

Sulfur Fungicides

Sulfur is available as liquid lime sulfur and as dry wettable powders or liquid (flowable) formulations of elemental sulfur.

Liquid Lime Sulfur

Liquid lime sulfur can be used at high concentrations as a dormant spray on raspberries and blackberries for control of cane blight, spur blight and anthracnose and on grapes for control of anthracnose. At high concentrations, it should be used only when plants are dormant. It can cause severe damage if applied after green foliage appears. Lime sulfur has a foul odor that many people dislike. It is also registered for use on grapes and caneberries as a more dilute concentration for use during the growing season.

Dry Wettable Sulfurs or Flowable Sulfurs

Sulfur for use as a fungicide is available under many trade names. The microfine wettable sulfurs or flowable sulfurs are usually much less injurious to foliage and fruit than liquid lime sulfur, but their use during hot weather (above 85□F) may result in some leaf burning and fruit damage. Sulfur fungicides are very effective for control of powdery mildew on most fruit crops, but are not highly effective for control of most other fruit crop diseases. Sulfur is very toxic to foliage of certain grape varieties (mainly American grapes) including Concord, Chancellor, DeChaunac and Foch. Sulfur is relatively safe on most other varieties but you need to make sure that the grape varieties you treat with sulfur are sulfur tolerant. Applications of sulfur after the fruit begins to ripen may pose problems during fermentation if the grapes are intended for wine making. A rule of thumb in Ohio is not to apply sulfur or copper on grapes within 30 days of harvest.

Growers should note that sulfur is lethal to some beneficial insects, spiders and mites. These beneficial insects are natural predators of harmful insects and mites that affect fruit crops. Killing these beneficial insects may increase certain pest problems, especially mites. Specific comments on fungicide use will be made in the text for each crop where
applicable.

“New Alternative” Disease Control Materials for Small Fruit

Many products are currently available or currently being introduced as “biological control agents” or “biopesticides”. These include living microorganisms, “natural chemicals” such as plant extracts, and “plant activators” that induce resistance in plants to disease. For most of these products, independent evaluations are currently being conducted; however, their effectiveness under moderate to high disease pressure is uncertain. Although many of these new products have great potential for use within organic production systems, their effectiveness needs to be determined in field tests. It is important to remember that registration of these materials for control of a specific disease on a crop is no guarantee that they will provide effective control under moderate to heavy disease pressure. In addition, many products may be effective for only one or a few diseases and most have very limited residual activity (they have to be applied often).

It is also important to remember that these are registered pesticides and growers need to be certain that their use is permitted within their organic certification program. The IR-4 project is a federally funded program that facilitates the registration of sustainable pest management technology for specialty crops and minor uses. IR-4 has a very helpful searchable database for all registered biopesticide products. I think the following web sites probably have the best information on biopesticides that are available nationally and in your state

For background go to:
http://ir4.rutgers.edu/biopesticides.html

For the searchable database on biopesticides go to:
http://ir4.rutgers.edu/Biopesticides/LabelDatabase/index.cfm

Also, the Biopesticide Industry Alliance recently updated their web site. On it there is some general information about biopesticides that should be useful to organic growers.
http://www.biopesticideindustryalliance.org/

These web pages list all the products currently available along with information such as registered crops and diseases controlled. It also lists the name of the company that manufacturers or distributes the product along with phone numbers and web site addresses. These sites are updated regularly and should be a valuable resource for growers interested in these products. The following are a few of the most common "alternative" disease control products currently registered for use on small fruit.

- **AC10** (*Ampelomyces quisqualis*) is a biofungicide registered for control of powdery mildew in grapes, strawberries, blueberries, raspberries, currants, and gooseberries. *A. quisqualis* is a fungus, that parasitizes powdery mildew fungi. Preliminary results in grapes in Michigan show moderate disease control. Adding an adjuvant such as Nufilm (0.02% v/v) enhances its efficacy. Application should start as soon as susceptible tissue becomes available and continue on a 7 to 14 day schedule. A minimum of 2 sequential applications if needed to maintain the population of *A. quisqualis*. The following chemicals cannot be tank-mixed with AQ10: sulfur and potassium salts of fatty acids.

- **Armicarb 100** (potassium bicarbonate=baking powder) is a reduced-risk, protectant (contact) fungicide. Armicarb 100 is registered for control of powdery mildew and other diseases in grapes, blueberries, strawberries, and brambles. Preliminary results in grapes in Michigan indicate moderate control of powdery mildew. Start applications at the first sign of disease and continue on a 7-14 day schedule. The preharvest interval (PHI) on all crops is 0 days.

- **Galltrol** (Agrobacterium radiobactor strain 84) is a biological control product for control of crown gall, caused by Agrobacterium tumifaciens on several tree fruit and nut crops. The active ingredient is the bacterium, Agrobacterium radiobactor strain 84. On small fruits it is effective for control of crown gall on raspberry and blueberry. It is not effective for controlling crown gall on grapes. It is purchased

as a pure culture grown on agar in petri plates. The bacterial mass from one plate is diluted into one gallon on non-chlorinated water and plants are treated with a pre-plant dip in the solution or as a soil drench.

- **Kaligreen** (potassium bicarbonate = baking powder) is a reduced-risk protectant (contact) fungicide. Kaligreen is registered for control of powdery mildew on grapes, strawberry, brambles (raspberry and blackberry) and blueberry. It provides good control of powdery mildew when applied on a frequent-protectant program of 7 to 10-day intervals. It has little or no efficacy against most other fungal diseases on small fruit. It is formulated as a micro-encapsulated powder that is mixed in water and sprayed directly on the crop. Kaligreen has a preharvest interval (PHI) of 1 day on all small fruit crops.

- **Messenger** (harpin) is a reduced risk product registered for use on grapes, blueberries, cranberries, strawberries, brambles, and currants. The active ingredient is derived from a protein produced by certain bacteria. This protein stimulates natural plant defenses. Messenger has no direct effect on pathogens. The efficacy of this material for disease control or suppression has not been sufficiently confirmed. Messenger has a 0 day PHI.

- **Mycostop** (Streptomyces griseoviridis strain K61) is a biocontrol product registered for use on all fruit crops for control of several important pathogenic fungi that cause seed, root, and stem rot and wilt diseases. The active ingredient is the bacterium, Streptomyces griseoviridis strain K61. It is sold as a powder formulation that is mixed with water and applied as a spray or a drench.

- **Oxidate** (hydrogen dioxide) is a broad-spectrum bactericide/fungicide registered for use in grapes, blueberries, cranberries, strawberries, and brambles. It is a rather corrosive material and works by oxidizing fungal and bacterial cells. The efficacy of the material for disease control has not been sufficiently confirmed on several diseases. In one Ohio fungicide evaluation, it provided no control of grape black rot.

- **Serenade** (*Bacillus subtilis*) is a biocontrol product registered for control of powdery mildew, Botrytis bunch rot and sour rot in grapes. Serenade is also reported to provide some suppression of downy mildew. This product needs further evaluation, but preliminary results show a moderate level of control of Botrytis bunch rot and powdery mildew. Serenade did not control grape black rot in Ohio. Good coverage is important for control. Applications are recommended on a 7-10 day schedule. Serenade has no maximum seasonal application rate and has a 0 day PHI.

- **Trichodex** (Trichoderma harzianum) is a biofungicide registered for use on all small fruit crops for control of a wide range of diseases, but primarily for control of Botrytis fruit rot. It is sold as a wettable powder formulation that is mixed with water and sprayed directly onto the plants.

- **Trilogy** (Clarified Hydrophobic Extract of Neem Oil). The label states that Trilogy is a broad spectrum fungicide of certain diseases and controls mites in citrus, deciduous fruits and nuts, vegetable crop, cereal grains and other miscellaneous crops. The label does not state what diseases are controlled on specific crops. Trilogy is registered for use on grapes, strawberry, brambles (raspberry and blackberry), and blueberry. Trilogy is a liquid that is applied for diseases as a 1% solution in sufficient water to achieve complete coverage of the foliage. As the efficacy of these new materials is tested and validated, they will be included in these guidelines where appropriate.

Efficacy of Disease Control Materials for Powdery Mildew

Powdery mildew is different from most other plant diseases caused by fungi, because the
fungus that causes it lives almost entirely on the surface of infected plant parts. The fungus may penetrate only one cell layer deep into the plant. Thus, it is exposed to eradication following topical treatment with a range of products that do not affect many other pathogenic fungi that colonize deeper into infected plant tissues. Research in New York and other locations has demonstrated that many new and “alternative” materials can provide effective control of powdery mildew if applied often enough (7 day schedule) through the growing season. These materials burn out the fungus growing on the surface, but do not provide protection against new infections; thus, repeated applications are important. These materials include: Nutrol (manopotassium phosphate); Kaligreen and Armicarb (potassium bicarbonate-baking soda); oils such as Stylet Oil and Trilogy; and dilute solutions of hydrogen peroxide (Oxidate).Unfortunately, these materials have little or no effect on many other small fruit diseases.
In addition, organic growers need to consult with their certification agency or program to be sure that any material they use is “certified” or acceptable as organic

Managing Insects Under High Tunnels

Donn T. Johnson
AGRI 320 Department of entomology, Division of Agriculture, University of Arkansas, Fayetteville, AR 72701; dtjohnso@uark.edu

Biography: Dr. Donn T. Johnson is a professor at the University of Arkansas. He received a B.S. in biology from the University of Minnesota-Duluth, and a M.S. and Ph.D. (1978) in entomology from Michigan State University. He teaches Insect Pest Management and Insect Behavior. He develops and implements fruit pest management programs for conventional, organic and high tunnel systems; monitors fruit insect vectors; evaluates effectiveness of insecticides and biopesticides; and is developing an attract-and-kill system for green June beetles.

Abstract: This is an overview of the management of pollinators and pests in high tunnels.

The USDA's Natural Resources Conservation Service (NRCS) has provided partial funding to growers to construct over 2,400 high tunnels in 43 states. The goals of that project are to conserve water, reduce pesticide use, maintain vital soil nutrients and increase crop yields.

Heidenreich et al. (2007) wrote a publication on high tunnel raspberries and blackberries that included bumble bee management. Drummond (2009) answered questions on eXtension about managing bumble bees for pollination in high tunnels. Iowa State University has a website on high tunnel pest management and scouting (Anonymous 2007). Thomas et al. (2004) discusses high tunnel integrated pest management (IPM). Majumdar and Akotsen-Mensah (2010) outline organic pest management for high tunnel crop production in Alabama.

Bumble bee management. Cross pollination for melon, cucumber, squash and berry production is essential for fruit set and increased yield. Off season high tunnel production with outside temperatures below 50 °F prevents flight of natural pollinator species so growers must purchase and maintain pollinators like bumble bees in the tunnel. The native bumblebee, *Bombus impatiens* is recommended for use in the eastern parts of North America. Depending on hive size, colonies pollinate from 3 to 12 weeks. Hive costs range from $79 for small hives that pollinate less than 5,000 sq ft to $315 for large hives that pollinate 8,000 to 15,000 sq ft (Suppliers: Koppert Biological Systems, Inc. - USA (http://www.koppert.com/distribution-koppert-products/usa/); ARBICO Organics (http://www.arbico-organics.com/category/beneficial-insects-pollinators); and Biobest Biological supplies (http://www.biobest.be/v1/en/).
Jett (2007) and suppliers of bumble bee hives (above) cite hive practices for high tunnels. It is important to set hive on a pedestal about 20-30 inches above the ground. Protect hive from ants by using a barrier of grease or insect glue on the pedestal. Screened sidewalls or tunnels with all sides closed prevent bumblebee escape. For first orientation flight, in the late afternoon close the tunnel ventilation sides and open the

hive door to allow bees to fly within the tunnel only. Bumble bees pollinate best when temperatures are between 59° and 77°F. Feed your bumble bee colony sugar water solution provided by hive supplier. Do not use any pesticide during the time the bees are pollinating. Place a warning sign up that announces the presence of bumble bees to alert people with a venom allergy (have Epipen available).

Pest management of crops in high tunnels often have fewer and different pest complex than crops growing in the open field. Cultural practices that prevent pest buildup include: maintain broadleaf weeds to a minimum inside the tunnel and at least 20 feet around the exterior to reduce reservoir of mites, aphids and whiteflies; use transplants that are pest-free; grow pest and disease resistant plants; and screen tunnel sides and ends to preventive pest entry. Exclusion of pests by screening tunnel sides and ends can eliminate several other potential pests including: Japanese beetles, stink bugs, raspberry crown borer (RCB) and rednecked can bore (RNCB). For brambles it is important to exclude RCB and RNCB egg laying because the larvae feed on the root crown and lower cane or the cane, respectively, which can lead to reduced yields and plant death. Daily or at least weekly monitoring of plants allows grower to detect the expected and unexpected pests and make decisions to suppress a pest by timing release of biological control agents against aphids, mites or whiteflies or application of recommended insecticides. Keep a good record of your pest counts by date, crop and plant part. If you have trouble identifying any pest, please contact your county agent for help. Save money, labor and time by spraying only pest hot spots in early morning or late evening. Conserve pollinators and natural enemies by providing retreats of untreated spots. The biopesticides have reduced-risk to humans and natural enemies and usually shorter worker re-entry intervals of 12-24 hours. Note, tunnels prolong residual activity of most pesticides. Biopesticides include: insecticidal soap (M-Pede), horticultural oils (JMS Stylet oil), *Bacillus thuringiensis* (*Bt*), *Beauveria bassiana*, Aza-Direct, and pyrethrum (Pyganic). Insecticides include: Asana, Actara, Malathion and Sevin.

Whiteflies can cause off-color of leaves or stunted plants **and thrips** can transmit viruses. There are three species of greenhouse whitefly, silverleaf whitefly and the banded-wing whitefly. Host plants for the greenhouse whitefly are ornamental and vegetable crops. Host plants for the silverleaf whitefly are beans, broccoli, *Ficus*, Lantana lettuce, melons, grape, sweet potato and poinsettia. Host plants for the banded-wing whitefly are poinsettia, geranium, hibiscus and petunia. For each 250 square feet of tunnel, place one yellow sticky trap for white flies and one blue sticky trap for thrips. Check traps and 100 plants weekly to detect the presence of each. Look for thrips on the underside of leaves or inside flowers. Trapping helps to keep pest numbers low. Change traps when dirty (100 yellow sticky cards cost $32 and 100 blue sticky cards are $52 from Great Lakes IPM). If 0.5 whiteflies are found per sticky card early in the season, or if there are 2 whiteflies/card/day when the crop reaches maturity, you can: 1) apply recommended insecticides; or 2) release the appropriate biological control insect; or 3) gently walk through the tunnel shaking the infested plants to make white flies fly and suck them into a shop vacuum; or make your tunnel host free for two weeks to help reduce numbers. For biological control, you will need to remove all the sticky cards first, then release 1-3 female parasitoids per plant per week until scouting

confirms 80% parasitization of immature white flies. Parasitoids will cost at least $20 per 1000 (Koppert, Bioline, Bioconet or Rincon-Vitova).

Aphids suck sap from your plants which will cause leaf curl, cause water stress and reduce growth. Green peach aphid, potato aphid, and melon aphid are common species each have a pair of short tubes (cornicles) at the end of the abdomen. Weekly inspect underside of leaves and growing points of 100 plants and on yellow sticky cards throughout the tunnel for presence of aphids. When aphids appear release 250 aphid midges (*Aphidoletes aphidimyza*) per acre or use a recommended insecticide application for control (Majumdar and Akotsen-Mensah 2010).

Mites will suck the chlorophyll from the leaves of you plants. Check about 100 leaves weekly for mites. The action threshold is when you see 1-2 mites per leaf. You can release 3 predatory mites *Amblyseius fallacies* per 10 square feet at $43 per 1000 mites (Rincon-Vitova Insectaries).

Slugs thrive under high moisture conditions with heavier soil types and poor ventilation, which can be present in high tunnel environments. Ventilate to reduce the humidity, avoid organic mulches where slugs hide (grass clippings/straw), moistened newspaper placed on the soil surface will concentrate slugs and pans of beer or sugar/water+ yeast extract will trap and drown the slugs. Moisten the soil then apply iron phosphate around the plants (Sluggo, Slug Magic and EscarGO) for chemical control for up to 4 weeks (Cranshaw and Leatherman 2008).

Acknowledgements: Partial funding of our research came from USDA/NRI Organic Program; USDA/Southern Region IPM Grants Program; USDA/SARE/PDP Project: 0104-23573-31-7700; USDA NIFA Small Business Initiative Research No:2010-00204; Southern Region Small Fruit Consortium and IR-4 Program No: 2009-08; and University of Arkansas Agricultural Experiment Station Research Incentive Grant. Special thanks to Barbara Lewis, Soo-Hoon Sam Kim, Heather Friedrich, Jason McAfee and Erin Walters for field and laboratory assistance.

References:

Anonymous. 2007. High tunnel pest scouting model. Leopold Center for Sustainable Agriculture, IA State University Extension. Online at: http://www.leopold.iastate.edu/research/marketing_files/pest.pdf

Cranshaw, W.S., and D.A. Leatherman. 2008. Pear slugs. trees and shrubs quick facts. CO State University Extension No. 5.560. Online at: http://www.ext.colostate.edu/pubs/insect/05560.pdf

Drummond, F. 2009. If I purchase commercial bumble bees are there any management guidelines that I need to be aware of? eXtension Bee Health Home. Online at: http://www.extension.org/faq/40602

Heidenreich, C., M. Pritts, M. Kelly, and K. Demchak. 2007. High tunnel raspberries and blackberries. Cornell University, Horticulture Publication No.47. Online at: http://www.fruit.cornell.edu/berry.html

Jett, L.W. 2006. Growing strawberries in high tunnels in Missouri. Online at: http://www.hightunnels.org/PDF/Growing_Strawberries_in_High_Tunnels.pdf

Majumdar, A. and C. Akotsen-Mensah. 2010. Pest management in high-tunnel crop production. AL A&M and Auburn Universities Coop. Ext. System. Online at: http://www.aces.edu/timelyinfo/Horticulture/2010/July/July_2_2010.pdf

Thomas, C., E.P. Burkhart, and T.T. Nennich. 2004. High tunnel integrated pest management (IPM): Insects and mites. MN High Tunnel Production Manual for Commercial Growers M1218. Online at: http://www.extension.umn.edu/distribution/horticulture/components/M1218-10.pdf

Economic Analysis for Raspberry Production Using High Tunnels

Hector Rodriguez
University of Arkansas

While there is limited commercial berry production in Arkansas, interest in raspberries continue to grow as more consumers demand a local supply of fresh, high quality fruit. Demand for these berries typically exceeds supply in much of the state. Commercial production offers promise for those producers willing to make the necessary capital investment toward properly establishing this crop. Consequently, estimating the costs of production and conducting what-if analyses around costs, revenues and production levels are important components for planning and for financial management of fruit production.

Although many berry producers develop their own budgets, some prefer to begin with existing budgets and adjust them according to their specific situation. The budget developed in this project serve as a starting point for the latest group. Information was placed into an Excel spreadsheet to make the budget interactive.

Sample costs and revenues to produce one acre of raspberries (with and without/high tunnel production for extended seasons) are presented in this study. Sample costs for labor, materials, equipments and custom services are based on current figures gathered at the University of Arkansas experimental station at Fayetteville, Arkansas. The practices described are based on production procedures considered typical for northwest Arkansas and do not apply to every berry orchard.

Producers select interest rate, inflation rate, planting density, expected prices, marketing plan and the production system (field or high tunnel production); then the budget is calculated automatically. Graphical options provide visual explanations of costs, revenues and net returns under different scenarios chosen by the user. Users can review information for any given production year or for the expected life of the orchard.

Several interactions of hypothetical scenarios show that cash flows will be negative until the crops have matured and generate returns to cover the cost of establishment. In general, projects start to be profitable after year five of production. However, this situation is limited by the management practices selected.

The use of high tunnels in berries production could greatly extend the production season. Extended season could assist growers in capturing a larger market share, especially early and late season when premium prices are paid. Consequently, producers could use this interactive budget 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 cultivar varieties and high tunnel dimensions would assist berry producers to make better planning and financial decisions.

Contact Information

Dr. Germán Rodríguez, Research Program Associate, Department of Agricultural Economics and Agribusiness, 217 Agriculture Building 1 University of Arkansas, Fayetteville, AR; hrodrig@uark.edu, 479-575-2259 (Presenter)

Dr. Jennie Popp, Professor, Department of Agricultural Economics and Agribusiness

Ms. Heather Friedrich, Program Technician II, Horticultural Department, University of Arkansas.

Dr. Rom Curt, Horticultural Department, University of Arkansas.

Mike Ellis Handouts

Using Fungicides to Control Strawberry Fruit Rots in Ohio 2010

Michael A. Ellis
Department of Plant Pathology
The Ohio State University/OARDC

In Ohio, perennial matted row production has a long tradition and still is the most common strawberry production system. In recent years, annual plastic culture production has increased considerably in Ohio. Both systems have the same fruit rot diseases and will use the fungicides discussed below for control. In matted row production, we have a limited bloom period that help us to time sprays for control of Botrytis and a fairly defined harvest period that allows us to better time or target fungicide applications for anthracnose and leather rot. In annual plastic cultures systems, Bloom occurs over a much longer period of time and will require more applications for Botrytis control. In addition, anthracnose is inherently a far greater problem in the annual plastic culture system. Thus, a more intensive fungicide program will probably be required for plastic culture berries. For example, sprays for anthracnose control should be applied throughout the production season. The sprays used for anthracnose control can also be effective for controlling Botrytis and leather rot as well. Therefore, it is very important to know what fungicides are effective for each specific disease.

The most common fruit rots on strawberry in Ohio are: Botrytis fruit rot (gray mold), caused by *Botrytis cinerea*; anthracnose fruit rot, caused by *Colletotrichum acutatum*; and leather rot caused by *Phytophthora cactorum*. Especially in wet growing seasons, successful strawberry production may depend on the simultaneous control of all of these diseases. Generally, all three diseases do not occur simultaneously in the same planting, but this can occur. Botrytis fruit rot or gray mold is the most common disease and generally requires some level of fungicide for control each year. Anthracnose is a problem in years with warm to hot temperatures combined with prolonged rainfall prior to and during harvest. Anthracnose is generally not a problem in most plantings; however, when it does develop, it can be devastating. New fungicide chemistry with good to excellent activity against anthracnose has recently been registered for use on strawberry and should be helpful in providing effective control. Leather rot is a problem in years with excessive rainfall or in fields with poor drainage that have standing water (all of these diseases are a problem in situations such as this). Many growers do a good job of controlling leather rot by planting on sites with good soil drainage and maintaining a layer of straw mulch to prevent contact of berries with soil. In years with excessively wet weather or on sites with problem soil drainage, fungicides may be beneficial for leather rot control.

As previously mentioned Botrytis or gray mold is the most common disease and is probably the easiest to control with effective fungicide use. Most fruit infections by Botrytis occur only during bloom. Therefore, most growers in perennial matted row systems apply fungicides only during bloom and generally do a very good job of

controlling Botrytis and do not need to apply fungicides pre-bloom or during harvest. If anthracnose and leather rot **are not a problem**, fungicide sprays during bloom only are generally all that is required. Obviously this is an ideal situation in relation to reducing costs and overall fungicide use.

In Annual plastic culture systems and in perennial matted row plantings during growing seasons (warm and wet) where anthracnose or leather rot are problems, the need for a more intensive fungicide program is greatly increased. In most years, an intensive fungicide spray program will be required in plastic culture systems. The following information provides guidelines for developing an effective fungicide program for control of the major fruit rots in matted row production systems in Ohio.

Prebloom

In most years, there is generally little or no need for fungicides prior to bloom for control of Botrytis. If weather is exceptionally wet from rain or overhead irrigation from frost protection, some early season fungicide may be required prior to bloom. If anthacnose is a concern, especially in plastic culture berries, prebloom applications of fungicide are beneficial in reducing the buildup of inoculum in the planting. This is especially true if prebloom temperatures are abnormally warm and conditions are wet. Applications of Captan or Thiram alone at the highest rate (Captan 50WP, 6 lb/A; Captan 80WDG, 3.75 lb/A; Captec 4L, 3 qts/A, Thiram 75WDG, 4.4 lb/A) should be effective in reducing inoculum buildup of all three diseases. A seven day application interval should be sufficient.

During Bloom

This is the critical period for control of Botrytis. In addition, in fields infested with Colletotrichum (anthracnose), the fungus may be able to build up inoculum on symptomless (apparently healthy) foliage during warm, wet weather. Increased inoculum could result in increased fruit infections if weather remains favorable for disease development. The main fungicides for control of Botrytis are Elevate 50WG, Captivate 68WDG, Switch 62.5WG, Scala SC and Pristine 38WG. Captivate is a package mix of Captan and Elevate. All of these materials have excellent efficacy for control of Botrytis, but only Switch and Pritine have efficacy against anthracnose. This is an important point to remember if anthracnose is a problem in the planting. I also recommend that all of these materials be tank-mixed with Captan or Thiram during bloom. Captan and Thiram are protectant fungicides that provide some additional control against Botrytis (gray mold), anthracnose fruit rot, and leather rot. In addition, mixing the materials should also aid in reducing the risk of fungicide resistance development.

Elevate, Scala, Switch, and Pristine are all at high risk for development of fungicide resistance in Botrytis. None of these fungicides should be used alone in a season long program for Botrytis control. They all have different chemistry so they can be alternated with each other as a fungicide resistance management strategy. It is wise

not to apply any of these fungicides in more than two sequential sprays without alternating to a different fungicide.

For successful Botrytis control, it is important to provide fungicide protection throughout bloom. Remember that early blooms (king bloom) may be your largest and best quality fruit, so protection needs to be started early (at least 10% bloom). The number of bloom sprays required depends upon the weather. If it is hot and dry, no fungicides are required. All of the fruit rot diseases discussed here require water on the flowers and fruit in order to infect. If it is very dry and overhead irrigation is used for supplemental water, irrigation can be applied in early morning so that plants dry as fast as possible. Keeping plants dry reduces the need for fungicide application. Fortunately, most years are not this dry and fungicides are generally applied on at least a 7-day schedule through bloom. If it is extremely wet, a shorter interval (4-5 days) may be required in order to protect new flowers as they open. Although Botrytis is the primary pathogen we are trying to control during bloom, the selection of the proper fungicides should also aid in reducing the buildup of anthracnose as well. This is important to remember in plantings where anthracnose is a problem or threat. This is especially true in plastic culture plantings.

Post Bloom Through Harvest

As bloom ends and green fruit are present, the threat from Botrytis infection is generally over. Green fruit are resistant to Botrytis. If you got fruit infection by Botrytis during bloom, the symptoms (fruit rot) will not show up until harvest as fruit start to mature. At this point, it is too late to control it.

As new fruit form through harvest, the threat of anthracnose fruit infection increases. In many perennial matted row plantings, anthracnose is not present or is not a problem. In these plantings no additional fungicide should be required after bloom through harvest. Unfortunately, you cannot determine if anthracnose is a problem until you see it. Often, this is too late to control it. In plantings with a history of anthracnose fruit rot, or if the disease is identified in the planting, fungicides with efficacy for anthracnose control may be required from the end of bloom through harvest. Remember, anthracnose is favored by warm to hot wet weather. In addition, anthracnose is a much greater problem in plastic culture plantings and in my opinion requires season long control.

Abound 2.08F, Cabrio 20EG, and Pristine 38WG are strobilurin fungicides and are the most effective fungicides currently registered on strawberry for control of anthracnose fruit rot and all are very effective for control of leather rot. These fungicides are also registered for control of powdery mildew and leaf spots and they also provide good suppression of Botrytis fruit rot (gray mold).Pristine provides excellent control of Botrytis. In fact, Pristine is the only fungicide that provides excellent control of all three fruit rots. All of these fungicides are at high risk for fungicide resistance development in the anthracnose fungus. In addition, they are all in the same class of chemistry; therefore, they cannot be alternated with each other as a fungicide resistance management strategy. In order to delay the development of fungicide resistance, the label states that no more than four applications of Abound or five applications of Cabrio

or Pristine can be made per season. In addition, the label states that no more than two sequential sprays of each fungicide can be made without switching to a fungicide with a different type of chemistry. For anthracnose control, the only fungicides that currently can be used in such a rotation with these fungicides are Captan, Thiram, or Switch. Switch 62.5 WG has been reported to provide good to excellent control of anthracnose fruit rot as well as excellent control of Botrytis, and would be my fungicide of choice in an alternating program with Abound, Cabrio or Pristine.

The following are suggestions for developing a fungicide program for simultaneous control of strawberry fruit rots.

Fungicide and (rate/A)	Comments
Prebloom Captan 50 WP (6 lb) or Captan 80WDG (3.75 lb) or Captec 4L, 3 qt or Thiram 75WDG (4.4 lb)	Prebloom applications should be required only if excessive water from rain or irrigation is a problem early in the season. Fungicides here could help reduce build-up of Botrytis and Colletotrichum inoculum. In dry or more “normal” seasons, fungicide is probably not required until bloom starts.

During bloom Switch 62.5WG (11-14 oz) or Scala SC (18 fl. oz) or Elevate 50WG (1-1.5 lb) **PLUS** Captan 50WP (4-6 lb) or Captan 80WDG (3.75 lb) or Captec 4L (2-3 qt) or Thiram 75WDG (4.4 lb) **OR** Captevate 68WDG (3.5-5.25 lb) **OR** Pristine (18.5 - 23 oz)	This is the main time to control Botrytis and if temperatures are high, Anthracnose could build up in the planting. Pristine is highly effective for Botrytis, Anthracnose and leather rot. Switch is excellent for control of Botrytis and has been reported to have good activity for control of anthracnose. Obviously, this is ideal. The addition of Captan or Thiram provides additional protection against all the fruit rot diseases and may aid in reducing fungicide resistance development. Scala and Elevate are excellent for control of Botrytis, but have no activity against anthracnose. Where anthracnose is not a threat, these fungicides will provide excellent Botrytis control. When Elevate, or Scala are combined with the high rate of Captan or Thiram, the combination should provide some level of anthracnose control. Captevate is a package-mix combination of Elevate plus Captan. If anthracnose is a concern, Pristine or Switch would be the fungicide of choice. None of the fungicides (Pristine, Switch, Scala, or Elevate should be applied more than twice before alternating with a fungicide of different chemistry. This is to aid in reducing fungicide resistance development. Abound, Cabrio, and Pristine are the fungicides of choice for anthracnose control. They also provide excellent control of leather rot. Abound and Cabrio provide some control of Botrytis. Pristine provides excellent control of all three fruit rots. Although they could be used during bloom, I prefer to use them after bloom in perennial matted row systems and from bloom thorough harvest in plastic culture systems when the threat of anthracnose fruit infection is greatest.

Post bloom Through Harvest Abound 2.08F (6.2-15.4 fl oz) or Cabrio 20EG (12-14 oz) or Pristine 38WG (18.5 - 23 oz) or Switch 62.5WG (11-14 oz) tank-mixed or alternated with Captan 50WP (3-6 lb) or Captan 80WDG (3.75 lb) or Captec 4L (1.5-3 qt) If more than two applications of Abound, Cabrio, or Pristine are required, Switch should be considered as an alternating fungicide.	As green fruit develop the threat of anthracnose infection increases, especially under warm, wet conditions. Abound, Cabrio, or Pristine are the most effective materials for anthracnose control. If anthracnose is a problem, the highest label rate should be used. This may be the best time to use Abound, Cabrio, or Pristine. Switch also has good activity for control of anthracnose. If the risk of anthracnose is high or the disease has been observed in the planting, Quadris, Cabrio, or Pristine plus Captan should be applied 7 days after the last bloom spray for Botrytis in matted row plantings. If anthracnose remains a threat, sprays should probably be repeated on a 7 day interval through harvest. In plastic culture plantings sprays should be made from early bloom through harvest. As harvest approaches, Captan should be removed from the program. Captan applied close to harvest could result in visible residues on fruit and this can be a big problem. Abound, Cabrio, Pristine or Switch applied alone should result in minimal visible residues on fruit and can be applied on the day of harvest (0-day PHI). Remember, **these preharvest sprays are required only if anthracnose or leather rot is a threat or problem in matted row plantings. I would apply them as a good form of insurance in plastic culture berries.**

The extensive use of Captan in this program could result in problems with visible residues on fruit. This needs to be considered, but under heavy disease pressure for anthracnose a high level of Captan usage may be required. The Captec 4L (flowable) should result in less visible residue than the Captan 50W (wettable powder) or Captan 80WDG formulation. The use of Abound, Cabrio, Pristine or Switch alone in the last spray or two before harvest should aid greatly in reducing visible residues.

Leather Rot

As mentioned previously, leather rot should be controlled by good soil drainage (no standing water) and a good layer of straw mulch to prevent berries from soil contact. If leather rot is a threat or a problem, fungicides may be required. Abound, Cabrio, and

Pristine have excellent activity against Phytophthora diseases on other crops. Although leather rot is not on the label, studies in Ohio have shown that Abound, Cabrio, and Pristine all have very good to excellent activity for control of leather rot in addition to anthracnose and Botrytis gray mold. Pristine would be the fungicide of choice because it provides excellent control of all the major fruit rot diseases (Botrytis gray mold, anthracnose, and leather rot). If applied at the time suggested above (green fruit through harvest) for anthracnose, Abound, Cabrio, and Pristine should be beneficial for control of leather rot as well. Recent research at Ohio State indicated that these materials have good to excellent activity against leather rot.

Fungicides for Leather Rot Control

As previously mentioned, emphasis for leather rot control should be placed on the use of cultural practices such as planting on well drained sites or improving water drainage in the planting and a good layer of straw mulch to prevent berry contact with the soil. When needed, the following fungicides are labeled specifically for control of leather rot.

Ridomil Gold SC is labeled for control of Red Stele (caused by *Phytophthora fragarieae*) and Leather Rot (caused by *Phytophthora cactorum*). The label for perennial strawberries reads as follows: “Established Plantings: Apply Ridomil Gold SL at 1 pt. per treated acre in sufficient water to move the fungicide into the root zone of the plants. Make one application in the spring after the ground thaws and before first bloom. A second application may be applied after harvest in the fall. **Note:** Although not labeled for leather rot control, the early spring application for red stele control should provide some control of leather rot. **For supplemental control of leather rot**, an application may be made during the growing season at fruit set. This application at fruit set (as green fruit are present) has been very effective for leather rot control.

Phosphorous acid Fungicides

Several phosphorous acid (phosphite) fungicides are registered for control of red stele and leather rot on strawberry. They all have essentially the same active ingredient. These fungicides include Aliette, Agri-Fos, PROPHYT, Phostrol and Topaz. There are several other phosphite fungicides on the market and new ones continue to be introduced. These materials are highly systemic and are applied as foliar sprays for leather rot control.
Research at Ohio State University has shown that phosphorous acid fungicides are highly effective for control of leather rot when applied in a protectant program on a 7-day interval. In addition, Agri-Fos provided up to 36 hours of curative activity against leather rot in laboratory and field trials. Use recommendations and price varies among products. Compare price and see labels for rates and use recommendations.

Table 1. Efficacy of Fungicides for Strawberry Disease Management.

Fungicide[a]	Gray Mold	Leather Rot	Leaf Spot	Powdery Mildew	Anthrac-nose	Preharvest Interval Days
Alone						
Abound[b]	++	+++	++	+++	+++	0
Aliette	0	+++	0	0	0	0
Cabrio[b]	++	+++	++	+++	+++	0
Captan[c]	++	+	++	0	++	0
Elevate	+++	0	0	0	0	0
Nova	0	0	+++	+++	0	1
Ridomil	0	+++	0	0	0	0[a]
Sulfur	0	0	0	+++	0	0
Switch	+++	0	0	0	++	0
Thiram[d]	++	+	++	0	+	0[c]
Topsin[e]	+++	0	+++	+++	++	1
Phosphorous Acid	0	+++	0	0	0	0
Pristine[b]	++	+++	++	+++	+++	0
Scala	+++	0	0	0	0	0
In Combination						
Abound + Captan	++	+++	++	+++	+++	0[c]
Cabrio[b] + Captan[b]	++	+++	++	+++	+++	0[c]
Elevate + Captan	+++	+	++	0	++	--
*Elevate + Thiram	+++	+	++	0	+	--
Switch + Captan	+++	+	++	0	++	--
Switch + Thiram	+++	+	++	0	+	--
Topsin + Captan	+++	+	+++	+++	++	--
Topsin + Thiram	+++	+	+++	+++	++	--

* Scala will perform similar to Elevate in combination with Captan or Thiram.

Efficacy rating system: +++ = highly effective; ++ = moderately effective; + = slightly effective; 0 = not

effective, ? = activity unknown.

[a] See label for harvest restrictions.
[b] Abound, Cabrio, and Pristine have good activity against leather rot.
[c] Although the preharvest interval for Captan is 0 days, protective clothing must be worn for 24 hours after application when entering the planting or harvesting fruit.
[d] Thiram can not be applied within 3 days of harvest.
[e] Always apply Topsin, Elevate, Scala or Switch in combination with an unrelated fungicide such as Captan or Thiram, or in an alternating program with a fungicide of different chemistry.

Remember these are only suggested guidelines for a fruit rot control program. It is always the grower's responsibility to read and understand the label. For the most current pesticide recommendations in Ohio, growers are referred to Bulletin 506-B "Midwest Commercial Small Fruit and Grape Spray Guide".

If growers have questions regarding the information covered here, they should contact: Mike Ellis; PH: 330-263-3849 and e-mail: ellis.7@osu.edu.

Fungicides for Bramble Disease Control

Mike Ellis
Department of plant pathology
The Ohio State University, OARDC

Fungicides can play an important role in the bramble disease-management program. However, in order to obtain maximum benefits with minimal use, fungicides must be integrated with the use of the previously described cultural practices and resistant or less susceptible cultivars. Several important bramble diseases cannot be controlled with fungicides. These include Verticillium wilt and all of the virus diseases. On the other hand, fungicides can be a very effective component in control programs for Botrytis fruit rot (gray mold), powdery mildew, Septoria leaf spot, raspberry leaf spot, anthracnose, cane blight, Phytophthora root rot, and rust diseases.

Although fungicides are an important disease management tool, the diligent use of cultural practices within the disease-management program is **extremely important.** The content presented here is intended to provide some general information about the currently registered fungicides. It is always the growers' responsibility to read and follow all label instructions. Regulations and recommendations can **change rapidly**; therefore, the information contained here could change before you read it.

Abound 2.08F
Abound is a strobilurin fungicide registered for control of several diseases including anthracnose, powdery mildew, leaf spots, spur blight and rosette or double blossom of blackberry. It only provides suppression of Botrytis fruit rot. It is the same fungicide chemistry as Cabrio and cannot be used in alternation with Cabrio in a fungicide resistance management program. The label is very similar to Cabrio. No more than four applications can be made per season, and no more than two sequential sprays can be made without alternating to a fungicide with a different chemistry in order to prevent the development of fungicide resistance.

Cabrio 20EG

Cabrio is a strobilurin fungicide registered for control of anthracnose, spur blight, leaf spot, powdery mildew, and rust on brambles. Cabrio provides good to excellent control of all these diseases and provides some suppression of Botrytis fruit rot (gray mold). It is used at the rate of 14 oz per acre and can be applied up to and including the day of harvest; however, the re-entry interval for Cabrio on brambles is 24 hrs. No more than four applications can be made per season, and no more than two sequential sprays can be made without alternating to a fungicide with a different chemistry in order to prevent the development of fungicide resistance.

Pristine 38WG

Pristine 38WG fungicide is registered for use on all brambles (blackberry and raspberry) for control of anthracnose, Botrytis gray mold, leaf spots, powdery mildew, rust diseases, and spur blight. Pristine is a combination of two active ingredients (pyraclostrobin and boscalid). It cannot be applied more than four times per season and

has a 0-day preharvest interval. Pyraclostrobin is the same material as in Cabrio (strobilurin fungicide) and the same fungicide chemistry as Abound; thus, Cabrio, Abound and Pristine cannot be alternated with each other in a fungicide resistance management program. For control of rust diseases, Cabrio, Abound and Pristine should be alternated with Rally to prevent fungicide resistance development.

Captan 50WP, 80WP,
and Captec 4L

The reentry interval for captan fungicide ranges from 48 hours to four days on various crops ranges. Always check the label of the captan product you intend to purchase for a specific crop before you purchase it.
Captan fungicides are registered for conrol of anthracnose, botrytis fruit rot (gray mold), and spur blight.

In bloom and preharvest sprays for control of Botrytis fruit rot (gray mold), Captan is an excellent material to use in combination (tank mix) with Switch, Elevate, Rovral, Cabrio or Pristine. Captan may result in visible residues on fruit. If this is a problem, use Elevate, Switch, or Pristine alone in preharvest sprays.

Liquid Lime Sulfur or Sulforix

Lime sulfur is recommended for use on brambles as a delayed-dormant application in early spring (when buds show 1/4-inch green). It is used at the rate of 6-12 gallons per per acre. Sulforix is essentially a different formulation of Lime sulfur that is used at a rate of 3 gallons per acre. It has been reported that the different formulation of Sulforix allows it to penetrate plant tissues and thus can be used at a lower rate. Lime sulfur applied at these high rates later in the season, can cause severe damage to leaves and young canes. Lime sulfur is recommended for control of the cane-infecting fungi (anthracnose, cane blight, and spur blight). The delayed dormant application in spring is intended to eliminate or reduce the overwintering inoculum for these diseases on canes. Where cane diseases are a problem, this spray is very important. When good sanitation is used (old fruited and infected canes are removed from the field) and cane diseases are not a problem, this spray may not be necessary.

Lime sulfur has a bad smell (like rotten eggs) so there can be a problem spraying it around your neighbors. Some growers have received complaints from neighbors after applying lime sulfur. In addition, lime sulfur is very caustic. It is harmful to machine parts, paint (especially on cars), and sprayers. Special care should be taken to avoid drift to non-target objects, and proper protective clothing should be worn by the applicator.

If a delayed-dormant application of fungicide is required and lime sulfur cannot be used, Bordeaux mixture or a fixed copper fungicide can be used in its place. Although lime sulfur is the proven material, delayed-dormant sprays of copper should provide some level of control. The use of copper in the growing season (after leaves are present) could result in significant plant damage.

Rally 40W

Rally 40 W was originally marketed as Nova 40 W is registered on blackberry for control

of cane and leaf rust, orange rust, powdery mildew, and yellow rust. On raspberry it is registered for control of cane and leaf rust, leaf spot, orange rust, powdery mildew, and yellow rust. Although late leaf rust is not mentioned on the label, Nova should be highly effective for its control. Nova has excellent activity against most rust diseases and powdery mildew. It is used at the rate of 2.5 ounces per acre. No more than 10 ounces may be used per acre per growing season. It can be applied up to the day before harvest.

Phosphorous Acid
(Agri-Fos, ProPhyt, Phostrol and several others)

Several products containing phosphorous acid (PA, also called phosphite or phosphonate) are sold as nutritional supplements and plant conditioners, and some of them (Agri-Fos, ProPhyt, Phostrol and others) are currently registered for control of plant diseases. These products are registered on brambles for control of Phytophthora root rot. They are essentially the same active ingredient that occurs in the fungicide Aliette (fosetyl-AL), and most have labels that are very similar Aliette. The materials are applied to the foliage where they are absorbed and translocated down to the roots to provide disease control.

Sulfur

Sulfur is registered for control of powdery mildew. It is available as a wettable powder, a dry flowable or in liquid (flowable) formulations. Sulfur has little or no activity against the other bramble diseases caused by fungi. Because powdery mildew is generally not a serious problem in the Midwest, sulfur is generally of little importance within the bramble disease-management program.

Rovral 50WP and 4F

Rovral has excellent activity against Botrytis fruit rot (gray mold) but has little or no activity against the other fungal pathogens on brambles. Rovral is at risk for resistance development by the fungus that causes gray mold fruit rot. Therefore, Rovral should not be used more often than necessary; the less it is used, the longer it will last. Its use should be limited to no more than two applications before switching to a fungicide with a different mode of action. These fungicides include Elevate, Switch, and Captan.

Rovral can be applied up to and including the day of harvest (0-day preharvest interval or PHI). In addition, the label states it can be used on “caneberries;” therefore, it can be used on all brambles. Rovral may be applied to caneberries at the rate of 1 to 2 pounds per acre. Apply Rovral first at early bloom (5% to 10% bloom) and make a repeat application again at full bloom. Up to three subsequent applications can be applied at 14-day intervals or as required. The final application can be made up to and including the day of harvest.

It is our intention to provide a program that will allow growers to use a **minimum** number of fungicide applications. In general, use of Rovral can be minimized by cultural practices that improve air circulation in the planting (very important for Botrytis control); prompt harvest of ripe fruit and removal of overripe or rotten fruit from the planting (also very important for Botrytis control); and focusing sprays during bloom (and immediately before harvest, if necessary), just before long rainy or foggy periods.

Elevate 50WDG

Elevate is registered for control of Botrytis fruit rot on brambles and provides excellent control. Use recommendations for Elevate are identical to those of Rovral for control of Botrytis fruit rot. Elevate, Switch, and Rovral have different chemistry or modes of action. Because all of them are at high risk for fungicide resistance development in Botrytis, alternating their use in one to two spray blocks is recommended. Elevate may be applied up to and including the day of harvest. The following information is taken from the label:

For control of *Botrytis cinerea* (gray mold), apply 1.5 pounds ELEVATE 50 WDG Fungicide per acre (0.75 lb AI/acre). Begin application at 10% bloom and continue through harvest. Applications should be made every seven days or when conditions favor disease development.
Avoid making more than two consecutive applications with ELEVATE 50 WDG Fungicide. After the second application, use an alternative fungicide effective in controlling *Botrytis cinerea* for two consecutive applications before reapplying the active ingredient in this product. Alternative fungicides include Rovral, Switch, and Captan. Consult your local crop advisory for appropriate alternative products. The final application may be made up to and including the day of harvest (PHI = 0). DO NOT apply more than 6.0 pounds of product per acre per season
(3.0 lb AI/acre/season).

CaptEvate 68 WDG

CaptEvate is a combination product of Elevate and Captan (14% Elevate and 53% captan). It is an excellent material for control of Botrytis fruit rot (gray mold). If you intend to use a tank mix of Elevate and captan, this material makes good sense. At the recommended rate, it has about the same amount of the material that you would use as Elevate or captan alone.

Ridomil Gold SC

Ridomil Gold SC is labeled for control of Phytophthora root and crown rot on raspberries. It has no activity against the other bramble diseases caused by fungi in the Midwest. It is available in a liquid or granular formulation. Although Ridomil is very effective for control of Phytophthora root rot, it needs to be emphasized that cultural practices (primarily good soil drainage) are the primary means for controlling this disease. In other words, Ridomil is most effective when used in combination with these cultural practices and/or the avoidance of highly susceptible cultivars (Titan, Ruby, Hilton). It is often ineffective if used in very wet sites, particularly on the above cultivars.

Switch 62.5%WDG

Switch is registered on blackberries and raspberries for control of Botrytis fruit rot (gray mold). Switch is an excellent material for control of Botrytis. It is used at the rate of 11 to 14 ounces per acre and has a 0-day

preharvest interval. No more than 56 ounces of product can be applied per acre per year.

The label states:

Make the first application during early bloom. A second application should be made seven to 10 days later. Additional applications can be made at seven- to 10-day intervals if conditions remain favorable for disease development.
Make no more than two (2) sequential applications before using another registered fungicide. Switch 62.5WG may be applied in an alternating or blocking program.
For purposes of fungicide resistance management, no more than two sequential applications can be made before using another registered fungicide with different chemistry. For Botrytis control on brambles, Switch can be used in alternating programs with Elevate, Rovral, Pristine or Captan. No more than four applications of Switch can be made per growing season.

Fungicides for Strawberry Disease Control

Mike Ellis
The Ohio State University
OARDC, Wooster OH

Most fungicides used on strawberries are directed at the control of fruit rots and foliar diseases (Table 1). By using resistant cultivars to control foliar diseases, the use of fungicides can be directed primarily toward controlling fruit rots. The fruit rots that are most prevalent in the Midwest are leather rot, Botrytis fruit rot (gray mold), and anthracnose fruit rot.

Leather Rot

Most fungicides currently available for use on strawberries are generally ineffective for controlling leather rot. Although Captan and Thiram are beneficial in suppressing leather rot, they will not provide adequate control if an epidemic develops. Furthermore, the use of these fungicides is restricted or prohibited during harvest due to re-entry restrictions or preharvest intervals.

Ridomil Gold SC is registered for use on strawberries for control of red stele and leather rot. Ridomil Gold SC is very effective for control of leather rot and may be applied in the spring after the ground thaws and before first growth. This early application is recommended primarily for control of red stele but may be beneficial in providing some control of leather rot. A second application is recommended specifically for leather rot and can be made during the growing season at fruit set. Ridomil Gold SC will provide up to 36 hours of curative activity against leather rot. Thus, if applied with 36 hours after infection occurs, it will still provide good control.

Strobilurin Fungicides
Abound (azoxystrobin), Cabrio (pyraclostrabin), and Pristine (pyraclostrobin plus boscalid) are strobilurin fungicides registered for use on strawberry for control of powdery mildew and anthracnose fruit rot. Although leather rot is not listed on the label, Abound, Carbrio and Pristine are very effective for controlling leather rot if applied on a protectant schedule.

Phosphorous Acid (Agri-Fos, ProPhyt, Phostrol, Aliette)

Several products containing phosphorous acid (PA, also called phosphite or phosphonate) are sold as nutritional supplements and plant conditioners. Agri-Fos, ProPhyt, Phostrol and several others are currently registered as fungicides for control of plant diseases. These products are registered on strawberry for control of leather rot. They are essentially the same active ingredient that occurs in the fungicide Aliette (fosetyl-AL) and most have labels that are very similar to the label of Aliette. They are very effective for control of leather rot and recent research at Ohio State University indicates that they can provide up to 36 hours of curative activity against leather rot.

Thus, they can be applied 36 hours after infection has occurred and still provide good control.

Although the previously mentioned fungicides are effective against leather rot, the emphasis for controlling leather rot should be placed on the use of cultural practices, such as using a good layer of mulch and preventing standing water in the planting (good drainage). In well- drained plantings throughout the Midwest and in drier growing seasons, leather rot is generally not a problem.

Botrytis Fruit Rot (Gray Mold)

Several fungicides have excellent activity against Botrytis. Topsin-M has been registered for many years and is highly effective in areas where Botrytis has not developed resistance to it. However, if your planting has a long history of Topsin or Benlate use, the chance that you have Botrytis resistant stains is quite high.
Rovral is registered for control of Botrytis on strawberry and was highly effective for gray mold control prior to some changes in the label use recommendations in 1999. At present, the label states that not more than one application can be made per year, and it cannot be applied after first fruiting flower. These label restrictions make Rovral of little value for gray mold control on strawberry.

Elevate, Switch, Scala and Pristine are fungicides that have excellent activity against Botrytis. A major problem involved with using these fungicides (Topsin-M, Elevate, Switch, Scala or Pristine) for control of Botrytis fruit rot is that all of them are at risk with respect to the development of resistant strains of Botrytis. Because of differences in fungicide chemistry and previous frequency of use, the threat of resistance developing may be somewhat greater for -Topsin-M than it is for Elevate, Switch, Scala or Pristine. In order to aid in fungicide-resistance management, the use of minimal numbers of fungicide applications, alternation of fungicides, and fungicide combinations should be encouraged in the disease-management program. The benefits of these fungicide-use strategies (at least in theory) are to provide a wider spectrum of disease control and to reduce or delay the development of fungicide-resistant strains of the fungus. The strobilurin fungicides Abound and Cabrio will provide some suppression of Botrytis fruit rot.

Fungicide application timing is important for gray mold management. Sprays applied during bloom are much more effective than sprays applied after fruit set and during harvest. Bloom sprays are critical for control of Botrytis fruit rot on strawberry. Care must be taken when making sprays at or during harvest because fungicides such as captan may leave visible residues at harvest. Elevate ,Switch, Scala and Pristine are used at rates that should not leave visible residue on harvested berries. In addition, research at Ohio State has shown that pre harvest sprays with Switch or Pristine provides good control of post harvest botrytis fruit rot. This may be important where berries will be held or stored for any length of time.

Anthracnose Fruit Rot

Anthracnose fruit rot is not a common problem in many areas, but its occurrence is increasing across the Midwest. The disease is very important in plasticulture systems. Once anthracnose fruit rot is established in a planting, it is difficult to control and can be very severe, resulting in complete loss of the crop.

Captan and Thiram are protectant fungicides that have some activity against anthracnose. If used in a protectant program, they will provide some level of control. Abound, Cabrio, and Pristine are strobilurin fungicides and are labeled for control of anthracnose on strawberry. They have the best activity against anthracnose on strawberry of all currently registered fungicides. For purposes of fungicide-resistance management and increased efficacy, Abound, Cabrio, and Pristine should be used in alternation with or in combination with Captan or Thiram. Abound, Cabrio, and Pristine are the same class of chemistry so they should not be alternated with each other as a fungicide-resistance strategy. The label states that no more than two applications of one of these fungicides can be made without switching to a fungicide with a different mode of action.

Switch has moderate to good activity against anthracnose fruit rot. Therefore, Switch may be used in alternation with Abound, Cabrio or Pristine for anthracnose control.

Leaf Diseases

Leaf Spot, Leaf Scorch, Leaf Blight

The emphasis for controlling leaf diseases should be placed on the use of resistant cultivars whenever possible. If resistance is not available, highly susceptible cultivars should be avoided. If susceptible varieties are planted and leaf diseases are a serious problem, post-harvest or post-renovation applications of these fungicides may be required. In Ohio, most strawberry plantings do not require fungicide applications for foliar disease because resistant varieties are generally used. Several fungicides are registered for control of strawberry leaf diseases. Topsin-M, Captan, Thiram, Rally (previously marketed as Nova), Syllit (previously marketed as Cyprex), Orbit, and Procure are registered for use on strawberries. The label states that Topsin-M cannot be applied before early bloom; thus, applications made very early in the season (as new growth starts) should use Syllit, Captan, Nova, Procure, or Thiram. The strobilurin fungicides (Cabrio, Abound, and Pristine) also have some activity against leaf diseases. If leaf diseases are a serious problem, post-harvest or post-renovation applications of these fungicides may be required.

Powdery Mildew

Powdery mildew is another foliar disease and the use of cultivars with resistance to powdery mildew should be emphasized for its control. The use of varieties that are highly susceptible to powdery mildew should be avoided.

Topsin-M is labeled for use on strawberries and was very effective against mildew when it was first introduced; however, due to the development of fungicide resistance, Topsin-M generally does not provide adequate control in many production areas across the country. In areas where Topsin-M has not been used to control powdery mildew, it still might provide effective control.

Rally, Procure, Abound, Cabrio, Quitec, Orbit and Pristine are all registered for control of powdery mildew on strawberry and should provide excellent control. Sulfur is also effective for powdery mildew control if used in a seven- to 10-day-interval protectant program. Sulfur has little or no activity against the other strawberry diseases.

Red Stele in Established Plantings

The emphasis for control of red stele should be placed on the use of resistant cultivars and good soil drainage. However, if red stele develops in an established planting, the use of Ridomil Gold SC may help reduce losses. Ridomil Gold Sc should be applied in sufficient water to move the fungicide into the root zone of the plants. The label states: “Make one application at time of transplanting or in the spring after the ground thaws before first growth. Make another application in the fall after harvest.”

Phosphorous Acid (Aliette, Agri-Fos, ProPhyt, Phostrol)

Several products containing phosphorous acid (PA, also called phosphite or phosphonate) are sold as nutritional supplements and plant conditioners. Agri-Fos, ProPhyt, Phostrol and several others are currently registered as fungicides for control of plant diseases. These products are registered on strawberry for control of Phytophthora root rot (red stele) and leather rot (see above). They are essentially the same active ingredient that occurs in the fungicide Aliette (fosetyl-AL), and most have labels that are very similar to the label of Aliette.

Table 1. Efficacy of Fungicides for Strawberry Disease Management.

Fungicide[a]	Gray Mold	Leather Rot	Leaf Spot	Powdery Mildew	Anthrac-nose	Preharvest Interval Days
Alone						
Abound[b]	++	+++	++	+++	+++	0
Aliette	0	+++	0	0	0	0
Cabrio[b]	++	+++	++	+++	+++	0
Captan[c]	++	+	++	0	++	0
Elevate	+++	0	0	0	0	0
Nova	0	0	+++	+++	0	1
Ridomil	0	+++	0	0	0	0[a]
Sulfur	0	0	0	+++	0	0
Switch	+++	0	0	0	++	0
Thiram[d]	++	+	++	0	+	0[c]
Topsin[e]	+++	0	+++	+++	++	1
Phosphorous Acid	0	+++	0	0	0	0
Pristine[b]	++	+++	++	+++	+++	0
Scala	+++	0	0	0	0	0
In Combination						
Abound + Captan	++	+++	++	+++	+++	0[c]
Cabrio[b] + Captan[b]	++	+++	++	+++	+++	0[c]
Elevate + Captan	+++	+	++	0	++	--
*Elevate + Thiram	+++	+	++	0	+	--
Switch + Captan	+++	+	++	0	++	--
Switch + Thiram	+++	+	++	0	+	--
Topsin + Captan	+++	+	+++	+++	++	--
Topsin + Thiram	+++	+	+++	+++	++	--

* Scala will perform similar to Elevate in combination with Captan or Thiram.

Efficacy rating system: +++ = highly effective; ++ = moderately effective; + = slightly effective; 0 = not effective, ? = activity unknown.

[a] See label for harvest restrictions.
[b] Abound, Cabrio, and Pristine have good activity against leather rot.
[c] Although the preharvest interval for Captan is 0 days, protective clothing must be worn for 24 hours after application when entering the planting or harvesting fruit.
[d] Thiram can not be applied within 3 days of harvest.
[e] Always apply Topsin, Elevate, Scala or Switch in combination with an unrelated fungicide such as Captan or Thiram, or in an alternating program with a fungicide of different chemistry.

Pre-harvest Intervals and Restricted Entry Intervals (REI)* for Common Fungicides

			Pre-harvest Interval - Days					
TRADE NAMES	COMMON NAMES	FRAC CODE**	APPLE	PEAR	PEACH	CHERRY	PLUM	REI* (hours)
Adament	tebuconazole **plus** trifloxystrobin	11+3	–	–	1*	1*	–	24
Aliette	fosetyl-AL	33	14***	14***	–	–	–	12
Agri-Fos, Phostrol, ProPhyt, Topaz	phosphorous acid	33	0	0	0	0	0	4
Agri-strep	streptomycin	25	50	30	–	–	–	12
Bayleton	triadimefon	3	0	0	–	–	–	12
Bravo	chlorothalonil	M	–	–	***	***	***	48
Captan	captan	M	0	–	0	0	0	****
Captevate	captan + fenhexamid	M+17	–	–	–	0	–	24
Carbamate	ferbam	M	7	7	21	0	–	24
Dithane M-45	mancozeb	M	77***	77***	–	–	–	24
Elevate	fenhexamid	17	–	–	0	0	0	12
Elite	tebuconazole	3	–	–	0	0	–	12
Flint	trifloxystrobin	11	14***	14***	–	–	–	12
Gem	trifloxystrobin	11	–	–	1	1	1	12
Indar	fenbuconazole	3	14***	–	0	0	0	12
Inspire Super MP	difenoconazole + cyprodinil	3	72	72	–	–	–	12
Manzate	mancozeb	M	77***	77***	–	–	–	24
Mycoshield, Flameout	oxytetracycline	–	–	60	21	–	–	***
Orbit	propiconazole	3	–	–	0***	0***	0***	24
Penncozeb	mancozeb	M	77***	77***	–	–	–	24
Polyram	metiram	M	77***	–	–	–	–	24
Pristine	pyraclostrobin + boscalid	11+7	0***	0***	0***	0***	0***	12
Procure	triflumizole	3	14	14	–	1	–	12
Quash	metconazole	3	–	–	14	14	14	12
Quintec	quinoxyfen	13	–	–	7***	7***	7***	12
Rally	myclobutanil	3	14	–	7***	7***	–	24
Ridomil	mefenoxam	4	***	–	0	0	0	12
Rovral	iprodione	2	–	–	***	***	***	24
Rubigan (Vintage)	fenarimol	3	30	30	–	0	–	12
Scala	pyrimethanil	9	72	72	2***	–	2***	12
Sovran	kresoxim-methyl	11	30***	30***	–	–	–	12
Sulfur		M	0	0	0	0	0	24
Syllit	dodine	M	7	–	15***	0	–	48
Topsin-M	thiophanate-methyl	1	0	1***	1	1	1	12
Vangard	cyprodinil	9	72	72	2	2	2	12
Ziram	ziram	M	14	14	14	14	–	48

– Not registered or recommended.

* All fungicides have a REI, which is the time immediately after a pesticide application when entry into the treated area is limited. Check labels for REI; restrictions in REI may prohibit the use of certain pesticides during harvest.

** FRAC Code represents the Mode of Action of the fungicide. For fungicide resistance management, do not tank mix or alternate fungicides with the same FRAC number in the spray program. M = multi-site inhibitors

*** Limited number of applications allowed or other restrictions apply - REFER TO LABEL DIRECTIONS.

**** The REI for most formulations of Captan is 24 hr; however, some product labels still have a 4-day REI. See note on Captan REI for tree fruit on page 22.

Note on Fungicide Resistance Management

For fungicide resistance management, avoid successive applications of fungicides within the same group or with the same types of chemistry. **Strobilurin fungicides include:** azoxystrobin (Abound), trifloxystrobin (Flint or Gem), kresoxim-methyl (Sovran), and pyraclostrobin (Pristine). **Sterol-inhibiting fungicides include:** triadimefon (Bayleton), tebuconazole (Elite), fenbuconazole (Indar), myclobutonil (Rally), propiconazole (Orbit), and fenarimol (Rubigan). **Benzimidazole fungicide:** thiophanate-methyl (Topsin-M).

The following fungicides are also at risk for resistance development: mefenoxam (Ridomil Gold), iprodione (Rovral), cyprodinil (Vangard), and pyrimethanil (Scala).

The following fungicides are broad spectrum protectants and are not considered at risk for fungicide resistance development: captan (Captan), copper, mancozeb (Dithane, Manzate, Penncozeb), chlorothalonil (Bravo), metiram (Polyram), ziram (Ziram), and sulfur.

Efficacy of Selected Fungicides Against Apple Diseases

FUNGICIDE	SCAB	POWDERY MILDEW	RUST	BLACK ROT WHITE ROT	BITTER ROT	SOOTY BLOTCH	FLYSPECK
Bayleton*	P	E	E	O	O	O	O
Captan	G	O	O	G	E	F-G	F-G
Flint	E	G	G	G	E	E	E
Indar	E	E	E	O	O	G	G
Inspire Super MP*	E	E	E	–	–	G	G
Mancozeb (Dithane, Manzate, Penncozeb)	G	O	G	G	E	E	E
Polyram	G	O	G	G	E	E	E
Pristine	E	E	E	G	G	E	E
Procure*	E	E	E	O	O	O	O
Rally*	E	E	E	O	O	O	O
Rubigan (Vintage)*	E	E	E	O	O	O	O
Scala	G	–	–	–	–	–	-
Sovran	E	G	E	G	G	E	E
Sulfur	F	G	O	F	–	P	P
Syllit*	E	O	P	P	O	P	P
Topsin-M*	E	E	O	G	P	E	G
Vangard	G	–	–	–	–	–	-
Ziram	F	O	G	P	E	F-G	F-G

— = unknown or doesn't apply O = none P = poor F = fair G = good E = excellent

* Many areas of the Midwest may contain strains of the apple scab and powdery mildew fungi tolerant to these chemicals. Therefore, these fungicides may not be effective in some areas.

Efficacy of Selected Fungicides Against Stone Fruit Diseases

FUNGICIDE	BROWN ROT BLOSSOM BLIGHT	BROWN ROT FRUIT ROT	PEACH LEAF CURL	PEACH SCAB	POWDERY MILDEW	CHERRY LEAF SPOT	BLACK KNOT OF PLUM
Adament	E	E	–	E	E	E	–
Bravo	G	–	E	G	O	E	E
Captan	G	F-G	–	G	O	G	G
Captevate	E	E	–	–	–	G	G
Elevate	E	E	–	–	–	–	–
Elite*	E	E	–	–	G	G**	–
Fixed copper	–	–	G	–	F	G	P
Gem	–	–	–	E	G	E	–
Indar*	E	E	–	–	G	E**	–
Orbit*	E	E	–	G	G	G**	–
Pristine	G	G	–	G	E	E	–
Procure*	G	G	–	–	E	G**	–
Rally*	E	–	–	–	E	E**	–
Rovral	E	E	–	P	–	F	–
Rubigan (Vintage)*	–	–	–	–	G	E**	–
Quash	G	G	–	G	–	–	–
Quintec	O	O	O	O	G	O	O
Scala	G	G	–	–	–	–	–
Sulfur	F	P	–	G	G	P	O
Syllit*	–	P	–	–	O	G	–
Topsin-M*	E	E	–	G	F	G	F
Vanguard	G	G	–	–	–	–	–
Ziram	P-F	P-F	G	G	–	F	–

– = unknown or doesn't apply; O = none; P = poor; F = fair; G = good; E = excellent

* Many areas of the Midwest may contain strains of the brown rot, powdery mildew and cherry leaf spot fungi tolerant to these chemicals. Therefore, these fungicides may not be effective in some areas.

**Excellent where the leaf spot pathogen is not resistant, but only fair where sterol-inhibiting fungicides have been used extensively.

Public Garden/Master Gardener Sessions

Integrated Pest Management (IPM) as a Pest Control Strategy: Applying IPM in Your Landscape

John D. Hopkins
Extension Entomologist, Univ. of Arkansas
Division of Agriculture, Coop. Extension Service, Little Rock, AR

Powerpoint available on CD.
Integrated Pest Management or **(IPM)** as an approach to pest control is not new as records from as far back as 1200 B.C. indicate that the Chinese were controlling insect pests through hand removal followed by the burning of toxic plants as a fumigation method. IPM in US agriculture took root in the 60's & 70s and was developed as response to over-reliance and overuse of synthetic insecticides after WWII.

This over-reliance & overuse of pesticides for pest control led to 1) Selection of resistance in pest populations, 2) Destruction of beneficial species, 3) Resurgence of target pest populations, 4) Outbreaks of secondary pests, and 5) Hazards to humans and the environment.

To understand the concept of Integrated Pest Management we need to understand what a **PEST** is. A pest has no biological definition but is based on human perception. Any animal (insect / mite / nematode / etc.), plant (weed), or disease (fungal, bacterial, viral) that adversely impacts us or the things we value is a pest. In the nursery and greenhouse trade pests are capable of causing economic damage. In the landscape pest damage affects our quality of life through aesthetic impacts.

Integrated Pest Management (IPM) had been defined to fit many situations but a general overall definition is that IPM is a decision making process that anticipates & prevents pest activity & infestation by combining several tactics to achieve long term solutions.

An IPM Program consists of five basic steps: 1) Inspection / Monitoring, 2) Pest identification, 3) Establishment of an action threshold, 4) Employment of two or more control measures that are environmentally compatible and economically feasible, and 5) Evaluation of effectiveness through continued inspection and record keeping.

IPM Step 1 – Inspection: Why do we inspect or monitor for pests? We inspect to determine the location and extent of a pest problem, to note damage to the foliage, stems, and other plant parts, to determine conditions conducive to pest infestation, and to identify other items or factors that could impact the pest control program.

IPM Step 2 – Identification: The pest must be positively identified before deciding what control measures to employ in addition to when, where and how best to employ those control measures. In identifying the pest, it is important to understand pest food preferences, habitat requirements, behavioral patterns, pest life cycle and biology, and

in the case of diseases, the disease triangle (relationship among the pathogen, host, and environment.

IPM Step 3 - Establishment of Threshold Levels: From a lawn and landscape perspective, thresholds are based on aesthetics or individual tolerance to damage. The goal is not to kill every last pest out there but to manage populations/damage at tolerable levels. When the pest population density reaches this tolerance level that point is called the **Economic Injury Level (EIL)**. Another way to define the EIL is that pest density level where the cost of control equals the value of the damage inflicted. The **Economic Threshold (ET)** is another important concept of IPM. The ET is the pest population density at which control measures are implemented. The ET is always below the EIL because there is a time lapse between the discovery that a pest population has reached the ET, the actual employment of control measures, and the time it takes those control measures to stop the increase in the pest population. Establishing an ET has traditionally been based on the value of crops / plants, the amount of potential pest damage, and the cost of control.

In a landscape setting, you can determine control costs, but… it is difficult to assign a value to the economic consequences of pest infestation. A low pest infestation may be tolerated in some areas while in other areas there may be zero tolerance to pest damage. In a landscape situation, pest management decisions depend on the cost of control measures vs. perceived benefits. Thus thresholds are established based on aesthetics or individual tolerance to damage and will vary from individual to individual.

IPM Step 4 - Employment of 2 or More Control Measures: Pest control measures fall into the following categories: A. Cultural, B. Mechanical/Physical, C. Biological, D. Chemical, and E. Regulatory. Control tactics chosen should be:
most likely to produce permanent reduction of pest population
easiest to carry out effectively
most cost-effective over the short & long term
least disruptive of natural controls
least hazardous to human health
least toxic to non-target organisms
least damaging to the general environment

A. Cultural Controls: From a lawn and landscape perspective, appropriate cultural practices can affect whether pest or abiotic problems (sunscald, drought, etc.) develop. Cultural control measures include proper plant selection (resistant or tolerant varieties), fertility, watering, cultivation, & reduced competition from adjacent plants. Healthy plants are better able to withstand pest attack.

B. Mechanical / Physical Controls: These types of controls are used to help inhibit pest establishment. Examples include: greenhouse pest proofing (screens, seals, nets, caulking), use of row covers, use of traps (light, sticky, pheromone, snap & multiple catch), physical pest reduction (mowing, hoeing, or trimming), direct competition reduction through careful tillage or mulching, hand removal of pests. Also, pest

problems can be reduced by avoiding mechanical damage to plants (String trimmer wounds)

C. Biological Controls: When available or sufficiently developed, biological control strategies tend to be among the least environmentally disruptive pest control measures. Biological control is the use of parasites, predators, or pathogens to control or manage pests (Conservation, Augmentation, Importation). Examples include: release of phorid flies for fire ant suppression, release or conservation of lady beetles for aphid control, and use of *Bacillus thuringiensis* (*B.t.*) for caterpillar control, however the EPA considers *B.t.* a chemical control measure.

D. Chemical Controls: When developing an IPM program, chemical control measures should be the last consideration. However, being last does not imply that pesticides aren't an important component of an IPM control program. Often, a pesticide will have to be the first control strategy used because of the immediate need to significantly reduce or eliminate a pest population. Chemical control measures should be thought of as only one of several control measures available

E. Regulatory Controls: The easiest way to prevent a pest problem is simply to not allow the pest to become established. In other words, **don't import your problem**. This is particularly important for exotic / invasive pest species. It is much more difficult to eliminate exotic pest populations after they become well established because after they get here they lack their natural compliment of natural enemies that helped keep the pest in check in its home range. Federal and state agencies can and often do place quarantines on certain exotic pests to prevent their spread into other areas of the state or country. Invasive species examples: red imported fire ant, gypsy moth, emerald ash borer, sudden oak death, thousand cankers d***isease,*** spotted knapweed, kudzu

IPM Step 5 - Evaluation of Effectiveness: The final step in an IPM strategy is an evaluation of control measure effectiveness. Follow-up monitoring allows for assessment & adjustment of control measures. Why monitor?:
To determine effectiveness of previous practices
To identify new or overlooked pest problems
To enhance pest management effectiveness
To identify a need to reapply or revise any previous pest management procedures
To develop accurate records and enhance your pest management knowledge base.

Contact your local County Extension Agent with IPM questions or
University of Arkansas Extension Specialists:
John Hopkins - Extension Urban Entomologist - (501) 671-2000
Janet Carson - Extension Horticulturist - (501) 671-2000
Steve Vann - Extension Urban Plant Pathologist - (501) 671-2000
John Boyd - Extension Weed Specialist - (501) 671-2000

Sherrie Smith - Plant Disease Clinic – (479)-575-2727

Garden Based Learning in Elementary Schools

Mark Bray
County Extension Agent, Agriculture
Benton County, AR

Powerpoint Presentation available on CD.
Slide 1: This presentation is designed to provide you with theory and practice. School gardens are all about theory and practice. Children get theory, or book learning in the classroom and practice in the garden. The garden serves as a learning space where application of theory creates a tangible reality of the learning experience.

Slide 2: History of school gardens in US; GBL theoretical framework, Model school garden

Slide 3: School gardens are kinda like courdory pants. They've always been popular but from time to time we see a resurgence of interest in them.

History: 1891 Henry Lincoln Clapp sent to Europe to study school gardens.
Installed 1st school garden in America at George Putnam School in Roxbury, MA. This launched national movement—by 1918 every state in America had a school garden (Sealy, 2001).
Over 1 million students contributed to food production during WWI.
After WWII school gardens declined—playgrounds and athletic fields took over garden plots and schools focused on technology.
Second wave – 1964-1975 occurred in response to environmental movement; however didn't' take roots due to conservatism of 1980s.
1990s – move towards more innovative education methods: experiential and environmental education combined with an interest in agricultural literacy.
First Lady, Michelle Obama's Let's Move Initiative -- Headline from NGA web site: **First Lady Michelle Obama Really Digs Kids Gardening,** NGA President Mike Metallo Remembers Kitchen Garden Season Kick-Off

Slide 4: Garden-Based Learning (GBL) GBL defined: instructional strategy that utilizes a garden as a teaching tool

Slide 5: Role of GBL in education
Provides experiential education in support of traditional curriculum.
Hands on learning
Provides model for child's outdoor landscape
3 realms of child's learning experience (Moore and Young, 1978)
Physiological/Psychological environment of body/mind
Sociological environment of interpersonal relations
Physiographic landscape of spaces, objects, persons, natural and built elements.

Slide 6: School Garden Benefits
Create opportunities to discover origins of food and encourage healthier choices
Gardens offer dynamic setting to integrate disciplines of science, math, language arts, history, social studies, and art
Encourage stewardship of earth
School gardens nurture community spirit and provide opportunities to build bridges among students, staff, families, local business, community based orgs.
School gardens create link to sustainable food systems.

Slide 7: Breaking Ground on a School Garden Project
Organize a garden committee/support base
Call your county extension agent/master gardeners
Select a garden site
Design the garden
Develop a budget/cost analysis
Fundraising/partnership development
Coordinate work days

Slide 8: Keys to Success
Support from administration
Leadership from teachers
Community support
Focus on education
Developed in phases
Appropriate site
Strategic partnerships

Slide 9: Local GBL Model for School Gardens
R.E. Baker Elementary, Bentonville, AR

Slide 10: Strategic Partnerships
The Farm is a sustainable agriculture system designed to:
Grow food to supplement community hunger relief efforts
Create sustainable community supported agriculture systems
Provide an educational resource for agricultural development
Develop training and education programs for schools
Provide self-sustaining/funding models for economic development
Engage a community into the practice of growing food

Slide 11: The Farm/R.E. Baker Gift Card Program
Impacts
Harvested 3500 lbs of produce
Sold $1500 of produce at farmers market
Donated +1400 lbs of produce to local charities
Raised $47K in grant support
Implemented food voucher system for 65 elementary kids.
Logged 850 volunteer

Slide 12: References

Desmond, Daniel et al. Garden based learning in basic education. International Institute for Educational Planning. www.unesco.org/iiep

Sealy, M.R. 2001. A garden for children at Family Road Care Center. Graduate faculty of Louisiana State University and Agricultural Mechanical College: School of Landscape Architecture

Association for Experiential Education. 2002. Web site: www.aee.org

Moore, R., Young, D. 1978. "Childhood outdoors: toward a social ecology of the landscape". In : I. Altman; J.F. Wohlwill (Eds.), children nad the environment. New York, London: Plenum Press.

Slide 13: Resources

National Gardening Association http://www.garden.org/ , http://www.kidsgardening.org/grants.asp

Fiskars, Project Orange Thumb http://www2.fiskars.com/Activities/Project-Orange-Thumb

Lowe's Toolbox for Education http://www.toolboxforeducation.com/

Bonnie's Plants http://www.bonnieplants.com/

America the Beautiful Fund http://america-the-beautiful.org/free_seeds/index.php

Gardening With Native Plants

Corrin Troutman ACNLP
Director of Horticulture & Foundation Gardens
The Peel Compton Foundation

Powerpoint Presentation
Slide 2: Native plant – plants that are indigenous to a region
Slide 3: Reasons to use Native Plants
Low maintenance – if planted in the right place. No fertilization needed and disease resistant
Slide 4: Drought tolerant – usually only have to water until they are established
Slide 5: Soil – they help to improve the soil and prevent soil erosion
Slide 6: Wildlife – attract more wildlife such as bees, birds and butterflies
Slide 7: Setting – Can be used in a formal or informal setting
Slide 8: Missouri Primrose, *Oenothera macrocarpa*
Slide 9: Bluestar, *Amsonia* spp.
Slide 10: Purple Coneflower, *Echinacea purpurea*
Slide 11: Bllue False Indigo, *Baptisia australis*
Slide 12: Columbine, Aquilegia canadensis
Slide 13: Celandine Poppy, *Stylophorum diphyllus*
Slide 14: Dwarf Crested Iris, *Iris cristata*
Slide 15: Witchalder, *Fothergilla gardenia*
Slide 16: Red Buckeye, *Aesculus pavia*
Slide 17: American Smoketree, *Cotinus obovatus*
Slide 18: Yellowwood, *Cladrastis kentukea*
Slide 19: Books

Wildflowers of Arkansas Carl Hunter
Trees & Shrubs of Arkansas Carl Hunter
Ozark Wildflowers Don Kurz
Last Child in the Woods Richard Louv
Bringing Nature Home Dr. Douglas W. Tallamy
Growing and Propagating Wildflowers William Cullina
Native Ferns Moss and Grasses William Cullina
Native Trees, Shrubs and Vines William Cullina
Gardening with Native Plants of the South Sally Wasowski
Native American Medicinal Plants An Ethnobotanical Dictionary Daniel E. Moerman
Native American Ethnobotany Daniel E. Moerman

Youth Gardening

Julie D. Treat
Horticulture Program Technician

Powerpoint available on CD.

Slide 2: Why garden with kids
Slide 3: What kind of gardening program?
Slide 4: How many times will you meet?
Slide 5: You can't do it along.
Slide 6: Choose the curriculum
Slide 7: What supplies will you need?
Slide 8: Who can you partner with?
Slide 9: Train your volunteers
Slide 10: . . .
Slide 11-12: Raised Beds
Slide 13: Paperwhites
Slide 14: Hands-on approach to learning
Slide 15: Have fun in the Garden
Slide 16: Water Conservation – Create Rain barrels
Slide 17: Living Wreaths
Slide 18-19: Think seasonality
Slide 20: Think Education
Slide 21-23: Plant Sales
Slide 24: Think of ways to make it interesting
Slide 25: Boone County
Slide 26-27: Themed Gardens
Slide 28: You have larvae and adults.
Slide 29: Themed Gardens: Prehistoric
Slide 30: Herb Garden at school for the blind
Slide 31: Harry Potter Garden
Slide 32-34: Alphabet Garden
Slide 35: Outdoor Classrooms
Slide 36: Gibbs/Dunbar School Garden
Slide 37: How can your youth garden program impact the community?
Slide 38: Youth Gardening Resources
Slide 39: Public Awareness
Slide 40: Demonstrations
Slide 41-43: Garden Fairs and Events
Slide 44: Science Fairs
Slide 45: Think Safety
Slide 46-49: Be creative, have fun, think big & small
Slide 50: Start them young on a lifetime journey!

An Update on Crystal Bridges

Scott Eccleston
Crystal Bridges, Manager
Bentonville, AR

Crystal bridges Museum of American Art is currently under construction in Bentonville, Arkansas. The museum is being designed by the world famous architect Moshe Safdie. Once built, the museum will be the home of world class paintings, works on paper, and indoor and outdoor sculpture. The museum grounds are the home of 130 acres of native species of flora and 4 miles of trails. The grounds and trails will be interpreted by trail volunteers that are being trained by the Master Gardening programs of Northwest Arkansas. The current installations are being supervised by Scott Eccleston who is the Director of Grounds and Trails for Crystal Bridges Museum of American Art.

Welcomes all to celebrate the American spirit in a setting that unites the power of art with the beauty of landscape. We explore the unfolding story of America by actively collecting, exhibiting, interpreting and preserving outstanding works that illuminate our heritage and artistic possibilities.

Values:

- We believe in a great museum's power to transform individuals and communities
- We encourage engagement between people and works of art
- We foster meaningful and relevant experiences for each guest
- We perpetuate the honored tradition of sharing and hope to inspire others to give

What is Crystal Bridges? Crystal Bridges Museum of American Art
Architecturally significant complex of buildings

- Over 100,000 s.f.
    - Art galleries
    - Library
    - Education spaces
    - Dining and function spaces
    - Set within a new public park

Tourist Destination

- 3 miles from I-540
- 10 blocks from the Bentonville Town Square

Trails and Grounds

- Design and Build trails that will excite the visitor's imagination, encompass the history of this land, and embody the spirit of this great museum.

Plants

American Yellowwood, *Cladrastus kentukea*
American Beech, *Faagus grandifolia*
Whiteshield Osage Orange, *Maclura pomifera*
Nuttall Oak, *Quercus nuttalli*
Summer Wine Ninebark*, Physocarpus opulifolius* 'Seward'
American Hophornbeam, *Ostrya virginiana*
Common Pawpaw, *Asimina triloba*
Maidenhair Fern, *Adiantum pedatum*
Jack-in-the-pulpit, *Arisaema triphyllum*
Snakeroot, *Cimiguga racemosa*
Mayapple, *Podophyllum peltatum*
Celandine Poppy, *Stylophorum diphyllum*
Trillium, *Trillium grandiflorum*
Lurid Sedge, *Carex lurida*

"We conceive of architecture as a natural extension of its surroundings, urban or rural, ancient or entirely new, and recognize its responsibility to contribute richly to its setting and enduringly to its community." —Moshe Safdie & Associates

Bio:

Scott Eccleston was born in Bartlesville, OK and started in the landscape business at age 14. At the age of 17, he became the manager of grounds and was responsible for maintaining the Phillips Petroleum campus in Bartlesville.

In 1993, Scott received a Bachelor of Landscape Architecture from Oklahoma State University and completed his internship from the National Park Service at Indiana Dunes National Lakeshore. From 1994 - 2008 Scott owned and operated a landscape design build company in Northwest Arkansas. Scott moved on to become the landscape consultant for Crystal Bridges Museum of American Art until December 2008. Starting

January 1 2009, he became the Manager of Parks and Grounds for Crystal Bridges Museum of American Art and project manager for the Crystal Bridges Skyspace " Way of Color"

Botanical Garden of the Ozarks

Gerald Klingaman
Director of Operations

Botanical Garden Facts:

- Incorporated 1994, construction begun 2004, opened officially Oct. 2007
- 84 acre garden abuts Lake Fayetteville and is secured by a 100 year lease
- 1400 memberships, most family memberships
- 30,000 visitors in 2009 from 37 states and 5 countries.
- 5,000 students/teachers attended BGO environmental and educational programs.
- Incorporated 1994, construction begun 2004, opened officially Oct. 2007
- 84 acre garden abuts Lake Fayetteville and is secured by a 100 year lease
- 1400 memberships, most family memberships
- 30,000 visitors in 2009 from 37 states and 5 countries.
- 5,000 students/teachers attended BGO environmental and educational programs.

BGO Income in 2010

- Venue rentals 13%
- Events & sponsorships 17%
- Gate receipts 7%
- Memberships 12%
- Educational programming 3%
- Grants (Foundations & Corporate) 23%
- Donations 25%

Botanical Garden Recognition

- Certified Teacher Education Center
- Certified Wildlife Habitat
- Certified Monarch Butterfly Way-station

Botanical Garden of the Ozarks

- Nine demonstration gardens showing woody, herbaceous, and exotic plant species represented in Northwest Arkansas. Gardens: Sensory, Ozark native, Shade, Four Seasons, Children's, Vegetable & Herb, Japanese, Rock & Water, and Rose & Perennial

Featured Events 2011

- Greening of the Garden – May 12
- Firefly Fling – July 16
- Chefs in the Garden – September 15
- Bar & Grill – TBD
- Gardenland Express – December 5

Focus of the Garden

- Promoting garden sustainability
- Protecting the environment
- Providing education

Educational Activities

- Little Sprouts
- Nine week summer day camp for 2nd to 5th graders
- Earth Day
- Butterfly Day

Garden Volunteers

- 197 Volunteers donated 7,300 hours of work valued at $135,000+

Garden Impact

- 2010 Economic Impact on Northwest Arkansas: $3,018,633

Growing the Garden: The Botanical Garden of the Ozarks has grown in beauty and in activity but a great deal needs to be done to continue its growth.

- Additional fencing
- Complete Reading Railroad
- Butterfly House and Gazebo
- Install Garden Lighting
- Plan for Education Pavilion
- Plan stream/ Nature trail development

Contact Information

- Ron Cox, Director
- Botanical Garden of the Ozarks, PO Box 10407, 4703 North Crossover Road, Fayetteville, AR 72703; phone 479-750-2620; Email: rcox@bgozarks.org
- Gerald Klingaman, gklingaman@bgozarks.org ; phone: 479-445-7835

Planning Now for Summer Time Watering Needs

Mark Brown
University of Arkansas Division of Agriculture
Pulaski County Extension Agent

Mark Brown has been an Extension Agent since April 2010 specializing in outdoor water conservation and turfgrass management. He received his Bachelor of Science in Turfgrass Science from University of Arkansas Fayetteville 2005, and is currently graduate student in Agriculture Education at University of Arkansas. He has experience in golf course and sports field management.

Topic: Planning for Summertime Watering Needs
Discuss the difference in an in-ground sprinkler system and garden hoses. How to reconnect your sprinkler system after the winter is over. What to look for as you run your sprinkler system and problems that might have developed during the winter that can greatly affect the performance of your system. Understand how a sprinkler system works and the parts that a homeowner needs to understand. Talk about how the weather of spring and summer can affect your plants. Helpful hints on how to maximize the most out of what water you put on your landscape. Renovation projects and what the homeowner need to know when selecting a sprinkler project.

Powerpoint available on CD.
Planning Now—Watch the weather . . .only water when it is necessary

- Make sure your home irrigation system is in good working order (in-ground or hose) before you plant in the spring.
- Timing is very important in spring and summer watering.
- Maintaining the health of your plants in the summer time without overwatering.

Spring Hook Up—What to look for when inspecting your meter.

- Re-connecting the backflow preventer and checking the meter.
- Why we check for leaks: broke pipes, values, blocked heads.

Why we check our sprinkler system:

- Pipes and equipment in the ground get old and need to be replaced..
- Have plants with similar water needs on the same zone.
- Replace your nozzles with the same or what type you need
- New controller or a rain sensor
- Hose timers and soaker hoses

Calibrating your system

- Place 5-10 straight sided containers in a zone
- Run zone for set time
- Measure how much water in containers

- Calculate and adjust runtimes for desired amount

Spring time watering

- Summer is more predictable you can water more on a schedule. Spring the weather can change, your plants will tell you when they need water.
- Because more rainfall, late spring the weather can change
- A spring rain of ¼ inch will last a week in early spring
- In summer that same amount will only last a day or two
- Remember rainfall is the best watering

Why we water?

- The goal of watering is to establish and maintain a healthy plant in our climate.
- New plants need to be watered more often during establishment. Water at the base of the plant. Hand water where needed
- To water or not to water?? Check soil moisture level. Overwatering can be more damaging then under watering!! Have a rain gauge!!

Water tips for landscape plants and turf

- Group plants with similar water needs
- Use drought resistant plants
- Always use mulch!! Holds moisture in
- Train your turf to be more drought resistant
- Water infrequently and deep
- Always try to water in early morning: avoid peak demand time
- Don't water leaves in full sun ultraviolet rays can burn the leaves.

In ground or hose

- In ground systems are more efficient, save water and time.
- Hoses are less expensive on the front end.
- Always have a separate meter. See you local water co.
- Finding a Contractor? Be careful!!
- www.rainbird.com and www.hunterindustries.com

Resource

- http://www.uaex.edu/ – click on the sprinkler (water Conservation)
    - Drought Tolerant Plants
    - Home Lawns – Water Conservation
    - Home Irrigation System Overview – Water Conservation
    - Tips for Landscaping – Water Conservation

Vegetable Sessions

Experiences in Developing a Fruit/Vegetable Niche Market

C. Robert Stark, Jr. and Paul B. Francis
Southeast Research & Extension Center, University of Arkansas at Monticello, Monticello, AR

ABSTRACT – Presented at 30th Annual Horticulture Industries Show
Fort Smith, AR – January 14-15, 2011

Niche markets have become a popular pursuit in recent years with the growing popularity of local fruit/vegetable products. Successfully developing niche markets requires several key elements. This presentation outlines our experiences in developing a niche market for heirloom tomatoes through seven basic steps. The process should be readily adaptable to other fruits/vegetables. By following the steps in this presentation, persons interested in developing a niche market can hopefully avoid costly mistakes and increase their probability of success.

Powerpoint available of this session found on the CD.

End Wall Design and Construction Considerations for High Tunnel Hoop Houses

Steve Upson
The Noble Foundation
2510 Sam Noble Parkway
Ardmore OK 73401
(580) 223-5810
sdupson@noble.org

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 22 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.

As a consultant with the Noble Foundation, I routinely receive calls from growers requesting information on hoop house construction. It has been my experience that most folks have the ability to erect a hoop house that will meet their growing requirements and give them many years of service if they plan adequately in terms of what they need in a structure and pay attention to detail when erecting the hoop house. In a survey of Oklahoma and Texas market gardeners conducted by the Noble Foundation in 2007, thirty-two percent of growers using hoop houses erected custom made structures. Thirty-nine percent of the respondents purchased a commercial structure. Of the 34 structures erected by growers participating in the survey, both commercial and custom made, 30 were equipped with custom designed end walls or commercial end wall packages that had been modified by the grower. End wall installation was also rated as the most challenging and time consuming activity of hoop house construction.

One complaint growers often voice when shopping for a commercial hoop house structure is that many do not come equipped with functional end walls. Some merchandisers offer functional end wall packages as optional in order to keep the cost down. Another reason many merchandisers are hesitant to offer a one size fits all end wall package is because in the real world of hoop house production, one size doesn't fit every growers needs. Depending on location, the type of house being used, permanent or movable, and the crops being grown, end wall requirements can vary greatly. Before you commit to a particular end wall design, make sure you have the required skill set and help to construct the end wall. Basic carpentry skills, including the use of a carpenter's level, are needed to install a permanent end wall. On large end walls, two or three people will be needed to install structural members.

Also, don't underestimate the material cost to construct a set of end walls. Up to fifty percent of the cost of a hoop house can be tied up in well constructed end walls. When designing an end wall, there are several points to consider including structure type (permanent or movable), accessibility requirements and the size (surface area) of the end wall.

Movable structures are typically equipped with detachable end walls or end walls that are securely attached to the frame permitting the entire structure to move as one unit. Most permanent structures are equipped with stationary end walls but a few are equipped with end walls that can be detached to permit equipment access. Portable end walls are typically small in size and are anchored using removable ground stakes, a base plate and bracing or a combination of the three. Construction plans for a portable end wall that can be used in combination with a permanent or movable hoop house can be obtained from the Noble Foundation. Our portable end wall uses a base plate for anchorage and back braces for stabilization.

If you plan on using cultivating equipment and/or a bedding machine in a hoop house equipped with stationary end walls, make sure access points are wide and high enough to accommodate the equipment. To make entering and exiting the structure more convenient, both end walls should be designed for drive through capability.

A 36-inch wide door provides just enough access for most hand operated equipment including tillers, back pack sprayers and garden carts. At the Noble Foundation, our permanent houses are equipped with permanent raised beds making the need for tractor operated equipment unnecessary. In retrospect, installing a 40-inch wide door or better yet, a 4-foot wide door would have provided a little more clearance when moving in and out of the structures with hand held equipment and supplies.

If you ever anticipate growing in large containers, the use of a motorized utility vehicle such as a "Gator" or "Mule" makes moving containers in and out of the house much easier. At the Noble Foundation, we have used 15-gallon containers to produce a wide array of hoop house vegetable crops. A common practice involved alternating between two sets of containers to eliminate any down time between crops. We used our Gator to move one set of containers out of the house and replace them with a second set of containers planted to a later crop. The pedestrian door located at the center of the house is too small to accommodate the Gator so we designed the end wall with two 7-foot wide removable panels on either side of the door. These panels, present on both end walls, permit easy drive through access making container change out much easier and less time consuming.

As a general rule, the larger the end wall, the larger the structural member requirement to compensate for greater wind loads. On structures 14 feet or less in width, two columns comprised of laminated 2-inch by 4-inch lumber will provide sufficient structural support to withstand most storms. On structures over 14 feet in width, I recommend using 2-inch by 6-inch laminated columns. At the Noble Foundation, the end walls on one of our original 20-foot wide houses is equipped with four columns comprised of laminated 2-inch by 6-inch lumber. This arrangement not only imparts additional

strength but serves as a frame for the removable panels on each end wall. This house has not incurred any wind damage in over 10 years of service!

Growers have several options when choosing materials to frame end walls. Dimensional lumber remains the number one choice as it is readily available and is easily worked. Other materials include steel tubing (square and round), angle iron, and steel C-purlin. To save money, some growers tamp soil around end wall support columns during installation. While this may prove satisfactory on small structures, I recommend the use of concrete for setting columns on larger structures. To provide stability under adverse conditions, plan on setting columns at a depth of three feet.

Because portable end walls do not use columns anchored in the earth, they must rely on the use of braces to provide stabilization. Rigid braces made from wood or pipe can be attached to the back (interior) side of the end wall to provide stabilization. The Noble Foundation's portable end wall uses rigid back bracing for stabilization.

Rope bracing is another effective method of stabilizing portable end walls. Rope attached to the front side of the end wall along the other edge and coupled to auger style earth anchors is a quick and inexpensive method of stabilization.

There are a few downsides associated with braces. Any brace that extends out from the end wall presents a tripping hazard. Depending on the length of back braces, they can consume valuable production space. Also, depending on how your door is configured, rope bracing can interfere with the operation of the door.

Several materials are available to clad end walls including, from the most expensive to the least, polycarbonate, PVC, woven "rip stop" poly fabric and standard greenhouse poly film. The rigid polycarbonate and PVC panels are excellent choices for stationary end walls. Because it resists puncturing, a problem often incurred when moving end wall frames, woven poly fabric is my choice for covering portable end wall frames and door panels.

Growers can choose from a bevy of custom made door designs. Hinged doors remain the most popular. Styles of hinged doors include single sided (single door), double sided (double doors) and top hinged (old style garage door). Penn State University uses a top hinged design on their hoop houses. Plans for this design can be accessed at http://plasticulture.psu.edu. The Noble Foundation portable end wall uses a double sided design which utilizes chain link fence hanger bolts as hinges for the removable door panels.

One word of caution if you purchase a prefabricated door for your hoop house; you get what you pay for. If at all possible, avoid cheap storm doors equipped with plastic hinges. It has been our experience that with heavy use the hinges will break and the kick plate will be knocked out within a year.

Other door designs include the sliding door and the scissor door. A sliding door incorporates the use of track located at the top, bottom or top and bottom of the door frame. The top track mounted model is the most popular with growers as the track is less likely to get plugged with debris.

The scissor door is a simple design consisting of two, equal length pieces of metal tubing each of which is connected at one end to the top of the end wall frame. The two pieces of tubing, oriented side by side, are attached loosely to the frame allowing both tubes to move out and away from each other at the base in a scissor motion opening the door. The end wall poly film cover is cut down the middle from top to bottom and the cut ends attached to the tubing. Because this design does not incorporate the use of a true door frame for stability, it is better suited for use on small, low profile structures.

The simplest door design (it's a stretch to call it a door) I've ever seen used on a hoop house consists of a rectangular piece (flap) of poly film permanently attached along the top of the door frame. To enable the sides of the flap to be attached and detached from the door frame, fabric clips are fastened along both edges of the flap at 1-foot intervals. The clips are placed over nails or screws inserted into the side (upright) members of the frame. The nail or screw heads prevent the clips from detaching without using your hands. I refer to this design as the "Israeli" door because I first saw it in use during a recent trip to Israel.

In the southern Great Plains, growers erecting large, permanent hoop houses should incorporate some type of venting into stationary end walls. The more venting you can provide, the less heat stress your crops will be exposed to. Because heat rises, emphasis should be given to locating vents as high on the end wall as possible. At the Noble Foundation, all of our permanent houses are equipped with wing vents located above the pedestrian doors.

Call or email me for additional information on hoop house end wall design and construction.

Oklahoma Pumpkin Trial: A Look at Hybrids and Open Pollinated Types

Lynn Brandenberger, Brian Kahn, Lynda Carrier, and Robert Havener
Oklahoma State University and Bixby Research Station

Introduction and Objectives: Pumpkin is a seasonal crop that is very popular in the U.S. in the fall. Fall pumpkins are normally planted in June and harvested in late September and early October in Oklahoma. Several challenges are involved in growing pumpkins including pest control issues such as weed, insect, and disease control. One key concern is the control of plant viral diseases such as cucumber mosaic virus (CMV), squash mosaic virus (SqMV), and watermelon mosaic virus-2 (WMV-2). Another concern is powdery mildew, an important fungal disease that can cause extensive early defoliation. The trial at Bixby was designed to observe not only performance characteristics (yield, fruit quality, color) of hybrid and open-pollinated varieties, but also to observe trial entries for tolerance or resistance to plant diseases.

Materials and Methods: Field preparation included deep tillage of the plot area and creating raised free-standing beds for planting with a bed shaper. All plots were hand seeded on 6/21/10 on top of the non-mulched raised beds with 15ft. bed centers and a finished plant spacing of three feet between plants in the 24ft. long plots (8 plants/plot). Strips of sorghum x sudan haygrazer were planted between raised beds on 6/22/10 as windbreaks and to aid in virus control. The windbreaks were mown three times during the season to a height of 2 ft. to reduce competition with the pumpkin crop. All pumpkin plots received a tankmix of preemergence herbicide including Sandea (halosulfuron) at 0.032 lbs. active ingredient (ai/acre) per acre and Curbit (ethalfluralin) at 0.56 lbs ai/acre on 6/22/10. Immediately following the herbicide application the experimental area received 0.5 inches of water via an overhead irrigation system. Plots received a total of 110 lbs. of nitrogen per acre from 46-0-0, 75 lbs/acre on 7/16/10 and 35 lbs/acre on 8/02/10. Insect and disease control consisted of applications of both insecticide and fungicide on 10 to 14 day intervals. Crop water needs were met using regular scheduled irrigations from the overhead linear irrigation system.

Results and Discussion: Cultivars were organized into five groups. Each group was relatively comparable in average weight per fruit, and included at least one hybrid cultivar.

Group 1: Within Group 1, ‘Baby Pam’ usually was statistically comparable to ‘Touch of Autumn’, but the handles on ‘Baby Pam’ were longer, thicker, and tan. A concern with ‘Baby Pam’ was lack of early seedling vigor. ‘Touch of Autumn’ beat every other entry for number of fruit per acre on a trial-wide basis (Table 2). Its fruit were relatively uniform and very attractive, showing a nice contrast of orange skin and green handles. The edge in this group definitely went to the hybrid ‘Touch of Autumn.’

Group 2: The three entries here were distinct from each other. ‘Small Sugar’ matched the hybrid ‘Orange Smoothie’ for yield, although it was less uniform in appearance.

‘Small Sugar’ is a classic pie pumpkin and appearance is less of a concern. ‘Orange Smoothie’ showed why it was chosen as an All-America™ winner. It had a relatively high yield of smooth, attractive fruit that would be ideal for painting. ‘Winter Luxury’ had a unique appearance, with a rough white netting, almost like a netted muskmelon. Perhaps because of this trait, it seemed to be more susceptible to damage from pickleworms attacking the rind. It is another classic pie pumpkin, and it had better uniformity than ‘Small Sugar’ (Table 4).

Group 3: ‘Orange Bulldog’ was unique in that it belongs to a different species (*Cucurbita maxima*) from the other entries. It is not yet a pure line and it showed a lot of genetic variation for fruit size, fruit shape, and rind color. It was bred for virus resistance and it also appeared to have some tolerance to powdery mildew (Table 1). It could be a novelty that would attract attention in a display. However, none of the fruit would ever be mistaken for a *Cucurbita pepo* jack-o-lantern-type pumpkin, even though some were pinkish-orange with a flattened globe shape. ‘Tom Fox’ was not especially impressive overall, and was generally inferior to the hybrid ‘Charisma’ within this group. ‘Charisma’ was vigorous and produced the (numerically, not statistically) highest weight of fruit per acre on a trial-wide basis. It showed some early tolerance to powdery mildew, but the tolerance did not hold up into early October (Table 1). Still, it easily was the best overall performer in this group.

Group 4: With average weights per fruit ranging from 10.5 to 13.3 lbs., pumpkins in this group would be versatile in ultimate use. ‘Magician’ showed some tolerance to powdery mildew (Table 1) and had good fruit uniformity (Table 4). ‘Howden’ and ‘Trojan’ were statistically comparable to ‘Magician’ in many traits and would be good open-pollinated alternatives in this group, with perhaps a slight edge to ‘Trojan’ for yield (Table 3). ‘Wolf’ may have been at a yield disadvantage, because extra space was not provided for it as recommended. It had rank vine growth and late maturity, as per its catalog description. We would hesitate to recommend ‘Wolf’ except as a specialty item for growers with a market for a pumpkin with huge, distinctive handles.

Group 5: The two pumpkins in this group had relatively low numbers of fruit per acre (Table 2), but within the group, ‘Mustang’ beat ‘Gold Rush’ (Table 3). ‘Mustang’ showed good tolerance to powdery mildew (Table 1) and had a good, uniform orange color (Table 4). ‘Gold Rush’ had the largest fruits on a trial-wide basis (Table 2). The handles on ‘Gold Rush’ were nearly as thick as those on ‘Wolf’ (Table 4), although they were shorter (data not presented). A few ‘Gold Rush’ fruits had poor color, possibly due to virus infection, and further trials would be needed before deciding whether or not it would be recommended.

Table 1. 2010 Pumpkin Variety Trial, Bixby, OK

Cultivar	Hybrid/ Open Poll.	Source	Stand 7/27/2010	% Powdery mildew infection 7/27/2010	% Powdery mildew infection 10/5/2010[y]	% Defoliation 10/5/2010[y]
Baby Pam	O.P.	Seedway	10.0 a[z]	48 b-f	85 a-b	46 a-c
Touch of Autumn	Hybrid	Seedway	9.0 a	42 c-f	58 c-d	36 b-c
Small Sugar	O.P.	Willhite	9.7 a	75 a-b	92 a	75 a
Orange Smoothie	Hybrid	Twilley	9.0 a	55 a-e	87 a-b	51 a-c
Winter Luxury	O.P.	Johnny's	8.7 a	80 a	95 a	82 a
Orange Bulldog	O.P.	UGA	9.0 a	28 e-f	39 d	22 c
Tom Fox	O.P.	Johnny's	9.3 a	68 a-c	88 a-b	53 a-c
Charisma	Hybrid	Johnny's	8.0 a	30 e-f	82 a-b	50 a-c
Magician	Hybrid	Seedway	7.0 a	32 e-f	56 c-d	18 c
Howden	O.P.	Willhite	7.3 a	63 a-d	93 a	62 a-b
Wolf	O.P.	Seedway	7.7 a	40 d-f	69 b-c	30 b-c
Trojan	O.P.	Seedway	8.3 a	53 a-e	81 a-b	51 a-c
Mustang	Hybrid	Seedway	8.3 a	22 f	39 d	18 c
Gold Rush	O.P.	Seedway	8.3 a	47 c-f	84 a-b	49 a-c

[y] Powdery mildew and defoliation ratings on 10/5/2010 rated by Dr. John Damicone.
[z] 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 2. 2010 Pumpkin Variety Trial, Bixby, OK

Cultivar	Average weight per fruit (lbs.)	Number of fruit per acre	Weight of fruit per acre (lbs.)
Baby Pam	1.8 i[z]	3509 b-d	6272 d
Touch of Autumn	1.9 h-i	5364 a	10346 c-d
Small Sugar	3.0 g-i	3791 b-c	11261 c-d
Orange Smoothie	3.8 g-h	4033 b	15387 a-d
Winter Luxury	4.3 g	2501 c-f	10918 c-d
Orange Bulldog	8.1 f	2743 b-e	22199 a-b
Tom Fox	8.5 f	1331 f-g	11156 c-d
Charisma	9.0 e-f	2743 b-e	25483 a
Magician	10.5 d-e	2178 d-f	23135 a-b
Howden	12.2 c-d	1170 f-g	14226 b-d
Wolf	12.7 c	484 g	6179 d
Trojan	13.3 c	1452 e-g	19320 a-c
Mustang	15.3 b	1533 e-g	23861 a-b
Gold Rush	19.2 a	807 g	15117 a-d

[z] 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 3. 2010 Pumpkin Variety Trial, Bixby, OK

Cultivar	Average weight per fruit (lbs.)	Number of fruit per acre	Weight of fruit per acre (lbs.)
Group 1			
Baby Pam	1.8 a [z]	3509 a	6272 a
Touch of Autumn	1.9 a	5364 a	10346 a
Group 2			
Small Sugar	3.0 b	3791 a	11261 a
Orange Smoothie	3.8 a	4033 a	15387 a
Winter Luxury	4.3 a	2501 a	10918 a
Group 3			
Orange Bulldog	8.1 a	2743 a	22199 a
Tom Fox	8.5 a	1331 b	11156 a
Charisma	9.0 a	2743 a	25483 a
Group 4			
Magician	10.5 b	2178 a	23135 a
Howden	12.2 a-b	1170 b	14226 a-b
Wolf	12.7 a	484 b	6179 b
Trojan	13.3 a	1452 a-b	19320 a
Group 5			
Mustang	15.3 a	1533 a	23861 a
Gold Rush	19.2 a	807 b	15117 a

[z] Numbers in a column (by group) followed by the same letter exhibited no significant differences based on Duncan's Multiple Range Test where P=0.05.

Table 4. 2010 Pumpkin Variety Trial, Bixby, OK

	Uniformity ratings[x]			Circumference [y]		Fruit Shape [y]	
Cultivar	**Size**	**Shape**	**Color**	**Ped. (in.)**	**Fruit (in.)**	**Height (in.)**	**Width (in.)**
Group 1							
Baby Pam	2.7 b [z]	3.7 a	3.3 a	2.1 a	15.6 a	3.6 a	4.6 a
Touch of Autumn	3.8 a	5.0 a	4.3 a	1.6 b	15.0 a	3.9 a	4.4 a
Group 2							
Small Sugar	2.5 b	3.0 b	2.5 a	2.2 b	17.7 a	4.9 c	5.3 a
Orange Smoothie	3.7 a	4.2 a	4.0 a	2.6 a	20.1 a	5.9 a	5.8 a
Winter Luxury	3.7 a	3.8 a	2.8 a	2.1 b	20.3 a	5.3 b	5.8 a
Group 3							
Orange Bulldog	1.8 a	1.2 b	1.0 a	1.7 b	28.5 a	7.0 a	8.1 a
Tom Fox	2.7 a	2.3 b	2.2 a	3.5 a	26.8 a	7.3 a	7.3 a
Charisma	3.3 a	4.2 a	3.3 a	3.0 a	29.7 a	7.8 a	8.3 a
Group 4							
Magician	4.0 a	3.8 a	4.2 a	4.4 b	30.3 a	9.1 a	8.2 a
Howden	2.7 a	2.2 a	2.2 b	3.6 b	27.8 a	10.6 a	8.0 a
Wolf	3.0 a	3.0 a	3.0 a-b	6.5 a	29.1 a	9.1 a	8.5 a
Trojan	2.8 a	2.3 a	2.8 b	3.4 b	32.2 a	9.6 a	8.9 a
Group 5							
Mustang	3.0 a	3.2 a	4.5 a	3.7 b	33.7 a	9.8 a	9.1 a
Gold Rush	3.0 a	3.0 a	2.8 a	6.0 a	35.8 a	10.7 a	10.0 a

[x] Uniformity ratings on a 1-5 scale, 1=least, 5=most uniform in size, shape, and color within a cultivar.
[y] Circumference and fruit shape measurements taken on three fruit per plot that were closest to the average weight per fruit for that plot. Ped. = peduncle circumference just above the fruit attachment flair.
[z] Numbers in a column (by group) followed by the same letter exhibited no significant differences based on Duncan's Multiple Range Test where P=0.05.

Extended Season Leafy Greens

L. Brandenberger[1], B. Kahn[1], W. Roberts[1], J. Shrefler[1], S. Gray[1], M. Taylor[1], L. Carrier[1] C. Rohla[2], S. Upson[2], J. Laughlin[1]
Oklahoma State University[1], Samuel Noble Foundation[2]

Introduction:

Cool season greens can be produced throughout the fall-winter-spring in unheated hoop houses because of their tolerance to cold temperatures. This project is being carried out at four locations in the state (Ardmore, Lane, Oklahoma City, and Tulsa). The project includes trialing several leafy greens crops that can be grown for local fresh market sales. Leafy greens in the replicated trials include several brassica greens (collard, kale, mustard, spinach-mustard, turnip, broccoli raab) and spinach, chard, and Romaine lettuce. The project is working to determine which crops will have the highest potential for profitability for fresh producers within the state.

Methods:

Raised soil beds within the hoop-house were prepared for planting in early September including soil testing to determine the levels of nitrogen, potassium, and phosphorus and soil pH. Fertility levels were targeted at 120 lbs of nitrogen and 150 lbs of phosphorus and potassium per acre. Plots were direct seeded with a hand push planter (Johnny's 9156 seeder) with 4.5 inch row spacing and approximately 8 to 9 seeds/linier foot. Plots were replicated four times in a randomized plan. Harvests began in October of 2010 with additional harvests expected throughout the remainder of spring of 2011.

Greens crops and variety and seed sources.

Crop	Variety	Source
Spinach	Olympia	Chriseed
Chard	Rhubarb Chard	Harris
Romaine Lettuce	Green Towers	Seedway
Broccoli Raab	Zamboni	Seedway
Collard	Champion	DeWitt
Kale	Vates Blue Curled Scotch	DeWitt
Mustard	Southern Giant Curled	DeWitt
Spinach Mustard	Savanna	Chriseed
Turnip	Southern Green	Chriseed

Hand planter

Spinach Mustard

Vegetable Posters

Impact of Mulching Methods on Herb Production and Weed Control in a Certified Organic Production System

Charles L. Webber III[a], Angela R. Davis[a], and James W. Shrefler[b]
[a]USDA, ARS, Wes Watkins Agricultural Research Laboratory, Lane, Oklahoma
[b]Oklahoma State University, Lane, Oklahoma

Abstract
Reducing weed competition is a critical step in organic cropping systems. Use of black plastic as a weed barrier is widely used and effective. The expense associated with black plastic as well as the ecological impact of disposal has a negative impact with its use. Research was conducted at Lane, Oklahoma on certified organic land at the USDA/OSU Wes Watkins research center to compare the impact of mulching types on weed control and herb yields. The 4 mulching treatments included black plastic, hay mulch (wheat and cereal rye), hay mulch over newsprint, and bare soil (no mulch). Four herbs, basil (*Ocimum basilicum* L.), sage (*Salvia officinalis* L.), garlic chives (*Allium tuberosum* Rottler ex Spreng.), and arugula (*Eruca vesicaria* (L.) Cav. ssp. *sativa* (Mill.) Thell.), were transplanted into the four mulching treatments in 4 replications. Weed control efficacy of the mulching treatments were determined by recording the time required to maintain the plots weed-free by hoeing and hand-weeding. Herb yields were determined for each mulching treatment. Arugula and garlic chives produced the best yields on the black plastic. Basil and sage produced their highest yields when grown without a mulch (bare ground). The black plastic and bare soil treatments required the most time to handweed compared to the hay and hay/newsprint mulches, which required the least. The research demonstrated the importance of selecting the appropriate mulch for the specific herb and the potential benefits of natural and biodegradable mulches.

Introduction
The weed control challenges for horticulture production are formidable; however, these challenges are even greater for those considering organic crop production. Organic weed control methods include crop rotations, cover crops, planting systems, mechanical methods, organic herbicides, and mulches. Although mechanical weed control through cultivation is useful for controlling weeds between rows, it is ineffective for controlling weeds between plants within rows. Mulches have the potential to conserve soil moisture, reduce soil erosion, and minimize weed growth. Although plastic mulch has advantages in weed control, initial cost and disposal add to the overall production costs. Alternative mulches were investigated to reduce weed competition.

Objective
Hay mulch (wheat and cereal rye), hay/newsprint mulch, and bare soil (no mulch) were compared to black plastic to determine the impact on herb yields and time to remove weeds (handweeding and hoeing).

Methods and Materials

The experiment was conducted on certified organic land at the USDA/OSU Wes Watkins Research Center, Lane, OK. The soil was a Bernow fine sandy loam, 0-3% slope (fine-loamy, siliceous, thermic Glossic Paleudalf). The field was prepared for planting on April 26, 2010 with raised beds on 6-ft centers. Plastic mulch was applied on April 27 and the hay and the hay/newsprint mulches were applied on April 29. Two to three inches of hay (wheat and cereal rye) mulch was placed over bare soil for the hay mulch treatment or over sheets of newsprint for the hay/newsprint mulch treatment.

All mulches (black plastic, hay, and hay/newsprint) covered a 6-ft wide strip the length of the raised bed. Every other raised bed was planted to produce 12-ft centers between planted rows. Herbs (basil, arugula, garlic chives, and sage) were transplanted into the field on May 3, 2010. All plots were handweeded and hoed to a width of 6 feet on a weekly basis. The time required to produce weed-free plots by handweeding were recorded for each plot. All herbs were harvested on September 7, 2010 and fresh weights determined.

Results and Discussion

Weed Removal

Although black plastic mulch required the greatest time to handweed, primarily due to the weed removal along edges of the plastic mulch, the total time required for all mulching treatments was very low compared to typical expectations. The weed pressure in this research study were minimal due to the location's historical low weed populations, the use of drip irrigation to promote crop growth while reducing soil moisture for weed growth, and early removal of weeds. The hay mulch decreased the weeding time by 17% compared to the black plastic mulch and 11% compared the bare ground (no mulch) (Figure 1).

Herb Yields

Mulching types significantly influenced herb yields. Black plastic mulch produced the greatest yields for arugula and garlic chives, and the second greatest yields for basil and sage (Table 1). Basil produced the highest herb yields for each mulching type. Arugula had the greatest percentage differences due to mulching treatments. Sage and basil yields were greater when grown on bare ground, although the black plastic produced the second highest yields (Table 1). When comparing the biodegradable (hay and hay/newsprint) mulches, the hay/newsprint mulch herb yields were greater than the hay mulch herbs. The herb yields for the hay mulch were significantly lower than all other mulching treatments.

Conclusions

Arugula and garlic chives produced the best yields on black plastic compared to basil and sage, which grew best on bare ground (no mulch). The black plastic and the bare soil required the most time to handweed compared to the hay and hay/newsprint mulches, although the weeding times for all treatments were minimal due to the low weed pressure. These results demonstrated the importance of selecting the appropriate mulch for the specific herb and the potential benefits of natural and biodegradable mulches.

Figure 1. Impact of mulching treatments on the relative time to remove weeds by handweeding.

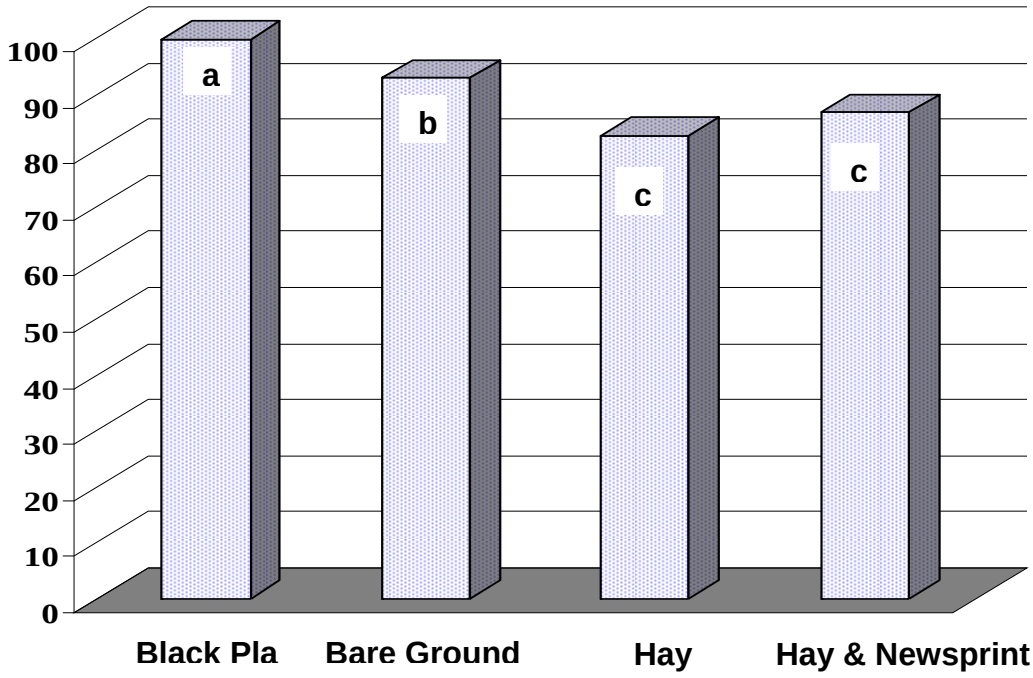

Table 1. Impact of mulching treatment on herb fresh yields (g) averaged across 4 replications in 2010.

Mulching Treatment	Basil	Arugula	Sage	Garlic Chives
	g	g	g	g
Black Plastic	6612.4 b	2374.1 a	784.0 b	256.3 a
Bare Ground	7225.0 a	740.2 b	954.4 a	100.2 b
Hay*	2500.6 d	252.0 d	126.5 c	52.4 c
Hay* and Newsprint	3550.4 c	643.2 c	712.2 b	138.4 b

*Hay (wheat and cereal rye straw)

Acknowledgements
The authors would like to thank Buddy Faulkenberry and Amy Helms, USDA, ARS, Research Technicians for their field work, data processing, and leadership of the field crews. We would also like to thank Michael Mobbs and Cody Sheffield for field maintenance and data collection. We would also like to thank Jim Vaughn, John Johnson, Shannon Reece, Phil Powell, Tony Goodson, Jaquie Pruit, Lacey Howery for their help in harvesting the herbs.

Over-the-Top Broadcast Applications of Racer® on Onion Weed Control, Crop Injury, and Yields

Charles L. Webber III[a], James W. Shrefler[b], and Lynn P. Brandenberger[c]
[a]USDA, ARS, Wes Watkins Agricultural Research Laboratory, Lane, Oklahoma
[b]Oklahoma State University, Lane, Oklahoma
[c]Oklahoma State University, Stillwater, Oklahoma

Introduction

The weed control challenges for onion production are formidable; however, these challenges are even greater for those considering organic crop production. Organic weed control methods include crop rotations, cover crops, planting systems, mechanical methods, and organic herbicides. Although mechanical weed control through cultivation is useful for controlling weeds between rows, it is ineffective for controlling weeds between plants within rows. Corn gluten meal is a potential alternative to hoeing or hand removal of weeds from rows in organic crops. Although corn gluten meal has shown promise as an early-season pre-emergent organic herbicide in sweet onion production (Webber et al., 2006), uncontrolled weeds can inflict serious yield reductions by the end of the growing season. Organic onion producers need organic herbicides that can effectively provide post-emergent weed control.

Racer®[1,2] has been labeled as a herbicide for food use and cleared as an organic herbicide for organically grown food crops. The main component (40%) of Racer® is ammonium nonanoate (ammonium pelargonate), which occurs in nature and is primarily formed from biodegradation of higher fatty acids. Although previous studies provided important information concerning use of Racer® as an organic herbicide, further research is indicated in order to increase the understanding of the relationship among application rates, weed species, and weed maturity on herbicidal efficacy and crop injury. In order to address these issues, field research was conducted in southeast Oklahoma (Atoka County, Lane, OK) to determine the effect of application rates and broadcast application of Racer® on weed control efficacy, crop injury, and yields.

Materials and Methods

The experiment was conducted on a Bernow fine sandy loam, 0-3% slope (fine-loamy, siliceous, thermic Glossic Paleudalf) soil at Lane, OK. Intermediate day, sweet onion cvs. 'Candy' and 'Cimarron' were transplanted on March 20, 2009 into 2 rows per 6 ft-wide raised beds. Each plot consisted of two onion rows per 10 ft length of bed. The

[1] Racer®, 40% Ammonium Nonanoate, Falcon Lab LLC, Wilmington, Delaware

[2] 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.

experiment included 8 weed control treatments (3 application rates at 2 hand-weeding levels, plus an untreated weedy-check and an untreated weed-free) with 4 replications. Nutsedge (*Cyperus esculentus* L.) and grass weeds were removed from all plots, including the weedy-check, to investigate the impact of ammonium nonanoate on the broadleaf weeds. Racer® (40% ammonium nonanoate) at three rates, 7.5, 10, and 15% v/v, over-the-top broadcast was applied on May 22, 2009, 63 days after transplanting (DATr) using a tractor mounted CO_2 sprayer equipped with four extended range, stainless steel, 0.30 gallons/min nozzles[3] on 20-inch spacings at a spraying height of 19 inches at 35 gpa. The two weed control treatments within each application rate (7.5, 10 and 15% v/v) involved no hand-weeding, where the uncontrolled weeds were allowed to grow, or a season-long hand-weeding, where all weeds were removed.

Data Collection

Weed control and injury (phytotoxicity) ratings were collected at 3, 10, 18, and 33 days after treatment (DAT). Weed control ratings represent the percent broadleaf weed control for a treatment compared to the weedy-check. A 0 to 100% visual rating system was used in which 0% represented no weed control, while 100% represented complete weed control. A 0 to 100% visual rating system was used in which 0% represented no crop injury, while 100% represented crop death. Weed control and crop injury data were converted using an arcsine transformation to facilitate statistical analysis and mean separation

Onions were harvested on June 25, 2009, 97 days after transplanting, sorted by size, counted, and weighed. The sorted onion grades included “small” (< 2.0 in.), “medium” (>2.0 to 3.0 in.), “large” (>3.0 to 3.75 in), and “colossal” (> 3.75 in.) for marketable size. Split and decomposed onions were placed in the unmarketable group. All data were subjected to ANOVA[4] and mean separation using LSD with P=0.05.

Results and Discussions

Rainfall

Rainfall during the 2009 growing season, from transplanting to harvest (97 days), was 18.40 inches. The 30-yr. average rainfall for the same location and time period (March 20 to June 25) is 16.01 inches.

Weed Control

The experiment had very high weed densities with multiple broadleaf species. Weeds present at spraying included spiny amaranth (*Amaranthus spinosus* L.), cutleaf ground-cherry (*Physalis angulata* L.), cutleaf evening primrose (*Oenothera laciniata* Hill), and carpetweed (*ollugo verticillata* L.). At the time of spraying, spiny amaranth, cutleaf ground-cherry, and cutleaf evening primrose averaged 2-5 leaves and were less that 1 inch tall. Carpetweed seedlings were no more than 1 inch wide with 3 or 5 leaves. No other weed species contributed more than 5% to the weed cover. Grass weed species and nutsedge (*Cyperus esculentus* L.) were removed after spraying Racer® and were kept hand-weeded throughout the remainder of the growing season. Only data for the combined ratings for total broadleaf weed control are reported.

[3] XR TeeJet, XR8003VS, Spraying Systems Co., P.O. Box 7900, Wheaton, IL 60189-7900.

[4] SAS Institute Inc., 100 SAS Campus Drive, Cary, NC 27513.

Total broadleaf weed control for Racer® increased as the percentage of Racer® increased (Table 1). Within application rates, Racer maintained consistent weed control through 10 DAT. Racer® at 10 and 15% provided excellent (≥90%) weed control. while Racer® at 7.5% peaked at 10 DAT with only 69% total broadleaf weed control.

Table 1. Total broadleaf weed control percentage at 3, 10, 18, and 33 DAT by weed control treatment.

Weed Control Treatment	Hand-Weeded	3 DAT	10 DAT	18 DAT	33 DAT
		%	%	%	%
Racer® 7.5%*	No	69 c**	69 c**	40 d**	6 d**
Racer® 7.5%	Yes	100 a	100 a	100 a	100 a
Racer® 10%	No	91 b	91 b	61 c	14 c
Racer® 10%	Yes	100 a	100 a	100 a	100 a
Racer® 15%	No	97 a	97 a	73 b	21 b
Racer® 15%	Yes	100 a	100 a	100 a	100 a
Weedy-Check	No	0 d	0 d	0 e	0 e
Weed-Free	Yes	100 a	100 a	100 a	100 a

*Racer applied using a broadcast over-the-top application.
**Means within columns followed by the same letter are not significantly different, Least Significant Difference (LSD) test, P=0.05.

Crop Injury

No significant differences were observed between onion cultivars for crop injury; crop injury is presented averaged across cultivars. Onion injury increased as Racer® application rates, peaking at 3 DAT and decreasing to 33 DAT where there was not a significantly difference among the treated and untreated controls (Table 2).

Table 2. Crop injury averaged across onion varieties at 3, 10, 18, and 33 DAT by weed control treatment.

Weed Control Treatment	Hand-Weeded	3 DAT	10 DAT	18 DAT	33 DAT
		%	%	%	%
Racer® 7.5%*	No	10 c**	6 c**	4 c**	2 a**
Racer® 7.5%	Yes	10 c	6 c	4 c	2 a
Racer® 10%	No	25 b	20 b	11 b	2 a
Racer® 10%	Yes	25 b	20 b	11 b	2 a
Racer® 15%	No	50 a	44 a	23 a	2 a
Racer® 15%	Yes	50 a	44 a	23 a	2 a
Weedy-Check	No	2 d	2 d	2 d	2 a
Weed-Free	Yes	2 d	2 d	2 d	2 a

*Racer applied using a broadcast over-the-top application.
**Means within columns followed by the same letter are not significantly different, Least Significant Difference (LSD) test, P=0.05.

Onion Yields

Data are for the total marketable yield combined across the 4 onion grades. There were significant yield differences between cultivars and among weed control treatments (Table 3). Onion yields decreased as Racer rates increased, with the greatest yields at the 7.5% rate. Yield differences between the non hand-weeded and hand-weeded treatments within Racer application rates indicate that the lack of weed control reduced crop yields. Cimarron yields were greater than Candy yields when comparing application rates and control treatments (weedy-check and weed-free).

Table 3. Total onion yields for Cimarron and Candy for Lane, OK as a result of weed control treatments.

Weed Control Treatment	Hand-Weeded	Cimarron	Candy
		lb/a	lb/a
Racer® 7.5%*	No	419 e**	82 e**
Racer® 7.5%	Yes	1209 b	825 a
Racer® 10%	No	320 f	24 f
Racer® 10%	Yes	945 d	750 b
Racer® 15%	No	307 f	42 ef
Racer® 15%	Yes	1017 c	683 c
Weedy-Check	No	261 g	44 ef
Weed-Free	Yes	1524 a	628 d

*Racer applied using a broadcast over-the-top application.

**Means within columns followed by the same letter are not significantly different, Least Significant Difference (LSD) test, P=0.05.

Conclusions

Broadcast applications of Racer® at 7.5% produced poor (70% or less) broadleaf weed control, while Racer® at 10 and 15% provided excellent (≥90%) total broadleaf weed control through 10 DAT. Onion injury increased as Racer® application rate increased with no significant difference among treatments at 18 DAT. Crop injury and lack of weed control from Racer® did reduced crop yields compared to the untreated weedy-check. If the Racer's® application method can be modified to reduce crop injury, the higher application rate has potential to make significant impact on broadleaf weed control in spring-transplanted onions.

Acknowledgements

The authors would like to thank Sam McClure, Spring Creek Ranch, Calvin, OK for supplying the onion transplants and Falcon Lab LLC, Wilmington, Delaware for providing the Racer®. We appreciate Buddy Faulkenberry, USDA, ARS, Research Technician, for his field work, data processing, and leadership of the field crews. We would also like to thank Tony Goodson, Ron Marble, Tim Abney and John Johnson for helping to transplant the onions and Buddy Faulkenberry and Will Baze for plot maintenance and harvesting.

References

Webber, C.L. III and J.W. Shrefler. 2006. Corn gluten meal and spring-transplanted onions (*Allium cepa* L.): Crop safety, weed control, and yields. 2006 National Allium Research Conference. Dec. 6-9, 2006. College Station, TX. p. 87-97.

Organic Onions and Potential Organic Herbicides for Post-Directed Applications

Charles L. Webber III[a], James W. Shrefler[b], and Lynn P. Brandenberger[c]

[a]USDA, ARS, Wes Watkins Agricultural Research Laboratory, Lane, Oklahoma
[b]Oklahoma State University, Lane, Oklahoma
[c]Oklahoma State University, Stillwater, Oklahoma

Abstract

Organic onion producers need organic herbicides that can effectively provide post-emergent weed control. Research was conducted in southeast Oklahoma (Atoka County, Lane, OK) to determine the impact of potential organic herbicides on weed control efficacy, crop injury, and yields. The experiment included 12 weed control treatments (5 herbicides at 2 rates, plus an untreated weedy-check and an untreated weed-free) with 6 replications. The 5 herbicides and the rates included Burnout®, 15 and 30% volume/volume (v/v), MatranEC®, 5 and 7 % v/v, Scythe®, 5 and 7%, Racer®, 9 and 12.6% v/v, and vinegar, 40 and 80 gpa). Each herbicide was applied on May 20, 2009 and then reapplied after an 8 day interval between applications. Intermediate day, sweet onions, cv. 'Cimarron' were transplanted on March 20, 2009 into 2 rows per 6 ft-wide raised beds. Each plot consisted of two onion rows per 10 ft length of bed. The post-directed application of MatranEC® produced the highest onion yields among the herbicides, although not significantly greater than the weedy-check. Sequential-applications significantly increased weed control when comparing weed ratings at 7 days after the first herbicide application and 1 day after the second application. Scythe®, Racer®, and vinegar produced the best weed control at the application rates used in this study.

Introduction

Oklahoma producers are interested in sweet onion (*Allium cepa* L.) as an alternative crop for farm diversification. Onions do not compete well with weeds due to their slow growth rate, short height, non-branching plant structure, low leaf area, and shallow root system. The weed control challenges for onion production are even greater for those considering organic crop production. Although corn gluten meal has shown promise as an early-season pre-emergent organic herbicide in sweet onion production, any uncontrolled weeds can inflict serious yield reductions by the end of the growing season. Organic onion producers need additional organic herbicides that can provide effective post-emergent weed control.

Research with post-emergence organic contact herbicides determined that these herbicides must be applied to very young/small weeds if acceptable weed control is expected. Previous onion research with over-the-top applications of potential organic contact herbicides determined that at effective weed control herbicide rates onion injury was unacceptable resulting in onion yield reductions. A potential solution to increase weed control efficacy on larger weeds and decrease onion injury is the use of multiple/sequential post-directed herbicide applications (herbicides sprayed at the base of the crop rather than over-the-top). The objective of the current research was to determine the impact of sequential post-directed applications of potential organic herbicides on weed control efficacy, crop injury, and yields.

Materials and Methods

The experiment was conducted on a Bernow fine sandy loam, 0-3% slope (fine-loamy, siliceous, thermic Glossic Paleudalf) soil at Lane, OK. Intermediate day, sweet onions cv. 'Cimarron', were transplanted on March 20, 2009 into 6 ft-wide raised beds. Each plot consisted of two onion rows per 10 ft length of bed. The experiment included 12 weed control treatments (5 herbicides at 2 rates, plus an untreated weedy-check and an untreated weed-free check) with 6 replications. The herbicide treatments included Burnout® (12% clove oil, 15 and 30% v/v application rates), MatranEC® (50% clove oil, 5 and 7% v/v application rates), Scythe® (57% pelargonic acid, 5 and 7% application rates), Racer® (40% ammonium nonanoate, 9 and 12.6 % v/v application rates), and vinegar (20% acetic acid, 40 and 80 gpa application rates). Except for the 80 gpa application of vinegar, all herbicides were applied with a post-directed application with four extended range, stainless steel, 0.40 gallons/min nozzles at 40 gpa.

Data Collection

Weed control and injury (phytotoxicity) ratings were collected at 1, 3, 7, 9, 11, 15, 21, and 28 days after treatment (DAT). Weed control ratings represent the percentage broadleaf weed control for a treatment compared to the weedy-check. A 0 to 100% visual rating system was used in which 0% represented no weed control, while 100% represented complete weed control. A 0 to 100% visual rating system was used in which 0% represented no crop injury, while 100% represented crop death. Weed control and crop injury data were converted using an arcsine transformation to facilitate statistical analysis and mean separation

Onions were harvested on June 30, 2009, 102 days after transplanting, sorted by size, counted, and weighed. The sorted onion grades included "small" (< 2.0 in.), "medium" (>2.0 to 3.0 in.), "large" (>3.0 to 3.75 in), and "colossal" (> 3.75 in.) for marketable size. Split and decomposed onions were placed in the unmarketable group. All data were subjected to ANOVA and mean separation using LSD with P=0.05.

Results and Discussion

Racer® (9 and 12.6 % v/v) and vinegar (80 gpa of 20% acetic acid) provided good to excellent early weed control (1, 5, and 7 DAT) prior to the second, 8 DAT, sequential herbicide treatment (Table 1), unfortunately onion injury for the same time period (1, 5, and 7 DAT) was the greatest for the 80 gpa vinegar treatment, 5%, 4.7%, and 5% respectively (Table 2).

The second of the two sequential-applications, at 8 days after the first application, significantly increased weed control when compared to weed ratings at 7 DAT and 9 DAT (Table 1). The second herbicide application produced the greatest weed control increase for the Scythe® treatments (5 and 7%) and the 40 gpa vinegar treatment. Scythe®, Racer®, and vinegar produced the best weed control at the application rates used in this study.

Twenty-eight days after the initial herbicide treatment (28 DAT) and 89 days after onion transplanting, vinegar applied at 80 gpa maintained the highest total weed control (83%) of herbicides used. Overall, total weed control and adverse yield reductions were not acceptable with the herbicides used at these rates and application timing. Although vinegar, when applied at 80 gpa, did provide good weed control until 28 DAT, yield reductions were unacceptable.

Matran EC® produced the highest yields among herbicide treatments, but did not produce significantly greater yields than the weedy-check (Table 3). Weed competition and herbicide damage to onions severely reduced onion yields compared to the weed-free treatment. Although certain herbicide treatments did fairly well controlling the larger weeds, the lack of early weed control and the regrowth of weeds after the second herbicide application combined to produce severe weed competition and yield reductions for the onions (Table 3). Total onion yields were reduced across all weed control treatments because of excessive seasonal rainfall, which also resulted in high percentages of unmarketable onions (Table 3).

Conclusions

Although onion injury was reduced compared to previous research with the over-the-top broadcast applications of these herbicides, the application timing needs to be improved to control weeds at earlier growth stages and provide virtually weed-free conditions from the point of onion transplanting through harvest.

Acknowledgements

The authors appreciate the work of Buddy Faulkenberry, USDA, ARS, Lane, OK, on field work, data collection, statistical analysis, and graphic design for this presentation.

Table 1. Impact of sequential herbicide applications on total weed percentages across rating dates 1 to 28 days after initial treatment (DAT).

Herbicide	Rate (v/v or gpa)	1 DAT		3 DAT		7 DAT		9 DAT		11 DAT		15 DAT		21 DAT		28 DAT	
		%		%		%		%		%		%		%		%	
Burnout	15%	6	gh*	10	fgh	10	fgh	46	f	46	f	33	f	27	g	22	g
Burnout	30%	47	e	54	de	54	de	86	de	86	de	80	de	60	ef	45	ef
MatranEC	5%	2	hi	5	gh	5	gh	22	g	22	g	20	g	15	h	13	h
MatranEC	7%	11	h	16	fg	16	fg	43	f	43	f	43	f	37	g	31	g
Scythe	5%	21	fg	22	f	22	f	91	bcd	91	bcd	87	bcd	63	e	33	e
Scythe	7%	66	cd	71	cd	71	cd	96	b	96	b	93	b	76	cd	63	cd
Racer	9%	91	b	91	b	91	b	95	bc	95	bc	93	bc	75	cd	58	cd
Racer	12.6%	82	bc	87	bc	87	bc	93	bcd	93	bcd	93	bcd	80	bc	68	bc
Vinegar	40 gpa	25	fg	37	e	37	e	81	e	81	e	80	e	68	de	55	de
Vinegar	80 gpa	86	b	89	b	89	b	96	b	96	b	95	b	89	b	83	b
Weedy-Check	NA	0	i	0	i	0	i	0	h	0	h	0	h	0	i	0	i
Weed-Free	NA	100	a	100	a	100	a	100	a	100	a	100	a	100	a	100	a

*Values in a column followed by the same letter are not significantly different at *P* =.05 LSD.

Table 2. Impact of sequential herbicide applications on onion injury across rating dates 1 to 28 days after initial treatment (DAT).

Herbicide	Rate (v/v or gpa)	1 DAT		3 DAT		7 DAT		9 DAT		11 DAT		15 DAT		21 DAT		28 DAT	
		%		%		%		%		%		%		%		%	
Burnout	15%	2.0	d*	2.0	d	2.0	d	4.0	d	4.0	d	4.0	c	3.0	c	3.0	c
Burnout	30%	2.0	d	2.0	d	2.0	d	4.0	d	4.0	d	4.0	c	3.0	c	3.0	c
MatranEC	5%	2.0	d	2.0	d	2.0	d	4.0	d	4.0	d	3.0	d	2.0	d	2.0	d
MatranEC	7%	4.0	b	3.7	b	4.0	b	6.0	b	6.0	b	7.0	a	6.0	a	5.0	a
Scythe	5%	2.0	d	2.3	cd	2.0	d	4.0	d	4.0	d	3.0	d	2.0	d	2.0	d
Scythe	7%	5.0	a	4.5	ab	5.0	a	7.0	a	7.0	a	6.0	b	5.0	b	4.0	b
Racer	9%	2.0	d	2.5	cd	2.0	d	4.0	d	4.0	d	4.0	c	3.0	c	3.0	c
Racer	12.6%	2.0	d	2.0	d	2.0	d	4.0	d	4.0	d	4.0	c	3.0	c	3.0	c
Vinegar	40 gpa	3.0	c	2.8	cd	2.8	c	4.8	c	4.8	c	4.0	c	3.0	c	3.0	c
Vinegar	80 gpa	5.0	a	4.7	a	5.0	a	7.0	a	7.0	a	6.0	b	5.0	b	5.0	a
Weedy-Check	NA	2.0	d	2.5	cd	2.0	d	3.7	d	3.7	d	3.0	d	2.0	d	2.0	d
Weed-Free	NA	2.0	d	2.0	d	2.0	d	3.7	d	3.7	d	3.0	d	2.0	d	2.0	d

*Values in a column followed by the same letter are not significantly different at *P* =.05 LSD.

Table 3. Impact of herbicide applications on total onion yields and percentage of marketable and non-marketable onions.

Herbicide	Rate (v/v or gpa)	Total	Total	Marketable	Non-Marketable	Marketable	Non-Marketable
		onions/acre	lb/acre	onions/acre %	onions/acre %	lb/acre %	lb/acre %
Burnout	15%	19,844 bc*	313 b	44 f	56 a	63 e	37 a
Burnout	30%	18,755 c	360 b	54 de	46 bc	78 bcd	22 bcd
MatranEC	5%	19,481 bc	442 b	61 c	39 d	80 bc	20 cd
MatranEC	7%	22,022 ab	512 b	54 d	46 bc	76 c	24 bc
Scythe	5%	19,723 bc	360 b	61 c	39 c	80 bc	20 cd
Scythe	7%	21,296 bc	421 b	55 de	45 bc	76 c	24 bc
Racer	9%	20,691 bc	367 b	51 e	49 b	77 c	23 bc
Racer	12.6%	18,876 c	362 b	53 e	47 bc	79 bc	21 cd
Vinegar	40 gpa	20,207 bc	449 b	71 b	29 e	83 b	17 d
Vinegar	80 gpa	19,239 bc	384 b	58 cd	42 cd	80 bc	20 c
Weedy-Check	NA	20,449 bc	441 b	51 e	49 b	73 d	27 b
Weed-Free	NA	24,805 a	1,859 a	95 a	5 f	98 a	2 e

*Values in a column followed by the same letter are not significantly different at *P* =.05 LSD.

Horticulture Industries Show Sponsors

Cooperative Extension Service & Department of Horticulture

Cooperative Extension Service
&
Department of Horticulture
and Landscape Architecture

We hope you enjoyed the conference!

We look forward to seeing you next year, January 6-7, 2012
At Tulsa Community College!