Ornamental Plants

Annual Reports and Research Reviews

2004

THE OHIO STATE UNIVERSITY
OARDC

January 2005
Special Circular 195
Ohio Agricultural Research and Development Center
In Partnership With Ohio State University Extension
and the OSU Extension Centers at Wooster and Piketon

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Ornamental Plants
Annual Reports and Research Reviews
2004

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Plants shown on the covers are from the Ohio Nursery and Landscape Association (ONLA) publications *Landscape Plants for Ohio* and *Perennial Plants for Ohio,* which were developed in 2004 through the partnership of ONLA and the Ohio State University Extension Nursery Landscape and Turf Team (see the article on page 34).

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Ohio State University Extension Nursery, Landscape, and Turf Team Directory: 2005

Our Vision

The vision of the Extension Nursery, Landscape, and Turf Team is to serve as the University's partner with the green industry to position us for the future.

Our Mission

The mission of the Extension Nursery, Landscape, and Turf Team, through our interdisciplinary and industry partnerships, is to improve the process of acquisition, delivery, and support of accurate, practical, and timely educational resources.

An Invitation

Membership on the team is based on interest and commitment to the vision and the mission of the team. Potential members are encouraged to participate in some of our activities to determine if they would like to become a part of our team. If you are interested in the work of the team, please contact any of the team members.

The ENLT Team greatly appreciates the significant funding support of the Ohio Nursery and Landscape Association.

Team Members

Betsy Anderson

- Ornamental plant pesticide research (IR-4 Program)
- Biological pest control
- Identification of nursery, greenhouse, and landscape pesticide needs
- Registration of new pesticide products

Biological Science Technician, USDA, Agricultural Research Service

---

Directory developed by Jack Kerrigan, Ohio State University Extension, Cuyahoga County.

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- Insect identification
- Greenhouse management
- Garden center employee training
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- Communications
- Master Gardener Program

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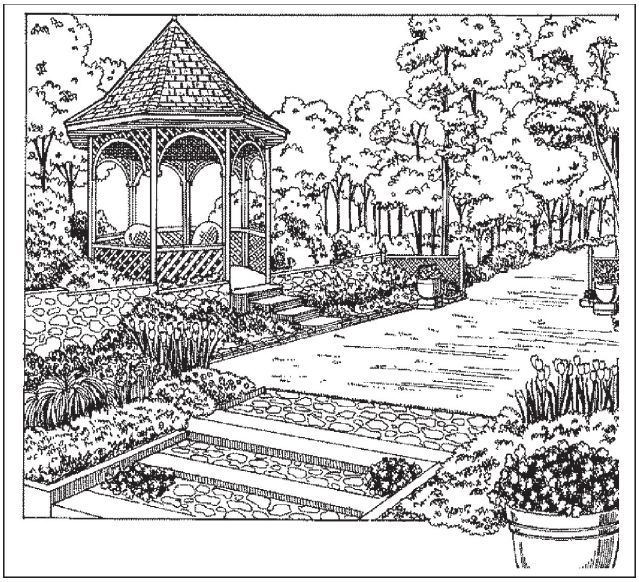

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- Diagnosis of landscape cultural problems
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- Diagnosis of plant diseases
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- Greenhouse management
- Fruit production

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During the growing season, the team teleconferences weekly and develops a newsletter called the *Buckeye Yard and Garden Line,* which is available by a fax subscription service (contact a local team member) or on the World-Wide Web at:

http://www.hcs.ohio-state.edu/hcs/hcs.html

(Ohio State University Department of Horticulture and Crop Science, *Horticulture and Crop Science in Virtual Perspective)*

Buckeye Yard and Garden Line
Fax Centers

Clark County	Pam Bennett
Clermont County	Gary Gao
Cuyahoga County	Tim Malinich
Franklin County	Jane Martin
Hamilton County	Joe Boggs
Lake County	Randy Zondag
Lucas County	Amy Stone
Montgomery County	Pete Lane
Putnam County	Glen Arnold

~ 2 ~

Floriculture Industry Roundtable of Ohio

Financially supported by the Floriculture Industry Research Scholarship Trust

Our Mission

The mission of the Floriculture Roundtable of Ohio is to provide an educational forum to floriculture Extension personnel, growers, and members of the allied industries across the Midwestern region, currently including Ohio, Michigan, Pennsylvania, Kentucky, and Indiana, for the exchange, discussion, and dissemination of information related to floriculture.

Serving You

Do you ever have problems with crops? The Roundtable offers you free assistance in finding solutions. All persons listed in this directory are just a phone call away. Take advantage of the opportunity!

Directory developed by Charles Behnke, Ohio State University Extension, Lorain County, and Claudio Pasian, The Ohio State University, Department of Horticulture and Crop Science.

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Gao, Gary
Kneen, Hal
Krauskopf, Dean
McMahon, Peg
McMahon, Robert W. (Bob)
Metzger, Jim
Pasian, Claudio

Plant Pathology

Ellsworth, Denise
Taylor, Nancy

Entomology/IPM

Cañas, Luis
Cloyd, Raymond
McMahon, Robert W. (Bob)

Food, Agricultural, and Biological Engineering/Greenhouse Environment

Brugger, Mike
Ling, Peter

Management and Economics

Kneen, Hal
Rhodus, Tim

Composting

Watson, Maurice

Crop Physiology

Carver, Steve
Jones, Michelle
McMahon, Peg
Metzger, Jim
Pasian, Claudio

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Carver, Steve
Krauskopf, Dean
Pasian, Claudio
Watson, Maurice

Postharvest Physiology

Jones, Michelle

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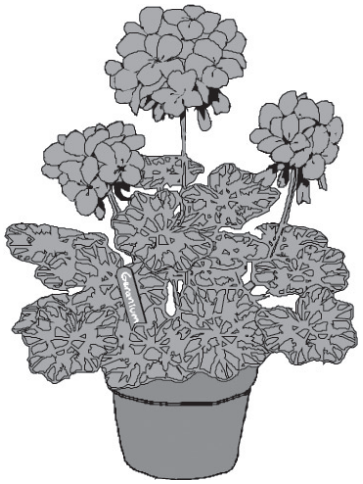
Tim Rhodus



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217-244-7218
217-333-4777 Fax
rcloyd@uiuc.edu

- Integrated pest management and biological control of greenhouse pests
- Effects of plants on natural enemy foraging success
- Compatibility of pest control materials with natural enemies
- Efficacy of new pest-control materials
- Tank mix compatibility

Mary Donnell

OSU Extension Educator, Commercial Horticulture/Agricultural Economic Development
Agricultural Business Enhancement Center
440 E. Poe Road, Suite 201
Bowling Green, OH 43401-1351
419-354-6916
419-354-6416 Fax
donnell.8@osu.edu

- Marketing
- Business management
- Hydroponic vegetable production
- Greenhouse management

David Dyke

OSU Extension Educator, Commercial Floriculture, Hamilton County
110 Boggs Lane, Suite 315
Cincinnati, OH 45246-3145
513-946-8983
513-505-1202 Cell phone
513-528-0034 Fax
dyke.15@osu.edu

- Greenhouse management
- Small business management
- Marketing

Denise Ellsworth

OSU Extension Educator, Horticulture, Summit County
2525 State Road

Cuyahoga Falls, OH 44223-1602
330-928-4769
330-928-9418 Fax
ellsworth.2@osu.edu

- Integrated pest management
- Plant diseases

Craig Everett

OSU Extension Program Assistant, Horticulture, Wood County
440 E. Poe Road, Suite A
Bowling Green, OH 43402
419-354-9050
419-352-7413 Fax
everett.33@osu.edu

- Greenhouse management and production

Gary Gao

OSU Extension Educator and County Director, Horticulture, Clermont County
P. O. Box 670, 1000 Locust Street
Owensville, OH 45160
513-732-7070
513-732-7060 Fax
gao.2@osu.edu

- Greenhouse management

Michelle L. Jones, Ph.D.

Assistant Professor, Floriculture/Molecular Biology
Department of Horticulture and Crop Science
Ohio Agricultural Research and Development Center
The Ohio State University
1680 Madison Avenue
Wooster, OH 44691-4096
330-263-3885
330-263-3887 Fax
jones.1968@osu.edu

- Production/post-production physiology
- Biotechnology
- Germplasm enhancement
- Ethylene

Hal Kneen

OSU Extension Educator, Horticulture, Meigs County
Mulberry Heights
P. O. Box 32
Pomeroy, OH 45769
740-992-6696
740-992-7931 Fax
kneen.1@osu.edu

- Greenhouse management
- Small-business management
- Production economics
- Marketing

Dean Krauskopf

Greenhouse Educator, Southeast Michigan
Michigan State University
MSU Extension
640 Temple
Detroit, MI 48201
313-833-3278
313-833-3298 Fax
krauskop@msue.msu.edu

- Greenhouse crop nutrition
- Foliar and media analysis
- Greenhouse crop management

Peter Ling

Assistant Professor
Food, Agricultural, and Biological Engineering
Ohio Agricultural Research and Development Center
The Ohio State University
1680 Madison Avenue
Wooster, OH 44691-4096
330-263-3857
330-263-3670 Fax
ling.23@osu.edu

- Greenhouse plant growth control systems
- Digital image applications

Margaret (Peg) McMahon

Associate Professor
Department of Horticulture and Crop Science
The Ohio State University
2001 Fyffe Court
Columbus, OH 43210
614-292-8867
614-292-3505 Fax
mcmahon.43@osu.edu

- Floriculture crop physiology
- Light quality regulation of crop development
- Greenhouse management
- Production of floriculture crops

Robert W. (Bob) McMahon

Professor
The Ohio State University
Agricultural Technical Institute
1328 Dover Road
Wooster, OH 44691-4000
800-647-8283 Ext. 1320 (Ohio only)
330-264-3911 Ext. 1320
330-262-7634 Fax

- IPM
- Control of insect pests of floriculture crops with natural enemies and use of hot-water drenches and sprays, and manipulation of plant height by environmental manipulation (water and temperature)
- Greenhouse production and management

James (Jim) Metzger

Professor
Department of Horticulture and Crop Science
The Ohio State University
2001 Fyffe Court
Columbus, OH 43210
614-292-3854
614-292-7162 Fax
metzger.72@osu.edu

- Role of hormones in plant growth and development
- Environmental control of flowering
- Use of biotechnology to improve floricultural crops

Claudio Pasian

Associate Professor and Extension Specialist, Floriculture
Department of Horticulture and Crop Science
The Ohio State University
2001 Fyffe Court
Columbus, OH 43210
614-292-9941
614-292-3505 Fax
pasian.1@osu.edu

- Production and management
- Modeling and timing of floricultural crops
- Water quality and nutrition of floricultural crops

Tim Rhodus

Professor
Department of Horticulture and Crop Science
The Ohio State University
2001 Fyffe Court
Columbus, OH 43210
614-292-3871
614-292-3505 Fax
rhodus.1@osu.edu

- Management and economics of horticultural crops
- Multimedia applications for marketing and education

Nancy Taylor

Director, C. Wayne Ellett Plant and Pest Diagnostic Clinic
The Ohio State University
110 Kottman Hall
2021 Coffey Road
Columbus, OH 43210
614-688-5563
614-292-4455 Fax
taylor.8@osu.edu

- Diagnosis of diseases of floral and other greenhouse crops

Watson, Maurice

Associate Professor and Extension Soil Specialist
School of Natural Resources
Ohio Agricultural Research and Development Center
The Ohio State University
1680 Madison Avenue
Wooster, OH 44691
330-263-3755
330-263-3658 Fax
watson.8@osu.edu

- Analysis of soil, soilless mix, sewage sludges, manures, and water
- Water quality, composting, and environmental pollution problems

Floriculture Industry Roundtable of Ohio (FIROO) Activities Include:

- Assisting growers with crop production problems.
- Holding biweekly conference calls to assess the state of the industry. These calls are used as an educational forum by Roundtable members. Grower participation in the biweekly phone calls is possible (and encouraged) on a port-available basis by contacting Charles Behnke at 440-326-5859 prior to the biweekly conference.
- Preparing and faxing out informational alerts (FIROOFAX) to industry members when emergencies arise.
- Collaborating with the Ohio Florists Association and other regional grower associations in the organization of educational seminars and workshops.

Feel free to get in touch with any of the Roundtable members listed in this Directory if you have any floricultural problem or wish to share information.

~ 3 ~
Ohio State University Extension 2004 Buckeye Yard & Garden Line Evaluation Survey

Amy K. Stone and James A. Chatfield

Summary

A total of 182 respondents completed and returned the 2004 *Buckeye Yard & Garden Line (BYGL) Survey.* From their subscriptions, information from *BYGL* is then further disseminated to more than 845,000 additional persons through radio programs, newspaper columns and articles, Master Gardener volunteers, students, and other green-industry employees.

Typical comments from respondents included: "I have learned so much." "A must read upon arrival." "*BYGL* makes me look smart." "Very informative and timely; very useful. I look forward to every issue."

Some 91% of the survey respondents agreed that *BYGL* was useful to their job and business. For the individuals who responded to the survey, *BYGL* has had an estimated economic impact of more than $250,000. This is a significant under-representation of the economic impact, since no attempt was made to translate the reported impact to the overall BYGL audience.

Amy K. Stone, Ohio State University Extension, Lucas County; and James A. Chatfield, Ohio State University Extension Center at Wooster, Horticulture and Crop Science.

Introduction

The *Buckeye Yard and Garden Line* (*BYGL*) is one of the key ways through which Ohio State University Extension and the Extension Nursery Landscape and Turf (ENLT) Team provide ornamental-plant and plant-problem information to the green industry, Extension offices, and the general public. This article answers some questions about *BYGL* and provides the results of the 2004 *BYGL* Evaluation Survey.

What Is *BYGL?*

The *Buckeye Yard and Garden Line (BYGL)* is a weekly update in the form of a horticultural newsletter. It is written by Ohio State University Extension educators and specialists, from a conference call held every Tuesday from April-September. *BYGL* is funded by the Ohio Nursery and Landscape Association (ONLA) and OSU Extension, with additional contributions from the Ohio Chapter of the International Society of Arboriculture (Ohio–ISA).

Who Is *BYGL's* Audience?

BYGL is written for green-industry professionals, Extension Educators, Extension Master Gardener Volunteers, and other horticulturists in Ohio and throughout the United States, especially the Midwest.

Some of those receiving *BYGL* are members of the following: ONLA; ISA; Ohio Turfgrass Foundation (OTF); Ohio Florists Association (OFA); Ohio Fruit Growers Association; Ohio Vegetable and Potato Growers Association; Ohio Christmas Tree Association; Ohio Lawn Care Association (OLCA); Ohio Association of Garden Clubs; Ohio Sod Producers Association; American Association of Botanical Gardens and Arboreta (AABGA); American Horticultural Society (AHS); Associated Landscape Contractors of America (ALCA); American Community Gardening Association (ACGA); Perennial Plant Association (PPA); and Professional Grounds Management Society (PGMS).

How Do You Receive *BYGL*?

There are three ways to receive *BYGL* — by e-mail, by fax subscription, and by going directly on the World Wide Web. Here's how:

- By e-mail: simply send your e-mail address to Jim Chatfield:

  chatfield.1@osu.edu

- On the World Wide Web: Access *Buckeye Yard and Garden onLine* on Ohio State University's *Horticulture and Crop Science in Virtual Perspective*

  http://bygl.osu.edu/

- For fax newsletter subscriptions, contact one of these Ohio State University Extension offices:

  Clark County
  Pam Bennett
  937-328-4607

  Clermont County
  Gary Gao
  513-732-7070

  Cuyahoga County
  Tim Malinich
  216-397-6000

  Franklin County
  Jane Martin
  614-247-6046

  Hamilton County
  Joe Boggs
  513-946-8993

  Lake County
  Randy Zondag
  440-350-2269

  Lucas County
  Amy Stone
  419-578-6783

  Montgomery County
  Pete Lane
  937-224-9654

  Putnam County
  Glen Arnold
  419-523-6294

Is There a Cost for *BYGL*?

Fax subscriptions have a $40 fee to cover phone line costs. If you are a member of the Ohio Nursery and Landscape Association (ONLA), the Ohio Chapter of the International Society of Arboriculture (Ohio-ISA), or the Ohio Turfgrass Foundation (OTF), this fee is waived as part of your membership benefits.

Where Can You Find the Time for *BYGL?*

Reading time during the growing season comes at a premium, and that is why *BYGL* is formatted in short bytes — one to two paragraphs — of the most relevant

information on a particular topic. We also strive for a lively, user-friendly, and humorous style.

What Is *Buckeye Yard & Garden onLine?*

This is the World Wide Web version of *BYGL,* and it comes not only with the text of *BYGL* available, but also with hot links to color images of pests and plants referenced in the *BYGL,* and to more than 260,000 pages of information from Ohio State University and other land-grant universities.

What Is *BYGLive*!?

BYGLive! is a series of informal programs held at arboreta throughout Ohio. The participants have a chance to see plants and plant and pest development throughout the season, to do some diagnostic troubleshooting, and to provide observations and insights that will add to the *BYGL*. The dates, times, locations, and contacts for each of these programs will be listed in the upcoming event section of *BYGL.* Stay tuned to find out where the closest BYGLive will be held in your part of the state.

Survey Results

Total Number of Returns: 182

I. General Background Questions

A. What is your primary type of business, operation, or profession?

Number of Commercial or For-Profit Companies: 89

(i.e., nursery; greenhouse; golf course; lawn-care service; contract landscape maintenance; tree care/arborist; garden center; industrial or office park/plant; landscape architect/designer; or supplier/dealer)

Number of Non-Profit Companies: 64

(i.e., Extension; park, school, college, or university; museum; cemetery/memorial garden; or government facility)

Number of Non-Professional Readers: 25
(i.e., home gardener or Extension Master Gardener)

B. Are you a member of the following (please select all that apply):

Ohio Nursery and Landscape Association: 53
International Society of Arboriculture: 26
Ohio Turfgrass Foundation: 42

C. How do you receive *BYGL?*

E-mail — 147
Fax — 22

D. Do you share your *BYGL* with others?

Yes — 125
No — 37

II. BYGL Impact and Usefulness

A. How strongly do you agree with each of the following statements? Please write down the most appropriate response.

SA = Strongly Agree
A = Agree
N = Neutral
D = Disagree
SD = Strongly Disagree
NA= Not Applicable

1. *BYGL* was useful to my job and business:

SA = 98
A = 56
N = 00
D = 00
SD = 00
NA = 14

2. *BYGL* helped in answering client/customer questions:

SA = 84
A = 60

N = 04
D = 00
SD = 00
NA = 19

3. I (we) changed some horticultural practices based on information in *BYGL*.

SA = 31
A = 87
N = 35
D = 01
SD = 00
NA = 14

4. I (we) changed some pest management practices based on information in *BYGL*.

SA = 34
A = 93
N = 30
D = 00
SD = 00
NA = 30

5. *BYGL* has resulted in improved customer service in our company or business.

SA = 43
A = 63
N = 21
D = 00
SD = 00
NA = 39

B. What have you learned from *BYGL* this season? Please fill in the blank following each statement.

1. Number of new insects learned: 1,967
2. Number of new diseases learned: 374
3. Number of new cultural (non-insect, non-disease) problems learned: 276
4. Number of times pesticide use was improved: 2,236

C. Has the information in *BYGL* saved your company money or increased your net profit?

Yes — 81
No — 47

1. If you answered "Yes" to question C, please check all that apply. This information will only be used for reporting the economic impacts of *BYGL*.

Time savings to you and your operation = 46
Reduction of pesticide usage = 53
Proper selection of plant material = 34
Proper selection of pesticides = 54
Improved customer service = 53

Selected Comments

One of the best publications out there — very helpful. I use the information continually. It is accurate and up-to-date. Keep up the good work.

— Alan Klonowski
Ohio Chapter of the ISA

A continuing education of sorts for us. BYGL gives us the current and updated information that we need to know to share with customers and employees about what is happening in the Central Ohio landscape.

— Cindy Dill
Dalgara's Landscaping and Garden Center

Publication is very useful for employees. It is required reading for all staff and personnel (full-time, part-time, and seasonal).

— David Gasior
Village Green

The first place our Master Gardeners check for current horticulture information.

— Dusty Sonnenberg
OSU Extension, Henry County

BYGL is very helpful to our company and customers. Keep up the good work!

— Keith Hiser
Wasson Nursery

Essential to the green industry! It keeps us up-to-date on the latest disease and insect information.

— Lisa Huddy
City of Upper Arlington

A very valuable tool in helping individuals with the seasonal mystery bugs!

— Richard Sorg
Muskingum Soil and Water Conservation District

By all means, one of the most important sources of weekly information.

— Ron Wilson
William A. Natorp Co.

Keep up the growing degree days things – it is sinking in. THANK YOU!

— Susan Muenzer
Nilsson's,
A Full Service Landscape Co.

~ 4 ~
Teamwork Is Its Own Reward

James A. Chatfield, Joseph F. Boggs, Gary Y. Gao, Erik A. Draper, Keith L. Smith, Barbara G. Ludwig, and Stephen R. Baertsche

The Extension Nursery Landscape and Turf Team (ENLTT) is an example of a collegial, interdisciplinary team that works at Ohio State University Extension (OSUE). ENLTT was formed in response to severe budget cuts at The Ohio State University in the early 1990s.

In looking at what makes ENLTT work, our group has identified eight key characteristics of our team that have value in discussing teamwork in general.

1. Teams do not form in a vacuum.
2. Teamwork is not a zero-sum game.
3. Money is not the root of all evil.
4. Teams change everything.
5. Teams need to constantly re-invent themselves.
6. Teams need to be one of a kind.
7. Teams empower.
8. Teams are jazz.

James A. Chatfield, Ohio State University Extension Center at Wooster, Horticulture and Crop Science; Joseph F. Boggs, Ohio State University Extension, Hamilton County, OSU Extension Center at Piketon; Gary Y. Gao, Ohio State University Extension, Clermont County; Erik A. Draper, Ohio State University Extension, Geauga County; Keith L. Smith, Ohio State University Extension, Director; Barbara G. Ludwig, Ohio State University Extension, Associate Director; Stephen R. Baertsche, Ohio State University Extension, Assistant Director.

Note: This article is modified from an article entitled *Teams Change Everything* in the international publication, *Journal of Extension,* April 2004, 42(2).

No. 1:

Teams Do Not Form in a Vacuum

Team history and a team's defining moments are important in understanding team development. The ENLTT formed in 1992, during a period of budgetary challenge within the Ohio State University (OSU) College of Agriculture (now the College of Food, Agricultural, and Environmental Sciences) and Ohio State University Extension (OSUE). For example, due to decreased statewide funding at that time, the number of faculty in the Department of Horticulture fell from 30 to 21. This included an early retirement by a key Extension Specialist in landscape horticulture. This resulted in the chairman of the department calling a meeting of industry clientele; field faculty in the Department of Extension; and research, teaching, and field faculty in horticulture and related departments to discuss how to address resource challenges.

During that meeting, several key statements were made. The first was that with the retirement of the landscape horticulture specialist, the "Extension landscape/nursery program was gone." This statement hung in the room for several beats. It was not an unusual sentiment with regards to a key retirement,

but it sounded so wrong — especially with industry clientele present.

We all looked around the room, and finally someone spoke up that this was not exactly true. After all, there were numerous Extension agents in the room who had horticulture as their specialty area. There were landscape horticulturists with teaching and research positions in the horticulture department; there were entomologists and plant pathologists and turfgrass agronomists from other departments in the room. In fact, a group of at least 20 people easily came to mind as part of an "Extension landscape/nursery program" at Ohio State University.

With that information in mind, someone spoke up and asked industry representatives if they would support a transformation of the program. Instead of 20 talented, competent people who loosely knew what each other was doing in the landscape horticulture program, what if we re-organized as a team of 20 talented, competent people who communicated well enough to additionally harness the genius of team? What if we seriously ran with the ideas of agent specialization and interdisciplinary cooperation? Brian Decker, then president of the Ohio Nurseryman's Association, said that if we seriously developed such a team, "We would not be able to get to the bank fast enough to cash the check."

Talk about defining moments! The rest is history.

From this hook, a team jelled over the next month, coming up with a clear proposal to the industry, asking for financial support for team-building — not simply for money to hire a new person or to provide a new service — but for new money to encourage development of the team. More on that later, but the important lesson is that our team did not arise from simply saying that teamwork is good or necessary, but from a history that includes several defining moments, including a budgetary challenge and a critical interchange with clientele.

No. 2:

Teamwork Is Not a Zero-Sum Game

There are two questions that inevitably occur when a person considers becoming a member of a team:

- How much time will be devoted to team activities?
- What will a team member give up in order to work on team projects?

This relates to the zero-sum idea that team activities will simply replace activities that were previously done individually and that teams will simply make life even more busy, complicated, and stressful.

This means that a team must be able to define how the team will make each person's job more fruitful and successful. A team must be able to show its members how "teamwork is its own reward."

In our case, the *Buckeye Yard and Garden Line (BYGL)* is an example of how we buttressed the altruistic impulses toward teamwork with the energy of synergy that teamwork provides. *BYGL* (Chatfield, Boggs, and Shetlar, 1996) was started in 1993 as a weekly electronic newsletter for our team. Each week from April-October, team members from around the state meet by conference phone on Tuesday morning, discussing landscape and garden plant problems from their area.

A group of *BYGL* writers then convenes on the conference call to decide which items should be written up that week. Over the next two days, each writer completes his or her assigned items, and rotating *BYGL*

senders and proofers construct, proof, and send out the overall *BYGL* in its fax, e-mail, and web versions **(http://bygl.osu.edu/**, enhanced by more than 59,000 fact sheet and 5,000 image links).

The finished *BYGL* is a timely, professional newsletter that comes out every week and is used by diverse sources, including other Extension offices in Ohio and elsewhere, green industry and other horticultural professionals, Master Gardener volunteers, consumers, and the media. It provides the wealth of the Ohio State University expertise emanating as an electronic newsletter from each OSU Extension office.

A quite important internal benefit of the *BYGL* is that contributors directly benefit from a weekly 90-minute interdisciplinary in-service, complete with clarifications, point-counterpointing (Boggs and Chatfield, 1995), and the educational benefit of translating the spoken word into written information — a highly important skill to be regularly honed by Extension professionals. It was once posed that we should try to imagine a world in which we are not truly sure of what we want to say until we have to write about it — and that this is precisely the world in which we live.

Evaluations for *BYGL* are strong. For example, in the 2004 *BYGL* Evaluation Survey, 67% of the respondents indicated that they had changed horticultural practices on the basis of *BYGL*, and 66% indicated that they had changed pesticide-use practices due to *BYGL*. Respondents, who represented less than 10% of actual readers because web-site users were not surveyed, indicated that *BYGL* had saved their company or increased net profits by more than $250,000 (Stone, *et al.*, 2004). *Buckeye Yard and Garden onLine* averaged 5,156 hits for the first six months of 2000.

The bottom line for Extension educators is as follows: Each *BYGL* contributor puts in an average of perhaps four hours a week on the *BYGL*. What do they get back? The most timely, useful, and heralded newsletter any of us have ever developed, one that is available to a diverse clientele in every county. Plus we benefit from a weekly 90-minute interactive, interdisciplinary in-service each week during the growing season. What do we have to give up to spend time on team activities? *BYGL* benefits make the question moot.

No. 3:

Money Is Not the Root of All Evil

We all know that money is only one type of resource, that teams fundamentally rise and fall on their human resources. We also all know how targeted money can sometimes drive a program in ways that interfere with a more open prioritization of activities. An example is certain grants in which dollars flow in attached only to one particular static project that will not allow for needed re-prioritization on the basis of changing circumstances.

With our team, we identified early on that we wanted to develop a new relationship with our industry partners (the Ohio Nursery and Landscape Association and others) that would commit us, together, more clearly to a yearly proposal and yearly funding and accountability. An early question that arose from these discussions was whether this was just a one-shot deal or whether we would continue to make proposals and seek this funding commitment if our budgetary crisis ended. We quickly focused on the proposal, the partnership, the commitment, and the idea of team-

building by being very clear that this was not a short-term relationship we sought, but rather the beginning of a new way of doing business.

With that clear understanding early and with yearly proposals and accounting with our industry partners, we have been generously funded by the Ohio Nursery and Landscape Association with more than $350,000 over the past 12 years. What is this money for? It is essentially for team-building — to make our team better able to deliver information and programming to this important clientele group.

Some of the examples of our expenditures include:

- Reference resources for use of team members for Extension teaching.
- Laptop computers to facilitate rapid development of the *BYGL* each week.
- Cameras to take images used for the *Buckeye Yard and Garden onLine* web site and industry publications such as *Landscape Plants for Ohio.*
- Development of pilot projects such as a Plant Health Care Program.
- Defraying costs for Extension educators throughout the state to send "educator information" samples in to the Plant and Pest Diagnostic Clinic.
- Out-of-state study tours for team members to travel to other states and countries, learning about other Extension systems and alternative horticultural practices, thus providing better insights about our own system ("He who only England knows, knows England least.").
- Addressing local concerns that statewide team activities add costs to county offices (phone costs for *BYGL* are rebated to the county offices from team funds).

No. 4:

Teams Change Everything

Teams such as the ENLTT can help change a broader culture. This happened at the Ohio State University. By 1992 the concept of agent specialization had been put in place by Ohio State University Extension administration. Entrepreneurial team development helped give it form, and administrative support provided ongoing nurture. The process started with ENLTT and others, but OSU Extension now has more than 20 highly active and creative, diverse agricultural and environmental commodity and issue teams. All provide better collegial communication and cooperative planning that ultimately improves delivery of research-based programming and development of partnerships with clientele groups. Teams have also developed in Family and Consumer Sciences, Community Development, and 4-H Youth Development.

As noted in the OSU Extension team brochure:

> *"The development and formation of interdisciplinary commodity/issue teams is aimed at improving communication within our faculty and to better meet the needs of our commodity groups and industry clientele. These teams have focused on improved dissemination of new technology and the development of more comprehensive educational programs aimed at the commercial agriculture and horticulture industries and recreational/urban gardening. Teams are coordinated by county agents, district specialists, and associates represented across departments and colleges. Team directories are available upon request. (Ohio State University Extension, 1999)."*

An acknowledgment of the cultural shift engendered by these teams was highlighted in 1996 with this statement by the national Cooperative States Research Extension and Education System (CSREES) reviewers of the horticulture and crop science department at Ohio State. To quote:

> *"Those Extension teams that the review team learned about were highly productive and able to respond rapidly to clientele. A review team member who recently reviewed Extension programs in several other North Central states observed that Ohio State University was the only one of these institutions where Extension personnel were moving boldly ahead with creative programs.... There are some other departments and colleges in the country that have a strong relationship with their industry clients, but Ohio is near the top of the list."*

No. 5:

Teams Must Reinvent Themselves

ENLTT benefitted from being the first commodity team in the Ohio State University network and from the positive energy that being present at the creation provides. Whether your team is the first of its kind or not, though, it is important to constantly nurture this type of creative energy. Some techniques we recommend to try to keep this energy fresh are presented here.

One of our team mottoes comes from William Shakespeare: "A lily that festers smells far worse than a weed." We use this to jettison programs that do not work for the team.

We learned early on that certain programs become more vigorous from team cooperation *(BYGL* is an example), but that others flounder. One example was a Perennial Plants School that one team member had successfully developed for years. It was, in fact, growing in attendance and quality.

For one, brief, non-shining moment, it became a team activity, with shared responsibility and leadership by none. The energy was lost, the program suffered, and we quickly realized: this was not an example of the energy of synergy. It would decline as surely as a hosta planted in a hot, sunny site. This program was one that was best done by the person who had developed it, rather than doing it as a team activity.

We decided early on that membership in ENLTT was not guaranteed simply on the basis of job description or other presumptions of interest. We formed as a team partly to foster better communication with our clientele, and we were concerned that if any member of our team was not involved enough to know what the team was doing, we would all suffer. So we do expect some level of commitment to team activities. We do not automatically assume people are members of the team when hired, regardless of their position. We post a standing invitation on our team directory:

> *"Membership on the team is based on interest and commitment to the vision and mission of the team. Potential members are encouraged to participate in some of our activities to determine if they would like to become a part of our team. If you are interested in the work of the team, contact any of the team members."*

Our mission and vision statements, torturous as they are to thrash out, provide a good opportunity to think about what we are as a team. As we progress, we periodically revisit and rewrite these statements.

Are we just a commercial horticulture team, or do we also serve the consumer horticulture area? Should we include members from outside the university? How should we proceed to expand our funding base? These are important itches to constantly scratch.

No. 6:

Teams Must Be One of a Kind

Once a team is successful, it can be tempting to try to clone it, to look for a recipe. In a way, this article might seem like just such an attempt. Though we do believe there is value in looking at such stories of teams that have something going and continue to grow (Leholm, *et al.,* 1999), without belaboring the point overmuch, it is not our intent to suggest that any team should look like ours. It is our opinion that cookie-cutter recipes for teams and teamwork, as tempting as they may be, are simply recipes for disaster. Teams work when members believe that teamwork is its own reward; energy cannot be mandated.

No. 7:

Teams Empower

One of the crucial aspects of our team is its high degree of collegiality. It is non-hierarchical in nature, maximizing human resources. Leadership is shared, but often with discrete roles that can be identified for others. Examples include our CTO (Chief Travel Officer) and our Team Financial Czar (TFC). Agent/Educator specialization plays a big role here, with increasing professionalism and recognition region-wide, statewide, and nationally for many of the team members.

Several times at presentations at national Extension meetings, one of the authors was asked how many agents are on the team compared to the number of state specialists. The honest answer, though it could be easily determined, was a suddenly realized "I don't know." We do have a Team Coordinator for administrative contact purposes, and that person calls meetings, assembles meeting agenda items, organizes certain team contacts with clientele groups, and doubles, perhaps, as a CCO, Chief Communication Officer.

Another key human resource component of our team is the extent to which each team member is constantly challenged. This culture has been encouraged in a number of ways.

Point CounterPoint is a popular magazine column that two team members write for a statewide trade journal (Chatfield and Boggs, 1994 - Present). This idea of open, back-and-forth debate is encouraged in team meetings and in *BYGL* conference calls.

The edges of sensitive egos have worn off over time as people learn that different perspectives can be expressed without retribution, that ideas will not be used against the other person. The history of again and again coming into meetings with widely divergent, strongly held opinions only to emerge from the meeting with decisions reflecting the "genius of team" has built strong commitment to vigorous debate in the best tradition of academic and intellectual ferment. We encourage opening our minds to different ways of doing things and have annual team study tours outside Ohio in order to see how Extension works in other states and to see different approaches in the horticultural subject matter area.

Though we value brainstorming and the acceptance of vetting any and all ideas ("multihorticulturalism," so to speak), we also have a team culture that adheres to the principles of reason. In the words of Carl Sagan (Shermer, 1997): "If you are open to the point of gullibility and have not an ounce of skeptical sense in you, then you cannot distinguish useful ideas from the worthless ones. If all ideas have equal validity then you are lost, because then it seems to me, no ideas have any validity at all."

Above all — *Cogita tute! Think for yourself!*

No. 8:

Teams Are Jazz

The social commentator and jazz critic Stanley Crouch (Crouch, 1995) puts into broader perspective the implications of true teamwork, and fittingly sums up the ENLTT experience:

> *The high degree of individuality, together with the mutual respect and co-operation required in a jazz ensemble carry with them philosophical implications that are so exciting and far-reaching that one almost hesitates to contemplate them. It is as if jazz were saying to us that not only is far greater individuality possible to man than he has so far allowed himself, but that such individuality, far from being a threat to a cooperative social structure, can actually enhance society.*

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Landscape Plants and Perennial Plants for Ohio

Timothy J. Malinich, William F. Hendricks, Jane A. Martin, Pamela J. Bennett, Jennifer Gray, Erik A, Draper, Kenneth Chamberlain, Fred Hower, Joseph F. Boggs, Kenneth D. Cochran, Jack Kerrigan, Daniel A. Herms, Curtis E. Young, Larry G. Steward, David E. Dyke, and James A. Chatfield

One of the major OSU Extension Nursery Landscape and Turf Team (ENLTT) projects in 2004 was the team's partnership with the Ohio Nursery and Landscape Association (ONLA) in the development of two popular ONLA publications:

- *Landscape Plants for Ohio*
- *Perennial Plants for Ohio*

These new publications include hundreds of pictures taken and plant descriptions written by the authors listed with this report, with Bill Hendricks providing the most images, Tim Malinich doing exemplary and exhaustive photo editing and computer image management work, and Jennifer Gray providing her ever-professional editorial touches in working with the printers.

Jane Martin, Pam Bennett, Jack Kerrigan, Erik Draper, and Jim Chatfield provided plant descriptions and other written text for the publications. We learned a great deal about the supremacy of digital photography (Pam Bennett was right — again) and about how many things have to go right to get the image you want. And we greatly improved our plant knowledge with the many days needed to make this project work. Special thanks to Jane Martin for her professionalism, expert photography, and endless time dedicated to this project.

Check out a few of the hundreds of images from *Landscape Plants for Ohio* and *Perennial Plants for Ohio* which are shown on the cover of this Special Circular. Read all about plants such as:

Cornus kousa
KOUSA DOGWOOD Zone 5

Small (15- to 20-foot) tree with showy white flower bracts; appealing multicolored bark of grays, browns, and

Timothy Malinich, Ohio State University Extension, Cuyahoga County; William F. Hendricks, Klyn Nurseries; Jane A. Martin, Ohio State University Extension, Franklin County; Pamela J. Bennett, Ohio State University Extension, Clark County; Jennifer Gray, Ohio Nursery and Landscape Association; Erik A. Draper, Ohio State University Extension, Geauga County; Kenneth Chamberlain, Communications and Technology; Fred Hower, The Fred Hower Co.; Joseph F. Boggs, Ohio State University Extension, Hamilton County, OSU Extension Center at Piketon; Kenneth D. Cochran, Secrest Arboretum, Ohio Agricultural Research and Development Center; Jack Kerrigan, Ohio State University Extension, Cuyahoga County; Daniel A. Herms, Ohio Agricultural Research and Development Center, Entomology; Curtis E. Young, Ohio State University Extension, Allen County; Larry G. Steward, Ohio State University Agricultural Technical Institute, Horticultural Technologies; David E. Dyke, Ohio State University Extension, Hamilton County; and James A. Chatfield, Ohio State University Extension Center at Wooster, Horticulture and Crop Science.

tans; stratified horizontal branching pattern; attractive dark green leaves (red-purple fall color), and colorful roundish oversized raspberry-like fruits. Vase-shaped plant grows rounded with age. Prefers sunny moist soils, but better adapted to drought than *C. florida*. Flowers three weeks later and has blossoms elevated above foliage by short flower stalks.

There are many cultivars with white and pink flower forms, foliage variegation, and other features. 'Satomi' is one popular cultivar with pink floral effects. 'Milky Way' is a cultivar of *C. kousa* var. *chinensis,* and has greater numbers of flowers and fruits than the species. Rutgers hybrids are crosses of *C. kousa* and *C. florida* with intermediate characteristics and improved disease resistance over some *C. florida* cultivars. One example is 'Rutcan' (Constellation™) with exceptional flowering.

You may order your copies from:

The Ohio Nursery and Landscape Association, Inc.
72 Dorchester Square
Westerville, OH 43081

614-899-1195, 800-825-5062
Fax: 614-899-9489, 800-860-1713

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buckeyegardening.com

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Weather Summary and Environmental Problems of Ornamental Plants in Ohio: 2004

Pamela J. Bennett

Introduction

This report includes a compilation of Ohio weather conditions and noteworthy environmentally induced plant problems in 2004. Observations were drawn from information provided in Ohio State University Extension's *Buckeye Yard and Garden Line,* the Ohio Department of Natural Resources *Monthly Water Inventory Report,* the National Weather Service, and the State Climatologist's Office for Ohio.

Discussion

Weather Background

This section discusses precipitation and temperature reports for the season. This section contains tables showing statewide precipitation from January through September, the number of days with temperatures over 90ºF, and the average temperatures and departures from normal for three locations in the state, April through September.

January precipitation was above normal across most of the state; the northwestern portion was below normal. Precipitation fell as both rain and snow during every week of the month. The first four days of the month had the most significant amount of rainfall. Several central counties along and south of Interstate 70 were declared disaster areas as a result of flooding.

February precipitation was below normal across most of the state, with more than a dozen reporting stations receiving less than 0.50". Most of the precipitation fell during the first week. The state was still above normal for precipitation amounts for the year.

Precipitation was scattered during March and was generally above normal except for the western third and in some areas of central and east-central Ohio. Snow amounts were above normal in northeastern Ohio as Geauga County reported 28" of snow for the month. This was notably above the area's normal of 15" for March.

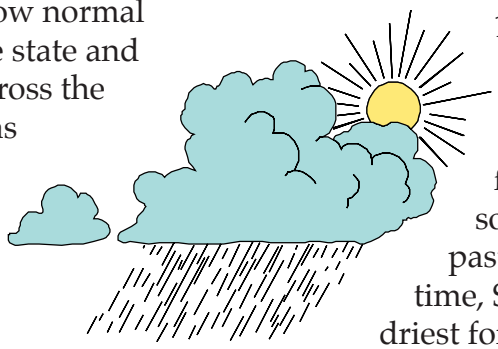
April was below normal for the northwestern part of the state, resulting in the second driest April in 110 years. Several weather stations reported less than an inch of precipitation for the month. Precipitation was above normal for the southeastern portion of the state; Jefferson County reported 6.56" of rain for April.

May was wet, as precipitation was markedly above normal statewide. Regional precipitation averages ranged from 8.09" to 6.31". This was the second wettest May for the state during the past 122 years. Knox County received 11.78" of

Pamela J. Bennett, Ohio State University Extension, Clark County.

rain in May. Precipitation occurred during every week with some locally severe storms on several days. Year-to-date precipitation was above normal for the state except for northwestern Ohio.

June precipitation was below normal in the southern third of the state and generally above normal across the rest of the state. Tuscarawas County reported 11.09" while Clermont reported the least amount at 1.23". Most of the precipitation occurred during the week of June 9 to 17. Precipitation for the calendar year was still above normal except for northwestern Ohio.



Precipitation in July left portions of the west-central and south-central region below normal; the rest of the state was above normal. Van Wert County reported the greatest amount of precipitation with 9.45", and Jackson County reported the least with 1.78". The majority of the rain fell in the second half of the month.

August also brought above-normal precipitation in most of the state, except for the southwest and south-central regions and a few other scattered locations. Coshocton County reported 8.50" of rain, and Ross County reported 1.34". As in July, most of the rain fell in the second half of the month.

The heaviest rain fell on August 27 across the northeastern area, resulting in severe flooding, with the worst conditions occurring in Columbiana County. The area was in a state of emergency as flash floods washed out several roads and bridges. Estimates indicated that nearly 7" of rain fell in about a six-hour period. Early estimates put the damage at more than $10 million. Precipitation for the year was still above normal for most of the state.

In September, precipitation was noticeably above normal in the eastern half of the state as a result of hurricane season. It was below normal in the western half, where hurricane after-effects did not occur. The southeast region averaged 10.25" of rain, while the west-central area averaged 0.92". This was the wettest September for the southeastern and south-central regions in the past 110 years. At the same time, September was the 10th driest for the west-central and southwest-central regions.

Remnants of Hurricane Frances moved through the eastern half of the state on September 9 and dumped anywhere from 3" to 8" of rain. A week later, effects of Hurricane Ivan brought heavy rains to the same areas. Precipitation for the calendar year was above normal statewide.

October precipitation was generally above normal in the southern half of Ohio and below normal in the northern half. The first 12 days were rather dry with light and spotty showers. Precipitation was still above normal statewide. Highland County reported 6.39" while Sandusky County reported 1.35".

Overall, the growing season of 2004 was cool and wetter than normal.

Temperature

Temperatures were generally warmer than normal across the state in April and May and cooler than normal during June, July, and August. The last two summers have been cooler than 2002. See Table 2 for a summary of days over 90°F for June, July, and August for the last three years. Table 3 is a breakdown of the number of days over 90°F for the 2004 season.

Table 1. Statewide Precipitation, January through September, 2004.		
Month	**Average Inches Precipitation**	**Above or Below Normal**
January	3.76	+1.19
February	1.38	-0.88
March	3.32	+0.15
April	3.30	-0.28
May	7.01	+3.10
June	4.87	+1.02
July	4.60	+0.52
August	4.26	+0.82
September	4.30	+1.35
Source: Data from Ohio Department of Natural Resources — Monthly Water Inventory Reports.		

Table 2. Number of Days Over 90°F in June, July, and August.			
	2002	**2003**	**2004**
Cleveland	21	5	0
Columbus	30	5	2
Cincinnati	37	5	4

Table 3. Number of Days 90°F or Above: June – September 2004					
Location	**June**	**July**	**August**	**September**	**Season Total**
Cleveland	0	0	0	0	0
Columbus	0	2	0	0	2
Cincinnati	0	2	2	0	4

Table 4. Temperature in Selected Cities, January through September 2004.						
	Cleveland		Columbus		Cincinnati	
Month	Avg. Temp. F°	Departure F°	Avg. Temp F°	Departure F°	Avg. Temp F°	Departure F°
April	49.0	+1.4	52.6	+0.60	53.5	-0.2
May	62.1	+3.6	66.8	+4.2	67.0	+3.3
June	66.7	-0.8	70.1	-1.10	71.0	-1.0
July	71.4	-0.5	73.7	-1.4	73.3	-3.0
August	68.1	-2.1	70.6	-2.9	70.6	-3.9
September	65.8	+2.5	68.0	+1.5	68.5	+1.1
Source: Average temperature is an average of all high and low temperatures recorded daily for the given location. Data for Cleveland were taken from: **www.csuohio.edu/nws/climate/cle/climatecle.html** Data for Columbus and Cincinnati were take from: **www.nws.noaa.gov/er/iln/lcdpage.htm**						

Some useful websites for weather-related topics are listed here:

Ohio Department of Natural Resources Division of Water, monthly water inventory report
http://www.dnr.state.oh.us/water/

National Oceanic and Atmosphere Administration (NPOAA) drought report
http://www.drought.noaa.gov/

USDA Topsoil Moisture Chart
http://www.cpc.ncep.noaa.gov/products/monitoring_and_data/topsoil.html

Degree day, phenology update for Ohio
http://www.oardc.ohio-state.edu/gdd

Environmental Problems in Landscapes

Low temperatures the second week of May led to frost damage on many garden plants. *Buxus* spp. (boxwood), *Acer saccharum* (sugar maple), and many perennials were damaged as a result. Recommendations were to prune out frost-damaged foliage or allow new growth to cover the damage.

Mushrooms and Other Fungi in Lawns and Gardens

A wet spring led to perfect environmental conditions for mushroom development in lawns, gardens, and flower beds. Numerous calls were made to Extension offices with people inquiring about the kind of mushroom and what should be "sprayed" to eliminate them. There are no sprays recommended to eliminate mushrooms. The best remedy is to wait until they dry up or use a rake or mower to knock them down. Mushrooms tend to sprout from underground fungal growth after prolonged periods of wet weather and often in areas where dead organic matter has accumulated.

Shotgun or artillery fungus continued to persist as a landscape problem and reared its ugly head in mid-April. The fungus, *Sphaerobolus stellatus,* is commonly found in mulched beds and is one of the many organisms responsible for decomposing organic matter in the landscape. The problem with this fungus is that it produces small cup-shaped fruiting structures that shoot spore masses high into the air. The black globules that resemble spots of tar remain stuck to

anything they touch and can be difficult to remove.

Improper Mulching Continues

Volcano mulching is a problem that has been continually addressed by Extension educators, yet it still is practiced in the landscape. This inappropriate method of piling mounds of mulch against the tree trunk can cause a tree to decline in the landscape. Trees that are mulched too deeply can develop stem girdling roots (SGR). As these SGRs continue to grow, they may circle and eventually girdle the tree. A two- to three-inch layer of mulch is sufficient and should be applied such that it is a few inches away from tree trunks and shrub stems.

Other mulch problems include *mulch roots* when shovels or mechanical edgers are used to create a ditch around the edges of mulched areas. The challenge with this practice is that tree roots are often severed, and the resulting tree root system is then confined to the mulched area.

Wet Soils and Sour Mulch

Torrential rains in May left some soils too wet too work. The best advice, of course, was not to work wet soils. However, there are times when plants have to be planted in the landscape. When this occurs, the recommendation is to minimize compaction damage by working in as small an area as possible and avoiding equipment and pedestrian traffic on waterlogged soils. Planting during the wet spring of 2004 was likely responsible for plant stresses later in the season.

A wet spring also provided the perfect conditions for *sour mulch.* Normally, mulch has a pleasant, humus-like odor that is similar to compost or fresh-cut wood. However, under extreme wet conditions, mulch undergoes anaerobic (without oxygen) decomposition, and the microbes produce organic alcohols and acids that have a strong sour odor or an acrid or alcohol-like smell. This *sour mulch* can damage fibrous plant roots and may kill herbaceous plants and turfgrass. If you have this mulch, spread mulch out in a thin layer on a driveway or tarp to aerate until the odor and volatiles dissipate. This may take several days.

Walnut Toxicity

Extension offices frequently receive questions about the adverse effects of black walnut on nearby plants in the landscape. This plant chemical warfare is known as an alleopathy. The roots of black walnut *(Juglans nigra* L.) and butternut *(Juglans cinerea* L.) produce a substance known as juglone that occurs in the leaves, bark, and wood of walnut, but in lower concentrations than in the roots. Juglone is poorly soluble in water and does not move very far in the soil. Many plants, such as tomato, potato, blackberry, blueberry, azalea, mountain laurel, rhododendron, red pine, and apple, may be injured or killed within one or two months of growth within the root zone of these trees.

The toxic zone from a mature walnut tree occurs on average in a 50′ to 60′ radius from the trunk, but can be up to 80′ or more. Young trees 3′ to 8′ in height can have a root diameter twice the height of the tree's canopy, with susceptible plants dead within the root zone and dying at the margins. Susceptible plants that have contact with walnut roots wilt shortly thereafter, even when there is ample soil moisture. Wilting may occur on only part of a plant, or the whole plant may be affected. If detected early, plants in the early stages may recover if additional water is applied. Later, wilting becomes more severe, and browning of the leaves

along with wilting usually results in the death of the plant.

Though there is anecdotal information on plants that are affected, there is no sound scientific research on the subject. Ohio State University Extension (OSUE) has a list of plants that have been observed growing near black walnuts and whether they are affected. OSU Extension Fact Sheet *Black Walnut Toxicity to Plants, Humans, and Horses* (HYG 1148-93) can be obtained from county Extension offices or online at **ohioline.osu.edu**

Yellow Leaves on Maples

A lively discussion occurred this year on *BYGL* when participants were pressed to diagnose interveinal yellowing of maple leaves in a commercial landscape. First impressions were to consider manganese deficiency. However, the discussion quickly branched out into the difficulties of diagnosing such a common problem. Rather than gravitating toward a common cause, the diagnostician must consider other possibilities to avoid overlooking other plant-health issues. Here is the result of the discussion:

> *"First, use soil tests and foliar analysis to identify if a nutritional disorder exists and what that disorder may be. Quick fixes of foliar-applied iron chelates could provide temporary greening, but may in the long term exacerbate the problem under some circumstances if the problem instead is manganese deficiency. The soil test will address the issue of nutrient unavailability due to high pH. The foliar analysis will help identify elements actually in short supply within the leaf.*
>
> *"Second, look at the roots. Conditions inhibiting movement of nutrients into the plant could show up as deficiency symptoms even if the nutrient is available in the soil. Check for girdling roots, girdling twine or wire, disease, or damage from compaction or poor drainage. Air spades provide a non-destructive method of examining root conditions, though careful examination with hand tools is always possible. Samples can be submitted to the C. Wayne Ellett Plant and Pest Diagnostic Clinic.*
>
> *"Third, determine if the tree was properly installed. Poor preparation or improper planting can contribute to a host of problems years after the initial installation. Finally, consider local environmental stresses that might be causing leaf drop or discoloration. Step back and look at the whole landscape to determine if heat, drought, construction, or traffic patterns are an issue. Pinpointing the cause of leaf chlorosis is not as simple as it might seem. Make use of available resources and do not focus on the easiest answer, as it might not be the correct answer."*

Flood Damaged Trees and Other Plants

The floods in August led to the question: "What is the long-term effect of flood water on trees?" It depends on many factors, such as if the tree species is an upland or lowland species *(e.g.,* flood plain species) and how long the tree roots were flooded. The good news was that most trees, even upland or flood-sensitive ones, escape injury if flood waters recede within seven days. From the *BYGL:*

> *"If flood waters cover roots of sensitive trees for longer periods, injury may occur. Flood injury may be exhibited by symptoms such as curling of leaves, leaf chlorosis, and leaf drop. Branch dieback may also occur. In extreme cases of prolonged exposure to flooding, the entire tree may die. Water temperature and*

running or stagnant water conditions may also play a role. Flooding restricts the amount of oxygen in the soil, especially in slowly moving or stagnant water. Cold water helps slow or delay the response of the trees to flooding, while swiftly running water removes layers of soil exposing roots or it may deposit silt and soil on top of the roots. Actively growing tree roots use oxygen at higher rates than when they are dormant.

"Silt deposited when flood waters recede further restricts oxygen availability to the roots, especially on newly planted trees or young seedlings. Tree roots also must contend with toxic compounds carried by the flood waters or produced as a byproduct of anaerobic (without oxygen) decomposition of dead plant materials. A simple bioassay, using tomatoes planted into the deposited silt and soil, will determine if toxic compounds are present.

"Species native to upland habitats, such as pines, white and red oak, sugar maple, tulip tree, black walnut, redbud, linden, and flowering dogwood, exhibit little tolerance to flooding. Healthy, native bottomland species, such as silver maple, green ash, American elm, hackberry, hawthorn, osage-orange, walnut, box elder, river birch, cottonwood, and sycamore, seemed to fare best even after extended periods of flooding. Some species, such as baldcypress, black willow, and water tupelo, tolerate months of floodwaters. Seedlings and saplings of these species that were completely inundated suffered the same fate. Similarly, overmature and stressed trees did not do well.

"Stress allows the weakened trees to be invaded by insects and disease organisms. These 'secondary attackers' prey on stressed trees, most likely due to restricted defense systems of the trees. Stem borers are an important group of insects to be concerned with after a flood or other severe stress event. Borers affect both the water- and food-conducting systems in the trees, creating additional stress, which eventually may lead to plant death.

"Diseases most likely to occur are root rots and cankers due to stressed root systems; also, wounded stems and branches provide easy entrance for diseases."

Dry Plants in September

Despite all of the weather information indicating that the state was above normal in precipitation amounts, September was warm and dry for the west central and southwest part of the state. Gardeners were encouraged to water trees and shrubs deeply to avoid damage and potential loss to new plants. Those in the eastern portion of the state didn't want to hear any more about water; they'd had enough.

References

1. Dr. Jeffery Rogers, State Climatologist, with the State Climatologist's Office for Ohio, provides current and archived weather information for several locations in the state. This information is available at: **http://www.geography.ohio-state.edu/faculty/rogers/statclim.html**
2. The National Weather Service Forecast Office, Cleveland, Ohio, at: **http://www.erh.noaa.gov/cle/climate/cle/climatecle.html**
3. The National Weather Service Forecast Office, Wilmington, Ohio, at: **http://www.erh.noaa.gov/er/iln/lcdpage.htm**
4. The *Buckeye Yard and Garden onLine* is available at: **bygl.osu.edu**

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Insect and Mite Activity Noted in Ohio Nurseries and Landscapes: 2004

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Introduction

Insect and mite activities reported in 2004 in Ohio State University Extension's *Buckeye Yard and Garden Line (BYGL)* and *Pest Evaluation and Suppression Techniques (PEST)* newsletters as well as other sources are summarized and compared to previous seasons. Unusual insect and mite activity is also reported.

Summary

Caterpillars that produce general defoliation were conspicuous by their relative absence in Ohio landscapes during the 2004 season. These included gypsy moth *(Lymantria dispar);* yellownecked caterpillar *(Datana ministra);* and walnut caterpillar *(D. integerrima).* However, giant silkworm moths were commonly noticed, including hickory horned devil *(Citheronia regalis);* polyphemus moth *(Antheraea polyphemus);* cecropia moth *(Hyalophora cecropia);* promethia moth *(Callosamia promethea);* and imperial moth *(Eacles imperialis).* High populations of grasshoppers were observed in western Ohio, but heavy infections of the fungal insect pathogen, *Entomophaga grylli,* were also observed.

A number of sawfly defoliators made their presence known, including dusky birch sawfly *(Croesus latitarsus);* European pine sawfly *(Neodiprion sertifer);* redheaded pine sawfly *(Neodiprion lecontei);* introduced pine sawfly *(N. similis);* and white pine sawfly *(N. pinetum).*

The common bagworm *(Thyridopteryx ephemeraeformis)* appeared in high numbers in the southern and central parts of Ohio, with few damaging populations found in the northern part of the state. Mimosa webworm *(Homadaula anisocentra)* populations were heavy in central and northeastern Ohio. Localized high populations of forest tent caterpillars *(Malacosoma disstria)* occurred in southwestern Ohio, but eastern tent caterpillar *(Malacosoma americanum)* and fall webworm *(Hyphantria cunea)* were virtual "no-shows" in much of the state.

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Boxwood leafminer *(Monarthropalpus flavus)* was a common pest on their namesake in central and southwestern Ohio, and basswood leafminer *(Baliosus ruber)* was heavy in the northwestern and north central parts of the state.

The non-native emerald ash borer *(Agrilus planipennis)* once again garnered a significant amount of attention in northwestern Ohio. The native six-spotted green tiger beetle *(Cicindela sexguttata)* caused some identification confusion with the emerald ash borer in some areas of the state. White pine weevil *(Pissodes strobi)* made its annual appearance in northeastern Ohio, but damaging populations were also common in central Ohio, and this insect surprised landscapers by appearing in the western and southwestern parts of the state.

A number of sucking insects appeared in significant numbers in Ohio, but the emergence of Brood X of the 17-year periodical cicada *(Magicicada* spp.) was by far the most significant insect event in Ohio during the 2004 season. More than 20 counties in the western and southwestern part of the state were affected.

Other sucking insects noted in Ohio for producing significant localized populations during the 2004 season included several species of lace bugs — oak lace bug *(Corythuca arcuata)*, hawthorn lace bug *(C. cydoniae)*, azalea lace bug *(Stephanitis pyrioides)*, sycamore lace bug *(C. ciliata)*, walnut lace bug *(C. juglandis)*, rhododendron lace bug *(S. rhododendri)*, chrysanthemum lace bug *(C. marmorata)*, the basswood lace bug *(Gargaphia tiliae)*, and the beech blight aphid *(Grylloprociphilus imbricator)*.

Spruce spider mite *(Oligonychus ununguis)* populations continued almost unabated throughout much of the 2004 growing season in Ohio, and the pearleaf blister mite *(Phytoptus pyri)* was again a common occurrence on ornamental pears in the southwest and central parts of the state.

Japanese beetle *(Popillia japonica)* adult emergence was very inconsistent between geographical areas of the state, with significant leaf-feeding damage in some areas of Ohio. European chafer *(Rhizotrogus majalis)* adults were once again observed in northeastern Ohio. Bluegrass billbug *(Sphenophorus parvulus)* were common in a number of areas of the state.

New homes were again invaded by foreign grain beetles *(Ahasverus advena)*. Other homes, both new and old, were surrounded or invaded by an unusually heavy population outbreak of springtails. European paper wasp *(Polistes dominulus)* nests were commonly found in Ohio landscape plants, and this introduced insect seemed to make further headway in replacing native wasps. A report on the sumac flea beetle *(Blepharida rhois)* appeared for the first time in the *Buckeye Yard and GardenLine (BYGL)* during the 2004 season.

General Defoliators

Gypsy Moth

Currently, 43 counties in Ohio have established gypsy moth populations. These counties are in the northwestern, northeastern, and eastern parts of the state. However, gypsy moth populations in this area of general infestation have remained at relatively low levels over the past few years in Ohio, and the 2004 season was no exception.

The fungus *Entomophaga maimaiga*, which has become known as the gypsy moth fungus, has been generally credited with limiting gypsy moth population

outbreaks. The fungus infects caterpillars, and increased rates of infection are linked to wet spring weather.

National Weather Service records indicate that Akron/Canton received 6.62 inches of rain during May 2004, which is 3.07 inches above normal. Toledo (Lucas County) had 4.67 inches of rain, which is 1.53 inches above normal. In *BYGL* 2004-12 (6/24/04), we reported that gypsy moth caterpillars in Lucas County were heavily infected with the gypsy moth fungus.

Yellownecked and Walnut Caterpillars

Wet weather conditions may also have played a role in reducing populations of yellownecked and walnut caterpillars. Both are also subject to fungal infections. However, second generation yellownecked caterpillars, which occur during July and August, were also at low levels in the southwestern part of the state at a time when this area was relatively dry. It was speculated that the increased occurrence of the European paper wasp *(Polistes dominulus)* may play a role in reducing caterpillar populations (see the section on the European paper wasp later in this publication). This wasp is a major predator of caterpillars and sawflies.

Giant Silkworm Moth Caterpillars

A considerable number of caterpillars of several species of giant silkworm moths (Family Saturniidae) were observed during the 2004 season in Ohio including hickory horned devil *(Citheronia regalis);* polyphemus moth *(Antheraea polyphemus);* cecropia moth *(Hyalophora cecropia);* promethia moth *(Callosamia promethea);* and imperial moth *(Eacles imperialis).* Although these silkworm moths feed as defoliators, their solitary nature and generally low numbers mean that they seldom cause significant injury to their host plants, so control measures are not recommended.

Indeed, these caterpillars eventually develop into some of the most beautiful moths found in Ohio. Their numbers this past season seemed to represent a reversal of a general decline of these moths over the past several years, generally attributed to the depredations of parasitoids imported to control gypsy moth. *BYGL*ers speculated that the rise of the silkworm moths may be connected to low populations of gypsy moth, and a subsequent reduction in multi-host parasitoids associated with gypsy moths.

Grasshoppers

As with the 2003 season, grasshoppers were once again abundant during the 2004 season in the western part of Ohio. The two most common species observed were the redlegged grasshopper *(Melanoplus femur-rubrum)* and the differential grasshopper *(M. differentialis).* Nymphs of both species were found in great abundance along roadsides, edges of fields, and in other grassy areas, as well as in Ohio landscapes where they caused noticeable damage to a wide range of plants.

However, as with gypsy moth, grasshopper populations also appeared to be significantly affected by a fungal disease. In *BYGL* 2004-24 (6/16/04), Curtis Young reported observing a macabre scene in an old field in western Ohio. Thousands of dead grasshoppers were found clinging to weed and grass stems near the tops of the plants. The grasshoppers had succumbed to the pathogen *Entomophaga grylli. E. grylli* is actually a species complex that has at least two distinct pathogens in North America — *E. macleodii* and *E. calopteni.* These fungi are common in the western

United States and Canada where they are very important agents in managing grasshoppers in crops and rangelands.

E. grylli-infected grasshoppers crawl to the tops of plants and die with their heads pointing upward and their legs wrapped tightly around the stalks of the plants. The cadavers remain attached to the plants for several days until their bodies, having been digested and consumed by the pathogen, dry out. As the grasshopper disintegrates, millions of resting spores of the fungus release into the environment. These spores fall to the ground where they remain on or under the soil. When the spores germinate, they are ejected into the surrounding area.

The spores adhere to the bodies of foraging grasshoppers where they germinate, allowing the fungus to penetrate the grasshopper's body. The fungus consumes the internal organs of the grasshopper, then forms new resting spores. Just prior to its death, the grasshopper climbs to the top of the nearest plant where it dies. Because of the grasshopper's behavior of climbing to the top of the weeds, this disease is commonly called "summit disease."

Summit disease is capable of causing high mortality in grasshopper populations, but epizootics (outbreaks) are usually sporadic and localized, and generally occur late in the season after economic damage to crops and rangelands has occurred. Curtis Young noted that differential grasshoppers were most heavily infected.

Sawfly Defoliators

Dusky Birch Sawfly

As with the 2003 season, significant populations of dusky birch sawfly *(Croesus latitarsus)* were once again observed feeding on birch host in southwestern and central Ohio. The larvae feed on all species of birch, but seem particularly fond of gray birch *(Betula populifolia).* Early instars are grayish-green with indistinct black spots. Middle-instar larvae are greenish-gray with distinct black spots, and late instars are yellowish-green with black spots. All instars have shiny black head capsules and they feed in colonies, lined up head-to-tail along leaf margins.

When disturbed, larvae hang on with their prolegs and form their bodies into a distinct "S" shape, which is another great self-identifier for this insect — S for sawfly! Dusky birch sawflies have two generations in Ohio, so trees can be heavily defoliated during the season. However, they are easily controlled with any standard insecticide labeled for birch trees.

Conifer Sawflies

European pine sawfly *(Neodiprion sertifer)* is a perennial spring pest in Ohio of Scotch, mugo, red, jack, Table Mountain, and Swiss mountain pine, with white and Austrian pines serving as occasional hosts. During the 2004 season, only highly localized pockets of this sawfly were observed with infestations often confined to single trees in landscapes. Indeed, damage was often made more apparent by the stark contrast with unaffected conifers near the infested tree.

This sawfly has one generation per year. It spends the winter in the egg stage. Females use their saw-like ovipositors to deposit eggs in envelope-like slits cut into needles. Egg scars become light yellow, and rows of these scars are usually very evident on infested trees during the winter. Hatched overwintered eggs of the European sawfly were noted in Ohio this year by mid-April.

Heavy localized infestations of late season conifer sawflies were also observed during the 2004 season, particularly in the western and southwestern parts of the state. These included redheaded pine sawfly *(Neodiprion lecontei);* introduced pine sawfly *(N. similis);* and white pine sawfly *(N. pinetum).*

Redheaded pine sawfly larvae have red head capsules, and their bodies are yellowish-white with six rows of black spots. This sawfly overwinters in cocoons in the soil as late instar larvae, or as pre-pupae. Adults emerge, mate, and lay eggs on conifers in the spring. The larvae are gregarious feeders, and their colonies may be found on Scotch, white, red, mugo, and jack pines, as well as on larch, cedar, and Norway spruce. The larvae feed on new and old needles, and occasionally on the tender bark of young twigs. Thus, this sawfly is considered to be one of the most destructive of the pine sawflies. There are at least two generations per year in Ohio.

Introduced pine sawfly larvae favor eastern white pine but may also be found on Scotch, jack, red, and Swiss mountain pines. The larvae have shiny black head capsules. Their bodies have a double black stripe bordered by yellow along the dorsal midline, and their sides are dark with numerous yellow and white spots.

Winter is spent as cocooned larvae on the bark of their host tree. In the spring, adults emerge, mate, and lay eggs. The first generation larvae feed on the previous year's foliage. Early instars feed gregariously, but later instars feed singly. Second-generation larvae feed on both new and old needles. Like the redheaded pine sawfly, larvae of this sawfly will occasionally consume bark tissue when needles are exhausted; however, high populations sufficient to cause this feeding behavior are rare.

White pine sawfly has a distinct preference for its namesake host. However, the sawfly may occasionally be found on pitch, shortleaf, red, mugo, and Swiss mountain pines. Adult wasps emerge in spring, mate, and then females deposit eggs in the needles. Larvae are present between mid-June and late-July, and sometimes for a second generation between mid-August and late-September.

The black-headed larvae are yellow to white in color with four rows of square black spots running along the length of the body. Mature larvae migrate down, or drop out of the tree to the soil or duff under the tree, where they spin brown, oval cocoons. The larvae will either pupate immediately, or remain larvae and overwinter as pre-pupae. There is one, and sometimes a partial second, generation each year.

White pine sawfly feeding can result in branch or tree mortality following complete defoliation. Thus, management may be required when populations are large and the potential for extensive defoliation is high. White pine sawfly is easily managed with many common materials such as acephate, azadirachtin, carbaryl, and spinosad. Applications should be made when larvae are young or as soon as they are discovered. Remember, *Bacillus thuringiensis* var. *kurstaki (Btk)* does not work on sawfly larvae. *Btk* is only effective against the larvae of moths and butterflies.

Nest-Making Caterpillars

Bagworm

Historically, the common bagworm *(Thyridopteryx ephemeraeformis)* is found in higher numbers in the southern half of Ohio, roughly below a line bounded on the northern edge by Interstate 70.

However, during the 2003 season, high populations were observed throughout the state, with significant damage found in Toledo. During the 2004 season, the population distribution of this moth appeared to conform to historical boundaries. Few damaging populations were observed in northern Ohio while heavy infestations were common in the southern and west-central parts of the state.

Bagworms practice an unusual form of reproduction called paedogenesis (reproduction by larvae). Only the males pupate and emerge as flying moths. The female bagworm larvae do not pupate, nor do they exit their bags. They enter the last larval instar stage with mature sexual organs and produce a sex pheromone that attracts the male moths. Males fly to and mate with the females as they remain in their larval bags. After mating, the female's body rapidly fills with fertilized eggs, then she dies and becomes a dried, mummified "egg case" surrounding 300 to 1,000 eggs. Thus, the eggs overwinter inside the female's body, inside the bag.

Egg hatch occurs in the spring. This season, egg hatch began in the Cincinnati area in mid-May and was completed by the end of the month. Male moths began emerging in that part of the state in early September.

Mimosa Webworm

*BYGL*ers in northern and central Ohio observed heavy localized infestations of mimosa webworm *(Homadaula anisocentra)* on honeylocust during the 2004 season. Larvae of this moth feed gregariously within webs spun over the foliage. They feed primarily as skeletonizers on the lower leaf surface, and the damage causes leaves to turn orangish-brown and appear fire-scorched. Unlike with other web-makers, these clusters of "torched" leaves, rather than the actual webbing, usually draw attention to an infestation.

There are two to three generations per season in Ohio, and they typically overlap so that larvae may be present anytime from June into September. Also, female moths often deposit their eggs on nests from which they developed, so nests continue to expand and become more dense with silk and spent leaves from one generation to the next. Once nests become large and tightly woven, control applications may fail to penetrate the thick webbing.

The best time to control the caterpillars is early in the season, when nests are small and consist of loosely woven silk. Effective early season materials include *Bacillus thuringiensis (Bt),* as well as other insecticides listed in Ohio State University Extension Bulletin 504, *Insect and Mite Control on Woody Ornamentals and Herbaceous Perennials.*

Forest Tent Caterpillar

Significant numbers of forest tent caterpillars *(Malacosoma disstria)* were observed cavorting among the periodical cicadas in southwestern Ohio. Despite its common name, forest tent caterpillars construct only rudimentary mat-like silk nests on leaves, or on bark.

The caterpillars are only gregarious in their nesting behavior during early instar stages. Later instar caterpillars break from the colonies and feed singly among the host's branches. They are general defoliators and feed on a wide variety of deciduous trees, including sweetgum, oak, birch, aspen, maple, elm, and basswood. This moth caterpillar is capable of producing significant defoliation during population outbreaks.

Forest tent caterpillars have short grayish-white hairs and distinct white markings running down their backs. These markings have been variously described as looking like foot prints, or as being keyhole-shaped. The markings are flanked by cobalt blue lines running the length of the caterpillar's bodies.

The caterpillars are sometimes mistaken for other hairy caterpillars, such as eastern tent caterpillars or gypsy moth caterpillars. Eastern tent caterpillars have a distinct, unbroken white stripe down their backs. Gypsy moth caterpillars have five pairs of blue spots followed by six pairs of red spots running down their backs.

Eastern Tent Caterpillar

Overwintered eggs of eastern tent caterpillar *(Malacosoma americanum)* hatched in the Cincinnati area by the end of March, and small nests constructed in branch forks were evident the first week of April. However, as with the rest of the state, overall populations were relatively low, with only an occasional significant infestation.

Fall Webworm

Likewise, fall webworms *(Hyphantria cunea)* were also something of a no-show during the 2004 season. Despite numerous reports of significant numbers of first-generation nests, the second generation failed to make the curtain call. First-generation nests are usually very small and inconsequential, owing to small numbers of caterpillars.

Truly impressive nests enveloping large areas of leaves at the ends of tree branches are constructed by the greater caterpillar work force available in the second generation.

Leafminers

Boxwood Leafminer

As with the 2003 season, heavy localized boxwood leafminer *(Monarthropalpus flavus)* populations were observed in southern and central Ohio during the 2004 season. This tiny midge-fly spends the winter in the larval stage in blister-like leaf mines.

As spring approaches, the orangish-yellow larvae resume feeding for a short period, then pupate. Pupation was reported to occur in southern Ohio from mid-to-late April, and high numbers of adults were observed the first week of June. Adults superficially resemble miniature mosquitoes; however, they have bright orange abdomens.

Once larvae begin to pupate, the delaminated leaf tissue turns from light green to yellow, and finally to yellowish-orange. The color change is usually complete only after adults emerge. Damage produced by this leafminer is sometimes misdiagnosed as a nutrient deficiency or winter injury.

Larval control options include an application of imidacloprid *(e.g.,* Merit), made as a soil drench in late fall, which kills overwintering larvae. This strategy has proved to be very effective and also controls boxwood psyllids *(Psylla buxi).* Overwintered leafminer larvae may also be killed with a spring soil drench application of imidacloprid; however, this application may not control the psyllids.

A more traditional approach involves applying acephate *(e.g.,* Orthene) as a foliar systemic spray once egg laying is completed in the spring. Timing of the application is critical and requires close monitoring of leafminer activity.

Basswood Leafminer

The basswood leafminer *(Baliosus ruber)* once again caused noticeable defoliation of American basswood or linden *(Tilia americana)* in northwestern and north central Ohio. This beetle was first noted in the *BYGL* in 2000, with heavy populations and noticeable damage observed in the western part of the state.

The small, wedge-shaped reddish-yellow beetles have dark markings on their wings. They spend the winter in leaf litter under host trees and emerge in the spring to begin skeletonizing newly expanded foliage. Eggs are laid singly at the edges of skeletonized areas in early to mid-June. Larvae mine leaves until about mid-July and produce blotch mines. When large numbers of larvae are present, individual mines run together, producing extensive blister-like mines.

After pupation in late-July to early August, new adults begin to appear and continue to skeletonize the foliage. It is the late-season adult feeding that does the most damage to the leaves. When the adults are abundant and the feeding is intense, the entire canopy of a tree may be completely skeletonized, causing the foliage to turn brown, wither, and fall off. Trees that are heavily attacked for two to three years may show thin crowns and dead branches.

The basswood leafminer occurs throughout the eastern United States and Canada, wherever basswood grows. Although basswood is its preferred host, it has been reported feeding on oak, maple, willow, birch, hop hornbeam, apple, and cherry. In Ohio, it has been observed feeding on American basswood and oak only in woodlots.

However, during the 2004 season, adult beetles were observed feeding on ornamental lindens at Stranahan Arboretum near woodlots with heavily infested basswoods. Control of this beetle is not currently recommended, but if it continues to spread into landscapes, its control may be necessary in the future.

Borers

Emerald Ash Borer

In 2004, the non-native emerald ash borer *(Agrilus planipennis)* once again garnered the lion's share of attention among tree borers. More infestations were found in Ohio, but all were confined to the northwest part of the state. More information on this very significant borer may be found at this web site — **http://ashalert.osu.edu** — and later in this special circular.

White Pine Weevil

White pine weevil *(Pissodes strobi)* has been traditionally viewed as a Christmas tree and nursery production pest in Ohio, and in the past it was rarely found outside the northeastern part of the state. However, over the last few years *BYGL*ers have noted that the white pine weevil is now a common landscape pest that is frequently being found in the central part of Ohio.

During the 2004 season, a significant localized infestation of this borer was found in southwestern Ohio. This may indicate the weevil is now establishing itself in the southern part of the state. The change could present a diagnostic challenge to landscape and nursery managers unfamiliar with this insect.

This weevil has one generation per year. Overwintered females deposit eggs in the terminals of their conifer hosts, which include their namesake as well as Scotch, jack, red, and pitch pine plus Douglas-

fir, Colorado blue, and white spruce. The resulting white, legless, slightly curved, grub-like larvae tunnel downward just beneath the bark until pupation. Mature larvae construct pupation chambers, called chip cocoons, beneath the bark. The cocoons are created by the larvae positioning their bodies in tub-shape grooves excavated in the xylem, and then surrounding themselves with small, white wood chips.

Larval development is typically completed by mid-to-late summer. The tops of infested trees become wilted, turn brown, and die. Main leaders are often curved into a shepherd's crook. Larval tunneling usually does not progress past the top two lateral limb whorls; however, on small trees, larvae may tunnel to the base of the main stem, killing the entire tree.

Control measures focus upon preventative insecticide applications and sanitation. Wilted terminals should be removed and closely examined for evidence of weevil activity as soon as this symptom becomes evident. The cut ends of the removed stems should be inspected to make certain all the larvae have been removed. Infested material must be destroyed since the weevils will complete their development in cut tops left on the ground.

Insecticide applications made to terminals in early spring target overwintered female weevils as they feed on terminal tissue. Timing of these applications is critical, since the weevils only feed a short period of time before they lay eggs.

Another approach is to use imidacloprid *(e.g.,* Merit) sprays or soil drenches. The drenches appear to be more effective, especially if applied in October or November of the previous season. Soil drenching with imidacloprid is a viable control approach for managing white pine weevil in landscapes, where only a few trees must be protected. However, it may not be a cost-effective choice in nursery or Christmas-tree production.

Sucking Insects

Brood X Periodical Cicada

The emergence of Brood X of the 17-year periodical cicada *(Magicicada* spp.) was by far the most significant insect event in Ohio during the 2004 season. More than 20 counties in the western and southwestern part of the state were affected. Ohio was not alone. This cicada brood is the largest in the United States in terms of geographical distribution. Cicadas emerged in parts of Georgia and other states north to Michigan, and east into New Jersey. Observations made in Ohio are captured in excerpts from two *BYGL*s:

BYGL 2004-08 (5/20/04):

• Joe Boggs and Dave Dyke noted that periodical cicada activity has progressed rapidly, from a trickle to a roar, over about a 10-day period (May 15 – May 24) in Greater Cincinnati. The cicada males have been chorusing in unison since late last week; mating is in full swing; and oviposition is now occurring. Joe indicated that Kamikaze cicada strikes to his windshield as he drove the I-275 loop around western Hamilton County were bracing. Motorcyclists beware! Dave Shetlar reported that cicadas are now in full emergence in Greater Columbus, with males beginning to chorus and mating now occurring.

• On May 17, Joe Boggs checked a mix of 100 newly emerged (cream-colored) and fully colored cicadas in Oak Hill Cemetery in northern Hamilton County and found they were all were males, and they were all one species — *Magicicada cassini.* On May 19, he checked 50 fully colored

cicadas and found the male/female ratio to be 40/10. However, 50 newly emerged cicadas checked that day were found to be all females. It is common among many mass-emerging insects for males to emerge first.

Joe noted that *M. cassini* continues to be the only species he has found at the Oak Hill location. Dave Shetlar indicated that it is not unusual for localized segregation to occur among the three periodical cicada species common to Brood X *(M. cassini, M. septendecula,* and *M. septendecim).* He noted that *M. cassini* tended to be found in dry, upland locations. Dave reported that he is finding all three species in central Ohio.

• *BYGL*ers reported observing a soft "rain" falling from trees heavily populated by cicadas. Dave Dyke described it as looking like a fine mist as it was being reflected in shafts of sunlight filtering through tree canopies. The observation reminded *BYGL*ers that cicadas are indeed sucking insects (they resemble giant aphids), and they do feed. The observed "cicada-dew" is analogous to the "honey-dew" excreted by aphids. While *BYGL* readers have reported observing serious injury to herbaceous plants caused by the sucking activity of emerging cicadas, the most significant injury to plant materials is caused by the oviposition activity of the females. *BYGL*ers noted that oviposition damage is not yet evident.

BYGL 2004-10 (6/10/04):

• Jim Chatfield and Joe Boggs reported that periodical cicadas received a great deal of attention at this week's Ohio Plant Diagnostic Workshop held at Spring Grove Cemetery and Arboretum in Cincinnati. Workshop participants observed heavy oviposition on a wide range of trees and shrubs. The subsequent dieback of branch tips, or flagging, was just becoming evident, primarily on oaks. However, all agreed that the amount of flagging observed was just the tip of the iceberg. More is expected over the coming weeks. A surprising observation was the amount of egg laying that had occurred on ash leaf petioles, causing leaves to drop from the trees. The ground beneath several ash trees was littered with a considerable number of leaves, all with oviposition slits.

• While cicadas continue to sing in Cincinnati, they appear to be running out of steam — dead cicadas are now raining down from heavily infested trees in many locations. Pam Bennett noted that she has received phone calls from homeowners reporting foul odors from the accumulating dead cicadas in Clark County.

• Curtis Young noted that he has been amazed at the considerable discontinuity of cicada populations within the reported range of Brood X. The historical method of using clusters of counties as a basis to delineate brood emergence boundaries does not accurately depict the actual population distribution. For example, Curtis (ever the intrepid entomologist) reported that he had to leave his location in Allen County and drive all the way to Defiance County to enjoy the Brood X experience!

*BYGL*ers also noted they have observed extremely spotty, localized concentrations of cicadas. Areas with high populations and areas with negligible populations are often separated by only a few miles. However, several *BYGL*ers reported that they had observed large numbers of cicadas appearing in areas where there was little or no emergence from the ground. This movement did not appear to be over great distances since the newly infested areas were generally in close proximity to localized cicada "hot spots."

Lace Bugs

Lace bugs were very active in Ohio during the 2004 growing season with oak lace bugs *(Corythuca arcuata)* on bur and chestnut oaks, hawthorn lace bugs *(C. cydoniae)* on hawthorns, and azalea lace bugs *(Stephanitis pyrioides)* on azaleas leading the pack.

Other lace bugs commonly observed included sycamore lace bug *(C. ciliata);* walnut lace bug *(C. juglandis);* and rhododendron lace bug *(S. rhododendri).* The unusual chrysanthemum lace bug *(C. marmorata)* that lives on both the upper and lower leaf surfaces of its host caused damage to several herbaceous perennials, particularly asters.

Basswood lace bug *(Gargaphia tiliae)* was observed causing considerable damage to silver lindens *(Tilia tomentosa)* in northern Kentucky, just across the river from Cincinnati. Silver lindens have long been appreciated for their distinctive foliage. Their leaves feature an upper surface that is a lustrous, glistening dark green, while the lower surface is a soft silver. Breezes prompt glimmering displays as the silvery undersides of the leaves flicker in and out of view.

Unfortunately, when basswood lace bug populations are high, the captivating leaf features of the silver lindens are obscured. The normally dark green upper leaf surface appears light green to yellowish-green.

While such heavy damage on *Tilia* is rare for this insect, it is not unknown, and it is not confined to one species of lace bug. Walnut lace bug may also be found on the undersides of *Tilia* leaves, as well as butternut and black walnut leaves. Most insecticides labeled for use on *Tilia* control these insects.

Beech Blight Aphid

Over the past few years, the beech blight aphid *(Grylloprociphilus imbricator)* has waltzed from oddity to common occurrence in northeastern and central Ohio. During the 2004 season, the aphid kicked up its heels in the southwestern part of the state, with high populations commonly observed on American beech.

This woolly aphid enshrouds itself in a profuse mass of white, wool-like filaments. The aphids gather together in prominent colonies on twigs, branches, or on the underside of leaves of American beech trees. When a colony is disturbed, the aphids exhibit an unusual collective behavior by vibrating their posterior ends in unison. This behavior has been accurately described as causing the aphids to look like "dancing dust balls shaking their rear ends to the boogie woogie."

On large trees, aphid colonies are usually relegated to a few branches. However, on small trees, the entire canopy may become infested. The aphids are also prolific producers of honeydew, causing branches, sidewalks, parked cars, slow-moving gardeners, etc., beneath the colonies to become covered in sticky goo. The honeydew may become colonized by black sooty molds, converting the gummy accretions into blackish heaps.

Fortunately, the aphids are easily controlled with a focused stream of water, and the water pressure available to most homeowners is sufficient to convert the aphid's dance into a cascading water ballet.

Mites

Spruce Spider Mites

The spruce spider mite *(Oligonychus ununguis)* is often a serious pest of conifers

in Ohio. Damage symptoms include tiny yellow speckles, or stippling, on needles that may coalesce to produce intense yellowing or bronzing of the foliage. This is a cool-season mite, with damaging populations typically occurring in the spring and fall. The mites spend the summer months in the egg stage. Spring populations shift into the egg stage once the mites experience three consecutive days with temperatures above 86ºF.

However, during the 2004 season, the shift into the summer egg stage did not occur in much of Ohio until early September. Consequently, damage continued to accumulate throughout much of the season. Fortunately, landscape and nursery managers experienced a bit of a reprieve, since the normal egg hatch and development of high populations in the fall also failed to materialize with any significant regularity throughout the state. Reasons for the failure of fall adult populations to appear are unknown, but it was speculated that heavy rains may have washed mites from their hosts before significant numbers could accumulate.

Pearleaf Blister Mite

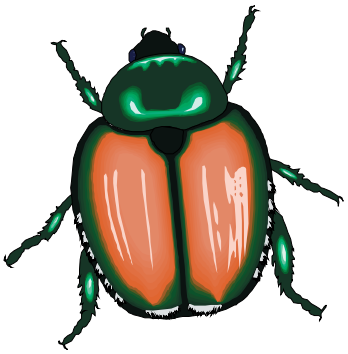
Pearleaf blister mite *(Phytoptus pyri)* was again a common occurrence on ornamental pears in southwestern and central Ohio during the 2004 season, with heavy localized populations observed. Symptoms may superficially resemble other problems, such as fungal leaf diseases, and in extreme cases, even bacterial fireblight.

The microscopic carrot-shaped eriophyid mites feed between the upper and the lower leaf surfaces, causing blisters to form on the upper leaf surface, and patches of brown-to-black necrotic tissue to form on the lower leaf surface. The blisters are at first light-green, but later they turn pinkish-red and finally black. When mite populations are high, the entire leaf may blacken and droop.

Turf Pests

Japanese Beetle

Japanese beetle *(Popillia japonica)* adult emergence in Ohio during the 2004 season appeared to be very inconsistent between different areas of the state. In some areas, beetles emerged over an extended period of time in a trickle of low numbers that seemed to go on forever. Feeding damage accumulated. This has been a common trend over the past few years in much of the state. However, other areas experienced a rapid emergence of high numbers of adults, but the emergence quickly came to a halt. Intense feeding damage seemed to occur "almost overnight."

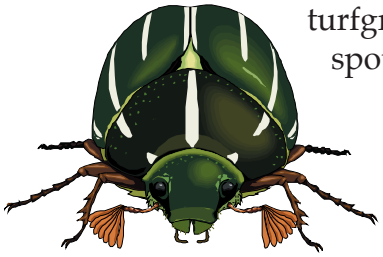


Speculation regarding reasons for the disparate emergences focused on weather patterns during previous seasons. Dry soil conditions occurring during the egg stage, a time when soil moisture is critical to egg development, may have caused some geographical populations to become more synchronous. Regardless, the observations reinforce the notion that insect behavior throughout Ohio cannot be painted with a broad brush.

European Chafer

There was once again a significant emergence of European chafer

adults *(Rhizotrogus majalis)* in northeastern Ohio. Mass mating flights of this beetle have become a common occurrence in late June in that part of the state in recent years. Although the beetles do little damage to trees and shrubs, these chafers participate in spectacular mating flights. Beginning at sunset, swarms of the brown adult beetles hang in large groups from the lower branches of trees. As mating progresses, the preoccupied beetles lose their grip and fall to the ground. The adults separate, and the female eventually seeks moist organic soils in which to lay her eggs.



Eggs hatch in mid- to late-July with second instar grubs developing in early August. Best controls for European chafer grubs are achieved by treating from the latter part of July into early August with products containing imadicloprid or halofenozide. So far, this non-native beetle has only been found in the northeastern part of the state.

Other Turf Insects

As with the 2002 and 2003 seasons, heavy localized infestations of bluegrass billbug *(Sphenophorus parvulus)* were again observed in central and southwestern Ohio. However, continued rains tended to mask damage produced by larvae feeding on stems and crowns.

Hairy chinch bugs *(Blissus leucopterus)* were very active in the Dayton, Columbus, and Akron-Canton areas. The first sign of chinch bug feeding damage is that some leaves turn a purple color. These damaged leaves soon turn yellowish-orange. Chinch bug damage may appear similar to symptoms associated with summer drought, and it is also sometimes mistaken for symptoms produced by certain turfgrass diseases such as dollar spot, leaf spot, or brown patch.

Household and Nuisance Pests

Foreign Grain Beetle

In 2004, construction of new homes in Ohio once again achieved a record high. Consequently, encounters with the foreign grain beetle *(Ahasverus advena)* were also a very common occurrence throughout the state. The consistent connection between this beetle and newly constructed homes has caused some entomologists to propose that it be re-named New House Beetle.

This elongated, and slightly flattened, beetle is reddish-brown and about 1/16" long. It belongs to the same family (Cucujidae) as the saw-toothed grain beetle *(Oryzaephilus surinamensis)*. Indeed, it is almost a dead-ringer for its toothy cousin but lacks the saw-toothed projections on the pronotum, which is the thoracic segment just behind the head. Another important distinction is that the foreign grain beetle is seldom found feeding on grain, except for moldy grain. This insect belongs to a group of beetles known as fungus beetles, because the larvae feed on fungi.

The adult beetles are attracted to fungi growing on the surface of damp grain or on damp plaster and drywall, as well as poorly seasoned wood. Damp sawdust within walls that is left behind during construction may also provide a good substrate for molds or mildews. The beetles lay their eggs on the fungal infested materials, and the larvae feed on the fungi. Typically, larval development continues as the new homes are being finished, and a new batch of homesteading beetles emerge, shortly after the new homeowners move in.

The beetles are only a nuisance since they do not bite or damage wood, fabric, or other materials. They most frequently are associated with homes constructed during the summer months. Populations found in homes tend to disappear after the initial adult emergence, unless air-tight construction techniques limit drying. Drying-out newly constructed homes can be enhanced by increasing ventilation using fans and dehumidifiers.

European Paper Wasp

The European paper wasp *(Polistes dominulus)* continues to expand its beach-head in Ohio; it is now one of the most common wasps found in the state. This exotic, invasive species is native to countries around the Mediterranean Sea.

It was first discovered in the United States in Cambridge, Massachusetts, during the late 1970s. Since then, it has spread to Maine, Vermont, Connecticut, New York, New Jersey, Maryland, Pennsylvania, Ohio, Michigan, California, and Washington. In many of these states, the European paper wasp also appears to be displacing the northern paper wasp *(Polistes fuscatus)*, a native species.

The wasp looks like a yellowjacket because of its yellow-and-black color patterns. The nest it constructs is the typical upside-down umbrella shape with open cells pointing downwards. It is typically a cavity nester, but when a cavity is not found, it will use other protected sites such as under deck railings and roof eaves, but more importantly, the European wasp has also been observed nesting in dense trees and shrubs.

During the 2004 season, nests of varying sizes were observed in several types of trees and shrubs including boxwoods, arborvitae, privet, spruce, and viburnum. Although much less aggressive than its American cousin, the wasp's nesting behavior increases the possibility and danger of landscapers, nurserymen, and homeowners encountering these wasps while working on or around ornamental trees and shrubs.

The Unusual

Springtails

Each year, *BYGL*ers encounter certain insects that are "enjoying" a truly remarkable population outbreak. This season, reports of springtails covering the mulch and flower beds near homes and "flooding" into homes continued from spring to early fall in Ohio, especially in the central and southwestern parts of the state. Although springtails are a common insect found in mulch and moist areas indoors, the *BYGL*ers were surprised to hear stories of "millions" teeming across the mulch, covering the surface of swimming pools, and dying by the thousands in first-floor rooms and basements.

Springtails (Order Collembola) are small (less than 1/8") wingless insects with a gradual form of metamorphosis. Unlike complete or incomplete metamorphosis, there are almost no outwardly detectable morphological changes to the insects as they mature to adults. Springtails derive their name from a structure called a "furcula." The furcula is a forked apparatus on the fourth-fifth abdominal segment which is kept folded underneath until the springtail needs to jump to escape danger. At this point, the furcula springs downward and back, catapulting the insect 15 times its length to safety.

The springtail family most often encountered in leaf litter, under bark, and around homes is Entomobryidae. These elongate, grayish to black insects eat

fungi, bacteria, dead insects, and decaying debris. They are considered beneficial in small numbers outdoors; however, when the environmental conditions cause moisture-loving bacteria and molds to escalate in growth, the springtails multiply to peak populations as well, and they may reach pest status.

Most entomologists agree that controlling these outbursts requires detecting the source(s) of moisture and the habitats that support the springtails, and modifying these areas. This management strategy is recommended over using a pesticide, because not only will solving the moisture problem reduce the springtail population to acceptable levels, but neglecting to repair a leakage may precipitate more serious problems.

Common sources of moisture outdoors include newly sodded lawns which are irrigated frequently, or lawns and flower beds which have an improperly set irrigation system. Lawn managers should closely monitor the amount of water distributed. Turfgrass specialists advise watering thoroughly (up to 1"), only once a week.

Thatch should be kept less than a half-inch in thickness as moist thatch contains a myriad of organic debris and does not dry as long as water is continuously supplied. Irrigation heads should be directed away from the foundation, and downspouts should extend several feet away from the house.

Gutters that are clear of leaves and debris are less likely to spill water onto the ground or against the house. Water lines and air conditioner pipes which are prone to condensation should be wrapped. Grading the soil so that rainwater flows away from the foundation will also help to keep the interior walls dry as well.

Mulch is an enormous source of springtails, as the wood provides moisture, food, and protection for numerous insects including springtails as well as spiders and other arthropods. A graduate student in entomology at Ohio State found that hardwood mulch supports a wide variety and number of insects, followed by wood bark and nuggets. Inorganic mulch had the fewest number and variety of insects.

For best results, maintain no more than 2" of mulch in the beds, and keep it at least 6 to 8" away from the outside parameter of the building.

Indoors, springtails are commonly found in bathrooms, basements, and crawl spaces. Molds which live on cool, moist walls and floors are consumed by springtails. Leaking or sweating pipes and appliances that use water often support small amounts of molds and bacteria as well. Newly built homes that are tightly insulated are often slow to dry and can be infested with springtails, fungus beetles, and foreign grain beetles for the first several years. Stacks of firewood, moldy paper, rolled rugs and boxes of fabric, magazines, or books are good habitats for springtails as well. Houseplants with constantly wet soil or drainage trays that never dry are also prone to springtail invasions.

Normally, once the source of the constant moisture is amended, either outside near the home or indoors, the springtails diminish. Cooler weather and a dryer environment also thwart springtail populations. These record numbers of springtails may or may not occur again for several years.

Sumac Flea Beetle

Curtis Young reported encountering a beetle he had not seen before while on

a diagnostic walk for Master Gardeners in Hancock County. The beetle was discovered devouring the foliage of over half of a 20′ long by 8′ wide stand of sumac in an ornamental planting. Multiple plants were completely defoliated with obvious branch die back. Numerous beetles were present on the remaining foliage and were easily collected. While looking at the beetles in the palm of his hand, they began to jump like flea beetles. The beetle was eventually identified as the sumac flea beetle *(Blepharida rhois).*

The beetle has a body shape that is very similar to the Colorado potato beetle; however, it is only about one-fourth to one-third the size of the potato beetle. The sumac flea beetle is one of the largest flea beetles in the United States.

The head and thorax is a shiny caramel-brown color, and some of the females have a caramel-olive green color. The rest of the body is a dark chestnut-brown color. The elytra (front wings) also are chestnut brown, overlaid by varying amounts of white, causing the elytra to look as though they were sprayed with artificial snow used to frost windows. The hind legs of the beetle have the enlarged femurs typical of flea beetles.

Little is known of the basic biology of the sumac flea beetle. However, Curtis was fortunate to observe beetles that were mating and laying eggs. The eggs were discovered on the main trunks, branches, and stems of the sumac plant. Initially, the egg masses were overlooked because they look like piles of fecal material.

Samples were collected and examined more closely, and it was found that females lay a random pile of eggs, and then they defecate on the pile. This egg laying behavior is also practiced by several other insects to disguise the eggs and conceal them from predators and parasites. The sumac flea beetle may overwinter in the egg stage.

Six-Spotted Green Tiger Beetle

Extreme concern over emerald ash borer is causing any green insect to be viewed with suspicion. During the spring, several *BYGL*ers received phone calls from Ohioans reporting emerald green beetles cruising wood-lots and forests in the southwestern part of the state. The callers feared the beetles were the dreaded emerald ash borer. The green beetle in question was the six-spotted green tiger beetle *(Cicindela sexguttata).* This is actually a native insect, and it is a predator with a very predatory-sounding name.

Tiger beetles belong to the family Cicindelidae. The common name for this family is descriptive since all tiger beetles are ferocious predators. Adults seize their prey, which includes small insects, with powerful sickle-shaped mandibles. Tiger beetles have long legs, and they are fast runners. They are also very good fliers.

As one would expect of a predator, they have excellent eyesight, and their protruding eyes make the beetles look like they are wearing goggles. Tiger beetles have elongated bodies, but the thorax is usually about half the width of the front wings and abdomen. Most tiger beetles have a shiny metallic color. This adds to the confusion with Agrilus beetles, which share similar colors and are commonly called metallic wood borers.

The tiger beetle's fine eyesight, quick speed, and flying agility makes it difficult for people to get a close look at the beetles, hampering positive identification. The six-spotted green tiger beetle has spots that are white and arranged along the trailing edge of the wing covers, three per side. However, reflective light bouncing off their shiny green color sometimes

obscures these spots. Their green color is a slightly lighter shade than the color of the emerald ash borer. Also, as with most Agrilus beetles, the thorax of the emerald ash borer is almost the same width as the abdomen. Green tiger beetles are common insects in the woods of Ohio, and they seem to prefer zipping around forest paths.

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Summary of Diseases of Landscape Plants in Ohio: 2004

James A. Chatfield, Nancy A. Taylor, Erik A. Draper, Amy K. Stone, Gary Y. Gao, David J. Goerig, Joseph F. Boggs, Curtis E. Young, and David E. Dyke

Introduction

The growing season of 2004 started wet and continued cool and wet through late spring and into mid-summer for many areas of the state, especially in the northeastern and central Ohio areas. This resulted in considerable disease pressure for many foliar diseases of landscape plants, from apple scab and rose black spot to anthracnose diseases on trees and *Botrytis* gray mold problems on herbaceous landscape plants.

In addition, continued cool and wet conditions in summer resulted in unusually severe incidences of diseases such as *Septoria* leaf spot of shrub dogwoods and downy mildew of doublefile viburnums, with considerable defoliation on these plants from these diseases in 2004. Here are additional disease highlights, gleaned from the *Buckeye Yard & Garden Line (BYGL)* and other sources. Also included is a discussion on fungicide use and the annual edition of *BYGLosophys* for your edification and amusement.

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Breaking the Disease Cycle

Remember that of the three components of the plant disease triangle — susceptible host plant, virulent pathogen, and environment conducive to disease — the sweetest way to control disease is to prevent it in the first place by selecting plants with excellent genetic resistance to key diseases. If you find yourself each year getting call after call about why the leaves are falling off the crabapples you installed and you are muttering that "it is the same darn thing over and over again," break the cycle.

Need an upright scab-resistant crabapple? Try 'Adirondack.' Need a spreading weeper? Try 'Manbeck's Weeper.' A true weeper with soft pink flowers? 'Louisa.' Wild and crazy growth habit which somehow still works? 'Strawberry Parfait.' Yellow fruits? 'Holiday Gold.' Purple fruits? 'Prairifire.' Bright red fruits that persist well into winter? 'Red Jewel.' A Sargent type with pink flowers? 'Candymint.' For more on crabapple taxa and their susceptibility to apple scab disease, see the article on crabapples in this Special Circular.

Similarly, tired of those zinnias with powdery mildew disease? Try the

'Profusion' hybrids, which are crosses between *Zinnia angustifolia* and *Zinnia elegans*. Same beef with powdery mildew on beebalm? Go with *Monarda didyma* 'Petite Delight.' We do not have plants with outstanding resistance to key diseases in all of our ornamentals, but when we do, lets not waste this information. Knowledge is (flower) power!

A Wet Spring May Mean Apple Scab on Crabapple

In the world of apples and crabapples, one thing that really begins to show up during a very wet spring is the fungal disease called apple scab. The pathogen, *Venturia inaequalis,* depends upon hours of leaf wetness in order to infect susceptible leaves and fruit on apples and crabapples. Symptoms first appear in the spring as spots (lesions) on the lower leaf surface, because the lower side is first exposed to fungal spores when leaf buds open.

At first, the lesions are usually small, velvety, olive green in color, and have unclear margins. As lesions mature, the fungal infection becomes darker and more distinct. Heavily infected leaves become distorted and may begin to drop early in the summer. Trees of highly susceptible varieties may be severely defoliated by mid- to late-summer.

The apple scab fungus overwinters on infected leaves on the ground around the tree. Millions of spores are produced on these dead leaves at about the time new growth begins in the spring. During rainy periods, these spores are discharged and lodge on succulent susceptible tissue, like leaves, flower parts, and fruit.

A spore germinates in a film of water, and the fungus penetrates into the plant tissue. Depending upon weather conditions, symptoms (lesions) show up in as little as nine to 17 days. The infection originating from the overwintering stage is called primary scab. Because a film of water on leaves and fruit is required for infection to occur, apple scab is most severe during years with frequent spring rains.

The primary scab fungus produces a different kind of spore in these newly developed lesions. Spores produced on a primary scab lesion are responsible for secondary infections. These spores are carried and spread by splashing rain to other leaves and fruits where new infections occur.

Secondary infection can occur in 12 to 20 days. This secondary infection cycle may continue to develop and spread throughout the summer. As long as environmental conditions favor development of the fungus, the cycle of infections, spore production, spore release, more infections, etc., will continue.

The use of genetically resistant or scab-immune varieties is the ideal method for controlling scab. Most commercially grown apple varieties are susceptible to scab; however, they differ in their degree of susceptibility. Crabapples vary widely in their susceptibility to the apple scab fungus, but there are many crabapples with both excellent scab resistance and superior horticultural characteristics for Ohio. Fungicides are another option but need to be applied early in the season, for crabapples starting with petal fall.

Why Disease Evaluation Is Forever

Evaluating plants for disease resistance is important — and it needs to occur in different locations, and it needs to be ongoing. For example, the International Ornamental Crabapple Society (IOCS) plots throughout the United States help provide growers with a profile of where each crabapple shines or does not shine.

'Weeping Candied Apple' belies the latter part of its name if it grows where fruit scab is severe. 'Golden Raindrops' is outstanding as long as it is not growing in a climate where it is regularly warm and wet during bloom, since these are the keys to bacterial fireblight which can be the Achilles heel for 'Golden Raindrops.'

'Thunderchild' has been defoliated by apple scab many years in Ohio. However, it is still attractive and has wonderful blueberry-colored fruits in the low scab pressure environs of Idaho.

But what of a plot at one location? Is there really any point in continuing with evaluations once you know how well a particular crabapple does? It certainly makes sense to rate new crabapples, but what about ones that have been around for a long time? Don't we know by now how well they will do? What more is there to learn?

Well, plants and their pathogens prove all the time that there are new things under the sun. A few decades ago 'Indian Magic' crabapple was listed by evaluators as "highly resistant" to apple scab. Today we would rate it as "highly susceptible." What happened? Though we have not proved it, the key is probably the development, in nature's ongoing natural laboratory, of a new race of the apple scab fungus *(Venturia inaequalis),* resulting in 'Indian Magic' now exhibiting a high degree of scab.

Is the same thing happening to 'Prairifire' at the IOCS plot at Crablandia at Secrest Arboretum in Wooster? Erik Draper and Jim Chatfield have evaluated 'Prairifire' at Secrest for over a decade, and there are records for its scab incidence (actually lack thereof) going back for more than two decades. For much of that time, it was clean as can be, but several years ago we began noticing "a trace" of scab on 'Prairifire.' This was significant because the absence of scab over the previous years was clear-cut. It was not an example of disease "escape," in which there was no disease observed simply because the plants were not challenged by the pathogen. There was plenty of *Venturia inaequalis* in the same plot, merrily defoliating other crabapples, while 'Prairifire' was unscathed. So something had changed, again presumably the presence of a new race of the scab fungus.

The latest findings? In 2004, scab on 'Prairifire' in the plot at Secrest is significantly worse, though still moderate. This might be expected, since this was a big year for scab overall due to the wet spring weather we had in much of northeast Ohio. Nevertheless scab on 'Prairifire,' at least at this location, has progressed from merely being a curiosity, probably unnoticed by most, to a level that is now obvious, though still by no means severe. Nature has demanded that we stay tuned.

Mayapple Rust

This rust disease is a spectacular annual reminder that plant pathogens interacting with plants is part of the fabric of nature, not just a landscape or garden aberration. The bright orange pustules of the mayapple rust fungus become evident on the parasol-like leaves of mayapple each May in woodlands throughout the state. The disease is seen as yellow spots on the upper leaf surfaces and incredibly bright orange pustules of the rust fungus itself on the undersurface of the leaves. In some cases these pustules result in major distortion and early senescence of the leaves.

This is an autoecious rust disease, occurring only on may-apples, not going back and forth between two

different plants such as with cedar apple rust (junipers and rosaceous hosts) or white pine blister rust (white pines and gooseberries). Populations of mayapples in the woods seem to handle the annual occurrence of this disease each year and no controls are recommended for these habitats.

Note: Two optional conventions were deliberately used in the previous item for mayapples. You could call them mayapples or you could call them may-apples. Either the compound word or the hyphenated word is acceptable, though may apples as two separate words is not. Why? Because may-apples, *Podophyllum peltatum,* a plant in the Berberidaceae or barberry family, is obviously not a "true"apple (it is not in the genus *Malus* in the Rosaceae or rose family), and to indicate this, the word is properly denoted by either hyphenating or compounding. Similar examples are pineapple and osage-orange.

Phytophthora Root Rot of Fraser fir

The pathogen for this disease *(Phytophthora cinnamomi)* has a wide host range and a very bad reputation among horticulturists relative to its ability to cause root rot on plants. Fraser fir is definitely a host of this pathogen and *Phytophthora* root rot of Fraser fir was a problem for Christmas tree growers in Ohio in 2004.

One grower sent samples to Ohio State University's C. Wayne Ellett Plant and Pest Diagnostic Clinic with significant root rot, including brownish-black root discoloration indicating the presence of the pathogen, and even some overall deep blackening of the root system. This latter is suggestive of low soil-oxygen conditions — and that is the key to how significant and successful this pathogen will be in winning the war in the rhizosphere between pathogen and plant roots.

Although fungicides such as metalaxyl can help with management of this fungus, the presence of significant problems in field plantings suggests that the real problem to address is soil drainage. This involves either living with what you have by shifting to less susceptible crops or doing something to address drainage — not the easiest thing to accomplish if the problem is not external drainage. Sometimes growers think Phytophthora cannot be a problem because the plants are growing on a slope, but this ignores the reality of poor "internal" drainage, the presence of low air pore space in heavy clay soil conditions.

Black Knot of Plum

This disease, caused by the fungus *Dibotryon morbosum,* is commonly noted each year on fruiting plums and cherries and on ornamental *Prunus* species as well. The black knot fungus mainly affects twigs, branches, and fruit spurs. On infected plant parts, abnormal growth of bark and wood tissues produces small, light-brown swellings that eventually rupture as they enlarge. In late spring, the rapidly growing young knots have a soft (pulpy) texture and become covered with a velvety, olive-green growth of the fungus. In summer, the young knots turn darker and elongate. By fall, they become hard, brittle, rough, and black.

During the following growing season, the knots enlarge and gradually encircle the twig or branch. The cylindrical or spindle-shaped knots may vary from 1/2" to 1' or more in length and up to 2" in diameter. Small knots may emerge from larger knots, forming extensive galls.

After the second year, the black knot fungus usually dies, and the gall is

invaded by secondary fungi that give old knots a white or pinkish color during the summer. Smaller twigs usually die within a year after being infected. Larger branches may live for several years before being girdled and killed by the fungus. The entire tree may gradually weaken and die if the severity of the disease increases and effective control measures are not taken.

To control this fungal disease, infected twigs should be pruned out and destroyed, or removed before bud break. It is important to prune at least 2 to 4" (5 to 10 cm) below each knot because the fungus grows beyond the edge of the knot itself. Fungicides can offer significant protection against black knot, but they are unlikely to be effective if pruning and sanitation are ignored. Where infectious spore concentrations are high because of an established black knot problem, or a neighboring abandoned orchard, protection may be needed from bud break until early summer.

For the most current fungicide recommendations and spray schedules, backyard growers are referred to Bulletin 780, *Controlling Diseases and Insects in Home Fruit Plantings,* and commercial growers are referred to Bulletin 506-A2, *Ohio Commercial Tree Fruit Spray Guide.* Both are Ohio State University Extension publications and may be obtained from your county office of OSU Extension or by contacting Media Distribution, Communications and Technology, The Ohio State University, 385 Kottman Hall, 2021 Coffey Road, Columbus, OH 43210-1044. Phone: 614-292-1607; fax: 614-292-1248. E-mail: pubs@ag.osu.edu. Visa and MasterCard accepted.

Coccomyces Leaf Spot of Cherry

"Mild, wet summer weather promotes *Coccomyces* leaf spot." That should be enough to predict it would be more noticeable than usual in the summer of 2004, and that was, indeed, the case. This leaf spot is a big deal if you are a sour cherry orchardist, and spray programs are important in such cases, but for landscape and woodland cherries, this disease is more a matter of curiosity, though we tend to get curiouser and curiouser in years like the cool, wet summer of 2004.

Symptoms start with clusters of small purple spots on one area of the leaf blade, coalescing over time, turning a dark brown, and being associated eventually with leaf yellowing and leaf drop. Sometimes areas of the spots drop out, leaving a shothole appearance, but there are also several other cherry leaf diseases that also exhibit shothole symptoms.

Final note: Modern taxonomists identify this pathogen as *Blumeriella jaapii,* but the use of the old (incorrect) name of *Coccomyces* as the pathogen name is so entrenched that *"Coccomyces* leaf spot" is retained. More than you wanted to know!

Why Fungicides 'Fail'

This fungicide does not work! I want my money back! Who recommended it! I just want a simple solution to this dratted disease!

These are common laments when it comes to fungicides and when it comes to infectious diseases. These laments reflect an understandable but unreasonable desire to make horticulture, plant pathology (the study of plant diseases), and fungicide use simple. The fact is that control of diseases and the use of fungicides is anything but simple.

It's now over a hundred years since a plant pathologist quipped that "Plant pathology must be far more than mere squirt gun botany," but this observation still holds

true. There is more to disease control than fungicides, and there is more to proper fungicide use than simply pointing and spraying. Let's look at some of the key reasons why fungicides "fail." Note that often the fault lies not in the fungicide, but in the fungicide user. As Pogo would say, "We have met the enemy — and he is us." Let's start with some examples that point out the importance of proper plant problem diagnosis.

- **Faulty Diagnosis of Disease**

This is one of the most common reasons for fungicide "failures." For example, over the years, many growers and landscape managers have complained that this or that fungicide is just not effective in controlling *Phomopsis* blight on juniper in their plantings. This disease causes the dieback of shoots of juniper and can cause quite a bit of unsightliness and damage to the plant.

As pointed out by research in Ohio and Pennsylvania, however, one of the most common reasons for "failure" is that the problem was initially misdiagnosed. Many factors cause dieback on junipers, from juniper tip midge insects and juniper tip dwarfmites to winter desiccation injury and vole damage to the stems. Naturally, if these are the causes of the dieback rather than the *Phomopsis* fungus, then fungicides will surely "fail" over and over again.

The problem is simply not a fungal disease. Proper diagnosis is Step 1 relative to proper, and successful, use of fungicides.

- **Faulty Diagnosis of the Type of Disease**

Even when a problem is correctly diagnosed as an infectious disease, fungicides may not be even part of the answer. Remember that there are different types of plant pathogens, from fungi to bacteria, from viruses to nematodes. For example, a common term used for many diseases is "blight." *Phomopsis* **blight** of juniper, *Sphaeropsis* tip **blight** of pine, *Volutella* leaf **blight** of pachysandra — all are fungal diseases, and fungicides may play a role in control of these diseases.

However, **fireblight** of pyracantha, crabapple, and Callery pear and bacterial **blight** of lilac are caused by bacteria, and so different types of pesticides must be used for control, rather than simply using a fungicide, though certain copper products are helpful in control of some bacterial and fungal diseases.

Simply thinking that if it is a blight, then a fungicide should help control it, is not good enough.

- **Faulty Fungicide Selection**

Even if the problem is correctly diagnosed as a fungal disease, it is important to remember that all fungi are not equal — and all fungicides are not equal. For example, certain fungicides are effective against water mold fungi such as *Pythium* and *Phytophthora,* while other perfectly good fungicides work for other fungi, but not for water molds.

Jim Chatfield distinctly remembers two decades ago using a soil drench systemic fungicide in cutting geranium production and still getting about 25% loss to *Pythium* blackleg disease — until he realized that the benzimadazole product he was using in the Colorado greenhouse he was managing, while excellent for certain soil fungi, was next to useless for water molds. He shifted to a combination product which included a water mold fungicide (etridiazole) and got good overall control of soil fungal pathogens, and a rate of *Pythium* blackleg of about 1% to 2%.

If this were simply a quaint historical footnote, then no matter, but the same type of mistakes are being made today.

Remember that each fungicide has its strengths and weaknesses. By way of example, chlorothalonil is great for *Botrytis* and many leaf spot and leaf blight fungi; propiconazole is excellent for rusts, powdery mildew, and many leaf fungi; thiophanate-methyl is an excellent overall fungicide for leaf diseases and for certain root and crown rotting fungi but not water molds; and metalaxyl is excellent for water mold fungi but not other fungal disease problems.

- **Improper Timing**

Once the disease is properly diagnosed and the right fungicide is selected, then everything should fall into place, right? Not. Another major reason for fungicide failures is improperly timed applications.

The fact is that for fungicides to be effective, we must apply them before the disease develops. This is clearly true for "protectant" fungicides, and it is effectively true even for products which are described as "eradicants" and "curatives."

Let's use as an example — rose black spot disease (pathogen: *Diplocarpon rosae).* The fungal pathogen infects through leaves of susceptible rose taxa — if there are a certain number of hours of leaf wetness at a given temperature. Under these conditions, spores germinate and penetrate the leaf surface and into leaf cells where the fungus establishes a host-parasite infection.

Protectant fungicides are applied to the foliage to kill the fungus during its period of spore germination and attempted penetration of the leaf. These fungicides are essentially a toxic barrier to the fungus, preventing the fungus from getting inside the leaf where the infection occurs. If the fungicide is not present and infection does occur, some time later (typically a week or more) symptoms of black spot disease become evident (black spots, foliar yellowing, leaf drop, plant stress).

Eradicant or curative fungicides provide a little leeway, along the order of getting rid of the fungus within 24 to 72 hours of initial infection.

There are several important things to keep in mind relative to this disease progression. First of all, you cannot see any of this happen, at least not until symptoms of black spot develop, perhaps seven to 10 days or more after initial infection. *Diplocarpon rosae* spores are invisible to the naked eye, and we also cannot see the spores germinate, penetrate, or infect the leaf cells.

Second, even the eradicant and curative products will not stop infections beyond a few days at most. So, you may spray a fungicide on what looks like a perfectly healthy, non-infected rose leaf which is nevertheless already infected and fated to develop rose black spot.

When the disease develops, of course, we rage about the fungicide not working. The fact is that it never had a chance to work if it was applied after the infection was underway. This hardly seems fair, but such is the problem with disease control. It is largely preventive in nature. You must prevent infections, not see the disease symptoms and then try to get rid of the problem.

With most diseases, all is not necessarily lost once you see the disease, since in most cases the disease is reasonably localized, and prevention of new infections is helpful in disease control even if you cannot get rid of the infections already present

by using fungicides. Applications after symptoms are observed make sense if there is a repeating cycle of the disease on the host.

For example, rose black spot keeps coming and coming all season long, so even if you see symptoms, it makes sense to prevent new infections which will surely come if the weather remains wet.

However, with cedar hawthorn rust disease, there is no repeating infection cycle on the hawthorn after initial infections in the spring, and once you see the rust spots on the leaves, there is no reason to spray. What's done is done, and there are no more infections that will come that season, so more fungicide applications are beside the point. Of course, the key in both cases is to prevent initial infections — if the particular disease in question is deemed important enough to prevent.

Remember, that each disease is unique and that understanding the disease cycle for that particular disease is the key to effective fungicide use.

• Over Reliance on Fungicides

Fungicides are an important tool in fungal disease control, but they are rarely stand-alone miracle answers to disease problems. Rose black spot again provides a good example. Here it is important to remember the concept of the disease triangle. This simple, but important, concept is that for disease to occur it is necessary for all three of the following to be present — a susceptible host, an environment conducive to disease, and a virulent pathogen.

In managing a rose garden for rose black spot disease, attacking the components of the disease triangle means:

- Planting as many rose taxa as possible that have good genetic resistance to black spot disease.
- Limiting leaf wetness by avoiding overhead watering, by planting in the sun, and otherwise promoting good leaf drying conditions.
- By limiting the pathogen.

Limiting the pathogen involves good sanitation in removing diseased leaves and canes during and after the season — and the use of fungicides to prevent infections.

Of course, complete success in breaking the disease triangle at any point would control disease. For example, with the host part of the triangle, use of only roses with excellent genetic resistance to black spot would prevent the disease. Similarly, the environmental part of the disease triangle can be attacked by never allowing the leaves to get wet. This seems impossible until you realize that greenhouse rose growers can do exactly that, with greenhouse roofs stopping the rain and through the use of trickle irrigation in which the leaves stay dry. Finally, complete sanitation of black-spotted rose tissue in the garden (and nearby gardens) or complete and perfect timing and coverage with the proper fungicides could theoretically break the pathogen component of the triangle.

Reality, though, is far different. Black-spot-susceptible roses are planted or inherited by the manager due to lack of information on resistance or because certain horticultural characteristics are desired from a particular rose taxon despite black-spot susceptibility. As opposed to greenhouse production, roses grown outdoors are subject to unwanted and uncontrolled irrigation — known as rainfall — and wet years mean bad black-spot years.

Finally, sanitation and fungicide timing and coverage are never perfect. The upshot of this is that you cannot rely on any one form of disease control — and this includes fungicide use. Good plant-health-management programs require integrated approaches in which fungicides are only one component.

Avoid the mistake of waiting until you have a major problem and then trying to solve it with a quick fix.

• Confusing Fungicide Names

The Chinese philosopher Krishtalka noted that "The beginning of wisdom is calling things by their right names." The same can be said about proper and successful use of fungicides and, of course, all pesticides. Pesticides have three different names — the chemical name, the common name, and the trade name.

Horticulturists usually deal with common and trade names but often fail to even realize what they have in their pesticide cabinets. For example, just a few trade names for the fungicide with the common name of chlorothalonil are Exotherm Termil, Ortho Daconil Plant Disease Control, PathGuard 6F, Thalonil, Bravo, Bravado, and Echo 500. Different formulations and different trade names, but all containing chlorothalonil. An applicator needs to know what he has at hand by knowing both trade names and common names.

Another example of knowing what is in the products you buy and use is that there are a number of combination products which combine fungicides with different activity. Some products combine a contact and a systemic fungicide. Examples would be combining thiophanate-methyl and chlorothalonil. Brand names of this combination include ConSyst WDG and Spectro WDG. Other combination products mix in a good water mold fungicide with a fungicide good for control of other fungi. Examples would be etridiazole and thiophanate-methyl sold under the brand name of Banrot.

Horticulturist, know thy products!

• Fungi May Develop Resistance to Fungicides

The active ingredients of fungicides attack certain sites of the fungi that result in affecting fungal metabolic processes and killing fungal cells. Of course, as with everything in nature, fungi fight back. Through genetic recombination and mutations, over time fungi develop various modes of overcoming the action of certain fungicides.

Imagine a world in which a mutation occurs in a few individual spores out of millions and millions of spores of a particular fungal pathogen, conferring resistance of those spores to the mode of action of a particular fungicide. Imagine that you keep spraying that same fungicide over and over. The result would be that your spraying would be selecting for the survival of only the resistant strains of the fungus. Soon, only resistant strains would be present and the fungicide would lose its usefulness. The reality is that to a certain extent, this is exactly what happens.

Fungicide resistance is a real problem, and a good reason to rotate fungicides. For example, there are some great new fungicide products, called strobilurins (*e.g.*, Heritage, Compass, Cygnus). Many fungicide users like them because they consider them "green fungicides" since they are derived from a naturally occurring organism, *Strobilurus tenacellus*. However, there are concerns over the development of resistance to the strobilurins, if used exclusively.

The simple solution is to rotate your fungicide use to different classes of fungicides, thus avoiding selecting each time for the resistant strains of the fungus. Diversify.

There are more reasons for fungicide failures, from inadequate coverage of the susceptible parts of the plants (adjuvants are sometimes necessary) to phytotoxicity from using too high a rate or using a particular product on a sensitive plant. Good horticulturists know that you need to keep observing and keep learning to effectively use any plant management tool, and fungicides are no exception.

One great learning resource for all pesticides is to READ THE LABEL. Recent polls show that fewer and fewer average Americans read pesticide labels. Lets make good on the claim that professional horticulturists are far above average!

*BYGL*osophys — And Then Some

Here are some thoughts to ponder in the coming year, starting with the ever-inspiring words of University of Georgia horticulture professor emeritus Michael Dirr:

I have been fortunate to work at a great university that supports and encourages the faculty to improve their subject matter competence via sabbatical and travel. A respectable professor is an even better student. Plants are neither learned nor appreciated from Internet gleanings. They must be observed, stroked, studied, grown and photographed at different times and places. With hydrangeas on the brain, I have traveled to many collections for such activities. At one garden in the southwest of England, approximately 360 cultivars of Hydrangea macrophylla unfolded before my purview. The mind became mush, the knees buckled, and the camera imploded.

And now more for your quotebook:

[on seeding]: "One for the rook, one for the crow, One to die, and one to grow."

Spring makes its own statement, so loud and clear that the gardener seems to be only one of the instruments, not the composer.
— Geoffrey B. Charlesworth

Dead Trees are like road-kill; the tree will have borers like the road-kill has maggots.
— Dan Herms

I have found, through years of practice, that people garden in order to make something grow; to interact with nature; to share, to find sanctuary, to heal, to honor the earth, to leave a mark. Through gardening, we feel whole as we make our personal work of art upon our land.
— Julie Moir Messervy

Earth knows no desolation. She smells regeneration in the moist breath of decay.
— George Meredith

In June, as many as a dozen species may burst their buds on a single day. No man can heed all of these anniversaries, no man can ignore all of them.
— Aldo Leopold

And tis my faith, that every flower enjoys the air it breathes.
— William Wordsworth

Learning is a treasure that will follow its owner everywhere.
— Chinese Proverb

Summer afternoon - summer afternoon; to me those have always been the two most beautiful words in the English language.
— Henry James

An early morning walk is a blessing for the whole day.
— Henry David Thoreau

There can be no other occupation like gardening in which, if you were to creep up behind someone at

their work, you would find them smiling.
— Mirabel Osler

Gardening is a kind of disease. It infects you, you cannot escape it. When you go visiting, your eyes rove about the garden; you interrupt the serious cocktail drinking because of an irresistible impulse to get up and pull a weed.
— Lewis Gannit

Doubt is not a pleasant condition, but certainty is an absurd one.
— Voltaire

The nature of science is such that every case is perpetually open to appeal on procedural grounds or in light of new evidence. This chronic uncertainty is what irritates many of the observers of science — and it is precisely what excites the practitioners.
— Jeffrey Lockwood, in "Locust"

What a man needs in gardening is a cast-iron back, with a hinge in it.
— Charles Dudley Warner

Nature does have manure and she does have roots as well as blossoms, and you can't hate the manure and blame the roots for not being blossoms.
— Buckminster Fuller

The supreme accomplishment is to blur the line between work and play.
— Arnold Toynbee

By all these lovely tokens
September days are here,
With summer's best of weather
And autumn's best of cheer.
— Helen Hunt Jackson

Observe these green meadows how they are decorated, they seem enameled with the beds of flowers.
— William Bartram, Naturalist

Winter is an etching, spring a watercolor, summer an oil painting, and autumn a mosaic of them all.
— Stanley Horowitz

The beginning of wisdom is calling things by their right name.
— Krishtalka.

Fine writers should split hairs together, and sit side by side, like friendly apes, to pick the fleas from each other's prose.
— Logan Pearsall Smith

In libraries and museums, the [scientist] may find the dry bones of knowledge, but only in Nature's own museum can he clothe those dry bones with beauty and life.
— Charles Riley.

Ecology is boring for the same reason that destruction is fun.
— Don DeLillo

Whatever could make two ears of corn, or two blades of grass, to grow upon a spot of ground where one grew before, would deserve better of mankind, and do more essential service to his country, than the whole race of politicians put together.
— Jonathan Swift

There are two spiritual dangers in not owning a farm. One is the danger of supposing that breakfast comes from the grocery, and the other that heat comes from the furnace.
— Aldo Leopold

...making the yellow soil express its summer thought in bean leaves and blossoms rather than in wormwood and piper and millet grass, making the earth say beans instead of grass — this was my daily work.
— Henry David Thoreau

And finally...

There was a young wormling from Rome
Who yearned to make Malus his home
He searched and he searched
For a perch to besmirch
But crab-apple was too tiny a pome.
— 1st Earl of Pome-roy

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Performance of Five Ornamental Crabapples (*Malus* sp) on Seven Size-Controlling Rootstocks

D. C. Ferree, J. C. Schmid, and K. D. Cochran

Commercial apple growers have a long history of using a wide range of size-controlling apple rootstocks to tailor tree size to meet desirable tree spacing and training systems. Many of these rootstocks also encourage earlier and more profuse flowering and fruiting and may also offer disease resistance.

To satisfy the variable needs due to space limitation and garden design, it would appear desirable to tailor-make crabapples to meet these needs. Ideally, crabapples selected for disease resistance and desirable ornamental characteristics could be made available in a range of tree sizes by selecting the appropriate rootstocks. Since these trees would be designed to fill special needs, they should be a value-added product.

To determine the feasibility of this approach, an experiment was established to evaluate the performance of five ornamental crabapples that were important commercially on seven apple rootstocks selected to produce a range of tree sizes from very small to full size.

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Materials and Methods

In the spring of 1998, apple rootstock liners were ordered from commercial suppliers as follows: M.27EMLA, M.9EMLA, M.26EMLA, M.7EMLA, MM.111EMLA from TRECO, Woodburn, Oregon; domestic seedling, Bailey Nurseries, Inc., St. Paul, Minnesota; Antanovka 306 from Lawyer Nursery, Inc., Plaines, Montana. The rootstock liners were set in the nursery area of Secrest Arboretum at a spacing of one foot in the row and six feet between rows. Any shoots developing on the bottom 10 inches were removed during the summer, and weeds were controlled by hand as needed.

Scion wood of the flowering crabapples listed here was secured from the commercial nurseries that propagated these cultivars — 'Adirondack,' 'Golden Raindrops,' 'Louisa,' 'Prairifire,' and 'Molten Lava.' Thirty trees of each rootstock were T-budded with each crabapple on August 27, 1998. Both rootstock and scion wood were slipping with good budding condition. All trees were cut above the inserted buds in early spring of 1999.

A significant number of buds failed, and these rootstocks were cut to a single shoot and budded a second time in August of 1999. Bud take and average shoot length were recorded for each combination. In the fall of 2000, a U Blade Barerooter was

borrowed from D. L. Crawford Nursery to dig the trees, which were placed in underground storage over the winter.

The following spring (2001), the eight best trees of each combination were selected and planted at a spacing of 10′ x 20′ in eight north-south rows at Horticulture Unit I of The Ohio State University's Ohio Agricultural Research and Development Center in Wooster. Treatments were arranged as a split plot with crabapple cultivar as the whole plot and rootstock as the split plot with eight single-tree replications.

Trees on M.27 and M.9 were staked with a metal T-post and tied, with all others being free-standing. Trees were pruned as little as possible, only removing branches below 2.4 inches and any broken branches. Herbicide was used to control vegetation in a four-foot band in the tree row and row middles mowed as needed.

This planting was adjacent to a pear planting with considerable fireblight, and in 2001 and subsequent years, infection occurred, and the degree of the trees infected was counted. Following the growing season of 2003, tree height and spread were measured, and the percentage of the tree with fruit estimated.

Results and Discussion

Bud take in the nursery of the cultivar rootstock combinations differed widely, with no buds surviving of 'Adirondack'/M.26 and 'Louisa'/M.27 (Table 1). The same people budded the trees. In adjacent rows of some of the same rootstocks budded to commercial apple cultivars, bud take exceeded 85% of all combinations.

Across all rootstocks, the best bud take occurred in 'Prairifire,' with nearly 85% take, and poorest with 'Louisa,' with only 33%. Across all cutivars, the best bud take occurred with Antanovka 306 with 85% and poorest with M.27 with only 31%. If a take of 66% (20 out of 30) is selected as the lower limit of acceptable, there were 14 combinations below this level.

Although we cannot definitely ascertain the cause of the poor bud take of some combinations, the following can be eliminated: personnel doing the budding; quality of the rootstocks; and quality of the scion wood, since some combinations of all cutivars and rootstocks had acceptable bud take.

Crabapples are often indicators for latent viruses, and it is possible that certain combinations had a hypersensitive reaction, causing the buds to abort. The dismal bud take of some combinations with all cultivars except 'Prairifire' would suggest that commercial producers of crabapples should avoid many rootstocks until a test of compatibility is accomplished. It is interesting that all these rootstocks are considered compatible with commercial apple cultivars.

Due to tree quality or lack of adequate bud take, the following combinations were not included in the field plantings: 'Adirondack' on M.7 or M.26 and 'Louisa' on M.27 and MM.111. Survival in the field also varied considerably due to the cultivar rootstock combination. Each cultivar had 100% survival on one or more rootstocks, and all rootstocks except Antanovka 306 had one or more cultivars with complete survival. Some of this loss, particularly with 'Golden Raindrops,' was due to infection with fireblight, but other losses were likely a combination of incompatibility identified in bud take in the nursery.

Generally, shoot length and trunk cross-sectional area differences had similar extremes caused by the cultivars and

Table 1. Survival of Nursery Bud Take and After Three Years in the Field of Five Flowering Crabapples *(Malus)* on Seven Rootstocks.

Rootstock	Nursery Survival (of 30 budded)					
	'Adirondack'	'Golden Raindrops'	'Louisa'	'Prairifire'	'Molten Lava'	Total
M.27	20	9	0	7	21	57
M.9	12	25	22	22	27	108
M.26	0	12	22	28	28	90
M.7	11	26	6	29	26	98
MM.111	27	29	3	21	27	107
Antanovka 306	21	27	25	28	27	128
Domestic Seedling	16	13	3	16	22	70
Total	107	141	81	151	178	
Field Survival (of 8 trees planted)						Total % of Planted
M.27	8	4	–	7	5	75
M.9	5	5	8	6	7	77
M.26	–	5	8	5	5	72
M.7	–	8	8	6	8	94
MM.111	8	7	–	8	7	94
Antanovka 306	7	6	6	5	7	77
Domestic Seedling	7	6	4	8	6	77
Total as % of Planted	87	73	85	80	80	

rootstocks selected in this study (Table 2). 'Golden Raindrops' and 'Prairifire' were the largest cultivars, and 'Adirondack' the smallest cultivar, both when initially planted and after three years in the field.

The rootstocks are listed in order of increasing tree size based on performance of commercial apple cultivars in previous trials. Generally, the same order occurred in growth in the nursery and after three years in the field. The significant interaction between cultivar and rootstock for planting height occurred because 'Louisa' on M.9 was much taller than expected and 'Molten Lava' on MM.111 was much shorter than expected (data not presented).

Trunk cross-sectional area (TCA) for commercial apples has been shown to be the most highly related nondestructive measurement to total tree dry weight. The significant interaction in the 2001 TCA was due to a smaller than expected value for 'Adirondack' on domestic seedling and a

Table 2. Performance of Five Flowering Crabapples on Seven Rootstocks With Potential to Influence Tree Size.

Cultivar	Planting Height (m) 2000	Trunk area (cm^2) 2000	Bloom % tree covered		Fireblight (2001)		Suckers/ tree	Fruiting % Tree covered	Tree size (m)	
			2001	2003	% Tree infected	Number strikes			Height	Spread
Adirondack	1.22dz	1.67d	20.9b	88.7a	3.6b	1.55b	1.07	71.3a	1.67b	0.7c
Golden Raindrops	1.97a	2.59b	49.9b	54.5b	20.5a	4.12a	0.89	15.3c	2.04a	1.5b
Louisa	1.21d	2.91ab	59.1a	84.8a	2.4b	0.94b	0.55	17.7c	1.24d	2.0a
Prairifire	1.66b	2.14c	58.5a	98.8a	6.6b	2.20b	1.16	71.9a	2.03a	1.6b
Molten Lava	1.50c	2.96a	65.9a	96.3a	7.6b	1.11b	.50	48.2b	1.50c	2.2a
Rootstock										
M.27	1.20e	1.20d	32.4bc	86.7	16.2a	2.22abc	0.54	65.0a	1.13e	.80d
M.9	1.50cd	2.21c	73.6a	82.6	14.8a	3.76a	0.19	44.0bc	1.63cd	1.50bc
M.26	1.41d	2.41bc	69.4a	86.1	12.9ab	3.00ab	0.13	38.0c	1.50d	1.91a
M.7	1.59bc	2.66ab	59.8ab	86.7	10.7abc	2.62abc	1.06	36.6c	1.77bc	1.88a
MM.111	1.69ab	2.71ab	40.3bc	78.6	3.66bc	1.41bc	0.90	49.0b	1.83bc	1.50c
Antanovka 306	1.78a	2.91a	40.2bc	79.5	1.9c	0.86c	1.09	40.8bc	1.86b	1.77ab
Domestic Seedling	1.67b	3.00a	42.4c	83.0	3.1bc	0.88c	2.22	45.0bc	2.11a	1.88a
F Significance										
Cultivar	**	**	**	*	**	**	–	**	**	**
Rootstocks	**	**	**	NS	**	**	–	*	**	**
RS x Cv	**	**	**	NS	NS	NS	–	NS	*	**

Mean separation by Duncan's multiple range test, $P \leq 0.05$.
NS, *, ** = Nonsignificant or significant at $P < 0.05$ or 0.01, respectively.

larger value on M.9 and smaller value on M.7 for 'Molten Lava' than expected (data not presented).

As a general rule, the more dwarfing rootstocks cause earlier flowering and fruiting of commercial apple cultivars. One of the concerns of this study was that this increased precocity might cause the crabapples that were also selected for profuse flowering to go biennial in bloom. 'Adirondack' and 'Golden Raindrops' had less bloom in 2001 than the other cultivars, and generally trees on M.9 and M.26 had more bloom than on the rootstocks producing the largest trees and on the smallest trees on M.27 (Table 2).

The significant interaction in 2001 bloom was caused by trees of 'Golden Raindrops' having almost no bloom on Antanovka 306, and 'Prairifire' having very light bloom on this rootstock, with bloom of 'Louisa' on seedling being much greater than expected. In 2003, there was no interaction between rootstock and cultivar for amount of bloom, and all trees had heavy blooms. Thus, to date, no evidence of a biennial bloom pattern has developed.

Although not recognized when this experiment was planned, 'Golden Raindrops' was very susceptible to fireblight, and infection occurred with only small amounts in the other cultivars

(Table 2). Rootstocks M.9 and M.26 are very susceptible to fireblight, and they tended to have more infection than some of the trees on larger rootstocks. No interaction occurred between rootstock and crabapple cultivar in fireblight infection. Some trees of 'Golden Raindrops' died on susceptible rootstocks. Because of the heavy inoculum pressure from the adjacent pear planting, some fireblight was recorded in this planting each year.

Rootsuckering is undesirable in both commercial apple and crabapple plantings. Suckering in this planting was very light, but the largest amount occurred on trees on domestic seedling, which is an industry standard rootstock for crabapples.

The amount of tree covered in fruit was estimated in 2003 with 'Adironback' and 'Prairifire' displaying the most fruit, followed by 'Molten Lava,' with rather light fruiting on 'Golden Raindrops' and 'Louisa.' The effect of rootstock on fruiting was less than the effect of cultivar with heavy fruiting on the very dwarf trees on M.27, followed by trees on MM.111, and little difference among the other rootstocks.

Tree size was influenced by both cultivar and rootstock at the end of the 2003 growing season, and the interaction was significant (Tables 2 and 3). Generally, trees on 'Adirondack' and 'Prairifire' followed the expected tree size induced by the rootstocks. Trees of 'Golden Raindrops' were much larger on M.9 and M.7 than expected. Trees of 'Louisa' on M.7 were smaller than expected. 'Molten Lava' trees on M.9 were larger and trees on MM.111 smaller than expected.

In summary, it appears that rootstocks used in the commercial apple industry to adjust tree size can offer similar possibilities for ornamental crabapples. The effect is most evident with upright spreading cultivars such as 'Prairifire,' and, in hindsight, cultivars such as 'Adirondack,' 'Molten Lava,' and 'Louisa' that modify tree size by growth habit should have been excluded from the study. The biggest concern that was unanswered in this work was the significant loss in bud take of some combinations. It did not appear predictable by either cultivar or

Table 3. Interaction of Flowering Crabapples and Rootstocks on Initial Bloom and Tree Height and Spread After Four Years in the Field.

	Bloom (% tree covered) 2001					Tree height (m) 2003					Tree spread (m) 2003				
Rootstock	Adi-ron-dack	Golden Rain-drops	Louisa	Prairi-fire	Molten Lava	Adi-ron-dack	Golden Rain-drops	Louisa	Prairi-fire	Molt-en Lava	Adi-ron-dack	Golden Rain-drops	Louisa	Prairi-fire	Molt-en Lava
M.27	13.8	45.1		42.7	32.0	1.07	1.17		1.45	0.82	0.48	1.17		1.37	1.64
M.9	21.7	69.8	67.5	47.2	75.8	1.78	2.06	1.75	1.81	1.40	0.62	1.35	2.05	0.143	1.98
M.26		65.4	82.7	69.7	59.5		1.80	1.17	1.94	1.25		1.60	2.05	1.70	2.20
M.7		51.0	32.5	71.7	83.1		2.27	0.95	2.25	1.73		1.75	1.97	1.76	2.37
MM.111	24.6	13.7		63.1	62.7	1.81	1.96		2.00	1.45	0.75	1.21		1.61	2.00
Anta-novka 306	26.7	2.7	36.0	75.2	63.2	1.98	1.85	1.48	2.40	1.77	0.92	1.51	2.23	1.85	2.40
Domestic Seedling	17.8	20.6	96.0	38.7	84.1	1.81	2.76	1.40	2.41	1.81	0.75	2.06	2.17	1.88	2.00
	LSD 0.05 = 31.4					LSD 0.05 = 0.35					LSD 0.05 = 0.38				

rootstock. Thus, if crabapple producers were to capitalize on the value added by adjusting tree size by rootstock, a trial for bud take would be needed for each combination. This was an unexpected finding, since these rootstocks appear compatible with a wide range of commercial apple cultivars.

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New and Difficult Weeds in Ohio Nurseries

Hannah M. Mathers and Randall H. Zondag

The ornamental industry is always facing something new. New plants, new chemicals, new production methods are a given; however, new pests are always somewhat unexpected — even though they happen consistently. I know this is a contradiction, and it would take another article, another time, to explain why. However, it is still reality.

A grower once told me, "We have at least one new pest each year." New pests, more than any other change in the nursery business, seem to create anxiety and frustration for ornamental managers. New weeds do not rank in the same class, for short-term devastation posed, as do new insect pests like Emerald Ash Borer or new diseases like Sudden Oak Death. However, for nursery operations, new weeds can cause long-term expense and just as much, and maybe more, anxiety and frustration on a day-to-day level, to a nursery operation.

In Ohio, we are seeing two relatively new nursery field weeds — creeping yellow field cress, also known as kik *(Rorippa sylvestris),* and red stem filaree *(Erodium cicutarium)* — and one old, but difficult weed — wild garlic *(Allium vineale)* — causing control problems for growers.

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Creeping Yellow Field Cress or Kik

Creeping yellow field cress or kik *(Rorippa sylvestris)* is a relatively new weed to Ohio nursery fields. It has been in Ohio for a number of years, but only recently has it become important in nursery fields. Unlike marsh yellowcress *(Rorippa islandica),* which is more familiar to Ohio growers and is an annual, creeping yellow field cress is a perennial that spreads by rhizomes. A three-centimeter piece can make 2,000 creeping yellow field cress plants in one year (C. Elmore, personal communication). Unfortunately, *R. sylvestris* can also cross with the annual *R. islandica,* increasing its ability to spread and reproduce.

The leaves of kik are more finely cut than those of marsh yellowcress (Uva *et al.,* 1997). It overwinters as a rosette of finely lobed leaves. The leaves are alternate and pinnatified with three to seven irregularly toothed lateral lobes and a larger terminal lobe (Uva *et al.,* 1997). Kik tolerates a wide range of soil types and conditions but is often found on heavy, wet, or poorly drained fields.

A suggested control is products with the amine formulation of 2,4-D (ex: Solution Water Soluble) + Gallery (isoxaben). The amine formulations are recommended because they are less volatile than the esters. Casoron (dicholbenil) at 2 to 4

lbs active ingredient per acre is another suggestion. However, both of these controls need to be used with extreme caution around nursery stock due to potential phytotoxicity issues. Check the label carefully for stock tolerance and restrictions; *e.g.,* do not apply Casoron when soil temps are above 16°C on sandy soils or soils with less than 2 to 3% organic matter. The 2,4-D products are broadleaf postemergent weed killers and generally are only used in non-crop nursery areas, never as over-the-top applications, and should be used with extreme caution even as directed sprays.

Red Stem Filaree *(Erodium cicutarium)*

Red stem filaree is also known as filaree or common storksbill (Uva *et al.,* 1997). It is a winter annual or biennial that overwinters as a prostrate basal rosette. Stems elongate the following spring and can reach 10 to 50 cm in height. Leaves and stems are often reddish.

The flowers are pink to purple and 5 to 8 mm long (Uva *et al.,* 1997). Each flower produces a beak-like fruit that separates into five sections (mericaps) when mature. Each section consists of a seed and a spirally twisted hairy tail that coils under dry conditions and uncoils when moist (Uva *et al.,* 1997). This tail creates a corkscrew action with the seed — which digs it into the ground. It is usually found on dry, sandy soil and is a problem in many perennial crops including nursery, orchards, and Christmas trees. It is also a problem in turfgrass and landscape plantings.

Nursery growers in other states have found success using a combination of Goal and dinitroaniline (DNA) herbicides, such as OH II (oxyfluorfen + pendimethalin) (C. Elmore, personal communication). In a search of the Crop Protection Reference in C&P Press (2003), Surflan (oryzalin) and Snapshot (isoxaben + trifluralin) were the only two DNA and DNA-containing herbicides (respectively) that were registered for use. OH II did not appear as a registered product.

Another suggested control is Goal 2XL (oxyfluorfen) applied in the fall. Since filaree is primarily a winter annual, this approach has worked (C. Elmore, personal communication).

Again, check the label carefully for stock tolerance and restrictions as Goal can be quite injurious to many nursery crops and is quite volatile. Gallery 75DF (isoxaben) applied in the fall with a "kicker" or booster in the spring is another suggestion.

Wild Garlic *(Allium vineale)*

This weed is an increasing problem in Ohio nurseries. It is a bulbous perennial. Fibrous roots are attached to the bottom of a rounded to egg-shaped bulb. The bulbs have a papery outer coating (Uva *et al.,* 1997). Bulblets form at the base of larger bulbs.

Reproduction is by aerial bulblets and the underground bulblets and rarely by seed (Uva *et al.,* 1997). Bulblets often remain dormant over the winter and germinate the following spring or one to five years later.

Growers in Ohio report that wild garlic "quickly becomes a problem" in a nursery field. A typical comment is: "Where one plant was last year, five plants come up the following spring." Flowers or aerial bulblets are produced in May and June at the top of stems. These later become globe-shaped umbels (Uva *et al.,* 1997).

Wild garlic is also known as field garlic or wild onion. Wild onion *(Allium canadense),* however, as the scientific name indicates, is a different species. The leaves of wild onion are flat in cross section, not hollow, and the bulb has a fibrous outer coating, not papery and thin like wild garlic. Wild garlic usually grows on rich soils but can tolerate a wide range of soil conditions (Uva *et al.*, 1997).

Suggested controls include 2,4-D products when the plants are quite small and 2,4-D + Gallery. Again, 2,4-D products are broadleaf postemergent weed killers and generally only used in non-crop nursery areas, never as over-the-top applications. Late fall tilling has been effective in row crops as the bulblets are exposed to killing temperatures (C. Elmore, personal communication). Plateau and Image 70 DG are registered pre/post-emergent controls.

Conclusions

The three weed species reported earlier are becoming serious weed problems in Ohio nurseries that are using standard herbicide-based weed control programs (glyphosate, triazines, and DNAs). The standard programs are actually increasing the weed populations of these species by releasing them from competition with other weeds. Research is needed to evaluate a variety of preemergence herbicides alone, or in combination, that might control these three species.

The word "suggested" has been used previously in the control sections for each weed. As indicated, all the "suggested" controls have limitations and should be used only with caution. They are only "suggestions," not recommendations!

Research is needed to determine viable management controls. Red stem filaree, creeping yellow field cress, and wild garlic will never cause the destruction and tax-payer burden that emerald ash borer poses; however, these weeds, if allowed to get out-of-control, can be potentially more damaging to a nursery grower's business.

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Retracting Statements: Tree Liner Production in Retractable-Roof Greenhouses (RRGs)

Hannah M. Mathers, Dan Struve, Alison Stoven, Dale Hammersmith, and Tom Demaline

Introduction

This article describes a study that began at The Ohio State University, Columbus, Ohio, in August 2002 and in September 2002 at Willoway Nurseries, Inc., Avon, Ohio. The research was led by graduate student Alison Stoven at Ohio State, under the guidance of Drs. Hannah Mathers and Dan Struve. The Willoway study was led by Dale Hammersmith, Liner and Pot-in-Pot Production Manager at Willoway, and Tom Demaline, President, Willoway Nurseries, Inc.

In nursery production, a "liner" refers to a small plant that is transplanted and grown on to become a larger plant. Tree liners are often referred to as whips. They are small trees, branched or unbranched, typically 4-ft. to 8-ft. tall and 1/2-in. to 3/4-in. in caliper. Liner shoots are one or two growing seasons old. Their root systems may be three- to six-years old, depending on the species and whether they have been grafted or budded. If they are produced from seed or tissue culture, the root system is generally the same age as the top.

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However, this is not always true; oaks, as an example, are produced from seed and may have three-year-old roots and one-year-old tops.

Traditionally, Midwestern and Eastern U.S. growers buy bareroot, field-grown whips, and transplant and grow these on to become caliper trees. These whips are harvested bare root, stored, and shipped by trucks to the Midwestern and Eastern states. Bareroot liner growers are progressive, and their years of experience and expertise in liner production should not be underestimated.

However, there is a place for a Retractable-Roof Greenhouse (RRG)-grown containerized liner based on price, availability, and niche markets, such as coarse-rooted and difficult-to-transplant taxa. RRG liners may also fit well in pot-in-pot production. Therefore, two years ago, in 2002, Willoway Nurseries, Inc., Avon, Ohio, started to experiment with growing tree liners for their own use.

The first year Willoway started production in a large polyhouse growing between 30 and 40 plant taxa. They wanted to assess liner production and determine what they were capable of producing before making a capital investment to purchase a specialized structure. Their first year of producing liners yielded good results.

Beginning in September 2002, Willoway was able to produce a RRG liner in a three-gallon container that was large enough to be shifted to a seven-gallon by September 2003. Willoway was mainly interested in using the RRG liners in their pot-in-pot operation; however, in 2002 and 2003, they have also placed some of their liners into field production for side-by-side comparison with bareroot tree liners. At Ohio State, we have also taken some of the liners produced from our 2003 study and are doing a similar replicated field trial. Results from the OSU field study should be available in winter 2006.

Obtaining Greater Control

In 2003, Willoway Nurseries constructed a RRG to begin container whip production. This decision coincided with Drs. Mathers and Struve, at The Ohio State University, approaching Willoway Nurseries to be a cooperator on the *Development of a Tree Liner Production System in Retractable-Roof Greenhouses.* This project was submitted to the United States Department of Agriculture and the Ohio Department of Agriculture, through the Ohio Nursery and Landscape Association (ONLA), for developing a tree liner production system using retractable-roof greenhouses.

The retractable-roof house design allows for the roof to retract 90%. The houses also use roll-up ends and side-walls. Opening and closing the roof and the side-walls controls temperature, humidity, wind, and light conditions and extends the growing season. The Cravo (Cravo Equipment, Ltd., Brantford, Ontario, Canada) retractable-roof greenhouse used at Ohio State University (constructed in 2001) can be purchased with flat- or peaked-roof styles. Prices for the bare bones structure in 2001 for the flat-roof houses averaged $1.00 per sq. ft; bare-bones peaked-roof houses, $3.00 per sq. foot.

Liner production in a RRG at Ohio State

Four taxa of trees were evaluated — *Acer* x *freemanii* 'Jeffersred' (Autumn Blaze™ red maple), *Malus* 'Prairifire' (Prairifire crabapple), *Cercis canadensis* (Eastern redbud), and *Quercus rubra* (red oak). The crabapples and maples were rooted tissue-culture cuttings that were grown in band-pots. The redbuds were bed-grown bareroot seedlings; the red oaks were grown from seed started in February at Ohio State. All plants except the oak were approximately one-year-old plants. They were approximately 12- to 18-in. tall with a 2- to 4-in. root system.

Rooted cuttings and seedlings were planted in Spinout-copper treated 250-XL containers (Nursery Supplies Inc., Chambersburg, Pa.) in February in a heated greenhouse at Ohio State University, Columbus. The medium was 510 MetroMix (O. M. Scotts & Sons, Marysville, Ohio), a soilless medium with a nutrient charge. In mid-March, the plants were taken to the Cravo retractable-roof structure and placed on heated mats (A. M. Leonard, Inc., Piqua, Ohio) set at 70°F. The objective of the heated mats was not to heat the house but to stimulate root growth and establishment without stimulating top growth. It was felt that by May, when light levels were sufficient to support vigorous top growth, the roots would be established and able to "push" vigorous shoots.

In mid-May, plants were upshifted into 3-gallon Spin-out® treated containers and spaced out. Harvests were conducted in May (for initial measurements), July, and October. At each harvest, height and caliper of a select number of trees were measured, and the entire plant was destructively harvested to obtain dry root and shoot weight. Trees were trained to

6-ft. bamboo stakes and a wired trellis system, pruned on a regular basis, and not allowed to develop lateral shoots until August.

The roof and sidewalls of the OSU Cravo were controlled by a MicroGrow control system (MicroGrow Systems, Temecula, Calif.). The MicroGrow controller operated according to outside air temperature. The roof remained open when the temperature was between 55°F and 85°F. If the outside temperature dropped below 55°F or went above 85°F, the roof closed. The sidewalls were programmed to close when the outside temperature dropped below 70°F.

These controller settings were chosen to provide optimum growing conditions through reduction of environmental stress such as high and low temperatures. In general, the sidewalls were open all summer to allow ventilation and wind movement to build tree caliper. Four data loggers were placed throughout the two environments to record air temperature, soil temperature, and light intensity on an hourly basis throughout the growing season.

Height, Caliper, and Root Growth at Ohio State

The tallest trees produced in the Cravo were the redbud (7.5′) followed by the red maple (7.1′). The maples had the largest caliper of any trees (0.65″). Root dry weights increased significantly from July to October for all four species. Most trees filled the three-gallon pots by October. In October, the tree with the largest root dry weight was maple (3.5 oz) in October; however, maple root mass was not significantly larger than oak or crabapple in July. The root dry weight of maple increased more than six times over the three months (0.5 oz in July, 3.5 oz in October). Many Ohio growers have expressed an interest in producing their own tree liners after seeing the 2003 Ohio State University results.

Growing in RRGs at Willoway Nurseries

In 2003 Willoway evaluated 84 taxa in its RRG that were potted in September of 2002. They felt that by potting in the fall, they could establish the plants, over winter them in the house, and have them ready to start growing in early April. This was quite different from the Ohio State study, where plants were started in early spring. A study beginning in fall 2004 at Ohio State will explore the Willoway fall planting timeline.

Willoway set the heaters to 32°F daytime and 28°F night temperatures for the winter. Willoway wanted the plants to go dormant for the winter but they did not want the pots to freeze solid. They tried to achieve a light crust of frost on the top of each container. With the aid of the end vents, they could maintain these temperatures even when the sun warmed up the house above freezing on sunny days.

The plan was to turn up the heat April 1, 2003; however, March was warmer than expected, so they decided to increase the heat in the house starting March 15 to 65°F daytime and 50°F night, providing a positive DIF. DIF was developed by Dr. Royal Heins, retired from Michigan State University, and is commonly used in greenhouse production. DIF refers to the difference between day and night temperatures. A positive DIF means the daytime temperatures are higher than the night temperatures. The reverse is true of negative DIF. These temperatures were maintained for one week.

On March 22 temperatures were increased to 75°F daytime and 65°F night until mid-May 2003. May 15 temperatures were lowered to 65°F daytime and 50°F night. Willoway indicates they are continuing to work with these temperature settings and adjustments in 2004.

In tree-liner production, keeping the trunk straight is extremely important. The trees in the Willoway and Ohio State trials are growing exceptionally fast. To keep them straight, Willoway and Ohio State used pencil thin, six-foot bamboo stakes and tied the trees to these stakes. Dale Hammersmith does not recommend using masking tape for tying; however, he uses a loose fitting tape that does not stick to the trunk. As side branches started to grow, Willoway would head these back, but not remove them. They believe the side branches were important to caliper development.

Caliper and Root Development at Willoway

Increasing caliper development is one of the most important goals in the studies at Willoway and Ohio State. The ability of the sidewalls to open allows for free air movement within the houses; this improves air circulation to reduce disease infestation and allows for tree movement which results in improved caliper development.

However, spacing can also be an important criterion in caliper development. Side branch development, which further aids in caliper enlargement, will not occur if the trees are spaced too close together. At Willoway, trees were placed can tight from the beginning of the trial (fall 2002) to May 1, 2003. On May 1, plants were spaced out to 12- to 18-in. centers to allow for greater side branch development. By September 30, 2003 (end of the trial), average calipers for most species were one inch. Willoway and Ohio State researchers considered these calipers to be very impressive.

Root masses were also excellent! For Willoway, most species filled the three-gallon copper-treated pots by September 1, 2003. Some species were up-shifted into seven-gallon containers. One species chosen for seven-gallon up-shifting was *Acer* 'Red Sunset.' The Red Sunsets were shifted from three- to seven-gallon pots on September 1, 2003. By October 30, 2003, the Red Sunsets' roots filled the seven-gallon containers as did the roots of several other species. Dale and Tom decided that in 2004 some species will go straight from three-gallon to 15-gallon pots.

Height Growth at Willoway

One of Willoway's objectives was to produce a healthy tree, five-feet high, by early July. Three different plants from a large number of taxa were selected, labeled, and heights were measured every two weeks starting on April 1 and continuing to July 3, 2003. Most taxa reached five feet by July 4, 2003.

In fact, some species, such as *Prunus, Taxodium, Betula,* and *Malus,* were so tall by June 10, 2003, that they needed to be moved outside the RRGs in order to slow their growth. Some species such as pin oaks *(Quercus palustris)* and sourgum *(Nyssa sylvatica)* did not make it to five feet by July 4, 2003, or even by August. Listed in Table 1 are the heights of *Acer* 'Autumn Blaze' taken during the course of the growing season.

Conclusions

Retractable-roof greenhouses have been described as a brand-new style of growing structure (Grey 2001). Retractable-roof

Table 1. Heights (inches) of Three Selected Plants of *Acer* 'Autumn Blaze' Recorded over the 2003 Growing Season at Willoway Nurseries, Inc., Avon, Ohio, in an Erie Greenhouse.

Acer 'Autumn Blaze'	Tree No. 1	Tree No. 2	Tree No. 3
Starting Height (April 2003)	15″	11.5″	10.5″
May 13, 2003	21″	19.75″	20.5″
June 5, 2003	36″	36.5″	38.25″
June 17, 2003	46.75″	45.5″	51.25″
July 3, 2003	66.5″	65.25″	73.75″

production allows for greater manipulation of the growing environment in winter, summer, and spring.

However, with any new system or structure, there is much to learn. For example, the optimum set points for the roof and the side-walls may be species specific. Which species do best in this production system and to what extent do container sizes, types, and growing media influence growth potentials are all key questions. However, we do know containerized liner production increases the number of species that can be grown and reduces production times.

Acknowledgments

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Ohio Battles the Borer: An Emerald Ash Borer Update

Amy K. Stone, Daniel A. Herms, and Melissa Brewer

Introduction

The emerald ash borer *(Agrilus planipennis)* is an exotic, invasive species that has infested and killed more than 12 million ash trees since its accidental importation from Asia. The infestation is now established across more than 6,000 square miles in southeastern Michigan, northwestern Ohio, and neighboring Essex County, Ontario.

Isolated, localized infestations, termed "outliers," exist elsewhere in Michigan, Ohio, and northeastern Indiana. All major eastern North American ash species are susceptible to emerald ash borer, which infests trees ranging in size from 1/2-inch-caliper nursery stock to fully mature trees in forests.

While most native borers colonize only weakened trees, emerald ash borer attacks healthy trees as well, making it especially devastating. If it is not contained and eradicated, the impact of emerald ash borer on ash trees in North America will be similar to that of the chestnut blight and Dutch elm disease. These exotic pests devastated natural and urban forests in the 20th century.

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However, an aggressive, coordinated containment and eradication program undertaken by federal, state, and Canadian agencies provides reason to be optimistic that North American ash trees can ultimately be spared the fate of the chestnut and elm.

The emerald ash borer was unknown in North America until June 2002, when it was determined to be the cause of unusually widespread ash mortality in southeastern Michigan.

This insect is native to areas of Asia, including eastern Siberia, northeastern China, Mongolia, Japan, and Korea, where it occurs on several species of ash. It was probably imported into Michigan at least 10 to 15 years ago by means of infested ash crating or pallets.

Emerald ash borer was first discovered in Ohio, near Toledo, in February of 2003. Isolated infestations were subsequently found in five additional counties in northwestern Ohio, as well as in suburban Columbus.

In the spring of 2004, two additional outlier infestations were discovered in northeastern Indiana. Most of these outlier infestations have been linked to the artificial spread of the emerald ash borer from southeastern Michigan through the movement of infested nursery stock, logs, or firewood. This largely occurred before

Figure 1. Emerald ash borer adult. The emerald ash borer has the potential to decimate ash throughout their range in North America, and efforts to eradicate this invasive pest are underway. For additional information about this serious threat, see the article titled *Emerald Ash Borer: The Beginning of the End of Ash in North America?* in Special Circular 193.

emerald ash borer was identified and state and federal quarantines were imposed.

Economic and Ecological Impact

The economic and ecological impacts of the emerald ash borer have already been substantial and will be staggering if the infestation continues to spread. Ash species inhabit a variety of soils and ecosystems and are dominant throughout the forests of eastern North America.

According to USDA Forest Service statistics, there are 3.8 billion ash trees in Ohio, with a standing timber valued at more than $1 billion. Furthermore, ash has been one of the most important nursery and landscape species. According to the USDA, the wholesale value of ash sold in Ohio exceeded $2 million in 1998, while a recent survey conservatively estimated the value of the standing ash crop to exceed $20 million. This market has been decimated since the discovery of emerald ash borer, and many growers are destroying their trees.

Emerald ash borer has already caused tens of millions of dollars of damage to Michigan's landscapes, urban forests, and woodlots, and this cost is increasing at an exponential rate. The cost of removing dead and dying ash has overwhelmed municipal budgets in affected counties. The quarantine on ash timber and firewood has also had negative economic impacts on sawmills, tool handle factories, and firewood dealers in Michigan and Ohio.

Taxonomy and Biology

The emerald ash borer is a beetle (Coleoptera) belonging to the family known as metallic wood-borers (Buprestidae). Larvae of these beetles are known as flatheaded borers, deriving their common name from the larval stage, which appears to have a broadly flattened head (it is actually the thorax which mostly conceals the much smaller head).

Emerald ash borer larvae (Figure 2) are white with a long (about one inch when mature) narrow, segmented abdomen that is also flattened, which gives them the appearance of small tapeworms. Adults are elongate, 1/2-inch-long beetles with striking, metallic-green coloration.

Generally, there is one generation per year, although recent studies by Michigan State University (MSU) researchers suggest that development may sometimes take two years in newly infested healthy trees. Adult beetles emerge from infested ash trees in late May through early August, with emergence peaking in mid to late June.

As adults emerge, they leave small (1/8 inch), distinctly D-shaped exit holes (see

Figure 2. Emerald ash borer larva.

Figure 1) in the trunk and main branches. Adults may live three to six weeks and nibble on small patches of ash leaves during this period.

Females generally produce 50 to 80 reddish eggs, which are laid individually on the bark surface, or within bark cracks and crevices. When the larvae hatch, they tunnel into the tree, where they feed on the phloem and outer sapwood, excavating S-shaped, serpentine galleries just under the bark. The galleries disrupt the flow of nutrients and water between the canopy and roots. This causes canopy thinning and branch dieback, and ultimately tree death.

Larvae continue to feed through the summer and into the fall. They overwinter in the outer bark or within the outer inch of sapwood. Pupation occurs in mid to late spring. Adults emerge soon thereafter to complete the typical one-year lifecycle.

Host Plants and Impacts

Ash species known to be susceptible include green *(Fraxinus pennsylvanica),* white *(F. americana),* black *(F. nigra),* and blue ash *(F. quadrangulata),* as well as horticultural cultivars of these species. Only living trees are colonized. Emerald ash borer will not colonize a dead tree.

In China, emerald ash borer colonizes the Asian ash species *F. mandshurica* (Manchurian ash) and *F. chinensis.* In Japan, species of *Juglans* (walnuts and bitternuts), *Ulmus* (elms), and *Pterocarya* (wingnuts) have also been recorded as hosts. However, emerald ash borer has not been well studied in Asia (a total of three published pages), and these host records may reflect the existence of subspecies or simply taxonomic confusion.

Furthermore, host records for borers are notoriously unreliable, and often include tree species from which adults were collected, even when the larvae are not able to develop on those species. Research on host range and host preference is underway, and preliminary results from Michigan State University studies strongly suggest that walnut and elm will not be viable hosts for emerald ash borer in North America.

Studies are also underway to investigate the susceptibility of plants related to ash, such as lilacs and privet. To date, these species have not been observed to be infested, even when growing in close proximity to infested ash trees.

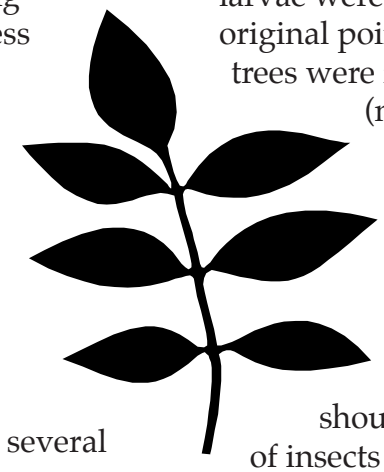
The Plan to Eradicate Emerald Ash Borer: The Cooperative EAB Project

USDA-APHIS (Animal Plant Health Inspection Service), the USDA Forest Service, and the Canadian Food Inspection Agency (CFIA), in cooperation with state Departments of Agriculture and Natural Resources have joined forces to implement a long-term program to contain and eventually eradicate emerald ash borer from North America.

The plan, which is in the early stages of implementation, is to (1) locate and promptly eradicate outlier infestations,

(2) prevent establishment of new outlier infestations through aggressive enforcement of state and federal quarantines, and (3) contain, suppress, and ultimately eradicate the core infestation.

A key component of the eradication plan is an intensive monitoring program to evaluate the success of outlier eradication efforts, identify existing low-density infestations that have so far escaped detection, and quickly detect new infestations.



Rapid elimination of outlier infestations before they expand and become entrenched is critical. To date, several outlier eradication programs have been implemented in Michigan, Ohio, Maryland, and Virginia, resulting in the destruction of more than 100,000 ash trees. Eradication of outlier infestations involves removal of all visibly infested trees, as well as all other ash trees within a 1/2-mile radius of the visibly infested trees.

Since infested trees do not show external signs or symptoms of attack during the first year, there is no way to determine which trees in the vicinity of infested trees were infested themselves. Consequently, it is necessary to cut even apparently healthy trees to destroy the insects lurking within before they can emerge, disperse, and reproduce. Felled trees are chipped and incinerated at a co-generational power plant, and stumps are treated with herbicide to prevent sprouting.

Three major studies of outlier infestations conducted in 2003 and 2004 by Michigan State University researchers and cooperators provide a science-based rationale for the current eradication strategy. This research involved felling and peeling bark from a large number of ash trees of all sizes occurring within one-half mile of a known point source — *e.g.*, the infested firewood or nursery trees from which the infestation was known to originate.

Intensive sampling showed that 80% of all larvae were in trees within 100 yards of the original point source. At one site, infested trees were found as far as 750 meters (nearly one-half mile) from the point source. But at the other two sites, all larvae were found within 0.38 miles of the point source. Therefore, the cutting of all ash trees within a one-half-mile radius of visibly infested trees should eliminate the vast majority of insects in outlier infestations, if not the entire infestation.

Treating infested trees with insecticides as an alternative to destroying them is not a viable option for eradication sites. While research has shown that preventative insecticide applications can effectively protect shade trees from emerald ash borer in the core infestation in southeastern Michigan, no insecticide program has been effective enough for eradication purposes.

To ensure success, these outlier eradication sites are being monitored for at least three years after cutting to determine if there is a need to "mop up" any beetles that may have slipped the dragnet.

However, monitoring efforts have been complicated by the research that indicates that emerald ash borer apparently does not produce the long-range pheromones that have been so useful in trapping other insect pests such as the gypsy moth. Rather, monitoring is currently being conducted in Michigan, Ohio, and Indiana by means of an extensive grid of "trap trees," which consists of a girdled green

ash tree wrapped with a band of sticky tanglefoot or similar substance.

Research conducted by MSU and USDA Forest Service scientists in 2003 showed that adult beetles were more strongly attracted to girdled trees than unwounded trees, possibly due to host plant volatiles released in the air by girdled trees.

There are so many infested trees in the core infestation in southeastern Michigan and neighboring Essex County, Ontario, that it is physically and economically impossible to remove them all or to treat them with insecticides. Scientists and regulatory officials have developed a plan to surround and contain the core infestation with a Reduced Ash Zone (RAZ) that will likely extend through central and southwestern Michigan and across northeastern Indiana and northwestern Ohio.

The optimal location of the RAZ is being determined by analyzing a combination of aerial photos, land-use data, and ground surveys to estimate ash density and emerald ash borer distribution. The RAZ will be routed as much as possible through areas with naturally low densities of ash such as agricultural land, industrialized areas, and large bodies of water.

Incentive-based programs and ash markets will be developed to encourage property owners to remove and sell ash trees of all sizes before they are killed by emerald ash borer or removed in an eradication action. An aggressive emerald ash borer suppression program will occur just inside the RAZ to relieve pressure on the leading edge and minimize emerald ash borer breakouts.

An intensive monitoring program within and beyond the periphery of the RAZ will be implemented to rapidly detect the spot infestations that will inevitably breach the RAZ so that they can be quickly extinguished. It is important to realize that all of the ash trees in the RAZ inevitably will be killed by emerald ash borer, as will billions more, if emerald ash borer is allowed to spread unchecked across North America.

Preventing the artificial spread of emerald ash borer is another major component of the eradication plan. Accordingly, federal, state, and Canadian quarantines have been enacted to prohibit the movement of firewood, ash nursery stock, logs, wood chips, and untreated lumber.

Preventing the movement of firewood presents a particularly tough challenge. Many federal, state, and provincial agencies, along with Extension personnel at Ohio State, Michigan State, and Purdue Universities, and state Department of Natural Resources are assisting regulatory officials by actively spreading the word about the emerald ash borer and particularly the dangers posed by transporting firewood.

A multi-media, multi-agency publicity campaign featuring television, radio, and newspaper ads, billboards, press releases, fliers, posters, and bulletins has been launched to inform people about the firewood quarantine. Highway signs warn motorists of substantial fines for moving firewood outside the quarantine zone.

A stepped-up inspection and enforcement program has targeted violators at rest areas, along highways, and at campgrounds at critical times such as major holidays and during hunting season. Regulatory and law-enforcement officials have even established check-points on highways at the Ohio-Michigan border to stop vehicles and intercept firewood. Canadian officials have been ticketing violators at the camp sites. These and related outreach and enforcement

efforts will continue to expand to minimize the artificial spread of the emerald ash borer.

EAB in Ohio

Since the first discovery of Emerald Ash Borer in Ohio, satellite infestations have been identified in Defiance, Franklin, Fulton, Henry, Lucas, and Wood counties. To date, 17 sites throughout these counties in northwestern Ohio and in Franklin County have been marked for eradication by the Ohio Department of Agriculture (ODA) to eliminate the pest and to protect the state's 3.8 billion ash trees from devastation. Five of these sites have been eradicated, and nearly 38,000 ash trees have been destroyed. These locations are indicated with dots in the map shown in Figure 3. The eradication process continues at the remaining sites, indicated with the numbered dots.

In 2004, eradications occurred in Rossford in Wood County (424 trees destroyed), Columbus in Franklin County (17,713 trees destroyed), Whitehouse in Lucas County (6,000), Toledo Express Airport in Lucas County (10,000), and Hicksville in Defiance County (3,379 trees destroyed). ODA also removed ash trees in North Baltimore in Wood County, where approximately 15,000 trees were cut, chipped, and incinerated.

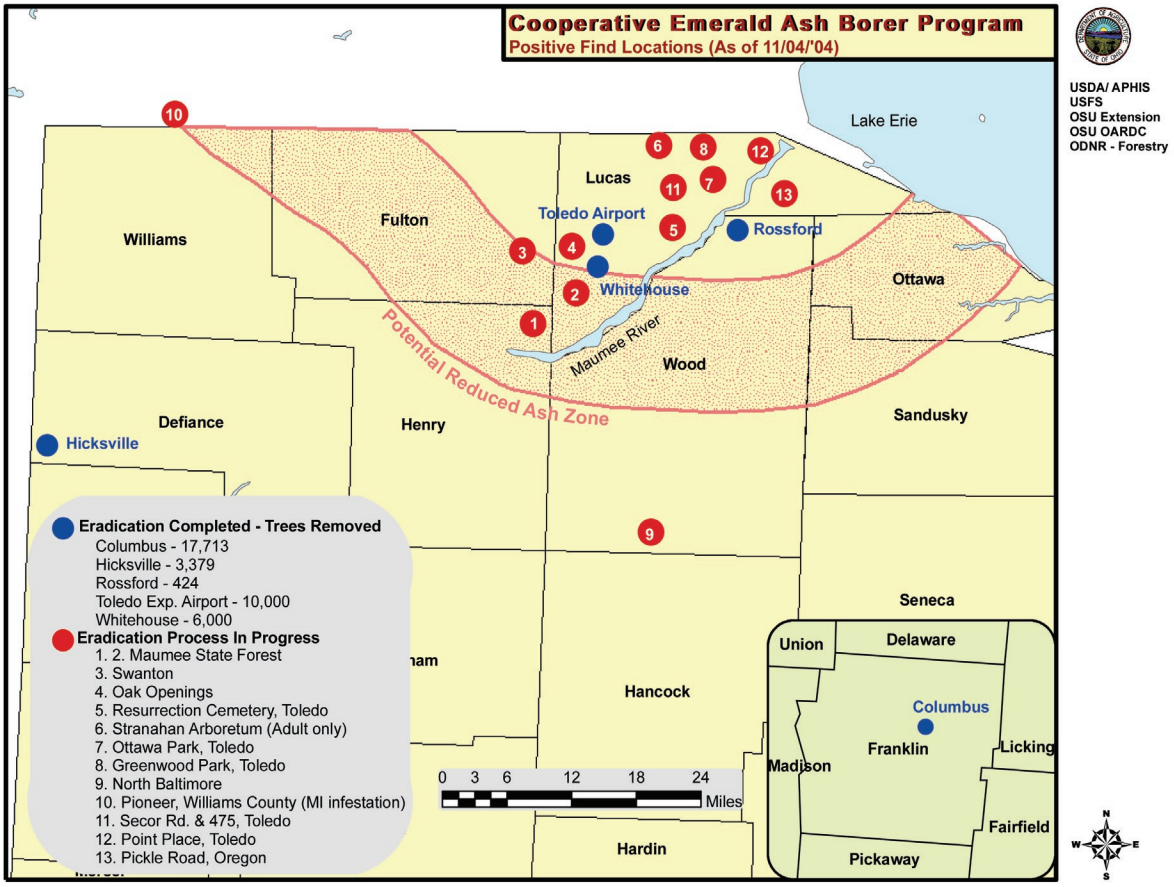


Figure 3. Nearly 38,000 ash trees have been destroyed in five sites in Ohio in efforts to eliminate this pest and to protect the state's 3.8 billion ash trees from devastation.

Additional infestations slated for eradication include Swanton in Fulton County; Maumee State Forest in Henry County; Maumee State Forest, Oak Openings Metropark, Resurrection Cemetery, Ottawa Park, Greenwood Park, Secor Road and I-475, Point Place, and Pickle Road in Lucas County; and Pioneer in Williams County, which stems from a Michigan-based infestation.

ODA also has regulated areas in northwestern Ohio that restrict the movement of ash trees, branches, firewood, bark, wood chips, and other ash materials. Restricted items in these areas can only move out of the regulated areas after a compliance agreement has been done with the department.

Currently, regulated areas include Hicksville Township in Defiance County and the area formed by Lucas County, north of the Maumee River; Fulton County, east of State Route 109; and Henry County, east of State Route 109 and north of the Maumee River. An Ohio ban also prohibits movement of any ash materials from Michigan into Ohio.

Though ash firewood is the only firewood named in the quarantine, the state is asking every citizen to refrain from moving unidentified firewood, which could inadvertently contribute to the spread of emerald ash borer. To strengthen its regulations, ODA is currently changing its quarantine to include all "non-coniferous" firewood.

Agency collaboration in Ohio is key as we battle the borer. ODA's role is that of regulatory; Extension's includes research and educational outreach; and the Department of Natural Resources is focusing efforts on the reforestation aspect.

In Closing

The emerald ash borer has the potential to decimate ash throughout North America, but efforts to eradicate this invasive pest are now underway. Eradication is possible, but it will require considerable resources and political will. Even if these efforts are not successful, as some critics suggest, the Cooperative Eradication Project will dramatically slow the spread of the infestation, buying time needed for research advances on effective traps, biological controls, and host-plant resistance and other strategies.

The eradication program will require a long-term commitment of funds and efforts. But these costs will be miniscule compared to the devastating economic and ecological impacts of the emerald ash borer if it is allowed to spread unchecked throughout North America. It is a battle that must be fought.

For additional information on the emerald ash borer, check out these sites:

Ohio State University Extension
http://ashalert.osu.edu

Ohio Department of Agriculture
http://www.ohioagriculture.gov/eab/

Ohio Department of Natural Resources
http://www.dnr.ohio.gov/forestry/eab/default.htm

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The Viburnum Leaf Beetle in Ohio

Curtis E. Young

Introduction

The viburnum leaf beetle (VLB), *Pyrrhalta viburni* (Paykull), which is native to most of Europe, can cause severe damage and possibly death of ornamental viburnums. The VLB is listed as a secondary target pest species by APHIS for Cooperative Agricultural Pest Surveys.

VLB was first discovered in North America in Ontario, Canada, in 1947. Since then, VLB has spread into the Canadian Maritime Provinces and portions of Maine, New York, Pennsylvania, Vermont, and Ohio. In 2001, VLB was observed infesting plants in Erie, Pennsylvania (personal communication with Richard Hoebeke, associate curator of the Cornell Entomology Collection, and personal observation).

In 2002, VLB was discovered in the far northeastern corner of Ohio in the town of Conneaut (Viburnum Leaf Beetle Survey, 2002). Because of climatic similarities with its native habitat, and a preferred host range that includes *Viburnum* species commonly used in ornamental plantings, VLB is considered to have a high probability of becoming established and spreading in Ohio. Heavy infestations by VLB could defoliate shrubs, cause dieback, and eventually kill plants.

Curtis E. Young, Ohio State University Extension, Allen County.

Costs to homeowners, parks, arboretums, municipalities, and nurseries to manage heavy infestations of VLB and to replace killed plants could be high. Additionally, Ohio's nursery industry is the nation's fifth largest. Quarantines imposed, as a result of establishment of VLB in Ohio, would represent an economic burden to the many growers who export nursery stock from Ohio. Because of the potential economic impact to both the public and the nursery industry in Ohio, it is important to maintain surveillance on the spread of VLB in Ohio.

The facts presented here were developed to disseminate information about VLB in Ohio. Most of the information was originally written by Paul A. Weston and E. Richard Hoebeke, Department of Entomology, Cornell University, and Brian C. Eshenaur, Cornell Cooperative Extension, Monroe County, New York.

Viburnum Leaf Beetle, *Pyrrhalta viburni* (Paykull)

The viburnum leaf beetle (VLB), *Pyrrhalta viburni* (Paykull), a native of Europe, was first found in North America in 1947 in the Niagara Peninsula of Ontario, Canada. In 1996, it was discovered in New York State in northern Cayuga County. VLB has continued to spread south and west through New York into Pennsylvania, and in 2002 was discovered in Ashtabula

Figure 1. Adult Viburnum Leaf Beetle (VLB).

Figure 2. Viburnum Leaf Beetle Eggs and Adults.

County, Ohio, where it appeared to have been established for at least two years based on egg scars from two different growing seasons.

VLB was found on both native plantings and ornamental plantings of arrowwood *(Viburnum dentatum)* and European cranberrybush *(V. opulus*) viburnums. In areas where large VLB populations have developed, viburnum shrubs can be totally defoliated by larval and adult feeding.

Because the environmental conditions in VLB's native European homeland are very similar to that of the northern United States and southern Canada, VLB is expected to continue to spread through these areas where viburnum plantings are found.

Distribution

The native range of VLB includes most of Europe. In North America, this exotic leaf beetle is known to inhabit many areas of Ontario, the Canadian Maritime Provinces, and portions of Maine, New York, Pennsylvania, Vermont, and Ohio. In Ohio, VLB has only been detected in one county, Ashtabula, in the city of Conneaut.

Figure 3. VLB Larvae and Damage. From Viburnum Leaf Beetle Citizen Science, Citizen Scientist Photo Gallery (http://www.hort.cornell.edu/vlb/csphoto.html), Cornell University. Used with permission.

Identification Characteristics

VLB adults are 1/4" to 3/8" long, the females being larger than the males. The adult has a golden-brown coloration that has a sheen when the beetle is held in the sun. The sheen is produced by a thick, golden-grey pubescence. The head, thorax, and elytra (wing covers) are generally brownish, but the shoulders of the elytra are darker.

Larvae of the viburnum leaf beetle are about 1/2" 1ong when mature, worm-

like, and feed gregariously on viburnum foliage. Larvae skeletonize leaves in the spring (May-June); adults chew holes through leaves in the summer (July-September); and female beetles produce characteristic oviposition marks on terminal twigs. The females produce characteristic egg "caps" arranged in straight rows, seen throughout the summer, fall, and winter months. All of these visual indicators are characteristic of a VLB infestation.

Life Cycle, Habits, and Host Plants

VLB overwinters in the egg stage. By early to mid-May, the eggs hatch and the larvae feed gregariously on the underside of tender, newly expanding viburnum foliage. Larvae skeletonize viburnum foliage, leaving only midribs and major veins intact.

By early to mid-June, mature larvae drop to the ground, enter the soil, and pupate. By early July, adults emerge and begin to feed on viburnum foliage. Complete development from egg hatch to adult emergence generally takes eight to 10 weeks.

Adult feeding damage consists of irregular circular holes. From late June to early July until October, females chew holes (1/8" x 1/8") in small branches or twigs of viburnum (generally the current year's growth, but occasionally in the previous year's growth) for oviposition. The oviposition sites are often arranged in a straight row on the under surface of the terminal twig.

Several eggs (average of five) are inserted into each cavity. In excavating each oviposition site, the female chews away bark, splits the wood into small fibers that remain attached to the upper circumference of the area chewed away, and hollows out the egg cavity by excavating the pith. After filling the cavity with eggs, the female closes the opening by making a "cap" or lid composed of excrement, chewed bark, and cement from her collateral glands and pushing it up beneath the cluster of previously shredded wood fibers. A female can lay up to 500 eggs.

From summer through fall, adults will continue to be active, mating, laying eggs on terminal twigs, and feeding upon foliage until the first killing frosts. There is one generation annually.

Figure 4. VLB feeding. From Viburnum Leaf Beetle Citizen Science, Citizen Scientist Photo Gallery (http://www.hort.cornell.edu/vlb/csphoto.html), Cornell University. Used with permission.

The VLB is restricted to feeding on species of *Viburnum.* It exhibits a strong preference for the popular arrowwood viburnums *(V. dentatum),* European cranberrybush viburnum *(V. opulus),* American cranberrybush viburnum *(V. trilobum),* and Rafinesque viburnum *(V. rafinesquianum).*

Other viburnums known to serve as hosts include Sargent viburnum *(V. sargentii),*

wayfaringtree viburnum *(V. lantana),* nannyberry viburnum *(V. lentago),* and blackhaw viburnum *(V. prunifolium).*

Particularly resistant species include Koreanspice viburnum *(V. carlesii),* Burkwood viburnum *(V. burkwoodii),* doublefile viburnum *(V. plicatum* var. *tomentosum),* Judd viburnum *(V.* x *juddii),* lantanaphyllum viburnum *(V.* x *rhytidiphylloides),* and leatherleaf viburnum *(V. rhytidiphyllum).*

Figure 5. Devastated field of *V. dentatum*. From Viburnum Leaf Beetle Citizen Science, Citizen Scientist Photo Gallery (http://www.hort.cornell.edu/vlb/csphoto.html), Cornell University. Used with permission.

Economic Impact

Heavy infestations by viburnum leaf beetle can defoliate shrubs, cause dieback, and eventually kill plants. Valued plantings of the European cranberrybush viburnum can be severely damaged by larval and adult feeding. Shrubs repeatedly defoliated over a period of two to three years are likely to die.

Management Recommendations

The most effective means of control for small scale plantings is pruning and destroying infested twigs after egg laying has ceased in the fall, anytime from October to April. When pruning is not practical, a number of pesticides may be effective in controlling VLB.

Home gardeners may use acephate, carbaryl, cyfluthrin, imidacloprid, or malathion. Spray when larvae first appear in early May for best results. If damage from adults is excessive, a second application in mid- to late-summer may be helpful.

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Cicada Mania Hits the Eastern United States

Curtis E. Young, Joseph F. Boggs, and David J. Shetlar

Introduction

Periodical cicadas, *Magicicada* spp., emerge in specific locations once every 17 years in the northern part of their range and once every 13 years in the southern part. Every year periodical cicadas emerge somewhere in the eastern United States. The different groups that emerge each year in different locations are called "broods."

The group that emerged in 2004 is known as Brood X (Brood 10) and is the largest of the 17-year cicadas. The last time Brood X emerged was in 1987 and occurred in parts of 15 states from New York to Georgia to Illinois and Michigan. Media coverage of the emergence of Brood X began as early as January because of the massive numbers of insects expected to appear on the scene and the negative response that these insects were expected to stimulate in people who live in areas where the emergence occurs.

Periodical cicadas belong to the insect order Homoptera, so they are sucking insects. When viewed head-on, or from the side, the adults vaguely resemble giant aphids. Although cicada adults have sucking mouthparts, they do very little feeding, and their feeding damage is considered insignificant.

The female cicadas produce the most dramatic damage when they lay eggs. They deposit eggs by jamming their long, sturdy ovipositors through the bark and into the wood of twigs and small branches. They prefer oviposition material with a diameter of 1/4 to 1/2 inch. The females usually inch forward as they lay eggs, producing longitudinal slits.

Multiple oviposition slits may kill the twigs and small branches, producing a symptom called "flagging." On a large tree, the damage is of minimal consequence to the overall health of the tree. However, damage on small trees may have a significant impact on tree health when a high percentage of branches are affected.

The literature indicates that females may lay eggs on more than 270 species of plants, including most of the deciduous tree species found in Ohio. Some of the more unusual hosts include Rose of Sharon, rose, raspberry, grape, black-eyed Susan, hollies, spirea, rhododendron, viburnum, junipers, and arborvitae. Egg laying has even been observed on annuals and herbaceous perennials.

However, lists of possible oviposition hosts should always be viewed "through the lens of common sense." The nymphs

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that hatch from the eggs cannot move far from the oviposition host selected by the females, and the nymphs need to feed for 17 years. Rarely are cicadas a significant threat to herbaceous plants in home gardens and landscapes.

Periodical cicadas are truly a fascinating biological phenomenon. After spending 13 to 17 years feeding, growing, and developing under the soil, they emerge from the soil somewhat synchronously to become adults. Most nymphs in a particular area crawl out of the soil within a few nights of one another.

In Ohio, in 2004, Brood X was expected to emerge in scattered locations throughout much of the western half of the state. Some locations had huge populations while others had little or no populations, which, though a relief to most, was disappointing to entomologists living in those areas. Distribution maps of where and when the different broods of periodical cicadas emerge can be found on Ohio State University Extension Fact Sheet HYG-2137-99, *Periodical and Dog-Day Cicadas,* and on several sites on the World Wide Web — e.g., **http://bugs.osu.edu/~bugdoc/PerioCicada/.**

Periodical cicadas cause a lot of excitement when they appear for several reasons. First, in some areas, hundreds of thousands of these 1-1/2"-long insects are found per acre, sitting on everything and flying through the air. For people who don't like insects, massive numbers of insects surrounding them can be quite disturbing.

Second, the song the adult males produce is very loud and, multiplied by thousands, the noise can be deafening. Often the males synchronize their singing and can be heard more than one-half mile away.

Third, although the adults do not feed excessively, females can damage trees and shrubs by depositing eggs in slits they produce in twigs and stems. The splintering of the wood and bark of the small twigs and stems may result in twig dieback. Fourth, some pet owners discover their dogs and cats eating the emerging cicada nymphs.

Chorusing is used by male cicadas to attract the females. The sound is produced by very obvious white-colored structures called tymbals located beneath the hind wings on each side of the top of the abdomen. Males congregate en masse in trees and react to one another with their songs rising and falling in unison. Females also produce sounds, but they use their wings. In response to the male's love song, the females vibrate their wings. This "wing flick" behavior produces a soft, rustling broad-frequency sound, or a sharp snapping noise.

Massive brood emergence is believed to overcompensate for the feeding of predators, which are mostly birds. This ensures that enough survivors will be left behind to reproduce. Male cicadas are capable of making a loud buzzing noise and squawk when disturbed. The males often synchronize their buzzing in trees, producing a deafening noise. It is believed that such droning and squawking is effective in deterring predators.

Cicadas and Quackers

The availability of large numbers of insects in a concentrated area can cause changes in behaviors of many different animals, resulting in unusual and sometimes mysterious looking symptoms. During a plant diagnostic event at Spring Grove Cemetery and Arboretum in Cincinnati, participants observed hundreds of round or oval-shaped holes about 1" to 1.5" in

diameter and 3" deep throughout a rain-saturated area under some trees. The size of the holes and lack of soil mounded around them indicated that they were not periodical cicada emergence holes, although there were many of those in the area.

The holes were too neat and small to be the work of raccoons digging for cicada nymphs or other subterranean insects. Further observation revealed the causative agent of the holes when a trio of mallard ducks waddled under the trees. The mallards, far from a pond or other water, began drilling their bills into the soil with a twisting motion until their eyeballs were barely visible above the soil line. They were enjoying the once-in-a-lifetime (for a duck) opportunity to fatten up on cicada nymphs and, in the process, were leaving the tell-tale holes as evidence of their good fortune.

Mallards are not alone in taking advantage of the plentiful supply of protein in the form of insects. Numerous birds, snakes, moles, and other mammals will stuff themselves with the easy prey. Unfortunately, family pets — dogs and cats — will also consume excessive numbers of the cicadas, with resultant regurgitation after a short period of time.

Trees Under Wraps

Increased public awareness of the Brood X emergence escalated concerns as to how to prevent severe damage to tender plant materials. The management tactic adopted by many homeowners was to wrap critical plants in various coverings in an attempt to prevent female cicadas from ovipositing in twigs and branches. Many misuses or misunderstandings as to how to use tree canopy coverings to prevent oviposition were observed in different areas of the state.

Some examples of misuse included trees wrapped two to four weeks earlier than necessary; trees wrapped too tightly, with cloth spiraling around compressed branches and held firm from top to bottom by rope bindings, producing what appeared to be "tree-mummies;" and some tree canopy coverings where cloth was secured only to the trunk and basal branches of the tree. With this latter approach, the upper canopy was left uncovered and susceptible to oviposition damage.

Covering small, newly planted trees with light-weight cloth *(e.g.,* cheese-cloth), netting (openings 1/4" or less in size), or other appropriate material will prevent cicada oviposition injury. This is a recommended practice in areas where high cicada populations portend significant damage to small trees.

However, this method of reducing cicada damage is not without risk to the "protected" trees. Here are some common-sense points to consider:

- Trees should not be covered until the cicada emergence is under way. Delay covering trees until you see the first cicadas on the plant. Male cicadas emerge first followed by females, and oviposition does not immediately occur.
- Tree-covering material should not significantly interfere with the passage of light to the canopy. This is particularly important for trees that require full sun to thrive.
- The material should allow for good airflow, keeping foliage dry and less susceptible to fungal infections. Good airflow across leaf surfaces also cools the foliage and supports evapotranspiration, a process that is important to water and nutrient uptake by the tree.

- The covering material should be kept loose over the canopy. Limbs and foliage should not be compressed.
- Covering material should be removed periodically and reapplied as needed. This will keep new growth from becoming deformed by the cover. Cloth material should also be removed when weather reports predict strong storms that include high winds. Otherwise the material may act as a wind-sail, causing damage to branches and main stems.
- Using tree canopy covers to protect against oviposition damage should be treated as a short-term endeavor. Long-term use of some materials for covering trees may produce noticeable damage to the tree. Cicada activity should be closely monitored, and the tree covers removed as soon as oviposition activity has abated.

Cicada Observations

Ohio State University Extension personnel kept a close watch on the development of the Brood X cicadas from the start of their late springtime activities until well after the singing of the males had ceased. Selected observations made through the cicada event are presented here:

- Early evidence of periodical cicada activity was seen in the form of mud tubes appearing in turf. These tubes were built by nymphs 3 to 5" above the soil, apparently to escape water-saturated soils. The tubes are similar to those constructed by crayfish but are smaller in diameter (circa April 1 to 8, 2004).
- In Ohio, cicada emergence started in Cincinnati and spread northward from there. It was noted that periodical cicada activity started as a trickle of individuals but progressed rapidly to a roar over about a 10-day period (May 15 to May 24). The cicada males started chorusing in unison during this time, mating began, and oviposition was also observed. It was reported that cicadas were in full emergence in the Columbus area as well, but male chorusing and mating were at their beginning.
- Cicada species composition varied from location to location. It was noted that *M. cassini* was the only species found in Cincinnati. Localized segregation among the three periodical cicada species common to Brood X *(M. cassini, M. septendecula,* and *M. septendecim)* is not an uncommon occurrence. *M. cassini* tends to be found in dry, upland locations. All three species were found in central Ohio.
- Observers of periodical-cicada-infested plants reported observing a soft "rain" falling from trees heavily populated by cicadas. Some described it as looking like a fine mist as it was being reflected in shafts of sunlight filtering through tree canopies. Cicadas are sucking insects, and they do feed. The observed "cicada-dew" is analogous to the "honey-dew" excreted by aphids (circa May 20 to 27, 2004).
- Heavy oviposition on a wide range of trees and shrubs was observed throughout the Cincinnati area. The subsequent dieback of branch tips, or flagging, was just becoming evident, primarily on oaks in early June (circa June 3 to 10, 2004).
- As the periodical cicadas began to die, a new problem developed — the smell of decay. As quickly and synchronously as the cicadas appeared, they were also dying. Dead cicadas were raining down from heavily infested trees in many locations. Reports of foul odors from the accumulating dead cicadas

were received from many areas in the Brood X range (circa June 10 to 17, 2004).

- The construction of new distribution maps for Brood X is required since observations of Brood X's appearance or lack of appearance were recorded. There was considerable discontinuity of cicada populations within the reported range of Brood X. The historical method of using clusters of counties as a basis to delineate brood emergence boundaries does not accurately depict the actual population distribution.
- Brood X was observed to have redistributed over short distances to previously non-infested areas. Cicada watchers reported that they had observed large numbers of cicadas appearing in areas where there was little or no emergence from the ground. This movement was generally in close proximity to localized cicada "hot spots."
- Some possible reasons for the often dramatically uneven distribution of periodical cicada populations within the historical boundaries of Brood X include:

  ▲ Brood X in Ohio primarily occurs in the western half of the state, an area with a long history of field-crop production and limited wooded areas.

  ▲ Ohio is one of the fastest urbanizing states in the United States, and loss of mature trees as well as heavy soil disturbances most likely resulted in loss of cicada nymphs.

  ▲ A more speculative reason could be the impact of unidentified pathogens.
- Although the presence of the adult Brood X cicadas was relatively short lived, their impact will be evident for several years. Flagging was most visible on oak and beech, particularly European beech, but oviposition damage occurred on numerous plants. In areas where other broods of periodical cicadas were active in other years, considerable amounts of twig and branch dieback and breakage occurred for two to three years after the cicada event.
- In areas of extremely heavy periodical cicada emergence, millions of dead bodies dropped from trees and the odor of decay became overpowering. Some tried to put a recycle spin on the event by telling homeowners that the bodies are actually good fertilizer, being rich in nitrogen, phosphorus, and potassium. In fact, recent research at sites in the eastern United States show that this "resource pulse" from cicada decomposition is real and may explain long-known observations of tree growth ring increases following years of cicada emergence.

Summary

Brood X emergence began in early May (May 4 to 11, 2004), and the adult activity extended into late June to early July (June 29 to July 8, 2004), although their impacts will be felt for several years to come. During the cicada emergence, and subsequent adult activity, Ohioans living in heavily infested areas met the onslaught with a range of reactions, from genuine curiosity and amazement, to taciturn acceptance, to mild panic. Their sentiments are epitomized by a few selected farewells — "goodbye garish gadflies," "adios transient troubadours," and "don't let the door slam on your ovipositor on the way out."

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Gypsy Moth in Ohio

David Adkins, Amy K. Stone, and Daniel A. Herms

Introduction

The gypsy moth, *Lymantria dispar* (L.), is one of the most notorious and destructive insect pests threatening our hardwood forests and ornamental landscape plants in Ohio. The caterpillar stage of the insect feeds on more than 300 species of trees and shrubs. Favorites include oaks, aspens, birches, lindens, sweetgum, crabapples, hawthorns, mountain ash, and willows. Severe defoliation can weaken trees, leaving them more susceptible to other stresses, such as drought, disease, and other insect pests including borers.

Since its accidental introduction in Massachusetts in 1869, this non-native insect has steadily moved throughout the New England and North Atlantic states down to northern North Carolina and west to the states surrounding the Great Lakes Region, including Ohio. Infestations have also occurred in the west coast states of Washington, Oregon, California, and Utah.

The first adult male moths in Ohio were trapped in 1971, in Ashtabula County. Two years later, the first chemical eradication program was implemented by the Ohio Department of Agriculture (ODA). For the next 15 years (1973 through 1987), efforts were aimed exclusively at the eradication of localized gypsy moth populations. Despite this effort, the population continued to grow. In 1987, Ashtabula County became the first Ohio county to have gypsy moth quarantine regulations imposed. Additional townships in three contiguous counties (Trumbull, Lake, and Geauga) were also regulated at the same time. Since then, 42 more counties have been added to the quarantine list in Ohio.

In 1989, ODA, in conjunction with the U.S. Department of Agriculture (USDA) Forest Service, initiated the Gypsy Moth Suppression Program with a two-acre treatment block in Geneva State Park, in Ashtabula County. The Gypsy Moth Suppression Program continues today, but is now a voluntary treatment at the request of the landowner/landowners meeting the program's minimum qualifications.

In 1998, pheromone traps were placed over the entire state of Ohio, in eight-kilometer grids. This was done to estimate the infestation densities of the gypsy moth across the Buckeye State. With this data, an infestation line was drawn (the 10-moth line), with the area to the east of this line being considered generally infested. The suppression program generally operates in this area.

David Adkins, Ohio Department of Agriculture, Gypsy Moth Program Manager; Amy K. Stone, Ohio State University Extension, Lucas County; Daniel A. Herms, Associate Professor, Ohio State University, Ohio Agricultural Research and Development Center (OARDC).

In 1999, the Slow the Spread (STS) Program was added by USDA's Forest Service and Animal Plant Health Inspection Service (APHIS) in Ohio as a means of monitoring the advancement and to eradicate populations of gypsy moth that were ahead of the infestation line. A 100-kilometer swath paralleling the infestation line to the west was established and this became the STS Action Zone. This STS zone passes through eight states.

The activities and results that ODA was able to accomplish in 2004 related to the gypsy moth in Ohio are described here.

Figure 1. The map indicates three zones in Ohio.

The Suppression Program

In the fall of 2003, ODA received nine suppression survey applications for consideration for the 2004 program. Applications came from Coshocton, Holmes, Jefferson, Licking, Lucas, Morgan, and Sandusky Counties. After review of the applications and a survey of the blocks, it was determined that only one application qualified for suppression treatment.

Minimum qualifications that must be met to be included in ODA Suppression Program include the following:

1. A fully completed application must be received by ODA no later than September 1 of the year prior to treatment.
2. The proposed spray block must be located in a county that has been designated in the quarantine for gypsy moth by ODA.
3. The proposed spray block must contain a minimum of 50 contiguous acres.
4. The proposed spray block must have a concentration of at least 250 egg masses per acre in forested residential areas and 1,000 egg masses per acre in uninhabited forested areas.
5. The proposed spray block must have a tree canopy that covers no less than 50% of the block.
6. The proposed spray block must consist of at least 35% tree species that are either susceptible or resistant to gypsy moth.
7. The proposed spray block must receive a favorable T&E Assessment from the Ohio Department Natural Resources (ODNR) and the U.S. Fish and Wildlife Service.
8. ODA must receive the total cost share payment from the landowner no later than March 1 of the treatment year.*

* In the fall of 2004, ODA implemented a Landowner Cost Share as part of the Suppression Program. Landowners whose applications qualify for a suppression treatment will be required to pay 50% of the average cost of application of the project before their land is treated. Under the current aerial

contract, the cost to the landowner would range from $8.90 to $22.49 per acre, depending on total acres treated and products used.

In 2004, the single suppression treatment block was located in Lucas County, east of Swanton, Ohio. The 294-acre Swanton block was located in the Whitehouse quadrangle and was made up of forested residential and private recreational land use.

The pre-treatment egg mass count was 6,914 egg masses per acre (EM/A). Two applications of Foray 48F, a microbial insecticide *Bacillus thuringienis* var. *kurstaki (Btk),* was applied at the rate of 24 BIU/A/application. Amy Stone, Extension Educator with Ohio State University Extension in Lucas County, acted as block coordinator.

The first application was made on May 12 at 9 a.m. Weather conditions at the time were:

temperature: 75° F
relative humidity: 71%
wind speed : 1 to 3 mph.

The second application followed five days later on May 17 at 7:51 a.m. The weather conditions at the time were:

temperature: 62° F
relative humidity: 80%
wind speed : 3 to 5 mph.

The weather readings were made at ground level within the treatment block.

A post-treatment egg mass count conducted by ODA in October found 165 EM/A. This was a 97.6% reduction in the population.

Figure 2. Location of the 2004 Treatment Block in Lucas County.

Slow the Spread Program

1. The Eradication Treatment Project

Five treatment blocks were targeted for eradication treatments in 2004 for a total of 2,548 acres (Table 1). All blocks received two applications of Foray 48F, a microbial insecticide *Bacillus thuringienis* var. *kurstaki (Btk),* at the rate of 24 BIU/A/application.

STS Eradication Treatment Locations

The first round of treatments began at Pike State Forest on May 5, with the second round concluding on May 17, 2004. Because of the wide range of leaf and larva development between the Pike SF Block and the Oakwood Block, both treatment applications to the Pike SF, Catawba, and Mingo Blocks were completed before moving to the Mt. Victory and Oakwood Blocks for their first application.

The results of ODA treatments, based on the findings of the trapping in and surrounding the treatment blocks (delimit trapping), indicated a 100% control in four

Table 1. Eradication Treatment Blocks in 2004.			
Block	**County**	**Quadrangle**	**Acres**
Pike SF	Pike	Bainbridge / Morgantown	584
Catawba	Clark	South Vienna	246
Mingo	Champaign	Kings Creek	324
Mt. Victory	Hardin	Mt. Victory	241
Oakwood	Putnam / Paulding	Oakwood / Continental	1,153

Table 2. Weather Conditions During Applications, 2004.					
Block	**Date**	**Time**	**Temp**	**R.H.**	**Wind**
Pike SF	5/5 5/10	6:14 am 6:06 am	50° F 61° F	94% 82%	1-3 mph 1-3 mph
Catawba	5/5 5/10	7:59 am 7:35 am	55° F 66° F	94% 70%	8 mph 6 mph
Mingo	5/5 5/10	7:45 am 8:25 am	54° F N/A	63% N/A	2-3 mph N/A
Mt. Victory	5/11 5/17	7:41 am 8:51 am	68° F 61° F	71% 84%	1 mph 6-7 mph
Oakwood	5/11 5/17 5/17	11:47 am 6:31 am 9:57 am	75° F 51° F 64° F	66% 82% 68%	5 mph 1-2 mph 4-5 mph

Figure 3. STS Eradication Treatment Locations, 2004.

of the five blocks. In the Oakwood Block, male moths were caught again, but at a greatly reduced number. Because of the catches in the Oakwood Block, it will be treated again in 2005.

2. Mating Disruption Treatment Project

Fifteen blocks were targeted in 2004 for mating disruption treatments, for a total of 82,761 acres (Table 4). Applications of Disrupt II flakes, a gypsy moth mating disruptant, were made at either the 6 gram or 15 gram rate (Table 5), depending on the moth catch levels obtained during trapping in 2003. Trapping will be conducted again in 2005 to determine the effectiveness of the treatment. The Vinton Block was used as a test plot for a new mating disruption product from 3M.

Table 3. Eradication Treatment Results, 2004.			
Block	**2003 Moth Catch**	**2004 Moth Catch**	**% Reduction**
Pike SF	3 +EM	0	100
Catawba	17	0	100
Mingo	44	0	100
Mt. Victory	7	0	100
Oakwood	126	18	85.8

Table 4. Mating Disruption Treatment Blocks, 2004.			
Block	**Acres**	**2003 Moth Catch**	**MD Rate**
Mulga	18,215	399	15 g
Vinton	5,360	136	15 g
Leo	12,111	260	15 g
Morgantown 04	21,449	134	6 g
Scioto Trail	5,326	29	6 g
Great Seal	11,939	112	6 g
Middletown	254	18	6 g
New Jasper	1,147	10	6 g
Five Points	318	14	6 g
Byron	800	12	6 g
Green Township	2,245	28	6 g
Donnelsville	325	31	6 g
Georgesville	2,675	21	6 g
Lima	268	6	6 g
Columbus Grove	329	6	6 g

In 2004, mating disruption treatment blocks from 2003 were trapped to determine the effectiveness of the treatment. Six of the 11 treatment blocks — New Moorefield, Cedarville, Bellbrook, Trenton, Hanging Rock, and East Cincinnati — showed an excellent result, with 100% reduction in moth catches. The South Webster block had a good treatment result with a 92.9% reduction in moth catches. The last four blocks had less than expected results.

The Morgantown and Bainbridge Blocks are scheduled to be treated again in 2005 as parts of the larger Anerville 05 and

Figure 4. Mating Disruption Treatment Locations, 2004.

Table 5. Mating Disruption Treatement Results, 2003.					
Block	**Acres**	**MD Rate**	**2002 Moth Catch**	**2004 Moth Catch**	**% Reduction**
New Moorefield	1,273	6 g	12	0	100
Cedarville	1,218	6 g	32	0	100
Bellbrook	1,754	6 g	18	0	100
Trenton	829	15 g	8	0	100
Cincinnati East	986	15 g	62	0	100
Hanging Rock	1,750	6 g	18	0	100
South Webster	1,437	6 g	14	1	92.9
Summit Hill	1,370	6 g	18	5	72.3
Bourneville	821	6g	6	3	50.0
Morgantown	1,490	6 g	36	28	22.3
Bainbridge	3,947	6 g	55	50	9.1

Lapperall 05 treatment blocks, respectfully. This time around, a *Btk* treatment is planned. The Bourneville and Summit Hill Blocks are listed as areas of concern in the STS Decision. This northern Pike County and southern Ross County area continues to be a problem site. Stronger efforts are planned in 2005.

3. Trapping Survey Project

Pheromone traps were placed in all or part of 66 of Ohio's 88 counties in 2004 to monitor the advancement of the gypsy moth population and isolated hot spots within the STS Monitoring and Action Zone, as well as the APHIS monitoring Zone. This amounted to trapping in 28,413 square miles of Ohio. Delta traps were used in monitoring and action areas, and milk-carton traps were used in delimit areas.

The state was divided into 38 trapping territories. Thirty-eight trappers and five crew leaders were hired on a seasonal basis, with one trapper assigned to each territory. Each crew leader was assigned to oversee seven or eight trappers. Each trapper, on average, was asked to set 359 traps.

Trappers started setting traps May 23. Delimit traps had to be set by June 19, with all others having a deadline of June 26. Midseason counts were to be completed between June 27 and July 31. Final counts and pulls could begin August 1, with an August 28 completion date.

A total of 13,645 trap placements were proposed in 2004, with 13,457 traps actually placed (98.7%). A total of 188 traps were omitted (1.38%) for one of the following reasons — inaccessible terrain, no structure to hang the trap on, access denied by landowner, or safety hazard. Of the traps that were placed, 1,074 traps (8.0%) were placed outside their target circle. Midseason checks were done on 10,618 traps (78.9%) and final trap pulls and counts were done on 13,403 traps (99.6%).

Table 6. Trap Placement Summary, 2004.		
	No. Traps	%
Proposed Trap Placements	13,645	100
Actual Trap Placements	13,457	98.6
Omitted Traps	188	1.4
Traps Outside Target Circle	1,074	8.0
Midseason Checks	10,618	78.9
Final Count and Pulls	13,403	99.6
Traps with Positive Catches	2,090	15.6

Positive trap catches were reported on 2,090 traps (15.6%), with a total of 21,603 male moths caught. The highest single trap catch was 1,005, in the Springfield quadrangle. The county with the highest total catch was Licking County at 2,267 moths. Lucas County had the highest per trap average at 54.54 moths.

Over all, the 10-moth line in Ohio has receded again this year. Since 2001, the 10-moth line has receded just a little more each year. Even though the general movement west has slowed, more concentrated hot spots are showing up in the STS Action Zone.

The average catch per trap went up in 18 counties, stayed the same in four counties, and decreased in 44 counties in 2004, compared to 2003 averages. Of the 18 counties that showed increases, 10 were within the STS Action Zone, and three were within the APHIS Monitoring Area, and five were in counties in the Suppression Area.

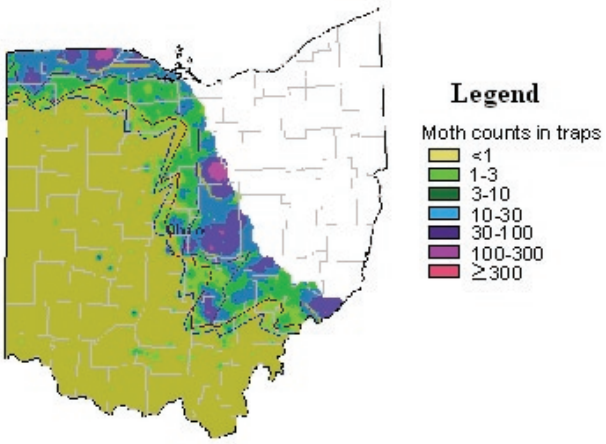

Figure 5. Smoothed Moth Counts, 2004.

APHIS Program

Since the southwestern corner of Ohio is outside the 100-kilometer STS Action Zone, ODA runs a trapping survey project for USDA-APHIS in this area. The area includes all or parts of Brown, Butler, Clermont, Darke, Hamilton, Mercer, Miami, Montgomery, Preble, Shelby, and Warren Counties.

Approximately 3,428 square miles were trapped on 2 and 3 kilometer grids. Eleven 500-meter delimits were placed within the larger grids. A total of 1,625 traps were set. Fifty positive traps were reported, with a total catch of 80 male moths, a 0.05 average catch per trap.

One mating disruption treatment block fell within the APHIS area in 2004. The Middletown Block, which was basically the Miami University campus, was treated with 6 grams per acre of Disrupt II. STS paid for the treatment.

Defoliation Survey

In cooperation with ODNR and ODA, an aerial defoliation survey was conducted over the entire state, starting the last week of June and concluding mid-July. Five-minute and three-minute flight lines were flown, depending on visibility, in

Table 6. Average Catch per Trap by County							
County	**2003**	**2004**	↑↓ =	**County**	**2003**	**2004**	↑↓ =
Adams	0.05	0.04	↓	Logan	0.08	0.11	↑
Allen	0.18	0.08	↓	Lucas	65.0	54.54	↓
Athens	3.7	0.76	↓	Madison	0.34	0.17	↓
Auglaize	0.01	0.03	↑	Marion	1.1	1.04	↓
Brown	0.02	0.00	↓	Meigs	0.57	0.16	↓
Butler	0.09	0.02	↓	Mercer	0.03	0.02	↓
Champaign	0.21	0.10	↓	Miami	0.03	0.01	↓
Clark	0.33	3.82	↑	Montgomery	0.02	0.1	↑
Clermont	0.04	0.09	↑	Morgan	6.4	4.73	↓
Clinton	0.04	0.04	=	Morrow	7.1	3.86	↓
Coshocton	61.0	23.5	↓	Muskingum	31.0	19.13	↓
Crawford	3.3	1.62	↓	Noble	4.5	6.33	↑
Darke	0.01	0.01	=	Ottawa	32.0	22.68	↓
Defiance	4.9	7.42	↑	Paulding	0.93	0.58	↓
Delaware	2.6	3.38	↑	Perry	18.0	11.2	↓
Erie	21.0	19.0	↓	Pickaway	0.56	0.29	↓
Fairfield	6.0	3.36	↓	Pike	0.47	0.79	↑
Fayette	0.08	1.03	↑	Preble	0.00	0.00	=
Franklin	1.2	4.28	↑	Putnam	0.30	0.15	↓
Fulton	27.0	20.65	↓	Richland	35.0	41.14	↑
Gallia	0.53	0.03	↓	Ross	0.92	0.47	↓
Greene	0.17	0.02	↓	Sandusky	10.0	5.83	↓
Hamilton	0.07	0.08	↑	Scioto	0.08	0.02	↓
Hancock	0.65	0.34	↓	Seneca	4.8	2.62	↓
Hardin	0.19	0.04	↓	Shelby	0.01	0.06	↑
Henry	2.3	1.78	↓	Union	0.28	0.21	↓
Highland	0.06	0.29	↑	Van Wert	0.11	0.07	↓
Hocking	17.0	20.47	↑	Vinton	4.3	1.24	↓
Huron	8.3	8.31	=	Warren	0.06	0.04	↓
Jackson	2.0	0.44	↓	Washington	30.0	16.58	↓
Knox	22.0	22.67	↑	Williams	44.0	18.22	↓
Lawrence	0.02	0.01	↓	Wood	7.2	4.44	↓
Licking	57.0	33.33	↓	Wyandot	0.70	0.86	↑

Note: The trap data included in the STS Trapping Survey Project covers the entire state, including the APHIS trap survey area.

an east-west direction. The survey was delayed a couple weeks due to the lack of availability of a plane and pilot from ODOT. This made detection more difficult because peak defoliation had passed, and the trees were starting to shoot new leaves.

After identifying potential defoliation and mortality sites from the air, ground surveys were conducted to verify the cause of the defoliation or mortality. Seventy-one sites in nineteen counties showed signs of gypsy moth defoliation or mortality. A total of 5,305 acres of defoliation and 555 acres of mortality were confirmed. This is a 21.7% increase in defoliation and a 15.2 % increase in mortality from 2003.

Table 7. Defoliation and Mortality Locations and Acres, 2004.

County	No. Sites	Defoliation Acres	Mortality Acres
Ashland	2	15	9
Carroll	7	266	8
Coshocton	5	235	86
Cuyahoga	4	0	273
Erie	12	292	0
Fulton	4	27	0
Harrison	3	6	71
Holmes	4	20	0
Knox	1	1	0
Lorain	1	87	0
Lucas	2	30	0
Ottawa	14	2,620	6
Sandusky	1	503	0
Seneca	2	822	0
Summit	2	0	102
Tuscarawas	2	106	0
Washington	3	214	0
Wayne	1	34	0
Williams	1	27	0
TOTAL	71	5,305	555

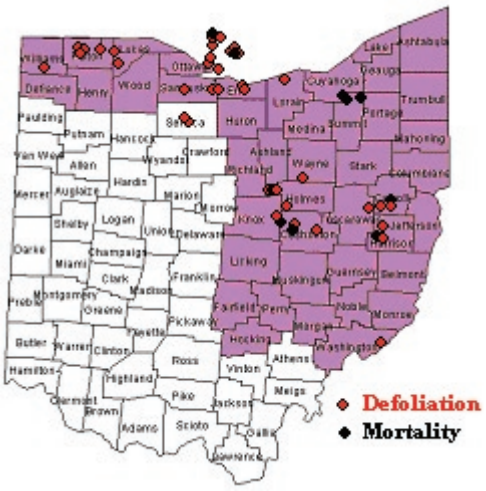

Figure 6. Defoliation and Mortality Locations, 2004.

Quarantine Counties

A county may be designated as generally infested with gypsy moth and quarantine regulations may be set if any one of the following are met:

1. When the majority (51%) of a county is behind the 10-moth per trap boundary line for three consecutive years (as the 10-moth line is plotted by the Slow-the-Spread strategy).
2. When 10 or more male gypsy moths are caught per trap in more than one-third of the detection traps, and alternate gypsy moth life stages are documented at multiple locations throughout the county.
3. When, after three consecutive years of program-recommended control efforts during which there are two consecutive years of delimiting surveys, an expanding gypsy moth population persists and multiple life stages are documented.
4. In the absence of meeting any of the previous criteria, when the federal and state regulatory officials determine that a potential for gypsy moth spread exists, they may mutually request that the county be regulated.

The criteria for designating a previously regulated county for gypsy moth as deregulated (free from gypsy moth) is:

1. Three consecutive years of negative trap data, with two consecutive seasons of delimiting trapping.

Regulated articles under the quarantine include trees and woody shrubs (including cut Christmas trees); logs; pulpwood; slabwood; firewood; wood-bark chips; outdoor household articles (tables, benches, chairs, doghouses, birdhouses, feeders, planters, utility sheds, grills, garden equipment, playhouses, sandboxes, recreational vehicles, boats, trailers, tents); and any other product or article that may carry a life stage of the gypsy moth.

After reviewing the trap catches, ODA did not add any additional counties to the Gypsy Moth Quarantine list. Currently, 43 counties in Ohio are under the quarantine regulations. The counties are Ashland, Ashtabula, Belmont, Carroll, Columbiana, Coshocton, Cuyahoga, Defiance, Erie, Fairfield, Fulton, Geauga, Guernsey, Harrison, Henry, Hocking, Holmes, Huron, Jefferson, Knox, Lake, Licking, Lorain, Lucas, Mahoning, Medina, Monroe, Morgan, Muskingum, Noble, Ottawa, Perry, Portage, Richland, Sandusky, Stark, Summit, Trumbull, Tuscarawas, Washington, Wayne, Williams, and Wood Counties.

Figure 7. Gypsy Moth Quarantined Counties, 2004.

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Biological Calendars: The Statewide Network of OSU Phenology Gardens

Denise Ellsworth and Daniel A. Herms

Effective monitoring is the backbone of any Integrated Pest Management (IPM) program. However, planning and implementing a monitoring program in nurseries and landscapes is challenging because of the tremendous diversity of plants, each with its own complement of insect pests. Furthermore, many insects are difficult to detect and observe. Consequently, pesticide applications are often scheduled on a calendar-day basis, which is frequently inaccurate because of annual and geographic variation in weather patterns.

The use of plant phenology provides an alternative approach for predicting insect activity. Phenology is the study of recurring biological events and their relationship to weather. Examples of phenological events include bird migration, flowering of plants, and the seasonal appearance of insects.

The development of both plants and insects is temperature dependent; thus, phenological events of plants, such as flowering time, may accurately track degree-day accumulation and predict insect development and emergence. To test this hypothesis, the phenology of 91 ornamental plant species and/or cultivars and 43 key insect and mite pests has been monitored every year since 1997 at the Ohio Agricultural Research and Development Center's Secrest Arboretum in Wooster, Ohio (Herms 2000, 2003).

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The Biological Calendar

This intensive, long-term research project has demonstrated that phenological events occur in virtually the same order each year (Herms, 2003). This has led to the development of a Biological Calendar that is used by Extension personnel and green-industry professionals to predict pest activity and schedule pest-management appointments (Herms, 2004).

The Biological Calendar can greatly ease the complex logistics of scheduling a monitoring and management program when confronted with a large number of pests. Instead of monitoring every plant and pest species in a nursery or a landscape on a weekly basis (which is often not feasible), the Biological Calendar can be used to schedule pest-management appointments as they come due.

For example, because egg hatch of pine needle scale always begins as common lilac approaches full bloom, this blooming event can be used as a reminder to scout for pine needle scale crawlers or plan for insecticidal soap, horticultural oil, or other pesticide applications. On the other hand,

when common lilac is blooming, spruce spider mite eggs have already hatched, and it is still too early for bronze birch borer adult emergence.

OARDC's Phenology Web Site

The Biological Calendar can be accessed at the Ohio Agricultural Research and Development Center's (OARDC) phenology web site at: **http://www.oardc.ohio-state.edu/gdd.** Degree-day data is accessible to users for any location in Ohio.

Daily temperature data from 12 OARDC Research Stations and three USDA-ARS weather stations located throughout Ohio are used to calculate cumulative degree-days in real-time. Degree-days for locations between weather stations are extrapolated from climatic isotherms for Ohio.

Upon entering any Ohio zip code, current degree-day accumulation for that location is calculated, and the user is automatically directed to the appropriate spot on the Biological Calendar. By scrolling up or down the Biological Calendar, it is possible to see what blooming and pest events have already occurred, as well as what has yet to happen.

Timing pest activity and management tactics in Ohio is complicated by the substantial climatic variation that occurs across the state. A particular phenological event, such as gypsy moth egg hatch, may occur a month or more earlier along the Ohio River than it does near Lake Erie. However, the phenology web site can overcome this logistical problem because it predicts what plants are in bloom and what pests are active anywhere in the state. This is a bold prediction, but one that can be easily tested simply by visiting the web site and looking out the window.

The Ohio State University Phenology Garden Network

To further demonstrate, evaluate, and teach the concept of using a phenological sequence as a Biological Calendar, the OSU Phenology Garden Network was developed and implemented throughout Ohio in 2004.

Demonstration and research gardens were installed at 28 public locations across the state. (See Table 1 for a list of charter garden sites, and Figure 1 for a map of their distribution.) Each garden contains identical plant material, consisting of 16 species and cultivars, the blooming sequence of which spans the growing season. (See Table 2 for the list of plants comprising each garden.)

Beginning in 2005, volunteers at each site, including OSU Master Gardener volunteers, naturalists, OSU Extension staff, and others, will monitor the blooming sequence of plants in the gardens over the course of the season, beginning with the first bloom of Gold Tide™ Forsythia in early spring and ending with the full bloom of 'Blushing Bride' Rose-of-Sharon in mid-summer.

The dates of first bloom and full bloom will be recorded for each plant and reported online by Master Gardner volunteers. The data will then be accessible to the general public on the web as it is collected, so it can be used to track the "phenological wave" moving north through Ohio as the plants bloom throughout spring and summer.

First bloom is defined as the date on which the first flower bud on the plant opens, revealing pistils and/or stamens, and full bloom as the date on which 95% of the flower buds have opened *(i.e.,* one bud out of 20 has yet to open).

Table 1. Charter Garden Sites in the Ohio State University Phenology Garden Network.

- Ashtabula County, Ohio Agricultural Research and Development Center, Ashtabula Research Station, Kingsville
- Athens County, Ohio University Environmental and Plant Biology Department, Greenhouse and Garden, Athens
- Clark County, Ohio State University Extension Gateway Learning Gardens, Springfield
- Clark County, Northridge Elementary School, East Springfield
- Clinton County, Wilmington Middle School, Wilmington
- Coshocton County, Lake Park, Coshocton
- Delaware County, The Alpha Group, Delaware
- Delaware County, Wyandot Run Elementary School, Powell
- Erie County, Osborn Park, Huron
- Franklin County, Chadwick Arboretum, The Ohio State University, Columbus
- Geauga County, Berkshire Schools Board of Education Building, Chardon
- Green County, Green County Park District Master Gardener Demonstration Garden, Xenia
- Hancock County, Hancock County Demonstration Gardens, Findlay
- Huron County, Shady Lane Park, Norwalk
- Licking County, Master Gardener Demonstration Gardens, Newark
- Lucas County, Ohio State University Extension at Toledo Botanical Garden, Toledo
- Mahoning County, Millcreek Metropark, Canfield
- Pickaway County, Monroe Township Park, Mt. Sterling
- Pike County, Ohio State University South Centers, Piketon
- Portage County, Ohio State University Extension Master Gardener Demonstration Garden, Ravenna
- Richland County, Ohio State University Extension Richland County Office, Mansfield
- Ross County, Canal Gardens, Chillicothe
- Stark County, Ohio State University Extension Master Gardener Demonstration Garden, Massillon
- Stark County, Canton Country Day School, Canton
- Summit County, F.A. Seiberling Naturealm Metropark, Akron
- Summit County, Adell Durbin Arboretum, Stow
- Trumbull County, Ohio State University Extension Master Gardener Research and Demonstration Garden, Cortland
- Wayne County, Secrest Arboretum, Ohio Agricultural Research and Development Center, Ohio State University, Wooster

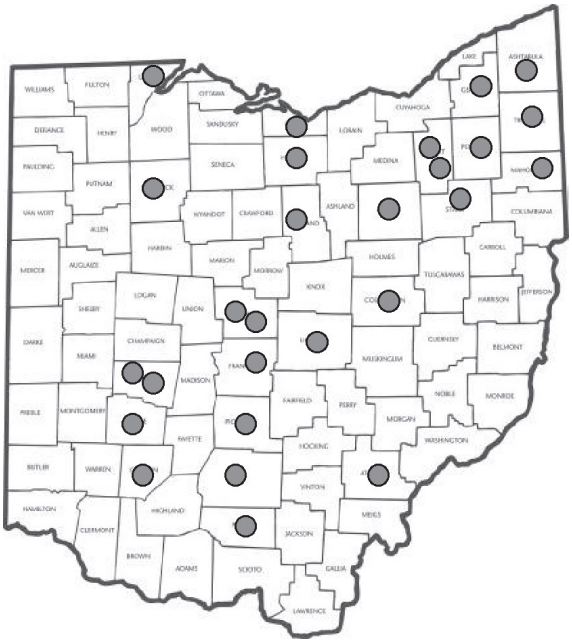

Figure 1. Geographic distribution of gardens currently participating in the Ohio State University Phenology Garden Network.

Table 2. Plants in Each Garden in the OSU Phenology Garden Network.
Each garden contains the plants listed here in the order they are expected to bloom over the course of the growing season.

Plant	Scientific Name (if applicable)	Cultivar	Mature size (height x spread)
Gold Tide™ Forsythia	*Forsythia* x *intermedia*	'Courtasol'	1.5' x 5'
Star Magnolia	*Magnolia stellata*	'Royal Star'	15' x 20'
PJM Rhododendron	*Rhododendron* 'PJM'	'PJM'	3-6' x 4'
Koreanspice Viburnum	*Viburnum carlesii*		5' x 5'
Coralburst™ Crabapple	*Malus* 'Coralcole'	'Coralcole'	10-15' x 8-10'
Common Lilac	*Syringa vulgaris*	'Charles Joly'	12' x 10'
Vanhoutte Spirea	*Spriraea* x *vanhouttei*		8' x 10'
Miss Kim Lilac	*Syringa patula*	'Miss Kim'	6' x 6'
Redosier Dogwood	*Cornus sericea* f. *baileyi*		8' x 8'
Red Prince Weigela	*Weigela florida*	'Red Prince'	5' x 5'
Autumn Jazz® Arrowwood Viburnum	*Viburnum dentatum*	'Ralph Senior'	8-10' x 10-12'
Bumald Spirea	*Spiraea* x *bumalda*	'Goldflame'	3' x 3'
Abottswood Potentilla	*Potentilla fruticosa*	'Abbottswood'	3' x 3'
Oakleaf Hydrangea	*Hydrangea quercifolia*		6' x 6'
Cutleaf Elderberry	*Sambucus canadensis*	'Laciniata'	6' x 6'
Rose-of-Sharon	*Hibiscus syriacus*	'Blushing Bride'	8-12' x 6-10'

Research will continue at Secrest Arboretum in order to calibrate the Biological Calendar against the phenological gardens, so the gardens can be used to predict the large number of pests already included on the Biological Calendar. The great consistency in the sequence of phenological events from one year to the next (even when the weather varies dramatically) means that even one year of observation provides useful data that can be used to modify and expand the Biological Calendar.

For example, users could add additional plants (including weeds) or insects (including butterflies) to the calendar just by observing where in the sequence those phenological events occur relative to those that are already included.

Phenological data reported from these gardens will be used to fine-tune local timing recommendations for pest management practices and document patterns of weather variation across the state. Over the long-term, these data will document changes in the length of the growing season predicted to occur as a result of global warming. By teaching and demonstrating plant and pest phenology, this project will facilitate phenologically based timing of pest management decisions by gardeners and green-industry professionals, which will increase the efficiency of pest-management programs

in nurseries and landscapes while decreasing pesticide use.

This project is made possible thanks to a partnership between OSU Extension, Ohio's green industry, and the OSU Master Gardener volunteer program. All of the plants used to establish the 28 phenology gardens were donated by seven Ohio nurseries (see Table 3 for a list of cooperating nurseries), with the total value of this contribution exceeding $10,000. Volunteers at each site secured garden space, prepared the soil, and installed the plant material. Many of these volunteers are OSU Master Gardener volunteers who have completed a specialized program focusing on insects.

Table 3. Nurseries That Donated the Plant Material to Establish the OSU Phenology Garden Network.

Herman Losely and Son, Inc., Perry, Ohio
Klyn Nurseries, Inc., Perry, Ohio
Roemer Nursery, Inc., Madison, Ohio
Studebaker Nurseries, New Carlisle, Ohio
Sunleaf Nursery, Madison, Ohio
The Cottage Gardens, Inc., Perry, Ohio
Willoway Nurseries, Inc., Avon, Ohio

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The Evaluation of Insecticides for Control of the Hairy Chinch Bug in Ohio Lawns

David J. Shetlar, Jennifer Andon, and Daniel Digman

Introduction

The hairy chinch bug, *Blissus leucopterus hirtus* Montandon (HCB), is one of the top five pests of cool-season turfgrasses (Potter, 1998; Vittum *et al.*, 1999; Niemczyk and Shetlar, 2000). HCB has been a periodic pest, especially in lawns, since the rise of commercial lawn care in the 1970s. Research on its biology indicates that two generations per year are the norm over most of its range (Mailloux and Streu, 1981; Niemczyk, 1982; and Niemczyk *et al.*, 1992), though a single generation is often seen in Canadian Provinces (Shetlar, personal observations).

Some books and Extension fact sheets state that HCB is rarely a problem during wet seasons or in regularly irrigated turf. Over the last few years, we have been alerted by lawn-care specialists that they are seeing HCB infestations in high-quality lawns that are often irrigated. We have seen such infestations in the Dayton and Columbus, Ohio, areas. During the last four years, we have also seen a general increase in HCB activity in Ohio lawns, so we were presented with the opportunity to evaluate new control materials. This is especially important as the Food Quality Protection Act has restricted from residential use the primary chinch-bug-control insecticides, chlorpyrifos (Dursban™) and diazinon.

Materials and Methods

In general, we perform HCB control trials on lawns that have been found to be infested with chinch bugs in June through September. Test areas are usually divided into 5′ x 5′ treatment plots, and the slate of treatments is replicated four times in a randomized complete block design.

Liquid treatments are usually applied with a four-foot-wide spray boom using a CO_2 pressure tank. Sprays are usually applied at 1.5 gallons of mix per 1,000 ft^2 followed with a light irrigation (see individual table notes for variations from this general protocol). Granular (dry) products are generally applied by shaker jars followed with a light irrigation, depending on the protocols.

Populations are sampled after treatments by twisting 4.5-inch diameter stainless steel cylinders (actually restaurant condiment containers with the bottom cut off) through the turf into the top inch of soil. These cylinders are then filled with water, and the chinch bugs are collected into alcohol as they float to the surface. Sampling locations are determined using

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a "biased" technique *(i.e.*, the turf within the center 4' x 4' area is spread to look for active chinch bugs in the thatch). If no chinch bugs are found after five attempts, the cylinder is placed in a spot that looks like it may have been damaged by chinch bugs.

Cylinders are kept filled until no chinch bugs float to the surface in a two-minute period. The chinch bugs are then sorted into groups — small nymphs (1 to 3 instar), large nymphs (4 to 5 instar) and adults — and recorded for statistical analysis. For rapidity-of-kill, samples are taken at three to seven days after treatment (DAT), at 10 to 14 DAT for maximum knock down, and at 21 to 28 DAT to determine residual effects.

In 2001, two studies were undertaken in early September in Springboro, Ohio (south of Dayton), when the second generation of HCB was ending its development. In 2002, two studies were undertaken in late August and early September in a home lawn in Dublin, Ohio (northwestern Columbus area). In 2003, three studies were undertaken in late September into early October in a home lawn in Pickerington, Ohio (southeastern Columbus area). In 2004, three studies were undertaken in late August into early September in home lawns in Pickerington, Ohio.

Results

In 2001, the neonicotinoids, Merit™ (imidacloprid) and Arena™ (clothiandin), were found to be effective for control of HCB (Table 1). Tempo™ (cyfluthrin) was not effective, but Tempo Ultra™ (beta-cyfluthrin) and Talstar™ (bifenthrin) were effective pyrethroids. Testing of permethrin granulars (another pyrethroid) showed that it was not effective, even at very high rates (Table 2).

Studies in 2002 showed that Merit and Meridian™ (thiamethoxam, another neonicotinoid) were effective, but Arena yielded mixed results (Table 3). Scimitar™ (lambda-cyhalothrin) granular formulations (many were experimental) generally yielded satisfactory control of HCB when compared to a Talstar granular standard (Table 4).

Table 1. Efficacy of Insecticides Applied for Control of Hairy Chinch Bugs in a Home Lawn on August 30, 2001, Springboro, Ohio.

Treatment	Rate lb. ai./A	HCB/ft² @ 7 DAT	% Control	HCB/ft² @ 14 DAT	% Control
Merit 75WP	0.3	72.40	92 a	18.10	96 a
Arena 50WP	0.3	95.03	90 a	54.30	87 a
Arena 50WP	0.4	203.63	78 a	79.19	81 a
Tempo Ultra SC	0.1	165.16	83 a	156.11	63 ab
Tempo 20WP	0.2	735.31	22 b	597.30	0 c
Talstar 0.67SC	0.1	18.10	98 a	9.05	98 a
Check	—	943.46	— b	418.56	— bc

Plots 5' x 5' replicated 4 Xs. Application volume 1.5 gal./1,000ft².
Averages are based on one 4.5" flotation area within each plot (raw totals were multiplied by 9.05 to get average per ft²). HCB population structure was: 515.85 1 to 3 instar, 332.59 4 to 5 instar, 95.03 adult @ 7 DAT; 162.9 1 to 3 instar, 165.16 4 to 5 instar, 90.5 adult @ 14 DAT. Percent controls followed by the same letter are not significantly different using LSD @ ≤ = 0.05.
Post-treatment irrigation: ~1/4" after 24 hr.

Table 2. Influence of Permethrin Insecticide Applied for Control of Hairy Chinch Bugs in a Home Lawn on August 30, 2001, Springboro, Ohio.

Treatment	Rate lb. ai./A	HCB/ft² @ 7 DAT	% Control
Permethrin 0.5G	0.25	909.53	14 a
Permethrin 0.5G	0.5	816.76	23 a
Permethrin 0.5G	1.0	823.55	22 a
Permethrin 0.5F	0.43	721.74	32 a
Check	—	1,058.85	— a

Plots 5′ x 5′ replicated 4 Xs.
Averages are based on one 4.5″ flotation area within each plot (raw totals were multiplied by 9.05 to get average per ft²). At 14 DAT an average of 373.3 HCB/ft² were found in the Permethrin 0.5G @ 1.0 lb.ai/A plots, so no further sampling was undertaken. Percent controls followed by the same letter are not significantly different using LSD @ ≤ = 0.05.
Post-treatment irrigation: ~1/4″ after 24 hr.

Table 3. Efficacy of Insecticides Applied for Control of Hairy Chinch Bugs in a Home Lawn on August 27, 2002, Dublin, Ohio.

Treatment	Rate lb. ai./A	HCB/ft² @ 3 DAT	% Control	HCB/ft² @ 15 DAT	% Control
Arena 50WP	0.3	47.5	32 a	221.9	29 abc
Arena 50WP	0.3	50.9	27 a	65.7	79 c
Confidential DP	0.25	29.4	58 a	142.6	54 bc
Confidential DP	0.125	55.5	21 a	332.8	00 a
Merit 75WP	0.3	24.9	65 a	63.4	80 c
Meridian 25WG	0.2	63.4	10 a	58.8	81 c
Talstar EZ 0.2G	0.1	34.0	52 a	98.5	69 c
Check	—	70.2	— a	312.5	— ab

Plots 5′ x 5′ replicated 4 Xs. Application volume 1.5 gal./1,000ft².
Averages are based on two 4.5″ flotation areas within each plot (raw totals were multiplied by 9.05 to get average per ft²). Percent controls followed by the same letter are not significantly different using LSD @ ≤ = 0.05.
Post-treatment irrigation: ~1/4″.

Table 4. Efficacy of Various Lambda-Cyhalothrin (Scimitar™) Granules for Control of Hairy Chinch Bugs in a Home Lawn on August 27, 2002, Dublin, Ohio.

Treatment	Rate lb. ai./A	HCB/ft² @ 8 DAT	% Control	HCB/ft² @ 16 DAT	% Control
lambda-c (1118)G	0.035	71.3	70 bc	45.3	80 b
lambda-c (1125)G	0.035	53.2	78 bc	49.8	78 b
lambda-c (1126)G	0.035	67.9	72 bc	82.6	63 b
lambda-c (1127)G	0.035	148.3	38 ab	63.4	72 b
lambda-c (1128)G	0.035	107.5	55 bc	38.5	83 b
lambda-c (1129)G	0.035	60.0	75 bc	36.2	84 b
Talstar EZ 0.2G	0.1	14.7	94 c	6.8	97 b
Check	—	240.0	— a	224.2	— a

Plots 5′ x 5′ ft replicated 4 Xs. Application volume 1.5 gal./1,000 ft².
Averages are based on two 4.5″ flotation areas within each plot (raw totals were multiplied by 9.05 to get average per ft²). Percent controls followed by the same letter are not significantly different using LSD @ ≤ = 0.05.
Post-treatment irrigation: ~1/4″.

In 2003, Merit and Arena produced satisfactory HCB control by 13 DAT, being slower to act than the standard, Talstar (Table 5). Spinosad (Conserve™, a microbial insecticide) formulations showed some suppression of HCB populations, suggesting that two applications may be necessary to achieve desired control.

An evaluation of acetamiprid (another neonicotinoid) showed that it has good potential as a HCB control product (Table 6). In the evaluation of combinations of Merit plus Talstar (Table 7), such combinations appeared to produce better results than Merit alone, but not better than Talstar alone.

In 2004, Arena and acetamiprid again showed that they are excellent neonicotinoid candidates for HCB control (Tables 8 and 9). The Merit and Talstar combinations continued to show excellent control (Table 9). In a search for alternate products that are botanical or biologically based, Spinosad and azadirachtin (Azatin™) formulations were evaluated as well as a new botanical essential oil (FACIN™, Tables 9 and 10). Azatin shows good promise, but Spinosad will likely need sequential applications (possibly at 10 to 14 days) to achieve acceptable control. The botanical, FACIN, also shows good promise, but it may also need sequential applications to achieve high levels of HCB control.

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Table 5. Efficacy of Insecticides Applied for Control of Hairy Chinch Bugs in a Home Lawn on September 18, 2003, Pickerington, Ohio.

Treatment	Rate lb. ai./A	HCB/ft² @ 6 DAT	% Control	HCB/ft² @ 13 DAT	% Control
Merit 75WP	0.3	246.5	58 bc	122.8	67 bc
Merit 75WP	0.4	223.6	62 bcd	83.4	78 cd
Arena 50WP	0.3	203.4	66 bcd	50.4	87 cd
Arena 50WP	0.4	173.2	71 cd	51.3	86 cd
Spinosad GR	0.4	189.7	68 bcd	194.2	49 b
Spinosad NAP	0.4	350.9	41 b	127.4	66 bc
Talstar EZ 0.2G	0.1	82.5	90 d	17.4	95 d
Check	—	592.8	— a	377.5	— a

Plots 5′ x 5′ replicated 4 Xs. Application volume 2.0 gal./1,000 ft².
Averages are based on two 4.5″ flotation areas within each plot (raw totals were multiplied by 9.05 to get average per ft²). Percent controls followed by the same letter are not significantly different using LSD @ ≤ = 0.05.
Post-treatment irrigation: none, but 1/4″ rain occurred within 48 hours.

Table 6. Efficacy of Acetamiprid Insecticide Applied for Control of Hairy Chinch Bugs in a Home Lawn on September 18, 2003, Pickerington, Ohio.

Treatment	Rate lb. ai./A	HCB/ft² @ 6 DAT	% Control	HCB/ft² @ 13 DAT	% Control
Acetamiprid G	0.15	170.4	61 b	13.7	96 b
Acetamiprid G	0.30	109.0	75 b	16.5	96 b
Acetamiprid G	0.45	84.3	81 b	2.7	99 b
Acetamiprid G	0.60	82.5	81 b	2.7	99 b
Talstar EZ 0.2G	0.1	115.4	73 b	8.2	98 b
Check	—	432.5	— a	374.7	— a

Plots 5′ x 5′ ft replicated 4 Xs. Application volume 2.0 gal./1,000ft².
Averages are based on two 4.5″ flotation areas within each plot (raw totals were multiplied by 9.05 to get average per ft²). Percent controls followed by the same letter are not significantly different using LSD @ ≤ = 0.05.
Post-treatment irrigation: none, but 1/4″ rain occurred within 48 hours.

Table 7. Efficacy of Talstar, Merit, and Combinations Applied for Control of Hairy Chinch Bugs in a Home Lawn on September 25, 2003, Pickerington, Ohio.

Treatment	Rate lb. ai./A	HCB/ft² @ 6 DAT	% Control	HCB/ft² @ 14 DAT	% Control
Talstar EZ 0.2G	0.1	25.7	86 b	4.6	98 c
Talstar EZ 0.2G	0.2	25.7	86 b	1.8	99 c
Merit 0.5G	0.3	88.0	52 b	66.0	72 b
Talstar F + Merit 2	0.15+ 0.15	20.2	89 b	3.7	99 c
Talstar F + Merit 2	0.2+ 0.2	36.7	80 b	1.8	99 c
Check	—	183.3	— a	232.7	— a

Plots 5′ x 5′ ft replicated 4 Xs. Application volume 2.0 gal./1,000ft².
Averages are based on two 4.5″ flotation areas within each plot (raw totals were multiplied by 9.05 to get average per ft²). Percent controls followed by the same letter are not significantly different using LSD @ ≤ = 0.05.
Post-treatment irrigation: none, but 3/8″ rain occurred within 72 hours.

Table 8. Efficacy of Arena Formulations and FACIN Insecticide Applied for Control of Hairy Chinch Bugs in a Home Lawn on August 25, 2004, Pickerington, Ohio.

Treatment	Rate lb. ai./A	HCB/ft² @ 7 DAT	% Control	HCB/ft² @ 14 DAT	% Control	HCB/ft² @ 28 DAT	% Control
Arena 50WP	0.2	6.4	95 b	0.0	100 c	0.9	100 b
Arena 50WP	0.3	0.0	100 b	7.3	97 c	0.0	100 b
Arena 50WP	0.4	2.8	98 b	0.0	100 c	0.0	100 b
Arena 0.5G	0.2	7.3	94 b	4.6	98 c	0.0	100 b
Arena 0.5G	0.3	5.5	96 b	0.9	100 c	0.0	100 b
Arena 0.5G	0.4	0.0	100 b	3.7	99 c	0.0	100 b
FACIN	8.5oz/M[a]	13.8	90 b	38.5	85 bc	1.8	99 b
FACIN	10oz/M[a]	25.7	81 b	94.4	64 b	76.1	71 b
Talstar F	0.2	2.8	98 b	5.5	98 c	0.9	100 b
Check	—	132.9	— a	260.4	— a	263.1	— a

Plots 5′ x 5′ replicated 4 Xs. Application volume 1.5 gal./1,000 ft² except FACIN was applied in 2.0 gal water per plot followed by another 2.0 gal water per plot.
Averages are based on two 4.5″ flotation areas within each plot (raw totals were multiplied by 9.05 to get average per ft²). Percent controls followed by the same letter are not significantly different using LSD @ ≤ = 0.05.
Post-treatment irrigation: none.
[a] M = 1,000 ft²

Table 9. Efficacy of Acetamiprid and Merit/Talstar Combos Applied for Control of Hairy Chinch Bugs in a Home Lawn on August 25, 2004, Pickerington, Ohio.

Treatment	Rate lb. ai./A	HCB/ft² @ 7 DAT	% Control	HCB/ft² @ 14 DAT	% Control	HCB/ft² @ 21 DAT	% Control
Acetamiprid	0.18	10.1	95 b	2.8	99 b	2.8	99 b
Acetamiprid	0.28	9.2	96 b	0.9	100 b	0.0	100 b
Acetamiprid	0.36	3.7	98 b	0.9	100 b	0.9	100 b
Acetamiprid	0.45	11.9	94 b	0.0	100 b	0.0	100 b
Talstar One	0.1	2.8	99 b	3.7	98 b	1.8	99 b
Talstar One	0.2	1.8	99 b	0.9	100 b	0.0	100 b
Merit 2 + Talstar One	0.2+0.16	1.8	99 b	0.9	100 b	0.0	100 b
Merit 2	0.3	19.3	90 b	10.1	95 b	0.9	100 b
Check	—	212.8	— a	212.8	— a	274.1	— a

Plots 5′ x 5′ ft replicated 4 Xs. Application volume 1.5 gal./1,000 ft².
Averages are based on two 4.5″ flotation areas within each plot (raw totals were multiplied by 9.05 to get average per ft²). Percent controls followed by the same letter are not significantly different using LSD @ ≤ = 0.05.
Post-treatment irrigation: none, but a significant rainfall event occurred within 24 hours.

Table 10. Efficacy of Alternate Products (Botanical and Biobased) Applied for Control of Hairy Chinch Bugs in a Home Lawn on August 10, 2004, Pickerington, Ohio.

Treatment	Rate lb. ai./A	HCB/ft² @ 5 DAT	% Control	HCB/ft² @ 14 DAT	% Control	HCB/ft² @ 28 DAT	% Control
Spinosad G	0.4	41.3	6 a	12.8	71 bcd	65.1	12 a
Spinosad G	0.6	24.8	44 ab	17.4	60 ab	61.5	17 ab
Azatin G	0.05	19.3	56 bc	16.5	63 abc	46.8	37 ab
Azatin G	0.1	6.4	85 bc	31.1	52 abc	32.1	57 bc
Bug-B-Gon Max (bifenthrin G)	0.2	2.8	94 c	4.6	90 cd	0.9	99 c
FACIN	8.5oz/M[a]	19.3	56 bc	6.4	85 bcd	33.0	56 bc
FACIN	10oz/M[a]	18.3	58 bc	3.7	92 d	24.8	67 bc
Check	—	44.0	— a	44.0	— a	74.3	— a

Plots 5′ x 5′ replicated 4 Xs. Application volume 1.5 gal./1,000 ft² except FACIN was applied in 2.0 gal water per plot followed by another 2.0 gal water per plot.
Averages are based on two 4.5″ flotation areas within each plot (raw totals were multiplied by 9.05 to get average per ft²). Percent controls followed by the same letter are not significantly different using LSD @ ≤ = 0.05.
Post-treatment irrigation: none but rain came the night after the applications.
[a] M = 1,000 ft²

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The Evaluation of Fungicides for the Curative Control of Red Thread (*Laetisaria fuciformis)* in Kentucky Bluegrass *(Poa pratensis)*

Joseph W. Rimelspach, T. E. Hicks, and Michael J. Boehm

This test was conducted in 2002 at The Ohio State University Turfgrass Research Center, Columbus, Ohio, on a stand of Kentucky bluegrass established in 1972. Mowing height was 3.5", and the clippings were returned to the plots.

The area was not irrigated. The condition of the sward was fair with no thatch; it had a thin density. No fertilizer was applied in 2002 prior to the study. The soil was Crosby B silt loam with a pH of 7.3.

Individual plots measured 6' x 10', with 6' between blocks, and were arranged in a randomized complete block design with three replications.

Treatments were applied with a hand-held, CO_2 -powered boom sprayer, with 6503 TeeJet nozzles at 40 psi (water equivalent to 2.0 gallons water/1,000 sq ft).

Treatments were a single application on May 28. The average high and low air temperatures (F) and rainfall for each month respectively were:

Month	Average High	Average Low	Rainfall
April	65.4°F	43.7°F	4.2"
May	70.7°F	47.3°F	10.2"
June	85.2°F	62.4°F	7.6"

There was little disease activity in early spring. At the end of May, a sudden, severe, and uniform outbreak of red thread occurred in this area from natural inoculum. An evaluation of products for curative control was initiated.

The disease period was rather short so only a single application of products was made. All treatments demonstrated significant disease reduction within 10 days after application. Ratings are visual inspections of the plots to determine percent of the area blighted by red thread. Insignia at 0.9 oz and Heritage at 0.4 oz provided outstanding disease reduction. No phytotoxicity, growth regulator, or color effects were noted on the turf.

Joseph W. Rimelspach, Plant Pathology; T. E. Hicks, Plant Pathology; and Michael J. Boehm, Plant Pathology.

Percent of the Plot Area Blighted by Red Thread.			
Treatment and Rate /1,000 sq ft (A single application was made on May 28.)			
	May 28	June 7	June 14
Untreated	11.7	10.0	16.7
Insignia 20WG 0.5 oz	16.7	1.0	0.3
Insignia 20WG 0.9 oz	11.7	0.7	0.0
BASF 50503 50WG 0.2 oz	15.0	2.7	0.3
Cuprofix MZ30 42DF 6.0 oz	11.7	1.3	0.0
Bayleton 50DF 0.5 oz	15.0	5.0	0.3
Heritage 50WP 0.4 oz	15.0	0.7	0.0
Bayleton 50DF 1.0 oz	13.3	3.3	1.3
Endorse 2.5WP 4.0 oz	15.0	2.0	1.0
LSD (P≤0.05)	6.2	4.3	4.6

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The Evaluation of Fungicides for the Management of Red Thread *(Laetisaria fuciformis)* in Perennial Ryegrass *(Lolium perenne)*

Joseph W. Rimelspach, T. E. Hicks, and Michael J. Boehm

This test was conducted at the Ohio State University's Turfgrass Research Center, Columbus, Ohio, in 2003 on a stand of perennial ryegrass consisting of a blend of three cultivars at one third each, of 'PS-8990,' 'Buccaneer,' and 'Boardwalk.' The stand was established in 1994.

The mowing height was 3.5 inches, clippings were returned to the plots, and the area was not irrigated. The condition of the sward was fair with no thatch; it had a thin density. No fertilizer was applied in 2003 prior to the study. The soil was Crosby B silt loam with a pH of 7.3.

Individual plots measured 6' x 10', with 6' between blocks, and were arranged in a randomized complete block design with three replications. Treatments were applied with a hand-held, CO_2 -powered boom sprayer, with 6503 TeeJet nozzles at 40 psi (water equivalent to 2.0 gallons of water/1,000 sq ft).

Applications were made on May 8, May 22, and June 6, except for three treatments which received only a single application on May 8. The ratings were done by visually assessing the percent of plot area blighted by the disease red thread on a linear scale of 0 to 100% scale, where 0 equals no blight and 100 equals entire plot blighted. Analysis of variance was performed with least significant difference at the $P \leq 0.05$ level.

The average high and low air temperatures (F) and rainfall for each month respectively were:

Month	Average High	Average Low	Rainfall
April	67.0°F	42.4°F	2.1″
May	71.1°F	52.5°F	11.4″
June	78.4°F	57.4°F	2.6″

Red thread developed in early May in the test area from natural disease inoculum. Treatments were initiated just at the onset of the disease. Significant disease reduction was observed in 13 days (May 21) by all treatments.

Cuprofix, Bayleton, Heritage, and Endorse all showed exceptional red thread control throughout the study. Rust developed in July, and the plots were rated 35 days after the last application for treatments that received the last application on June 6, and 65 days after the treatments that received a single application on May 8.

Joseph W. Rimelspach, Plant Pathology; T. E. Hicks, Plant Pathology; and Michael J. Boehm, Plant Pathology, The Ohio State University.

Treatment, Formulation, and Rate per 1,000 Sq Ft	% Plot Blighted by Red Thread				% Plot Blighted by Rust
	May 12	May 21	May 29	June 6	July 11
Untreated	5.0	8.3	15.0	13.3	16.7
Medallion 50WP 0.25 oz *	5.3	1.0	5.0	3.0	43.3
Medallion 50WP 0.33 oz*	6.7	3.0	1.7	2.0	33.3
Medallion 50WP 0.5 oz *	4.0	2.3	1.0	0.7	26.7
Cuprofix MZ 30 42DF 6 oz	3.3	0.3	0.0	0.0	16.7
Bayleton 50DF 0.5 oz *	3.3	2.3	0.7	0.0	3.0
Heritage 50WG 0.2 oz**	3.3	0.0	0.0	0.0	13.3
Bayleton 50DF 1 oz**	6.0	1.0	0.3	0.0	4.7
Endorse 2.5WP 4 oz*	3.7	0.0	0.0	0.0	7.3
LSD-P≤0.05	2.5	2.5	4.2	3.4	19.2

* Treatments were made on May 8, May 22, and June 6.
** A single application was made on May 8.

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Sudden Oak Death: Monitoring *Phytophthora ramorum* in the North Central United States

Frances S. Ockels, Manfred Mielke, and Pierluigi Bonello

Introduction

In the mid-1990s, a new disease of tanoaks and coast live oaks appeared in northern California. Hundreds of trees appeared to be dying suddenly across the landscape, both in woodlands and in suburban properties around the San Francisco Bay area. In reality, infected large landscape trees did not die very suddenly; a few months to a few years could pass between infection and death.

However, once visible symptoms appeared, death occurred rather rapidly, hence the common name, Sudden Oak Death (SOD), which has been popularized in the press and most scientific literature. Interest in the disease increased progressively until it became obvious that SOD was becoming an epidemic of frightening proportions — thousands of trees were dying along the north and central California coasts.

In 2000, University of California scientists discovered that a *Phytophthora* spp. was consistently associated with the cankers that were characteristic of the syndrome in oaks. They soon realized that the same pathogen had previously been isolated and described from Viburnum in nurseries in the Netherlands, where it caused a branch-and-twig dieback. For this reason, the Dutch scientists had named the pathogen *Phytophthora ramorum (ramorum* literally means *of the branches* in Latin).

Over the next few years, it was recognized that the pathogen has a very large host list, which is not unusual for *Phytophthora* spp. The host list comprises a large number of woody shrubs that are characteristic of the understory in forests across the temperate zone, including plants such as viburnums, rhododendrons, honeysuckles, mountain laurel, and many others. On these plants, the pathogen only causes minor leaf spotting and twig dieback. The importance of these plants lies in the fact that they can act as conduits and reservoirs for the pathogen and that many of them are mainstays of the ornamental industry. (See: **http://www.aphis.usda.gov/ppq/ispm/sod/usdasodlist.html .)**

Movement of infected host plants through the nursery trade is therefore feared as a route through which the pathogen could potentially spread to areas where susceptible tree hosts are naturally distributed. Among the susceptible tree hosts are red oaks, including the northern red oak *(Quercus rubra)*, a dominant species in the eastern mixed deciduous forests of North America. No natural infections of red oaks are known in the eastern United States. In Europe, however,

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natural infection centers of *P. ramorum* were found in late 2003 in England and the Netherlands on two North American red oak species, northern red oak and southern red oak *(Q. falcata),* as well as on European beech *(Fagus sylvatica)* and horsechestnut *(Aesculus hippocastanum).*

This was a rather ominous development for Ohio, because the range of prevailing temperatures and relative humidity of the Midwestern region of the United States includes the range of climatic conditions found in England and the Netherlands. At least in principle, these findings demonstrated that there may be no climatic limitations to a potential spread of the pathogen to Ohio and the Midwest.

Fear that the pathogen could spread through the nursery trade was confirmed in dramatic fashion early in 2004. In March 2004, the pathogen was found in two large ornamental nurseries in southern California. At least one of the two nurseries regularly distributes nursery stock nationwide, including shipments to Ohio.

Indeed, on March 31, 2004, the state of Florida announced that *P. ramorum* had been found in a nursery that had imported stock from one of the infected nurseries in southern California. As of September 29, 2004, the total number of confirmed positive sites from trace-forward, national, and other survey finds was 160 in 21 states, including three residential finds — two in Georgia and one in South Carolina (these finds were connected with plants obtained by homeowners through the nursery/retail trade.) None of these finds were in Ohio.

The results of these surveys, conducted in commercial nurseries by the U.S. Department of Agriculture's Animal and Plant Health Inspection Service (USDA-APHIS) in cooperation with state agencies, clearly underscore the high risk of movement of *P. ramorum* on infested plants around the country. A single escape from an infested nursery into surrounding woodlands or forests in areas potentially conducive to development of the disease, *e.g.*, on red oaks in Midwestern states, could be devastating.

Thus, large sections of U.S. forests are under potential threat of attack by *P. ramorum.* To date, however, except for an unconfirmed finding in New York state, Sudden Oak Death has been confirmed only in forests of California and Oregon. In response to this threat, the U.S. Forest Service conducted a National Sudden Oak Death Survey in 2004. The purpose of the SOD survey was to examine forested areas around nurseries receiving potentially infected stock from California and Oregon, as well as other general forest sites, for the presence of *P. ramorum.* If the pathogen was found in these areas, eradication efforts would be initiated immediately in an attempt to destroy the pathogen before it becomes established.

Methods

Our Ohio State University lab participated in the 2004 SOD survey, processing samples from sites in the North Central United States, including Ohio, Indiana, Illinois, Missouri, Iowa, and Wisconsin, based on U.S. Forest Service protocols (Figure 1). Two types of surveys were conducted — nursery perimeter surveys and general forest area surveys.

A nursery perimeter survey examined tree lines or woodlots located within a quarter mile of the nursery, while a general forest area survey examined a forested area that was more than a quarter of a mile from the nursery receiving stock. In addition, some forest area surveys were done with no relation to a nursery. Each

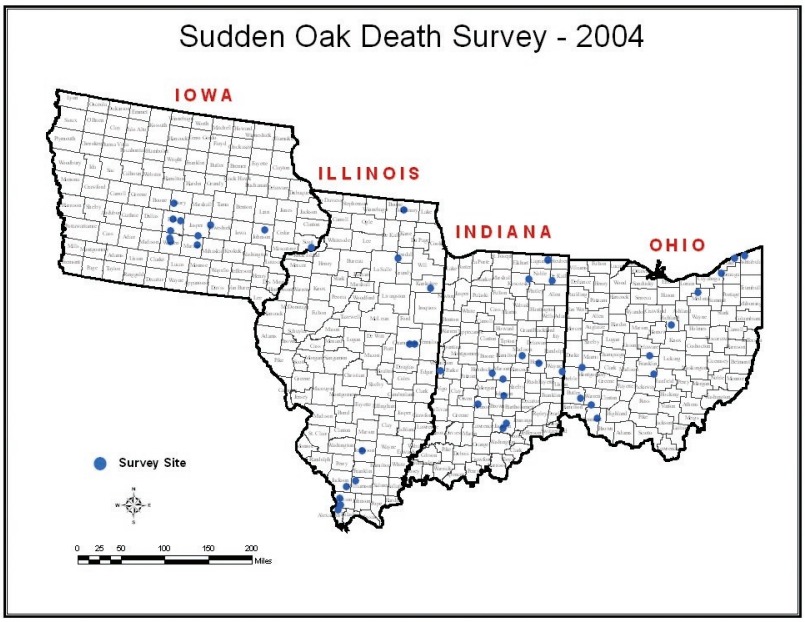

Figure 1. Distribution of all sites directly surveyed by the Ohio State University Plant Pathology Lab during the summer of 2004. The geographic distribution of sites in Missouri and Wisconsin that were the origins of the samples the Ohio State lab processed was not available.

site was surveyed with four 100-meter transects. Since the host list of *P. ramorum* is large, a subset of host species was chosen for this survey. Plant material with symptoms of leaf spots and/or twig dieback were sampled when present on *Acer* spp. (*e.g.*, boxelder), *Aesculus* spp. (buckeyes), *Hamamelis* spp. (witch hazel), *Kalmia* spp. (mountain laurel), *Lonicera* spp. (honeysuckle), *Rhododendron* spp., *Vaccinium* spp. (blueberry), and *Viburnum* spp.

When present, phloem at the margin of oozing stem lesions was also collected from *Quercus* spp. (oaks). When symptoms were present, five leaves/shoots were collected from a tree/shrub and a maximum of 50 symptomatic leaves/shoots of a species per transect were collected. For each transect, the 10 most representative symptomatic leaves for each species were selected (Figure 2).

Bleeding cankers from oak trunks were also collected. A hand axe was used to chip away the outer bark to reveal the symptomatic inner bark beneath. A 5-x-5 cm section of the active canker margin was cut out and wrapped in plastic food wrap. All samples were then double-bagged and stored in an ice chest on sealed coolant and shipped to the lab for *P. ramorum* detection within 72 hours of collection.

Figure 2. Immediately after collection, the samples were sorted, and the most representative leaves were selected for processing.

In the lab, samples (Figure 3) were processed for DNA extraction and PCR-based detection according to U.S. Forest Service protocols. One piece of necrotic tissue was cut from each suspect SOD-infected leaf using a cork borer. Ten pieces of tissue from a sample were combined for DNA extraction. Once DNA was extracted, PCR amplification of specific *P. ramorum* DNA was attempted. Each PCR set contained positive controls of *P. ramorum* DNA (to ensure that the PCR reaction was working) as well as negative water controls (to ensure that no *P. ramorum* DNA was being amplified when not present).

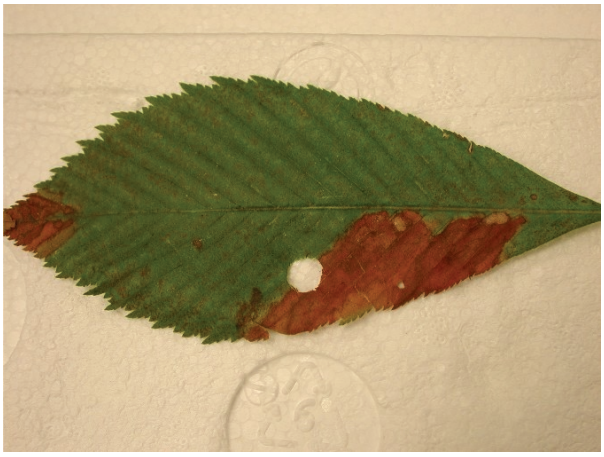

Figure 3. Discs of leaf tissue (a buckeye leaf is shown here) collected for DNA extractions were cut from the margins of necrotic lesions, where a pathogen is most active.

Results and Conclusions

The 2004 SOD Survey in the North Central United States did not detect the presence of *P. ramorum.* The following numbers of samples were processed — 89 from Ohio, 100 from Indiana, 75 from Iowa, 62 from Illinois, 75 from Missouri, and 219 from Wisconsin. Despite these reassuring results, further work is needed.

The 2004 survey inspected a subset of nurseries receiving potentially infected stock from California and Oregon, so there are more sites that need to be surveyed. Furthermore, in early December 2004, it was disclosed that the pathogen was detected in nursery samples in Connecticut.

The North Central United States apparently has the climatic conditions and host species for development of the disease on oaks, which means that the only missing element is the pathogen. If *P. ramorum* escapes from infected nursery stock and becomes established in the landscape and forest, the effects will be devastating ecologically, aesthetically, and monetarily. Therefore, it is important to remain diligent in efforts to detect *P. ramorum.* More nationwide surveys are already being planned for the summer of 2005.

Acknowledgments

Funding for these activities was provided in the form of a Cooperative Agreement (04-CA-11244225-432) between the U.S. Forest Service and P. Bonello. We thank S. Dharba (Ohio Department of Agriculture) for assistance with GIS-based site characterization. We appreciate technical help in the field and the laboratory from Emily Helliwell, Nathan Kleczewski, Duan Wang, and Justin Whitehill. Phil Marshall (Indiana Department of Natural Resources), Steve Pennington (Iowa Department of Natural Resources), and Jerry Pirtle (Illinois Department of Natural Resources), and several other state cooperators are gratefully acknowledged.

Additional information can be found at:
http://www.CNR.Berkeley.edu/comtf/
http://www.ncipm.org/sod/
http://www.aphis.usda.gov/ppq/ispm/sod/

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Application of Imidacloprid Through Drip Irrigation for Control of White Grubs in Field-Grown Nursery Crops

Michael E. Reding, Heping Zhu, and Randall H. Zondag

Introduction

In recent years, exotic white grubs (Coleoptera: Scarabaeidae) have been found stunting and killing field-grown nursery crops in northern Ohio. Grubs injure and kill plants by feeding on the roots. The plants we have found killed by grubs are generally devoid of fibrous roots. Young plants appear more vulnerable to feeding injury by grubs than older, more-established plants. In 2003, we broke apart and carefully searched through the root balls of field-grown trees (14 *Amelanchier canadensis* and eight *Malus sargentii)* from a nursery in northern Ohio. These trees were planted in 2000 and had not been treated with insecticides to control grubs.

We found an average of 22 grubs per *Amelanchier* and 19 per *Malus.* The trees appeared healthy, but according to the grower, they were stunted and should have been much larger. More than 90% of those grubs were oriental beetle *(Exomala orientalis).* In 2001 and 2002, European chafer *(Rhizotrogus majalis)* grubs were found damaging nursery crops in the same county. Oriental beetle and European chafer were the most common exotic species of white grubs found in the nurseries we surveyed in that county.

Preventive insecticides, such as imidacloprid (Marathon and Merit), are generally sprayed or broadcast on the soil surface to control white grubs in turf and field-grown nursery crops. However, efficacy is usually dependent on applications of sufficient amounts of water to facilitate movement of the chemical into the root zone. The root zones of nursery crops such as trees and shrubs usually penetrate deeper into the soil than turf. As a result, coverage of the root zones of nursery crops with insecticides is more difficult. Facilitating movement of insecticides into the soil is, therefore, especially critical for effective grub control in nursery crops.

In 2002, a nursery in northern Ohio sprayed imidacloprid on the soil in the rows of field-grown trees to control grubs. This nursery used drip irrigation and was unable to apply water other than through irrigation. The treatment was not effective, which was probably related to the limitations of the irrigation system. The small amounts of water and small area of soil coverage substantially limit the amount of insecticide that can be flushed from the surface into the soil.

The objective of this trial was to evaluate drip irrigation as a method of applying

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imidacloprid (Marathon II) to nursery crops for control of white grubs.

Materials and Methods

This experiment was conducted in a field production nursery in northern Ohio in 2004. The field we used was planted in May 2004. The only hosts for grubs in this field were the trees; there was no grass. The experiment was a completely randomized design.

On July 1, 2004, Marathon II (imidacloprid) was applied into the drip irrigation line of three rows of Kousa dogwood *(Cornus kousa* 'Starlite') in row 1 (replication 1) and 'Heart Throb' in rows 2 and 3 (reps 2 and 3, respectively). Each row was a replication of insecticide-treated and untreated control (irrigation water only) trees. The experimental trees were in randomly chosen pairs of adjacent trees with three pairs of each treatment per row. Two drip lines were installed on the soil surface and close to the middle line of each tree row, one for injection of insecticide, and the other for regular drip irrigation (Figure 1).

The drip lines were a 1.75 cm (0.690") OD and a 1.24 cm (0.490 ") ID polyethylene tubing and were connected to the main irrigation supply line. Pressure-compensating drippers (Part Number 01WPC2, NETAFIM USA, Fresno, Calif.) with a nominal flow rate of 1.89 LPH (0.5 GPH) per dripper were used to trickle water to trees. Drippers were installed in the two drip lines in such a manner that each tree received irrigation water from only one dripper. The insecticide-treated trees received irrigation from the chemical injection drip lines, and the control trees received water from the regular drip irrigation lines. Therefore, trees of both treatments were supposed to receive the same amount of water every time irrigation was applied.

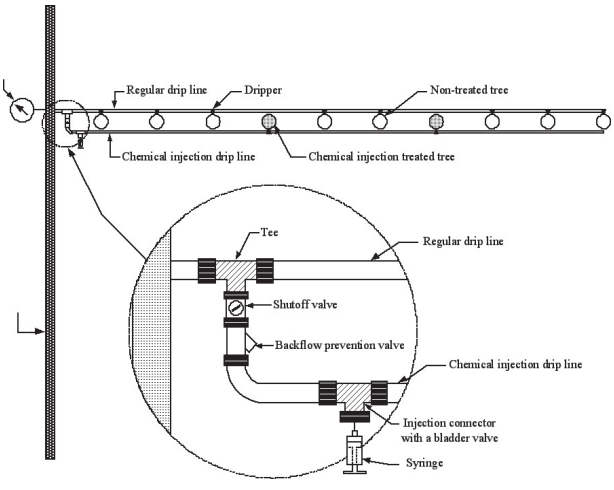

Figure 1. Schematic diagram of a regular drip irrigation line and a chemical injection drip irrigation line near a row of dogwood trees.

Water was run through the lines for at least 20 minutes before application of the insecticide and remained on during the application. The total irrigation period was about two hours. A pressure gauge was installed on the main irrigation supply line to monitor water pressure during irrigation. Irrigation was applied at 16.5 psi for two hours a day on the condition that there was insufficient rainfall to wet the soil during that day. Because of abundant rainfall during spring and summer, irrigation in the trial rows was terminated for the season on July 29.

A chemical injection connector was designed and installed at the beginning edge of each chemical injection drip line (Figure 1). The injection connector was assembled with a 1/2" thread PVC tee (Lasco Fittings, Inc., Brownsville, Tenn.); a 1/2" NPT electric wire connector (Kleinhuis North America, Inc., Worthington, Ohio); and a volleyball bladder valve (Figure 2). A 50 mL Pro-PistolTM pistol grip syringe (Model 1005, Neogen Corporation, Lexington, Ky.) with a 0.9 mm (0.035") inside diameter needle was used to inject pesticide into the bladder valve of the injection connector.

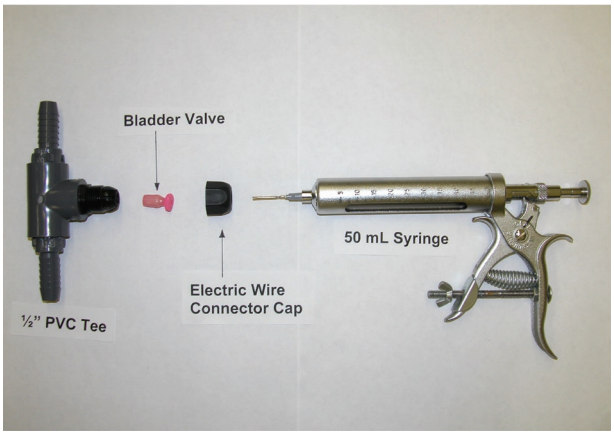

Figure 2. Chemical injection connector assembly and the syringe used to inject pesticide into drip lines.

The first dripper in the insecticide injection line was at least 6.1 m (20') away from the injection connector, so the insecticide had enough time to uniformly mix with water inside the drip line before reaching all six drippers. A backflow prevention valve was installed between the beginning edge of the insecticide line and the injection connector, to prevent insecticide flowing upstream to the regular drip line or main irrigation supply line.

The rate of insecticide was based on the highest labeled rate for 7-gallon containers (0.67 ml per tree, 4 ml per row). The root zones of the trees were estimated to be about the size of a 7-gallon container. In the first two rows (replications 1 and 2), we used undiluted Marathon II in the applicator (syringe). We put enough insecticide into the applicator for two rows (10 ml to apply 4 ml per row).

However, there was a considerable portion of leakage from the needle at the valve. We decided this was caused by a combination of back-pressure from the line, applying a low amount of compressible liquid formulation, and not emptying the applicator. Therefore, for the third row (replication 3), we mixed insecticide (4 ml) with water for a total volume of 40 ml in the applicator. Then we dispensed the entire volume, which resulted in no apparent leakage.

This trial was evaluated on September 21, 2004. The trees were dug by hand, the root balls were broken apart, and the soil and roots were carefully searched for grubs. The grubs collected from each tree were saved separately in plastic cups with snap-on lids then transported to the laboratory to determine species. Mean grubs per treatment and tree were computed. Numbers of grubs per treatment were analyzed by analysis of variance.

Results

We found four species of exotic grubs — Oriental beetle, European chafer, Asiatic garden beetle *(Maladera castanea),* and Japanese beetle *(Popillia japonica)* — in the root zones of the trees in this trial (Table 1). Most of the grubs (85%) were Oriental beetle. The other species found, in descending order of frequency, were Asiatic garden beetle, European chafer, and Japanese beetle (1 grub). Marathon reduced the number of grubs by 62% compared to the untreated trees (Table 2).

We had some application problems related to the volume of solution applied in replications 1 and 2 (there was more leakage in row 1 than 2 and a 31% and 49% reduction of grubs, respectively), and the treatments were less effective in those rows than in replication 3 (90% reduction). Because of the leakage of insecticide, the trees in rows 1 and 2 did not receive as high a dose as those in row 3, which probably influenced the efficacy of the treatment in those rows.

Overall, the application system and insecticide treatment were effective. Even with the difficulties in rows 1 and 2, for all

rows together, we were able to reduce the numbers of grubs from 9.4 per tree in the untreated trees to 3.6 in the treated.

We plan to conduct further research in 2005, using this system to apply various treatments to control white grubs in nursery crops.

Acknowledgments

We thank Betsy Anderson and Corrie Yoder for technical assistance (digging trees and searching for grubs) evaluating this trial and Adam Clark for assembling chemical injection connectors. We also thank the nursery owner for providing us with a site and supplies to conduct this research and allowing his employees to deploy the irrigation lines in the trial rows.

Disclaimer

Mention of proprietary products or companies is included for the reader's convenience and does not imply any endorsement or preferential treatment by either USDA-ARS or The Ohio State University.

Table 1. Composition of Exotic White Grub Complex Found in the Chemigation Trial.

Treatment	Total Grubs	Percentage of All Grubs Found[a]			
		OB	AGB	EC	JB
Marathon II	64	88.1	5.1	5.1	1.7
Untreated	170	83.7	11.8	4.6	0.0

[a] Species designations: OB = oriental beetle, AGB = Asiatic garden beetle, EC = European chafer, JB = Japanese beetle.

Table 2. Comparison of Mean Numbers of Scarab Grubs (± Standard Error) and Mean Grubs per 7ree (± Standard Error) Between Dogwoods *(Cornus kousa)* Treated with Marathon II Applied Through Drip Irrigation and Trees Receiving Irrigation Water Only.

Treatment	Mean Number of Grubs (± SE)	Mean Grubs per Tree (± SE)[b]	Percentage Reduction of Grubs in Treated vs. Untreated Trees
Marathon II	21.3 (± 7.3)	3.6 (± 1.2)	62.4%
Untreated[a]	56.7 (± 8.8)	9.4 (± 1.5)	
df	1,4	1,4	
F	9.5	9.6	
P	0.037	0.037	

[a] Received water only, applied through drip irrigation.
[b] There were three pairs of trees per treatment per row with each row a replication.

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Preliminary Investigation of Water and Nutrient Use, Substrate Temperature, and Moisture in Pot-in-Pot Production[1]

Heping Zhu, Randall H. Zondag, Charles R. Krause, Richard C. Derksen, Tom Demaline

Introduction

Efficient use and availability of quality water sources has been a major concern in the nursery industry for many years (Yeager, 1992; Irmak, *et al.*, 2003). Without scientific guidelines for proper application of water and nutrients, future choices of nursery-crop-production sites and species will be limited (Beeson, *et al.*, 2004). Due to the current lack of scientific methodologies to guide irrigation practices, nursery growers often apply water to crops by simply turning on valves without knowing how much water is lost through runoff or drainage.

Overhead sprinkler systems are widely used to irrigate container-grown nursery crops, but water applied by this method is usually either excessive or insufficient, resulting in uneven application. During the growing season, more than 80% of the water from sprinkler systems may be lost through runoff, drainage, and evaporation (Weatherspoon and Harrell, 1980).

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Nursery growers are using pot-in-pot systems to produce higher-quality tree crops at reduced labor cost. This production system has expanded rapidly during the past decade. The system can moderate root temperature and improve root quality, prevent blowing over of container-grown trees, and reduce harvesting labor costs (Ruter, 1997). However, with this technique, it is essential to apply sufficient water two or more times throughout the day along with supplemental nutrients to sustain rapid tree growth (Ruter, 1998; Beeson and Keller, 2003). Irrigation and fertilization practices have raised concerns over water-use efficiency because of water loss from containers and the extent of nutrient and chemical leaching to soil and ground water from drainage water. This is due to the fact that containers are buried in soil, and it is not easy to observe water and nutrient loss with such production circumstances.

With pot-in-pot production systems, knowledge is lacking on interactions between water and nutrients for optimal growth of plants. Techniques are needed to ecologically monitor nursery production practices for proper use of water resource and nutrient management. To fully explore potential impacts of pot-in-pot production systems on nursery production,

knowledge of water quality and quantity to produce healthy trees is needed to improve application efficiency and avoid soil and groundwater contamination.

Materials and Methods

An experimental system to examine water quality, irrigation efficiency, and drainage from pot-in-pot nursery container production was established in a commercial nursery field. The system consisted of a plot containing 50 trees planted in 50 pot-in-pot containers and irrigated with micro-spray stakes, 10 drainage water measurement devices, 10 container substrate moisture probes, 10 thermocouples, a weather station, and data loggers.

After the system was established in July 2003, data were collected on the amount of irrigation, drainage water loss, substrate moisture content and temperature, weather conditions, and tree caliper 18 cm above the soil surface. The levels of nitrate nitrogen (NO_3-N), phosphate (P), and potassium (K) in water drainage were analyzed weekly from water samples. A detailed description of system development is given by Zhu *et al.* (2004).

Red Sunset maple (*Acer rubrum* 'Franksred') trees were selected for the test because of their popularity in nursery marketing. The system will be expanded in the future to look at three species at one time. Caliper of each tree at 7" above the ground was measured during the growing season. The average tree caliper of bare root trees was 0.55" when they were transplanted to the pot-in-pot system.

The container substrate on a volumetric basis was composed of 55% aged pine bark, 3% sharp silica sand, 5% expanded shale Haydite soil conditioner, 20% steamed composted nursery trimmings and potting mix waste, 12% fibrous light Sphagnum peat, and 5% composted municipal sewage sludge. The container substrate provided for natural suppression of *Pythium* and *Phytophthora* root rots (Hoitink and Boehm, 1999).

A 5- to 6-month controlled-release Scotts granular fertilizer 20-5-8 (N-P-K) was applied on the top of substrate at a rate of 119 grams per tree when the bare-root trees were transplanted in the containers. Then, water soluble urea with 28% nitrogen was injected into irrigation water at a constant rate of 200 ppm at every 19-day watering cycle, although the application rate of this liquid feed program was supposed to vary with the condition of plant growth during the growing season.

The system was placed in use on August 6, 2003, with irrigation applied twice a day, once in the morning and once in the afternoon, until November 16 (total of 14 weeks). Irrigation application rate during the rest of the growing season was managed with the 3 GPH spray stakes following the production practice in a 45-acre commercial pot-in-pot production area adjacent to the experimental system. This allowed the researchers to set a base line for future comparison. Between August 6 and November 16, 2003, a total of 7.6" irrigation was applied to the trees, and total precipitation received was 23.5".

Results and Discussion

Data in Figure 1 show the comparison of weekly total amounts of irrigation, rainfall, and drainage water collected from 10 rows of the 50 pot-in-pot system between August 6 and November 16 in 2003. During the 14-week period, total volume of drainage water from 50 containers was 490 gallons, while total irrigation water and rainfall to the 50 tree containers was 1,790 gallons. About 38% of irrigation

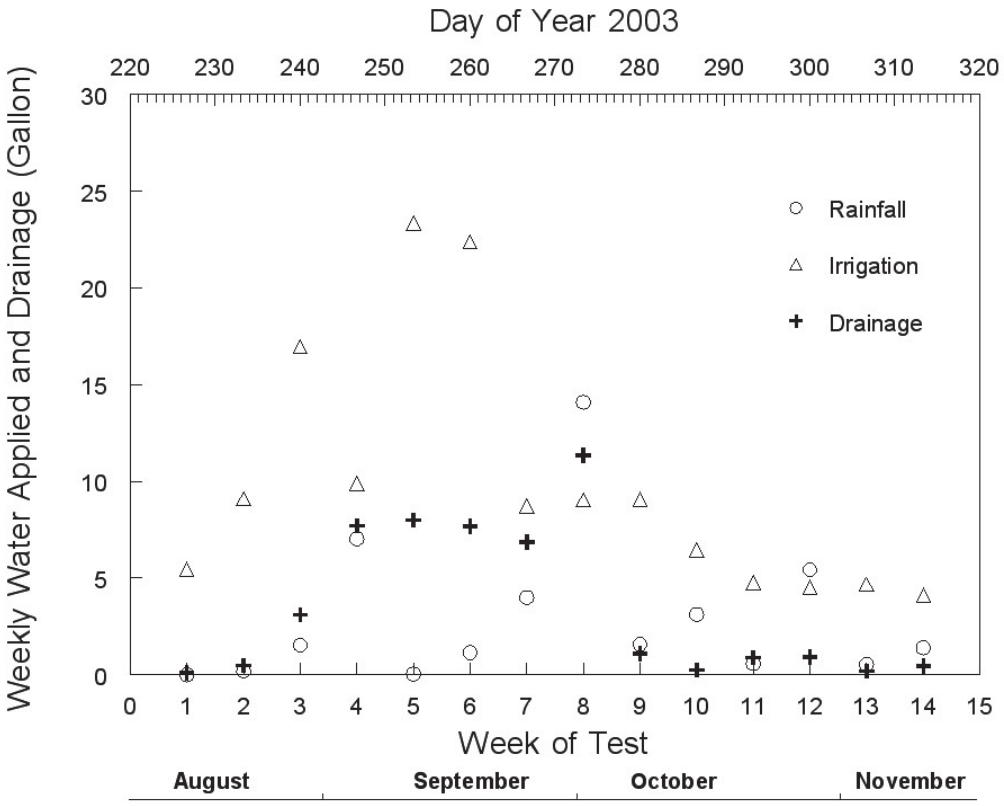

Figure 1. Weekly total rainfall and irrigation applied to, and drainage from, 50 pot-in-pot production containers between August 6 and November 16, 2003.

water and rainfall was lost through drainage during September and the first week of October 2003, because of large amounts of irrigation applied to maintain tree caliper growth during this dry period. Many times, when large rainfall periods occurred, there was more runoff.

The average drainage start time from the 10 rows was 22.3 minutes after irrigation started with 3 GPH flow rate applied for three minutes, and was 7.6 minutes with 7 GPH flow rate applied for three minutes. Higher flow rate caused earlier drainage because of limited substrate capability of holding water in containers.

Figure 2 illustrates the average weekly amount of NO_3-N, P, and K leachate in drainage water from 10 rows between August 6 and November 16 in 2003. The system detected that the total amount of NO_3-N, P, and K lost through drainage from 50 containers during 14 weeks was 142.8, 7.2, and 97.8 grams, respectively. Most loss of nutrition occurred between week 4 and week 8 because of a large amount of drainage. After week 9, the amount of NO_3-N, P, and K leachate decreased considerably because it was close to the end of the growing season, and the residual level of NO_3-N, P, and K in the container substrate might be very low.

The mean pH of drainage water samples stayed within the range from 6 and 8 most of the time for all 10-row samples except for weeks 4 and 12 (Figure 3). Unexpectedly, the average pH in week 4 was 5.3, and the average pH in week 12 was 8.6. High water pH can occur when water levels are low in dry periods and result in negative impact on tree uptake, substrate quality, and drainage water quality.

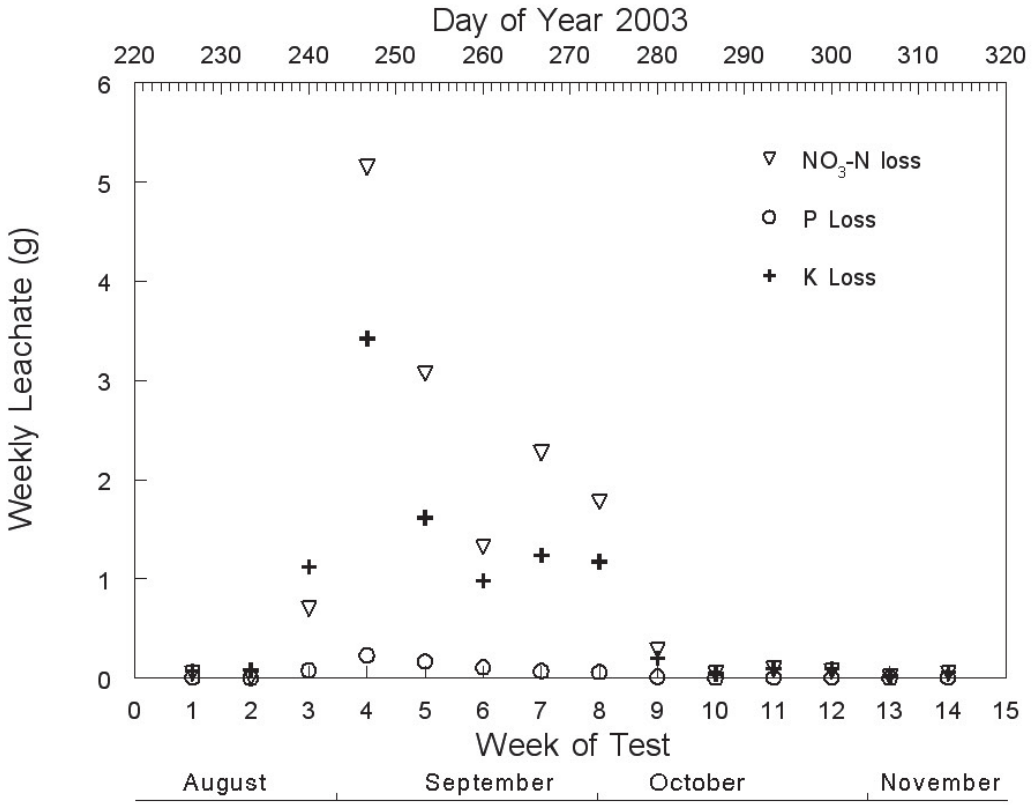

Figure 2. Average weekly amount of NO_3-N, P, and K in drainage water from 10 rows of total 50 pot-in-pot containers between August 6 and November 16, 2003.

Figure 4 shows the response of substrate moisture content in four rows to 7 GPH of irrigation applied for three minutes, twice a day, on September 9 and 10. The moisture content of the substrate near the upper root zones reached the saturated point at about 55% in a very short time and then decreased to about 40% within two hours after irrigation stopped. Figure 5 shows the response of substrate moisture content in four rows to 0.78 in., and 1.14 in. of rainfall reached the area within 30 hours. The moisture content varied with the amount of rainfall, duration, and row location. Longer intensive rainfall caused the substrate to remain in a saturated condition longer. Moisture contents for other rows responded similarly to those shown in Figures 4 and 5.

Daily mean substrate moisture content near upper root zones fluctuated widely during four seasons, with the largest variation in January and February (Figure 6). The substrate moisture content from the end of November through December was higher than in September and October. In late November through December and early January, due to rainfall and snowfall, the top substrate was covered with ice which could hold moisture near the probe-sensing area in the root zone.

The moisture content in January and February generally declined below 20% because the probe-sensing area was frozen. However, in later February, due to the high ambient temperature, ice at the top of the substrate melted, and the moisture content increased above 40%. Moisture content of the container substrate varied with rows although the amount of irrigation water and rainfall to all rows were the same. Such differences

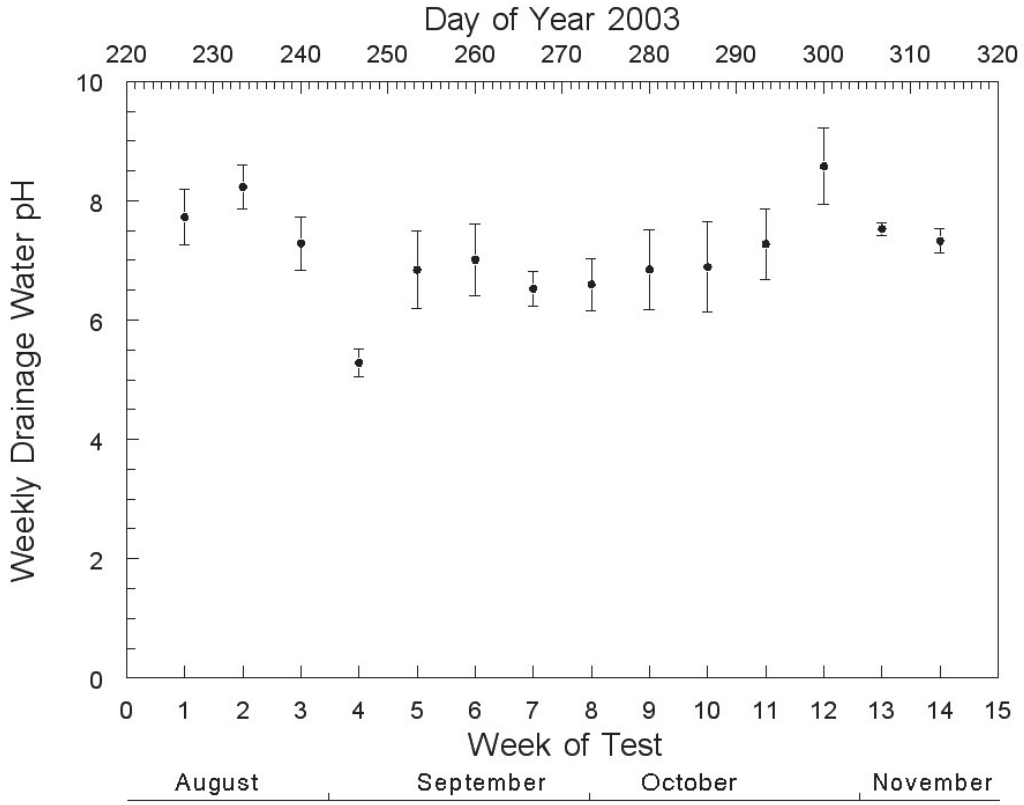

Figure 3. Average weekly drainage water pH from 10 rows of total 50 pot-in-pot containers between August 6 and November 16, 2003.

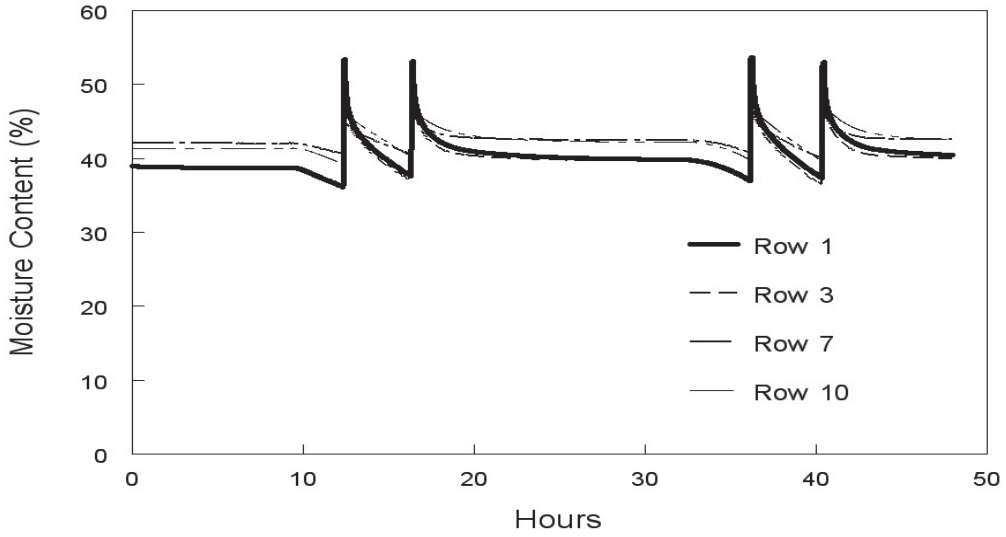

Figure 4. Example of substrate moisture content near the upper root zones for four rows when 7 GPH of irrigation was applied for three minutes, twice a day, on September 9 and 10, 2003.

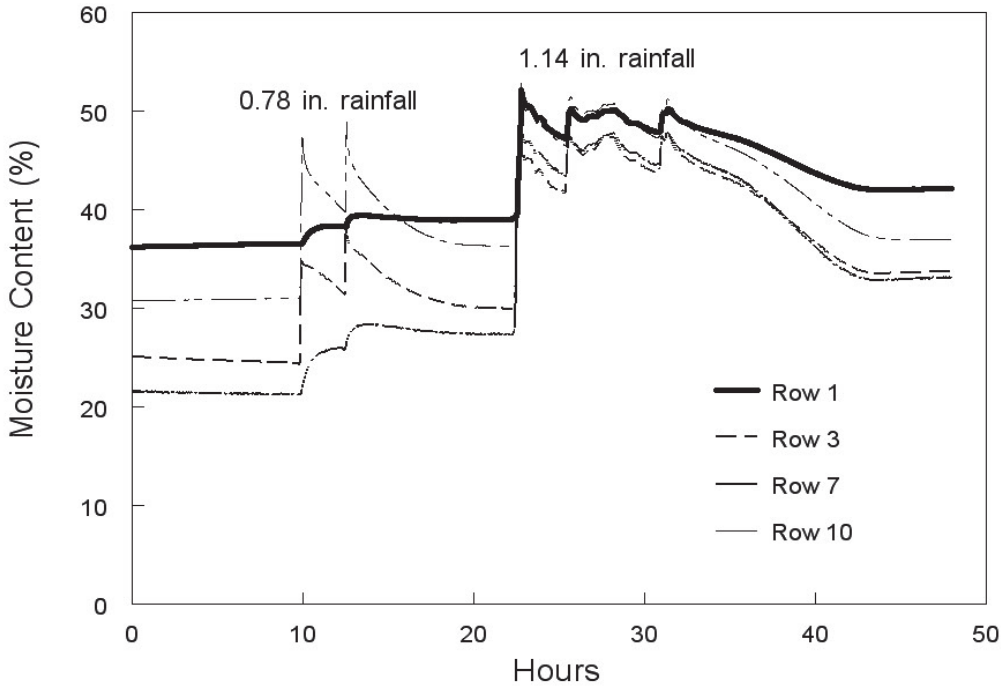

Figure 5. Example of substrate moisture content near upper root zones for four rows when 0.78 in. and 1.14 in. of rainfall reached the test plot within a 30-hour period.

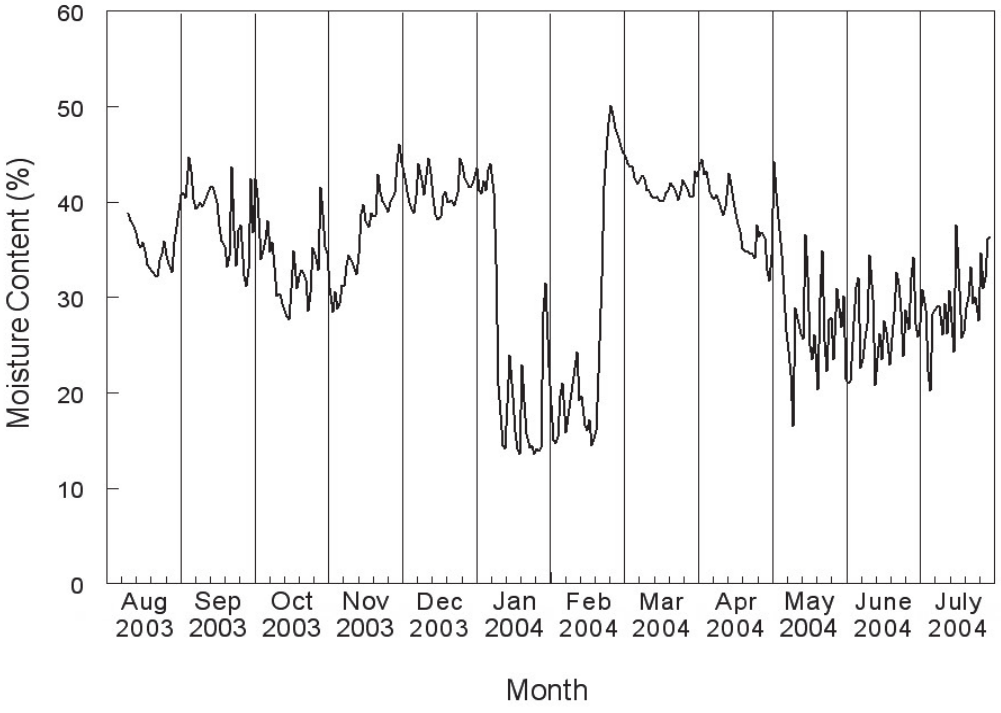

Figure 6. Mean container substrate moisture content measured with 10 probes between August 6, 2003, and July 31, 2004.

might be caused by the variations in substrate uniformity, tree sizes in different containers, and other unknown factors.

Figures 7 and 8 show the mean substrate temperature, and the daily maximum and minimum ambient air temperatures in September 2003 and February 2004, respectively. In September, the substrate temperature in 10 rows ranged from 53 to 78°F while the ambient air temperature ranged from 41 to 84°F (Figure 7). Comparatively, in February, the substrate temperature in 10 rows ranged from 24 to 33°F while the ambient air temperature ranged from -3.5 to 60°F (Figure 8).

Figure 9 shows the average daily substrate temperature of 10 rows and maximum and minimum daily ambient air temperatures between August 2003 and July 2004. The substrate temperature in the pot-in-pot system had much lower variation than the ambient temperature within a day and was independent of moisture levels before the substrate was frozen. In contrast to the substrate moisture content, the substrate temperature did not have much variation between different rows. Since the pot was not exposed to sunlight, root growth was uniform throughout the pot.

Figure 10 shows the caliper of trees at 7 in. above the ground between July 3 and November 5, 2003. Growth rate of trees was considerably higher in September than other months. Though the fact that growth rate among the 50 trees was not consistent, average tree caliper was 1 in. at the end of growing season, or a 178% increase during the growing season.

Summary

Results from this preliminary study indicated that the amount of drainage water loss and nutrition leachate varied with the amount of water received by pot-in-pot containers. Many growers are

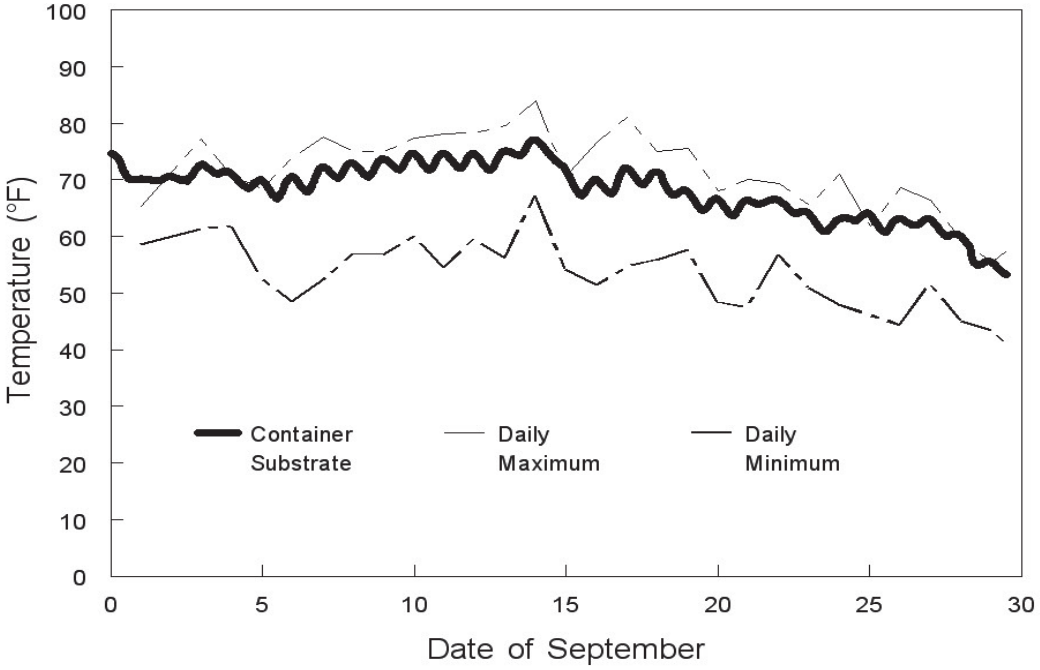

Figure 7. Mean container substrate temperatures measured with 10 thermocouples and daily maximum and minimum ambient air temperatures during September of 2003.

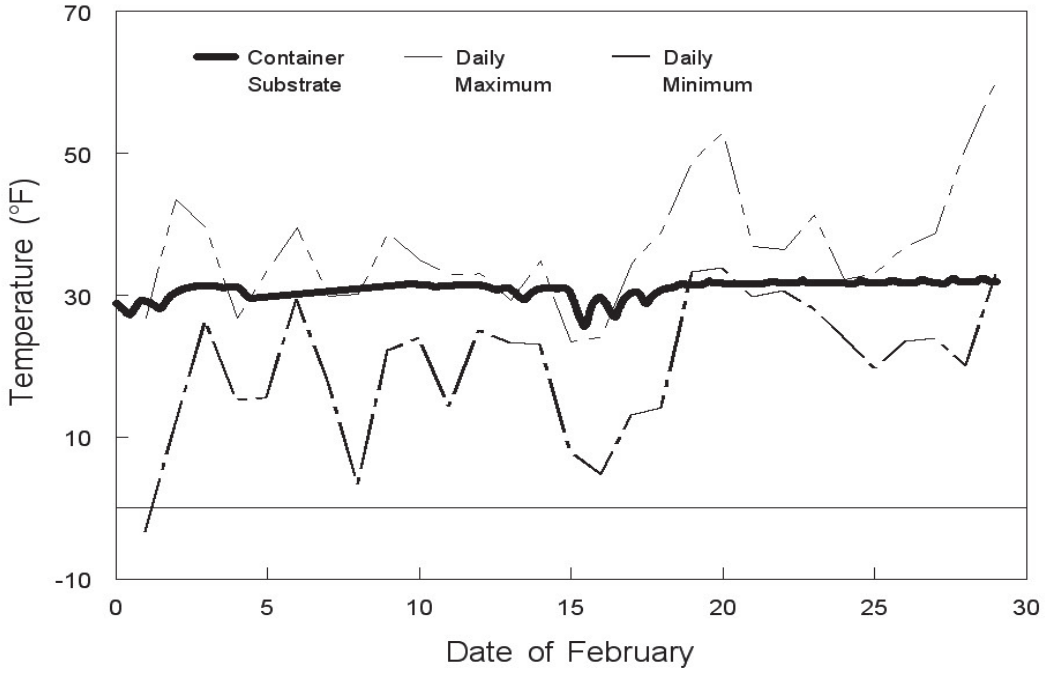

Figure 8. Mean container substrate temperature measured with 10 thermocouples and daily maximum and minimum ambient air temperatures during February of 2004.

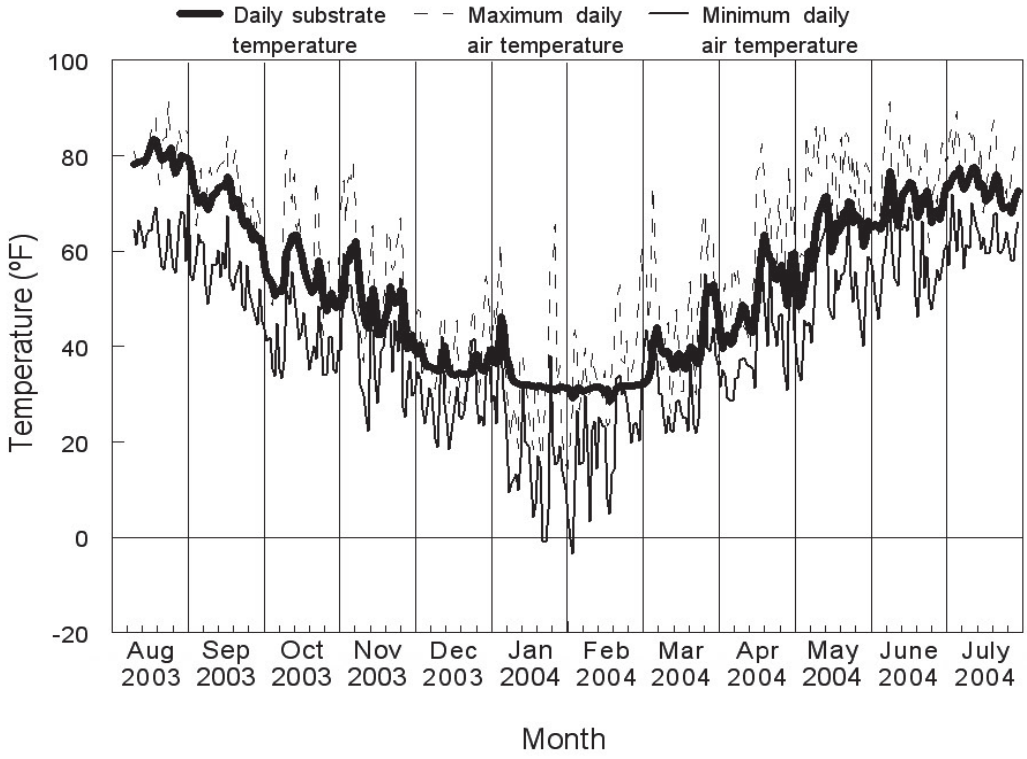

Figure 9. Average daily substrate temperatures in 10 rows and daily minimum and maximum ambient air temperatures between August 6, 2003, and July 31, 2004.

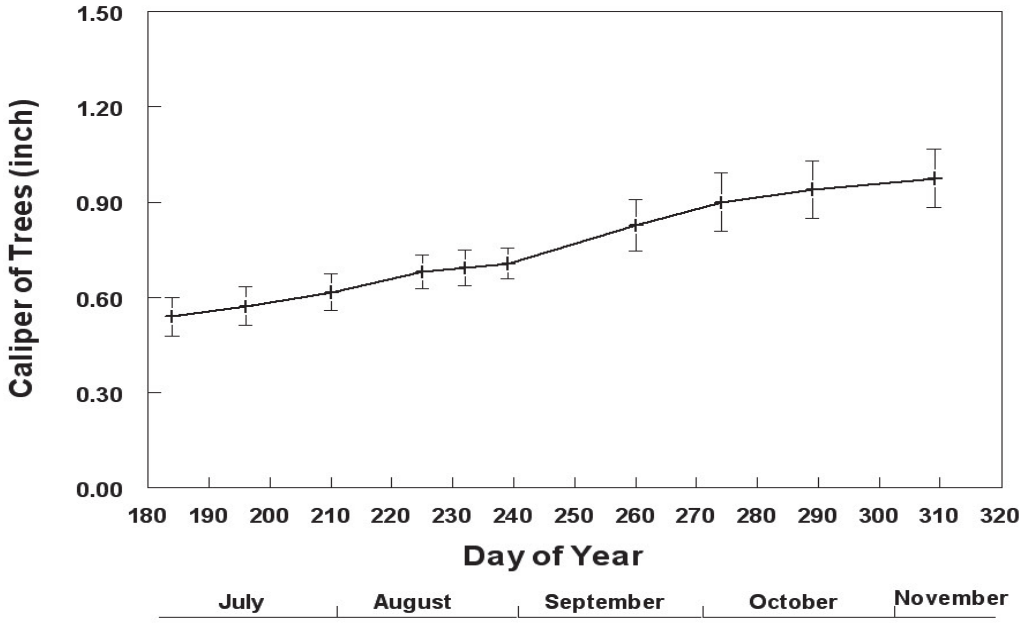

Figure 10. Average trunk caliper of 50 trees at 7 in. above the substrate between July 3 and November 5, 2003.

applying far more water and nutrient than plants can use. Single long irrigations can cause more leachate than several divided watering schedules during a day.

The moisture content varied with the amount of rainfall, duration, and row location. Longer intensive rainfall caused the substrate to remain in a saturated condition longer. The substrate temperature in the pot-in-pot system had much lower variation than the ambient air temperature within a day and was independent of moisture levels before the substrate was frozen.

Future studies will help growers determine how to apply both water and nutrient as trees actually need them, since growing is always an art due to variations in plant size and substrate uniformity.

Acknowledgments

The authors acknowledge the following individuals — K. A. Williams, A. Clark, D. Hammersmith, A. A. Doklovic, D. T. Troyer, B. E. Nudd, and L. A. Morris — for technical assistance.

Disclaimer

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Ohio State Learning Gardens 2004 Annual Flower Trials, Columbus Campus

Monica Kmetz-González and Claudio Pasian

In-Ground Trials

The 2004 season marked a year of continuing expansion for our trials. This was the first year our in-ground trials were conducted at a new site adjacent to our departmental buildings, in an area of high visibility on the Columbus campus of The Ohio State University. The beds are all located in full sun. New ground has already been broken which will more than double our trial bed space for the 2005 season.

General Information

Seeded entries were sown at staggered dates in March to early April by David Cuthbert at Darby Creek Growers, Orient, Ohio, and grown on until they reached full plug size. They were then transplanted to 3.5-inch cell paks in our departmental greenhouses, along with the majority of the vegetative entries, in mid-April. Vegetative geranium entries were received on March 12 and transplanted to 4.5-inch pots on March 15.

All plants were transplanted outside to the trial beds between May 20 and May 24.

In general, 7 to 10 plants per cultivar were trialed on 1.5-foot centers. Spacing was varied as needed by species.

Watering and Fertilization

Plants were watered as needed by hose or overhead sprinkler.

Plants were fertilized at post-planting with Peters 20-10-20 at 200 PPM N via Dosatron. Fertilization was at weekly intervals for the first month, then at two- to three-week intervals through August.

Weather Conditions

The first weeks of the growing season were wet with lower-than-normal temperatures, so plants were slow to start. Intermittent periods of high heat and humidity kicked the plants into gear. Overall, it was a season of lower-than-normal temperatures and above-average rainfall.

Pest and Disease Problems

There were a few problems with root rot early in the season on a few susceptible species due to the cool, wet conditions. There were not any noticeable insect problems.

Monica Kmetz-González, The Ohio State University, Department of Horticulture and Crop Science; and Claudio Pasian, The Ohio State University, Department of Horticulture and Crop Science.

Evaluation Dates

Evaluations were performed on a monthly basis, beginning approximately one month after transplant. This year, plant characteristic ratings were performed on July 19, August 17, and September 16 by the Trials Coordinator and Trials Leader.

Evaluation Criteria

Ratings were based on a 1 to 5 scale:

1 = Poor/not acceptable
2 = Fair
3 = Good
4 = Very good
5 = Excellent.

Plants were evaluated for the following characteristics:

Flower Number: 1 = Low, 5 = Very floriferous

Flower Quality: Aesthetics, color, health, and appearance.

Foliage/Plant Vigor: Vegetative vigor, aesthetics/color, health, and appearance.

Plant Uniformity: 1 = Quality is variable from plant to plant; 5 = Similar quality between all plants.

Overall: Overall rating for all plants in the grouping, taking all the previous aspects into consideration.

(Only the data from the Overall ratings are presented here.)

Consumer Preference Evaluations

In addition, our Annuals Team of Master Gardeners (comprised of seven individuals this season) evaluated the entries at monthly intervals on July 27, August 17, and September 21. An Overall rating on a 1 to 5 scale (with 5 = excellent) was given per entry. This was conducted as a personal preference rating.

Results

Trial results are presented in the accompanying tables.

Table 1 - Consumer Preference Evaluation.

Table 2 - Evaluation of Plant Characteristics — Overall Rating.

Complete trial results, including photos, can be accessed on the web at: **http://floriculture.osu.edu.** Click on Cultivar Trials and follow the links.

The BEST of 2004

Top Overall Season Performers in our Plant Characteristic Evaluations.

The plants listed here received the highest overall season ratings (listed in order, with rankings between 5 to 4.58):

Coleus 'Brown Sugar Drop'
Coleus 'Chocolate Drop'
Euphorbia 'Diamond Frost'
Scaevola 'Whirlwind Blue Velvet'
Ageratum 'Artist Blue'
Eragrostis 'Elliottii Wind Dancer'
Mecardonia 'Gold Flake'
Petunia 'Supertunia Lavender Dawn'
Coleus 'Strawberry Drop'
Phlox 'J.P. White'

Also scoring very high (between 4.5 and 4.42) were:

Pentas 'Graffiti Pink'
Petunia 'Easy Wave Red'
Phlox 'Intensia' series ('Lilac Rose,' 'Neon Pink,' and 'Lavender Glow')
Vinca 'Titan Blush'
Vinca 'Titan Burgundy.'

Please note that many other entries performed very well in the trials. See Table 2. Entries with overall average ratings of 4.0 and above would be recommended for the Columbus, Ohio, area.

Top Performers in the Consumer Preference Evaluations:

In order, the Top 15 entries for the Overall Season, as rated by our Master Gardeners were:

Scaevola 'Whirlwind Blue Velvet'
Phlox 'J.P. White'
Phlox 'Intensia Lavender Glow'
Euphorbia 'Diamond Frost'
Pentas 'Graffiti Pink'
Pentas 'Graffiti Violet'
Ageratum 'Artist Blue'
Phlox 'Intensia Neon Pink'
Angelonia 'Angelface White'
Petunia 'Supertunia Lavender Dawn'
Bracteantha 'Sundaze Flame'
Mecardonia 'Gold Flake'
Phlox 'Intensia Lilac Rose'
Gaillardia 'Arizona Sun'
Petunia 'Dreams Sky Blue'

Top Picks by the Trial Coordinator:

These were nonstop performers in our trials this season:

- *Ageratum* 'Artist Blue'
- *Coleus* 'Brown Sugar Drop' and 'Chocolate Drop'
- *Coleus* 'Sedona' (A very unique color and character in the landscape. This one did decline by September.)
- *Euphorbia* 'Diamond Frost' (A personal favorite. Nice light texture and was still performing in November).
- *Mecardonia* 'Gold Flake'
- *Petunia* 'Supertunia Lavender Dawn' (This one just flowered nonstop.)

Acknowledgments

A big thanks goes to David Cuthbert of Darby Creek Growers, Orient, Ohio, for sowing and growing on the seeded entries for this year's trial. We would like to acknowledge the help of our excellent Annuals Team of Master Gardeners — Caye Aiello, Joyce Gravlee, Ken Kotch, Kathy Krantz, Mary Straney, Juliet Taylor, and Bev Vogeley. Their hard work and dedication to this project is truly appreciated. Thanks also to Annette Duetz, Learning Gardens Supervisor, and David Snodgrass, Greenhouse Coordinator, for their expert assistance. And we thank the following companies for their participation in this year's trials:

- Ball Seed Company
- Benary
- Fischer USA
- Panamerican Seeds
- Proven Winners
- Twyford International.

In-Ground Annual Trial Gardens Summer 2004, The Ohio State University Learning Gardens, Columbus, Ohio.

Table 1. Consumer Preference Evaluation, 2004.

Genus	Series	Variety	Company	Veg/ Seed	Average Rating			Overall Season Avg.*
					27-Jul	17-Aug	21-Sep	
Scaevola	Whirlwind	Blue Velvet	Proven Winners	Veg	4.79	5.00	4.83	4.87
Phlox		J. P. White	Jackson & Perkins	Veg	4.36	4.88	4.33	4.52
Phlox	Intensia	Lavender Glow	Proven Winners	Veg	4.39	5.00	4.08	4.49
Euphorbia		Diamond Frost	Proven Winners	Veg	3.71	4.88	4.75	4.45
Pentas	Graffiti	Pink	Benary	Seed	4.07	4.50	4.75	4.44
Pentas	Graffiti	Violet	Benary	Seed	4.18	4.19	4.92	4.43
Ageratum	Artist	Blue	Proven Winners	Veg	4.14	4.38	4.75	4.42
Phlox	Intensia	Neon Pink	Proven Winners	Veg	4.11	4.88	4.08	4.36
Angelonia	Angelface	White	Proven Winners	Veg	4.36	4.38	4.33	4.36
Petunia	Supertunia	Lavender Dawn	Proven Winners	Veg	4.00	4.63	4.42	4.35
Bracteantha	Sundaze	Flame	Proven Winners	Veg	4.07	4.75	4.17	4.33
Mecardonia		Gold Flake	Proven Winners	Veg	4.07	4.75	4.08	4.30
Phlox	Intensia	Lilac Rose	Proven Winners	Veg	3.89	4.88	4.13	4.30
Gaillardia		Arizona Sun	Benary	Seed	4.71	4.50	3.67	4.29
Petunia	Dreams	Sky Blue	Pan American	Seed	3.93	4.56	4.33	4.27
Ageratum	Artist	Alto Blue	Proven Winners	Veg	4.39	3.94	4.42	4.25
Calibrachoa	Superbells	White	Proven Winners	Veg	4.32	4.63	3.75	4.23
Petunia	Double Cascasde	Blue	Pan American	Seed	3.57	4.31	4.58	4.15
Calibrachoa	Superbells	Blue	Proven Winners	Veg	3.93	4.31	4.17	4.14
Coleus		Sedona	Proven Winners	Veg	4.29	3.81	4.25	4.12
Vinca	Titan	Polka Dot	Ball	Seed	4.36	4.88	3.08	4.11
Vinca	Titan	Lilac	Ball	Seed	4.25	4.63	3.25	4.04

Table 1 (continued). Consumer Preference Evaluation, 2004.								
					Average Rating			Overall Season Avg.*
Genus	Series	Variety	Company	Veg/ Seed	27-Jul	17-Aug	21-Sep	
Petunia	Easy Wave	Red	Pan American	Seed	3.71	4.19	4.13	4.01
Ageratum	Artist	Purple	Proven Winners	Veg	4.00	4.06	3.96	4.01
Coleus		Chocolate Drip	Proven Winners	Veg	4.14	3.88	4.00	4.01
Coleus		Strawberry Drop	Proven Winners	Veg	4.07	4.19	3.75	4.00
Coleus		Brown Sugar Drop	Proven Winners	Veg	4.21	3.88	3.83	3.97
Begonia	Olympia Sprint	Deep Pink	Benary	Seed	2.86	4.63	4.38	3.96
Vinca	Titan	Blush	Ball	Seed	3.82	4.50	3.54	3.95
Pelargonium	Illusion / Shady Lady	Violet Rose	Proven Winners	Veg	4.11	4.31	3.38	3.93
Angelonia	Angelface	Blue	Proven Winners	Veg	4.00	4.44	3.08	3.84
Plectranthus		SIlver Shield	Pan American	Seed	4.00	3.88	3.63	3.84
Vinca	Titan	Burgundy	Ball	Seed	4.11	4.63	2.75	3.83
Osteosper-mum	Soprano	White	Proven Winners	Veg	3.82	4.25	3.33	3.80
Petunia	Double Wave (TC)	Purple	Twyford	Veg	3.46	4.13	3.79	3.79
Vinca	Pacifica	Halo Orchid	Pan American	Seed	3.86	4.25	3.25	3.79
Pentas	Graffiti	White	Benary	Seed	4.21	3.50	3.50	3.74
Pentas	Graffiti	Bright Red	Benary	Seed	3.36	3.56	4.29	3.74
Calibrachoa	Superbells	Pink	Proven Winners	Veg	3.89	3.44	3.79	3.71
Pelargonium (Ivy)	Holiday	Rose	Fischer	Veg	3.61	3.56	3.92	3.70
Vinca	First Kiss	Blush Improved	Benary	Seed	3.71	3.81	3.54	3.69
Pelargonium	Bulls Eye	Light Pink	Ball	Seed	3.89	4.00	3.13	3.67
Argyran-themum		Butterfly	Proven Winners	Veg	4.64	3.88	2.50	3.67
Petunia	Double Wave (TC)	White	Twyford	Veg	3.39	4.69	2.92	3.67
Argyran-themum		Vanilla Butterfly	Proven Winners	Veg	4.43	3.75	2.75	3.64

Table 1 (continued). Consumer Preference Evaluation, 2004.								
Genus	Series	Variety	Company	Veg/ Seed	Average Rating			Overall Season Avg.*
					27-Jul	17-Aug	21-Sep	
Scaevola	Whirlwind	White	Proven Winners	Veg	3.79	4.38	2.63	3.60
Pelargonium	Bulls Eye	Cherry	Ball	Seed	3.68	4.38	2.50	3.52
Pelargonium (Zonal)		Flamingo	Fischer	Veg	3.71	3.56	3.25	3.51
Pelargonium	Illusion	Ornge	Proven Winners	Veg	3.36	4.25	2.83	3.48
Nemesia		Compact Pink Innocence	Proven Winners	Veg	3.71	3.00	3.71	3.47
Petunia	Double Wave (TC)	Pink	Twyford	Veg	3.43	3.94	2.92	3.43
Pelargonium (Ivy)	Holiday	Purple or Violet	Fischer	Veg	3.50	3.75	3.04	3.43
Calibrachoa	Milky Way	Light Blue	Twyford	Veg	3.57	3.25	3.33	3.38
Gypsophila		Festival Star	Proven Winners	Veg	3.50	2.75	3.88	3.38
Pelargonium (Exotic)	Graffiti	Salmon Rose	Fischer	Veg	3.71	3.56	2.83	3.37
Dianthus	Garden Spice	Red	Twyford	Veg	3.21	3.25	3.63	3.36
Osteo-spermum	Soprano	Purple	Proven Winners	Veg	4.00	3.25	2.83	3.36
Portulaca	Margarita	Pepper-mint	Pan American	Seed	4.00	3.69	2.33	3.34
Phlox	21st Century	Blue Star	Pan American	Seed	3.79	3.69	2.54	3.34
Calibrachoa	Superbells	Light Pink	Proven Winners	Veg	3.57	3.63	2.75	3.32
Scoparia		Melon-golly (TM) Blue	Proven Winners	Veg	3.82	3.88	2.08	3.26
Gaura	Karalee	Petite Pink	Proven Winners	Veg	2.53	3.50	3.63	3.22
Petunia	Double Wave (TC)	Blue Vein	Twyford	Veg	3.64	3.81	2.17	3.21
Gerbera	Sunburst (Pot)	Red	Twyford	Veg	3.43	2.81	3.17	3.14
Petunia	Dreams	Rose Picotee	Pan American	Seed	3.07	3.50	2.83	3.13
Salvia		Salvatore	Benary	Seed	3.36	3.25	2.79	3.13
Eragrostis		Elliottii Wind Dancer	Pan American	Seed	2.86	3.50	3.00	3.12

Table 1 (continued). Consumer Preference Evaluation, 2004.								
Genus	Series	Variety	Company	Veg/ Seed	Average Rating			Overall Season Avg.*
					27-Jul	17-Aug	21-Sep	
Pelargonium (Ivy)		Molina 2005	Fischer	Veg	3.43	2.94	2.96	3.11
Satureja hybrid		Pink Sensation	Proven Winners	Veg	3.18	2.88	3.25	3.10
Calibrachoa	Colorful Expression	Lilac	Twyford	Veg	2.75	3.13	3.42	3.10
Penstemon		Lilliput Pink	Proven Winners	Veg	3.75	3.21	2.33	3.10
Pelargonium (Ivy)		Luna 2005	Fischer	Veg	2.96	3.13	3.04	3.04
Pelargonium	Illusion	Rose Pink	Proven Winners	Veg	2.75	3.69	2.67	3.04
Cosmos	Cosmic	Red	Benary	Seed	4.07	2.50	2.50	3.02
Coreopsis		Rising Sun	Pan American	Seed	2.96	3.00	3.08	3.01
Pelargonium (Exotic)	Graffiti	Pink	Fischer	Veg	3.36	3.06	2.54	2.99
Dianthus	Garden Spice	Pearl White	Twyford	Veg	3.00	2.69	3.25	2.98
Pelargonium (Zonal)		Avenida Fire	Fischer	Veg	3.29	2.13	3.42	2.95
Osteospermum	Soprano	Light Purple	Proven Winners	Veg	3.64	3.00	2.17	2.94
Calibrachoa	Superbells	Red	Proven Winners	Veg	3.75	3.06	2.00	2.94
Pelargonium (Ivy)		Tutti Frutti	Fischer	Veg	2.93	3.25	2.63	2.94
Pelargonium (Ivy)		Maxime	Fischer	Veg	2.50	3.63	2.63	2.92
Lobelia	Laguna	Compact Blue w/ Eye	Proven Winners	Veg	3.54	2.00	3.21	2.92
Pelargonium (Zonal)		Alba 2005	Fischer	Veg	2.61	3.06	3.08	2.92
Pelargonium (Ivy)		Ruby Dream	Fischer	Veg	2.68	3.13	2.88	2.90
Verbena		Quartz Silver	Pan American	Seed	2.96	3.31	2.38	2.88
Pelargonium (Zonal)		Himalaya Red	Fischer	Veg	3.18	2.50	2.92	2.87
Torenia	Catalina	Pink	Proven Winners	Veg	3.32	2.69	2.50	2.84
Torenia	Summer Wave	Amethyst	Proven Winners	Veg	3.21	2.83	2.46	2.83

Table 1 (continued). Consumer Preference Evaluation, 2004.								
Genus	Series	Variety	Company	Veg/ Seed	Average Rating			Overall Season Avg.*
					27-Jul	17-Aug	21-Sep	
Lobelia	Laguna	Sky Blue	Proven Winners	Veg	4.11	1.69	2.63	2.81
Pelargonium	Fireworks Collection	Cherry	Proven Winners	Veg	2.71	3.19	2.50	2.80
Pelargonium (Ivy)	Holiday	Ruby	Fischer	Veg	2.43	3.38	2.58	2.80
Torenia	Catalina	Purple	Proven Winners	Veg	3.21	2.88	2.25	2.78
Celosia	Glow	Pink	Pan American	Seed	3.43	3.38	1.42	2.74
Dianthus	Dynasty	Rose Lace	Ball	Seed	3.25	2.50	2.42	2.72
Pelargonium (Ivy)		Flair	Fischer	Veg	2.46	2.88	2.83	2.72
Pelargonium	Illusion/ Shady Lady	Cherry Rose	Proven Winners	Veg	2.50	3.06	2.50	2.69
Torenia	Catalina	Blue	Proven Winners	Veg	2.54	2.94	2.50	2.66
Pelargonium (Zonal)	Rocky Mountain	Salmon Rose	Fischer	Veg	2.29	2.00	3.67	2.65
Vinca	First Kiss	Blueberry	Benary	Seed	3.71	3.38	0.75	2.61
Dianthus	Garden Spice	Baby Pink	Twyford	Veg	2.57	2.19	3.00	2.59
Rudbeckia		Maya	Benary	Seed	4.71	2.88	dead	2.53
Nemesia	Sunsatia	Coconut	Proven Winners	Veg	3.54	2.50	1.54	2.53
Nemesia	Sunsatia	Peach	Proven Winners	Veg	3.25	2.56	1.71	2.51
Brachyscome		Blue Zephyr	Proven Winners	Veg	2.29	2.50	2.58	2.46
Pelargonium (Zonal)		Dolce Vita 2004	Fischer	Veg	2.29	2.00	2.92	2.40
Oenothera	Sunsatia	Lemon Drop	Proven Winners	Veg	3.04	2.19	1.88	2.37
Pelargonium (Zonal)		Tango Fire	Fischer	Veg	2.43	1.31	3.17	2.30
Pelargonium (Exotic)	Graffiti	Fire	Fischer	Veg	1.89	2.56	2.13	2.19
Calibrachoa	Colorful Expression	Cherry Rose	Twyford	Veg	2.21	2.13	2.17	2.17
Pelargonium (Zonal)	Rocky Mountain	Dark Red	Fischer	Veg	1.93	1.69	2.50	2.04
Calibrachoa	Colorful Expression	Blue	Twyford	Veg	2.11	2.19	1.58	1.96

Table 1 (continued). Consumer Preference Evaluation, 2004.

Genus	Series	Variety	Company	Veg/ Seed	Average Rating			Overall Season Avg.*
					27-Jul	17-Aug	21-Sep	
Gerbera	Sunburst (Pot)	Prange	Twyford	Veg	2.64	1.13	2.00	1.92
Gerbera	Sunburst (Pot)	Snow White	Twyford	Veg	2.50	1.25	1.50	1.75
Nemesia	Sunsatia	Lemon	Proven Winners	Veg	1.64	1.31	dead	0.98
Nemesia	Sunsatia	Cranberry	Proven Winners	Veg	1.25	0.38	dead	0.54
Nemesia	Sunsatia	Banana	Proven Winners	Veg	1.29	dead	dead	0.43
Delphinium	Summer	Stars	Benary	Seed	0.29	dead	dead	0.29

* Based on average of July, August, and September ratings performed by our seven-member team of Master Gardeners.
Ranked in decreasing order of Overall season average.
Rating scale: 1 to 5 (1 = Poor; 5 = Excellent).

In-Ground Annual Trial Gardens, Summer 2004, The Ohio State University Learning Gardens, Columbus, Ohio.

Table 2. Evaluation of Plant Characteristics, 2004 Annuals, Overall Rating, 2004.							
Genus	**Series**	**Variety**	**Company**	**Overall Rating 19-jul**	**Overall Rating 17-aug**	**Overall Rating 16-sep**	**Overall Season Average**
Coleus		Brown Sugar Drop	Proven Winners	5.00	5.00	5.00	5.00
Coleus		Chocolate Drop	Proven Winners	5.00	5.00	5.00	5.00
Euphorbia		Diamond Frost	Proven Winners	5.00	5.00	5.00	5.00
Scaevola	Whirlwind	Blue Velvet	Proven Winners	5.00	5.00	5.00	5.00
Ageratum	Artist	Blue	Proven Winners	5.00	5.00	4.75	4.92
Eragrostis		Elliottii Wind Dancer	Pan American	5.00	4.50	5.00	4.83
Mecardonia		Gold Flake	Proven Winners	4.50	5.00	5.00	4.83
Petunia	Supertunia	Lavender Dawn	Proven Winners	4.50	5.00	4.75	4.75
Coleus		Strawberry Drop	Proven Winners	4.50	4.25	5.00	4.58
Phlox		J. P. White	Jackson & Perkins	4.50	5.00	4.25	4.58
Pentas	Graffiti	Pink	Benary	4.25	4.50	4.75	4.50
Petunia	Easy Wave	Red	Pan American	4.25	4.25	5.00	4.50
Phlox	Intensia	Lilac Rose	Proven Winners	4.50	5.00	4.00	4.50
Phlox	Intensia	Neon Pink	Proven Winners	4.50	5.00	4.00	4.50
Phlox	Intensia	Lavender Glow	Proven Winners	4.50	5.00	3.75	4.42
Vinca	Titan	Blush	Ball	4.25	4.50	4.50	4.42
Vinca	Titan	Burgundy	Ball	4.50	5.00	3.75	4.42
Calibrachoa	Superbells	Pink	Proven Winners	4.75	4.25	4.00	4.33
Coleus		Sedona	Proven Winners	5.00	4.25	3.75	4.33
Pelargonium	Illusion	Orange	Proven Winners	5.00	4.50	3.50	4.33
Plectranthus		Silver Shield	Pan American	5.00	5.00	3.00	4.33

Table 2 (continued). Evaluation of Plant Characteristics, 2004 Annuals, Overall Rating, 2004.

Genus	Series	Variety	Company	Overall Rating 19-jul	Overall Rating 17-aug	Overall Rating 16-sep	Overall Season Average
Bracteantha	Sundaze	Flame	Proven Winners	4.50	4.50	3.75	4.25
Pelargonium	Bulls Eye	Cherry	Ball	4.25	4.50	4.00	4.25
Pentas	Graffiti	Violet	Benary	4.00	3.75	5.00	4.25
Petunia	Dreams	Sky Blue	Pan American	4.25	4.75	3.75	4.25
Vinca	Titan	Lilac	Ball	4.25	4.50	4.00	4.25
Vinca	Titan	Polka Dot	Ball	4.25	4.50	4.00	4.25
Ageratum	Artist	Alto Blue	Proven Winners	4.25	4.25	4.00	4.17
Argyranthemum		Vanilla Butterfly	Proven Winners	5.00	4.50	3.00	4.17
Calibrachoa	Superbells	Blue	Proven Winners	4.25	4.25	4.00	4.17
Calibrachoa	Superbells	White	Proven Winners	4.50	5.00	3.00	4.17
Ageratum	Artist	Purple	Proven Winners	4.50	4.25	3.50	4.08
Pelargonium	Bulls Eye	Light Pink	Ball	4.25	4.00	4.00	4.08
Pelargonium	Illusion/ Shady Lady	Violet Rose	Proven Winners	4.50	4.25	3.50	4.08
Scoparia		Melongolly (TM) Blue	Proven Winners	4.75	4.50	3.00	4.08
Vinca	Pacifica	Halo Orchid	Pan American	4.00	4.00	4.25	4.08
Gaillardia		Arizona Sun	Benary	4.50	4.00	3.50	4.00
Pelargonium (Exotic)	Graffiti	Salmon Rose	Fischer	4.00	4.25	3.75	4.00
Petunia	Double Wave (TC)	White	Twyford	3.75	4.75	3.25	3.92
Vinca	First Kiss	Blush Improved	Benary	4.00	4.25	3.50	3.92
Dianthus	Garden Spice	Red	Twyford	4.25	4.00	3.25	3.83
Nemesia		Compact Pink Innocence	Proven Winners	4.25	3.50	3.75	3.83
Begonia	Olympia Sprint	Deep Pink	Benary	3.75	4.00	3.50	3.75
Angelonia	Angelface	White	Proven Winners	4.00	3.50	3.50	3.67

Table 2 (continued). Evaluation of Plant Characteristics, 2004 Annuals, Overall Rating, 2004.

Genus	Series	Variety	Company	Overall Rating 19-jul	Overall Rating 17-aug	Overall Rating 16-sep	Overall Season Average
Gypsophila		Festival Star	Proven Winners	4.50	3.50	3.00	3.67
Pelargonium (Ivy)	Holiday	Rose	Fischer	3.25	4.25	3.50	3.67
Pentas	Graffiti	Bright Red	Benary	3.00	3.25	4.75	3.67
Petunia	Double Cascasde	Blue	Pan American	3.25	4.25	3.50	3.67
Petunia	Dreams	Rose Picotee	Pan American	4.25	4.00	2.75	3.67
Calibrachoa	Colorful Expression	Lilac	Twyford	3.25	4.00	3.50	3.58
Salvia		Salvatore	Benary	3.75	4.00	3.00	3.58
Angelonia	Angelface	Blue	Proven Winners	4.25	3.75	2.50	3.50
Argyranthemum		Butterfly	Proven Winners	4.00	4.00	2.50	3.50
Calibrachoa	Milky Way	Light Blue	Twyford	5.00	3.00	2.50	3.50
Osteospermum	Soprano	White	Proven Winners		4.25	2.75	3.50
Pelargonium (Zonal)		Flamingo	Fischer	3.75	3.75	3.00	3.50
Scaevola	Whirlwind	White	Proven Winners	4.25	4.00	2.25	3.50
Satureja hybrid		Pink Sensation	Proven Winners	4.00	3.00	3.50	3.50
Calibrachoa	Superbells	Light Pink	Proven Winners	4.25	3.50	2.50	3.42
Pelargonium	Fireworks Collection	Cherry	Proven Winners	3.00	4.25	3.00	3.42
Pelargonium (Ivy)		Molina 2005	Fischer	3.50	3.75	3.00	3.42
Petunia	Double Wave (TC)	Purple	Twyford	3.25	4.00	3.00	3.42
Portulaca	Margarita	Peppermint	Pan American	4.00	3.75	2.50	3.42
Pelargonium	Illusion	Rose Pink	Proven Winners	3.50	3.75	2.85	3.37
Penstemon		Lilliput Pink	Proven Winners	4.25	3.85	2.00	3.37
Pelargonium (Ivy)		Maxime	Fischer	3.00	4.00	3.00	3.33
Pelargonium (Zonal)		Himalaya Red	Fischer	3.50	3.50	3.00	3.33

Table 2 (continued). Evaluation of Plant Characteristics, 2004 Annuals, Overall Rating, 2004.

Genus	Series	Variety	Company	Overall Rating 19-jul	Overall Rating 17-aug	Overall Rating 16-sep	Overall Season Average
Petunia	Double Wave (TC)	Pink	Twyford	3.00	3.75	3.00	3.25
Pelargonium	Illusion/ Shady Lady	Cherry Rose	Proven Winners	3.00	3.75	2.75	3.17
Pelargonium (Ivy)		Tutti Frutti	Fischer	2.75	4.00	2.75	3.17
Pelargonium (Zonal)		Avenida Fire	Fischer	3.00	2.50	4.00	3.17
Torenia	Catalina	Blue	Proven Winners	3.25	3.25	3.00	3.17
Torenia	Catalina	Pink	Proven Winners	3.25	3.25	3.00	3.17
Torenia	Summer Wave	Amethyst	Proven Winners	3.75	3.00	2.75	3.17
Gerbera	Sunburst (Pot)	Red	Twyford	2.75	3.25	3.25	3.08
Pelargonium (Exotic)	Graffiti	Pink	Fischer	3.50	2.75	3.00	3.08
Pelargonium (Ivy)		Ruby Dream	Fischer	3.00	3.50	2.75	3.08
Torenia	Catalina	Purple	Proven Winners	3.75	3.00	2.50	3.08
Verbena		Quartz Silver	Pan American	3.75	3.25	2.25	3.08
Dianthus	Dynasty	Rose Lace	Ball	3.75	2.75	2.50	3.00
Pelargonium (Ivy)	Holiday	Purple or Violet	Fischer	3.25	3.00	2.75	3.00
Pelargonium (Zonal)		Alba 2005	Fischer	2.25	3.75	3.00	3.00
Celosia	Glow	Pink	Pan American	3.75	3.00	2.00	2.92
Pentas	Graffiti	White	Benary	4.00	2.50	2.25	2.92
Gaura	Karalee	Petite Pink	Proven Winners	2.75	2.50	3.25	2.83
Nemesia	Sunsatia	Coconut	Proven Winners	4.00	2.50	2.00	2.83
Nemesia	Sunsatia	Peach	Proven Winners	3.25	3.25	2.00	2.83
Pelargonium (Zonal)	Rocky Mountain	Salmon Rose	Fischer	2.75	2.50	3.25	2.83
Calibrachoa	Superbells	Red	Proven Winners	4.00	2.25	2.00	2.75

Table 2 (continued). Evaluation of Plant Characteristics, 2004 Annuals, Overall Rating, 2004.

Genus	Series	Variety	Company	Overall Rating 19-jul	Overall Rating 17-aug	Overall Rating 16-sep	Overall Season Average
Dianthus	Garden Spice	Pearl White	Twyford	2.75	2.75	2.75	2.75
Pelargonium (Ivy)	Holiday	Ruby	Fischer	2.50	3.00	2.75	2.75
Pelargonium (Ivy)		Flair	Fischer	2.50	3.00	2.75	2.75
Coreopsis		Rising Sun	Pan American	2.75	2.50	2.75	2.67
Dianthus	Garden Spice	Baby Pink	Twyford	2.50	2.75	2.75	2.67
Phlox	21st Century	Blue Star	Pan American	2.75	2.75	2.50	2.67
Vinca	First Kiss	Blueberry	Benary	4.25	3.50	dying back	2.58
Pelargonium (Exotic)	Graffiti	Fire	Fischer	2.00	2.75	2.75	2.50
Pelargonium (Zonal)		Dolce Vita 2004	Fischer	2.75	2.00	2.75	2.50
Pelargonium (Zonal)		Tango Fire	Fischer	2.50	1.75	3.25	2.50
Petunia	Double Wave (TC)	Blue Vein	Twyford	3.50	2.75	1.25	2.50
Lobelia	Laguna	Sky Blue	Proven Winners	4.25	2.75	dying back	2.33
Pelargonium (Ivy)		Luna 2005	Fischer	2.00	2.50	2.50	2.33
Pelargonium (Zonal)	Rocky Mountain	Dark Red	Fischer	2.50	2.25	2.25	2.33
Cosmos	Cosmic	Red	Benary	4.25	2.50	poor location	2.25
Oenothera	Sunsatia	Lemon Drop	Proven Winners	3.00	1.75	2.00	2.25
Osteo-spermum	Soprano	Light Purple	Proven Winners		2.75	1.50	2.13
Lobelia	Laguna	Compact Blue w/ Eye	Proven Winners	4.25	2.00	dying back	2.08
Brachyscome		Blue Zephyr	Proven Winners	2.00	2.00	2.00	2.00
Osteo-spermum	Soprano	Purple	Proven Winners		1.75	2.00	1.88
Rudbeckia		Maya	Benary	3.00	2.50	dead	1.83

Table 2 (continued). Evaluation of Plant Characteristics, 2004 Annuals, Overall Rating, 2004.

Genus	Series	Variety	Company	Overall Rating 19-jul	Overall Rating 17-aug	Overall Rating 16-sep	Overall Season Average
Calibrachoa	Colorful Expression	Blue	Twyford	2.50	1.75	1.00	1.75
Calibrachoa	Colorful Expression	Cherry Rose	Twyford	2.00	1.50	1.50	1.67
Nemesia	Sunsatia	Lemon	Proven Winners	1.75	1.75	dead	1.17
Gerbera	Sunburst (Pot)	Orange	Twyford	1.75	1.50	declined	1.08
Gerbera	Sunburst (Pot)	Snow White	Twyford	1.50	1.50	declined	1.00
Nemesia	Sunsatia	Cranberry	Proven Winners	1.50	0.50	dead	0.67
Nemesia	Sunsatia	Banana	Proven Winners	1.00	dead	dead	0.33
Delphinium	Summer	Stars	Benary	died early	in season		

* Ratings performed by Trials Leader and Trials Coordinator.
Rating Scale: 1 to 5 (1 = Poor; 5 = Excellent).

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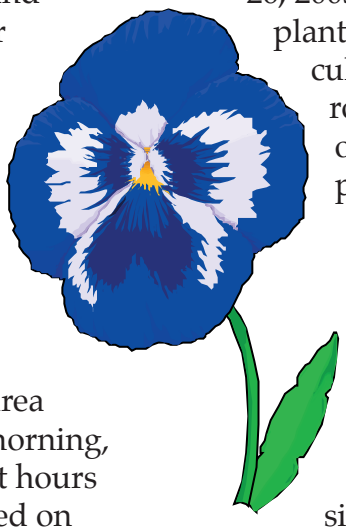
The Ohio State University Learning Gardens Pansy/Viola Cultivar Trial, 2003 - 2004

Monica Kmetz-González and Claudio Pasian

This was the fourth year we conducted our Fall Pansy and Viola Trials. Plants were transplanted outside in the fall and evaluated throughout the winter and the spring. This time, we also left the plants in-ground through July, to assess heat tolerance.



Trial Site Location: The in-ground trial site is adjacent to our departmental buildings on the Columbus Campus of The Ohio State University. The area receives full shade most of the morning, followed by approximately eight hours of full sun. The area was rototilled on September 15, 2003, just prior to planting.

Plant Material: Seed from participating breeders and distributors was grown on once again for us this year by Bob Barnitz of Bob's Market & Greenhouse, Mason, West Virginia. There were 33 Pansy entries and 17 Violas, bringing the total number of cultivars evaluated to 50.

Procedure: Plants were received in our greenhouses on September 23, 2003, in 2-1/4" cell paks. A Plantshield drench (5 oz/100 gal) was applied on the same day. Twelve plants per cultivar were transplanted in-ground on September 26, 2003. Spacing was 10" between plants within a cultivar, 14" between cultivars, and 20" between main rows. Post-planting fertilization occurred on October 7 with 200 ppm N 20-10-20 via Dosatron.

Weather Conditions: The initial planting period was cool with some rain. Early light frosts occurred in the surrounding areas from September 28, 2003, through October 4, 2003, but the trial site itself was unaffected.

Warmer weather came back on October 5, 2003, with 70ºF days and 50ºF nights, which kicked the plants into gear. The rest of October showed average temperatures, and from November 2, 2003, to November 5, 2003, unseasonably warm 70ºF days returned again.

The first hard freeze in the area occurred on November 9, 2003. Some warmer temps again followed. Overall mild temperatures occurred through the beginning of January 2004, and on January 5, plants were noted to be blooming and "looking good."

Cold temperatures then followed in mid-January with daytime highs in the 20ºFs, and night temps down to 9ºF. The lowest temperature experienced by the plants

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was -2.5ºF on January 31, 2004. The rest of the winter provided cold temperature conditions for good overwintering assessment. The period from March through the beginning of April 2004 was cooler than average. Frosts occurred through the beginning of May.

Evaluations and Results: Evaluations were performed in both fall 2003 and spring 2004. Plant characteristics were evaluated in depth by our core team of evaluators. Ratings were based on a 1 to 5 scale (1 = Not Acceptable, 5 = Excellent). The following characteristics were evaluated:

- Flower Quality: Aesthetics, color, health, and appearance.
- Flower Number: 1 = Low, 5 = Very floriferous.
- Foliage: Vegetative vigor, aesthetics/color, health, and appearance.
- Vigor/Overwintering: 1 = Poor; 5 = Overwintered very well; excellent vigor (for spring rating only).
- Overall: Overall rating for the group, taking all the previous criteria into consideration.

Results can be found in the following tables:

1: Plant Characteristic Evaluations

These were performed by a core team of evaluators, which was comprised of the trials leader, trials coordinator, and greenhouse supervisor.

Fall — performed October 29, 2003

Pansy: Table 1
Viola: Table 2

Spring — performed May 6, 2004

Pansy: Table 3
Viola: Table 4

Top Performers

Fall Evaluation

Pansies: Nature Ocean, Nature Blue, Dynamite Lavender

Violas: Gem Antique Lavender, Sorbet Beaconsfield, Gem Rose w/Blotch, Gem Pink Shades

Spring Evaluation

Pansies: Nature Blue, Ultima Morpho, Nature Yellow, Dynamite Lavender

Violas: Gem Yellow, Sorbet Blackberry Cream, Sorbet Beaconsfield, Sorbet Plum Velvet, Penny Violet Flare.

2: Consumer Preference Evaluations

The Consumer Preference Evaluations were held in fall 2003 and in spring 2004 and were performed by our team of Master Gardener Volunteers. The fall evaluation was based purely on personal preference, on a 1 to 5 scale (5 = Exceptional), rating the overall appearance of the individual cultivars. In the spring evaluation, the overall rating was based on an average of separate plant vigor and aesthetics ratings.

Fall — performed November 18, 2003

Pansy: Table 5
Viola: Table 6

Spring — performed April 27, 2004

Pansy: Table 7
Viola: Table 8

Top Performers (Consumer Evaluation)

Fall Evaluation

Pansies: Nature Blue, Nature Ocean, Clear Sky True Blue, Crystal Bowl Purple, Flamenco Mix, Whiskers Yellow, and Dynamite Lavender.

These entries were all rated 4.0 and above. Nature Blue, Nature Ocean, and Dynamite Lavender were also top finishers in the Plant Characteristics Evaluations.

Violas: Sorbet Beaconsfield, Sorbet Blue Heaven, Penny Yellow Jump-Up, and Gem Yellow.

These all rated 4.1 and above. Sorbet Beaconsfield also received top ratings in the Plant Characteristics evaluations.

Spring Evaluation

Pansies: Ultima Morpho, Dynamite Lavender, Nature Orange, Clear Sky True Blue, Nature Lemon Yellow, and Majestic Giants II Patricia.

These all rated 4.2 and above. Ultima Morpho and Dynamite Lavender also received top ratings in the plant characteristics evaluations.

Violas: Sorbet Blue Heaven, Sorbet Beaconsfield, Penny Violet Flare, Gem Yellow, Gem Rose w/Blotch, Sorbet Plum Velvet, Sorbet Coconut Delight, Sorbet Antique Shades, Sorbet Blackberry Cream, and Penny Yellow Jump-Up.

These all rated 4.2 and above. As evidenced by the long list, many Violas rated highly in the spring for a tremendous show. Penny Violet Flare, Gem Yellow, Sorbet Plum Violet, and Sorbet Blackberry Cream also received top ratings in the plant characteristics evaluations.

Additional Comments on Fall and Spring Consumer Preference Evaluations

The entries listed here placed high in BOTH fall and spring ratings:

Pansies: Clear Sky True Blue and Dynamite Lavender.

Violas: Sorbet Beaconsfield, Sorbet Blue Heaven, Penny Yellow Jump-Up, and Gem Yellow.

3: Heat-Tolerance Evaluation

A Heat-Tolerance Evaluation was conducted by the Trials Coordinator on July 13, 2004, just prior to the conclusion of the trial. The results from this rating can be found in Table 9.

Results of Mid-July Rating:

Best looking **Pansies** in the heat of summer (rating of 4.0 and above) were Dynamite Beacon Blue, Dynamite Purple, and Crystal Bowl Purple.

The following also looked good, with a rating of 3.8: Nature Orange, Dynamite Blue Center, Delta Premium Pure White, Delta Premium Pure Primrose, and Dynamite Lavender.

Best **Violas** in the heat of summer (rating of 4.0 and above) were Sorbet Blue Heaven, Gem Pink Shades, and Gem Antique Lavender.

Also good with a rating of 3.8 were Penny Violet Flare and Sorbet Coconut Duet.

Trial Coordinator Comments

As in the past three years of winter trials of pansies and violas here in Columbus, Ohio (Zone 6), we recorded an approximate 95% overall survival rate for the trial plants. These plants are very

low maintenance and offer an excellent addition to the fall color palette, as well as early and vibrant color in the spring. On average, the pansies and violas here burst into bloom ahead of daffodils and tulips.

In recent years, we have been receiving more of the "panola" type entries. These plants are an intermediate between pansies and violas, with vegetative vigor more closely resembling the hardier type viola. Flower size is midway between that of the pansy and viola. This group of entries has tended to perform very well in this area.

Acknowledgments

We would like to acknowledge our dedicated team of Master Gardener Volunteers who helped in all phases of this trial. Thanks to David Snodgrass, Greenhouse Supervisor, and Annette Duetz, Learning Gardens Supervisor, for their assistance. We thank Bob Barnitz of Bob's Market & Greenhouse for seeding and growing on the transplants. We thank Bioworks for donating Plantshield. And we thank the participating companies for their sponsorship in this year's trial.

For trial results, see the tables on the following pages.

Ohio State 2003-2004 Pansy/Viola Trial:

Table 1.* Pansy Fall Evaluation, October 29, 2004.						
Series	**Cultivar**	**Seed Company**	**Flower Appear-ance**	**Flower Number**	**Foliage**	**Overall**
Nature	Ocean	TAKII	4.0	3.3	3.5	3.5
Nature	Blue	TAKII	4.0	3.3	3.5	3.5
Dynamite	Lavender	Sakata	3.8	2.3	3.0	3.3
Whiskers	Yellow	Ball	4.0	1.3	2.5	2.8
Whiskers	Purple & White	Ball	4.0	1.3	2.5	2.8
Nature	Orange	TAKII	3.8	2.3	2.8	2.8
Clear Sky	True Blue	Syngenta	3.8	1.5	3.0	2.8
Nature	Red w/ Blotch	TAKII	3.5	2.8	2.8	2.8
Dynamite	Purple	Sakata	3.5	1.5	2.8	2.8
Fama	Dark Eyed Carmine	BENARY	3.3	2.3	2.5	2.8
Fama	Peach Shades	BENARY	3.3	2.0	2.5	2.8
Nature	Pink Shades	TAKII	3.0	2.8	2.8	2.8
Dynamite	Blue Center	Sakata	3.0	1.5	2.5	2.8
Nature	Yellow	TAKII	3.5	1.8	2.5	2.5
Delta Premium	Pure Primrose	Syngenta	3.5	1.8	2.3	2.5
Nature	Lemon Yellow	TAKII	3.3	2.0	2.5	2.5
Delta Premium	Yellow w/ Purple Wing	Syngenta	3.3	1.8	2.5	2.5
Crystal Bowl	Purple	Sakata	3.0	2.0	2.8	2.5
Flamenco	Mix	Sakata	3.0	2.0	2.3	2.5
Delta Premium	Pure White	Syngenta	2.8	2.0	2.8	2.5
Delta Premium	Pure Violet	Syngenta	2.8	1.8	2.5	2.5
Dynamite	Beacon Blue	Sakata	2.8	1.5	2.8	2.5
Ultima	Morpho	Sakata	2.5	1.8	3.0	2.5

Table 1 (continued).* Pansy Fall Evaluation, October 29, 2004.						
Series	**Cultivar**	**Seed Company**	**Flower Appear-ance**	**Flower Number**	**Foliage**	**Overall**
Dynamite	Wine Flash	Sakata	2.8	2.0	2.5	2.3
Majestic Giant II	Rosalyn	Sakata	2.8	1.8	2.8	2.3
Colossus	Purple w/ Blotch	Syngenta	2.8	1.8	2.8	2.3
Majestic Giant II	Patricia	Sakata	2.8	1.5	2.8	2.3
Fama	See Me Improved	BENARY	2.8	1.5	2.5	2.3
Fama	White	BENARY	2.0	1.5	2.5	2.3
Nature	Rose w/ Blotch	TAKII	2.8	1.8	2.0	2.0
Fama	Silver Blue Improved	BENARY	2.5	1.5	2.3	2.0
Accord	Black Beauty	Goldsmith	2.3	1.5	2.5	2.0
Dynamite	Scarlet	Sakata	2.3	1.3	1.8	1.8

* Ranked in descending order of Overall rating.
Rating Scale: 1 - 5 (1 = Not Acceptable; 5 = Excellent).

Table 2. * Viola Fall Evaluation, October 29, 2004.						
Series	**Cultivar**	**Seed Company**	**Flower Appear-ance**	**Flower Number**	**Foliage**	**Overall**
Gem	Antique Lavender	TAKII	4.5	5.0	3.5	4.0
Sorbet	Beacons-field	Pan-American	3.8	3.0	4.5	4.0
Gem	Rose w/ Blotch	TAKII	3.5	4.0	3.0	3.5
Gem	Pink Shades	TAKII	3.0	3.5	3.0	3.5
Gem	Yellow	TAKII	3.3	3.3	3.3	3.3
Sorbet	Coconut Duet	Pan-American	4.3	3.5	2.8	3.0
Gem	Red w/ Blotch	TAKII	3.8	2.0	3.0	3.0
Sorbet	Blue Heaven	Pan-American	3.8	2.5	2.8	2.8
Sorbet	Plum Velvet	Pan-American	3.5	2.0	3.0	2.8
Gem	Antique Pink	TAKII	2.5	2.8	3.5	2.8
Sorbet	Coconut	Pan-American	2.3	2.3	2.8	2.8
Sorbet	Antique Shades	Pan-American	3.5	2.3	2.5	2.5
Sorbet	Blackberry Cream	Pan-American	3.0	2.0	3.0	2.5
Penny	Violet Flare	Pan-American	2.3	2.0	2.8	2.5
Gem	Antique Apricot	TAKII	2.0	2.0	3.5	2.5
Gem	Orange	TAKII	2.8	2.0	2.5	2.0
Penny	Yellow Jump-up	Goldsmith	2.8	1.8	2.8	2.0
* Ranked in descending order of Overall rating. Rating Scale: 1 - 5 (1 = Not Acceptable; 5 = Excellent).						

Table 3.* Pansy Spring Evaluation, May 6, 2004.							
Series	**Cultivar**	**Seed Company**	**Vigor/ Over-wintering**	**Flower Appear-ance**	**Flower Number**	**Foliage**	**Overall**
Nature	Blue	TAKII	4.0	5.0	4.5	4.0	4.5
Ultima	Morpho	Sakata	4.5	4.5	4.0	4.0	4.5
Nature	Yellow	TAKII	3.8	4.5	4.3	4.3	4.3
Dynamite	Lavender	Sakata	4.8	4.3	4.3	4.0	4.3
Nature	Lemon Yellow	TAKII	3.0	4.5	3.5	3.8	4.0
Delta Premium	Yellow w/ Purple Wing	Syngenta	2.8	4.5	3.3	4.3	4.0
Whiskers	Purple & White	Ball	4.0	4.5	3.3	4.3	4.0
Nature	Orange	TAKII	5.0	3.8	4.0	5.0	4.0
Nature	Rose w/ Blotch	TAKII	4.8	3.5	4.0	4.3	4.0
Nature	Ocean	TAKII	3.0	3.5	4.0	3.5	4.0
Whiskers	Yellow	Ball	3.8	4.3	3.5	3.8	3.8
Majestic Giant II	Patricia	Sakata	4.0	4.3	3.3	4.0	3.8
Fama	See Me Improved	BENARY	2.8	3.8	3.5	2.8	3.8
Nature	Red w/ Blotch	TAKII	4.0	3.8	3.8	4.0	3.5
Dynamite	Purple	Sakata	4.8	3.8	3.5	3.8	3.5
Nature	Pink Shades	TAKII	4.5	3.3	3.8	4.0	3.5
Crystal Bowl	Purple	Sakata	4.8	2.8	3.3	4.0	3.5
Colossus	Purple w/ Blotch	Syngenta	4.3	3.5	3.5	4.0	3.3
Dynamite	Beacon Blue	Sakata	4.0	3.5	3.5	3.8	3.0
Dynamite	Wine Flash	Sakata	4.8	3.5	3.0	3.8	3.0
Delta Premium	Pure White	Syngenta	3.3	3.3	3.0	3.0	3.0
Clear Sky	True Blue	Syngenta	4.8	3.0	3.5	4.0	3.0
Fama	Silver Blue Improved	BENARY	2.5	3.0	3.5	3.8	3.0

Table 3 (continued).* Pansy Spring Evaluation, May 6, 2004.							
Series	**Cultivar**	**Seed Company**	**Vigor/ Over-wintering**	**Flower Appear-ance**	**Flower Number**	**Foliage**	**Overall**
Fama	Peach Shades	BENARY	2.5	3.0	3.5	3.5	3.0
Majestic Giant II	Rosalyn	Sakata	3.5	3.0	2.8	3.0	3.0
Dynamite	Blue Center	Sakata	4.8	2.8	3.5	3.3	3.0
Accord	Black Beauty	Goldsmith	5.0	2.8	3.0	4.8	3.0
Fama	White	BENARY	3.8	3.0	3.3	4.0	2.9
Flamenco	Mix	Sakata	2.0	3.8	3.0	2.8	2.8
Fama	Dark Eyed Carmine	BENARY	2.8	2.8	3.0	3.0	2.8
Dynamite	Scarlet	Sakata	3.5	2.8	2.8	3.0	2.8
Delta Premium	Pure Violet	Syngenta	2.5	2.8	2.8	2.8	2.8
Delta Premium	Pure Primrose	Syngenta	4.8	2.0	2.5	3.8	2.5
*Ranked in descending order of Overall rating. Rating Scale: 1- 5 (1 = Not Acceptable; 5 = Excellent).							

Table 4.* Viola Spring Evaluation, May 6, 2004.							
Series	**Cultivar**	**Seed Company**	**Vigor/ Over-wintering**	**Flower Appear-ance**	**Flower Number**	**Foliage**	**Overall**
Gem	Yellow	TAKII	5.0	5.0	5.0	5.0	5.0
Sorbet	Black-berry Cream	Pan-American	3.8	5.0	5.0	5.0	4.8
Sorbet	Beacons-field	Pan-American	4.8	5.0	4.8	5.0	4.8
Sorbet	Plum Velvet	Pan-American	4.8	5.0	4.8	5.0	4.8
Penny	Violet Flare	Pan-American	5.0	4.8	4.5	5.0	4.8
Sorbet	Coconut Duet	Pan-American	4.0	5.0	4.5	3.8	4.5
Sorbet	Antique Shades	Pan-American	4.8	4.5	4.5	4.3	4.5
Gem	Rose w/ Blotch	TAKII	4.5	4.5	4.4	4.5	4.5
Penny	Yellow Jump-up	Goldsmith	3.5	5.0	4.3	5.0	4.3
Sorbet	Coconut	Pan-American	4.5	4.0	4.4	4.0	4.3
Sorbet	Blue Heaven	Pan-American	2.9	4.3	4.8	4.5	4.0
Gem	Pink Shades	TAKII	4.8	4.0	4.3	4.5	4.0
Gem	Antique Lavender	TAKII	3.5	4.0	4.3	3.8	4.0
Gem	Orange	TAKII	4.5	4.0	3.8	5.0	4.0
Gem	Antique Pink	TAKII	3.0	3.8	4.3	3.8	4.0
Gem	Antique Apricot	TAKII	4.0	3.0	5.0	3.8	3.9
Gem	Red w/ Blotch	TAKII	2.5	4.5	4.5	4.5	3.5

* Ranked in descending order of Overall rating.
Rating Scale: 1 - 5 (1 = Not Acceptable; 5 = Excellent).

Table 5.* Pansy Consumer Preference Evaluation, Fall, Performed November 18, 2003.

Series	Cultivar	Seed Company	Average OVERALL	Standard Deviation
Nature	Blue	TAKII	4.6	0.5
Nature	Ocean	TAKII	4.5	0.6
Clear Sky	True Blue	Syngenta	4.4	0.6
Crystal Bowl	Purple	Sakata	4.3	0.7
Flamenco	Mix	Sakata	4.2	0.5
Whiskers	Yellow	Ball	4.2	0.9
Dynamite	Lavender	Sakata	4.0	0.1
Whiskers	Purple & White	Ball	3.9	0.8
Fama	See Me Improved	BENARY	3.8	0.4
Nature	Red w/Blotch	TAKII	3.8	0.4
Dynamite	Blue Center	Sakata	3.7	0.6
Dynamite	Wine Flash	Sakata	3.7	0.7
Delta Premium	Yellow w/Purple Wing	Syngenta	3.7	0.5
Nature	Yellow	TAKII	3.6	0.5
Nature	Pink Shades	TAKII	3.6	0.6
Nature	Orange	TAKII	3.6	1.1
Nature	Rose w/ Blotch	TAKII	3.5	0.6
Nature	Lemon Yellow	TAKII	3.4	1.0
Delta Premium	Pure Violet	Syngenta	3.4	0.6
Dynamite	Purple	Sakata	3.3	0.4
Dynamite	Beacon Blue	Sakata	3.3	0.4
Fama	Silver Blue Improved	BENARY	3.3	0.7
Majestic Giant II	Rosalyn	Sakata	3.3	0.4
Fama	Dark Eyed Carmine	BENARY	3.1	0.5
Fama	Peach Shades	BENARY	3.1	0.7
Ultima	Morpho	Sakata	3.1	0.6
Delta Premium	Pure White	Syngenta	3.1	1.0
Accord	Black Beauty	Goldsmith	2.9	1.4
Dynamite	Scarlet	Sakata	2.7	0.6
Majestic Giant II	Patricia	Sakata	2.7	0.6
Colossus	Purple w/ Blotch	Syngenta	2.6	0.4
Fama	White	BENARY	2.4	0.4
Delta Premium	Pure Primrose	Syngenta	2.1	0.5

* Ranked in descending order of Average Overall rating based on team of five evaluators. Rating Scale: 1 - 5 (1 = Not Acceptable; 5 = Excellent).

Table 6.* Viola Consumer Preference Evaluation, Fall, Performed November 18, 2003.				
Series	**Cultivar**	**Seed Company**	**Average OVERALL**	**Standard Deviation**
Sorbet	Beaconsfield	PanAmerican	4.4	0.8
Sorbet	Blue Heaven	PanAmerican	4.2	0.7
Penny	Yellow Jump-up	Goldsmith	4.1	0.7
Gem	Yellow	TAKII	4.1	0.7
Penny	Violet Flare	PanAmerican	3.9	0.5
Sorbet	Coconut Duet	PanAmerican	3.9	0.8
Gem	Antique Lavender	TAKII	3.9	0.4
Sorbet	Antique Shades	PanAmerican	3.9	0.5
Sorbet	Plum Velvet	PanAmerican	3.8	1.0
Gem	Red w/ Blotch	TAKII	3.6	0.5
Gem	Orange	TAKII	3.5	0.5
Sorbet	Blackberry Cream	PanAmerican	3.5	0.9
Gem	Rose w/ Blotch	TAKII	3.1	0.7
Sorbet	Coconut	PanAmerican	2.9	0.8
Gem	Pink Shades	TAKII	2.8	0.2
Gem	Antique Pink	TAKII	2.8	0.7
Gem	Antique Apricot	TAKII	2.5	0.4
* Ranked in descending order of Average Overall rating based on team of 5 evaluators. Rating Scale: 1 - 5 (1 = Not Acceptable; 5 = Excellent).				

Table 7.* Pansy Consumer Preference Evaluation, Spring, Performed April 27, 2004.						
Series	**Cultivar**	**Average Vigor**	**Standard Deviation Vigor**	**Average Aesthetics**	**Standard Deviation Aesthetics**	**Average OVERALL ****
Ultima	Morpho	4.6	0.4	4.6	0.4	4.6
Dynamite	Lavender	4.7	0.7	4.5	0.4	4.6
Nature	Orange	4.9	0.2	3.9	1.3	4.4
Clear Sky	True Blue	4.6	0.4	4.0	0.6	4.3
Nature	Lemon Yellow	4.0	0.1	4.4	0.7	4.2
Majestic Giant II	Patricia	4.4	0.4	4.0	0.7	4.2
Majestic Giant II	Rosalyn	4.0	0.6	3.8	0.9	3.9
Crystal Bowl	Purple	4.0	0.3	3.7	0.7	3.9
Dynamite	Purple	3.8	0.7	3.8	0.9	3.8
Fama	See Me Improved	3.6	0.6	3.9	0.6	3.8
Colossus	Purple w/ Blotch	3.9	0.4	3.7	0.4	3.8
Accord	Black Beauty	4.1	0.6	3.4	1.1	3.8
Delta Premium	Pure Primrose	4.2	0.6	3.3	0.9	3.7
Dynamite	Beacon Blue	3.5	0.5	3.9	0.7	3.7
Nature	Ocean	3.5	0.5	3.9	1.0	3.7
Nature	Red w/ Blotch	3.9	0.4	3.5	0.5	3.7
Whiskers	Yellow	3.7	0.5	3.6	0.7	3.7
Nature	Blue	3.4	0.4	3.6	0.4	3.5
Nature	Pink Shades	4.3	0.7	2.8	0.7	3.5
Whiskers	Purple & White	3.4	0.6	3.6	0.4	3.5
Nature	Yellow	3.6	0.4	3.4	0.7	3.5
Dynamite	Blue Center	3.7	0.4	3.3	1.0	3.5
Delta Premium	Yellow w/ Purple Wing	3.0	0.5	3.8	0.5	3.4
Dynamite	Wine Flash	3.6	0.6	3.1	0.6	3.3
Fama	White	3.7	0.6	3.0	0.5	3.3

Table 7 (continued).* Pansy Consumer Preference Evaluation, Spring, Performed April 27, 2004.

Series	Cultivar	Average Vigor	Standard Deviation Vigor	Average Aesthetics	Standard Deviation Aesthetics	Average OVERALL **
Fama	Silver Blue Improved	2.8	0.6	3.9	0.9	3.3
Nature	Rose w/ Blotch	2.9	0.4	3.3	0.7	3.1
Delta Premium	Pure Violet	2.5	0.7	3.6	0.7	3.1
Delta Premium	Pure White	3.6	0.5	2.6	0.9	3.1
Dynamite	Scarlet	3.0	0.4	3.0	0.6	3.0
Fama	Dark Eyed Carmine	2.4	0.4	3.4	0.5	2.9
Flamenco	Mix	2.0	0.5	3.6	0.9	2.8
Fama	Peach Shades	1.6	0.4	2.9	0.6	2.3

* Ranked in descending order of Average Overall rating based on team of 7 evaluators.
** Overall rating combines vigor and aesthetics ratings.
Rating Scale: 1 - 5 (1 = Not Acceptable; 5 = Excellent).

Table 8.* Viola Consumer Preference Evaluation, Spring, Performed April 27, 2004.

Series	Cultivar	Average Vigor	Standard Deviation Vigor	Average Aesthetics	Standard Deviation Aesthetics	Average OVERALL **
Sorbet	Blue Heaven	4.9	0.2	4.9	0.2	4.9
Sorbet	Beacons-field	5.0	0.0	4.7	0.4	4.9
Penny	Violet Flare	5.0	0.0	4.6	0.4	4.8
Gem	Yellow	4.9	0.2	4.5	0.5	4.7
Gem	Rose w/ Blotch	4.7	0.4	4.2	0.7	4.4
Sorbet	Plum Velvet	5.0	0.0	3.9	0.6	4.4
Sorbet	Coconut Duet	4.5	0.4	4.2	0.8	4.4
Sorbet	Antique Shades	4.9	0.2	3.9	0.8	4.4
Sorbet	Blackberry Cream	4.9	0.2	3.6	0.9	4.3
Penny	Yellow Jump-up	4.7	0.4	3.7	0.6	4.2
Sorbet	Coconut	4.1	0.6	3.6	1.0	3.9
Gem	Antique Lavender	3.6	0.4	3.8	0.7	3.7
Gem	Pink Shades	4.3	0.4	3.1	0.7	3.7
Gem	Red w/ Blotch	3.5	0.5	3.6	0.4	3.6
Gem	Orange	3.9	0.4	3.3	0.6	3.6
Gem	Antique Apricot	4.6	0.4	2.5	1.4	3.6
Gem	Antique Pink	3.8	0.3	2.8	0.5	3.3

* Ranked in descending order of Average Overall rating based on team of 7 evaluators.
** Overall rating combines vigor and aesthetics ratings.
Rating Scale: 1 - 5 (1 = Not Acceptable; 5 = Excellent).

Table 9.* Pansy and Viola Best Cultivars in Summer Heat Tolerance Rating, July 13, 2004.

Pansy			Viola		
Series	**Cultivar**	**Heat Tolerance**	**Series**	**Cultivar**	**Heat Tolerance**
Dynamite	Beacon Blue	4.3	Sorbet	Blue Heaven	4.5
Dynamite	Purple	4.0	Gem	Pink Shades	4.3
Crystal Bowl	Purple	4.0	Gem	Antique Lavender	4.0
Nature	Orange	3.8	Penny	Violet Flare	3.8
Dynamite	Blue Center	3.8	Sorbet	Coconut Duet	3.8
Delta Premium	Pure White	3.8	Gem	Orange	3.0
Delta Premium	Pure Primrose	3.8	Gem	Red w/ Blotch	2.8
Dynamite	Lavender	3.8			
Fama	White	3.5			
Nature	Red w/ Blotch	3.5			
Dynamite	Wine Flash	3.5			
Nature	Lemon Yellow	3.5			
Nature	Blue	3.3			
Delta Premium	Pure Violet	3.0			
Whiskers	Purple & White	3.0			
Nature	Rose w/ Blotch	2.8			
Nature	Pink Shades	2.8			
Whiskers	Yellow	2.8			
Majestic Giant II	Rosalyn	2.8			

* Only cultivars with a rating of 2.8+ are listed here. All others fared poorly.
Rating Scale: 1 - 5 (1 = Not Acceptable; 5 = Excellent).

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Ohio State University Extension Gateway Learning Gardens 2004 Herbaceous Ornamental Field Trial Results

Pamela J. Bennett

Introduction

Clark County Extension Master Gardener volunteers have evaluated annuals at the Clark County Extension office site in Springfield, Ohio, since 1995. The field trial plots are located in the Gateway Learning Gardens. Carolyn Allen and Barbara Brown are Master Gardener volunteer co-chairs of the project. The gardens are planted and maintained by volunteers. Some 40 volunteers work on this project, starting plugs and seeds in the greenhouse, and planting and weeding the plots.

The plots are typical of the west-central Ohio area — the soil is predominantly clay with a pH of 7.3. The current plots were established in the fall of 1996. The beds were tilled to a depth of 14", and 2" of compost was added. Compost was added when new beds were established and replenished every three years; compost was last added to all beds in the fall of 2002. There is approximately 5,000 square feet of bed space in full sun and approximately 1,000 square feet in shade.

The selection of plants for trials in the garden varies from year to year. The selection is based on entries from seed companies, performance in prior years, current trends, and on industry recommendations. Results of performance for the plants are based on the data collected at the plots and reflect the growing conditions of 2004. The purpose of the evaluation is to provide growers, landscapers, and homeowners a guide for plant selection for Ohio.

Method

The plants were started from seeds, plugs, or cuttings at Ulery Greenhouse in Springfield, according to the recommended starting dates. They were planted in the plots on May 26, 2004. There were six plants of each variety in a row, spaced 1.5' apart; and rows were spaced 2' apart. Trailing or vining plants were spaced 2' apart with 4' between rows. Osmocote™ (14-14-14) was soil-incorporated prior to planting at the labeled rate. Beds were hand weeded as needed throughout the season.

Irrigation was applied during dry periods so that plants received at least 1" of water per week. (See the weather information section and Table 1 for details.) No additional applications of fertilizer were made. The plants were not deadheaded or pruned during the growing season. No insecticides or fungicides were applied. No mulch was used; volunteers weeded the plots as needed. Plants were grown in full sun, unless otherwise indicated. (Note, the plants in bold type in Table 2 were

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those in the shade house). The material for the shade house provided 75% shade.

Three people conducted visual evaluations in June, July, August, and September (2004 was the first year that September was added to the evaluation dates). The entire row was given a visual rating from 1 to 5. A rating of 5 was considered to be excellent, and a rating of 1 was considered poor.

If there were fewer than three plants remaining in one row at any time during the evaluation, the variety was dropped from the trials. The three individual evaluation ratings were averaged for the monthly rating figure. Then, the monthly evaluations (June-September) were averaged for the overall rating for each variety.

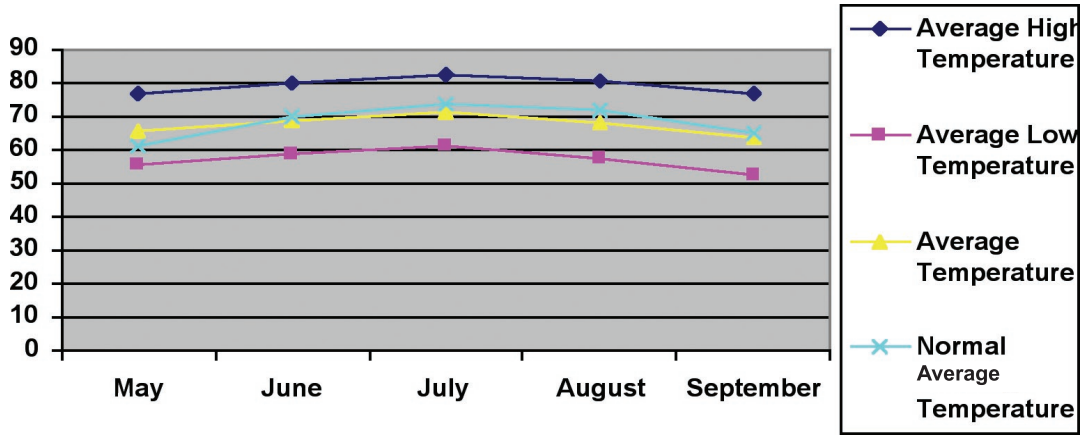
Weather Information

Precipitation for May was above average, while temperatures were slightly below normal. However, despite wet soil conditions during most of the month, the annuals were planted under good soil conditions. Temperatures were below normal in June, July, and August. There were no days above 90ºF this season, compared to three days above 90ºF last year and 30 days in 2002.

Supplemental irrigation was applied as needed in order to provide 1" of water per week. Weather conditions for this growing season as well as normal average temperatures and precipitation are shown in Table 1. Most plants were slow to establish after planting due to cool wet weather. In addition, some plants were lost due to too much rain.

Table 1. Weather Conditions for the 2004 Growing Season, Clark County.

Temperature	May	June	July	August	Sept.
Average high temperature F°	76.8	79.9	82.5	80.4	76.6
Average low temperature F°	55.7	58.8	61.4	57.4	52.8
Average temperature F°	65.7	69.0	71.5	68.2	64.0
Normal average temperature F°	61.3	70.3	73.8	72.0	65.2
Precipitation					
Normal average rainfall (inches)	4.59	4.16	4.08	3.50	2.99
Rainfall, 2004 (inches)	7.08	3.50	4.47	3.00	1.00
Days over 90°F, 2004	0	0	0	0	0



Results

The varieties in the Clark County 2004 field trials and their monthly ratings and overall rating are shown in Table 2. Varieties are listed in order from highest Overall Rating to lowest Overall Rating. A rating of 5 is the highest; a rating of 1 is the lowest. The plants listed in bold type are those varieties that were grown under the shade structure (75% shade cloth).

The supplier for each annual is listed in the table. The supplier key is at the end of the table. The plants are listed in order of Overall Rating from highest to lowest.

Table 2. Clark County 2004 Field Trial Ratings.

Plant	Series	Cultivar Name	Source	June	July	August	Sept	Overall Rating
Petunia	Surfinia®	Baby Purple	JP	4.67	5.00	5.00	5.00	4.92
Petunia	Supertunia®	Silver	PW	4.33	5.00	5.00	5.00	4.83
Petunia	Surfinia®	Baby White Compact	JP	4.33	5.00	5.00	5.00	4.83
Eragrostis		Wind Dancer™	PAS	4.33	5.00	5.00	5.00	4.83
Ageratum	Artist™	Alto Blue	PW	4.33	5.00	5.00	4.67	4.75
Coleus		**Chocolate Drop**	**PW**	**4.00**	**5.00**	**5.00**	**5.00**	**4.75**
Coleus	**Aurora**	**Black Cherry**	**BFP**	**4.00**	**5.00**	**5.00**	**5.00**	**4.75**
Euphorbia		Diamond Frost	PW	4.00	5.00	5.00	5.00	4.75
Coleus	**Stained Glassworks**	**Swiss Sunshine**	**PE**	**4.00**	**5.00**	**4.67**	**5.00**	**4.67**
Coleus	**Stained Glassworks**	**Kiwi Fern**	**PE**	**4.00**	**5.00**	**5.00**	**4.67**	**4.67**
Coleus		**Brown Sugar**	**PW**	**4.00**	**5.00**	**5.00**	**4.67**	**4.67**
Coleus	**Aurora**	**Peach**	**BFP**	**4.00**	**5.00**	**5.00**	**4.67**	**4.67**
Coleus	**Kong™**	**Rose**	**BS**	**4.00**	**5.00**	**5.00**	**4.67**	**4.67**
Petunia	Supertunia®	Silver	PW	4.00	5.00	5.00	4.67	4.67
Angelonia	AngelMist®	Lavendar Stripe	BFP	3.67	5.00	5.00	5.00	4.67
Angelonia	AngelMist®	White Improved	BFP	3.67	5.00	5.00	5.00	4.67
Petunia	Surfinia®	Lavendar Lace	JP	4.33	5.00	5.00	4.33	4.67
Petunia	Supertunia®	Bordeaux	PW	4.33	5.00	5.00	4.33	4.67
Angelonia	Angelface™	Blue Bicolor	PW	3.33	5.00	5.00	5.00	4.58
Coleus	**Stained Glassworks**	**Tilt-A-Whirl**	**PE**	**4.00**	**5.00**	**4.67**	**4.67**	**4.58**
Coleus		**Sedona**	**PW**	**4.00**	**5.00**	**5.00**	**4.33**	**4.58**
Coleus	**Kong™**	**Scarlet**	**BS**	**4.00**	**5.00**	**5.00**	**4.33**	**4.58**
Coleus	**Kong™**	**Red**	**BS**	**4.00**	**5.00**	**5.00**	**4.33**	**4.58**
Petunia	Surfinia®	Sugar Plum	JP	3.67	5.00	5.00	4.67	4.58

Table 2 (continued). Clark County 2004 Field Trial Ratings.								
Plant	**Series**	**Cultivar Name**	**Source**	**June**	**July**	**August**	**Sept**	**Overall Rating**
Calibrachoa	Superbells®	White	PW	3.67	5.00	4.67	4.67	4.50
Coleus		**Strawberry Drop**	**PW**	**3.67**	**5.00**	**4.67**	**4.67**	**4.50**
Dbl. Impatiens	**Fiesta™**	**Sparkler Cherry**	**BFP**	**4.00**	**5.00**	**5.00**	**4.00**	**4.50**
Dbl. Impatiens	**Fiesta™**	**Rose**	**BFP**	**3.67**	**4.67**	**4.67**	**5.00**	**4.50**
NG Impatiens	**Celebrette**	**Lavendar**	**BFP**	**3.00**	**5.00**	**5.00**	**5.00**	**4.50**
NG Impatiens	**Infinity™**	**Pink**	**PW**	**3.00**	**5.00**	**5.00**	**5.00**	**4.50**
Petunia	Surfinia®	Baby Purple Compact	JP	3.67	5.00	5.00	4.33	4.50
Petunia	Surfinia®	Baby Blue Compact	JP	4.33	5.00	5.00	3.67	4.50
Ageratum	Artist™	Purple	PW	3.67	4.67	5.00	4.33	4.42
Coleus	**Aurora**	**Raspberry**	**BFP**	**4.00**	**5.00**	**4.67**	**4.00**	**4.42**
NG Impatiens	**Celebration**	**Rose Star**	**BFP**	**3.00**	**5.00**	**5.00**	**4.67**	**4.42**
NG Impatiens	**Infinity™**	**Dark Salmon Glow**	**PW**	**3.00**	**4.67**	**5.00**	**5.00**	**4.42**
Verbena	Aztec®	Red Velvet	BFP	4.00	4.67	4.67	4.33	4.42
Ageratum	Exp. 0059-1	Pink	PE	3.67	5.00	4.67	4.33	4.42
Angelonia	Angelface™	Blue	PW	2.67	5.00	5.00	5.00	4.42
Dbl. Impatiens	**Fiesta™**	**Salsa Red Imp.**	**BFP**	**4.00**	**4.33**	**5.00**	**4.33**	**4.42**
Mecardonia		Gold Flake™	PW	2.67	5.00	5.00	5.00	4.42
Tr. Impatiens	**Fanfare™**	**Orange**	**BFP**	**3.00**	**5.00**	**4.67**	**4.67**	**4.33**
NG Impatiens	**Celebration**	**Deep Red**	**BFP**	**2.67**	**5.00**	**5.00**	**4.67**	**4.33**
NG Impatiens	**Celebrette**	**Red**	**BFP**	**3.00**	**5.00**	**5.00**	**4.33**	**4.33**
Petunia	Surfinia®	Rose Veined	JP	3.67	5.00	5.00	3.67	4.33
Lantana	Landmark™	Gold	BFP	3.00	5.00	4.33	5.00	4.33
Ageratum	Exp. 8501-5	Burgundy	PE	4.00	4.33	5.00	3.67	4.25
Angelonia	Angelface™	White	PW	4.00	4.33	4.67	4.00	4.25
Lobelia	**Laguna™**	**Compact Blue/Eye**	**PW**	**4.00**	**4.67**	**4.33**	**4.00**	**4.25**
Tr. Impatiens	**Fanfare™**	**Blush**	**BFP**	**3.67**	**4.67**	**4.67**	**4.00**	**4.25**
Mini Impatiens	**Pixie™**	**Pink Bicolor**	**BFP**	**4.33**	**3.67**	**5.00**	**4.00**	**4.25**
NG Impatiens	**Celebrette**	**Orchid**	**BFP**	**3.00**	**5.00**	**4.67**	**4.33**	**4.25**
NG Impatiens	**Infinity™**	**Orange Frost**	**PW**	**3.00**	**5.00**	**4.33**	**4.67**	**4.25**

Table 2 (continued). Clark County 2004 Field Trial Ratings.								
Plant	**Series**	**Cultivar Name**	**Source**	**June**	**July**	**August**	**Sept**	**Overall Rating**
NG Impatiens	**Infinity™**	**Lilac**	**PW**	**2.67**	**4.67**	**4.67**	**5.00**	**4.25**
Lantana	Landmark™	Flame Improved	BFP	2.67	4.67	5.00	4.67	4.25
Phlox	Intensia®	Lilac Rose	PW	4.33	5.00	4.33	3.33	4.25
NG Impatiens	**Infinity™**	**Dark Pink**	**PW**	**2.67**	**4.67**	**5.00**	**4.33**	**4.17**
NG Impatiens	**Infinity™**	**Cherry Red**	**PW**	**3.33**	**4.67**	**4.67**	**4.00**	**4.17**
NG Impatiens	**Infinity**	**Scarlet**	**PW**	**3.00**	**4.00**	**5.00**	**4.67**	**4.17**
Plectranthus		Silver Shield™	PAS	2.33	4.67	5.00	4.67	4.17
Geranium	Shady Lady	Cherry Rose	PW	3.00	4.67	4.67	4.33	4.17
Ageratum	Exp.8009-1	White	PE	3.67	5.00	4.67	3.33	4.17
Geranium	Fireworks™	Cherry	PW	3.67	5.00	3.67	4.33	4.17
Begonia		BabyWing Pink	PAS	1.67	4.67	5.00	5.00	4.08
Geranium		Pink Illusion	PW	2.33	4.67	4.67	4.67	4.08
Gaillardia	Torch™	Red Ember	BFP	4.00	4.67	3.67	4.00	4.08
Nemesia	**Aroma-tica™**	**Deep Blue**	**BFP**	**4.33**	**4.33**	**4.33**	**3.33**	**4.08**
NG Impatiens	**Infinity™**	**Light Purple**	**PW**	**3.33**	**4.67**	**4.00**	**4.33**	**4.08**
Phlox	Intensia®	Lavendar Glow	PW	4.33	4.67	4.00	3.33	4.08
Geranium	Shady Lady	Rose Pink	PW	4.00	4.00	4.33	4.00	4.08
Brachys-come		Blue Zephyr	PW	4.00	5.00	4.67	2.33	4.00
Nemesia		**Compact Pink Innocense**	**PW**	**4.33**	**4.67**	**4.67**	**2.33**	**4.00**
NG Impatiens	**Java**	**White Improved**	**PAS**	**2.67**	**4.67**	**4.67**	**4.00**	**4.00**
NG Impatiens	**Infinity™**	**White**	**PW**	**2.67**	**4.33**	**4.67**	**4.33**	**4.00**
Verbena	Tapiens	Lilac	JP	2.67	4.67	3.67	5.00	4.00
Mini Impatiens	**Pixie™**	**Double Purple**	**BFP**	**3.67**	**4.33**	**4.33**	**3.67**	**4.00**
Petunia	Surfinia®	Patio Blue	JP	4.33	5.00	4.33	2.33	4.00
Vinca	Pacificia	Punch Halo	PAS	3.00	4.33	5.00	3.67	4.00
NG Impatiens	**Celebrette**	**Purple Improved**	**BFP**	**3.00**	**5.00**	**3.33**	**4.33**	**3.92**
Verbena	Aztec®	Magic Purple	BFP	2.67	4.33	4.00	4.67	3.92
Phlox	Intensia®	Neon Pink	PW	3.67	4.67	4.00	3.33	3.92
Geranium	Shady Lady	Violet Rose	PW	2.67	4.33	4.67	4.00	3.92
Bracteantha	Sundaze™	Flame	PW	3.67	3.67	4.33	4.00	3.92

Table 2 (continued). Clark County 2004 Field Trial Ratings.								
Plant	**Series**	**Cultivar Name**	**Source**	**June**	**July**	**August**	**Sept**	**Overall Rating**
Dbl. Impatiens	**Fiesta™**	**Purple Pinata**	**BFP**	**3.67**	**4.00**	**4.00**	**4.00**	**3.92**
Torenia	**Catalina™**	**Blue**	**PW**	**4.00**	**3.67**	**4.67**	**3.33**	**3.92**
Vinca	Pacificia	Magenta Halo	PAS	3.00	4.33	4.67	3.67	3.92
Petunia	Ruffle™	Double Pink Imp.	BFP	4.33	4.33	3.67	3.33	3.92
Coreopsis grandiflora		Rising Sun	PAS	3.00	4.67	4.00	3.67	3.83
Lobelia	**Laguna™**	**Sky Blue**	**PW**	**4.67**	**4.33**	**4.00**	**2.33**	**3.83**
NG Impatiens	**Infinity™**	**Red**	**PW**	**3.33**	**4.00**	**4.33**	**3.67**	**3.83**
Torenia	**Summer Wave™**	**Amethyst**	**PW**	**3.33**	**4.00**	**4.00**	**4.00**	**3.83**
Petunia	Surfinia®	Patio Yellow	JP	4.00	4.67	4.33	2.33	3.83
Torenia	**Summer Wave™**	**Lavendar Blue**	**JP**	**3.67**	**3.67**	**4.00**	**4.00**	**3.83**
Satureja hybrid		Pink Sensation	PW	3.33	4.33	4.00	3.67	3.83
Geranium	Shady Lady	Orange	PW	2.67	3.67	4.67	4.33	3.83
Dbl. Impatiens	**Fiesta™ Olé**	**Purple**	**BFP**	**3.33**	**3.67**	**4.00**	**4.00**	**3.75**
Dbl. Impatiens	**Fiesta™ Olé**	**Peppermint**	**BFP**	**3.00**	**4.00**	**4.00**	**4.00**	**3.75**
NG Impatiens	**Infinity™**	**Orange**	**PW**	**2.67**	**5.00**	**3.33**	**4.00**	**3.75**
NG Impatiens	**Infinity™**	**Lavendar**	**PW**	**3.33**	**4.00**	**3.67**	**4.00**	**3.75**
NG Impatiens	**Infinity™**	**Salmon**	**PW**	**3.00**	**4.00**	**4.00**	**4.00**	**3.75**
Verbena	Tapiens	Lavendar Pink	JP	2.33	4.33	3.33	5.00	3.75
Geranium	BullsEye	Scarlet	BS	2.33	4.00	4.33	4.33	3.75
Petunia	Dreams	Burgundy Picotee	PAS	2.33	4.67	4.33	3.67	3.75
Gaura		Karalee Petite Pink	PW	2.67	3.67	5.00	3.67	3.75
Petunia	Easy Wave™	Blue	PAS	1.00	4.33	4.67	4.67	3.67
Petunia	Bravo	Apple-blossum	SG	3.33	4.00	4.00	3.33	3.67
Geranium	BullsEye	Salmon	BS	2.00	3.67	4.33	4.67	3.67
Gaura	Ballerina™	Rose	BFP	3.00	3.33	5.00	3.33	3.67
Verbena	Aztec®	Wild Rose	BFP	4.00	3.67	3.67	3.33	3.67
Morning glory		Sunrise Serenade	BS	2.00	3.00	4.67	4.67	3.58
Petunia	Surfinia®	Baby Pink Compact	JP	3.67	4.33	4.00	2.33	3.58
Calibrachoa	Superbells™	Pastel Pink	JP	3.33	4.67	2.33	3.67	3.50
NG Impatiens	**Infinity™**	**Pink Frost**	**PW**	**2.67**	**3.67**	**3.67**	**4.00**	**3.50**

Table 2 (continued). Clark County 2004 Field Trial Ratings.								
Plant	**Series**	**Cultivar Name**	**Source**	**June**	**July**	**August**	**Sept**	**Overall Rating**
NG Impatiens	**Infinity™**	**Blushing Lilac**	**PW**	**3.00**	**4.00**	**3.67**	**3.33**	**3.50**
NG Impatiens	**Infinity™**	**Pink Kiss**	**PW**	**3.67**	**4.00**	**3.33**	**3.00**	**3.50**
Torenia	**Catalina™**	**Pink**	**PW**	**3.67**	**3.67**	**3.67**	**3.00**	**3.50**
Thunbergia	Sunny™	Lemon Star	BFP	2.00	3.67	4.33	4.00	3.50
Verbena canadensis		Toronto Silver-Pink	K	2.67	4.33	3.33	3.33	3.42
Petunia	Bravo	Blue Veined	SG	3.67	4.67	3.33	2.00	3.42
Stachys coccinea		Chinook	K	2.67	4.00	3.67	3.33	3.42
Scoparia		Melon-golly™ Blue	PW	3.00	4.00	4.33	2.33	3.42
Achillea mille- folium		Summer Berries	S	1.67	3.67	4.00	4.33	3.42
Argyran-themum		Butterfly™	PW	2.33	5.00	4.00	2.00	3.33
Argyran-themum		Vanilla Butterfly™	PW	3.67	4.67	4.00	1.00	3.33
Nemesia	**Safari**	**Violet Rose**	**PW**	**3.33**	**4.67**	**4.00**	**1.33**	**3.33**
Portulaca	Margarita	Peppermint	PAS	2.67	4.67	4.33	1.67	3.33
Scaevola	Whirl-wind™	White	PW	2.33	3.00	3.00	4.67	3.25
Petunia	Bravo	Purple Star	SG	3.33	4.67	3.00	2.00	3.25
Snapdragon	Crown	Violet	SG	3.00	2.67	4.33	2.67	3.17
Torenia	**Catalina™**	**Purple**	**PW**	**3.00**	**3.33**	**3.33**	**2.67**	**3.08**
Argyran-themum	Sunlight		PE	3.67	3.67	2.67	2.00	3.00
Nemesia	**Sunsatia™**	**Coconut**	**PW**	**3.33**	**4.67**	**2.67**	**1.33**	**3.00**
Petunia	Dbl. Wave™	Purple	BFP	2.67	3.67	2.67	3.00	3.00
Bracteantha	Outback	Wallaby Orange Blaze	PE	2.67	3.00	3.67	2.67	3.00
Argyran-themum	Madeira	San Martino	BFP	2.00	3.00	2.67	4.00	2.92
Celosia plumosa	Exp. Ice Cream	Peach	K	2.33	2.33	3.33	3.67	2.92
Delphinium grandi-florum		Atlantic Blue	S	1.67	4.33	3.00	2.67	2.92
Nemesia	**Sunsatia™**	**Peach**	**PW**	**2.67**	**3.00**	**4.00**	**2.00**	**2.92**
Petunia	Dbl. Cascade	Blue	PAS	2.33	3.67	3.00	2.67	2.92
Calibrachoa	Superbells®	Light Pink	PW	2.00	3.67	3.33	2.33	2.83
Celosia plumosa	Exp. Ice Cream	Orange	K	3.00	2.67	3.00	2.67	2.83
Petunia	Dbl. Wave™	White	TW	2.33	2.67	2.67	3.67	2.83

Table 2 (continued). Clark County 2004 Field Trial Ratings.								
Plant	**Series**	**Cultivar Name**	**Source**	**June**	**July**	**August**	**Sept**	**Overall Rating**
Oenothera		Lemon Drop™	PW	3.00	3.33	2.33	2.33	2.75
Phlox sp	21st Century	Rose Star	PAS	2.00	3.67	3.00	2.33	2.75
Petunia	Surfinia®	Patio White	JP	3.00	4.00	3.67	0.00	2.67
Verbena x *hybrida*	Quartz	Silver	PAS	2.33	3.67	2.67	2.00	2.67
Geranium	Black Velvet	Scarlet	S	1.33	2.67	3.67	3.00	2.67
Petunia	Surfinia®	Victorian Cream	JP	2.67	3.33	2.33	2.00	2.58
Dianthus	Dynasty	Rose Lace	BS	2.67	4.33	1.67	1.33	2.50
Dianthus	Garden Spice®	Fuschia	TW	3.33	5.00	1.33	0.00	2.42
Celosia plumosa	Exp. Ice Cream	Cherry	K	2.33	2.00	2.33	2.67	2.33
Celosia plumosa	Exp. Ice Cream	Mango	K	2.67	2.67	2.33	1.67	2.33
Bracteantha	Dream-time™	Jumbo Yellow	BFP	3.00	1.67	1.67	2.67	2.25
Dianthus	Garden Spice®	Red	TW	3.67	4.00	1.33	Dead	2.25
Dianthus	Garden Spice®	Pink	TW	3.33	4.00	1.33	Dead	2.17
Snapdragon	Crown	Orange Bicolor	SG	3.00	2.00	2.33	1.33	2.17
Calibrachoa	Superbells®	Red	PW	3.00	2.67	1.67	1.33	2.17
Viola	**Rocky**	**Lavendar Blush**	**SG**	**2.00**	**3.67**	**2.67**	**Dead**	**2.08**
Celosia plumosa	Exp. Ice Cream	Banana	K	1.67	2.33	2.00	2.00	2.00
Lavendula stoechas		Sancho Panza	S	1.67	2.33	2.33	1.67	2.00
Snapdragon	Montego	Fire Mix	SG	3.67	2.33	1.67	Dead	1.92
Nemesia	**Sunsatia™**	**Banana**	**PW**	**4.00**	**3.67**	**0.00**	**Dead**	**1.92**
Celosia argentea	Glow	Pink	PAS	2.33	2.33	1.67	1.00	1.83
Scaevola	Whirl-wind™	Blue	PW	2.00	3.33	2.00	Dead	1.83
Petunia	Surfinia®	Victorian Pearl	JP	3.00	2.33	1.33	0.67	1.83
Lavendula stoechas		Purple Ribbon	K	1.67	2.00	1.67	1.67	1.75
Viola	**Rocky**	**Pure Orange**	**SG**	**2.00**	**2.33**	**2.67**	**Dead**	**1.75**
Petunia	Surfinia®	Baby Yellow Compact	JP	1.00	1.33	1.67	3.00	1.75
Snapdragon	Montego	Bronze	SG	2.67	2.00	1.67	0.67	1.75
Viola	Rocky	Cream/ Yellow Eye	SG	2.00	2.67	1.67	Dead	1.58

Table 2 (continued). Clark County 2004 Field Trial Ratings.								
Plant	**Series**	**Cultivar Name**	**Source**	**June**	**July**	**August**	**Sept**	**Overall Rating**
Nemesia	**Sunsatia™**	**Lemon**	**PW**	**2.67**	**3.33**	Died after 2nd evaluation		**1.50**
Phlox	Astoria	Cherry Blossom	JP	3.67	2.33			1.50
Petunia	Surfinia®	Red	JP	2.00	3.33			1.33
Diascia	Whisper™	Dark Coral	BFP	3.00	2.33			1.33
Rudbeckia hirta		Morena	K	2.67	2.33			1.25
Nemesia	**Sunsatia™**	**Cranberry**	**PW**	**2.67**	**1.67**			**1.08**
Petunia	Surfinia®	Patio Misty Pink	JP	1.67	2.33			1.00
Calibrachoa	Exp.Calib 1012	Compact Blue	PE	2.00	1.67			0.92
Gypsophila		Festival Star	PW	2.00	1.67			0.92
Phlox	Astoria	White	JP	3.00	0.67			0.92
Felicia	Pinwheel	Snow	BFP	1.67	1.33			0.75
Argyranthemum	Madeira	Santana	BFP	2.67	Died after 1st evaluation.			0.67
Calibrachoa	Superbells®	Blue	PW	2.33				0.58
Argyranthemum	Twinkle	Lavendar	PE	2.00				0.50
Argyranthemum	Madeira	Madelana	BFP	2.00				0.50
Calibrachoa	Million Bells®	Crackling Fire	JP	2.00				0.50
Calibrachoa	Exp. Calib1013	Compact White	PE	1.67				0.42
Celosia plumosa	Exp. Ice Cream	Strawberry	K	1.67				0.42
Argyranthemum	Madeira	Sao Vincente	BFP	1.33				0.33
Viola	**Rocky**	**Blue w Purple Wing**	**SG**	**0.33**	**1.00**	Died after 2nd evaluation.		**0.33**
Penstemom		Lilliput Rose	PW	.1.33	Died after 1st evaluation			0.33
Argyranthemum	Madeira	Camara	BFP	1.00				0.25
Calibrachoa	Colorburst	Violet	PE	1.00				0.25
Calibrachoa	Exp.1011	Compact Rose	PE	1.00				0.25
Lobularia maritima	Aphrodite	Dark Mixture	S	1.00				0.25
Argyranthemum	Comet	Pink	PE	All died due to wet conditions in the early part of the season. Were dead before the first evaluation.				0.00
Argyranthemum	Comet	White Imp.	PE					0.00
Gerbera	Sunburst®	Hot Pink	TW					0.00
Gerbera	Sunburst®	Orange	TW					0.00

Table 2 (continued). Clark County 2004 Field Trial Ratings.								
Plant	**Series**	**Cultivar Name**	**Source**	**June**	**July**	**August**	**Sept**	**Overall Rating**
Calibrachoa	Million Bells®	Blush Blue	JP	All died due to wet conditions in the early part of the season. Were dead before the first evaluation.				0.00
Calibrachoa	Million Bells®	Antique Rose	JP					0.00
Salvia roemeriana		Hot Trumpets	K					0.00
Osteo-spermum	Serenity™	White	BFP					0.00
Osteo-spermum	Soprano™	White	PW					0.00
Osteo-spermum	Soprano™	Purple	PW					0.00
Osteo-spermum	Soprano™	Light Purple	PW					0.00
Dorothe-anthus bellidi-formis	Gelato	Formula Mix	K					0.00

NG = New Guinea *Impatiens*
Dbl = Double
Exp = Experimental
Tr = Trailing
Imp = Improved

Acknowledgment

Ohio State University Extension and the Clark County Master Gardener volunteers would like to thank the following for their support:

Clark County Engineers, Springfield Township, Clark County Fairgrounds staff, Clark County Commissioners, and the companies listed here who participated in the trials.

Suppliers:

BFP — Ball FloraPlant
http://ballhort.com

BS — BallSeed Company
http://ballhort.com

JP — Jackson & Perkins Wholesale
http://www.surfinia.com/

K — Kieft
http://www.kieftseeds.com/

PAS — PanAmerican Seed
http://www.panamseed.com/

PE — Paul Ecke
http://www.theflowerfields.com/FFA/

PW — Proven Winners
http://provenwinners.com/

S — Sahin
http://www.sahin.nl/

SG — Syngenta Seeds, Inc.
http://www.sg-flowers-us.com/

TW — Twyford International
http://twyford.com

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Results of Herbaceous Annual Plant Trial Gardens at the Cincinnati Zoo and Botanical Garden, 2004

David E. Dyke and Steve Foltz

Ohio State University Extension - Hamilton County, the Cincinnati Zoo and Botanical Garden (CZ&BG), and the Cincinnati Flower Growers Association (CFGA) collaborated on demonstration/trial gardens at the CZ&BG in 2004. This was the third year of these collaborative trials.

The gardens were designed by Steve Foltz. Participating seed companies included Pan American Seed Co., Ball Floral, and Proven Winners. These companies provided plugs or seeds, which were then grown in 4-inch pots or flats by members of CFGA and by the CZ&BG. More than 13,000 plants of 150 varieties were planted for the trials. All varieties in the trials were labeled for easy identification for the 1.2 million visitors to the Zoo in 2004.

Three goals were set for the gardens. The first was to evaluate herbaceous annuals on the basis of quality and performance as seen in the late summer in order to determine which should be recommended for planting in area gardens.

The second was to provide the general public and commercial growers and landscapers an opportunity to observe many varieties of the latest, yet fairly well-proven, annuals available that were professionally grown in attractive garden settings (including in planters).

The third was to promote those annuals that performed well enough to be recommended for planting in area gardens.

Plants were planted in beds that were tilled with minimal compost added. Most beds were equipped with an automatic irrigation system. Those that were not were irrigated with a temporary spray stake system.

A liquid feed fertilization program was used, consisting of fertilizing with a balanced fertilizer at planting and then at two-week intervals until good color was maintained, then as necessary to maintain good color. No pesticides were used.

Plants were evaluated by members of the organizations involved in the trials on July 8 and August 20. All plants were evaluated on a scale from 1 to 5, in which 1 = poor, 2 = fair, 3 = good, 4 = very good, and 5 = excellent. Plants were rated on overall appearance. Factors considered included plant health (including insect and disease damage), color, presence, and vigor. Plants that rated poor were taken off the evaluation list.

The weather was generally favorable for good plant growth throughout the

David Dyke, Ohio State University Extension, Hamilton County; and Steve Foltz, Director of Horticulture, Cincinnati Zoo and Botanical Garden, Cincinnati, Ohio.

2004 growing season. However, some quite unusual growing challenges were encountered, including peacocks, ducks, and rabbits walking through the beds and/or eating plants. Also, more than a million people were walking by the beds — and sometimes not staying on the path. Therefore, some plants in the trials that did not make the recommended list may be quite good for the area but were removed from the trials due to one or more of the problems cited here.

The Top Picks of 2004 are listed here. These were outstanding plants that provided high impact with minimal effort. The additional annuals of note were also excellent plants that should be recommended for planting in the home landscape.

Top Picks of the Zoo's Annual Trials, 2004

Coleus 'Freckles'
Coleus 'Cranmore' and 'Religious Radish'
Coleus 'Dipt in Wine'
Impatiens Infinity™ Series 'Cherry Red' and 'Pink Kiss'
Impatiens Fanciful™ 'Mix Hawaiian' and 'Salsa'
Zinnia angustifolia 'Star White'
Angelonia Angelface™ 'Blue'
Lantana Patriot™ Classic™ Firewagon
Ipomoea batatas 'Black Heart'
Scaevola New Wonder®

Additional Annuals of Note, Zoo's Annual Trials 2004

Coleus 'Felix'
Coleus 'Saturn'
Coleus 'Amora'
Coleus 'Sunset'
Phlox Intensia™ 'Lavender Glow,' 'Lilac Rose,' 'Neon Pink'
New Guinea *Impatiens* 'Celebrette Hot Pink'
New Guinea *Impatiens* 'Celebrette Orchid Star'
New Guinea *Impatiens* Fiesta™ 'Appleblossom'
New Guinea *Impatiens* Fiesta™ 'Burgundy Rose Double'
Spilanthes 'Peek-a-Boo'
Canna 'Red Stripe'
Ipomoea Tricolor (Sweet Potato Vine)
Impatiens Showstopper Series
Angelonia Angelmist™ 'Orchid'
Plectranthus 'Nicolletta'
Black-Eyed Susan Vine
Hyacinth Bean

New trial gardens are planned for 2005.

For more information, contact Steve Foltz at the Cincinnati Zoo and Botanical Garden, Horticulture Department, at 513-475-6106 or Dave Dyke at 513-505-1202.

More Annual Trial information (including results of the last two years) can be found at **www.cincinnatizoo.org** and in *Ornamental Plants: Annual Reports and Research Reviews, 2003,* Special Circular 193, pp: 121–129 and at **www.ohioline.osu.edu.**

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Apple Scab on Crabapple at Secrest Arboretum: 2004

Erik A. Draper, James A. Chatfield, Daniel A. Herms, and Kenneth D. Cochran

Introduction

Apple scab pressure was high at the Secrest Arboretum of the Ohio State University's Ohio Agricultural Research and Development Center in 2004, as wet spring and early summer weather provided multiple infection periods for the *Venturia inaequalis* pathogen. Yet, even under this considerable disease pressure, 24 of the 64 taxa showed no evidence of apple scab in 2004, and a total of 30 never received a rating that exceeded 1 (no aesthetic impact) on any evaluation date. Nineteen taxa received a rating of 3 or higher on at least one date in 2004, indicating substantial defoliation and aesthetic impact (Table 1).

Materials and Methods

Sixty-three crabapple taxa were planted in 1997-1998 at OARDC's Secrest Arboretum in Wooster, Ohio, in a completely randomized design. One taxon, 'Cardinal,' was planted in 2003. There are five replicate plants for most but not all taxa, though fewer replicates exist currently due to a variety of factors, including inadequate original numbers (*e.g.*, 'Hamlet'), death due to fireblight (*e.g.*, 'Golden Raindrops'), and other attrition such as deer damage.

Plants are mulched with composted yard waste and were irrigated as needed during the year of transplanting. Weeds are controlled with spot applications of glyphosate. On June 9, July 16, and August 18, 2004, all trees were rated on a scale of 0 to 5, with 0 = no scab observed; 1 = less than 5% of leaves affected and no aesthetic impact; 2 = 5 to 20% of leaves affected, with some yellowing but little or no defoliation, moderate aesthetic impact; 3 = 20 to 50% of leaves affected, significant defoliation and/or leaf yellowing, substantial aesthetic impact; 4 = 50 to 80% of leaves affected, severe foliar discoloration and defoliation, severe aesthetic impact; and 5 = 80 to 100% of foliage affected, with 90 to 100% defoliation.

Results and Discussion

Results of the 2004 trials are presented in Table 1.

1. Despite significant scab pressure (19 taxa with apple scab ratings indicating significant symptoms and aesthetic effects), more than 1/3 of the crabapple taxa at Secrest Arboretum exhibited

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no scab for the 2004 season. This provides horticulturists with many crabapple selections with excellent scab resistance, from pink-flowered weepers ('Louisa') to white-flowered dwarfs *(Malus sargentii),* from golden-fruited crabapples ('Holiday Gold') to red-fruited trees ('Red Jewel').

2. Results over the past several years show that, for some taxa, scab incidence is changing, presumably due to the development of new races of the *Venturia inaequalis* pathogen.

   Apple scab was not observed on 'Prairifire' crabapple for several decades at Secrest until 2000 and 2001 when it first was noted, though at very low levels. Now in 2004, scab on 'Prairifire' is more noticeable, with its rating of 2 indicating moderate aesthetic impact on all replicates for the first time.

   Scab was found on 'Bob White' in 2004 for the first time, though only on one replicate and only to a minor extent.

3. Bacterial fireblight incidence at Secrest was low in 2004, presumably due to lower temperatures during bloom than in the peak fireblight years of 2001-2002. It was a problem on fireblight-sensitive taxa such as 'Silver Moon' and 'Golden Raindrops.' Cedar rusts have not been significant on crabapples at Secrest in the past, and this year was no exception, except for moderate rust levels on 'Calloway' and 'Brandywine.'

Table 1. Apple Scab at Secrest Arboretum in Wooster, Ohio, in 2004.

Crabapple Taxon	Aug 18	Jul 16	Jun 9	No. of Reps
'Adirondack'	0.00	0.00	0.00	5
'Callaway'	0.00	0.00	0.00	4
'Camelot'	0.00	0.00	0.00	5
'Canterbury'	0.00	0.00	0.00	4
'Cardinal'	0.00	0.00	0.00	3
'Cinderella'	0.00	0.00	0.00	4
'Dolgo'	0.00	0.00	0.00	5
'Excalibur'	0.00	0.00	0.00	4
'Firebird'	0.00	0.00	0.00	5
'Foxfire'	0.00	0.00	0.00	5
'Golden Raindrops'	0.00	0.00	0.00	2
'Hamlet'	0.00	0.00	0.00	2
'Holiday Gold'	0.00	0.00	0.00	5
'Jackii'	0.00	0.00	0.00	5
'Lancelot'	0.00	0.00	0.00	5
'Lollipop'	0.00	0.00	0.00	5
'Louisa'	0.00	0.00	0.00	5
'Prairie Maid'	0.00	0.00	0.20	5
'Rawhide'	0.00	0.00	0.00	4
'Red Jewel'	0.00	0.00	0.00	5

Table 1 (continuted). Apple Scab at Secrest Arboretum in Wooster, Ohio, in 2004.				
Crabapple Taxon	**Aug 18**	**Jul 16**	**Jun 9**	**No. of Reps**
M. sargentii	0.00	0.00	0.00	5
'Silver Moon'	0.00	0.00	0.00	4
'Sinai Fire'	0.00	0.00	0.00	5
'Strawberry Parfait'	0.00	0.00	0.00	4
'Tina'	0.00	0.00	0.00	5
'Guinevere'	0.20	0.20	0.20	5
'Bob White'	0.40	0.40	0.60	4
'King Arthur'	0.50	0.00	0.00	2
'Brandywine'	1.00	1.00	1.00	4
'David'	1.00	1.00	1.00	4
'Candymint'	1.40	1.00	0.40	5
'Purple Prince'	1.40	1.00	0.80	5
'Pink Princess'	1.50	1.00	0.50	3
'Coralburst'	2.00	2.00	1.00	5
'Manbeck Weeper'	2.00	1.50	1.50	5
'Mary Potter'	2.00	1.00	0.75	4
'Prairifire'	2.00	1.60	0.80	5
'Professor Sprenger'	2.00	1.50	1.25	4
'Red Jade'	2.20	2.40	1.00	4
'Silver Drift'	2.20	2.00	1.00	5
'Sugar Tyme'	2.20	2.00	1.00	5
'Doubloons'	2.40	2.00	1.00	5
'Molten Lava'	2.40	2.00	1.00	5
'American Salute'	2.80	1.80	0.80	5
'Canary'	2.80	2.00	1.60	5
'Harvest Gold'	2.80	3.00	2.80	5
'Adams'	3.00	3.00	2.60	5
'Donald Wyman'	3.00	2.00	1.80	5
'Red Splendor'	3.00	2.40	1.00	5
'Sentinel'	3.00	2.00	1.00	5
'Jewelberry'	3.50	3.00	1.50	4
'Royal Fountain'	3.60	2.80	1.80	5
'Indian Magic'	3.75	3.00	2.75	4
'Spring Snow'	4.00	2.80	2.00	5
'Snowdrift'	4.00	3.40	2.80	5
'White Cascade'	4.00	3.00	3.00	5
M. floribunda	4.20	3.20	3.00	5

Table 1 (continuted). Apple Scab at Secrest Arboretum in Wooster, Ohio, in 2004.				
Crabapple Taxon	**Aug 18**	**Jul 16**	**Jun 9**	**No. of Reps**
'Weeping Candied Apple'	4.20	4.00	3.00	5
'American Spirit'	4.25	3.00	2.00	4
'Thunderchild'	4.60	3.60	3.00	5
'Royal Scepter'	4.75	3.20	2.00	5
'American Masterpiece'	4.80	4.00	3.00	5
'Pink Satin'	4.80	4.00	2.40	5
'American Triumph'	4.80	3.40	2.40	5

* 0 = no scab observed; 1 = less than 5% of leaves affected and no aesthetic impact; 2 = 5 to 20% of leaves affected, with some yellowing but little or no defoliation, moderate aesthetic impact; 3 = 20 to 50% of leaves affected, significant defoliation and/or leaf yellowing, substantial aesthetic impact; 4 = 50 to 80% of leaves affected, severe foliar discoloration and defoliation, severe aesthetic impact; and 5 = 80 to 100% of foliage affected, with 90 to 100% defoliation.

** Means in a column with the same letter are not significantly different (LSD test, $p<0.05$).

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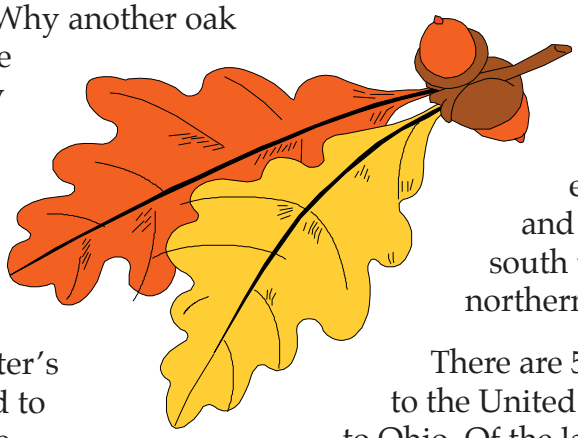
How Mighty Is the Oak: Oaks for the Midwest Landscape

Kenneth D. Cochran

Introduction

The oak genus *Quercus* (family: Fagaceae) has been the subject of numerous publications and presentations through the years. Even acorns, the fruits of oaks, are a household subject, at least in the eastern United States. Why another oak article? To reflect on the science and technology of oak growth and development, on the growing of oaks at The Ohio State University/Ohio Agricultural Research and Development Center's Secrest Arboretum, and to budge the reader to use, preserve, and plant the "mighty oak."



Oaks are valued for sturdy growth, truly large size, and grand character. They often enhance the landscape with staying power for centuries. Approximately 300 species of deciduous and evergreen trees (very few shrubs) constitute the genus. More than 500 oaks have been named, but many have been suggested as being varieties or hybrids and not species. There are 20 important oak tree species in the eastern states.

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Geographically, oaks are widely distributed, though not worldwide in occurrence. They are common across North America, Europe, and Asia. Most species are found in the cool and warm temperate parts of the northern hemisphere, extending as far north as the limits of the deciduous forests. A few species are found at high elevations in the tropics and subtropics, extending south to Cuba, Columbia, northern Africa, and Indonesia.

There are 55 oak species native to the United States and 14 native to Ohio. Of the large, native-Ohio trees, there are twice as many oak species as maple species.

Utilization of Oak

While many mature oak stands have great aesthetic landscape value, many oaks have been noted for their functional use. The chinkapin oak is valued for split rail fences, railroad tie construction, and steamboat fuel. The wood of the white oak is used for furniture, flooring, interior finishing, boat building, and wine and whiskey casks. The wood of red oak, although not as prized as white oak, is used in the manufacture of furniture and flooring. Chestnut oak has a sweet tasting

acorn that is relished by the gray squirrel, black bear, white-tailed deer, and many other forms of wildlife.

Today, oak forests contribute various resources beyond aesthetics such as watershed management, recreation, and wildlife management, as well as trees for the improvement of urban environments. Oak is a component of ecological landscaping with whitetail deer showing a preference for dried oak leaves and with acorns as a great contributor to the welfare of forest wildlife. Stands of pin oak in sites flooded in autumn often serve as feeding grounds for wild ducks that pick the acorns off the bottoms of such temporary lakes or ponds. Since the earliest settlers, oak has been basic to life in America.

Oaks at Secrest Arboretum

There are 23 selections of oaks growing as specimen trees or in forest-type plantings in the Secrest Arboretum. Some trees in the Arboretum remain from native stands and include the following species — white oak, *Quercus alba;* scarlet oak, *Q. coccinea;* shingle oak, *Q. imbricaria;* and black oak, *Q. velutina.* There are more individual oak trees growing natively in the Arboretum than trees of any other genus.

Of all the oaks growing at Secrest, the tree with the greatest diameter is a black oak measuring 57.5" diameter at breast height (DBH), 84' in height, and 66' in width, and a red oak *Q. rubra,* 67.5" DBH and 68' in width. These trees remain from the original mixed hardwood forest of the Arboretum and are in average condition.

The late John E. Ford, Arboretum curator until his retirement in 1984, recorded in 1981 that, in contrast to other oak species in the natural woodlands at Secrest, black oak is mostly past the peak of development and is beginning to decline. A significant black oak at Secrest was struck by lightning in 2004. At this date, it is still surviving, measuring 46.1 DBH, 64' in height, and 72.5' in width.

This may substantiate reports indicating black oak is a relatively short-lived oak, living 150 to 200 years. Some of the black oaks growing in the Arboretum today are second growth from clear cutting of black oak in 1895.

Pin oak, *Q. palustris,* is common in the Arboretum. In fact, more pin oak trees have been planted on OARDC's Wooster Campus than any other oak species. Ford also recorded that this species was showing signs of decline in plantings 60 to 70 years old. He found many trees having decayed wood in butts and boles, with decay fungus fruiting bodies on the trunks. Several such trees are located along Secrest Road.

One of the most significant losses of oak in the Arboretum has been from the infestation over time of the twolined chestnut borer, *Agrilus bilineatus,* in all eight *Q. robur* 'Fastigiata' in the Shade Tree Evaluation Plot. This cultivar with its tall architectural accent has great appeal in the landscape.

Cold Injury

Through the years, willow oak, *Q. phellos;* English oak, *Q. robur;* and sawtooth oak, *Q. acutissima,* have been found not reliably hardy at Secrest. The tops of many of the remaining trees of these three species have been damaged through winter injury (-20°F). These oaks should be more adaptable in southern Ohio.

In the Arboretum nursery, we are currently growing *Q. phellos* from the seed of five large landscape trees growing in Wayne County (survivors of -25°F).

Through this study, we are testing seed of an undetermined geographic origin, but because of the survivability over the last 25-plus years in Wooster, these trees could possibly be a seed source for hardy genetic material. I have been surprisingly pleased to find a few large *Q. phellos* growing in northeastern Ohio and am planning to continue this work of selection for genetic material of known hardiness.

In a limited way, we are evaluating turkey oak, *Q. laevis,* from seed of a northern source. Dr. George Olsen, a recently retired professor of the College of Wooster, favors this oak and has convinced me to try the species in the Arboretum to determine cold hardiness of specific seed sources.

Cold hardiness of oaks can be determined by understanding the climatic conditions of the natural range of the various species. Oak species that have been unable to survive cold temperatures at Secrest include Arkansas oak, *Q. arkansana;* bushes oak, *Q. x bushii;* bluejack oak, *Q. cinerea;* daimyo oak, *Q. dentate;* southern red oak, *Q. falcata;* bear oak, *Q. ilicifolia;* California black oak, *Q. kelloggii;* water oak, *Q. nigra;* and oriental oak, *Q. variabilis.*

While I like to dabble at trying my luck with growing oaks of various regions of the world, I recommend landscape oaks according to known adaptability to the extremes of the region where they will be grown (heat and cold hardiness zones). There is a great amount of truth in the philosophy expressed by the great plantsman Sir Peter Smithers: "I consider every plant hardy until I have killed it myself."

Soil and Drainage

In general, oaks grow and develop best in deep, loamy soil, though they're often found growing in a wide variety of soils. Many of the growing sites in Secrest Arboretum contain a soil stratum composed of silty-clay underlain by clay. While many oaks will grow in these conditions, this type of soil impedes internal drainage (extends soil wetness after precipitation) and soil aeration, and affects the growth of oaks.

Poor internal drainage and soil aeration usually limit the depth to which tree roots penetrate soils and result in reduced tree vigor and possibly death. Some Arboretum species growing under these conditions have developed a shallow root system, and trees have been liable to windfall. While these soil conditions have resulted in wind-fallen trees of conifers, ash, and tuliptree, these conditions have not resulted in wind-fallen oaks. This suggests that even though oaks may have a shallow depth of fine roots in the upper stratum of poorly drained soil, they have sufficient depth of anchor roots to support the tree.

Observations indicate that swamp white oak, *Q. bicolor,* and pin oak, *Q. palustris,* will tolerate wet sites with poor internal drainage better than other oak species. One of the attributes favoring the use of these two species in the landscape is that growth is actually maximized under wet soil conditions.

The moisture requirement of a species is an important environmental factor in optimizing tree growth and development.

Many oaks will not tolerate poor soil drainage (poor soil aeration) but grow best in a moderately moist soil environment. Know the soil requirement of a species before deciding which species to use for a specific site.

Drought is often associated with the decline of oaks, especially when combined with other detrimental factors such as insect defoliation and late-spring frost. It's been reported that bur oak, *Q. macrocarpa,* and chestnut oak, *Q. prinus,* are more tolerant of drought conditions than other oaks. The mean annual precipitation of 37 inches at Secrest Arboretum seems adequate for these species.

Some oaks are specific to an acid or alkaline soil condition. Pin oak requires an acid soil while bur oak and red oak are tolerant of an acid or alkaline soil.

Like many woody plants, oaks are slower in overall growth and weaker in development as favorable conditions of moisture, soil drainage, and sufficient soil depth become limited. The less-favorable conditions are stress conditions that limit the growth and development of some oak species.

Less favorable conditions can be compensated for somewhat during the first few years of establishment with early attention to fertilization and irrigation during prolonged drought, but one has to ask, what are the possibilities for the long term establishment of oaks under local climate and soil conditions?

Construction work around oak trees can lead to oak decline caused by modification of soil sites that will affect root growth and development. Dieback of oak branches is usually associated with root and soil problems and is the start of oak decline. Although the effect of soil site modifications may not be immediate, decline is inevitable when construction work disturbs the root system of oaks.

Many cultivated oaks are vulnerable to human-induced stresses (abiotic diseases). These stresses include soil compaction over roots, cultivation around established root systems, and changes of existing soil grades that the roots are growing under.

Ironically, one of the reasons for building homes among existing oak trees is the desirability of the trees, yet sufficient attention is not given to the requirements of a particular species. Good arboricultural technology should receive high priority for preservation of oaks during site development and construction around established trees, since many existing oaks are sensitive to soil and root disturbance.

Descriptions of Selected Oak Species

Quercus macrocarpa — Bur Oak or Mossy Cup Oak

A mature bur oak has a broad open crown that rises from a massive straight bole with grand, stout lower branches. It begins life as an awkward, irregularly branched sapling, transforming into beauty at about 3" caliper. Sometimes the branching of young trees and almost always of older trees provides a thick, irregularly ridged, corky, dark-gray winged bark — a massive winter framework.

The expanded leaves are deeply lobed and rounded and the summer foliage displays a dark, leathery, lustrous deep green with a grayish underside (a felt of fine hairs) that flashes in the wind. The autumn foliage of mature trees lacks ornamental brilliance, typically dull yellow to brown, but leaves do fall in autumn.

Bur oak is a picturesque but useful, hardy oak for the heat and cold of the Midwest (it is well adapted to the Northern Plains). Bur oak has a high water-use efficiency, putting down particularly deep tap roots. This long-lived species is adaptable to marginal soils from droughty, rocky hillsides to limestone-derived soils to dry clay sites, yet it is found on moist sites, such as flats and river bottoms, adapting in the pH range of 5.6 to 8.0

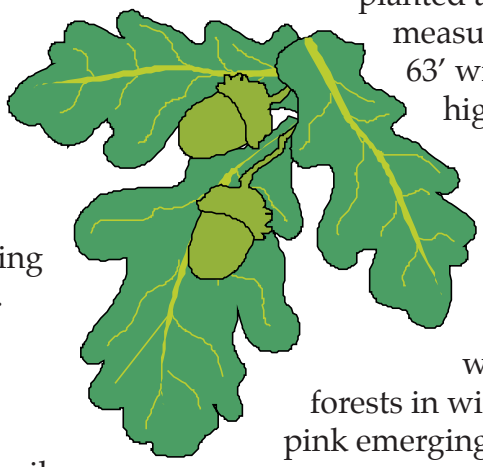
In seedling production under field soil conditions and by the end of the first growing season, the tap root of bur oak may be 4.5′ deep with a total lateral spread of 30″, which is one of the reasons that this species is drought resistant. This taproot description helps explain observations that bur oak is difficult to transplant and reestablish from field-grown nursery stock, especially when transplanting caliper size greater than 3″.

Observing grand bur oak trees growing as adaptable inhabitants of many landscapes does not necessarily translate into the ability of this species to establish callipered trees in newly created landscape sites. Remember that many native and naturalized trees have established well from spontaneous direct seeding, rather than transplants of callipered trees. We see many grand bur oak trees from native habitats, but our experience indicates that this species is not so readily transplanted from larger callipered trees, unless technology has produced an adequately fibrous root system.

At the Secrest Arboretum Nursery, we have observed that bur oak seedlings produced from large acorns and from seeds of trees with exceptionally large leaves exhibit exceptional vigor in the first years of production.

Quercus alba — White Oak

From Maine to Florida and west to Minnesota and Texas, white oak is one of the most noble of the oaks throughout the year. When grown in full sunlight and isolated from other trees, white oak surpasses many other trees in its majesty. One of three white oaks planted on the OARDC campus in 1957, as 1-3/4″ caliper, measured 18.5″ DBH and 41′ in height in 1985, and today it measures 33″ DBH, 51′ in height, and 71′ in width. Two other trees planted as 1-3/4″ caliper in 1957 measure 34.1″ DBH, 58′ high by 63′ wide, and 30.7″ DBH, 55′ high by 72′ wide.



An aged white oak is a dramatic feature throughout the year. Its striking gray silhouette dominates against the winter blue sky in white oak forests in winter. In spring, the silvery-pink emerging leaves create a delicate spring tapestry in the woodlands. The summer foliage is almost a bluish-green and with some variability changes to shades of bronze to red in autumn. After the foliage fades to brown, it falls over an extended period into winter.

White oak prefers an acid soil, moist and well drained. It does not have much of a tolerance to alkaline soils or to poorly drained soils as does its cousins, swamp white oak or swamp chestnut. Compaction due to construction as mentioned earlier is particularly negative to optimum growth and development of this species. White oak is native in Secrest Arboretum.

A reported limitation to acceptance of white oak is its difficulty in transplanting,

even as a young tree. This should not be a deterrent in outplanting this species as difficulty can be overcome somewhat with root development technology described under chinkapin oak.

The home of Abraham Lincoln in Springfield, Ill., is built largely of oak, including framework, flooring, and interior finish. It has been reported that the original shingles were made of hand-split white oak. Appropriately, the official state tree of Illinois is the white oak. Nineteen species of oak can be found growing throughout the state of Illinois.

Quercus bicolor — Swamp White Oak

For moist, low-lying areas (soggy soils) and for ease of transplanting, try *Q. bicolor* (or *Q. michauxii,* swamp chestnut oak, and *Q. lyrata,* overcup oak). *Q. bicolor* is a cold-hardy species even more northerly in its origin than *Q. alba,* growing as far north as southern Ontario. As the common name implies, it is a lowland tree growing on the edge of swamps, low wet flats and meadows, and in areas where soil drainage is poor. Common companion trees include black ash, *Fraxinus nigra;* pin oak, *Q. palustris;* red maple, *A. rubrum,* and willows, *Salix* — all trees that can survive on wet sites. Swamp white oak will be adaptable to Midwest landscapes where it will grow well on higher ground without sensitivity to drought, but it does require an acid soil.

Nine plantings of this native tree have been made in the Arboretum since 1909. Their growth has been exceeded in average diameter growth by all the other oaks in the planting, including white oak, bur oak, pin oak, red oak, and black oak. Swamp white oak, when young, is an attractive symmetrical tree. With advancing age, it becomes ragged, but picturesque.

In lawn plantings, where swamp white oak undoubtedly benefited from frequent lawn fertilization, a 30-year-old tree measured 19″ in diameter, 50′ in height, and 29′ in crown spread. A 50-year-old tree measured 29″ in diameter, 69′ in height. Although present day swamp white oak seldom exceed 24″ to 36″ in diameter and 60′ to 70′ in height, an Ohio tree in Adams County was measured in 1957 to be 68″ in diameter and 80′ in height. This species is long-lived and may reach 300 to 400 or more years old. It is not reported significantly as a shade tree in the Midwest, but maybe it should.

The specific epithet name, *bicolor,* refers to the leaf characteristic of the contrasting upper green leaf surface with the velvety tomentose or grayish-green color beneath. The summer leaf changes to a tinge of yellow-bronze in autumn. Swamp white oak frequently has the bark peeling off the smaller branches in long, dark, papery layers. It sheds its bark on the upper branches, somewhat reminiscent of sycamore.

The paired acorns are unique in that they have a long stalk, unlike many other native oaks in which the acorns have very short stalks connecting them to the twig or are even sessile, with the acorn setting directly on the twig .

Quercus muehlenbergii — Chinkapin Oak or Yellow Chestnut Oak

Q. muehlenbergii is native over much of the United States, from the northeast to the Midwest and as far southwest as Texas and New Mexico. The species occurs throughout Ohio, but it is more abundant in the southwestern portion.

The chinkapin oak is remarkably undemanding in cultural requirements. It tolerates droughty conditions and even prefers alkaline soil, not faring well in excessively acid soils, and it will suffer if planted in clay hardpans that do not drain well.

Conventional field-grown nursery trees do not transplant readily. Sturdy seedlings are produced in deep, bottomless containers for air root pruning in order to promote a fibrous root system. These can result in successful transplanting of 2" to 3" field-grown callipered trees.

The attractive leaves have rounded toothed margins, with dark to yellow-green lustrous foliage on the upper surface and with fine silvery hairs on the underside, contrasting well in the wind. Ornamental autumn foliage is an orange-brown.

Chinkapin oak is not used extensively for landscape development in Ohio, but from all observations, it should make a good shade tree.

Quercus imbricaria — Shingle Oak

Lowland areas and poorly drained soil conditions present challenges for landscape development. However, some large tree species, such as *Q. imbricaria,* are not only tolerant of water-logged soils but also thrive under such conditions and enhance the landscape. Shingle oak is an underused species for landscape use.

Leaves of this species are often said to be atypical for oak — neither lobed nor toothed, but oblong, dark green, leathery, and lustrous. The autumn foliage is not ornamental, drying tan in late autumn and usually persisting through the winter, falling gradually in late winter.

This native species is cold hardy throughout much of the central Midwestern and eastern states. It matures to a medium size. It is readily reestablished following transplanting, establishing well in various soil types. It has been reported to exhibit tolerance to urban conditions, such as can be found along a major thoroughfare on the campus of Iowa State University, Ames.

All eight replications of *Q. imbricaria* became heavily infested with horned oak gall during years in the Secrest Arboretum Shade Tree Evaluation Plot. No treatment was made to prevent galls, and no galls were removed from infested trees. The galls seemed to continually build up over a 20-year period.

Quercus palustris — Pin Oak

Many trees do not survive on wet sites or in soils with poor internal drainage. *Q. palustris* is one species able to survive such conditions and even make good growth. The species grows naturally on wet sites, often spoken of as Pin Oak Flats, where the surface water may lay from a few days to a month or more. Such periodic flooding is quite normal for natural stands. Some of these areas are so wet that they are locally called Crawdad Lands as they are identified by the presence of mounds of soil and holes made by crayfish.

Pin oak also grows naturally on deep rich soils of bottom lands and around borders of ponds and swamps where it often grows in company with American sweetgum, *Liquidambar styraciflua;* blackgum, *Nyssa sylvatica;* and red maple, *A. rubrum.* In fact, it grows so often in association with American sweetgum that a forest type or association has been described as Pin Oak-Sweetgum, found in the Ohio River Valley and its tributaries.

Pin oak will also grow on drier upland areas as it is adaptable to a wide range of growing conditions. It grows naturally all over Ohio and is one native species which has been used quite extensively as a shade and street tree. The lustrous, deep green summer foliage turns a yellow or slight bronzing before drying a tan, with some foliage remaining into winter.

A readily known issue about pin oak is that foliar yellowing is an indication of its striking intolerance to neutral or calcareous soils, developing interveinal chlorosis because of insufficient iron availability to the root system in such soils. I would say that successfully correcting iron chlorosis in trees planted on calcareous soils is a band-aid approach, with repeated applications needed over years. Plant the right tree according to the existing soil conditions.

The form of pin oak is distinct, with drooping, horizontal, and ascending branches depicting its broadly pyramidal outline. Descending lower branches are best removed to the trunk to accommodate pedestrian and vehicular traffic. In large lawn areas where there is plenty of room for a tree to grow, lower branches can remain drooping to the ground and provide an excellent landscape effect.

It has been reported over and over that it is one of the easiest oaks to transplant, and I would venture to say that more pin oaks have been transplanted in created landscape situations than any other oak. It has a spreading fibrous root system that is much shallower than most oaks. It does not have as well-developed a taproot as the white oak, especially when growing on wet sites. A shallow spreading root system is characteristic of many trees growing in wet locations.

A most beautiful pin oak selection at OSU Wooster is *Q. palustris* 'Sovereign,' set out in 1972. Sovereign pin oak has a more horizontal and ascending branching habit than the species, making it useful in accommodating pedestrian and vehicular traffic passing near the tree. It has been observed that most species plantings have grown faster than the selection Sovereign.

Quercus phellos — Willow Oak

Q. phellos leaves are quite different than most oaks. The attractive, bright green leaves are unusually slender — almost willow-like — and add a finer texture to the landscape than do most other oaks. The foliage is exceptional throughout the growing season. Autumn foliage is less striking and unreliably colorful — dull yellow to reddish and persisting well into winter.

From all comparisons of oaks for the Midwest that I have made, willow oak has the smallest acorn — 1/2" in diameter — obviously no ornamental value or litter problem. The overall tree form of willow oak is similar to the pin oak.

In Ohio, willow oak is reported growing locally in Jackson and Scioto Counties, but the native range is southward into Kentucky and Tennessee. The species is native on the eastern seaboard and Gulf States and hardy westward to St. Louis. It is found not only in lowlands and along borders of rivers and swamps but also on rich, sandy uplands. It is indigenous to areas receiving moderate rainfall, so it is not suitable to dry planting sites.

Q. phellos has a moderate growth rate and is reportedly readily transplantable. I have been significantly impressed with sizable specimens located in various locations in northeastern Ohio. I am going to pursue further seed propagation of genetic material as described earlier.

Quercus rubra — Northern Red Oak

Q. rubra has been praised as the most adaptable oak species in city plantings involving a relatively narrow tree lawn. According to Arboretum records of the late John Ford, red oak had been the fastest-growing oak in the Arboretum. One of the most northern grown of the American oaks, it is scattered throughout the hardwood forests of eastern North America from Nova Scotia to Minnesota south to Arkansas, in the East following the Appalachian Mountains and Piedmont into Georgia and then to central Alabama.

Large deep-green lustrous leaves turn a bright red in autumn, but the quality of coloration varies within the species. Northern red oak has been used as an lawn tree. It should be planted where it has ample growing space. Open-grown trees have short boles and can develop massive crowns nearly as wide as the tree is tall, while forest-grown trees have a tall straight trunk and a more restricted crown.

As reported in the Ohio State University Street Tree Evaluation Project (STEP), trees planted out in an open lawn area in 1942 on Oakley Avenue in Wooster, Ohio, are in excellent condition today and have a broad pyramidal habit, providing excellent shade. The trees have grown magnificently and average measurements are recorded as follows: 1967 — 12.3″ caliper, 32.8′ height, and 28′ spread; 1970 — 14.7″ caliper, 38.6′ height, and 33.4′ spread; 1997 — 35.2″ caliper, 82.6′ height, and 59.6′ spread.

For landscape plantings of red oak, heights of 25′ to 30′ can be reasonably expected in 10 years, 30′ to 60′ in 40 years, and 60′ to 90′ in 60 years.

Quercus shumardii — Shumard Oak

Q. rubra and a close relative, *Q. shumardii,* remain popular and serviceable shade and street trees and transplant readily. As reported in the Ohio State Street Tree Evaluation Project (STEP), trees were planted in a 6′ tree lawn in 1949 on West 107 Street in Cleveland, Ohio. In 1967 measurements were reported as 12″ caliper, 34′ height, and 24.8′ spread; 1970 — 15.4″ caliper, 39′ height, and 33.6′ spread; and in 1997 — 30.6″ caliper, 62′ height, and 59.8′spread with 100% of the planting surviving and creating a wonderful canopy effect.

This report is significant considering that a six-foot planting area can accommodate a tree with a mature height of 20′ to 35′, but in 1997 these trees were found to be 60′ in height and the trunks and root collars took up the entire six-foot tree lawn and the trees appeared to be thriving, a good indication that Shumard oak could be a serviceable street tree.

Shumard oak usually goes unrecognized by many people who simply call it red oak, as it resembles this tree in overall appearance. Shumard oak has been planted in the Arboretum and on the campus of the Ohio Agricultural Research and Development Center in Wooster since 1915 when five trees were set out. In 1975, the largest in this group was 36″ DBH and 65′ in height. Since this initial planting, 53 trees were outplanted in 17 different locations.

One of the fastest-growing individual Shumard oaks at Wooster is a Texas variety, *Q. shumardii* var. *texana,* planted in 1950. The tree measured 21″ in diameter and 50′ in height after 25 growing seasons. This tree measured 40.6″ DBH in summer 2000, and in summer 2004, it measured 43″ DBH, 75′ in height, and 68′ in width.

The tree is in average condition, growing in a turf area which is managed with fertilization. From 1979 to 1998, this tree had supplementary summer irrigation through a turf sprinkler system. This type of maintenance affects the growth of oaks which, in general, grow best under moist, fertile growing conditions.

Quercus coccinea — Scarlet Oak

One other oak species that I should describe and emphasize for its potential as a landscape tree is *Q. coccinea.* This North American species ranges from northern Georgia to southern Maine and westward to the Mississippi. In Ohio, the scarlet oak is fairly localized to the southeastern region of the state where it occurs abundantly on dry, rocky and sandy soils. The species real beauty occurs in autumn when the foliage reliably turns a maroon to vivid scarlet in coloration.

If I had two oaks to choose as the finest of oaks to try out in the residential landscape they would be *Q. coccinea* and *Q. phellos.* Both species are urban-tolerant, but the scarlet oak is more difficult to transplant unless grown in nursery production.

Conclusion

Considerable biomass has been produced in the genus *Quercus.* As with many plants, there are site-specific requirements in the growth of oaks. Some are within a broad spectrum of tolerance of soil and environmental conditions for plant growth. Truly mighty are the oaks and: *Parvis e glandibus quercus.* Mighty oaks from little acorns grow!

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Acknowledgment is made to researchers in forestry who greatly contributed to tree research work in Secrest Arboretum from 1908 to 1984 — Edmund Secrest, Ollie Diller, and John Ford. Additional acknowledgment is given to Secrest Arboretum staff technicians led by Jim Karcher, who worked with John Ford for many years in taking tree measurements, and more recently Jim working with staff technician, Roger Hamilton. Both provided the measurement work for this report.

A complete acknowledgment of people involved in my work with oaks would be most difficult, since a great number of colleagues, teachers, and green industry people have had input, but I am indebted to each of the previously mentioned people in particular. Each of these people was dedicated in their research work at Secrest, and they brought that work to a point in time where I could learn from it and pick up on their work.

I also acknowledge the authors of the resources listed here for the knowledge and ideas gained by reading their writings as well as through personal conversations in several instances.

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~ 29 ~
10 Things You Should Know About Lichens

David J. Goerig and James A. Chatfield

"...the lichens, gray, crisp, brittle, and crusted...deriving their food from certain kinds of small algae which they hold enslaved in their meshes."

— W. F. Gamong

It has been our observation during our years spent in education, diagnosing plant samples and insect specimens that come into Extension offices, that a number of us are a bit lost when it comes to organisms outside the "higher" plants and animals. This is especially true of the miniature worlds of bacteria, protists, and other less well-known organisms. What is a moss? And is "reindeer moss" a true moss? What are slime molds? Are fungi plants or animals? (Neither, actually). What about horsetails or club mosses or liverworts or water molds? We will not answer all of these questions in this article, but let's start with 10 questions about a most unusual component of our natural world — lichens.

What Is a Lichen?

Thoreau once penned: "I find myself inspecting little granules as it were on the bark of trees — little shields or apothecia springing from a thallus — such is the mood of my mind — and I call it studying...." He was talking about lichens, a few examples of which have such exotic names as rock pimples, earth wrinkles, angel's hair, freckle pelts, fog fingers, dragon's funnel, tar-jelly, and old man's beard.

What are lichens? They are a mutualistic symbiosis, or in the words of Irwin Brodo, Sylvia and Stephen Sharnoff, in their wonderful *Lichens of North America*, they are a "composite of a fungus and an organism capable of producing food by photosynthesis." The usual symbionts are a member of the Ascomycetes or "sac fungi" in the Kingdom Fungi and a green alga in the Kingdom Protoctista or a cyanobacterium (formerly blue green alga) in the Kingdom Protista. The "apothecia" of which Thoreau speaks are a type of cup-like fruiting body common in the Ascomycete fungi. The "thallus" of which he speaks is "the vegetative body consisting of both algal and fungal components" (glossary entry from *Lichens of North America).*

The alga or the cyanobacterium (the photobionts) produce carbohydrates through photosynthesis which then serve as food for the fungus. The fungus, in its turn, provides a steady supply of moisture to the photobiont, provides a substrate helpful in providing the right amount

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of light to the photobiont, and protects this alga or cyanobacterium photobiont within the fungal tissues. There are many variations of this relationship, including the fact that sometimes club fungi, rather than sac fungi, and brown algae, instead of green algae, are involved. Bottom line, as the great lichenologist Trevor Goward once said: Lichens are a case of "fungi that have discovered agriculture."

What Is Not A Lichen?

A lichen is not a true bryophyte, such as a moss or a liverwort (which are photosynthetic plants), though some of the common names of certain lichens, such as "reindeer moss," fool people into confusing lichens with true mosses. So the velvety green moss that often grows on the side of trees, in lawns, and on other surfaces is completely different biologically from the lichen symbiosis. The sphagnum mosses used for peat in horticulture are true mosses — and not lichens. Bryophytes are green and leafy and often live in the same places as lichens, but they are plants, not the symbioses between fungi and algae (or cyanobacteria) that we call lichens.

What Do Lichens Look Like?

The thallus body, which in structure is mostly composed of the fungal symbiont, is the most recognizable part of a lichen. There are three or four basic lichen body types:

- Lichens that produce leaf-like, two-dimensional, flattened, lobed thalli with upper and lower surfaces that grow in layers are known as *foliose lichens.*
- *Fruticose lichens* grow erect or pendulous in three dimensions and have no distinguishable upper and lower surfaces.
- *Crustose lichens* look somewhat like the name implies. They form a crust over their substrates, like rocks, trees, and sidewalks. The lower surface of crustose lichens attaches firmly to many surfaces and forms brightly colored patches of a thick, rough naturalized texture.
- *Squamulose lichens* can be described as intermediate between foliose and crustose growth forms. Their shape is scale-like, and they attach by the lower surface like tiny shingles. We should note, however, that there are other intermediate types that include one or more characteristics of the previously mentioned growth forms.

Where Do Lichens Grow?

Lichens are located on every continent on planet Earth, including both the Arctic and Antarctic. They survive in all climates and altitudes. Specific lichens have their specific requirements, but in general they need three things — undisturbed surfaces, time, and clean air.

Lichens will make themselves at home on most any undisturbed surface commonly known as their substrate. Bark, wood, mosses, rock, soil, and peat are all natural substrates. Thalli will also establish itself on glass, metal, plastic, and cloth. Most lichens are restricted to certain types of substrate; lichens normally found on tree bark, for instance, are rarely found on rock, and vice versa.

Lichens established on stone in the landscape give the garden a mature look. Discovering a lichen growing on your tree is not a bad thing. In fact, it should be celebrated by giving you peace of mind knowing that the environment in your neighborhood is clean enough to support this amazing dual organism.

What Is the Ecological Role of Lichens?

Lichens are important partners in nature's ecosystem and should be admired and studied when seen on landscape plants and hardscapes. They are an early colonizer that reestablishes life on rock and barren disturbed sites. Lichens play an important role in soil formation over much of the earth. As lichens colonize rocks, they trap dust, silt, and water.

Because of their association with cyanobacteria, lichens can provide themselves with nitrogen compounds. Lichens contribute to the nitrogen cycle by converting the nitrogen in the air into nitrates that contribute to their growth and development. Their ability to "fix" atmospheric nitrogen is beneficial to other plant life as well. When it rains, nitrogen is leached from both living and dead lichens and is available to plant life in the immediate areas. When lichens die, they contribute decayed organic matter to the area they inhabited, which enables mosses and seeds from vascular plants to begin developing among the pockets of new soil.

Animals utilize lichens in many interdependent ways. It is well documented that numerous animals use lichens for either food or shelter. Some 50 species of birds are known to regularly use fruticose-type lichen as their preferred nesting material. Small animals commonly use lichens to hide from natural predators through camouflage and direct cover.

What Are the Economic Benefits of Lichens?

Historically, lichens have had economic benefit. For many years, over different parts of the world, they have been a source of natural dyes for wool and fabric. These dyes were distinguished by the type of lichens used and the way the color was extracted. Lichen dyes are extracted by the boiling-water method or the fermentation method. Today, they are still used by local artisans as they demonstrate their crafts.

Some lichens have antibiotic properties that are valuable commercially. The genus *Usnea* is used in Europe in ointments and other commercial products and is said to aid healing in superficial wounds. Lichens have been used in such preparations as deodorants, laxatives, expectorants, tonics, and healing pastes throughout the years. Research with lichens around the world is suggesting these organisms hold promise in the fight against certain cancers and viral infections, including HIV.

In the ornamental horticulture profession, lichens are preserved in glycerine, painted different colors, and made available commercially to the floriculture industry for dried-flower decorative arrangements. These same materials are utilized by model railroad enthusiasts, architects, and others as miniature "plant" forms for their scale reproductions of new building concepts and old railroad towns.

Do Lichens Damage Plants?

We know that lichens occur when a sac fungus and a green or blue-green algae take a "lichen" to each other. One of the applied questions often asked is: Do lichens damage plants?

The short answer is no; lichens do not cause plant damage. The lichen symbiosis is not damaging bark in any direct ways. It does not rob bark of significant amounts of moisture. The fungal symbionts of the lichen do not parasitize living plant cells, and lichens do not appear to be associated with providing entranceways for pathogens into plant tissue. So why do so many people, including many

horticulturists, think lichens damage plants? Perhaps it is because when branch decline occurs due to other factors, lichen growth sometimes proliferates. This is due to increased sunlight that penetrates to the bark which favors the algae that are photosynthesizing, resulting in enhanced growth. The lichens did not cause the branch decline, but rather, one of the effects of the plant decline was an increase in lichen growth.

If we really want to stretch things, perhaps we could come up with a few indirect or unusual examples of lichens negatively impacting plants. For example, where lichens are especially abundant on bark, their presence may obscure desirable ornamental features of certain plants, *e.g.,* the beautiful bark features of crape myrtles in the South.

Another unusual example of indirect lichen effects is reported in *Lichens of North America* (Brodo, Sharnoff, and Sharnoff). In Canada, hemlock looper *(Lambdina fiscellaria)* is a serious forest pest. And guess what? This moth "lays its eggs almost exclusively on hair lichens such as *Bryoria trichodes,"* and so lichen is an important cog in this pest's life cycle.

Finally, in states more southernly than Ohio, there is an unusual role of lichens in plant disease. There is an algal plant pathogen, *Cephaleuros virescens,* which causes scurfy leaf spots and fissured twig cankers on many plants, including magnolias and azaleas.

Jim Chatfield and Nancy Taylor have noted this disease occurring abundantly in North Carolina woodland and parkland areas. Well, guess what? In some cases, the *Cephaleuros virescens* alga teams up with a *Strigula* spp. fungus to develop a lichen symbiosis, causing leaf spots and twig cankers due to the algal activity.

However, the bottom line is the few-and-far-between exception rather than the almost universal rule that lichens most definitely do not damage plants.

Are Lichens Good Eating?

Well, caribou, and their European cousins, Rudolph and the rest of his reindeer friends, certainly think so. They have a rumen digestive system and the bacterial flora to properly digest the complex carbohydrates that lichens have in rich abundance.

Overgrazing of lichens can even result in periods of starvation and population crashes for herds. In some cases more than 90% of winter food for caribou is derived from lichens. Many species of deer, mountain goats, flying squirrels, and voles also use lichens as an important food.

In some cases, western North American wildlife managers fell trees to deliberately make arboreal lichens more accessible for winter food. Finally, there are many mites, springtails, and other smaller fauna that consider lichens as food substrates.

As for humans, lichens have several disadvantages. It is tough for us to digest the complex carbohydrates, and a few lichen species are even poisonous. So "extreme cuisine" afficionados need to follow the usual precautions familiarized by the old saying that "there are old mushroom hunters — and bold mushroom hunters — but no old, bold mushroom hunters." Lichens are not mushrooms, but we trust that you get the point. However, there are some reports of native cultures eating certain species of lichens in times of famine.

Sometimes lichens are made palatable by going to great extreme, from adding wild onions and saskatoon berries in barbecue pits to the ages-old trick of

adding them to sugar, raisins, and apples (just about everything tastes good with these additives). There is even the practice of arctic populations mixing partially predigested lichens from caribou stomachs with raw fish eggs to make what is called "stomach ice cream." We will pass on that one. And yes, certain lichens have also been used on occasion as laxatives.

Finally, lichen history includes use for various value-enhanced beverages, from a bitter flavoring for beer in Siberian monasteries to fermented corn beverages in Mexico to a source of sugar for Swedish brandy distillers. All in all, though, using lichens as a food source is pretty limited, except for animals and their role in the food web.

How Are Lichens Named?

The Chinese philosopher Krishtalka said that "the beginning of wisdom is calling things by their right name." One way to indicate the right name of an organism is to use the universal language for a species, namely the Latin binomial name, specified according to the International Code of Botanical Nomenclature. But what about lichens?

Lichens are dual organisms, composed of two species living together in a mutually beneficial symbiosis. One species in the lichen symbiosis is a fungus, which provides a substrate and helps with mineral and water management, and the other species is an alga or a cyanobacterium (the photobiont), which uses water and carbon dioxide and the energy of sunlight to photosynthesize and produce food for the dual organism.

So what could the Latin binomial of a lichen be? Are the Latin binomials for lichens given as both the fungal and photobiont binomials? No. As it turns out, by convention of the Botanical Code of Nomenclature, lichen names are simply given as the Latin binomial of the fungal component of the dual lichen organism. This seems somewhat inelegant, but since the recognizable form of the lichen is the fungal component, the Latin name of the lichen is simply given as the Latin name of the fungus in the symbiosis.

So, when the *Cladonia cristatella* sac fungus gets together with the green alga *Trebouxia erici* to form a lichen, the official Latin name of the lichen is simply *Cladonia cristatella.* So, now you know. Having gotten that little detail out of the way, let's face it — the real fun with lichens comes with their common names. Though common names can cause confusion because of local variations, there are some wonderfully evocative lichen names.

The can-of-worms lichens *(Conotroma urceolatum)* is the fungal and lichen Latin binomial, so named for the long segmented spores of the fungus. How about these: powder-tipped antler lichen; black-eye lichen; bloody heart lichen; cowpie lichen; elf-ear lichen; five-o-clock shadow lichen; hairball lichen; naked kidney lichen; tattered rag lichen; and blackened toadskin lichen.

And after that motley crew, a number of lichens have foodie names, such as candy lichen, rock licorice lichen, and chocolate chip lichen. *No mas.*

Where Can I Learn More About Lichens?

Finding information on lichens is simple enough. Start by asking your children if you can see their science class book. It should be in there.

Numerous informational tidbits can be found online. A few of the web sites that

caught our attention include:

www.lichen.com
http://mgd.nacse.org
www.earthlife.net .

But if you really want to touch bases with the big leagues of lichenology, check out:

Lichens of North America, by Brodo, Sharnoff, and Sharnoff. It is a 795-page masterpiece of truly magnificent photography and information, including both accessible general information and details for the lichen afficionado.

"Sharing the stillness of the unimpassioned rock, they share also its endurance; and while the winds of departing spring scatter the white hawthorn blossoms like drifted snow, and summer dims on the parched meadow the dripping of its cowslip-gold — far above, among the mountains the silver lichen-spots rest, star-like, on the stone."

— John Ruskin

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The 20 Questions of Plant Problem Diagnostics

James A. Chatfield, Joseph F. Boggs and Erik A. Draper

Proper diagnosis of plant problems is a key factor in plant health management. As urban forester Alan Siewert quips: "Treatment without diagnosis, as in medicine, is malpractice." Despite this, diagnostics is often not given adequate attention.

Typically, diagnostics is a process to come up with the best possible explanation of why a good plant has gone wrong. Unfortunately, diagnostics almost always involves unknown variables and uncertainties that make an absolute slam-dunk diagnosis the exception, rather than the rule.

Nevertheless, if diagnostics is the start for finding proper treatment, the place to begin is to consider the questions that must be answered. You do not necessarily need to know the answers to all of the questions, nor do you have to ask them in order. Often, however, failure to accurately answer some of the early basic inquiries at the start is the reason for the faulty diagnosis.

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Question 1: What Is the Plant?

This is the first of three key questions concerning the plant itself. It is one of the reasons why truly useful, comprehensive diagnostic keys are so difficult to create — the plant ID key alone would be huge. In diagnosis and treatment, determining whether a plant is a pine or a spruce, determining if it is naturally variegated or deciding if it is supposed to be a dwarf are all crucial.

Spend time focusing on what plant you are looking at or having described to you. Many diagnoses flounder by initial misidentification. Identifying a plant properly leads to a focused consideration of questions such as the ones that follow.

Question 2: What Is Normal for the Plant?

Plant characteristics are variable enough that what is perfectly healthy for one plant may be a sign of a serious problem for another. A good example can be found in deciduous conifers such as bald cypress, dawn redwood, and larch. These three trees bear cones and needles, and neophyte plant lovers may think they are evergreens.

However, they are indeed deciduous, with fall colors ranging from spun gold to reddish brown, followed by leaf drop. Many a bald cypress has felt the bite of the

saw from new homeowners who notice a completely brown-leaved tree in their new landscape in late fall. Indeed this total browning of foliage would be a sign of almost certain death on a true evergreen conifer, such as pine. Knowing how to identify these deciduous conifers and understanding that their fall color and leaf drop are normal can be all you need for proper diagnosis.

Similarly, knowing that some yews, such as *Taxus* 'Helen Corbit,' naturally have needles trimmed in bright yellow should give a horticulturist pause if someone wonders if the yellowing is due to photosynthetic-inhibitor herbicide injury. Knowing that 'Lemon Drop' poinsettias are supposed to have yellow bracts, rather than the more familiar red, white, or pink colors of most poinsettias, is a key answer to concerns that something is wrong with the plant's nutrition.

Knowing that the greenish, straplike bracts on lindens naturally turn brown after flowering is key to responding to a concern that the browning is associated with some type of fungal disease. And if you understand that older sweet gum stems and young hedge maple stems often develop corky wings (almost like winged euonymus), you will realize it is not some strange sort of distorted growth on the plant.

These examples fail to prove that there is nothing wrong with the plant. After all, the *Taxus* may very well also have herbicide injury, the poinsettia may have a nutrient deficiency, there may still be diseases on the linden, and there may be other factors causing growth distortions on the stems of sweet gum and hedge maple. Nevertheless, understanding what is normal for a particular plant is a great early perspective in the diagnostic process.

Question 3: What Are the Common Problems with the Plant?

Another good diagnostic perspective is to consider a plant's common problems. All plants have their own set of diseases, insect problems, and cultural dilemmas; there are no problem-free plants. Pondering these common quandaries can create somewhat of a bias, especially if you are seeing something new, but it helps rule certain problems out.

For example, fire blight, caused by the bacterium *Erwinia amylovora,* causes a blighting of shoots that result in discolored leaves and a curling of the shoot often characterized as a shepherd's crook. This symptom is helpful in considering fire blight as a possibility. However, such symptoms can also be caused on many plants by far simpler problems, such as moisture stress, resulting in leaf and shoot wilting.

For which plants should fire blight be considered a possibility? As it turns out, fire blight occurs only on plants in the rose family (rosaceae). So, if you see a crabapple, firethorn, or mountain ash with a shepherd's crook symptom, fire blight should be considered and investigated. If the plant is a maple, white ash, or pine — not members of the rose family — fire blight is not a possibility.

Knowing your plants (and even what family they are in) is a great starting point for diagnostics. This, of course, helps not just with identifying infectious diseases like fire blight, but with other problems as well.

Consider a yew or rhododendron growing in poorly drained soil. Knowing these plants are particularly prone to root decline and root rot in poorly drained sites

helps immensely with a proper diagnosis when plant decline is evident. It should not blind you to other possibilities, but it certainly is the type of smoking gun that should be investigated.

Question 4. What Do You See That Looks Abnormal?

It is important to clearly consider and list what signs and symptoms are present that make you believe there is a problem in the first place. For example, are there signs of insect or mite feeding? If so, is the injury from pests with chewing or sucking mouthparts? Similarly, are there signs of fungal diseases, such as the orange fungal growth of rust disease? Are leaves missing, off-color, abnormally small, or scorched? Is there abnormally peeling bark? Are there girdling roots — or are the roots rotted in the pot or in the soil? Are there abnormal growths such as galls or discolored cankered areas on stems?

Finally, when considering symptoms of plant problems, keep in mind that often there is a series of symptoms, known as the "symptom complex," which together helps fingerprint a particular problem.

When questioning if lace bugs are a problem, check not only for flecking and yellowing of leaf tissue, but also for tarlike excrement deposits. When checking for *Verticillium* wilt on maple, check not only for leaf scorching and stem dieback but also for discolored streaking of the vascular tissue.

The list can be extended and extended. It is important to walk around the plant — looking at it up close and from far away — and to catalog every noticed item as you work on your diagnosis of what may possibly be multiple problems.

Question 5: What Is the Overall Health of the Plant?

It is a good reminder to put into perspective overall plant health. Presumably you have found something abnormal or you would not be continuing with the diagnosis, but step back for a moment to consider overall health. This helps later in terms of what you will recommend and how important various problems on the plant might be, but it also helps provide focus relative to how long problems might have been present. Consider, relative to a healthy specimen of the same plant, such questions as whether leaf size and color are normal, if the canopy is full, or if the growth rate is normal.

For example, if you measure the space between the sets of bud scale scars on the twig of a woody plant, you can tell how much it has grown in recent years. It is a little tricky to know what is a normal rate of growth and whether lower than normal rates necessarily mean the plant is unhealthy. However, declining rates of growth over the past several years can be telling, and they can often even be traced to a particular event, such as installation of new sewer lines or a new driveway. Conversely, pointing out normal annual growth can also help allay fears that something major is wrong with the plant — for example, on maple when all that is found is some tarry spots on the leaves.

Question 6: What Exactly Do You See?

After stepping back to consider the overall health of the plant, force yourself to step back again to consider in more detail Question 4 — What do you see that looks abnormal?

The key to diagnosis is often in such details, sometimes related to others who help with the diagnosis, such as a diagnostic lab technician or coworker in your company. A good example of this is the difference in symptoms between maple anthracnose and physiological leaf scorch of maple.

To the casual observer, both problems involve blotchy, scorchy, brown discoloration of the leaves. However, the details are quite different. With anthracnose, which is caused by a fungus, the blotched areas are more of a reddish brown than a tannish brown, but more importantly, they are concentrated along the leaf veins.

With physiological leaf scorch, caused by excess evaporation of water from leaves due to a variety of factors, the blotches are not concentrated along the leaf veins and are typically more to the outer margins of the foliage. Knowledge of this difference in symptoms is the sort of fine-tuning that diagnosticians develop as they improve their observational and reporting skills.

As can be seen with this maple example, noticing where symptoms are occurring is critical. *Diplodia (Sphaeropsis)* tip blight of pine is characterized by browning and stunting of new growth on young Austrian, red, Scots, and mugo pine shoots, in addition to dieback of this new growth (the growth farthest out on the branch). This disease typically occurs on the bottom branches of the tree first and works its way upward over the years.

Compare this to the normal seasonal loss of inner needles from previous years that occurs on pines. Every fall, many people become worried about the yellowing, browning, and falling needles on pine, even though loss of older needles is normal. Each evergreen species drops needles of different ages, so good plant identification and knowledge is essential. Careful observation of the details of whether the browning needles are on new or old growth is crucial for good diagnosis.

Question 7: What Do You See on Other Plants?

Now take note of the condition of surrounding plants. Are other specimens similarly affected? What is their general health? If you are looking at a grouping of a particular species, does symptom severity seem to relate to any kind of gradient of drainage or sun exposure?

Trying to answer such questions often provides key clues about major environmental factors. If, for example, a number of different vegetables in a garden are all dying, it is unlikely they are deteriorating from an infectious disease, since most disease-causing pathogens have limited host ranges. It is more likely that a major environmental factor, such as improper herbicide use or extended flooding, is involved.

Often noticing what is occurring on overhanging plants can prevent embarrassing misdiagnoses. Scale insects, which suck sap from plants, excrete this processed sap out the other end. Often this sugary, clear “honeydew” then becomes covered with a sooty mold fungus that simply grows on the sugary substance, rather than the plant tissue itself.

Consider what happens when a bed of pachysandra is growing under an oak tree infested by scales. The honeydew is excreted, falls from the tree onto the pachysandra, and then the sugary substance is colonized by the sooty mold fungus. If you do not look closely at the pachysandra, you might assume the presence of the sooty mold fungus is

associated with a scale infestation on the pachysandra.

Question 8: What Are the Plant's Site Conditions?

Question 7 leads directly to a more focused examination of the site in which the plant is growing. A few key site characteristics can include everything from soil characteristics and exposure to sun and rain, to construction history and competition from other plants.

The soil type relative to drainage, extent of compaction, amount of organic matter, and acidity/alkalinity can tell a great deal about the success and failure of various plants. Poorly drained soils with poor internal aeration sooner or later result in death and *Taxus.*

Acid-loving plants often develop yellowing between the veins (or to put it more stuffily — interveinal chlorosis) if growing in alkaline soils (pH above 7) due to iron deficiency. This can be diagnostically investigated by using soil tests and even plant-tissue analysis — or by simply looking at the plants on-site.

If you notice rhododendrons, birches, white pines, and other acid-loving plants thriving in a location, then a diagnostician might suspect the yellowing of leaves on the similarly acid-loving pachysandra is due not to iron deficiency, but rather to other factors such as overexposure to sun.

Sun and shade exposure is also critical to the success of many plants. Japanese maples tend to thrive in protected sites, developing physiological leaf scorch in hot, sunny areas.

Flowering dogwoods generally do poorly in open, hot sites (and often develop borer problems if stressed) and also in densely shaded sites where diseases, such as dogwood anthracnose, are favored. Partial shade is best for flowering dogwood.

Exposure to wind can result in desiccation of tissue of broad-leaved evergreens, such as rhododendron in winter, and should be considered while diagnosing these plants and the extent of wind exposure. Even exposure to rain can be an important clue. Diagnosticians often miss the implication of overhangs from houses when wondering why herbaceous ornamentals near structures seem to be languishing despite adequate recent rainfall.

The effects of construction are also a factor that should be investigated relative to the site. How much soil grades were raised; the effects of bulldozers on soil compaction and root destruction; installation of sewer lines, driveways, roads, and structures all play a role in plant health, often many years after the fact. Diagnosis would be easy if raising the soil grade six inches during construction activity caused trees to fall over within a week or two.

The truth, however, is that this kind of stress on root systems, due to reduced oxygen concentrations for the now-buried roots, can have effects for years from the contribution to overall plant stress. Nailing down exactly how much damage is due to various factors is difficult — if not impossible — to pinpoint, but it is the job of the diagnostician to put it into as clear a perspective as possible.

Question 9: Who Knows the Most About the Plant?

One of the limits of diagnosing plant problems, unlike with human medicine, is that the patients cannot talk. However, asking questions of the person who takes care of the plant often yields the most important information of all. People who

work in a diagnostic laboratory will tell you the information on the sample is often more important than the sample itself. Try to find out from them the answers to the next question.

Question 10: When Did Symptoms First Appear?

Although listed as No. 10 here, this is a very important question: When did the symptoms of the problem in question first become evident?

Sometimes the answer is unreliable, and we have all heard the up-and-died-overnight scenario. We can check this out, though, by looking at annual growth and symptoms such as long-term branch decay and peeling bark. Sometimes people do provide crucial information that helps solve the problem, such as noting that foliar collapse occurred soon after a spring frost.

The art and science of professional plant diagnostics are often overlooked by those with instant answers to every problem. Beware of those easy answers, especially if the diagnostician did not even ask the question. Diagnostics requires good detective and communication skills, and plant diagnosticians need a thorough knowledge of horticulture, botany, entomology, and plant pathology. But no matter how talented the professional, this combination of skill and knowledge is impossible to master. No one can ever be the perfect diagnostician, and there is always room to improve and grow, to make and correct mistakes.

Question 11: What Is the Horticultural History of the Plant?

This inquiry involves a whole series of important questions, some of which can be answered only by others, some of which you can determine from evidence at hand. For example, what is the plant's transplant history? Looking at a declining 40-foot tree can be a puzzle that is pretty easily put together when you discover the tree was transplanted two years previously. On younger plants, transplant history is often quite evident. A declining rhododendron that has branches growing out of the ground and is planted six inches deeper than the root-ball grade tells a great deal about the causes of decline.

The same combination of questions to ask and clues to look for applies to horticultural practices such as fertilization, mulching, pesticide spray programs, plant hardiness, use of girdling wires, and the source of plant material. You can ask about fertilization rates, but you can often find telltale signs that help ask more pointed questions, such as an excessive pile of granular fertilizer on the ground or on mulch.

Check the depth of organic mulches. The recommended amount is 2 inches to 2-1/2 inches, although more commonly six inches to eight inches (or even more) is applied, or mulch piles up over the years with reapplication exceeding breakdown.

Additionally, mulch is often piled up against the trunk of a tree or the base of a plant. The result of this overmulching may be the reduction of oxygen availability to feeder roots, especially on young plants, and excessive moisture retention may potentially lead to crown and root rots. Mulch mounded against the base of the crown can also provide a perfect protected location for rodents in winter, which can severely damage or kill young, thin-barked trees and shrubs.

Again, consider the always-important question of timing. An irrigation system that is present and seemingly functional

may not have been working during the hottest portion of the summer, when observed damage really was caused. Conditions may be cool and non-stressful in September, but what if a large tree was transplanted on a 100º day in July?

Question 12: What Is the Environmental History?

In addition to what we do horticulturally, it is important to consider past environmental events. How harsh have recent winters been, and how does this match up to a particular plant's hardiness range? Also, severe freezes in a given year can result in plant dieback and death well into a growing season.

Often clients think if a plant flowers normally or leafs out normally, then all is well with regard to surviving winter damage. Sometimes, however, bud tissue breaks. And furthermore, early freeze damage to a plant's cambium prevents that plant from growing beyond that initial bud break, and stems — or the entire plant — may die. These symptoms of delayed winter injury are quite common in cherries, as well as other *Prunus* selections.

Plants may also bud out and look fairly normal well into late spring and early summer. Then hot weather occurs, and the underlying damage to the cambium causes dieback to occur. This type of problem again highlights the separation in time of the cause of damage and the obvious symptoms of this injury that make diagnosis such an art.

If a plant is known to have difficulty under droughty conditions, early hot, dry weather in a given season can have major effects on plants, such as turfgrass and tender perennials, including *Ligularia* and *Astilbe.*

Severe drought in past years should be factored into the current condition of certain drought-sensitive trees, such as beech. How a plant responds to particular additional stress depends upon its entire horticultural and environmental history.

Question 13: What Does the Client Think the Problem Is?

If a diagnostician does not talk to the client directly, oftentimes he or she comes up with a perfectly accurate diagnosis of one problem but does not address the issue of the client's concern. You can make a great diagnosis of Cooley spruce gall adelgid on spruce twigs, provide a proper perspective of how significant the problem is, make accurate control recommendations, and walk away with a job-well-done feeling.

Then you later discover the real concern was why the blue spruce was not as blue as it used to be, or why there were some dead branches on the lower portion of the tree, or what the rows of holes in the side of the tree portend. Always ask for and address client concerns and make other observations as needed.

Question 14: What Diagnostic Tools Are Available?

Useful tools for diagnosis can obviously be high-tech, ranging from ever-more-elaborate microscopes and enzyme-linked immunosorbent assay tests for viruses and fungi in diagnostic labs to equipment from the gas company to check for gas leaks on properties where trees and turf grass along a gas line are dying. However, for horticulturists determining field diagnosis, basic equipment can be far more manageable and less expensive. Here are six basic items:

Soil probe. This tool is useful diagnostically for soil sampling to check soil pH

and nutrient levels. It can help explain, for example, foliar chlorosis due to iron deficiency on acid-loving plants like pachysandra, white pine, river birch, and rhododendron growing in alkaline soils. Probes can have more immediate diagnostic uses as well, such as checking to see how compacted or dry soils are or the depth of mulches.

Hand lens. A good 20X magnification hand lens is useful to check for mites and small insects on plant foliage or to look for fungal fruiting bodies on leaf tissue.

Cutting tools. Good, sharp hand pruners are important for cutting small twigs to look more closely at stem and leaf problems. It is also unprofessional, to say the least, to collect a sample by stripping a twig from a plant rather than making a good pruning cut.

For larger stems, a small foldable pruning saw is also easy to carry. A knife is useful for cutting into a stem to check for discoloration of the vascular system (typical of Dutch elm disease or *Verticillium* wilt disease) or to check stems for the presence of insect borers. Although less portable, pruning poles can also be useful tools to get samples from high in a tree.

Digging tools. It is often helpful to dig a bit around the base of a plant to check for girdling roots or twine, to check where the pre-transplant root system was located or to collect a root sample. A collapsible spade is quite handy, but sometimes blunt, wedgelike knife blades can do the trick.

Recording tools. It is important to take good notes of what you observe to later refresh your own memory and to accurately relay relevant information to others. Have a good field notebook, as well as weatherproof pens and markers. A hand-held recorder can also be helpful if you do many field diagnoses. Finally, a camera can help convey symptoms and site characteristics for others and can be a valuable validation of plant condition at the time you inspected the plant. This photographic evidence becomes especially useful if post-visit changes are made, such as the cutting down of an affected tree.

Sampling equipment. In addition to soil probes and pruners, it is always a good idea to carry along some large-sized plastic bags for collecting samples. Avoid leaving foliage samples exposed to the heat of the sun, and if collecting soil samples for nematodes, a small cooler can be quite helpful.

Question 15: What Additional Resources Are Available?

Of course, the most important diagnostic resource you have is your experience and the collective experience of your co-horts. Also be aware of the number of reliable resources on plant identification and selection; problem identification; and specific damage by insects, diseases, wildlife, and other pests. These sources range from books to great web sites to a wide range of educational programs provided by green-industry organizations and university Extension services.

Furthermore, recognize that diagnostic observations in the field sometimes need verification at a diagnostic lab. These labs use microscopic examination, fungal culturing, and a wide range of tests to help confirm or deny the presence of certain problems. Take advantage of university, government, or private diagnostic labs in your area.

In addition, other laboratories specialize in different pieces of the puzzle. Examples are soil-test and foliar-analysis laboratories used for information on possible nutrient

deficiencies or excesses, and analytical laboratories that check for chemical residues in plant tissue.

Question 16: How Do I Take Samples?

Each type of plant problem can require special techniques to get the best sample back to colleagues or to a diagnostic laboratory. Presented here are a few hints adapted from Ohio State University Extension Bulletin 614, *Disease Control in the Landscape*.

Obviously, many times you can only sample a small portion of a plant, but when large numbers of small plants are affected, collect entire plants, including roots. If 500 rhododendrons are going down, do not just send a leaf or two. Dig plants to keep roots intact rather than simply pulling the material out of the ground. Remove excess soil by gently shaking or washing with water. Do not wet leaves or stems. Wrap roots so clinging soil won't be loose in the packaging. Do not ship wet plants; let them air-dry first.

If only a portion of a plant is sampled, include the part showing symptoms. Also, when possible, collect about a pint of roots, soil, and fine rootlets.

When only localized parts of a plant are affected (leaf spots, stem cankers), ship several examples of the affected parts. Stem and branch sections should include a short section of healthy tissue so the transition area between healthy and diseased tissue is included. For example, if collecting a sample to check for *Verticillium* wilt disease, select one-inch-diameter stem sections about six-inches long, ideally from the area where the stem transitions between healthy and diseased tissue, rather than collecting dead stems.

If shipping, press non-woody plants or leaves on small twigs between paper and put them between pieces of stiff cardboard, then place in a padded envelope. For succulent plants, samples packed in airtight plastic often decay before arriving in a lab. Place the leaves of such specimens between paper towels before packing.

Use strong containers, filling spaces with shredded paper or other materials to cushion the sample in transit. Use rapid mail delivery for best results.

Question 17: What Else Needs to Be Considered?

By now, having asked all kinds of questions and in some cases consulting others or sending in samples for analysis, a good diagnostician asks for the last time: "What else might I be missing?"

A good example from a recent diagnostic workshop is a situation in which a cherry had some leaf discoloration — namely some bleaching of plant tissue on the leaf margins and between the veins. The assembled diagnosticians asked myriad questions regarding the specific identity of the plant, trying to make sure it was not some type of variegated cultivar. They questioned its horticultural history, especially with regard to the use of herbicides for weed control. Various nutrient deficiencies or excesses were pondered. Chlorophyll-damaging viral diseases were discussed, as were the types of damage caused by insects with rasping and sucking mouthparts. All these possibilities were pretty much discarded while listening to the client and looking at the sample.

Finally, one diagnostician asked whether a driveway had been installed or blacktopped recently. As it turned out,

this was the case two years previously. That led to a discussion among several diagnosticians concerning some of the herbicides used in the process of sealing driveways. Several had experiences with cases in which such nonselective herbicides caused precisely the kinds of symptoms observed on the cherry foliage. At last, they had a smoking gun.

"What else?" should always be a nagging question on a diagnostician's mind.

Question 18: What Is the Diagnosis?

The last example brings us to several cruel realities of diagnosis. First, sometimes you just won't have the insight to ask the "What else?" question that starts your light bulb blinking. Second, even when you do ask the question, it usually does not result in an open-and-shut case.

In the cherry situation, after all, diagnosticians still only had a better idea about what had happened to the plant. They had not proved it beyond all doubt. By doing expensive residue analysis of the suspect chemicals in the leaf tissue or in the soil, they might be able to get close.

Sometimes additional analysis helps; sometimes it is too late to find significant amounts of each possible chemical in question. Also, as you might expect, there is little definitive research to show how much of any herbicide in the world it would take to cause the observed symptoms on cherries, or for the particular type of cherry in question, or even what ultimate effect various levels would have on plant health.

The reality is that you are almost always somewhat uncertain as to your diagnosis. A more reasonable goal for diagnosis is to strive to come up with the best diagnosis possible while acknowledging the possibility of other factors. That being said, it is important to be clear about what you did diagnose and also, often just as importantly, about what you did not find. In reporting your diagnosis, remember to do the following:

A. Describe the symptoms you observed clearly and in detail.

B. Identify the problem or problems you think these symptoms signify.

C. Indicate how you made this connection (consulting with colleagues, references, and lab tests).

D. List what you did not find. As indicated earlier, what you did not find can often be critical. If you do not find Dutch elm disease or other infectious diseases, if there is no evidence of bronze birch borers or Asian long-horned beetles, and if the symptoms and/or residue analysis is not suggestive of growth-regulator herbicide injury, this may go directly to the heart of your client's greatest concerns.

E. Put diagnoses into perspective and provide recommendations.

Question 19: What Is the Significance of the Problem?

After making a diagnosis, it is important to put the suggested problem into proper perspective relative to overall plant health. For example, most pest and disease problems are insignificant relative to plant health. Tar spot on maple looks rather nasty with its blackish midsummer wavy blotches, but it is rarely relevant to the plant because it comes on late in the season and involves relatively little leaf tissue. Powdery mildew of lilac occurs every year and seems to cause little effect relative to overall lilac health and survivability. Most of the mite and insect

galls on plant leaves are quite fascinating but cause negligible effects on plant health.

However, here you need to be a good communicator, to understand your clients, and listen to their concerns. Just because a problem will not affect plant health or, in your opinion, affect aesthetics significantly, does not mean your client agrees. In some sense, plant problems are in the eye of the beholder.

While powdery mildew of lilac may be irrelevant to plant health in one landscape, it may matter a great deal to a client who will simply take his or her business elsewhere if you do not do something about the problem. And it certainly matters to a garden center displaying lilacs in its sales area. Tar spot on maple is rarely a major problem relative to plant health.

Question 20: What Are My Recommendations?

Finally we've reached the all-important decision of what you recommend to fix the problem.

First, remember that sometimes no action is in order. If the problem is trivial and the customer is not concerned about it, then simply letting the client know that the maple bladder gall mites are insignificant and nothing needs to be done is a good recommendation.

Second, sometimes nothing can be done to make the plant recover. In such cases, often the best recommendation relates to considerations for timely removal of the plant.

Third, when action recommendations are given, always remember the crucial element of proper timing. If you diagnose pine tip blight *(Sphaeropsis sapinea)* on pine in July, it is important to specify that any chemical to prevent new infections be applied the next spring since fungicides applied at any other time will be of no use for disease control.

Fourth, recommendations should be made within a range of proper expectations. A good example is of pin oak planted in highly alkaline soil at an institutional site. Years later, the root system has grown out beyond the original root ball and amended soil into the alkaline soil. The tree begins to show symptoms of iron chlorosis, starting with interveinal yellowing (chlorosis). After years of this, the problem becomes more severe, with leaf necrosis (browning) and stem dieback. Everyone begins to notice, and it is agreed that something must be done. Experts are called in and asked for diagnosis and recommendations. With reasonable certainty, buttressed with clear-cut symptoms, as well as soil and foliar analysis tests, iron deficiency is diagnosed.

Recommendations are another matter. There are a lot of possible treatments, ranging from trunk implants of iron to the use of chelated iron fertilizers in the soil to injections of iron in the roots. However, all are problematical relative to a long-term cure of the problem, especially if the situation is severe. If you make it seem like your recommendations are absolute, then you put the grounds maintenance people who have to act on your recommendations in jeopardy of being deemed incompetent once treatments fail.

Finally, always remember that with plant diagnostics, as with human medicine, it is useful to cultivate humility. The first surefire rule of plant diagnostics is — nothing is sure fire.

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The Lake County Nursery IPM Program

Randall H. Zondag, Daniel A. Herms, Charles R. Krause, Heping Zhu, Michael E. Reding, and Ross D. Brazee

Most nurseries are small companies that produce large numbers of crops on limited acreage. These operations deal with a multitude of plant pest, disease, weed, and cultural issues, and they must also take into account worker safety as well as environmental and economic issues. The nursery growers in Lake County, Ohio, asked Ohio State University Extension to work with them over a long term to together help address these issues.

We started the Lake County Integrated Pest Management (IPM) program by developing a prioritized list of key problems. Specialists with knowledge and resources in the area were asked to help growers identify and develop management plans to handle these problems. Growers meet with researchers, Extension professionals, and pest-management product producers every two weeks during the growing season and monthly throughout the rest of the season.

These meetings provided a place for everyone to learn, discuss, and exchange information. This article outlines some of the key products of those meetings.

This Nursery IPM program is a cooperative effort between the nursery industry in Lake County, Ohio State University Extension (OSUE), the U.S. Department of Agriculture-Agricultural Research Service (USDA-ARS), and the Ohio State University Ohio Agricultural Research and Development Center (OSU/OARDC).

Tools Introduced by This Program

This program teaches growers how to scout for pests by looking at a key plant/key pest process. During the growing season, specialists and educators meet with growers to help them identify pest life cycles, level of economic control, and best methods for control.

These regular meetings give growers the chance to suggest new topics for researchers to investigate as well as provide an opportunity for researchers to provide information on new methods for controlling pests. Growers were also schooled on both cultural and biological control options they could be using.

Dan Herms has developed a phenology calendar that gives growers estimated degree days by zip code, allowing for predicted emergence times of insect pests.

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(See also: *Biological Calendars: The Statewide Network of OSU Phenology Gardens* in this publication.) This program is linked to the Lake County Extension and the nursery growers web site. From a computer screen, growers were able to look at what was present as well as what could be predicted to emerge soon.

The U.S. Department of Agriculture-Agricultural Research Service placed two weather stations in Lake County that give growers real-time information on temperature, humidity, wind speed, rainfall, and soil moisture. This information was archived so growers would have the ability to look at past trends in making decisions on irrigation, pest potential, and reapplication of products, if needed. This information is available to growers at web sites in our county in real time.

USDA-ARS developed a leaf wetness chart, showing growers how long leaves stay saturated. This information, along with archived information on air temperatures, is a useful tool in determining infection periods for plant pathogens and subsequent disease-control decisions.

This information gives growers an understanding of when rainfall occurs compared to moisture development from humidity on plants. This is useful in helping growers determine when some products are no longer effective in disease control. The information is updated every three hours and can be found on local web sites in the county.

Through grants from OSU, OARDC, and USDA, growers were provided with new methods for detecting pest presence. New pheromone, color, sticky, and light traps helped growers identify pest presence before the pests reach populations that might cause major damage.

Scouts shared information they found and demonstated how to use these traps at grower meetings. Researchers worked with growers to determine if new traps would be successful in an IPM program.

USDA-ARS and OSU educators worked with growers to determine if spray equipment was achieving the coverage desired by growers. Classes were dedicated to helping applicators do hands-on calibration of both hydraulic and air-blast sprayers. Growers then had to evaluate coverage of crops using U-V sensitive dyes.

The teams learned what they could do to improve sprayer coverage. Classes were involved in looking at new spray technology that growers could purchase to improve control of pests. Trial work was conducted in the use of systemic pesticides to control pests and improve worker safety.

OSU and USDA professionals conducted trials on determining pest life cycles and new products to control these pests. These trials are best conducted in nursery settings using scientific methods. These trials have led to the labeling of several new pesticides. The IR-4 program helped provide funding to run trials of new products that otherwise would not have been considered.

Summary

The Nursery IPM program is a cooperative effort between the nursery industry in Lake County, Ohio State University Extension, USDA's Agricultural Research Service, and Ohio State's Ohio Agricultural Research and Development Center. Industry input is needed, and without it, the program would fail.

The program provides an environment where growers can interact with

researchers and participate in an environment for exchange.

New technology and information are provided in a timely manner so it can be used by growers in making control decisions. Access to the web site, weather stations, and phenology calendars further enhance a grower's ability to make good decisions. Growers in turn help researchers by providing access to trial sites and pest populations needed for research. The success of the program is growers supporting researchers along with researchers wanting to help the growers.

This is a model that can be repeated with almost any commodity group in agriculture. IPM requires an industry that will be willing to adapt new technology if it is proven to be better than current practices. We have been fortunate in Lake County to have top researchers working with an industry that wants to be a leader.

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Useful Horticulture References for Green Industry Professionals
Part III

Pamela J. Bennett and Gary Y. Gao

This is the third Special Circular installment of useful horticultural references for green-industry professionals, horticultural educators, and gardeners. This work-in-progress is a compilation of references that horticulturists use on a regular basis.

If there are any books that should be added to this list, e-mail pjbennett@ag.osu.edu and let her know. Please note that the prices may vary, depending upon the source.

General References					
Author(s)	**Name of Book**	**Publisher/ Year**	**ISBN**	**Approx. Cost**	**Comments**
Stanton Gill, David L. Clement, and Ethel Dutky	*Pests and Diseases of Herbaceous Perennials*	Ball Publishing/1999	1-883052-20-3	$69.00	Describes pests and how to combat them.
Michael A. Dirr and Charles W. Heuser Jr.	*The Reference Manual of Woody Plant Propagation*	Varsity Press, Inc./1987	0-942375-00-9	$35.00	A great resource for those propagation questions.
Whitney Cranshaw	*Garden Insects of North America*	Princeton University Press/2004	0-691-09561-2	$30.00	The ultimate guide to backyard bugs, includes color pictures.
Fred Hower and Alison Beck	*Tree and Shrub Gardening for Ohio*	Lone Pine Publishing/2004	1-55105-402-7	$19.00	Color pictures and text to help select, plant, and care for trees and shrubs.
Michael A. Dirr	*Dirr's Hardy Trees and Shrubs*	Timber Press/1997	0-88192-404-0	$70.00	Excellent color pictures describing the best woody plants to use in the landscape.

Author(s)	Name of Book	Publisher/ Year	ISBN	Approx. Cost	Comments
Denise Wiles Adams	*Restoring American Gardens*	Timber Press/2004	0-88192-619-1	$40.00	An encyclopedia of heirloom plants.
Lawrence Newcomb	*Newcomb's Wildflower Guide*	Little, Brown and Company/ 1977	0-316-60442-9	$15.00	Once you learn how to use this key, identifying wildflowers is easy.
Robert L. Henn	*Wildflowers of Ohio*	Indiana University Press/1998	0-253-21167-0	$20.00	Good color pictures to help identify wildflowers.
Gordon Cheers (publ.)	*Flora*	Firefly Books/2003	1-55297-843-5	$20.00	A compre-hensive list of common plant names and their Latin name.
Nancy J. Turner and Adam F. Szczawinkski	*Common Poisonous Plants and Mushrooms of North America*	Timber Press/1991	0-88192-312-5	$25.00	An excellent resource for answering questions about poisonous plants.
P. Allen Smith	*Garden Home*	Clarkson Potter Publishers/ 2003	0-609-60032-7	$30.00	A very interesting book on garden design.
Christopher Brickell	*Pruning and Training*	DK Publishing/ 1996	1-56458-331-7	$35.00	A fully illustrated plant-by-plant manual on pruning.

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Lessons Learned at the Mid-Pac Horticultural Expo and Hawaii Export Nursery Association (HENA) Conference

Charles T. Behnke and Harold H. Kneen

For the last several years, this newly emerging trade show — Mid-Pac Horticultural Expo and Hawaii Export Nursery Association (HENA) and conference — was held in Hilo, Hawaii, the last week in October to promote Hawaiian ornamental horticulture. This year the meeting was on October 25-29.

Production of sugarcane and pineapple has all but ceased to exist in Hawaii as a major agricultural revenue source. Hawaiian ornamentals are great potential sources not only to the mainland United States of America but also the affluent Asian markets. Remember, Hawaii is about midway between the continents.

Some 65 growers are listed in the HENA directory and on the Internet at **www.HENA.org.** These growers work to grow such certified nursery plant materials as orchids, anthuriums, proteas, bromeliads, exotic palms, dracaena, Norfolk Island pine, and other tropicals such as cacao and spices for local development.

Exporters are trying to develop a more comprehensive infrastructure to assist in the expansion of the ornamental horticulture industry.

Partnering with state and federal government, research universities, the Farm Bureau, trade associations, and ornamental and production horticulture entrepreneurs is vital for their future expansion. Even marketing on the Internet was being discussed with an e-commerce cooperative survey given to HENA members by the University of Hawaii-Hilo.

All the items destined for the mainland must be grown according to certification standards of the Hawaii Department of Agriculture, with special regard to preventing movement of the burrowing nematodes and other pests. Potted plants must be grown at least 18 inches above soil level. Inspections are done at least four times a year. Cut plant material such as palm fronds and philodendron leaves are hand washed both top and bottom with insecticidal soap before export.

Plants such as palms and dracaena are shipped to the U.S. mainland on 24' or 40' sealed sea containers that can take five days in transit to Long Beach. Recently, due to dock slowdowns, these sea containers often spent another 10 to 14 days in port, waiting to be unloaded, which caused significant stress on the plants.

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Trailers are then loaded on trucks or rail for shipment to their final destination. Some shipments are currently being diverted to Oakland, Calif.

We observed 15' to 20' container-grown palms being loaded into shipping containers. Smaller container-grown palms were being packed around the larger palms. This sea-land transportation and backup at mainland West Coast ports can lead to plant decline, but it seems it is worth the risk. A number of large palms were destined for construction projects in Las Vegas, Nev.

Smaller ornamentals may be shipped by FedEx, United Parcel Service, and other air-freight carriers providing two-day service to most of the U.S. mainland. Specialized shipping containers and boxes were used at several packing houses.

High-value crops such as orchids are shipped by air freight with two-day delivery. Mainland weather can play havoc at times, especially during the winter, and shippers are very attuned to mainland weather and packaging requirements.

Dracaena growers are looking for improved cultivars to offer clients. There is a breeding program to develop new cultivars through the University of Hawaii-Hilo and the Agricultural Research Service-U.S. Pacific Basin Agricultural Research Center, Hilo. Some orchid growers are diversifying into intergeneric forms of orchids.

Some of the upcoming compliance challenges with certifications are the Coqui frog invasion **(www.ctahr.hawaii.edu/coqui)** and brown snake; both can easily break certification barriers.

Other pests include nettle caterpiller on Rhapis palm, cycad scale *(Aulacaspis yasumatsui)* on cycad Sago Palm, little fire ant *(Wasmannia auropunctata)*, cotton lace bug *(Corythucha gossypii)*, giant whitefly *(Aleurodicus dugensii)*, and daylilly rust.

Most greenhouses are really shade houses with a 30 to 70% shade cloth suspended 15 to 20 ft. above ground on telephone poles or metal poles. These modify growing conditions and rainfall. Significant lichen populations are attached to these shade cloth structures.

Growing benches were placed on stacked cement blocks with stainless hog wire for pot support. Benches in some facilities had an additional copper screen as a barrier for slugs and snails. Orchid and anthurium cut flower and potted plants were growing in poly-covered gutter-connected houses. This minimized excessive rainfall and potential spotting on cut flowers.

Recently, the eastern side of the Big Island had a minor drought. Large water-holding tanks are common at nurseries. Some have in-ground rubber-membrane-lined ponds, with greater than two-million-gallon capacities. Rural water provides some growers year-round access, while several growers buy water just in emergencies.

Trickle spaghetti tubing was used by many growers in the drier areas to conserve water and reduce runoff. One nursery used ground tire mulch as a weed control on field production. Ground tire mulch was applied to containers for weed control with good results. It was noted that the soil application of recycled tire mulch could be a potential fire hazard in the greenhouse. It did give provide good weed suppression, however.

The main supporting soil is volcanic cinders and Canadian and European sphagnum peats in ratios from 40:60 to as much as an 80:20 mix. Growers like these mixes because of their porosity,

waterholding and cation-exchange capacity, lack of shrinkage, and longevity. Other substrates used in place of peat moss were coconut hull and bark chips which had greater breakdown.

Most growers used a slow-release resin-coated fertilizer. Liquid feed fertilizers were used when plants were small and as supplemental feed. The cinders allowed for good air porosity, especially when some production sites can get up to 300 inches of rainfall a year. In addition, cinders are very low in fluorides, which are detrimental to most foliage plants, especially dracaena production. Orchid plants, too, are grown in this mix, along with being placed in growing trays.

This trip was a once-in-a-lifetime opportunity for the authors, as we saw horticulture both exotic and familiar. Lessons learned are sure to find their way into our Extension programming and perspectives. As Rudyard Kipling quipped: "He who only England knows, knows England least."

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