Ornamental Plants

Annual Reports
and
Research Reviews

THE OHIO STATE UNIVERSITY
OARDC

THE OHIO STATE UNIVERSITY
EXTENSION

January 1998
Special Circular 157
Ohio Agricultural Research and Development Center
In Partnership with Ohio State University Extension

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OARDC

Thomas L. Payne
Director

Ohio Agricultural Research and Development Center
Wooster, Ohio

Cover Photo: Erik Draper of Ohio State University Extension stands next to towering dawn redwoods *(Metasequoia glyptostroboides)* at the Secrest Arboretum on the Ohio Agricultural Research and Development Center's Wooster campus. These fast-growing native Asian trees were planted at Secrest in 1953, following their discovery in China in the early 1940s. They are already among the tallest trees in the Arboretum.

Ornamental Plants

Annual Reports
and
Research Reviews

Edited By
Mary Ann Rose
and
James A. Chatfield

Ohio Agricultural Research and Development Center
Ohio State University Extension
Department of Horticulture and Crop Science
The Ohio State University

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Contents

Ohio State University Extension Nursery, Landscape, and Turf Team Directory: 1998

Directory Developed by Jack Kerrigan

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.

Team Members

Charles Behnke

- Diagnosis of cultural problems of trees and shrubs
- Weed identification
- Insect identification
- Greenhouse management
- Garden center employee training
- IPM

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Jack Kerrigan, Ohio State University Extension, Cuyahoga County.

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- Consumer and environmental horticulture
- Garden center employee training
- Landscape ornamentals
- Landscape maintenance
- Communications

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Joe Boggs

- Ornamental entomology
- Landscape management
- Turf management
- Tree nursery management
- Urban forestry
- Diagnosis of plant problems
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Jim Chatfield

- Diagnosis of plant problems
- Plant disease control
- Ornamental plant selection
- Plant pest monitoring
- IPM

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Ken Cochran

- Taxonomy and classification of ornamental plants
- Plant selection for environmental enhancement
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- Nursery operations and management
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- Tree fruits and small fruits
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- Phenology

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- Composting
- Compost-amended substrates to control disease

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- Consumer and environmental horticulture
- Landscape design and plant selection
- Diagnosis of landscape cultural problems
- Landscaper/home-owner conflict resolution
- Communications for media

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- Pesticide training
- Diagnosis of landscape problems
- Nematodes
- Pesticide regulations

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- Plant disease management
- Application technology research
- Spray drift
- Abiotic disease diagnosis
- Cultivar identification of nursery and greenhouse crops

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- Integrated pest management

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- Landscape ornamentals
- Landscape maintenance practices
- Garden center employee training
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Bill Pound

- Turfgrass fertility
- Turfgrass weed control
- Turfgrass selection and establishment
- Turfgrass growth regulators
- Turfgrass culture (aerification, irrigation, and mowing)
- IPM

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- Economics
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- Turfgrass management
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- Turfgrass patch diseases
- Landscape management
- Diagnosis of landscape problems
- IPM

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- Volunteer management
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- Nursery container production
- Weed control

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Dave Shetlar

- Ornamental tree and shrub entomology
- Turfgrass entomology
- Christmas tree entomology
- Pest monitoring and detection
- IPM

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Tom Shockey

- Garden center employee training
- Department of Horticulture and Crop Science intern placement
- Consumer horticulture
- Youth gardening project evaluation

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Amy Stone

- Consumer and environmental horticulture
- Green industry training (NW Ohio)
- Landscape maintenance practices

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- Turfgrass management
- Turfgrass fertilization
- Turfgrass weed control
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Nancy Taylor

- Diagnosis of plant diseases
- Diagnosis of ornamental, tree, and shrub diseases
- Coordinator of the C. Wayne Ellett Plant and Pest Diagnostic Clinic

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Randy Zondag

- Commercial nursery production (field and container, fertility, pesticide, safety, and water quality)
- Landscape installation and maintenance
- IPM
- Soils
- Greenhouse management
- Fruit production

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—•—

Floriculture Industry Roundtable of Ohio: 1998

Directory Developed by Charles Behnke

Our Mission

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

Roundtable Resources and Team Members

Greenhouse Management

Behnke, Charles
Everett, Craig
Gao, Gary
Kneen, Hal
Krauskopf, Dean
McMahon, Peg
Moll, Norm
Pasian, Claudio

Plant Pathology

Hoitink, Harry
Nameth, Steve
Taylor, Nancy

Entomology

Lindquist, Dick
Steele, Julie

Food, Agricultural, and Biological Engineering/Greenhouse Environment

Short, Ted

Management and Economics

Kneen, Hal
Rhodus, Tim

Composting

Hoitink, Harry

Crop Physiology

Carver, Steve
McMahon, Peg
Metzger, James
Pasian, Claudio

Nutrient Analysis/Water Quality

Carver, Steve
Krauskopf, Dean
Watson, Maurice

Charles Behnke, Ohio State University Extension, Lorain County

Team Members

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- Greenhouse management
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- Production/postproduction physiology
- Plant nutrition
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- Greenhouse management and production

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- Composting
- Potting mixes/container media formulation
- Biocontrol of plant diseases

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

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

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- Integrated Pest Management of greenhouse crops
- Testing of products, equipment, "beneficials"

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

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

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- Greenhouse management

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- Diseases of floral crops: identification, control, and management
- Identification and characterization of viruses of floral crops

Pasian, Claudio

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- Crop eco-physiology
- Production and management
- Modeling and timing of floricultural crops

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

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- Greenhouse system design for optimum production
- Evapotranspiration of greenhouse crops
- Solar energy systems
- Mechanization of horticultural crops

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- Diagnosis of plant diseases, all crops

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

Ohio State University Extension Buckeye Yard and Garden Line

James A. Chatfield, Pamela J. Bennett, Joseph F. Boggs, Gary Y. Gao, Jane C. Martin, David J. Shetlar, and Randall H. Zondag

Summary

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 Team (ENLTT) provide ornamental plant and plant problem information to the green industry, to Extension offices, and to the general public. The article that follows answers some questions about BYGL and provides the results of the 1997 BYGL Evaluation Survey.

What Is BYGL?

The *Buckeye Yard and Garden Line* (BYGL) is a weekly plant update in the form of an electronic newsletter. It is written by OSU Extension agents and specialists, from a conference call held every Tuesday from April–October. BYGL is funded by the Ohio Nursery and Landscape Association and OSU Extension, with additional contributions from the Ohio Chapter of the International Society of Arboriculture.

Who Is BYGL's Audience?

BYGL is written for green industry professionals, Extension agents, Master Gardeners, and other horticulturists in Ohio and throughout the United States, especially the Midwest.

How Do You Receive BYGL?

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

- By e-mail: simply send your e-mail address to chatfield.1@osu.edu
- On the World Wide Web: Access Buckeye Yard and Garden onLine on OSU's Horticulture in Virtual Perspective (*http//hortwww-2.ag.ohio-state.edu/hvp*) or on OSU Extension's Ohioline (*http://www.ag.ohio-state.edu*)
- For fax newsletter subscriptions: contact one of these Ohio State University Extension offices:

ABE Center (NW Ohio)
Amy Stone 419-354-6916

Clark County
Pam Bennett 937-328-4607

James A. Chatfield, Ohio State University Extension, Northeast District/Horticulture and Crop Science; Pamela J. Bennett, Ohio State University Extension, Clark County; Joseph F. Boggs, Ohio State University Extension, Hamilton County; Gary Y. Gao, Ohio State University Extension, Clermont County; Jane C. Martin, Ohio State University Extension, Franklin County; David J. Shetlar, Ohio State University Extension/Ohio Agricultural Research and Development Center, Entomology; and Randall H. Zondag, Ohio State University Extension, Lake County.

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Hamilton County	
Joe Boggs	513-825-6000
Lake County	
Randy Zondag	440-350-2269
Montgomery County	
Pete Lane	937-224-9654

Is There a Cost for BYGL?

Only the fax subscriptions have a fee ($35 a year) to cover phone line costs, and even fax subscriptions are free for members of the Ohio Nursery and Landscape Association, the Ohio Chapter of the International Society of Arboriculture, and the Ohio Turfgrass Foundation.

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 (1–2 paragraphs) of the most relevant information on a particular topic. We also strive for a lively, user-friendly, sometimes humorous style.

What Is Buckeye Yard and Garden onLine?

This is the World Wide Web version of BYGL, and it comes not only with the text of BYGL available on the e-mail and fax versions, but also with hot links to color images of pests and plants and to more than 9,000 additional fact sheets from Ohio State and other universities.

What Is BYGLive!?

BYGLive! is a series of informal programs at arboreta throughout Ohio on the first Monday or Tuesday of each month, May–October. The participants have a chance to see plants and plant and pest development throughout the season at sites listed here, to do some diagnostic troubleshooting, and to provide observations and insights that will add to the next day's BYGL conference call. Sites for 1998, with key contacts, are:

- **Cincinnati @ Spring Grove Arboretum**
  (starts in April)
  Joe Boggs
  513-825-6000
- **Central Ohio @ Whetstone Park of Roses**
  Joe Rimelspach
  614-292-9283
- **Wooster @ Secrest Arboretum**
  Ken Cochran
  330-263-3761
- **Toledo at Stranahan Arboretum**
  Amy Stone
  419-354-6916
- **Akron @ Seiberling Naturealm**
  (year-round on the 1st Monday of the month)
  Denise Ellsworth
  330-497-1611
- **Painesville @ Holden Arboretum**
  (Tuesdays)
  Randy Zondag
  440-350-2269

What Were the Results of the 1997 BYGL Evaluation Survey?

Number of respondents = 290
Key to Responses:

SA	=	Strongly Agree
A	=	Agree
N	=	Neutral
D	=	Disagree
SD	=	Strongly Disagree

Evaluation Question 1:
BYGL was useful to my job and business.

SA	=	211
A	=	79
N	=	0
D	=	0
SD	=	0

Evaluation Question 2:
BYGL helped in answering clientele questions.

SA	=	128
A	=	118
N	=	39
D	=	0
SD	=	0

Evaluation Question 3:
BYGL was timely.

SA	=	195
A	=	82
N	=	7
D	=	0
SD	=	0

Evaluation Question 4:
I (we) changed some horticultural practices based on BYGL.

SA	=	64
A	=	134
N	=	88
D	=	0
SD	=	0

Evaluation Question 5:
BYGL has resulted in improved customer service in our company.

SA	=	30
A	=	218
N	=	38
D	=	0
SD	=	0

Evaluation Question 6:
In this question, we asked respondents to rate in order of preference (1–6) a series of BYGL features. We subsequently considered the results to be unreliable once we discovered that some respondents used 1 as their "most useful" and others meant 6 to indicate the most useful feature. Therefore, we will not present the confused results here, but we will try this question, with better instructions, again next year.

Evaluation Question 7:
Do you use BYGL in employee training?

Yes	=	211
No	=	73

Evaluation Question 8:
How many people read BYGL from access to your subscription?

From 290 respondents = 2,972

Evaluation Question 9:
Has the information in BYGL saved your company money?

Yes	=	160
No	=	56

Note:
A number of institutional respondents responded "Not Applicable" to this question.

Evaluation Question 10:
Does your company have:

Fax	=	251
Computer	=	197
Compact Disc Drive	=	189
Modem	=	151
E-mail	=	139
Web Access	=	138

From 290 respondents.

Selected Suggestions and Comments from the Evaluation Survey
[with our responses in italics]:

"I would like to see enhancements via URL links to other sites."

— Doug Thompson
Cadsel-Mouristy Designs

We will improve this next year on Buckeye Yard and Garden onLine, under the tutelage of our Webmaster Tim Rhodus of the Ohio State University Department of Horticulture and Crop Science.

"Has helped us steer away from old-time favorite crabapples to ones that in the long run are more disease and pest resistant."

— Also from Doug Thompson

Now there is a welcome practice change we can all be proud of!

"I would like an index/table of contents at the beginning of each BYGL. Kind of lets me know what is coming up, especially if I have to zero in on an article of immediate interest."

— Larry Kaplan
Purdue

One of the BYGL writers, Randy Zondag, has argued for this the last several years. He wins!

"Appreciated it when Zondag gave planting recommendations because timing for extreme northeast Ohio is always a little different from the rest of the world."

— Northeast Ohio landscaper

This is one of several requests for more horticultural information to complement the pest and disease items in the BYGL. We shall gladly comply.

"I would prefer it if all the advertising, warnings, and caveats be moved to the end of the post."

We will improve this next year. Acknowledging those who help make BYGL possible, making sure that people know who is responsible for the text, and assorted caveats are very important, but we agree that we must find a more user-friendly way to include them in each BYGL.

"Keep the information as direct and brief as possible."

Each year we receive many pleas such as this, and we have concluded that the essence of BYGL is the short bytes of information that can be digested readily during the horticulturists' busy season. If BYGL is too wordy and long, users will simply become non-users, so we take this concern seriously.

"More specific pesticide information."

We get one or two of these requests yearly, and we do include pesticide information where it is essential. But, referring to the last concern regarding brevity, we continue to be wary about extensive listings of available pesticides.

"More turf management information."

We have taken this to heart, and there will be *more timely turf information available to the industry next year. Stay tuned.*

"BYGL saves us time and time is money!"
— Dan Balser
Ohio Department of Natural Resources

"It has reduced the urge to apply pesticides when results would be marginal or ineffective."
— Bob Avenius
TruGreen-Chemlawn

"Lower overall plant losses due to being informed."
— Rick Riccardi
University of Akron

"Saved on tree damage claims."
— Al Klonowski
First Energy

"We have used lots of PPFAX (the Boggs FAX BYGL+) info on new Tip Sheets that bring customers in. Our replacements are down due to info on certain varieties that have changed our product mix."
— Denny McKeown
Radio Host and Blooming Garden Center

"By using better timed pesticide and fungicide sprays. Also we are more time efficient with diagnosis and course of action."
— Keith Manbeck
Manbeck Nurseries

"By not treating past the application window."
— Landscape manager

"Valuable as a backup — if it's in the BYGLine then we are fine."
— Landscaper

"Particularly useful in not chasing the rainbow of control of certain pests."
— Landscape manager

"Made us more professional."
— Several respondents

These last 10 comments are representative of how people are putting BYGL to use and are the sort of thing for which we constantly strive. So keep letting us know of ways that BYGL is useful to you and how we can make it better.

"The BYGL is far-reaching."
— Deb Brown
University of Minnesota

The BYGL does get around, even to Hawaii, and there are quite a number of international hits on Buckeye Yard and Garden onLine. We may even have gone galactic with this response — "I've enjoyed BYGL since learning of it at a pesticide conference in Mars earlier this year"— though I suppose it was really Mars, Pennsylvania.

"Less playful banter — more useful information."

We do try to take it seriously when readers have had enough of the humor and playfulness that is part of BYGL. However, for every comic concern we receive many comments that a hint of humor is what keeps people reading. Here is one such note from Chris Starbuck from the University of Missouri.

"Bravo! The info is always timely and helpful, but most of all I love the humor. Entertaining education is hard to come by. I particularly like the piece that wove in all the herbicide names. Keep up the good work!"

To close this article, then we will repeat one of our responses this year to our BYGLMail.

"One BYGLer recently received a query regarding an item entitled 'Artillery Fungus Fusillade' from BYGL 97-2. It read, 'I am confused about the inclusion of the herbicide Fusilade in the article. What bearing does this have on the article as written? Is there some connection

between the herbicide and the artillery fungus? Please let me know if there is a link or if this was just a misprinted word.'

"Assuming that this ole hound's leg is not being pulled, we shall clarify. We were referring not to the herbicide 'Fusilade' (spelled with one 'l' by the way), but rather to the word 'fusillade' (spelled 'll') in the dictionary sense of 'a discharge from a number of firearms, fired simultaneously or in rapid succession.' This seemed like good imagery to describe the shooting into the air of the spore masses from the shotgun or artillery fungus onto siding, cars, and plants.

"Our dual goal is to manage to educate within the dimension of lively writing. Some give us acclaim for this. Others would like to stomp on us, to torpedo us, to oust, to pounce with the full force of all the ammo in their arsenal. Scimitar in hands, they would confront us at the barricade, to force a showdown to some grand finale. We welcome the point-counterpoint. We salute you. Bravo!"

We hope you noted the 16 pesticide trade names in that last paragraph and conclude by saying: "Ain't communication fun!"

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Environmental and Cultural Problems of Ornamental Plants in Ohio: 1997

Pamela J. Bennett and Jane C. Martin

Summary

The spring of 1997 unfolded slowly and was followed by a cooler than normal summer. Record lows on April 9 and 10 were reported from many parts of the state, followed by an abnormally cool May; there were reports of plants and insects emerging later than normal. April was dry across Ohio, with below normal rainfall. May and June rainfall was above normal, July was slightly below normal, and August was above normal. Rainfall as of September 23 was below normal.

A few species of plants exhibited winter injury while a number of plants experienced various damage due to low temperatures and scattered frosts in April. Dry periods during the summer resulted in several species exhibiting yellowing of foliage and leaf scorch. Reports continued into the fall regarding plants blooming later than normal and insects extending their activity.

Introduction

Included in this report is a compilation of Ohio weather conditions and noteworthy environmentally induced and cultural plant problems in 1997. Observations are drawn from information provided in Ohio State University Extension's *Buckeye Yard and Garden Line* and the *Ohio Department of Natural Resources Monthly Water Inventory Report* and information from the State Climatologist's Office for Ohio.

Discussion

Weather Background

The most significant early season weather event was severe March flooding in southern Ohio and northern Kentucky. Following this, the spring of 1997 developed slowly in Ohio. Temperatures averaged well below normal in April. Cincinnati and Columbus reported 22 days of below normal temperatures, and Cleveland reported an average of 3°F below normal. Record lows were set on April 9 and 10, with temperatures dipping as low as 15°F in some areas. Rainfall was noticeably below normal across the state in April. The state average was 1.65", which was 1.86" below normal. This ranked as the ninth driest April in the last 115 years. Most precipitation fell as light rain showers.

May remained cool. Cleveland reported the second coolest May on record, with the average high temperature being 52.2°F. Cincinnati reported the third coolest May on record, with an average high of 57°F;

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Columbus had an average high of 56.5°F. Rainfall was above normal across most of the state. The average was 5.31", 1.56" above normal. It was the second wettest May in 106 years in the northwest and north-central regions of Ohio. Heavy rain fell on May 1–2 and was much needed after a dry April. May 18–19 brought heavy storms, some with localized flash flooding in southern Ohio. Heavy storms arrived again on May 24 and 25 followed by a slow moving storm on May 29–June 2, which triggered some additional flooding.

Temperatures were below normal the first half of June, but warmed to near normal in the second half. Rainfall was above normal across most of Ohio, with a state average of 4.99", 1.03" above normal. Strong storms on June 16–18 were common statewide. The last 10 days of the month were dry.

Other than a cool period ranging from seven to 10 days around the Fourth of July weekend, July temperatures were normal or slightly above normal. Rainfall was slightly below normal with a state average of 3.34", which was .58" below normal. A few locations in southwestern Ohio and numerous locations in northeastern Ohio reported less than one inch of rain in July. Rain fell as showers and thundershowers with some locally heavy storms. Most rain fell in the first and last 10 days of the month with the middle rather dry in most locations. On July 26 and 27, 8" of rain fell in east-central Ohio, which caused severe flooding that closed I-70 for two days.

August cooled off with below normal temperatures; Cincinnati reported 18 days of below normal temperatures, and Columbus reported 15 days. Record lows were set the first week with Cleveland reporting 48°F, Mansfield reporting 49°F, and Youngstown reporting 41°F. August rain fell as showers typical of the season, and rainfall was above normal in most of the state, with a few locations in southern and western Ohio with below normal rainfall. The state average was 4.86", 1.38" above normal. Most rain fell in the middle of the month.

September was also cool and dry. Cincinnati reported 16 days and Columbus reported 12 days with below normal average temperatures. A low of 44°F was set on September 4 and 5 in Columbus and Cincinnati, respectively. Rainfall was also below normal for the month, with only .55" reported in Cincinnati and 1.36" reported in Columbus.

Weather Effects on Plants

Little winter injury to plants was reported with the exception of the following — stem splitting on rhododendron, leaf browning from winter desiccation on boxwood, and cane damage to roses.

Record low temperatures in early April resulted in leaf burn damage to Callery pears, crabapples, wintercreeper euonymus, red-leaved Japanese maples, ajuga, and katsuratree. Frost damage was noted on the primary buds of red oak and silver maple in central Ohio, and bur oak and green ash in southern Ohio. Perennials such as hosta and bleeding heart suffered foliage damage as a result of these frosts. It was observed that the farther south one went in Ohio, more damage was apparent. This was because plants were further along in development.

Cool spring weather conditions resulted in many plants experiencing delayed blooming or prolonged blooming. While the first blooms of roses were delayed, daffodil, serviceberry, and crabapples enjoyed a very long season in the spring. By mid-summer, plants were still noted to be about 10 days behind their normal blooming period. Plants such as daylilies, rudbeckia, anemones, hydrangea, and many ornamental grasses were delayed up to two weeks from their normal bloom times.

Hot, dry conditions in late June and July resulted in leaf yellowing of birch and tuliptree, and leaf scorch on red oak, horsechestnuts, and buckeyes. Dry summer weather also made the symptoms of iron deficiency more evident on sweet gum, pin oak, and birch, as with manganese deficiency on red maple. Interveinal chlorosis, or yellowing between the veins due to a micronutrient deficiency, is a key distinction from overall leaf yellowing due to general moisture stress.

Planting Conditions

Soil conditions for the spring and fall planting seasons were unusually good. In most areas of the state, the soils were fairly dry and workable. These dry soils also resulted in the need for watering newly planted landscape materials in both the spring and fall. In addition, people were able to plant annuals earlier than normal in the spring, planting in cold soils in many cases. This resulted in numerous observations of phosphorus deficiency in plants.

Trees and Construction

Injury as a result of construction was reported periodically this year. Individuals desiring to build in a wooded area need to make plans for tree protection prior to construction. Landscapers should also make clients aware of the potential damage that could result from soil compaction, soil fill added over the root zone, and injury to the trunk. Tree species respond differently to the stress of construction activity. Informational resources on the tolerance of trees to construction injury should be consulted prior to the project.

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Insect and Mite Activity Noted in Ohio Nurseries and Landscapes: 1997

Joseph F. Boggs, David J. Shetlar, Jane C. Martin, Pamela J. Bennett, James A. Chatfield, Gary Y. Gao, and Chris Carlson

Summary

High populations of several web-spinning caterpillars occurred this season in various areas of Ohio. Damaging population levels of the common bagworm *(Thyridopteryx ephemeraeformis)* were observed in the southern and central part of the state. Gypsy moth *(Lymantria dispar)* caterpillars appeared in both the northeast and northwest parts of the state; however, infection by the entomopathogenic fungus, *Entomophaga maimaiga*, suppressed populations in some areas of northeastern Ohio. Sawfly populations remained low throughout the state with the exception of the European pine sawfly *(Neodiprion sertifier)* and the elm leafminer *(Fenusa ulmi)*. Although lace bugs and spruce spider mites *(Oligonychus ununguis)* appeared in the spring, damaging populations were not observed until late summer and early fall, respectively.

Several insects had atypical life cycles this season. Various scale insects had unusually long crawler stages or crawlers appeared at unusual times of the year. Japanese beetle *(Popillia japonica)* adults were present for an extended period of time, and most late fall larvae were second instars rather than third instars, the stage that normally overwinters.

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Introduction

Insect and mite activities reported in 1997 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 are also reported.

Discussion

Bagworms

Populations of the common bagworm *(Thyridopteryx ephemeraeformis)* have been increasing each year in Ohio since the severe winter of 1993–94 significantly reduced the occurrence of this insect (3). However, the distribution of bagworm remains highly variable between the northern and southern parts of the state. For example, it was noted in July that this insect was common in the southern part of the state, slightly less evident in the central part, and less common in the extreme northern parts of Ohio.

Bagworms were reported hatching in southern Ohio in late May. Upon hatching, first instar larvae produce single threads of silk to catch the wind and "balloon" to new sites where they immediately begin feeding and constructing silk-lined bags from host plant material. Small bags were observed in early June in the southern part of the state and in mid-June in central Ohio. Insecticide efficacy is maximized if these early instar larvae are targeted.

High populations and heavy defoliation of many conifers and certain deciduous trees, particularly honeylocust and boxelder, were observed in central and south-central Ohio in mid- to late-July. Bagworms pupated in southern Ohio in mid-September, and male moths were observed in central Ohio in late September.

Webworms

Dave Shetlar designated 1997 as "The Year of Webbing Caterpillars." The abundant webbing produced in the spring by the Eastern tent caterpillar *(Malacosoma americanum)* on roadside cherries and landscape crabapples was soon followed by the bountiful nests of fall webworm *(Hyphantria cunea)* on cherry, walnut, and hickory. Mimosa webworm *(Homadaula anisocentra)* prominently displayed its unsightly nests on honeylocust, and baldcypress webworm *(Coleotechnites apicitripunctella)* added its handiwork to the tangled season.

Although fall webworm was evident in southern and central Ohio, populations were particularly heavy in northern Ohio. In early July, Dan Herms (Ohio State University, Entomology) was the first BYGLer this season to report that early instar larvae were spinning nests in Ohio. Dan noted in late July that nests throughout Ohio contained all larval instar stages, indicating a wide variation in developmental rates within the state. Heavy webbing and substantial larval feeding damage in north-central and northeastern Ohio were reported throughout August.

By mid-September, larvae were reported to be "bombarding" homes in northeastern Ohio as they searched for locations in which to pupate for the winter. Although larvae often pupate within the nests, under high population densities, the caterpillars may leave the trees and pupate in the ground or in other protected areas such as under decking.

Ohio State University Extension Fact Sheet HYG-2065-95, *Fall Webworm Management*, indicates that more than 80 species of parasites and predators have been identified as potential invaders of fall webworm domiciles, the large silk webs which enclose leaves at the tips of branches. On August 21, Dan Herms reported that a significant number of parasites were emerging from field-collected fall webworm colonies that he was maintaining for research purposes. He noted that "these parasites, as well as numerous predators, are responsible for the cyclic nature of fall webworm populations. Although this happens to be a particularly good year for this insect (or bad year, depending upon your perspective!), populations should continue to follow a 'peak and valley' cycle historically observed and begin to decline either next year or the year following."

Mimosa webworm on honeylocust has been reported in Ohio in past years; however, populations were unusually abundant during the 1997 season (3, 4). Larvae of this moth skeletonize the lower leaf surface as they feed within "nests" consisting of webs spun over the foliage. Small nests constructed by early instar larvae were first observed this season in early July in southern Ohio. Nests expanded rapidly, and heavy damage was reported in southern and central Ohio in late July. Some damage was also observed in northern Ohio. Spray programs to control this insect appeared to be most effective on early instar larvae since dense webbing produced by later instars is not easily infiltrated by insecticide materials.

Three generations of mimosa webworm occurred in Ohio this season. The first two generations overlapped, and the nearly continuous larval feeding activity caused extensive damage. However, the third generation did not appear until after a two- to three-week pause in feeding activity which lasted from mid-August to early September. This brief respite allowed some heavily defoliated honeylocusts to produce a flush of new growth which became fodder for the final generation. The third generation appeared in September and pupated in early to mid-October.

Two reports this season illustrated the importance of bio-allies in reducing mimosa webworm populations. The August 7 BYGL noted that nests on several trees in northern Ohio were found to be free of webworm larvae but were heavily populated by predaceous Hemipteran bugs. In the October 16 BYGL, third-generation pupae found in central Ohio were reported to be heavily parasitized. These observations are significant since the wide distribution and profusion of this insect during the 1997 season may cause some to conclude that mimosa webworm could be a serious problem next year.

In early July, Dan Balser (Ohio Department of Natural Resources, Division of Forestry) reported baldcypress webworm on baldcypress in several western Ohio counties. The tannish-green larvae of this small Gelechiid moth first mine the leaves of baldcypress or hemlock, then they web the mined leaves together, forming broad, flat nests. The insect seldom causes significant damage; however, Dave Shetlar observed a baldcypress on the Ohio State University campus that was completely defoliated by this insect earlier this year. Thus, high populations do sometimes occur and could warrant control measures.

Other Caterpillars

Gypsy moth *(Lymantria dispar)* eggs hatched this season in northeastern and northwestern Ohio in early to mid-May. Second and third instar larvae were observed in both areas of the state in late May to early June. By mid- to late-June, larvae in those parts of Ohio had reached the third and fourth instar stages, and some fifth instar larvae were found by the end of the month. Populations were high, and damage was heavy this season in some areas of northwestern Ohio; however, in northeastern Ohio, Dave Shetlar observed substantial larval infection by the entomopathogenic fungus, *Entomophaga maimaiga,* in early July. Dave Shetlar also reported that some populations in northeastern Ohio were seriously depleted by fungal infection.

In past years, gregarious feeding caterpillars such as the yellownecked caterpillar *(Datana ministra),* walnut caterpillar *(D. integerrima),* and the hickory tussock moth *(Lophocampa caryae)* were common, and some sporadic outbreaks were observed (3, 4). However, of the three, only the yellownecked caterpillar was observed causing significant injury this season in Ohio.

Also reported in BYGL in mid-September was the occurrence on maples in southwestern Ohio of another gregarious feeding caterpillar, the orangehumped mapleworm *(Symmerista leucitys).* The orangehumped mapleworm looks similar to another "Quasimodo" moth larva, the redhumped oakworm *(S. canicosta);* however, the mapleworm has an orange head capsule and hump (on the eighth abdominal segment) and three fine, black dorsal stripes. The redhumped oakworm has a reddish-orange head capsule and hump, and five fine, black dorsal lines. Early instar larvae of both insects feed in groups and skeletonize leaves. Later instars feed singly and devour the entire leaf, leaving only the midvein. There is one generation per year for both insects.

Large solitary-feeding caterpillars, such as the 4- to 6-inch-long hickory horned devil (regal or royal walnut moth, *Citheronia regalis),* the catalpa hornworm (catalpa Sphinx moth, *Ceratomia catalpae),* the tomato hornworm (five spotted hawk moth, *Manduca quinquemaculata),* and the parsleyworm (black swallowtail butterfly, *Popilio polyxenes),* were also common this season. However, heavy parasitism and predation were reported relative to these "giant caterpillars" in late August.

Sawflies

The abundance of sawflies in 1993 and 1996 caused those years to be tagged "the years of the sawflies" (1, 4). Conversely, the relative scarcity of these insects this season could justify calling 1997 "the year (nearly) without sawflies." The following sawflies were observed in Ohio landscapes — the introduced pine sawfly *(Diprion similis),* maple petiole borer *(Caulocampus acericaulis),* azalea sawfly *(Amauronematus azaleae),* dogwood sawfly *(Macremphytus tarsatus),* dusky birch sawfly *(Croesus latitarsus),* and the late-season white pine sawfly *(Neodiprion pinetum).* However, with few exceptions, little widespread damage from these sawflies was noted.

The two sawflies that proved to be exceptions to the general observation that sawflies were scarce this season were the early season European pine sawfly *(N. sertifier)* and the elm leafminer *(Fenusa ulmi).* High populations of European pine sawfly and heavy damage to pines in Christmas tree plantations and landscapes in southwest Ohio was reported in mid-May. The elm leafminer also appeared in impressive numbers in southwest Ohio (see "Leafminers" which follows).

Leafminers

The annual ravaging of black locust leaves by locust leafminer *(Odontota dorsalis)* occurred this season throughout much of Ohio (3). The digitate blotch mines produced by the larvae coupled with the skeletonized leaves produced by the adults caused many trees to become completely brown. Mimosa webworm damage on native honeylocust and locust leafminer damage on black locust caused *Gleditsia* and *Robinia* to both appear "flamed" and almost indistinguishable to the casual observer traveling on Ohio's interstate highway system this season.

Heavy elm leafminer infestations were observed on elms in several landscapes in southwestern Ohio by early June. This sawfly overwinters as prepupae in the topsoil. Pupation occurs in the spring, and adults emerge and lay eggs in the upper leaf surface in early to mid-May. The larvae tunnel between the upper and lower leaf surfaces, producing blotch or blister-like mines. Although there is only one larva per mine, multiple mines may occur on a single leaf. As the mines coalesce, entire leaves may become hollowed out and drop from the tree. By early June, larvae drop from mines in attached leaves or crawl from fallen, heavily damaged leaves, move into the soil, and form a cocoon. There is only one generation per year.

Borers

Several clearwinged moths (Family: *Sesiidae)* such as peach tree borer *(Synanthedon exitiosa),* lilac borer *(Podosesia syringae),* and dogwood borer *(S. scitula)* emerged unusually late this season, and adult flights lasted several weeks longer than "normal." Usually, adults of these borers fly during a rather narrow seasonal "window," which is open for only a few weeks sometime in late spring or early summer. For example, in 1996, these clearwing moths were first caught in pheromone traps in northeastern Ohio in early June. However, adults were first caught in traps this season in late June and were still being caught in high numbers in central Ohio in late July. This was significant since the adult stage is the most sensitive to control applications. Applications made when pheromone traps first indicated adult emergence had begun may have lost their efficacy while adults were still flying, mating, and laying eggs.

Other borers such as the *Agrilus* beetles were also sporadic in their activity this summer. Bronze birch borers *(Agrilus anxius)* were early in some locations and late in others, and twolined chestnut borers *(A. bilineatus)* appeared to have an extended period of activity.

Lace Bugs

Hawthorn lace bug *(Corythuca cydoniae)* egg hatch was reported in southwestern Ohio early in May; however, the characteristic small yellow spots, or stippling, produced by lace bug feeding activity did not become noticeable on hawthorn in that part of the state until late June. Heavy feeding damage by hawthorn lace bug on cotoneaster was observed in northeast Ohio in early July.

Damaging populations of various other lace bugs were also observed in several areas of Ohio. These lace bugs included sycamore lace bug *(C. ciliata)*, oak lace bug *(C. arcuata)*, walnut lace bug *(C. juglandis)*, azalea lace bug *(Stephanitis pyriodes)*, and rhododendron lace bug *(S. rhododendri)*. Although azalea lace bugs were particularly plentiful throughout the season, all of the aforementioned lace bugs seemed to benefit from dry periods in July and August, and high late-season populations occurred.

Scale Insects

Unusual life cycles this season for certain "hard" and "soft" scale insects presented serious control challenges. The hard scales, pine needle scale *(Chionaspsis pinifoliae)* and euonymus scale *(Unaspis euonymi)*, both had unusually long crawler stages. This mobile form of the hard scale insects is devoid of the hard, waxy covering that generally protects these insects from the effects of most insecticides. Thus, multiple insecticide applications were required this season to effectively suppress populations of these insects. It was speculated that the life cycles of these insects were greatly altered because of the cool, wet spring weather.

Crawlers of the magnolia scale *(Neolecanium cornuparvum)*, a soft scale, are generally first apparent in Ohio in late July; however, this season they were most evident in mid- to late-August. As with the hard scales, proper timing of insecticide applications targeting the vulnerable crawler stage of this insect required close inspection of plant materials rather than reliance upon "calendar dates."

Mites

As with 1995 and 1996, large numbers of spruce spider mites *(Oligonychus ununguis)* appeared to have been washed from their hosts by heavy spring rains (3, 4). Although eggs of this cool season mite hatched in late April and early May, damaging populations generally failed to appear in the spring. However, after their usual hiatus during the warm summer months, high populations of this mite were observed in late September and October.

Warm season mites generally flourished during the hot, dry weather experienced this season in July and August. In mid-August, damaging populations of two-spotted spider mite *(Tetranychus urticae)* were observed on roses and marigolds in central Ohio. Also in the same landscaping, high numbers of the mite were found on various weeds such as nightshade, oxalis, and crabgrass. This observation illustrates the point that since this mite has multiple hosts, it may develop on weeds in the landscaping and then move to more preferred plants. Thus, an effective weed control program may also function as an effective mite management program.

The oak spider mite *(Oligonychus bicolor)*, another warm season mite, was also common in Ohio this season. In the July 14 BYGL, Dave Shetlar reported that hot temperatures had been conducive to the rapid build-up of this mite in central Ohio, and heavy damage was observed.

Had Dave Shetlar not christened 1997 "The Year of the Webbing Caterpillars," it could very well have been dubbed "The Year of the Eriophyid Mites." Beginning with a report in early May of the leaf-epidermis-rupturing pearleaf blister mite *(Phytoptus pyri)* on callery pear and ending with a report in mid-October of the bronzing effects of baldcypress rust mite *(Epitrimerus taxodii)*, more than 11 eriophyid mite species found their way into BYGL reports this season. Most lack common names and are usually identified by their host and by the type of damage they produce.

Eriophyid mite species reported in BYGL included *Eriophytes tiliae* which produces light green, felt-like erineum galls on little leaf linden and *Acalitus fagerinea* which creates green to yellowish-brown erineum galls on American beech. *Eriophyes caulis* causes pubescent, reddish-brown leaf petiole galls to form on walnut, and *Phytoptus tiliae* produces "nail galls," or elongated growths with pointed tips, on the upper leaf surface of linden. These galls look similar to the finger-like "spindle galls" generated by *Vasates aceriscrumena* on the upper leaf surface of sugar maple as opposed to the globose, pouch-like "bladder galls" on the upper leaf surfaces of red and silver maples, caused by *V. quadripedes*.

BYGLers learned this season that trees aren't the only plants affected by eriophyid mites. *Aculops toxicophagus* produced puckered, irregular, wart-like galls on the lower and upper leaf surfaces of poison ivy. These galls turn from yellowish-green to brilliant red and make the usually dark-green ivy leaves very colorful.

Of course, as mentioned, rust mites were also observed this season, including the hemlock rust mite *(Nalepella tsugifolia)*, which causes hemlock foliage to turn blue-green then reddish-brown, and *Nalepella halourga* (no common name), which causes bronzing of the inner needles of Colorado blue spruce. These eriophyid rust mites, as well as the aforementioned baldcypress rust mite, behave as "cool season" mites. High populations are generally observed during cool months, especially in the fall.

White Grubs

The 1997 season presented some serious grub management challenges. Although some of the grub-producing beetles behaved in a relatively predictable fashion, several behaved very unpredictably. May/June beetle *(Phyllophaga spp.)* adults appeared on schedule, bouncing off windows and window screens and shattering the evening calm in mid-May. Despite their common name, green June beetles (*Cotinis nitida)* also arrived within their "normal" calendar-date window. The big metallic-green beetles emerged en masse and began cruising lawns in southern Ohio, terrorizing backyard gardeners, sunbathers, small pets, and others in early August.

Now for the "unusual." Japanese beetle *(Popillia japonica)* adults first appeared in southern and central Ohio landscapes in early July. This is not an unusual date for adult emergence; however, beetles continued to remain on the scene through July, August, and September. This extended tour prompted BYGLers to give the beetles a new moniker — Energizer beetles — because they just kept going, and going, and....

This unusually long period of adult activity also had an impact on grub production. As Dave Shetlar reported in PEST: "Japanese beetle grubs are still mainly second instars, and it appears that these will have to overwinter before reaching the third instar, their normal overwintering stage. This may set us up for spring damage that we haven't seen for many years."

Dave Shetlar also summarized the late-season status of other white grubs in the October 20 PEST. He noted: "Masked chafer *(Cyclocephala spp.)* populations have certainly caused their damage, and large grubs are beginning to dig down — where the soil is moist enough to allow for such movement! Much of central and southern Ohio is so dry, the turf has again entered drought dormancy. This has masked much of the damage. Even the moles, skunks, and racoons have slowed their digging because of the dry soil conditions.

"In the counties bordering Lake Erie, the European chafers *(Rhizotrogus majalis)* have been hanging low in the soil profile. These pests are very resilient and capable of moving deep into the soil profile in periods of drought. They will return with the rains, and they will feed well into November and December before going down. Watch out for late appearing patches of dead turf."

Unusual Sightings

Although numerous reports were made this year in the BYGL and PEST newsletters regarding aphids on landscape and nursery plants, most involved relatively common species. One exception was the four-spotted hawthorn aphid *(Macrosiphum crataegi)*. In mid-October, immense aggregations of this aphid were reported on and around a hawthorn tree in a southwestern Ohio home landscape. Aphids covered the underside surfaces of almost every leaf on the tree, and large numbers could be found marching up and down the twigs, branches, and main trunk. Also, massive aphid gatherings could be found at the base of the trunk and under hostas planted beneath the tree. However, despite the heavy infestation, no apparent damage could be found on the tree. No curled leaves, honeydew, or black sooty mold were observed.

The four-spotted hawthorn aphid is yellow-green, slightly ovoid in shape, and has four rectangular dark green spots on its back. The spots are arranged like the points of a rectangle. This aphid will execute mass migrations in the fall as the hawthorn leaves turn color; however, they generally abandon trees that have been severely damaged. Given the large population, the lack of apparent damage could not be explained.

In mid-August, Pete Lane (Ohio State University Extension, Montgomery County) reported observing evidence of an unusual turf-infesting webworm — the burrowing sod webworm *(Acrolophus popeanuellus)*. Unlike sod webworm larvae, which live in silk-lined burrows oriented in a horizontal plane, burrowing sod webworm larvae live in two- to four-inch-long vertical burrows that extend into the soil. Larvae line their burrows with a paper-like white sac made of silk. These sacs may appear resting on the surface of the grass as the result of bird predation. Birds pull out the burrow lining, extract the larvae, and leave behind the silk sac to be discovered by startled homeowners or enquiring Extension agents. Pete described the sacs as looking like "partially smoked, hand-rolled...cigarettes." The larvae feed at night, and damage may appear similar to that caused by cutworms; however, this insect is seldom a significant pest of Ohio turfgrass, and control is usually not needed.

A significant infestation of brown recluse spiders *(Loxosceles reclusa)* in a home in southwestern Ohio was reported in September. Although not generally considered common to Ohio, more than a dozen adults and a few immatures were discovered, mainly in the garage and basement — "prime hangouts" for this spider. Brown recluse spiders are tan to dark brown, a quarter to one-half inch long, and they have long, delicate, grayish to dark-brown legs with a span-width about equal to the size of a half dollar. The most distinguishing identifying feature of this spider is a dark brown marking on the upper surface of the flattened cephalothorax. The marking is shaped like a fiddle or violin and gives the brown recluse another common name — the "fiddle-back spider." The "neck" of the fiddle marking points towards the bulbous abdomen. As their name implies, these spiders are reclusive and tend to hide in dark, secluded areas (e.g., basements, closets, etc.). Brown recluse spiders are not aggressive, but if harassed, they can inject very serious toxins into a bite victim. Children, the elderly, and individuals in poor physical condition are particularly at risk to the venom.

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Summary of Ornamental Diseases in Ohio: 1997

James A. Chatfield, Nancy J. Taylor, Stephen N. Nameth, Chris Carlson, Joseph F. Boggs, Jane C. Martin, Dan Balser, and David Madison

Summary

This article is drawn from reports in the Buckeye Yard and Garden Line (BYGL) throughout the year, reports from the C. Wayne Ellett Plant and Pest Diagnostic Clinic (PPDC), reports from the Ohio Department of Natural Resources, and reports from the Ohio Department of Agriculture nursery inspectors.

1. Ohio State University Extension Bulletin 614

Bulletin 614, *Disease Control in the Landscape,* is a key resource for the green industry and homeowners, complete with more than 100 color pictures. Included in this bulletin are general principles of plant health management, diagnosing plant health problems, recognizing and understanding infectious plant diseases, integrated management of ornamental diseases, and an extensive section on descriptions and management options of the common diseases found in the landscape. The cost is $5.25 plus tax.

Bulletin 614 is available at all Ohio State University Extension county offices. Individuals living outside Ohio can contact the Extension Media Distribution Office at 385 Kottman Hall, 2021 Coffey Road, Columbus, Ohio 43210-1044, call 614-292-1607, or fax 614-292-2270 to order. There will be a shipping charge.

2. Anthracnose Diseases of Trees (*Gloeosporium* and *Discula* spp.)

The extended cool, wet conditions this spring as leaves of many trees were emerging and expanding resulted in greater incidence and severity than normal of the many different anthracnose diseases. With sycamore anthracnose, these conditions resulted in symptoms much more severe than the blotchy reddish discoloration along leaf veins that are commonly seen in periods of mild disease incidence. Severe infections resulted in the types of symptoms described in Bulletin 614:

"New leaves may be killed. Damage looks similar to frost injury. Older or mature leaves show small to large, irregular dead areas along the veins. In the spring, bud blight and twig cankers occur with some dieback. The lower portions of the tree are damaged more severely. Crooked branches

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and a witches-broom-like proliferation of twigs are also common symptoms. Defoliation occurs after leaf blight in the spring."

Fortunately, most of these sycamores recovered, with refoliation by late June, but early symptoms were severe.

Abnormally severe symptoms were also noted on white oaks throughout Ohio and the Midwest. There was an excellent description of this in the Purdue Educator Update, reprinted below:

"We recently received a sample of white oak with succulent growth from Warsaw, Indiana, that was confirmed to have anthracnose. Oak anthracnose usually shows up as a lighter tan discoloration on the margins and midribs of oak leaves, causing distortion of the leaves. The infected tissue on the oak leaves we just received was black, not tan! This could be due to the extended wet weather and the succulence of the young tissue. The use of chemicals is generally not warranted for managing anthracnose of shade trees in homeowner yards."

Anthracnose diseases were also common this year on ash, London plane (less severe than on sycamore), beech, maple, and dogwood. In most cases, plants recovered once warmer drier conditions prevailed, although major plant health problems did occur on flowering dogwoods affected by anthracnose caused by *Discula destructiva.*

3. Pine and Spruce Diseases

Cool, wet weather in the spring of 1996 and 1997 was highly favorable for infection and development of diseases in Scot's pine Christmas tree plantations. Samples received in the Plant and Pest Diagnostic Clinic (PPDC) included *Cenanagium* canker, *Diplodia (Sphaeropsis)* tip blight, and *Lophodermium* and *Cyclaneusma* needlecasts. The most important was *Diplodia (Sphaeropsis)* tip blight (which is also a common problem on Austrian, red, and mugo pines in Ohio).

Cenangium canker *(Cenangium* sp.) was reported in Ohio on Scot's pine Christmas trees for the first time in 1996, and was again identified in Ohio in 1997.

Samples examined in 1997 exhibited dieback of branch ends and whole branches. Control recommendations include pruning to remove disease tissue, which unfortunately often results in an unsalable tree for a Christmas tree grower. *Cenangium* canker was observed on Tanyosho pine *(Pinus densiflora* cv. *Umbraculifera)* in Ohio for the first time in 1997. This disease typically affects weakened trees, so control strategies should focus on good overall tree health management practices.

Cyclaneusma and *Lophodermium* needlecasts of Scot's pine samples were commonly received in the PPDC. Samples sent to the Clinic should include branches with both intact needles on twigs (to check for brown spotting and tan-colored banding) and detached needles caught up in branch crotches (most likely to have identifiable fruiting bodies of the disease-causing fungus).

Needles collected from the ground are often colonized by so many fungi that identification of the disease involved is impossible. This is important because spray timing for *Cyclaneusma* control is in spring and into summer while for *Lophodermium* control, spray timing is for late summer and early fall. Other controls include planting in sites that are not shaded, promoting good air movement by thinning and pruning, and roguing out badly infected plants.

Diplodia (Sphaeropsis) tip blight of pine was again quite common and severe in landscapes and Christmas tree plantings and is described in this quote from Bulletin 614:

"Dieback of tips of Austrian, red, mugo, and Scot's pine. Disease often visible early in the season. Stem tips are killed before needles reach full size. Small, black fruiting bodies of the fungus develop at the base of needles and on the old cones. Resin may ooze from the diseased stem tips. Usually occurs on lower branches first." Management options: Where feasible, removal and disposal of diseased twigs may be helpful. If fungicides are used, spray just before new growth starts, followed by one or two more sprays at 14-day intervals. Use a properly labeled fungicide (such as thiophanate methyl in Cleary's 3336, Fungo and Domain). Fertilize and water trees when needed."

Additional diseases on pine included a confirmed case of *Phytophthora* root rot on white pine and branch dieback caused by *Atropellis* canker on Austrian pine.

On spruces, *Rhizosphaera* needlecast disease samples were sent in to the PPDC. The *Rhizosphaera* fungus infects new spruce needles during the growing season, but symptoms do not show up until needles exhibit yellowing late in the season. The following spring and summer, needles turn various shades of purple and brown and are noticeable as discolored second-year needles behind the green needles of the current season's growth. A characteristic of this disease is tiny black fruiting bodies of *Rhizosphaera* seen lined up on the otherwise whitish stomates on the needles, especially if the needles are put into a moist chamber for a few days (a plastic bag with wet paper towels will do). New infections can be prevented with applications of labeled fungicides (e.g., those containing chlorothalonil).

4. Juniper Diseases

Cedar quince rust is caused by *Gymnosporangium clavipes*, a fungal species related to the fungi that cause more spectacular oozing galls associated with cedar apple rust and cedar hawthorn rust on junipers. As with the other cedar rusts, the fungus alternates living on Eastern red cedar (juniper) and a rosaceous host such as apple, crabapple, hawthorn, the occasional quince, and others.

Generally, little attention is paid to cedar quince rust on juniper. Instead, the orangish spore masses that later in the summer protrude from hawthorn fruits and swollen areas on stems are noticed. However, there are symptoms on juniper.

Quoting from Bulletin 614: "(There are) slight swellings on stems and twigs of susceptible junipers. The affected twigs are hardly noticed until yellow-orange, jelly-like spore masses form in late April and May. The twigs may die back."

In 1997, however, the PPDC received samples of certain junipers with dozens, if not hundreds, of cedar quince rust infections, including numerous swollen areas on stems from the disease. It was easily causing enough damage to make the plant ornamentally unsuitable with the considerable twig dieback present and was serious enough to significantly affect overall plant health in these cases. So, cedar quince rust can be a factor not only on the appearance of susceptible hawthorns, but also on the juniper host as well.

The two other common problems on junipers are *Kabatina* blight and *Phomopsis* blight. Both are covered extensively in Bulletin 614, with some details repeated here. Quoting from Bulletin 614 on Kabatina blight:

"Symptoms first appear in February and March and well before those of *Phomopsis* tip blight. The terminal 2–6 inches of diseased branches throughout the juniper first turn dull green, then red or yellow. Small ash gray to silver lesions dotted with tiny, black fruiting bodies of the fungus are visible at the base of the discolored tissue. The brown desiccated foliage eventually drops from the tree in late May or early June. Foliar blighting occurs only in early spring; it does not continue through the summer {while it does continue with *Phomopsis* blight}. Blighting is also restricted to the branch tips and does not cause extensive branch dieback or tree death. The primary infection period for *Kabatina* blight is thought to be in autumn, even though visible symptoms are not apparent until late winter or early spring. Infection often is associated with small wounds on branch tips caused by insect feeding and mechanical damage."

Control involves cultivar selection for disease resistance (extensive lists in Bulletin 614), spacing plants for good air ventilation, limiting plant wounds, avoiding overhead irrigation if possible, and pruning of affected twigs during dry weather. Unlike *Phomopsis,* blight fungicides are not labeled for this disease.

Quoting Bulletin 614 for *Phomopsis* tip blight:

"*Phomopsis* damages new growth on succulent branch tips of junipers from April to September. Older, mature foliage is resistant to infection; therefore, most blighting occurs on the terminal 4 to 6 inches of the branches. Affected foliage first turns dull red or brown and finally ash-gray. Small gray lesions often girdle branch tips and cause blighted foliage beyond the diseased tissue. Small, black, spore-containing fungal fruiting bodies develop near the base of dead tips."

New infections will occur with flushes of new growth for some time, especially if plants are sheared. Fungicides containing thiophanate-methyl, such as Cleary's 3336, are often used as preventive sprays.

5. Foliar Blackening on Arborvitae

Reports and samples of this problem continued in 1997. Typically only a portion of the foliage is affected and numerous causes are suggested, though follow-up research and observations remain sketchy. The most likely range of causes appear to be:

- Application of fertilizer directly to foliage, either directly with granular fertilizer or in some cases due to failure to purge spray lines of fertilizer solution, then using the sprayer for horticultural oil applications.
- Pet urine damage.
- A response to sudden temperature shifts.

The authors would appreciate receiving samples, descriptions, locations, and follow-up reports of recovery or non-recovery relative to this problem in the future so that better understanding of what causes this blackening can be achieved.

6. Powdery Mildews

Powdery mildew diseases were predictably common on many woody and herbaceous hosts in 1997, but two seem noteworthy due to the symptoms observed. Powdery mildew on flowering dogwood was again quite prominent this year, causing not only the familiar powdery fungal growth on foliage, but also distortion and curling of new shoots, and reddish foliar discoloration in some cases. Foliar browning and purpling were also noted on magnolia in response to powdery mildew infections.

7. Apple Scab *(Venturia inaequalis)*

For most of Ohio and at the Crabapple Evaluation Plots in Wooster, apple scab was moderate in severity, slightly below normal. However, there were some localized reports of severe scab this year (such as in the Mahoning Valley), including some "sheet scab" in which the entire leaf becomes colonized by the fungus in late spring. See the article on crabapples in this Special Circular (page 83) for five-year summaries of scab incidence on many common crabapple selections.

8. Rose Black Spot *(Diplocarpon rosae)*

It was another good year for this disease and thus a tough one for rosarians. Infections started during cool, wet spring weather as leaves emerged. An integrated plant-health management program for this disease in the landscape includes:

- Keeping irrigation water off the foliage.
- Planting roses in sun and pruning surrounding vegetation to promote good drying conditions of the leaves.
- Cleaning out affected leaves from the previous year and any infected leaves that develop in a current season, and pruning out old, infected rose canes.
- Protecting foliage with a regular program (10–14 day schedule) of protective fungicides during wet weather.
- Use of black-spot resistant varieties.

A few examples from each of the rose categories with good genetic rose black-spot resistance (thanks to Deborah C. Smith-Fiola's "Pest Resistant Ornamental Plants," published by Rutgers University,) include:

Hybrid Teas: Chrysler Imperial, Tropicana
Floribundas/Grandifloras: Betty Price, Sonia
Shrub Roses: All That Jazz, Carefree Wonder
Miniatures: Gourmet Popcorn, Rose Gilardi
Rugosa Hybrids: Polyantha, The Fairy

9. *Verticillium* Wilt Diseases

This vascular disease occurs on many different landscape plants, as well as a number of fruits and vegetables. It is perhapes best-known as an ornamental disease on various species of maple. Some other plants that were identified in the PPDC as having *Verticillium* wilt in 1997 included black-eyed susan, purple coneflower (first report for Ohio), smoketree *(Cotinus)*, yellowwood *(Cladrastis)*, and garden impatiens.

There are several sampling tips that help ensure a good diagnosis in a lab. First, when possible, send parts of the plant that appear to be actively declining, rather than parts that are completely dead or completely healthy-looking. Second, for herbaceous material, such as with impatiens, send the entire plant. Third, remember that on some species of plants, the characteristic vascular discoloration is often not present even when the plants are infected, such as on ash, Japanese maple, and yellowwood.

10. *Guignardia* blotch of Buckeyes and Horsechestnuts *(Guignardia aesculi)*

This blight of horsechestnuts and our beloved buckeyes (both in the genus *Aesculus)* was frequently reported again this year.

Symptoms are best described by quoting from Bulletin 614:

"Small to large irregular, reddish-brown spots with yellowish edges occur on leaves in late June to July. Spots enlarge with browning and curling of leaflets. The disease is more prevalent on lower leaves."

At many sites, the blotching often is so bad that plants look as if they were blow-torched by August. Starting in 1998, Ohio State University plans on "aesculating" its efforts to help answer the questions of species and cultivar resistance to this disease, comparative incidence and symptomatology of *Guignardia* blotch and non-infectious physiological leaf scorch and other studies.

11. Ohio Department of Natural Resources (ODNR) Forest Health Report

The Ohio forest health report is provided *in toto* in this disease article, although it includes not only infectious and non-infectious disease observations, but also insect damage.

"An aerial survey of Ohio's unglaciated hill country (an area south of a line from Belmont and Guernsey Counties to Adams County) was accomplished during late June. The five-million-acre survey did reveal 16 damage locations, 14 of which accounted for approximately 1,000 affected acres. The cause of every damaged site could not be accurately determined; however, ground checks did confirm flooding damage, pine sawfly damage, grazing damage, declining white pine, and anthracnose/lace bug damage to sycamore trees along riparian corridors. In addition, the survey indicated moderate defoliation/discoloration (browning) in the upper crowns of oak trees scattered throughout 40,000 acres in Adams, Gallia, Lawrence, and Scioto Counties. Telephone reports from property owners in these areas confirmed observations. Laboratory samples identified scarlet oak sawfly larvae and hickory tussock moth larvae skeletonizing the oak foliage. Scarlet oak sawfly larvae were probably causing the majority of the damage as they fed on black, scarlet, pin, red, and white oaks. Hickory tussock moth larvae were found feeding on chestnut and red oaks. Similar observations were reported by the West Virginia Department of Agriculture.

"Reports of white pine mortality continue to decrease, but 2 cases were documented in Jackson and Vinton Counties. Mortality is still being attributed to a complex of overcrowding, environmental conditions, and secondary insects and diseases. Yellow-poplar mortality was scattered throughout SE Ohio. The cause for this mortality is not fully understood; however, declining yellow poplar trees at Zaleski State Forest stopped growing after 1991 indicating that drought damage in the early 90s, followed by yellow poplar weevil damage, could be contributing factors. A 13-acre salvage harvest was implemented to remove dead and dying yellow poplar trees from one Zaleski stand.

"Mortality of swamp white oak, pin oak, and red oak in NW Ohio woodlots was reported again this year. The cause of mortality has not been established; however, regional reduction in ground water levels is suspected. Some oak mortality occurred at Maumee State Forest, resulting in salvage harvests totaling about 90 acres.

"Cherry scallop shell moth defoliated black cherry trees on 565 acres in the following counties: Guernsey (225), Harrison (140), Jefferson (110), and Columbiana (90). Dogwood anthracnose was reported across Ohio, but was not verified in any new counties. Beech bark disease was not found in 1997. Frequent reports were received of anthracnose diseases (ash, maple, oak, dogwood, sycamore), *Diplodia* tip blight (Austrian and Scot's pine), fall webworm (cherry, apple, crabapple, walnut), and locust leaf miner (black locust). This is the second consecutive year to receive a few reports of bald cypress webworm feeding on bald cypress trees in western Ohio. Elm yellows (red elm and American elm) was also prevalent in at least 7 Ohio counties this year."

12. Ohio Department of Agriculture Report

Each year the Ohio Department of Agriculture (ODA) compiles a list of the top diseases that are reported by ODA inspectors in their nursery inspections each year. The ODA list of the top 15 diseases appears here along with the number of times each disease was reported by inspectors.

Note: This list is not a rating of the most important or damaging ornamental diseases. It is, however, a list of common diseases, all of which you should be able to identify. If you cannot, 1998 is the year to learn.

1. Powdery Mildews (172)
2. Apple Scab (128)
3. Leaf Spots (65)
4. *Septoria* Leaf Spot (53)
5. *Diplodia* Tip Blight (50)
6. White Pine Root Decline (46)
7. Hawthorn Rusts (46)
8. *Phyllosticta* Leaf Spot (33)
9. Bacterial Leaf Spot (30)
10. Crown Gall (26)
11. *Verticillium* Wilt (25)
12. Black Spot of Rose (25)
13. Pine Needle Rust (23)
14. *Guignardia* Blotch of Aesculus (19)
15. *Phomopsis* Twig Blight (18)

13. New Diseases

A number of first reports of diseases in Ohio this past year were confirmed in the PPDC.

- Red horsechestnut (Aesculus x carnea) with Sclerotinia blight

This disease causes a blighting and flagging of young shoots. Presumably the infections started in the flowers and moved back into young stems. The tell-tale signs of this disease are the development of hardened fungal sclerotia enmeshed in powdery white fungal growth inside the pith of the stems. This uncommon disease (for this host) should not be confused with the buckeye petiole borer that causes flagging of individual leaves of certain buckeyes.

- Eastern white pine *(Pinus strobus)* with *Phytophthora* root rot

This disease was positively identified using ELISA enzyme immunoassay on roots from a declining white pine in a landscaping in southwest Ohio. The arborist who sent the sample suspected a number of possible problems including deterioration simply due to heavy soil and/or poor drainage. While those factors probably predisposed the tree for infection, the *Phytophthora* fungus was functioning as a microscopic, soil-borne Dr. Tree-Vorkian and finished the job of killing the tree.

- Harry Lauder's walkingstick *(Corylus avellana* cv. *Contorta)* with Eastern filbert blight *(Anisogramma anomala)*

Three samples of Harry Lauder's walkingstick *(Corylus avellana* cv. *'Contorta')* were received in the PPDC during 1997. Samples were exhibiting branch dieback. These were determined to be infected with eastern filbert blight, a fungal disease, which causes extensive cankering and dieback. Fruiting structures of this fungus occur in rows along the length of the affected branch.

- Andorra juniper *(Juniperus horizontalis* cv. *Andorra)* with *Phytophthora* root and stem rot (*Phytophthora* sp.)
- *Arabidopsis thaliana* with Impatiens necrotic spot virus
- Avalanche birch *(Betula* x *avalzam* with *Phomopsis* canker *(Phomopsis* sp.)
- Deadnettle *(Lamium* sp.) with *Phytophthora* root and stem rot *(Phytophthora* sp.)
- Golden marguerite *(Anthemis tinctoria)* with *Phytophthora* root and stem rot *(Phytophthora* sp.)
- Green lavender cotton *(Santolina virens)* with *Phytophthora* root and stem rot *(Phytophthora* sp.)
- Japanese stewartia *(Stewartia pseudocamellia)* with Black root rot *(Thielaviopsis basicola)*
- Maltese cross *(Lychnis chalcedonica)* with Impatiens necrotic spot virus
- Miss Kim lilac *(Syringa patula* cv. *Miss Kim)* with Bacterial leaf scorch (*Xylella fastidiosa)*
- Potterweed (*Stachytarpheta* sp.) with Impatiens necrotic spot virus
- Purple coneflower *(Echinacea purpurea)* with *Verticillium* wilt *(Verticillium* sp.)
- Tanyosho pine *(Pinus densiflora* cv. *Umbraculifera)* with *Cenangium* canker *Cenangium* sp.)
- Thrift *(Armeria maritima)* with Anthracnose *(Colletotrichum* sp.)

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Weed Problems in Ohio Landscapes and Nurseries: 1997

Gary Y. Gao, Joseph F. Boggs, Pamela J. Bennett, Jane C. Martin, Mary Ann Rose, Joseph W. Rimelspach, Randall H. Zondag, and William E. Pound

Summary

Crabgrass, dandelions, Canada thistle, poison ivy, garlic mustard, annual bluegrass, and dodder were reported as some of the weeds to cause problems to Ohio landscapes and nurseries in 1997. This report is a compilation of the noteworthy weed problems discussed during *Buckeye Yard and Garden Line* (BYGL) conferences that occurred weekly, from April to October in 1997.

Discussion

Crabgrass

There were some concerns about inadequate crabgrass control in 1997 due to the wet weather. Preemergent herbicide effectiveness may have been reduced due to heavy rains in May and June. By the week of July 31, heavy crabgrass infestations were noted.

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Dandelions

Dandelions started blooming in some parts of the state during the second week of April, but clientele were reminded that it was still too early to apply post-emergence herbicides which are most effective in the early puffball stage.

Canada Thistle

Canada thistle emerged in landscapes across Ohio during the second week of May and bloomed in mid- to late-June. This weed is a prolific seed producer. The weed also propagates itself from underground rootstocks and will sprout from any root pieces left after weeding. Theoretically, it can be eradicated by hand-pulling or mowing at least three times a season — June, August, and September.

Poison Ivy

Problems with poison ivy are reported every year, and 1997 was no exception. Poison ivy is a woody vine that has a distinctive compound leaf consisting of three leaflets, two- to four-inches long, dull or glossy green with pointed tips. The middle leaflet is generally larger than the two laterals. The margins of the leaflets are variable, appearing irregularly toothed, lobed, or smooth. The leaves are arranged alternately on the stems. In contrast, Virginia creeper, a non-poisonous vine often mistaken for poison ivy, has five leaflets radiating from one point of attachment. It may also be mistaken for boxelder seedlings, but boxelder has opposite leaves instead of alternate.

Garlic Mustard

In May, BYGL participants noted that this weed was in bloom in central Ohio. This relative newcomer to Ohio landscapes has aggressively spread throughout much of the Midwest, the eastern United States, and Canada. Garlic mustard is biennial, forming a basal rosette of kidney-shaped leaves in the first year, and flowering stalks, one- to four-feet in height, the following spring. Clusters of unexciting, small, white, four-petal flowers appear April through June. The leaves on the flowering stalks are triangular or heart-shaped and coarsely toothed. When crushed, the leaves have a pervasive smell of garlic. Ecologists and wildflower enthusiasts are concerned about the weed because it forms large stands to the exclusion of native wildflowers. Garlic mustard favors shaded, disturbed sites, but apparently is able to move into undisturbed woodland communities.

Annual Bluegrass

There were an unusual number of complaints regarding annual bluegrass in lawns in 1997. This weed is an apple-green colored annual grass that tolerates all mowing heights and grows vigorously in cool, moist weather, often forming extensive patches. It is considered a weed because of the different color and the fact that during hot, dry weather, it dies and leaves turf with unsightly bare areas.

People may be confused by the fact that Kentucky bluegrass and *Poa annua* produce seedheads around the same time, possibly masking diagnosis. The color of annual bluegrass makes it fairly easy to spot in a bluegrass lawn. One other factor, to make things even more confusing — it has been determined that there are some bio-types of the weed that behave like a perennial. These patches go dormant during hot, dry spells but come back in cooler weather.

Dodder — A Plant Parasite

Dodder was reported to have parasitized herbaceous perennials in 1997. This unusual weed may infect other wild and other cultivated plants. This wiry, yellowish-orange annual plant has the appearance of a 'bunch of tangled-up yellow fishing line.' Dodder lacks chlorophyll and functions as a parasitic plant, stealing nutrients from the host plant it covers. Dodder may be a vector of some hard-to-transmit diseases.

Although it is categorized as a broadleaf weed, dodder lacks leaves. This, coupled with its growth habit, makes postemergent control all but impossible. Dodder is a prolific bloomer and produces small white flowers borne in clusters. Hand-pulling the plant during the bloom stage will reduce seed production for the next season. To control dodder in the garden, try to pick it off the plants or kill the plants it is infesting.

Useful Resources

W. Pound, D. Shetlar, J. Rimelspach, and J. Street. 1997. Ohio State University Extension Bulletin L-187, *Control of Turfgrass Pests.*

North Central Regional Research Publication No. 281, *Weeds of the North Central States.*

Herbicide Damage CD. Mike Dana and others at Purdue University have developed a new CD titled *Picture The Damage! Herbicide Damage Symptoms on Ornamentals,* which has over 500 four-color images of herbicide damage from 12 different herbicides on 21 different ornamental plants. The cost of the CD is $39.95. For information and to order, contact the Agricultural Communication Service, Media Distribution Center, 301 South Second Street, Lafayette, IN 47901-1232. Phone: 317-494-6794; FAX 317-496-1540.

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Wildlife Problems in Ohio Landscapes: 1997

Gary Y. Gao, Joseph F. Boggs, Jane C. Martin, Charles T. Behnke, and James A. Chatfield

Summary

Nuisance pests, such as rabbits, voles, squirrels, deers, skunks, and racoons, caused damage to Ohio landscape plants in 1997. The control measures vary for each. However, the principles of wildlife damage prevention and control are similar. They include physical exclusion, live trapping, relocation of wildlife, alteration of habitats, shooting, and use of chemical and physical deterrents.

Introduction

Prevention and control of wildlife damage are an increasingly important part of the wildlife management profession because of expanding human populations and intensified land use. As more people move into previously agricultural areas, people and wildlife merge. People wish to control wildlife so that they can prevent or minimize damages to fruits, vegetables, trees, shrubs, and lawns. It is important to be aware of ways to handle wildlife problems as they relate to different geographic areas.

This report is a compilation of the noteworthy wildlife problems discussed during the *Buckeye Yard and Garden Line* (BYGL) conferences that occurred on Tuesdays, from April to October in 1997.

Discussion

Rabbits

The first sign of rabbit damage was reported in the first week of May. The top was eaten off newly planted ornamental blue fescues, and violas were eaten down to their crowns.

Rabbit feeding injury to euonymus was reported during the third week of July. Branches showed characteristic damage — young stems were severed cleanly at an angle. These stems wilted very rapidly. Control measures include exclusion with a low fence or hardware cloth cylinders, trapping, or taste repellents.

Voles

Vole injury on junipers was reported in the first week of April. Diagnosticians should check on the undersides of branches of low-growing junipers. Gnawing injury from vole feeding on the stems is normally seen on the undersides of stems.

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Squirrels

Squirrels were reported to clip twigs and remove bark from large and small deciduous trees. Damage to a small red buckeye was severe. BYGLers speculated that the bark stripping, twig clipping behavior may be associated with the rodents' need to gnaw frequently in order to wear down their front incisors. Unlike their forest brethren, urban squirrels often have fewer nuts such as acorns available, and bird seed probably offers little resistance to their four large incisor teeth.

Recommended control efforts primarily center on trapping (e.g., box and cage traps) and relocation. Taste repellents are also recommended to protect trees and shrubs; however, most are very water soluble and require frequent reapplication.

Deer

Flower buds on roses were nipped off by deer in southern Ohio, and similar phenomena were observed in northern Ohio. Deer damage is very difficult to control. Deer repellents such as "Deer-Away," "Hinder," "Thiram," "Miller's Hot Sauce Animal Repellent," "Tankage," "Ropel," hair bags, and bar soap may provide some short-term relief. It is important to read labels of commercial repellents to make sure target plants are listed.

Permanent, high-tensile electric fencing will provide year-round protection from deer damage. For more information on this recommendation, refer to Wisconsin Extension Fact Sheet G3083, *Controlling Deer Damage in Wisconsin*. To get a copy, contact Wisconsin Extension Publications at 608-262-3346.

Skunks and Racoons

Skunks and racoons caused significant damage to home lawns. Although skunks and racoons are dissimilar in appearance and classification, they all invade homes, damage lawns, and raid chicken coops and bee hives. They will continue to dig up lawns as long as grubs and earthworms are present.

Control methods are the same for both, but with extra precautions for skunks. They include habitat modification, live trapping, exclusion with fencing, fumigants, and shooting. Be sure to check with the Ohio Department of Natural Resources (ODNR) for appropriate permits before attempting to trap, fumigate, or shoot skunks and racoons. The most effective solution to skunk and racoon management is to make your home, lawn, and landscape unattractive to them by eliminating protective covers such as brush and wood piles, food sources such as pet food dishes and uncovered garbage cans, and potential sites for denning. It may be preferable to hire a pest control professional to deal with skunk and racoon problems, being sure that they have ODNR permits.

Useful Resources

Prevention and Control of Wildlife Damage, University of Nebraska.

This publication is available in both book and electronic format (CD-Rom). Copies of the book are $40.00 each plus $5.00 shipping. CD-Rom copies of the publication are $40.00 each plus $3.00 shipping. Copies of the book plus CD-Rom are available at a discount price of $60.00 plus $5.00 shipping. Reduced shipping rates are available for orders of 10 or more. Call 402-472-2188 for information.

Make check payable to the University of Nebraska. Mail to:

Wildlife Handbook
202 Natural Resources Hall
University of Nebraska
P. O. Box 830819
Lincoln, NE 68583-0819

Division of Wildlife, Ohio Department of Natural Resources.

Wildlife District One
1500 Dublin Road
Columbus, OH 43215
Phone: 614-644-3925

Wildlife District Two
952 Lima Ave., Box A
Findlay, OH 45840
Phone: 419-424-5000

Wildlife District Three
912 Portage Lakes Drive
Akron, OH 44319
Phone: 330-644-2293

Wildlife District Four
360 E. State Street
Athens, OH 45701
Phone: 740-594-2211

Wildlife District Five
1076 Springfield Pike, Box 576
Xenia, OH 45385
Phone: 937-372-9261

In Sandusky
Phone: 419-625-8062

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Summary of Turf Cultural and Disease Problems in 1997

Gary Y. Gao, Joseph F. Boggs, Pamela J. Bennett, Jane C. Martin, Joseph W. Rimelspach, and James A. Chatfield

Summary

This article is compiled from reports of turf cultural and disease problems in the weekly *Buckeye Yard and Garden Line* throughout the year of 1997. Many turf problems were related to unusual weather conditions. Turf problems included winter desiccation, pink snow mold, red thread, summer grass dormancy, brown patch, and dollar spot.

Discussion

Winter Desiccation of Turfgrasses

Browning in turf from wind drying and desiccation was reported because snow cover was limited during the winter of 1996–1997. Some *Poa annua* on golf courses was suffering from "crown hydration kill" due to fluctuating winter temperatures and moisture. Late December was wet with mild temperatures, then temperatures rapidly dropped to -10°F. The crowns froze but stayed green. The previous damage became evident as temperatures warmed in March. Many grass crowns appeared brown and dead in April.

Unsuccessful Fall Seeding

Some lawn areas seeded in the fall of 1996 failed despite the fact they went into winter looking nice and green. This was likely due to fluctuating winter temperatures and moisture.

Uneven Lawn Coloration

Yellow and green blotchiness and patterns of uneven coloration were reported on April 15, 1997. This occurred because different turfgrass species and varieties grew at different rates. Some of the taller growing varieties were being cut too short, resulting in yellowing and blotchiness.

Leaf Spot Disease

"Helminthosporium" leaf spot disease became noticeable in lawns the third week of April, on susceptible varieties of Kentucky bluegrass in poor and compacted soils, or in areas with heavy thatch. Leaf blades were spotting, girdled, and died prematurely. Proper mowing practices and core aerating in spring were recommended to maintain the health of the lawn. In addition, fungicides containing ipridione were recom-

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mended for long-term suppression of the disease where treatment was deemed necessary.

Fusarium Patch (Pink Snow Mold)

Fusarium patch (pink snow mold) was often reported into late May this year, due to the persistent cool weather in many areas. The Plant and Pest Diagnostic Clinic (PPDC) at Ohio State University received samples from numerous locations in northern and southern Ohio and from Pennsylvania, Utah, and California. Samples were most commonly on annual bluegrass from golf courses. In most cases, grasses outgrew this disease as the weather warmed. Where fungicides were necessary, those containing iprodione and vincozolin were used.

In some cases, pink snow mold was reported as late as June 12, 1997. Infections were found on older bentgrass as well as newly established bentgrass, which was an unusual occurrence. Pink snow mold produces circular, water-soaked patches of brown or yellowish-brown grass. The patches, ranging in size from one to eight inches, may have a slightly pinkish hue and exhibit a tinge of orange around the outer edge. Although Ohio State University Extension Bulletin L-187 lists several effective fungicides for control of this disease, rising temperatures and declining moisture levels normally halt infections in the summer. Pink snow mold infection reports had declined by the week of July 3, and turf that experienced damage from this disease had completely recovered due to warmer temperatures and some drying.

Red Thread

Red thread patches started to appear during the third week of May on fine fescues and perennial ryegrass in southwestern Ohio. This disease is usually first noticed when small, circular patches of yellow to light brown grass begin to develop randomly throughout a lawn.

Red thread disease was rampant in lawns with cool and wet weather by the first week of June. The disease produces irregular patches of blighted or browned grasses ranging in size from two inches to three feet in diameter. Water soaked spots appear first, followed by general drying out of the infected tissue. The tissue fades to a tan color. Under damp conditions, leaves may be covered with a pink, gelatinous, threadlike growth of fungus. This growth may extend out from the leaf tips to nearby plants. Control measures include a good fertility program at balanced rates, mowing a bit shorter to promote rapid drying of affected areas, and a fungicide program (e.g., chlorothalonil) if the problem is severe.

Rhizoctonia Blight or Brown Patch

During the week of June 17, *Rhizoctonia* blight was predicted to be a serious problem due to the abundant moisture, especially on tall fescue. Blades start out looking water-soaked and dark bluish-green, then they dry, wither, and turn brown; lesions are evident. Moisture must be present on the leaves for the fungus to spread rapidly to healthy plants. Turf growing under high nitrogen is more susceptible. By July 3, *Rhizoctonia* brown patch was reported to progress nicely on turfgrass in areas of high temperatures and rainfall.

Dollar Spot

During the week of July 24, dollar spot was active primarily on bentgrass but also was seen on Kentucky bluegrass and ryegrasses. Symptoms included round, brown, or bleached spots the size of a silver dollar or somewhat larger. Patches on bluegrass are generally larger and not quite as defined.

Dollar spot is generally found on sites that are low in fertility and in dry areas. The blighted blades normally have straw-colored tan areas with reddish-brown margins. The fungus reaches peak activity during humid weather when temperatures range from 70°F to 80°F.

Dollar spot was observed on turfgrass at the same sites where red thread occurred. This is not surprising since both diseases are found on turf that is slow-growing and has not been properly watered and fertilized. An application of slow release fertilizer was recommended to encourage recovery. The slow release component should be at least 50% of the fertilizer with about 3/4 pound or less of nitrogen per 1,000 square feet.

Summer Turf Dormancy

Cool season grasses went into dormancy when the weather turned hot and dry in August. Some concerned homeowners incorrectly blamed their neighbors' maliciously spraying lawns and killing them.

During the third week of August, many lawns recovered from their drought-induced state, with the onslaught of rains. Stolons and rhizomes needed to be checked to determine if they were still plump and fleshy. If they were, and if the area was small, recovery and filling in should occur, especially with cooler temperatures and rain.

Core Aeration of Turf

During the fourth week of August, core aeration of turf was recommended for many lawns. There are many benefits of core aeration if ample soil moisture is present to allow for core removal. Thatch reduction, stronger root growth, and healthier turfgrasses are some of the benefits.

Rust on Turfgrasses

Rust became apparent in Ohio lawns in late August and September. The rust-colored tiny spores of the fungus rub off easily on shoes, fingers, clothes, and even animals romping through the grass. It is most common on Kentucky bluegrass and perennial ryegrass lawns.

Rust causes the turf to take on a generally yellow appearance, and symptoms are more evident when the weather is dry. Alternating conditions of low light intensity, 70°F to 75°F temperatures, and high humidity for four to eight hours followed by high light intensity, 85°F to 95°F temperatures, and slow drying of leaf surfaces favor the development of rust disease.

Control recommendations included using blends of resistant turf cultivars and providing adequate water and fertility levels to keep the grass growing vigorously during dry periods. Fungicide treatments were recommended only if the lawn experienced continuous heavy infections.

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Master Gardeners Serve Ohio

Marianne Riofrio

Volunteers have always played an important role in delivering programs and services to Ohio residents through Ohio State University Extension. OSU Extension Master Gardeners are becoming widely recognized as a premier group of volunteers serving their counties.

Master Gardeners are trained to be volunteer educators in the area of consumer horticulture. The activities they carry out in their counties are broad-ranging. Many answer gardening calls, one-on-one, that come into the county Extension offices. These questions range from inquiries about the culture of specific plants to calls seeking help in determining the cause of a plant problem, identifying household pests such as termites and carpenter ants, and much more. Master Gardeners also educate the gardening public through classes, workshops, demonstration and trial gardens, and exhibits at Home and Garden shows, county fairs, and garden centers. School children, senior citizens, and even some of Ohio's prison population have benefitted from educational projects carried out by Master Gardeners.

In 1997, more than 500 Master Gardeners were trained in Ohio, serving 45 Ohio counties and three Kentucky counties. Seven Ohio counties were new to the Master Gardener program in 1997, joining the ranks of counties that have been training and utilizing these volunteers for up to 10 years, with Cuyahoga County holding the title of the longest continuously running Master Gardener program in the state.

Exciting developments in the Master Gardener program in 1997 included the new Master Gardener Web Page and the computerized call-logging program, both developed by Dr. Tim Rhodus and his program assistants in the Department of Horticulture and Crop Science. When visiting the web site at *www.hcs.ohio-state.edu/mg/mg.html*, you can find mission and vision statements as well as an interactive map of Ohio counties with information on individual county Master Gardener programs. There are also links to other internet resources of interest to gardeners and green industry professionals.

The Master Gardener call-logging program was developed to help counties and to track gardening calls that come into the office. A Master Gardener can simultaneously take a call, log the call on the computer, and find a fact sheet on Ohioline to assist in answering the caller's questions. In addition, data can be collected from the logs to help identify areas where additional resources need to be developed. For example, a list of frequently asked questions for which there are no fact

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sheets (with answers!) can be generated, followed by new fact sheet development.

In September, the annual state Master Gardener Conference attracted 250 volunteers for a day of learning and camaraderie at the Franklin Park Conservatory and Botanical Garden in Columbus. Local, state, regional, and international conferences provide the Master Gardeners with continuing education opportunties that serve the two-fold purpose of keeping these volunteers on the cutting edge and keeping them in the program.

Across the nation, Extension Master Gardener volunteers are attracting a lot of attention. The October–December issue of *HortTechnology,* a publication of the American Society for Horticultural Science, has, as its cover feature, "Celebrating 25 Years of Master Gardening." Several articles highlight the achievements of Master Gardener programs across the United States. The December 1997 issue of National Gardening magazine also features an article written by a Michigan Master Gardener and includes a list of state contacts for the program.

Ohio State University Extension's Master Gardener Program keeps getting bigger! At least another seven county Extension offices will join the ranks in 1998. Most of the newest counties to become involved have rarely directly served the gardening public before. With the many Extension resources in this area, all it takes is the peoplepower to deliver those resources to our customers. The Master Gardeners have a proven record of delivering the goods, satisfaction guaranteed.

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The Greening of Poland's Nurseries

Kenneth D. Cochran and Wojtek Grabczewski

Abstract

Since the collapse of the Eastern Bloc eight years ago, Poland's nursery industry has gained recognition and status. A recent study (September 1997) involving contacts, observations, and personal visits to Poland's nurseries, arboretums, botanical gardens, and garden centers reveals a positive pattern of growth. Polish nurserymen have realized the importance of plant differentiation, crop specialization, marketing techniques, nursery exhibits for the trade, and public and customer service.

Introduction

The development of Poland's nursery industry differs from other Eastern Bloc countries because many nurseries were privately owned before the collapse of the Bloc in 1989 (1). More than 70% of Polish land was privately owned whereas other Eastern Bloc countries had a major portion of state-owned and cooperatively worked land. Private nurseries were controlled by the state in that they were told how much they could grow and to whom they had to sell their products (2).

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Now, under its free enterprise system, Poland's nursery industry is showing remarkable growth in the production and marketing of ornamental plants. Current observations and studies support this fact.

The five climate regions of Poland compare to the average low-temperature regions of USDA Hardiness Zone 5, 6, and 7. Climates range from the warmest regions of the submontane zone with a growing period of more than 220 days, averaging 24 to 31 inches of precipitation per year, to the eastern zone with a cold continental climate of 190 to 210 growing days (Warsaw has 200) and precipitation of 20 to 27 inches per year (3). The eastern zones can experience more than 90 days with temperatures below 32°F. The record cold temperature of this century was -42°F, and the record high temperature was 112°F.

Materials and Methods

Basic studies, literature references, and observations show that Poland's nursery industry is collegial, innovative, distinctive, trendsetting, and blossoming. This study was done in conjunction with a Polish nurseryman and is a compilation of numerous contacts and personal visits to nurseries, arboreta, botanical gardens, and garden centers in Poland. Four Polish nurserymen visited Ohio in 1997 during late June and early July, and Ken Cochran visited Poland for 10 days in September 1997.

Results and Discussion

Collegial

The nursery industry in Poland is associating with the International Plant Propagators' Society (IPPS) as a select group of plant propagators. There is no question that nurserymen in Poland know how to propagate plants. They should take a great deal of pride in the fact that they are not keeping their know-how a secret. Under a free economy system they are readily exchanging ideas — seeking and sharing.

Poland's Plant Propagators' Society organized its first meeting under affiliation with the Great Britain and Ireland Chapter (of IPPS). The one-day conference was held March 15, 1997, at Warsaw Agricultural University. Presentations included nine technical sessions and 12 poster sessions with participation from Poland, Ireland, Germany, and England. Propagation sessions included topics on cuttage, micropropagation, and graftage; cultural sessions included capillary irrigation, IPM standards, and specific crop production sessions on such crops as heaths and heathers, blueberries, apples, and plums. One hundred people attended the first conference, and the proceedings were published in Polish with summaries in English.

While Poland may be three to five years away from forming an IPPS Chapter, conferences are scheduled for 1998 and 1999 (3). The 1998 meeting will be in June and will consist of one day of technical sessions and one day of field study in the area of Skierniewice, southwest of Warsaw.

A *Ginkgo* Symposium was held at Poznan Agricultural University in Poznan, Poland, on September 25 and 26, 1997. Ken Cochran presented a paper, "The Marketing Potential of *Ginkgo biloba* in the United States."

Innovative

Many valuable cultivars of ornamental trees and shrubs were selected and propagated in Poland during the last century, but very few of them reached foreign markets (5). *Clematis* cultivars are an exception. They have been propagated and distributed on a commercial scale outside Poland and are being exported to the United States.

One of Poland's contributions to the edible landscape is the "oversized" crabapple which seems to be commonplace in the country (6). Small trees produce large sweet to slightly tart crabapples, and many trees are disease-resistant. Edible fruits afford a landscape option for the do-it-yourself home owner.

It was interesting to learn that container plants, including liners of conifers, were overwintered without polyhouse structures. Layers of shade fabric cover plants. The fabrics are lightweight, durable, reusable, have a shade factor, are easy to install, and eliminate much of the winter maintenance required by polyhouses.

Many tools and technological advances that are used in Poland originated in Germany, although some Polish nurserymen have developed innovative devices of their own (2). One such device is an aluminum carrier used to transport multiple containers of plants.

Distinctive

Various nurseries in Poland are adding market value to plants by producing plant products with product differentiation. *Clematis* can have many landscape uses. For example, it can be planted as a ground cover, used to cover beds of spent spring bulbs, or allowed to ramble over lilacs (4). Polish nurserymen realize the importance of the customers' needs and let that input guide their decision.

Many nurseries are specializing in various crops and placing the ultimate marketing decisions in the hands of distribution centers, which purchase a large variety of plants from specialized growers providing customers with a larger selection of plants and services. Nurseries work together as colleagues more than competitors. Poland's nursery frontier is being built on quality, professionalism, overall presentation, prompt delivery, personal service, product range, and value.

A Polish-Dutch venture, Floriall-in Promotions, is a retail marketing concept. It produces leaflets, labels, and display boards with color photography and horticultural information. Currently, the venture owns and operates two garden centers in Poland.

Trendsetting

The growth of gardening activities has resulted in the need for various plant forms, such as imaginative standards, because garden space is limited. Nurseryman Stanistaw Zymon capitalized on this trend by growing deciduous azalea standards which allow for under-planting (7).

The trend towards grafted willow standards began six years ago with the pendulous *Salix caprea* 'Kilmarnock.' Today Polish nurseries market more than 30 cultivars of top-grafted willows which are used in small and large landscapes, rock gardens, patios, and balconies. There is an increasing interest in new species and new forms of ornamental plants that can serve specific landscape needs (3).

Blossoming

The fourth Polish International Nursery Show — "Green Is Life '97'" — was held August 29–31, 1997, at the Warsaw Agricultural University. This important communications effort by the Polish Nursery industry is looked upon as the umbrella for plant promotion.

The show was organized by the Polish Nurserymen's Association, whose objectives are to raise awareness of the nursery industry and to improve standards. While star billing goes to the plants, this show supports various aspects of gardening, including a plant doctor clinic, children's activities, seminars, plant sales, and show gardens. The exhibition is unusual in that it enables both the nursery trade and the public to participate. Leadership from the nursery industry is the reason plants have grown more popular in Poland.

A National Horticulture Exhibition is held each year in September in Poznan during the Polagra Agriculture Fair. The nursery industry is represented at this agricultural and horticultural exposition.

Summary and Conclusion

Plant production and marketing in Poland are of fine quality, and nursery personnel are attuned to basic and technological advances.

There is an opportunity and a need for the exchange of horticultural ideas, plants, and practices between Poland and the United States. Trade associations, nurseries, academia, and government personnel in both countries should make an effort to develop a horticultural alliance.

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The Marketing Potential of *Ginkgo biloba* in the United States

Kenneth D. Cochran

Abstract

Current studies and diverse samplings of information concerning *Ginkgo biloba* are indicants that the marketing of this species has capacity for growth. Marketing will depend on production meeting demand. The adaptability and heritage of *Ginkgo* is highlighted, and the importance of asexual propagation from superior staminate trees is emphasized. Production and marketing of cultivars of *Ginkgo* should be based on selecting:

- Scionwood from mature male trees.
- Propagation material from pyramidal forms.
- Trees with acute or rounded, angled branches.

Introduction

The East-West ties with *Ginkgo biloba* circle the globe. It probably originated in the temperate mixed mesophytic forests of Asia. The species was introduced into Europe through the Botanic Garden of Utrecht, Holland, in 1730, and then, in 1785 into North America from England to "Woodlands," the estate of William Hamilton (2).

In their search for tomorrow's plants, it is doubtful that early collectors knew the potential importance of this species to landscape horticulture. It is probable that their driving force was a passion for the species, whether for its legendary history, its charm, or its pattern of longevity. The *Ginkgo* has a noble heritage that has played a role in medicine, religion, and science.

Methods

Basic studies, observations, and current views are presented to indicate that the marketing potential for *Ginkgo biloba* in the United States and beyond has capacity for growth. This study is not comprehensive but rather a compilation of diverse samplings of information from horticulturists in California, Oregon, Ohio, New Jersey, and other states (3).

Discussion

Ginkgo is a survivor (4).

It has been closely associated with human beings for more than 5,000 years. Most Americans are familiar with *Ginkgo* either through childhood, school, or nature studies.

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Yet seldom is it found growing in the residential landscape. Today, it is considered a tree for collectors. People are startled when they come across a ginkgo and generally their first reaction is "Where do you get a ginkgo?" The acceptance of *Ginkgo* in the home landscape has developed slowly.

For more than 50 years, horticulturists in parks and public places, commercial landscapes, and street tree plantings have made use of *Ginkgo* (4). The species is particularly useful because of its resistance to insects and diseases (5). Therefore, it is appropriate for this species to be marketed as an environmentally friendly tree because pesticides are not needed in general tree management.

Trees in America have not always been recognized for their adaptive use, but rather have been selected for shade or aesthetic qualities. Adaptability of a tree means that it is tolerant of varied soils (modified soils other than shallow or poorly drained) and environmental conditions (temperature and precipitation). The trend toward recognizing the importance of adaptability started with the decline and death of various species of trees under stress. *Ginkgo* is considered one of the toughest and most adaptable of all cultivated trees in the temperate zone (4).

It is difficult to gauge the potential acceptance of *Ginkgo* in U.S. markets because nurseries have not produced enough trees of this species to test the market. Full recognition of this potential will only occur when nurseries produce and distribute enough trees so the public's reaction can be evaluated. Currently, wholesale nurseries report that demand exceeds supply (3).

The major opposition to *Ginkgo* is the abscission of the malodorous ripening fruit. The use of staminate cultivars from 50- to 60-year-old trees would overcome this objectionable characteristic. An enterprising municipal arborist in East Orange, New Jersey, had firemen use firehoses to knock the fruit from pollinated trees and then cleaned up the fruit before it fell under the onslaught of foot traffic (6).

A checklist of cultivated ginkoes lists 23 valid cultivar names (7). To that list the following cultivars are added: 'Magyar' (8), 'Firehouse' (9), 'Maytown' (10), 'Halka' (11), 'Tremonia' (12), and 'Horizontalis'(13). Today, the most frequently listed cultivars in U.S. nurseries are 'Princeton Sentry' PP#2720, 'Magyar,' and 'Autumn Gold.'

There is confusion about the verification of cultivar names. The cultivar 'Lakeview' originated at Lakeview Cemetery, Cleveland, Ohio. Nurseries asexually propagated from various ginkgoes at Lakeview and used the cultivar name 'Lakeview' for their progeny. Therefore, there are various clones of *Ginkgo* under the single cultivar name 'Lakeview.' This also happened during propagation of the cultivar 'Fairmount.'

It is interesting to note the origin of a few cultivar names. For example, the cultivar name 'Magyar' was selected in reference to a tree growing in front of the Magyar Bank in New Brunswick, New Jersey; 'Sinclair' was discovered in front of the Sinclair gas station in Princeton, New Jersey; and 'Princeton Sentry' was named for a tree selected from a row of ginkgos in a Princeton Cemetery (8). There are cultivars with non-valid names such as 'Cleveland,' 'Canopy,' and 'Umbraculifera' (7).

Many U.S. cultivars of *Ginkgo* have been selected and asexually propagated from superior staminate trees found in existing landscapes. Asexual propagation is the recommended technique to assure duplication of a parent plant.

Five to 15 centimeter caliper trees from asexually propagated cultivars of *Ginkgo biloba* have shown enough form variation in their branch structure that it is doubtful whether tree form can be predetermined in vegetative propagation. The following replicated cultivars were used in this study: 'Autumn Gold,' 'Princeton Sentry,' 'Sinclair,' and 'Lakeview.' Each cultivar replication showed variation in branch structure. In asexually propagated trees, one would expect similar branch structure within a cultivar.

The cultivar variation in *Ginkgo* may be answered by the work of Peter Del Tredici of the Arnold Arboretum of Harvard University. Dr. Del Tredici has demonstrated topophytic effect in *Ginkgo biloba* (14). His work indicates that vegetatively propagated lateral branches of ginkgoes will result in propagules that will continue in a lateral direction. It seems certain the cultivar 'Horizontalis' originated from a 90-degree angled branch of a *Ginkgo biloba*.

Ginkgo has varied branch orientation on a single tree. Scionwood collected from three branch structures will produce a comparable number of trees, each with a different formation.

William Flemer III of Princeton Nurseries, New Jersey, states that "it is hopeless to expect spreading forms of *Ginkgo* to be asexually reproduced and developed with a central leader and a whorl of spreading branches" (8). Scions selected from spreading trees for budding or grafting need to be staked to develop a central leader. Mr. Flemer's experience reveals that when the staked central leader grows beyond the stake, the leader grows horizontal. As a result of this experience, Princeton Nurseries will not grow cultivars that originate from a spreading clone. They grow 'Princeton Sentry' and 'Magyar' which have acute and rounded, angled branch formation.

Princeton Nursery has grown quite a few spreading males, but none of these cultivars remain in production today.

Barrie D. Coate, former director of horticulture at Saratoga Horticultural Research Foundation, reports that they have made selections of *Ginkgo* cultivars from seedling trees growing along streets and backyards in California (15). One of the finest selections was chosen for autumn color. It was named cv. 'Autumn Gold.' The parent tree is not alive today, but it originated as a spreading form. Coate says that he found that asexually propagated trees of this cultivar are erratic in trunk and branch formation. He also noted that cv. 'Saratoga' originated from a symmetrical parent tree, but of all the progeny that he has seen, none are like the parent tree.

Keith Warren of J. Frank Schmidt and Son Co. in Oregon says, "We are new at the *Ginkgo* game," but the company has moved from the experimental to the production stage (16). He said he suspects that in propagating from lateral branches, the meristem will maintain lateral growth. However, Warren noted that he has not yet replicated enough trees for confirmation. He said he has seen trees of *Ginkgo* cultivars that fail to meet the horticulture forms under which they are registered.

A rather striking use of *Ginkgo* in the city landscape is evident at Cleveland's Gateway, Jacob's Field (Cleveland Indians Baseball Stadium), and Gund Arena in Ohio. Two hundred and sixty male cultivars of *Ginkgo biloba* are planted around the perimeter. *Ginkgo* was chosen by the site planners because of its autumn color; its more vertical than spreading habit, and the unifying element and scale that the species provides in this urban landscape. Darrell Bird, landscape architect, said, "I do not know what other tree we could have used on the Gateway project to get the effect we wanted" (19).

The production and marketing of *Ginkgo* in the United States and beyond is believed to have a definite capacity for growth.

Here's why: *Ginkgo:*

- Is adaptable to moderate field soils and open environments.
- Is generally impervious to insects and diseases.
- Has charm in the landscape.
- Has a noble heritage and longevity.

Conclusion

Marketing of *Ginkgo* directly depends on:

- Selecting scionwood from mature male trees.
- Selecting propagation material from pyramidal forms (taller than width).
- Selecting trees with acute or rounded, angled branches.

One might consider experimenting with a branch bending technique early on in production by hanging weights on young side branches, or inserting "spreaders" to develop a little more width to the overall tree. This technique has been used successfully in the orcharding of apple trees (17).

I am proposing an international exchange of *Ginkgo* scionwood based on the criteria outlined in this paper. From an experimental point of view, my initial desire is to contribute scionwood from an outstanding *Ginkgo* more than 75 years old (18).

Secrest Arboretum would welcome the exchange of an outstanding *Ginkgo* from Poland. Perhaps this exchange will result in a cooperative venture for marketing *Ginkgo* internationally. This is a small step for the *Ginkgo*, but could be a big step for nursery marketing internationally.

References

1. A meeting at the Ohio Agricultural Research and Development Center, Secrest Arboretum, Wooster, Ohio, July 1, 1997, which included Karol J. Piatkowski of Konin and Wojtek Grabczewski of Warszawa, Piotr Goraczko and Leszek Stanislaw and Ryszard Zwierowicz of Olsztyn.

2. This estate later became the Woodlands Cemetery of Philadelphia, Pennsylvania.

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4. "Ginkgo and People — A Thousand Years of Interaction," Peter Del Tedici, *Arnoldia* 51 (2) 2-15, 1991.

5. "The Ginkgo, The Most Ancient Living Tree," Randolph T. Major, *Science* 157: 1270-1273, 1967.

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8. Conversation with William Flemer III and Louise Gross, Princeton Nurseries, Princeton, New Jersey.

9. Conversation with Robert K. Siebenthaler, The Siebenthaler Company, Dayton, Ohio.

10. Conversation with Tom McCloud, Appalachian Nurseries, Inc., Waynesboro, Pennsylvania.

11. Conversation with Chet Halka, Halka Nurseries Inc., Englishtown, New Jersey.

12. A plant received at Secrest Arboretum from C. Klyn and Company, Boskoop, Holland, through Walter Sutcliff, Glen Head, New York.

13. Plant name verified by the Botanical Garden of Leiden, Leiden, Holland.

14. "Topophysis in Gymnosperms: An Architectual Approach to an Old Problem," Peter Del Tredici, *Combined Proceedings, International Plant Propagators' Society,* 41:406-409, 1991.

15. Conversation with Barrie Coate, Barrie D. Coate and Associates, consulting arborist, Los Gatos, California, and member, Board of Trustees, Saratoga Horticultural Research Foundation, San Martin, California.

16. Conversation with Keith Warren, Horticulturist, J. Frank Schmidt and Son Co., Boring, Oregon.

17. "Influence of Training Stakes and Various Pruning and Bending Techniques on Early Performance of 'Fugi' Apple Trees," D. C. Ferree and J. C. Schmid, Ohio Agricultural Research and Development Center, Research Circular 298, pp. 11-17, June 1994.

18. Located in Wooster, Ohio, USDA Hardiness Zone 5b, originated from a seedling sent to the United States from Japan; currently 37 inches DBH and 65 feet in height (measured by Jim Karcher, Wooster, Ohio).

19. Conversation with Darrell R. Bird of Sasaki Associates Inc., Watertown, Massachusetts.

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Composts in the Landscape: Effects on Soil pH and Plant Growth

Mary Ann Rose and Hao Wang

Abstract

Throughout three growing seasons, the effects of sulfur and organic soil amendments on plant growth and the pH of a calcareous soil were studied. Bedding plant growth was increased by the incorporation of peat moss, yardwaste, and biosolids compost, but was not increased by sulfur or leaf compost incorporation. Leaf and yardwaste compost increased soil pH; biosolids composts had little net effect on soil pH. Peat moss and sulfur both decreased soil pH. No soil-pH effect was observed on the growth of bedding plants. However, azaleas grown in these plots during the third year responded strongly to soil pH differences. Only those azaleas grown in plots amended with both peat moss and sulfur had good color and growth. These plots also had the lowest pH. All other treatments produced unacceptable azaleas.

Introduction

Composts are widely used to improve the physical characteristics of soil and are also valuable sources of organic matter. However, many composts have a relatively high pH, in the range of pH 7 to 8. The high pH of various types of compost is potentially a problem when these materials are used in the high pH soils that are common in central and western Ohio.

In 1995, a three-year study was started on the effects of composts and sulfur on soil pH. Objectives over the three years have been to evaluate four types of composted waste materials available in Ohio for their suitability as soil amendments and to compare these to peat moss and untreated field soil. Bedding plants were grown the first two years of the experiment. First-year results with bedding plants were reported in a previous edition of this Ornamental Plants Special Circular (Rose and Wang, 1996). Azalea, a species with an acid-soil requirement, was grown the third year. In the third year, the hypothesis that composts alter the soil environment to enable acid-soil-requiring species to grow under high pH conditions was tested.

Materials and Methods

Research plots were located in Columbus, Ohio, on a Crosby silty-clay loam soil. Initial soil pH and nutrient levels (lb/A) were pH 7.1, 156 P, 663 K, 5310 Ca, and 826 Mg. Five soil amendments were used — composted leaves, composted yardwaste, two types of biosolids compost (Technagro, Kurtz Bros., Inc., and Comtil, City of Columbus), and sphagnum peat moss. Rototilled field soil with no amendment served as the control. All treatments were repli-

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cated three times. In June 1995 and May 1996, a two-inch layer of each soil amendment was applied to the soil surface and rototilled to a six-inch depth.

Granular sulfur at 0 and 3 lb/100 square feet was incorporated with the amendments in 1995, but was not reapplied until April of 1997. Organic soil amendments were not reapplied in the third year, since soil organic matter had already reached high levels (>20%) by the preceding fall. In the spring of 1995 and 1996, geranium, zinnia, petunia, and marigold transplants were planted in all plots. In spring of 1997, six four-inch potted liners of azalea 'Rosebud' were planted in each plot. A single fertilizer application of 1.5 lb. N per 1,000 sq. ft. was made in 1995 and 1997.

Visual observations were made, and soil samples were taken throughout the growing season in all years. Soil samples were tested for soluble salts (electrical conductivity) and pH.

Results and Discussion

Effect of Soil Amendments in the First Two Years

In the first two years, all soil amendments with the exception of composted leaves improved the growth of one or more species of bedding plants. All composts increased the percentage of soil organic matter. Sulfur significantly lowered soil pH, but did not affect bedding plant growth. In 1995, the ranking of the soil amendment treatments with respect to bedding plant growth was peat moss > both biosolids composts > yardwaste compost > unamended soil = leaf compost. In 1996, in contrast to the previous year, no fertilizer was added. The biosolids composts, with the highest nutrient content, produced the best growth in this year. The 1996 ranking was Comtil > Technagro = yardwaste compost > peat moss > unamended soil = leaf compost.

The results over these two years suggested that most types of composts were quite beneficial to growth, but it is possible to obtain materials that do not improve growth. It is likely that our poor results with one commercial source of leaf compost were linked to a problem with that specific source rather than a problem with leaf compost in general. Much anecdotal evidence from growers and landscapers supports the value of leaf compost from other sources. Our lack of success with one product underscores the importance of experimenting with a new product before using it on a wide scale.

Soil pH Over a Two-Year Period

Soil pH values over a two-year period (Table 1) indicated that yardwaste and leaf compost both elevated soil pH. The leaf compost raised soil pH the most, with values on some sampling dates as high as 7.8 in these plots. Overall, the biosolids composts did not affect soil pH very much. In contrast, the pH in peat-moss amended plots was decreased by one full unit, and this effect lasted at least for the entire growing season.

Effect of Sulfur on Soil pH

Sulfur applied at 3 lb/100 sq. ft. in the spring of 1995 effectively lowered soil pH throughout that year (Table 2). Since the sulfur reaction requires time, pH minimums did not occur until October 1995 or May 1996. Since sulfur was not reapplied until 1997, soil pH values increased throughout the summer of 1996. The soil pH was lowered by sulfur addition as much as a full unit in the control and peat moss-amended plots. However, the pH did not drop nearly as much in the compost-plus-sulfur plots. It appeared that all of the composts buffered the pH against changes due to sulfur (compare differences between Tables 1 and 2 for October 1995 and May 1996, when sulfur had maximum effectiveness).

Effect of Soil Amendments and Sulfur on Azalea Establishment and Quality Ratings

A distinct growth response of azaleas to both organic amendment and sulfur incorporation was observed. In most treatments, plants were unacceptably chlorotic with poor growth. Most of these plants are not expected to survive the winter of 1997–98. However, azaleas grown in soil amended with both peat moss and sulfur had deep green foliage color, good growth, and good visual quality ratings (Table 3). Most azaleas grown in compost-amended plots, plus or minus sulfur, were unacceptable and had significantly lower ratings than the azaleas grown in the field soil plus sulfur treatment. Even when sulfur was incorporated with the composts, the growth and color of plants in these treatments were unacceptable; results suggest this was because the composts raised the soil pH (Table 2). Results indicate a very strong pH effect associated with azalea growth that was not observed with bedding plants.

Conclusions

This study was carried out in a relatively high pH, calcareous soil. Under these conditions, some composts may significantly increase soil pH for at least a full growing season. In acid soils, or with pH-tolerant species, this probably does not present a problem, but with acid-preferring species, composts may reduce the chances of successful establishment in high-pH soils. The hypothesis that some composts may alter the soil environment to overcome the effects of high pH on azaleas was not supported. Peat moss plus sulfur proved to be the best treatment for establishing azaleas in a calcareous soil. However, this work also shows that the pH effect is transitory. Future work is needed to learn how to maintain a favorable soil environment over time.

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Table 1. Soil pH Values Over a Two-Year Period in Treatments Without Sulfur.

No Sulfur	Field Soil Control	Peat Moss	Composted Leaves	Composted Yardwaste	Technagro Compost	Comtil Compost
	Applied Organic Amendments, May 1995					
July 95	6.8	5.2	7.8	7.4	6.9	7.2
Oct. 95	7.0	6.0	7.6	7.5	7.2	7.3
May 96	6.6	5.2	7.3	6.8	6.4	5.8
	Reapplied Organic Amendments, May 1996					
June 96	6.6	5.8	7.3	7.3	6.7	7.1
Sept. 96	7.1	5.5	7.8	7.4	6.8	6.8
Apr. 97	7.1	6.6	7.3	7.4	7.0	7.0
June 97	6.7	6.6	7.3	7.4	7.0	7.1

Table 2. Soil pH Values Over a Two-Year Period in Treatments with Sulfur.

Sulfur Added 5/95 and 4/97	Field soil Control	Peat Moss	Composted Leaves	Composted Yardwaste	Technagro Compost	Comtil Compost
	Applied Sulfur and Organic Amendments, May 1995					
July 95	6.4	4.9	7.6	7.1	6.8	6.9
Oct. 95	6.2	4.6	7.2	6.9	6.6	6.7
May 96	5.3	4.7	7.2	6.6	6.1	5.7
	Reapplied Organic Amendments, May 1996					
June 96	5.4	4.5	7.1	6.8	6.6	6.6
Sept 96	6.7	5.5	7.5	7.0	6.6	6.5
Apr. 97	7.0	6.1	7.4	7.2	6.7	6.8
	Reapplied Sulfur, April 1997					
June 97	6.5	5.6	7.3	6.9	6.5	6.5

Table 3. Average Visual Ratings of Azalea 'Rosebud,' September 1997.

1 = extremely chlorotic with poor growth, 5 = excellent color and growth. Each value is an average of 18 observations.

Compost treatment	Minus Sulfur	Plus Sulfur
Field soil control	2.1	3.8*
Peat moss	3.0	4.3*
Comp. leaves	1.7	1.5
Comp. yardwaste	1.8	2.4
Technagro	1.7	3.1
Comtil	1.8	3.2

* Indicates this treatment had significantly higher ratings than field soil controls without sulfur.

How to Optimize Disease Control Using Composts

Harry A. J. Hoitink, Wei-Zheng Zhang, David Y. Han, Alexandra G. Stone, Matthew S. Krause, and Warren A. Dick

Abstract

Nursery operators and landscapers have recognized for centuries that composts can improve plant health. Many factors must be controlled, however, to obtain consistent effects.

The degree to which the raw material is heated during composting affects the potential for kill of pathogens and weed seeds. The degree to which the organic matter has been stabilized plays a role in disease suppression and plant growth. Furthermore, composts do not always become colonized naturally by beneficial microorganisms, and this can lead to failures.

Finally, the concentration of salts and the quantity of nitrogen released by composts plays a role. These factors are briefly reviewed here. General information is provided about composts widely available to the nursery industry and how best to use such products.

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Introduction

Most beneficial effects induced by composts are due to the activities of microorganisms in the rhizosphere, the area of soil immediately surrounding the roots. Some of these microorganisms produce plant growth hormones and stimulate plant growth directly. Others produce natural chelators called *siderophores* that, along with water-soluble humic substances in composts, keep iron at a high concentration in available form to plants in soil, even at pH 7.6. This probably explains why growers using composted biosolids can produce "acid-loving" plants such as azaleas at pH 7.4 in container media consisting of aged pine bark (60%), fibrous Sphagnum peat or composted long-grain rice hulls (20%), composted biosolids (10–15%), and silica sand, in regions where the irrigation water is high in carbonates. This is very difficult to do in peat mixes in areas with high carbonate water, because trace elements limit growth as the pH increases and their solubility decreases. The siderophores produced by beneficial microorganisms in compost-amended mixes reduce this problem. The soluble humic substances are abundant in manure and sludge composts.

Beneficial microorganisms that control diseases are known as biocontrol agents. Disease control obtained with this microflora is attributed to four mechanisms. The first is competition for seed, root, or leaf exudates (sugars, etc.) that leak out of seeds during germination or out of root tips as plants grow through the soil. Pathogens swimming to these sources of nutrients must compete with this beneficial microflora in the infection court. This reduces infections and therefore disease. Some biocontrol agents produce antibiotics that are effective against pathogens. Yet another group parasitizes pathogens. Microarthropods such as springtails and mites actually search out pathogen propagules in soils and devour them. The fourth mechanism involves the induction of systemic resistance in plants by microorganisms present in composts. A few beneficial microorganisms can induce all four mechanisms.

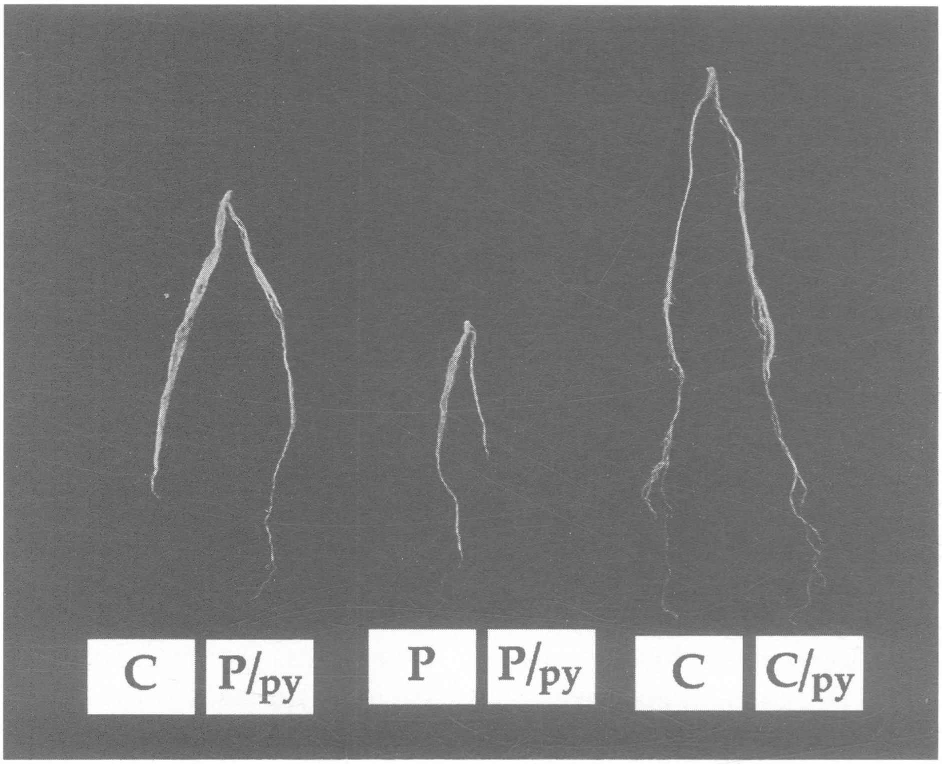
Ohio Agricultural Research and Development Center (OARDC) researchers have shown recently that some microorganisms colonizing roots in compost mixes actually activate biochemical pathways in plants, leading to resistance to root as well as foliar diseases. This mechanism explains the often-heard statement that plants on "healthy organic soils" are more able to resist disease. It has now been proven that compost can indeed support such effects. Details of this work are described here.

Most of the Sphagnum peat sold for use in container media is of a decomposition level that cannot support the growth and activity of beneficial microorganisms. OARDC research has determined that such peat mixes are conducive (no suppression) to all diseases tested. Figure 1 shows plants produced with one half of their roots in one mix and the other half in a second. The plant in the center had both sides in a Sphagnum peat mix (H_4 on the von Post decomposition scale). The right side was in a mix infested with *Pythium*, a root rot and damping-off pathogen. Note that the roots of the center plant with both sides in the peat mix were small relative to the others. The rest rotted. The plant on the right had both sides in a composted pine bark mix with *Pythium* on the right side. Note the healthy root system. The plant on the left shows the systemic effect. The right side was in peat, also with *Pythium*, but the left was in the compost mix. When the compost was sterilized, it did not control the disease. Somehow, the microflora in the compost seemed to induce factors in the roots on the left that transferred to roots on the right in the peat mix which made the plant resistant to root rot.

Figure 2 shows an example of control of a fungal disease of cucumber (anthracnose) on the foliage of a plant produced in a composted pine bark mix. The plant on the left, where the disease was much more severe, was grown in an H_4 peat mix. Some bacterial diseases in the foliage of plants can also be controlled in this way with several types of composts in the mix. This is an important finding because good control procedures for diseases such as fireblight, bacterial blight of lilac, Xanthomonas leaf spot on ivy, etc., are not available. It is important to stress, however, that fertility affects the severity of many bacterial diseases, and this may well prove very important to this type of disease control.

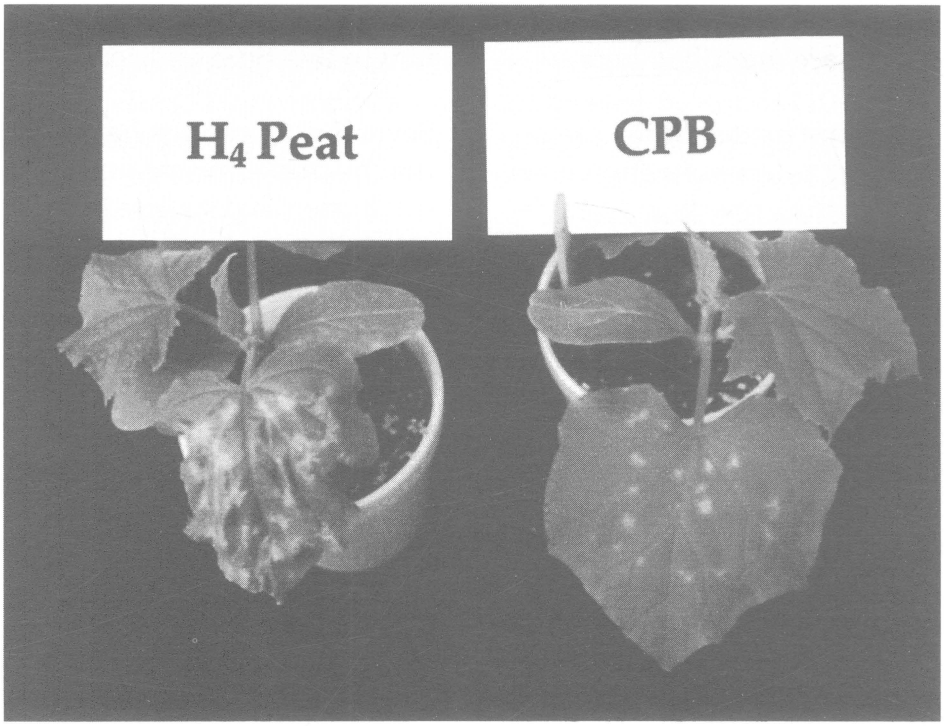
Several publications have shown recently that microorganisms on roots can induce this systemic response in plants. OARDC research has identified some of the microorganisms in composts that can induce this effect. Plants produced in any of several compost-amended mixes tested so far have higher concentrations of an enzyme related to host defense mechanisms. Plants grown in the peat mix that does not provide biological control do not have this elevated level of enzyme activity. In summary, this work shows that plants grown in substrates rich in biodegradable organic matter support microorganisms that induce systemic

Figure 1



Roots of cucumber plants were transplanted into split-root pots containing a suppressive compost mix (C) or a peat mix (P) conducive to disease in each half of the pot. The mix in the right half of each pot was infested with the pathogen *Pythium ultimum* (py). Note induced suppression by the compost mix.

Figure 2



Cucumber plants with anthracnose were grown in pots containing a peat mix (H_4 Peat) or a compost mix (CPB). Note the reduced disease severity on the plant grown in the compost mix.

resistance in plants. These plants have elevated levels of enzyme activity relative to disease control and are better prepared to defend themselves against diseases.

It is important to realize that composts usually do not provide total disease control. When all conditions are favorable, composts offer the potential to reduce many diseases to below critical threshold levels. *Pythium* and *Phytophthora* root rots are among the most easily controlled diseases. Some foliar diseases such as *Phytophthora* die-backs may not be controlled at all, particularly when high fertility levels are maintained in the crop.

Self-Heating Kills Pathogens and Many Beneficial Microorganisms

Some landscapers utilize fresh wood chips as mulch. The question is, can this lead to spread of diseases. The answer is yes, and such mulches also increase the activity of pathogens already on the site.

C. Ash, formerly at the University of Minnesota, has shown that fresh mulch, prepared from maple trees that died from *Verticillium* wilt, killed tomatoes mulched with this material. *Verticillium* was recovered from the dead tomato plants. This study demonstrated that pathogens in freshly ground infected trees can indeed cause problems in the landscape. Damping-off of bedding plants has been observed in Ohio landscapes mulched with fresh woody materials. Avocado trees mulched with fresh crop debris also suffer more from *Phytophthora* root rot. *Rhizoctonia* damping-off also occurs in bark mixes used during propagation even though *Phytophthora* root rot is controlled. How can these problems be avoided?

First of all, pathogens, insect egg masses, weed seeds, and so forth are killed when temperatures in compost piles exceed 130°F for just a few days. Turning of piles so that all parts are exposed to high temperature ensures that pathogen destruction occurs. Those that are not killed outright are weakened and are more susceptible to parasitism. Many technical articles support this statement.

It is important to stabilize organic matter in mulches. Organic matter must be stable enough so that plant pathogens cannot utilize it directly as a food base. Otherwise, the mulch actually increases the population of the pathogen. *Rhizoctonia* is an example of a plant pathogen that can actually grow on fresh mulches.

Another reason for partial composting of mulches is that some beneficial microorganisms grow strictly as saprophytes (on dead organic material) in fresh mulches. Once the mulch is partially decomposed, these beneficial microorganisms must now compete for nutrients at this stage of decomposition. Some of the beneficial microorganisms then produce several types of competitive products that lead to pathogen kill or inhibition. This does not occur in fresh wastes. Some *Trichoderma* isolates serve as examples of a group of beneficial microorganisms that behave in this manner in fresh woody materials (bark as well as sawdust and chips). In conclusion, application of fresh residues to crops or trees should be avoided when the crop is susceptible to disease. Fall or winter application avoids this problem.

What is the best method of composting fresh wood chip mulches to reach these beneficial effects? After just a few weeks of composting, the organic matter in materials examined so far is already stabilized enough for most diseases to be controlled. The best way to accomplish this quickly with fresh ground brush is to enrich it with nitrogen. Add 1 lb. urea per cubic yard or grass clippings (10–20% by volume), composted sewage sludge (10–15% by volume), composted poultry manure (10–20 lbs. per cubic yard), or another source of nitrogen to decrease the carbon to nitrogen ratio to within the optimum range for composting. Be certain to add water to the pile to maintain a moisture content of 50–60% on a total weight basis. Ammonium volatilizes out of the pile as gaseous ammonia when it is too dry. The best procedure is to compost these materials for six weeks before use as a mulch. It should no longer give off ammonia odors then and should begin to smell like soil.

The procedures proposed here kill pathogens and adequately stabilize most materials for use as mulches. Depending on the material being composted, it may have to stabilize much longer before it is suitable for soil incorporation as compost.

Colonization of Composts by Beneficial Microorganisms

Very few beneficial microorganisms can survive in the high temperature part of compost piles. Most survive in the outer low temperature layer where they constantly re-establish their populations after turning of windrows if several factors are addressed. First, the moisture content must be above 35% in the organic matter fraction of composts for beneficial microorganisms to colonize the substrate. They actually grow as biofilms on the surface of organic matter, particularly if the moisture content is maintained above 45%. Dusty, dry composts and mulches become predominantly colonized by molds that cause a variety of problems. These problems can range from difficulties in wetting of the compost-amended soil or mix because fungal masses repel water, to inhibition of plant growth due to deleterious-to-growth microorganisms (minor fungal pathogens). Other fungi cause problems due to their large fruiting bodies, such as a number of Basidiomycetes that produce mushrooms.

Allowing composts to cure while maintaining a moisture content of 45–55% reduces the potential for these problems. Plant growth promoting bacteria and bacterial biocontrol agents naturally colonize such higher moisture content mulches and compost after peak heating because a thin layer (film) of water surrounds organic matter particles at this moisture content. Bacteria cannot readily colonize dry surfaces, whereas fungi thrive as long as the moisture content ranges from 15–34%.

When all factors are optimized, 20% of the compost batches tested still are somewhat deficient in natural biological control when the moisture content of the compost is kept above 40% on a total weight basis. To avoid this, composts must be inoculated with specific biocontrol agents. Commercial inoculants for compost consistently providing these beneficial effects are now being registered with the U.S. Environmental Protection Agency (EPA). Mixtures of cultures are better than single strains, and broad spectrum control of soilborne as well as some foliar diseases should soon become possible in practice.

How Long Do Disease-Suppressive Effects Last?

The readily biodegradable fraction of the organic matter in composts sustains the activity of biocontrol agents. Humic substances do not support this activity; they are too resistant to decomposition to support such activity. Research has shown that the population of beneficial microorganisms steadily declines as decomposition proceeds. Each material has its own properties in this regard. These trends for Sphagnum peat and cow manure have been characterized utilizing direct infrared spectroscopy.

The concentration and chemistry of lignocellulosic substances, not the humic acids, determine this effect. Once these materials are decomposed, the beneficial microorganisms decline in activity, the pathogen population recovers, and fungicides must be applied for sensitive crops to remain disease free.

For light Sphagnum peat (H_2 to H_3 on the von Post decomposition scale), the beneficial effect lasts 6–12 weeks in greenhouse crops. In outdoor containers in hot weather, the length of time may be reduced 50% because of the higher temperature. Pine bark can support this effect six months to one year. However, pine bark aged in large piles where pyrolysis or fires occur behaves more like charcoal and offers little disease control potential, even though it still has ideal physical properties for use in container media to control root rots. Hardwood bark incorporated at 15% by volume lasts two seasons in Ohio. Composted sewage sludges last through two years (at 10–15% by volume in a mix). Composted rice hulls and coconut coir (husks) also have an effect, but will undoubtedly be shown to be short-term in nature.

Some knowledge is available from field studies also. In general, the same material should last longer in the field because soil temperatures are lower than those in containers. The best results are obtained in the field if the compost is applied as a mulch on the soil surface. Only a small fraction (5–10 dry tons/acre) of the compost should be incorporated into the soil. The remainder (25–50 dry tons/acre) should be applied on the surface after planting. An exception to this general rule is where compost is applied ahead of a vegetable crop planted for an early harvest. Soil temperatures remain lower in mulched soils, and this can set back early vegetable crops. The quantity and form of mineral fertilizers applied need to be adjusted in succeeding years to avoid overloading with nutrients.

Control of diseases with composts in field soils can be illustrated by the following examples. Composted hardwood bark mulch applied to apple trees at planting controlled *Phytophthora* collar rot through two years in a 1978–1981 Ohio State University field study where inoculum of the pathogen was used. In Ohio orchards, this mulch effect (4 gal./tree at planting) seems to last much longer. A recent study by Dr. Richard Funt from the Ohio State University Department of Horticulture and Crop Science revealed that composted yard waste (50 tons/acre) on strawberry maintained plant stand beyond three years whereas plants in control plots declined from any of several pathogens. Five-year beneficial results have been observed by growers utilizing bark instead of straw mulches. In western Australia, a composted manure suppressed *Phytophthora* root rot of avocado for well into the second year. Similar results are being obtained in orchards in southern California today. Much more work needs to be done in this field, however, before general advice can be provided.

Effects of Salinity and Fertility in Composts on Plant Diseases

Some composts immobilize nitrogen (N), but most composts available today release nitrogen. Some are consistently high in salinity (dairy manures) and others vary in salinity. An increasing number of compost producers with experience in this field realize that the composition of raw materials, the composting process as well as curing, screening, and more must be kept constant to produce a consistent quality product. Furthermore, soil analysis laboratories increasingly are capable of predicting the fertility values of composts. Nutrient inputs must be balanced against crop needs and the residuals in the soil.

Composted pine bark and peat, because of their resistance to decomposition, do not release or immobilize significant quantities of nutrients. Therefore, essential micronutrients must be incorporated into the mix. Composted hardwood bark immobilizes nitrogen early but releases various nutrients, including trace elements, later.

Composted sewage sludges available in Ohio release 25% of the total nitrogen in the first few months after utilization. Therefore, the incorporation rate needs to be adjusted to the fertility needs of the crop. Generally, this means not using more than 10–20% of this compost by volume in a mix, depending upon the crop's fertility need. Overloading with this nitrogen-rich compost may increase fireblight, *Phytophthora* die-backs, and *Fusarium* wilts. All trace elements are supplied adequately by composted sewage sludges, particularly in high pH irrigation water regions. Trace elements do not need to be applied.

Composted leaves also supply trace elements, not much nitrogen, and significant quantities of potash. Composted yard wastes supply some nitrogen, if prepared with grass clippings, and may contain up to 1% available potash. All of these composts provide phosphorus, calcium, and magnesium. Most do not have to be amended with lime, and addition of sulfur to lower the pH to 5.5 may not be necessary even though most laboratories recommend it. It makes a lot of sense to blend low nitrogen with high nitrogen composts. Mixtures of composted yard wastes and composted sewage sludges increasingly are preferred in several applications.

Two studies (Ohio State University and Israel) have shown that concentrations of available iron, zinc, and manganese are very high at a soil pH above 7.0 in composted cow manure or sewage sludge-amended mixes. As mentioned previously, studies have determined that plants, including azaleas, grow very well and without trace element deficiencies at pH 7.0 or higher in these mixes because microorganisms producing siderophores (natural chelators) and soluble humic substances keep them in solution.

All composts can be high in salinity. As composts mature, mineralization proceeds, and the concentration of salts increases. Because compost piles often do not leach, salts accumulate with time. Thus it is always important to monitor the conductivity reading of a new batch. Incorporate based on salinity limits, if needed, or apply composts well ahead of planting to allow for leaching. Manure composts, which are now becoming more widely available, will have to be monitored most closely for salinity problems.

During the early 1980s, composted sewage sludge was applied to soybeans in Ohio in an attempt to control *Phytophthora* root rot. The disease increased in each of four years when the compost was applied directly ahead of planting. However, in plots where the compost was applied three months prior to planting (February) or in the previous fall, the disease was controlled and the yield increased. The damage done by the compost could be mimicked by an application of salt (NaCl) directly ahead of planting. It is well known that *Phytophthora* and *Pythium* root rots are aggravated by salinity. These factors must be considered carefully in biological control of plant diseases.

The foregoing is a brief synopsis of some of today's knowledge of compost utilization relative to maintenance of plant health. Some references are suggested for further reading.

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The Flowering Sequence of Ornamental Plants as a Tool for Predicting the Phenology of Insect Pests

Daniel A. Herms

Summary

This report presents the phenological sequence of 56 plant and 22 insect species for Wooster, Ohio, in 1997. A phenological sequence developed in Midland, Michigan, based on five years of data was evaluated for its accuracy in predicting insect activity in Wooster in 1997. For some insects, correspondence was quite close; for other insects, reliance on the Michigan sequence would have resulted in mistimed treatments. These data suggest that phenological indicators developed in one region may need to be evaluated on a case-by-case basis before they can be used with confidence in another region.

Introduction

The tremendous diversity of ornamental plants, each with its own complement of insect pests, creates a logistical challenge for planning and implementing a successful pest management program. Insecticide applications must be timed precisely to maximize their effectiveness and minimize the number required. Improperly timed insecticide applications are expensive, environmentally detrimental, and result in customer dissatisfaction. Many insects are difficult to detect and monitor, further complicating the accurate timing of pesticide applications. Consequently, pesticide applications are frequently scheduled on a calendar-day basis. However, because of variation in patterns of degree-day accumulation from place to place and year to year, calendar-based scheduling is frequently inaccurate.

The use of ornamental plants as phenological indicators provides an alternative approach to predicting insect activity. Phenology is the study of recurring biological phenomena and their relationship to weather. Bird migration, hunting and gathering seasons, blooming of wildflowers and trees, and the seasonal appearance of insects are examples of phenological events that have been recorded for centuries (4,8). Because the development of both plants and insects is temperature dependent (6,12), plants may accurately track the environmental factors that affect insect development. Indeed, the use of plant phenology to predict insect activity is an old practice, with recorded observations that date back at least to the 18th century (7).

In recent years, two sets of phenological indicators have been published that demonstrate that phenological indicators can be useful tools for predicting the activity of insect pests. Donald A. Orton and Thomas L. Green published an extensive list of observations made in Illinois in their

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book *Coincide* (10). In addition, this author published a phenological sequence based on five years of data collected in central Michigan (5).

A critical but unresolved question is whether phenological indicators developed in one geographic region can be used accurately in another. The objectives of this report are:

- To present a phenological sequence for Wooster, Ohio, in 1997.
- To test the ability of the Michigan phenological sequence to predict the occurrence of insect activity in Wooster, Ohio.

Methods and Materials

During 1997, the phenology of 56 plant species and/or cultivars and 22 species of insects on or near the Ohio Agricultural Research and Development Center's Wooster campus were monitored (Table 1). For clarity, only common names are listed. To achieve standardization in nomenclature, common names of plants follow Dirr (3), and insect names are official common names as approved by the Entomological Society of America.

Plants were chosen to represent a range of blooming times from early March through late July. This time period corresponds with the activity of most of the important insect pests of ornamental plants. Four individuals of each species or cultivar were monitored. All individuals of a species were located either in uniform sun or shade, depending on the environment to which the species is adapted. Plants in microenvironments obviously altered by buildings, parking lots, and related areas were not used. Plants were monitored at least three times each week, and the dates of "first bloom" and "full bloom" were recorded. "First bloom" was defined as the date on which the first flower bud on the plant opened, 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). These phenological events can be identified and recorded with precision.

The phenology of 22 insect pests with diverse life histories was also monitored in 1997, including defoliators, scales, gall formers, wood borers, and leafminers. As opposed to methods used to monitor plant phenology, which were designed to minimize variation in order to increase predictive power, sampling protocols for insects were designed to characterize the phenology of the entire population.

The Michigan phenological sequence developed at Dow Gardens in Midland consisted of 55 plant and 24 insect species, the phenology of which was monitored for five years (1985–1989) using the exact protocols described previously (5). Since the Michigan and Wooster phenological sequences have in common 40 plant and 14 insect species, they can be directly compared in order to test the accuracy of a sequence developed in one region (Michigan) for predicting insect activity in another (Wooster).

Results and Discussion

The Phenological Sequence

The phenological sequence observed in Wooster, Ohio, in 1997 is presented in Table 1. The sequence of occurrence is much more important than the dates, which are only included to provide perspective, and which will vary dramatically with year-to-year variation in degree-day accumulation. During the cool spring of 1997, plant and insect phenology was substantially delayed relative to "normal" years.

Table 1. Phenological sequence for Wooster, Ohio, in 1997 (insect names are indicated in bold type).

Species	Phenological Event	Date
Silver Maple	first bloom	7 March
Corneliancherry Dogwood	first bloom	15 March
Red Maple	first bloom	25 March
Silver Maple	full bloom	25 March
Border Forsythia	first bloom	30 March
Manchu Cherry	first bloom	2 April
Korean Rhododendron	first bloom	3 April
Eastern Tent Caterpillar	**egg hatch**	**4 April**
Red Maple	full bloom	4 April
Star Magnolia	first bloom	4 April
Border Forsythia	full bloom	4 April
Corneliancherry Dogwood	full bloom	4 April
Sargent Cherry	first bloom	5 April
Norway Maple	first bloom	6 April
European Pine Sawfly	**egg hatch**	**15 April**
Inkberry Leafminer	**adult emergence**	**15 April**
Weeping Higan Cherry	first bloom	20 April
'Bradford' Callery Pear	first bloom	21 April
Rhododendron 'PJM'	first bloom	21 April
'Springsnow' Crabapple	first bloom	22 April
Allegheny Serviceberry	first bloom	23 April
Floweringquince	first bloom	23 April
Koreanspice Viburnum	first bloom	26 April
Allegheny Serviceberry	full bloom	29 April
Weeping Higan Cherry	full bloom	29 April
Rhododendron 'PJM'	full bloom	1 May
'Snowdrift' Crabapple	first bloom	2 May
'Donald Wyman' Crabapple	first bloom	4 May
Birch Leafminer	**adult emergence**	**5 May**
Japanese Flowering Crabapple	first bloom	5 May
Eastern Redbud	first bloom	7 May
Koreanspice Viburnum	full bloom	7 May
Gypsy Moth	**egg hatch**	**7 May**
Wayfaringtree Viburnum	first bloom	10 May
Sargent Crabapple	first bloom	10 May
'Coral Burst' Crabapple	first bloom	11 May
Tatarian Honeysuckle	first bloom	12 May
Ohio Buckeye	first bloom	14 May
'Springsnow' Crabapple	full bloom	15 May
'Snowdrift' Crabapple	full bloom	15 May
Common Lilac	first bloom	15 May
Honeylocust Plant Bug	**egg hatch**	**16 May**
'Donald Wyman' Crabapple	full bloom	16 May
'Coral Burst' Crabapple	full bloom	18 May
Imported Willow Leaf Beetle	**adult emergence**	**18 May**
Red Buckeye	first bloom	18 May
Sargent Crabapple	full bloom	19 May
Blackhaw Viburnum	first bloom	19 May
Red Chokeberry	first bloom	19 May
Eastern Redbud	full bloom	19 May
'Pink Princess' Weigela	first bloom	20 May
Wayfaringtree Viburnum	full bloom	20 May
Blackhaw Viburnum	full bloom	22 May
Japanese Flowering Crabapple	full bloom	22 May

Table 1 (continued). Phenological sequence for Wooster, Ohio, in 1997 (insect names are indicated in bold type).

Species	Phenological Event	Date
Eastern Spruce Gall Adelgid	**egg hatch**	**22 May**
Pine Needle Scale	**egg hatch**	**22 May**
Vanhoutte Spirea	first bloom	25 May
Umbrella Magnolia	first bloom	26 May
Red Chokeberry	full bloom	26 May
Common Lilac	full bloom	26 May
Winter King Hawthorn	first bloom	26 May
Redosier Dogwood	first bloom	27 May
Tatarian Honeysuckle	full bloom	28 May
Holly Leafminer	**adult emergence**	**29 May**
Slender Deutzia	first bloom	29 May
Black Cherry	first bloom	29 May
Euonymus Scale	**egg hatch**	**30 May**
Lilac Borer	**adult emergence**	**30 May**
Pagoda Dogwood	first bloom	30 May
Ohio Buckeye	full bloom	31 May
Vanhoutte Spirea	full bloom	1 June
Scarlet Firethorn	first bloom	1 June
'Pink Princess' Weigela	full bloom	2 June
'Red Prince' Weigela	first bloom	3 June
Beautybush	first bloom	3 June
Black Cherry	full bloom	3 June
Lesser Peach Tree Borer	**adult emergence**	**4 June**
Winter King Hawthorn	full bloom	5 June
Redosier Dogwood	full bloom	5 June
Red Buckeye	full bloom	7 June
Sweet Mockorange	first bloom	8 June
Scarlet Firethorn	full bloom	8 June
Black Locust	first bloom	9 June
Umbrella Magnolia	full bloom	9 June
Common Ninebark	first bloom	9 June
Oystershell Scale	**egg hatch**	**9 June**
White Fringetree	first bloom	9 June
Pagoda Dogwood	full bloom	9 June
Bronze Birch Borer	**adult emergence**	**12 June**
Arrowwood Viburnum	first bloom	12 June
Mountain-laurel	first bloom	12 June
Black Locust	full bloom	13 June
White Fringetree	full bloom	13 June
American Holly	first bloom	13 June
Bumald Spirea	first bloom	14 June
Juniper Scale	**egg hatch**	**14 June**
Common Ninebark	full bloom	15 June
Potato Leafhopper	**adult appearance**	**16 June**
Arrowwood Viburnum	full bloom	17 June
American Holly	full bloom	19 June
'Red Prince' Weigela	full bloom	20 June
Washington Hawthorn	first bloom	20 June
Japanese Tree Lilac	first bloom	21 June
Sweetbay Magnolia	first bloom	22 June
American Elderberry	first bloom	22 June
Northern Catalpa	first bloom	22 June
Slender Deutzia	full bloom	23 June

Table 1 (continued). Phenological sequence for Wooster, Ohio, in 1997 (insect names are indicated in bold type).

Species	Phenological Event	Date
Fall Webworm	**first instars**	**24 June**
Sweet Mockorange	full bloom	24 June
Sweetbay Magnolia	full bloom	24 June
Washington Hawthorn	full bloom	24 June
Mountain-laurel	full bloom	25 June
Northern Catalpa	full bloom	25 June
American Elderberry	full bloom	28 June
Littleleaf Linden	first bloom	29 June
Spruce Bud Scale	**egg hatch**	**30 June**
Bumald Spirea	full bloom	2 July
Japanese Beetle	**adult emergence**	**2 July**
Panicled Goldenraintree	first bloom	7 July
Rosebay Rhododendron	first bloom	7 July
Littleleaf Linden	full bloom	7 July
Peach Tree Borer	**adult emergence**	**8 July**
Rosebay Rhododendron	full bloom	20 July
Panicled Goldenraintree	full bloom	28 July
Magnolia Scale	**first instars**	**3 August**

It is important to emphasize that any conclusions drawn from this sequence are preliminary, as they are based on only one year of data. Because consistency in the sequence is essential if the sequence is to be useful for predicting insect activity, this study will continue for several more years to test this critical assumption. However, in the five-year Michigan study, there was substantial year-to-year variation in degree-day accumulation, yet little variation in the order in which plants bloomed and insects appeared from one year to the next.

When a phenological sequence of plants can be shown to correspond with the appearance of insects, pest managers can use the easily monitored plant sequence as a "biological clock" to anticipate the order and the time when pests reach vulnerable stages. This can greatly facilitate the logistics of serving many clients with a variety of problems. For example, one can see from Table 1 that when common lilac was in full bloom:

- Crawler emergence of pine needle scale was well underway, and sprays were appropriate.
- It was too late to worry about first generation birch leafminer.
- Lilac borer pheromone traps should have been deployed promptly.
- There was still time to plan for bronze birch borer.

Again, it must be emphasized that this first year of data should be considered preliminary. It remains to be seen if this sequence proves valid as the study continues.

A useful attribute of phenological sequences is that they can be readily expanded and customized. Once the basic sequence is in place, any new plants or pests can be added as the need occurs. For example, if a pest manager has made a particularly successful treatment, any plants in bloom at the time can be noted, added to the sequence, and used to duplicate the timing in future years.

Are Phenological Indicators Accurate Across Regions?

This critical question must be answered before published phenological sequences can be used with confidence outside the regions in which they were developed. To the degree that phenological relationships do not hold across regions, it will be necessary to develop localized sequences. Table 2 can be used to evaluate the accuracy of the Michigan plant sequence for predicting insect phenology in Ohio. The order in which phenological events occurred in Ohio in 1997 is compared with the average order in which they occurred in Michigan from 1985–1989. The magnitude of any disparity in the order in which a particular event occurred in the two sequences is also shown. A positive value indicates that the event occurred earlier in the sequence in Michigan that it did in Ohio, while a negative value indicates the opposite.

The correspondence in the flowering sequences of the plants common to both studies was quite close. Flowering of silver maple occurred first in both locations, followed by flowering of corneliancherry dogwood. Red maple flowered just before border forsythia in Ohio, and just after it in Michigan; first bloom of Norway maple was the ninth event in both sequences. In fact, in no case did the order of flowering by any species vary by more than the five places between the two sequences. As more plant species are included in the sequence, the chance of being led astray by one species that departs from the pattern will diminish.

The sequence of insect phenological events did not correspond as closely. Egg hatch of eastern tent caterpillar occurred before first bloom of red maple, border forsythia, and Korean rhododendron in Michigan, but after their first bloom in Ohio. Some of the discrepancies were substantial enough that any pesticide applications on which they had been based would have been mistimed and probably inefficacious. For example, egg hatch of oystershell scale closely followed first bloom of Vanhoutte spirea in Michigan, but did not occur until more than two weeks after first bloom in Ohio. There was even less correspondence in the phenology of euonymus scale egg hatch, which occurred just after first bloom of black cherry in Ohio, but not until after first bloom of common ninebark in Michigan. The much closer correspondence in other species including birch leafminer, pine needle scale, bronze birch borer, and juniper scale suggests that phenological sequences may have regional generality, at least in some cases.

A number of factors may affect the accuracy of plant phenological indicators as predictors of insect activity. The assumption that a given phenological correlation will occur in different climatic regions requires that all organisms included in the correlation have the same upper and lower temperature thresholds for development, as well as the same developmental responses to changing temperature. These traits are known to vary widely among both plants and insects (6,12).

Origin, or provenance, of indicator plants can affect their accuracy as phenological indicators. Both elevational and latitudinal gradients can affect plant phenology, as different provenances are adapted to different day-length and temperature regimes (12). Furthermore, the same genotype may display different phenological patterns when planted in different geographic regions (9). Substantial geographic variation has also been documented in the phenological patterns of insects (1, 2, 13).

Data from the Michigan study indicate that insects that overwinter in the soil, such as

Table 2. Comparison of a phenological sequence for Wooster, Ohio, in 1997 with a phenological sequence from Midland, Michigan, from 1985–1989 (insect names are indicated by bold type).

Species	Event	Order in Ohio	Order in Michigan	Disparity in Rank
Silver Maple	first bloom	1	1	0
Corneliancherry Dogwood	first bloom	2	2	0
Red Maple	first bloom	3	4	-1
Border Forsythia	first bloom	4	5	-1
Manchu Cherry	first bloom	5	8	-3
Korean Rhododendron	first bloom	6	7	-1
Eastern Tent Caterpillar	**egg hatch**	**7**	**3**	**4**
Star Magnolia	first bloom	8	6	2
Norway Maple	first bloom	9	9	0
Weeping Higan Cherry	first bloom	10	14	-4
'Bradford' Callery Pear	first bloom	11	12	-1
'PJM' Rhododendron	first bloom	12	11	1
Allegheny Serviceberry	first bloom	13	15	-2
Floweringquince	first bloom	14	16	-2
Koreanspice Viburnum	first bloom	15	19	-4
'Snowdrift' Crabapple	first bloom	16	21	-5
Birch Leafminer	**adult emergence**	**17**	**18**	**-1**
Japanese Flowering Crabapple	first bloom	18	20	-2
Eastern Redbud	first bloom	19	17	2
Gypsy Moth	**egg hatch**	**20**	**13**	**7**
Wayfaringtree Viburnum	first bloom	21	24	-3
'Coral Burst' Crabapple	first bloom	22	25	-3
Tatarian Honeysuckle	first bloom	23	26	-3
Ohio Buckeye	first bloom	24	23	1
Common Lilac	first bloom	25	22	3
Willow Leaf Beetle	**adult emergence**	**26**	**10**	**16**
Blackhaw Viburnum	first bloom	27	29	-2
Doublefile Viburnum	first bloom	28	30	-2
Cooley Spruce Gall Adelgid	**egg hatch**	**29**	**27**	**2**
Pine Needle Scale	**egg hatch**	**30**	**28**	**2**
Vanhoutte Spirea	first bloom	31	33	-2
'Winter King' Hawthorn	first bloom	32	37	-5
Black Cherry	first bloom	33	32	1
Euonymus Scale	**egg hatch**	**34**	**43**	**-9**
Lilac Borer	**adult emergence**	**35**	**31**	**4**
Pagoda Dogwood	first bloom	36	35	1
Beautybush	first bloom	37	38	-1
Lesser Peachtree Borer	**adult emergence**	**38**	**36**	**2**
Black Locust	first bloom	39	39	0
Common Ninebark	first bloom	40	41	-1
Oystershell Scale	**egg hatch**	**41**	**34**	**7**
White Fringetree	first bloom	42	40	2
Bronze Birch Borer	**adult emergence**	**43**	**42**	**1**
Mountain-laurel	first bloom	44	44	0
Juniper Scale	**egg hatch**	**45**	**45**	**0**
Washington Hawthorn	first bloom	46	46	0
Japanese Tree Lilac	first bloom	47	47	0
American Elderberry	first bloom	48	50	-2
Northern Catalpa	first bloom	49	48	1
Littleleaf Linden	first bloom	50	52	-2
Spruce Bud Scale	**egg hatch**	**51**	**54**	**-3**
Panicled Goldenraintree	first bloom	52	53	-1
Rosebay Rhododendron	first bloom	53	49	4
Peachtree Borer	**adult emergence**	**54**	**51**	**3**

the imported willow leaf beetle and white pine weevil, are less accurately predicted from year-to-year than insects that overwinter on aerial plant parts exposed to the same ambient conditions as flower buds. The phenology of insects overwintering in the soil may be influenced substantially by a number of factors not having as strong an effect on the phenology of flower buds, including vegetation, snow cover, and soil moisture (11).

Phenological indicators will be more accurate in the region in which they are developed because these factors are less variable within a region than among different regions. Furthermore, at any given location the weather is more similar from one year to the next than is the weather from one location to another. The results of this study suggest that while some phenological indicators may be regionally robust, others are not. Hence, phenological indicators developed in one region will need to be evaluated on a case-by-case basis before they can be used with confidence in another region. None the less, the use of plant phenological indicators for timing pest activity holds tremendous potential for improving the effectiveness of integrated pest management programs in the landscape.

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Reducing Maintenance Costs May Mean Selecting Plants With the Fewest Flaws

T. Davis Sydnor

Introduction

One thing that seems to be human nature is for people to search for the one plant that will serve all functions and sites equally well. Of course that tree or shrub does not exist. Sites can vary such that a plant could be a good choice for a specific location and would be a poor choice for a site a few feet away. All plants have good and bad features. The key to reducing maintenance costs is to match the plant to the site as closely as possible to minimize the undesirable characteristics. No plant is so bad that it cannot be used to good advantage nor so good that it cannot be a poor choice.

In marketing trees, the tendency is to concentrate on the characteristics such as flower color, fall color, variegation patterns, and other highly marketable characteristics. Undesirable characteristics are often ignored or minimized to close the sale. Patent laws in the United States compound the problem. Growers cannot afford to test the tree to ensure that it has a 25-year service life if the patent lasts for 17 years. Desirable plant lists can cause problems by making unstated assumptions. All planting sites are assumed to be normal. Serious plant selection errors can be made although the intent was good.

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A list of trees commonly grown in Ohio appears here. Undesirable and less well-known desirable characteristics of these commonly grown trees will be the focus of this report. Knowing these potential faults will enable landscape designing, contracting, and maintenance personnel to make better choices and to plan realistic maintenance. This report is not an attempt to sway people from using popular plants but an attempt to give more complete information on popular plant material to maintain a firm's profitability. The trees covered are listed alphabetically by scientific name in Table 1 and in the body of the text. Table 1 will enable you to find the write-up you need more easily.

Table 1. An alphabetical listing of the scientific names of trees covered in this article. The paragraph number in which the tree is covered is given.

Scientific Name	Common Name	Paragraph
Acer X Freemanii	Freeman Maple	1
Acer rubrum	Red or Swamp Maple	2
Acer saccharum	Sugar / Rock Maple	3
Amelanchier x grandiflora	Apple Serviceberry	4
Betula nigra	River Birch	5
Carpinus betulus	European Hornbeam	6
Fraxinus americana	White Ash	7
Fraxinus pennsylvanica	Green Ash	8
Gleditsia triacanthos	Thornless Honeylocust	9
Malus species	Crabapples	10
Platanus X acerifolia	London Planetree	11
Pyrus calleryana	Callery Pear	12
Quercus palustris	Pin Oak	13
Tilia cordata	Little-Leaf Linden	14

1. *Acer X Freemanii* — Freeman Maple

Height to 80 ft.

The major drawback for this plant is its close relationship to silver maple, the most over-planted maple in Ohio. This is a red by silver maple cross and as such has inherited much of the urban tolerance of the silver maple. One must also assume that some structural instability of silver maple has been inherited as well. These trees may need to be pruned to guarantee that they have a structurally stable branching pattern.

'Autumn Blaze' has the best fall color, but 'Celebration' has the better branching pattern. 'Armstrong' maple has an upright habit for the first 20 years and has a proven record of survival under urban conditions. 'Armstrong' has been sold for years as a red maple in the nursery trade but is now acknowledged as a Freeman maple.

Silver maple is the longest-lived maple in Ohio's urban areas. The life expectancy of Freeman maple is expected to be greater than 30 years. Freeman maples appear to tolerate wind and alkaline soils. These trees are also more tolerant of wounding than red maple. Like silver maple, this plant is likely to live long enough to outgrow a small site if it is improperly sited.

Under no circumstances should this large tree be used in a tree lawn less than six feet wide nor should it be used under power lines. Freeman maple's fruiting characteristics are variable but can be a nuisance in some years.

2. *Acer rubrum* — Red or Swamp Maple

Height 50–60 ft.

The bark is thin, and the wound response is poor. The tree must be protected from physical damage and should not be used in damage-prone areas such as tree lawns. It requires acid soil and is less tolerant of neutral soils than most other maples and even pin oak. Growth rates are slow in urban situations. Life expectancy in an urban situation is 20 years or less with trees dying before reaching eight inches in caliper.

Red maple's moderate size allows it to be used as a shade tree in suburban areas with acid soils. This plant has a rounded and regular outline with a 1.5 to 1 height to width ratio. The plant can adapt to low-oxygen situations if given time to adapt. Remember most nursery trees are grown in well-drained situations. Red maple is dioecious. Male plants can be selected if fruit is not wanted. Maturing fruit is red turning tan when mature in mid-June and can be ornamental.

The attractive fall color and grey bark are the principal reasons that this plant has been so popular during the last 30 years. 'Red Sunset' (a female) and 'Autumn Flame' (a male) are the best commonly grown cultivars for Ohio. 'Red Sunset' has red fall color and 'Autumn Flame' has yellow to orange fall color.

3. *Acer saccharum* — Sugar / Rock Maple

Height 50–80 ft.

The sugar maple is intolerant of urban sites. This is the principal climax forest tree in much of Ohio. It is beautifully adapted to a forest environment and is shade tolerant when young. New subdivision environments are not climax forests but are similar to an open field. Open fields are disturbed sites that are colonized first by weeds and pioneer tree species. Sugar maple does not adapt well to the increased light, heightened drought, and competition from grass found in suburban areas. Service lives are less than 10 years in an urban site, 25 years in a suburban lawn, and more than 40 years in a woodland setting.

Sugar maples, as do most maples, requires structural pruning to produce a stable branching pattern. Co-dominant leaders are normal when open grown. Shade imposes a more desirable branching pattern. Storm tolerance appears similar to other maples.

The wound response of sugar maple is excellent. A strong wound response allows late winter to be the time to tap sugar maples and to collect the sap for maple syrup. Wood density is higher than red and silver maples. The lumber trade calls this tree hard maple due to its density.

Many named cultivars are available in the nursery trade. 'Green Mountain' is the most popular cultivar but does not appear to differ from the species in stress tolerance as reported. 'Green Column' has not been evaluated long enough to be sure but may be more stress tolerant than the species.

4. *Amelanchier x grandiflora* — Apple Serviceberry

Height 25–35 feet

Forestry literature suggests that this is a pestiferous tree while horticultural literature advances serviceberry's pest resistance. The resolution to the contradiction is that it takes years for a newly introduced tree to be planted commonly enough to support a pest population. Problems have been building for five or more years. Serviceberry is a host to a variety of insects and diseases. The most serious is the lacebug that can turn the foliage white. Pear slugs, aphids, borers, and spider mites can also exact a toll. All insect and disease problems have been cosmetic.

Twenty years is the service life of this native tree in an urban environment despite the cosmetic insect and disease problems. This tree will tolerate restricted root areas better than most trees. The biggest problem in urban areas is the thin bark that provides little protection from mechanical damage. Although mechanical damage is the most limiting factor in urban situations, this may not be a concern in a residential setting.

This tree can be grown single or multi-stemmed. Serviceberry is a forest understory tree and can tolerate shade. Given time, the tree can adapt to poor drainage. The flowers are borne early but are frost tolerant, while magnolia is frost sensitive. Fruit can be eaten. If you want a tree that produces fruit, you can substitute serviceberries for blueberries in recipes. This assumes that you beat the birds to the fruit.

5. *Betula nigra* — River Birch

Height 50–60 feet

This birch is generally southern in distribution and tolerant of the heat and high soil temperatures found in the South. Southern Ohio is the northern limit of this tree's natural range. River birch is subject to several cosmetic insect and insect-like pests. The spiny witch-hazel gall aphid can cause some defoliation in some years. The problem is more severe when birch and witch-hazel are grown in close proximity. Birch leaf miner is generally a cosmetic problem for river birch.

The most serious problem is its alkaline soil intolerance. Iron chlorosis is the factor determining life expectancy. In acid soils river birch will last more than 25 years, but in alkaline soils around 15 years is to be expected. Since concrete, mortar, and limestone all increase the soil pH, river birch does poorly in some urban areas.

Bark color ranges from cinnamon to ivory. Some people are surprised when the tree produces mature bark that looks similar to a white oak. Only trees that are two to 10 inches in diameter have the exfoliating bark. The named selection 'Heritage' was selected for light colored bark. 'Heritage' was originally sold as a white birch substitute due to the light exfoliating bark and resistance to the borer that kills the white-barked birches. 'Heritage' grows more slowly and more irregularly than the species and thus is less desirable.

Foliage is a deep green in the summer. Lower branches sweep downward, allowing this plant to remain foliated to the ground. Fall color is poor. This tree grows rapidly and can reach a large size. This tree is often grown with multiple stems. In most situations only one or two stems will reach maturity. Turf does well in the dappled shade of river birch. Many other trees such as oaks, maples, and beeches shade out and kill turf.

6. *Carpinus betulus* — European Hornbeam

Height to 30 feet

This tree is of European origin as the name suggests. The performance of the American hornbeam might best explain its cousin's performance. American hornbeam is a forest understory tree that is pruned to the ground every 15 years or so by the hornbeam borer. Borers attack stressed or overmature trees. High light, drought, and transplant shock are all stresses that can result in a borer attack. Multiple suckers arise to replace the dead top in time.

The most popular selection of this tree is the upright European hornbeam. This tree has a habit that is three times higher than broad. The canopy is regular, and the foliage is dense, resulting in an attractive young tree. Habit changes rapidly for those trees living longer than 20 years. By 40 years of age, the tree, including the upright cultivar, will be twice as broad as tall. Avoid the tendency to try to use this tree in a restricted space because of its narrow, juvenile growth pattern. Such restricted spaces are often stressful and increase the likelihood of a hornbeam borer attack.

Transplanting is more difficult than average. Spring transplanting is preferred. The life expectancy is 20 years in an unstressful site but only eight to 10 years in an open, tree lawn site. Hornbeam borer seemingly attacks without warning. In truth, loss of foliage density and welting of the bark are present, but often go with out detection by the homeowner.

7. *Fraxinus americana* — White Ash

Height to 75 feet

White ash is the most common native ash to the state of Ohio. It exists as a secondary invader species in nature and does well in moist, well-drained sites. It does poorly in urban sites although it transplants well into such sites. Parks and open areas are ideal sites for this tree. This large plant is inappropriate for planting beneath power lines or in small tree lawns.

Tolerance to poor drainage, restricted root space, and drought is poorer for white than for green ash. White ash is more tolerant of lilac and ash borers than is green ash. Life expectancy in a tree-lawn situation would be around 15 years. It would be increased to 30 years in a lawn environment if irrigated during drought periods.

Fall color ranges from yellow to purple with brown as an intermediate color. Several named cultivars have been selected for wine fall color. 'Autumn Applause' and 'Autumn Purple' are the most popular. No differences have been observed in sensitivity to insects or disease among the cultivars.

Stress intolerance is usually seen as drought sensitivity. Numerous cankers are followed by twig dieback and death over a period of several years. Ash yellows is caused by a mycoplasma-like organism (MLO) and may be associated with declining trees. Ash yellows has been a serious threat to white ash in northern Ohio.

8. *Fraxinus pennsylvanica* — Green Ash

Height to 50 feet

Green ash is native in Ohio but its range extends further west than white ash. Green ash is more stress tolerant than white ash. The growth pattern is more irregular than white ash. Both white and green ash are fast growing when small. Green ash does not get as large as the white ash, but the smaller size may be desirable in urban situations. Green ash can tolerate restricted root spaces such as sidewalk cuts.

Lilac and ash borers can be serious problems for recently transplanted trees. A spray program is desirable for one or two years to get the green ash established. Once established the spray program can usually be eliminated unless there are many infested trees nearby. Green ash should be used sparingly to prevent a build up of the borers. Life expectancy of green ash is usually determined by the borers. Fifteen years can be expected in tree pits while 30 years is common in lawn situations where borer populations are low to moderate.

Named cultivars have been selected for a variety of characteristics including cold hardiness ('Patmore'), habit ('Summit'), and foliage color ('Urbanite'). 'Summit,' with its more uniform habit, is the most popular. Most of the named selections of green ash are male and fruitless. Differences in sensitivity to insects or disease have not been observed among the cultivars. Ash yellows is reportedly less of a concern for green ash than for white ash. Ash yellows has been seen more often in northern Ohio.

9. *Gleditsia triacanthos var. inermis* — Thornless Honeylocust

Height to 75 feet

This tree is uncommonly found in the wild but has been heavily planted for the last 30 years in urban areas in the Midwest. The rapid growth for the first 10 years and the lacy foliage have been major assets for many designers. The light shade cast by honeylocust allows for good turf growth beneath the crown of the tree.

Honeylocust's habit is highly variable. Some cultivars may be too irregular to suit some people's desires. Early reports suggested that the cultivars were fruitless but this has not been true for any cultivar. Cultivars generally fruit less heavily than the species but all cultivars have fruited. 'Halka' fruits more heavily than most cultivars.

Earlier honeylocust was listed as stress tolerant. This is not so since stress results in sensitivity to honeylocust borer. Honeylocust borer causes the plant to die seemingly without warning. A lawn environment is as much stress as can be tolerated over time. A preventive spray program may be needed to get this plant established where a honeylocust borer population is active.

In the 1960s this tree was touted as insect and disease free. Today this tree is a good example of the caution that you must have a host (tree) population to support a pest population. This tree is present in sufficient numbers to support a variety of insect and disease problems. The tree is not cold hardy past -25°F. Fortunately, most problems are cosmetic, but *Thyronectria* canker and honeylocust borers are potentially fatal.

'Skyline' has been the most consistent cultivar. 'Sunburst' (aurea) has the best record of the yellow-foliaged selections. Despite the problems, this plant will still give a life expectancy of 30 years in a lawn environment.

10. Malus species — Crabapples

Height 25–50 feet

There are many named crabapples that are available in the trade. Flower colors range from white to pink and red. Summer foliage colors vary from green to wine. Fruit color ranges from green to yellow to orange and red. Flower, foliage, and fruit colors are often the reason for selecting a specific cultivar. One should use cultivars that are disease resistant, first, and then select for ornamental characteristics. Apple scab and particularly fireblight resistance are important in selection of these plants. Crabapples are the longest-lived flowering trees used in Ohio with life expectancies of 30 to 40 years for fireblight resistant selections.

One cultivar of note is 'Spring Snow,' an essentially fruitless cultivar. Crabapples begin to spread as the plants age. A crabapple with an upright habit when it is small will become more wide spreading with age.

Crabapples are tolerant of restricted soil space and will tolerant alkaline soils. These plants handle storm loading very well. Structural pruning is needed for most selections. Wound response has been excellent. These plants can be grown under power lines and other restricted spaces quite nicely. This has been a very satisfactory tree in the urban scene. Suckering is a problem for all cultivars. Using specific rootstocks and own root production are being evaluated for reducing this problem.

11. *Platanus X acerifolia* — London Planetree

Height to 75 feet

This tree is an interspecific hybrid between the American sycamore and the Oriental planetree. The oriental parent is smaller than sycamore, but the resulting cross is large by any standard. A large tree is inappropriate in restricted root spaces and beneath power lines. Foliage is bold with a disappointing fall color. The exfoliating bark is showy but less so than American sycamore. Transplant success is high even into stressful sites.

'Bloodgood London' planetree is the most popular cultivar but it is not reliably cold hardy in Ohio. 'Bloodgood' is more sensitive to cankerstain than the species. Anthracnose resistance is used to market 'Bloodgood' but what does it mean? While anthracnose causes defoliation, it does not cause death as does cankerstain. Remember that Bloodgood is properly listed as disease resistant (anthracnose) although it is sensitive to a fatal disease. The National Arboretum recently released two new cultivars but they are reported as less cold hardy than 'Bloodgood.'

Originally this plant was thought to be stress tolerant. Time has shown this to be false. The Oriental planetree is only hardy to 0°F. The resulting cross is much less hardy than American sycamore.

Cankerstain is a disease aggravated by cold temperatures and high stress. Cankerstain has destroyed many plantings from New York to Ohio and beyond. Temperatures below -15°F can result in outright kill. A service life of eight to 10 years can be expected in tree lawns and similarly stressful sites due to cankerstain.

12. *Pyrus calleryana* — Callery Pear

Height 40 feet

Callery pear has performed well in urban situations for 30 years. The size is ideal with mature heights high enough to allow vehicular and pedestrian access beneath the canopy. The major problem has been the tendency of Callery pear to break up in storms as the plant exceeds eight inches in caliper. Formation of many co-dominant leaders results in structural instability. Wood is brittle. Structural instability must be addressed early with corrective pruning. If this is done, we can enjoy the urban tolerance of this plant without the increased risk of failure.

Wildlife is attracted both by the fruit and for nesting. The very dense branching patterns encourage nesting by birds. Several cities have found that nesting can be a problem in urban sites due to the bird droppings. Pruning to stabilize the branching pattern might also reduce nesting since an open branching pattern discourages nesting.

Selections can be chosen that have more storm-resistant branching patterns. Cultivars with potentially better branching patterns include 'Aristocrat,' 'Autumn Blaze,' 'Chanticleer,' 'Cleveland Pride,' 'Gladiator,' 'Metropolitan,' and 'Valiant.' Increased disease sensitivity and increased fruit size may be present in these newer cultivars. Experience to date with 'Bradford' can be beneficial as it is risky to assume that everything to be learned about the newer cultivars will be positive. Remember, the 30 years of experience with 'Bradford' is lacking in the cultivars listed earlier.

13. *Quercus palustris* — Pin Oak

Height to 70 feet

Pin oak has been something of a hate object for 25 years. The reason for concern is that the tree is intolerant of high pH soils. This is a partial truth. In Ohio, as you go from the southeast to the northwest across the 3-C line (a line defined by Cincinnati, Columbus, and Cleveland), you go from red maple to pin oak dominating the wetland woods. So we see that pin oak dominates wetland woods in the alkaline soil regions of Ohio. Native pin oak is more tolerant of neutral to slightly alkaline soils than red maple.

Why do many pin oaks exhibit iron chlorosis? In the 1940s and 50s the nursery industry in the United States began to diversify. A seedling nursery industry developed in the McMinnville, Tennessee, area and provided seedlings for much of the United States. Pin oak is native there and served as the seed source for pin oaks produced in the United States. Tennessee pin oak was falsely assumed to be the same as Ohio pin oak. Pin oak in the McMinnville area has adapted over the millennia to a soil pH of 4.5 to 5.5. Is there any wonder that McMinnville pin oaks develop an alkaline soil intolerance when grown in soil 100 to 1,000 times more alkaline than the soil in which their parents grew?

The trees in the McMinnville area can be called a seed source, provenance, or ecotype and vary from other seed sources within the plant's native range. These differences may be as important to landscape function in Ohio as the neutral to slightly alkaline soil tolerance of Ohio pin oaks is. Several Ohio nurseries are now offering pin oak from locally adapted seed sources. In Ohio, nurseries should ask for and use locally adapted seed sources to enjoy the landscape advantages of pin oak while protecting the customer.

If you are dealing with a chlorotic pin oak, the first step should be to plant an adapted replacement tree. The second step should be to try to lower the soil pH to 6.0 in the area with sulphur. Ohio's heavily buffered soils may require 10 years or more to lower the pH, so you will not see any rapid changes. Iron treatments such as trunk injection change the foliage color but do not return the tree to health or extend the tree's service life. Chlorotic trees usually decline and die over a 20-year period if the pH cannot be raised. Micronutrient deficiencies frustrate homeowners and maintenance personnel as well. Spending large amounts of money in a futile attempt to correct a micronutrient problem may cause you to lose a good customer.

Pin oaks are the most easily transplanted trees in the red oak group. Pin oak is more tolerant of soil compaction, construction activity, and wet soils than other red oaks. Tolerance of large tree lawns has been better for pin oak than other red oaks where adapted seed sources have been used. Response to wounding and structural stability of oaks is better than many other trees. Oaks are also resistant to serious insect problems except gypsy moth. Oak wilt is a local problem in most situations. Pruning near roads may be increased by pin oak's tendency to retain lower foliage although this can be an asset if screening is needed and the size can be tolerated.

14. *Tilia cordata* — Little-Leaf Linden

Height 60 feet

This plant has done well in urban situations although it shows an interesting response to drought or restricted root space. The plant just sits in a dwarfed condition and neither grows nor dies. When in the stunted condition, the plant could be used under power lines. The tree should give a 20-year life expectancy in stressful sites and 30 years in a lawn environment.

Structural pruning will be needed to space branches, reduce the number of co-dominant leaders, and ensure long-term structural stability. Little-leaf linden has very low density wood that can lead to breakage and increase the need for structural pruning. Lindens have a weak wound response that can lead to decay. Decay is often extensive and may result in a serious defect.

Fall color is poor in most years. The uniform branching and regular outline are its major assets as a young plant. The plant becomes rounded with age. Growth rates are highly variable. Many similar cultivars are available. 'Greenspire' appears to have the best growth rate. Insects are a significant problem with gypsy moth and Japanese beetle being the most serious.

An interesting problem for all lindens is the flowers. June flowers are very fragrant; that is good, but bees are attracted in swarms. Some people are sensitive and can be killed by bee stings. People who might be sensitive to bee stings should not be seated under the low crown of any linden tree in June.

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Comprehensive Aesthetic Evaluations of Crabapples at Secrest Arboretum in Wooster: 1993–1997

Erik A. Draper, James A. Chatfield, Kenneth D. Cochran, Peter W. Bristol, and David E. Allen

Summary

Forty-four crabapples (*Malus* spp.) were rated for five years for aesthetic qualities, flower duration, season of fruit effectiveness, tree form, and disease characteristics. Fourteen additional crabapple selections were evaluated under these same parameters in 1997. Overall profiles of these crabapples developed from these ratings are presented in this paper.

Introduction

Crabapples are often thought of and used mainly as a flowering tree, creating a welcome relief of blossoms in spring landscapes. However, this ornamental tree offers many seasonal impacts beyond the "flowering tree" label. Often ignored are aesthetic qualities like ornamental fruit effect and changing fruit color, leaf shape and fall color, bark exfoliation and tree form. The purpose of this on-going study is to develop an accurate year-round profile of commonly used ornamental crabapples.

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This profile benefits commercial landscapers, nursery operators, landscape architects, and homeowners alike in their selection of a particular crabapple for a specific landscape use. Understanding strengths and weaknesses of each crabapple increases the likelihood of complementing the landscape rather than causing a detraction.

Materials and Methods

Forty-four crabapples at Secrest Arboretum (planted in 1984) were rated monthly for aesthetic characteristics from September 1992 through October 1997. Three ratings were taken each year during bloom and combined for one average value. Ratings were made on a 1–5 basis with 1 = outstanding flower, fruit, foliage, form, and other qualities at time of rating. Results are presented as averages, over the five years, in Table 1. Similar results for 14 additional crabapple selections (planted in the 1990s), rated only from November 1996 to October 1997, are presented as averages for that period in Table 2.

From 1995 through 1997, crabapples were scrutinized for season of fruit impact every other week starting at petal fall. Effective fruit is defined as the period from when the tree's fruit first contributes to tree aesthetics until fruit is no longer ornamental.

Materials and Methods text continues on page 92.

Table 1. Aesthetic Evaluations of Crabapples at Secrest Aboretum: 1993–1997

	FRUIT		FLOWER			
Crabapple	Fruit Color	Season of[1] Impact	Bloom[1] Color	Bloom[2] Days	Bloom[2] Time	Tree Form
'Adams'	deep red	mid-July to mid-Oct.	pink	8	M	rounded spread
M. baccata 'Jackii'	maroon red	late July to mid-Dec.	white	10.3	E	rounded upright
'Beverly'	pink-red	mid-Aug. to late Sept.	white	14.3	E	upright spreading
'Bob White'	yellow	mid-Oct. to late Jan.	white	14.5	M	rounded
'Candied Apple'	cherry red	none — scabby fruit	pink	12.3	M	unique spreader
'Centurion'	red	late Sept. to mid-Nov.	rose	11.5	M	unique open
'David'	scarlet	mid-Sept. to mid-Nov.	white	13.7	M	rounded
'Dolgo'	red-purple	early Aug. to mid-Sept.	white	13.7	E	broadly rounded
'Donald Wyman'	bright red	mid-Sept. to late Mar..	white	15.5	L	broadly rounded
M. floribunda	yellow	mid-Oct. to early Nov.	white	12.3	M	broadly spreading
M. halliana 'Parkmanii'	yellow	mid-Oct. to early Nov.	white	11.5	M	rounded
'Harvest Gold'	yellow	late Oct. to mid-Dec.	white	11	L	upright
'Henningii'	orange-red	mid-Sept. to early Nov.	white	11.7	M	upright splayed
'Hopa'	red	none — insect damage	pink	8	M	broadly splayed
'Indian Magic'	red-orange	mid-June to late Mar..	pink	13.7	M	rounded
'Indian Summer'	red	early June to mid-Feb.	rose-red	14	E	rounded

Scab[3]	Aesthetic Rating[3] 93–97 Avg.	Comments ☺: positive aspects ☹: negative aspects
minor	3.3	☺: abundant tear drop fruit; attractive striated bark on branches and flaking trunk bark; ☹: 2- and 3-yr.-old mummies; chlorotic summer foliage.
none	2.7	☺: glossy green foliage; wonderful fall yellow foliage accents the maroon fruits; bark has orange cast ☹: sparse fruit clusters; mediocre winter appeal.
none	3.5	☺: abundant fruit; consistent floral display is fabulous ☹: fruits half-eaten by birds; large, persistent fruit mummifies into black blobs until spring.
none	2.8	☺: abundant yellow-gold fruits mature to orange-gold; standout for winter landscape; outstanding bloom ☹: alternate bloom; lacking summer appeal.
major	3.6	☺: red-tinged new foliage; unusual, irregular weeping form; namesake fruit color ☹: heavy scab year will mask fruit color and can almost defoliate tree.
minor	3.3	☺: unusual, irregular open branching habit; rust-orange fall foliage effect; nice bloom ☹: sparse, dull fruit; mediocre in appearance throughout much of the year.
trace	3.2	☺: snow-white flower display; impressive cherry-like fruits ☹: alternate bloom; large mummies hang until mid-winter; mediocre appeal until bloom.
none	3.6	☺: consistent early, large, fragrant blooms; edible, large neon red-purple fruit ☹: rotten fruit is a fermenting mess; big fruit mummies are ugly.
minor	2.5	☺: excellent floral display; glossy, exfoliating trunk bark; persistent fruit a mud-red after freeze ☹: mummies; heavy fruit scab can reduce appeal.
trace	3.0	☺: commingling of yellow and cider brown fruit; wonderful airy floral display ☹: yellow flecking of foliage; mediocre tree most of the year.
trace	2.9	☺: attractive blend of yellow and cider red-brown fruits; light, airy aspect to bloom ☹: mundane appearance through most of the year.
major	3.4	☺: yellow-gold fruit clusters accented by red pedicels; alternate bloomer ☹: long period of green fruit; extensive scab yearly; fireblight is a concern.
major	4.0	☺: consistent, profuse bloom; attractive fruit in early fall ☹: extensive leaf scab; ungainly upright growth is a landscape liability.
major	4.3	☺: good pastel floral display ☹: ungainly tree form; large, gnarly, deformed fruit from coddling moth larvae; wormy fruit drops all summer.
major	2.6	☺: incredible fruit display; consistent, profuse floral display; persistent fruit; fall foliage color ☹: yearly leaf scab and defoliation by mid-summer.
major	2.7	☺: prolific fruit display; consistent large blooms; orange fall foliage; flaky bark on trunk ☹: yearly extensive leaf scab; persistent mummies.

Table 1 (continued). Aesthetic Evaluations of Crabapples at Secrest Aboretum: 1993–1997

Crabapple	Fruit Color	FRUIT Season of[1] Impact	FLOWER Bloom[1] Color	Bloom[2] Days	Bloom[2] Time	Tree Form
'Liset'	maroon-red	early July to mid Nov.	rose-red	14.5	L	open rounded
'Mary Potter'	red	mid-Aug. to late Nov.	white	11.5	L	weeper spreader
'Molten Lava'	red	early Aug. to mid-Nov.	white	13	M	broad spreader
'Ormiston Roy'	orange	mid-Sept. to late Mar.	white	13	M	broadly rounded
'Prairifire'	purple-red	early July to mid-Nov.	coral-red	13.2	L	rounded
'Professor Sprenger'	orange-red	late Sept to mid-Nov.	white	12.2	M	upright spreader
'Profusion'	maroon	mid-July to mid-Oct.	purple-red	10	M	upright spreader
'Radiant'	red	none — scab ravaged	deep pink	10.7	M	broad upright
'Ralph Shay'	red	early Sept. to mid-Nov.	white	11.7	M	broadly rounded
'Red Barron'	dark red	none — scab ravaged	red-pink	10.5	M	narrow upright
'Red Jade'	red	early Sept. to mid-Nov.	white	13	M	weeper spreader
'Red Jewel'	cherry red	early Sept. to mid-Apr.	white	13	L	narrow upright
'Red Splendor'	red	late May to mid-Dec.	rose pink	15.5	E	upright spreading
'Robinson'	dark red	none — lack of contrast	deep pink	12	L	round spreader
'Royalty'	red-purple	none — lacks contrast	pink	11.2	M	upright open
'Ruby Luster'	rose-purple	none-unattractive fruit	pink	11.2	M	rounded open

Scab[3]	Aesthetic Rating[3] 93–97 Avg.	Comments ☺: positive aspects ☹: negative aspects
trace	3.1	☺ : attractive fruit display; red-maroon new foliage turning bronze green ☹ : awkward splayed form; mummies; minimal fruit to foliage contrast.
trace	2.3	☺ : consistent, petite, abundant fruit; fantastic floral display; elegant appearance; salmon-colored underbark ☹ : mummies distract mid-winter.
minor	1.8	☺ : outstanding fruit/fall foliage combination; excellent horizontal layered branching; consistent bloom ☹ : cluttered, dense, lacks summer appeal.
trace	2.8	☺ : wonderful glossy, oval-shaped persistent fruit; orangish bark deeply furrowed; good floral display ☹ : mummies may remain up to a year.
none	2.2	☺ : firm fruit with white speckles; yearly spectacular bloom; airy structure; peach-orange fall color ☹ : lacks winter and early summer appeal.
trace	3.3	☺ : consistent, large flower display ☹ : dull appearance of large yellow-green fruits during summer; mummies persist until late winter; awkward tree form; severe frogeye leafspot.
major	3.4	☺ : abundant fruit; new foliage emerges purple-red ☹ : floral show lacks contrast with foliage; yearly scab problems cause leaf defoliation.
major	4.1	☺ : bloom is pleasant ☹ : yearly scab ruins fruit and causes leaf defoliation; mummies cling on tree well into the next summer.
major	3.4	☺ : great floral display ☹ : very large fruit can be messy; insect feeding will cause misshapen fruit; mummified fruit is a problem.
major	4.2	☺ : unique pumpkin-shaped fruits ☹ : sparse floral show; heavy fruit scab and leaf defoliation; fruit blackens with age; ungainly, unsightly form.
minor	2.1	☺ : large, prolific bloom; reliable fruit and flower display; graceful growth habit ☹ : unsightly fruit rot in Jan.; scab on fruit can dull appearance.
none	2.8	☺ : phenomenal fruit; great flower display; can become alternate bloomer ☹ : tree form is somewhat ungainly.
major	2.9	☺ : exceptional profuse red fruits; fruit matures to orange-salmon color; reliable fruit and flower display ☹ : heavy scab can defoliate tree; fruit mess.
major	3.8	☺ : attractive flower display ☹ : small fruit; lacks fruit-foliage color contrast; coarse tree form; heavy leaf scab can defoliate.
major	4.1	☺ : purple leaf color ☹ : lacks fruit/flower contrast; ungainly tree form; blackened fruit mummies; leaf defoliation from scab.
major	4.2	☺ : ☹ : large coarse fruits; rough scaly fruit finish; gnarly shape from insect feeding damage; diminutive flowers hidden by newly emerged foliage.

Table 1 (continued). Aesthetic Evaluations of Crabapples at Secrest Aboretum: 1993–1997

	FRUIT		FLOWER			
Crabapple	Fruit Color	Season of[1] Impact	Bloom[1] Color	Bloom[2] Days	Bloom[2] Time	Tree Form
M. sargentii	red	mid-Aug. to late Nov.	white	11.2	L	wide spreader
'Selkirk'	red	early June to mid-Aug.	rose red	11.5	E	wide rounded
'Sentinel'	red	early Sept. to mid-Feb.	white	13	M	narrow upright
'Silver Moon'	burgundy	early Sept. to early Dec.	white	9.2	L	oval upright
'Snowdrift'	salmon-red	late Sept. to mid-Nov.	white	10.2	M	broadly rounded
'Strawberry Parfait'	red-cream	early June to late Jan.	pink	14.7	E	open spreading
'Sugar Tyme'	bright red	mid-Sept. to mid-Mar.	white	13	M	rounded
'Velvet Pillar'	reddish	none — lacks contrast	pink	9.5	L	oval upright
'White Angel'	red	mid-Nov. to early Feb.	white	9.7	M	broadly rounded
'White Cascade'	yellow	none — heavy scab	white	14.2	M	true weeper
'Winter Gold'	yellow	early Nov. to mid-Dec.	white	12.2	M	upright
M. zumi 'Calocarpa'	bright red	mid-Sept. to mid-Dec.	white	12.2	L	rounded spreader

1 Season of fruit impact derived from biweekly observations from 1995–1997 only. Effective fruit impact is defined as the period from when the tree's fruit first contributes to tree aesthetics until the fruit is no longer ornamental.

2 Bloom days and bloom time are derived from daily observations from April–May in 1995–1997 only. For bloom time, E (Early) = onset of first bloom in last week of April; M (mid-season) = onset of first bloom in first week of May; and L (Late) = onset of first bloom in second week of May. Bloom days are defined as starting with the emergence of the first flowers and ending when overall flower effect was no longer ornamental.

3 Scab and aesthetic ratings are from 1993–1997.
None = No scab noted.
Trace = A few leaves or fruit affected; no negative effect on aesthetics.
Minor = Significant defoliation and/or leaf yellowing; negative effect on aesthetics.
Major = Severe defoliation and discoloration of leaves; serious negative effect on aesthetics.

Scab[3]	Aesthetic Rating[3] 93–97 Avg.	Comments ☺: positive aspects ☹: negative aspects
none	2.8	☺: petite firm fruits; attractive low-spreading form; reliable fruit/flower display ☹: fruits rapidly deteriorate and shrivel like raisins.
major	3.5	☺: red-tinged new foliage; excellent floral show ☹: scabby fruit; large fruits drop all summer from insect feeding; lacks winter appeal.
minor	2.6	☺: spectacular pink-tinged bloom; persistent firm small round fruits; reliable fruit/flower display ☹: persistent mummies detract in spring and summer; upright habit lost somewhat as plant ages.
none	3.2	☺: glossy unique colored fruits; good late floral display ☹: erratic alternating bloomer; densely cluttered growth; fireblight can be a problem.
major	3.0	☺: reliable excellent flower display; distinctly colored small round fruits ☹: fruit shrivel by late fall; chlorotic summer foliage; extensive leaf scab.
trace	2.7	☺: reliable fruit/flower displays; abundant persistent fruits; stunning sugar white flowers; good tree form ☹: fruit drops all at once before bloom.
trace	2.4	☺: outstanding floral display; red-tinged newly emerged foliage; unusual growth form; firm persistent fruits ☹: persistent fruit mummies.
major	3.6	☺: purplish foliage; nice tree form ☹: meager fruit; lack of fruit/foliage contrast; mummies hang on tree into spring; dingy foliage.
none	3.4	☺: abundant fruits; reliable fruit/flower display; attractive bloom ☹: awkward growth until tree matures; mummified fruit hangs until spring.
major	2.8	☺: exquisite flower display on cascading branches; appealing weeping form ☹: overall dingy summer appearance due to extensive scab; leaf defoliation.
major	3.6	☺: butter yellow fruit clusters contrast with bright red pedicels; impressive bloom ☹: erratic alternate bloom; heavy fruit scab; green fruit for long period.
trace	2.9	☺: reliable fruit/flower display; abundant tiny red fruits; excellent floral show; nice tree form ☹: shriveled fruits; lacks winter appeal.

Aesthetic Rating Scale

Ratings include flower, foliage, form, and fruit characteristics, and effects of disease and pest problems. The rating system is as follows:

1 = Exceptionally ornamental crabapple. Based on outstanding flower, foliage, fruit, or form at time of rating.
2 = Highly ornamental crabapple. Good flower, foliage, fruit, or form at time of rating.
3 = Adequate as a landscape crabapple. Not highly ornamental at time of rating.
4 = Substandard as an ornamental crabapple at time of rating.
5 = Ornamentally unacceptable as a landscape crabapple at time of rating. Not recommended for use in the landscape.

Table 2. Aesthetic Evaluations of Additional Crabapples at Secrest Aboretum: 1996–1997

	FRUIT		FLOWER			
Crabapple	Fruit Color	Season of Impact	Bloom Color	Bloom Days	Bloom Time	Tree Form
'Adirondack'	orange-red	early Oct. to mid-Dec.	white	12	L	narrow upright
'Camelot'	rose-pink	early Aug. to late Oct.	white	14	L	low spreader
'Canary'	yellow	early Sept. to late Oct.	white	12	M	open spreader
'Candymint'	red-purple	early July to mid. Dec.	pink	14	M	low spreader
'Glen Mills'	bright red	early Sept. to mid April	white	10	M	rounded spreader
'Golden Raindrops'	yellow	mid-Oct. to mid-Dec.	white	10	L	open spreader
'Lancelot'	yellow	early Oct. to mid-Nov..	white	12	L	dense upright
'Louisa'	lemon-gold	late Sept. to mid-Dec.	pink	13	E	true weeper
'Naragansett'	cherry-red	early Sept. to mid-Jan.	white	15	M	broadly rounded
'Pink Satin'	dark red	none — scab ravaged	pink	10	L	upright spreading
'Prairie Maid'	orange-red	early July to late Oct.	deep pink	13	L	rounded
'Purple Prince'	deep purple	early July to late-Dec.	rose red	13	E	broadly round
'Silver Drift'	cherry red	early Sept. to mid-Mar.	white	13	E	broadly round
'Sinai Fire'	orange red	early Sept. to early Sept.	white	14	M	unique weeper

Scab	Aesthetic Rating 1997	Comments ☺: positive aspects ☹: negative aspects
none	3.0	☺: narrow upright form; red-tinged flowers; nice autumn fruit/foliage effect; fruit darkens with time to deep orange-gold ☹: fruit sparse and at top.
trace	3.0	☺: low spreading form; fuschia-tinged flower; oblong fruit; foliage dark green with burgundy overtones ☹: dull leaf appearance; slow growing.
minor	3.4	☺: clusters of tiny fruit; nice autumnal fruit/foliage effect ☹: some defoliation caused by scab; fruit deteriorates, turning cider-brown, then falls off.
none	2.1	☺: great overall form; reliable fruit/flower display; purple-tinged leaves ☹: slow growing; dull leaf appearance.
minor	2.7	☺: petite profuse fruit is sensational; long lasting fruit effects ☹: fast growing large tree; mediocre summer appeal.
none	2.4	☺: interesting cutleaf foliage; petite abundant fruit; reliable fruit/flower display; great autumnal leaf color ☹: bland green fruit through summer.
trace	2.9	☺: diminutive size; consistent tree form ☹: tight dense branching structure; fruit/flower mostly hidden on the interior of the plant.
none	2.0	☺: outstanding tree form is its greatest asset; fruit develops a rose blush; ☹: scattered, sparse fruit.
major	3.1	☺: consistent bloom; abundant fruit ☹: cluttered dense branching structure; fruit scab; tree form awkward.
minor	3.7	☺: nice true pink bloom ☹: abundant persistent blackened mummies are overwhelming; cluttered branch structure.
none	2.7	☺: reliable wonderful bloom; abundant clusters of fruit ☹: lacks winter appeal; waxy coating dulls fruit finish until coating is lost.
none	2.7	☺: large unusually colored fruit; consistent flower/fruit display; fast growing; leaves deep purple green ☹: somewhat lacking winter appeal.
trace	2.9	☺: nice persistent showy fruit, nice fruit/new leaves contrast ☹: some fruit mummies; fruit hidden by foliage.
none	2.7	☺: unique growth habit; large flowers ☹: scattered sparse fruit; unique form can limit usage.

For an explanation of the aesthetic rating scale, scab rating key, and fruit and flower data, see the footnotes for Table 1.

From 1995 through 1997, crabapples were studied to determine days of effective bloom from mid-April through May. Effective bloom was defined as starting with the emergence of the first flowers and ending when overall flower effect was no longer ornamental. The average onset of first bloom is reported as E (Early) = last week of April, M (Mid-Season) = first week of May, and L (Late) = second week of May.

Apple scab is reported due to the significance of this disease on aesthetics of crabapples. Incidence of scab is derived from the accumulated disease ratings (three to four per year) on the crabapples in the plot from 1993 to 1997 (1997 only for the 14 additional crabapple selections).

The crabapple plot was planted in 1984 in a completely randomized design with three replications of each crabapple. The cultural practices used to maintain the crabapple plot are minimal pruning, a 6- to 8-foot diameter mulch ring of a 1–2 inch depth around each tree, and removal of rootstock suckers and dead branches, thereby mimicking the cultural practices of an average landscape.

Results and Discussion

In our opinion, some ornamental crabapples are not attributes in the landscape due to a severe lack of aesthetic qualities. This deficiency of aesthetic appeal may be in part due to extensive defoliation or fruit deformation from apple scab, ungainly tree form, retention of mummified fruit, sparse clusters to no fruit, coarse or dull fruit finish, cluttered branching structure, or a general lack of ornamental effect. Any combination of these aesthetic defects would be extremely difficult to overcome. The trees listed in Table 3 are trees that have consistently demonstrated a substandard performance.

Table 3. Ornamental crabapples in the Secrest plot with severe scab problems and/or lacking other pleasing, consistent aesthetic qualities.

'Beverly'	'Red Barron'
'Dolgo'	'Robinson'
'Harvest Gold'	'Royalty'
'Henningii'	'Ruby Luster'
M. adstringens 'Hopa'	'Selkirk'
'Profusion'	'Velvet Pillar'
'Radiant'	'Weeping Candied Apple'
'Ralph Shay'	'Winter Gold'

It should be noted that both 'Dolgo' and 'Beverly' are resistant to apple scab. However, their blandness after bloom will not merit their use in most landscapes because both trees have large fruits that mature and drop.

Due to the prolonged cool (compared to averages for the past two years) moist weather this spring, the overall average days of bloom length was increased by two days. The four crabapples that did not show an increase in bloom length were *M. floribunda, M. halliana* 'Parkmanii,' 'Harvest Gold,' and 'Winter Gold.'

The aesthetic qualities of 44 crabapples (Table 1) were evaluated monthly for more than four years. Monthly ratings were combined, and the average derived for each crabapple selection. This mean is useful in determining the true character profile of a crabapple. Although there are both high and low ratings during a single year, averaging the ratings should eliminate uncharacteristic fluctuations. This cumulative mean is therefore the best indicator of how a crabapple will perform aesthetically in the landscape.

Fourteen new crabapples (Table 2) were evaluated this year, and the aesthetic mean and bloom length for these trees represents only one year of data. Therefore, the profiles of these new crabapples may not be an accurate or complete representation of their aesthetic qualities. More research is needed to confirm these findings and/or correct the inaccuracies.

It must be noted that these crabapple profiles of fruit, flower, form, and disease observations are limited to one site, Secrest Arboretum in Wooster, Ohio. Other limitations of this study, which can affect ratings, are the preferential biases of the evaluators as well as the inability to keep environmental conditions uniform. The lack of control over environmental conditions can directly impact aesthetic aspects like return bloom, bloom duration, fruit development, and ultimately tree size and form if conditions become severe.

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Precision Control of Microirrigation for Container-Grown Mini-Roses

Robert C. Hansen, Ted H. Short, C. C. Pasian, and R. Peter Fynn

Summary

A Q-COM computer-control system along with tensiometers was used to monitor and control moisture tension for container-grown mini-roses (*Rosa hybrida* 'Meidanclar' and 'Meirutral'). Control capability for low-tension (3 to 6 kPa), medium-tension (9 to 12 kPa), and high-tension (15 to 18 kPa) treatments was compared under winter-time conditions using 10 cm pots and summer-time conditions using 15 cm pots. Reliable, stable control of moisture tension within 3 to 6 kPa was achieved under both winter-time and summer-time conditions. Moisture tension above 12 kPa was not successfully controlled.

Introduction

Successful application of automated computer-controlled microirrigation for container-grown nursery plants depends on reliable, low-cost maintenance-free sensors that accurately measure soil-water tension at the root/potting-media interface. Tensiometers have been recognized for eight decades as standard devices for measuring soil moisture levels and have been commercially available for 45 years (Pogue and Kline, 1995). They are valuable because they sense moisture tension directly in the root zone. Ross (1994) describes tensiometers as the best device to indicate how strongly a soil particle is holding water away from a plant root. If ideal upper and lower soil-moisture tension limits can be specified, these sensors can be programmed with the use of appropriate computer software and hardware to cycle irrigation on and off. Optimum growth can occur while water is being conserved. If nutrients are injected into the water as a part of fertigation, then ideal control would provide sufficient nutrients for best growth but no more.

Burger and Paul (1987) successfully developed a solid-state electronic tensiometer for measuring the moisture potential of plants grown in container medias. Lieth and Burger (1989) used these tensiometers as a part of an irrigation system to compare four levels of soil moisture tension on the growth of Chrysanthemum. Abdel-Rahman et al. (1994) measured the effect of three tension levels on the growth of greenhouse tomato plants. Fynn et al. (1992) used soil tensiometers to control irrigation to potted Poinsettias on ebb-and-flood benches.

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The purpose of this paper is to describe experiences with tensiometers while irrigating container-grown *Rosa hybrida* 'Meidanclar' (pink mini-roses) and *Rosa hybrida* 'Meirutral' (red mini-roses).

Methods

A Q-COM computer control system was used to control, monitor, and record soil-water tension data for the research. Experimental Run No. 1 (December 29, 1995, to May 9, 1996) consisted of four treatments, with each treatment composed of three 10 cm pots. *Rosa hybrida* 'Meidanclar' (pink mini-roses) were potted in Metromix 360 media (The Scotts Co.) using Osmocote 14-14-14 slow-release fertilizer (Sierra Chemical Co.) applied at 2.5 g per pot. A second set of four treatments (Experimental Run No. 2, June 13 to August 15, 1996) consisted of *Rosa hybrida* 'Meirutral' (red mini-roses) grown in 15 cm pots.

Typical settings for each treatment are shown in Table 1 for Run No. 1 and Table 2 for Run No. 2. Low, medium, and high soil-water tensions were compared as Treatment No. 1, 2, and 3. For these treatments, tension control was designed so each irrigation event could be turned on for a few seconds (pulse time) when the maximum tension setting was reached after which irrigation stopped for approximately five minutes (pause time) to allow the wetting front to disperse both laterally and vertically within the container. This type of control was created in an attempt to avoid wetting the substrate beyond the minimum tension specified for a given treatment (overshooting). Treatment No. 4 was timed to irrigate at 0900 hr. and 1500 hr. for a three-minute duration each. The irrigation schedule for Treatment No. 4 was adjusted occasionally (based on weather conditions and plant growth) to maintain soil-water tension approximately between 2 and 6 kPa to simulate what a grower might do with manual watering.

In addition to collecting and storing tension data for each treatment, 1000 ml Erlenmeyer flasks were used to collect irrigation water from each treatment by using an additional line and emitter to monitor quantity of water applied (see Figure 1). Also, greenhouse temperature and humidity readings were measured, polled, and historical data was stored with the Q-COM system. The plants were randomly placed on a standard greenhouse bench. Dry-bulb temperatures in the house were set to range from 7 to 20°C (45 to 68°F) during Run No. 1 and 18 to 30°C (65 to 86°F) during Run No. 2.

Discussion

Experimental Run No. 1 (Winter Time)

An example three-day history of moisture tension measurements for all four treatments is shown in Figure 2 beginning with February 3. As a partial record of Run No. 1, these results were recorded when skies were generally overcast and the inside of the greenhouse was being artificially heated. The best system response for operating precisely within specification limits occurred for Treatment No. 1 (3 to 6 kPa). Control for Treatment No. 2 (7 to 10 kPa) was excellent at the upper specification limit but typically overshot the lower specification limit by 1 or 2 kPa, particularly in the early morning hours and near the end of the day. Similar control is evident for Treatment No. 3, except deviation from the lower specification limit is more pronounced (1 to 4 kPa) during the cooler part of the day and into the night. The graph shows that moisture tension measurements for all three tensiometer-controlled treatments cycled more frequently during mid-day and less frequently or not at all during morning, evening, and night-time hours. The timer-

Table 1. Experimental Setup for Run No. 1 (Dec. 27, 1995, to May 9, 1996).

Pink Mini-Roses	Treatment No. 1	2	3	4
No. of pots	3	3	3	3
Pot size (cm)	10	10	10	10
Irrigation control	Tensiometer	Tensiometer	Tensiometer	Timer
Tension (Min) (kPa)	3	7	15	0900 (3 min)
Tension (Max) (kPa)	6	10	18	1500 (3 min)
Pause time (min)	5	5	5	NA
Pulse time (sec)	5	4	3	NA

Table 2. Experimental Setup for Run No. 2 (June 13 to August 15, 1996).

Red Mini-Roses	Treatment No. 1	2	3	4
No. of pots	3	3	3	3
Pot size (cm)	15	15	15	15
Irrigation control	Tensiometer	Tensiometer	Tensiometer	Timer
Tension (Min) (kPa)	3	9	15	0900 (5 min)
Tension (Max) (kPa)	6	12	18	1500 (5 min)
Pause time (min)	5	5	5	NA
Pulse time (sec)	7	7	4	NA

controlled treatment (No. 4) shows expected cycling at 0900 hr. and 1500 hr.

More detail is evident in Figure 3, where a one-day history of moisture tension measurements is shown. Note that while the timed treatment was preset to cycle two times in 24 hours, the computer-controlled low-tension treatment cycled four times, the medium-tension treatment cycled six times, and the high-tension treatment cycled 10 times. Lieth and Burger (1989) reported the opposite scenario while growing Chrysanthemum in 15 cm pots, i.e., more frequent cycling occurred for two low-tension treatments, and less frequent cycling occurred for two high-tension treatments.

Experimental Run No. 2 (Summer Time)

An example of precision control of water tension within the range of 3 kPa to 6 kPa (low-tension treatment) is shown in Figure 4 over a 24-hour period beginning at midnight and ending at midnight on July 4. The corresponding dry-bulb temperature history, recorded inside the greenhouse, is also shown. These results were obtained on a bright summer day with fans and evaporative coolers being used to cool the greenhouse. As expected, the graph shows that irrigation frequency increased (cycle time shortened) during mid-day when radiation and temperatures were high and typically decreased (cycle time lengthened) after sundown. The number of cycles were identical to the winter-time run for this treatment.

Figure 5 compares tension history for low- and medium-tension results for three days (July 4, 5, and 6) along with dry-bulb temperatures. While precise control was typical for low tension, it did not occur for medium tension, particularly during summer conditions. Note that the specified settings (9 to 12 kPa) for Run No. 2, Treatment No. 2 were 2 kPa higher than for Run No.1, Treatment No. 2 (7 to 10 kPa). The graph shows a tendency for tension values to go above the 12 kPa upper specification limit and below the 9 kPa lower specification limit by 3 kPa or more. During the third day, tension reached 20 kPa in mid-afternoon during maximum radiation. This may have occurred because the seven-second irrigation pulse followed by a five-minute pause did not supply sufficient water to the plants to keep pace with evapotranspiration. Interestingly, this treatment cycled six times on July 4, five times on July 5, and four times on July 6.

Figure 6 shows results for the 15 to 18 kPa tension range along with corresponding dry-bulb temperature history during summer time conditions. Although there were brief periods when reasonable control was maintained, the erratic results shown are characteristic of this treatment during the summer-time run. The system did a poor job of controlling moisture tension for the high-tension treatment.

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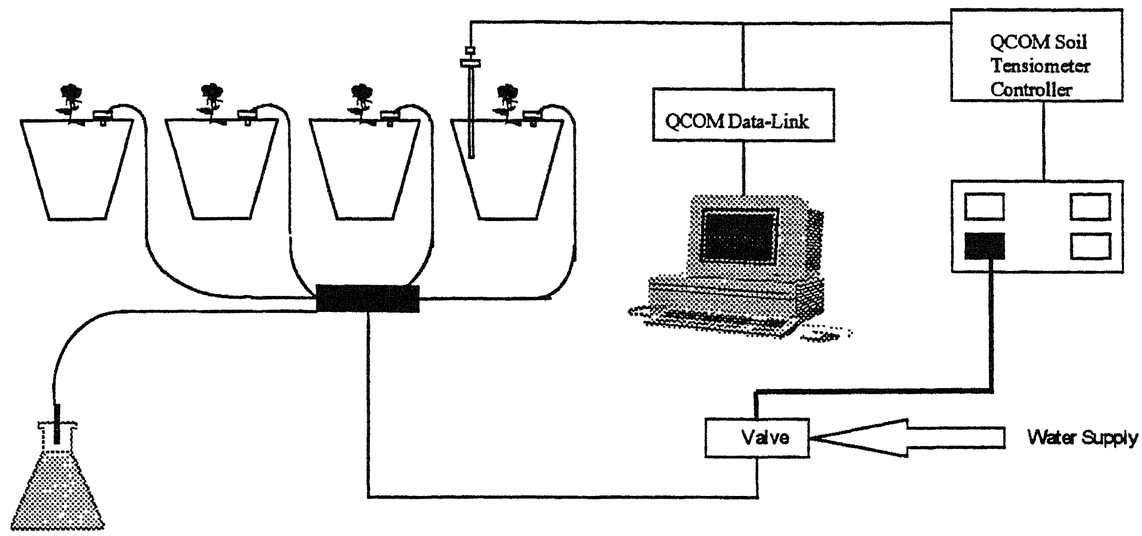

Figure 1. Schematic drawing of the computer-controlled irrigation system for a typical treatment.

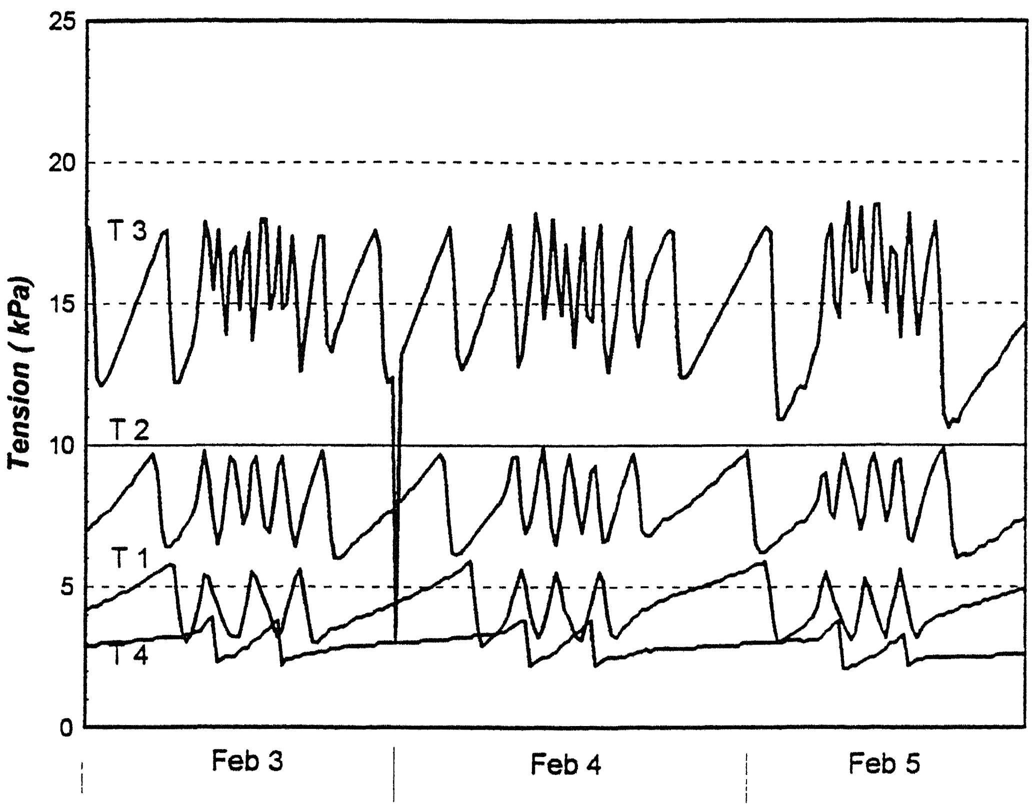

Figure 2. Three-day history of moisture tension measurements for all four treatments beginning with Feb 3.

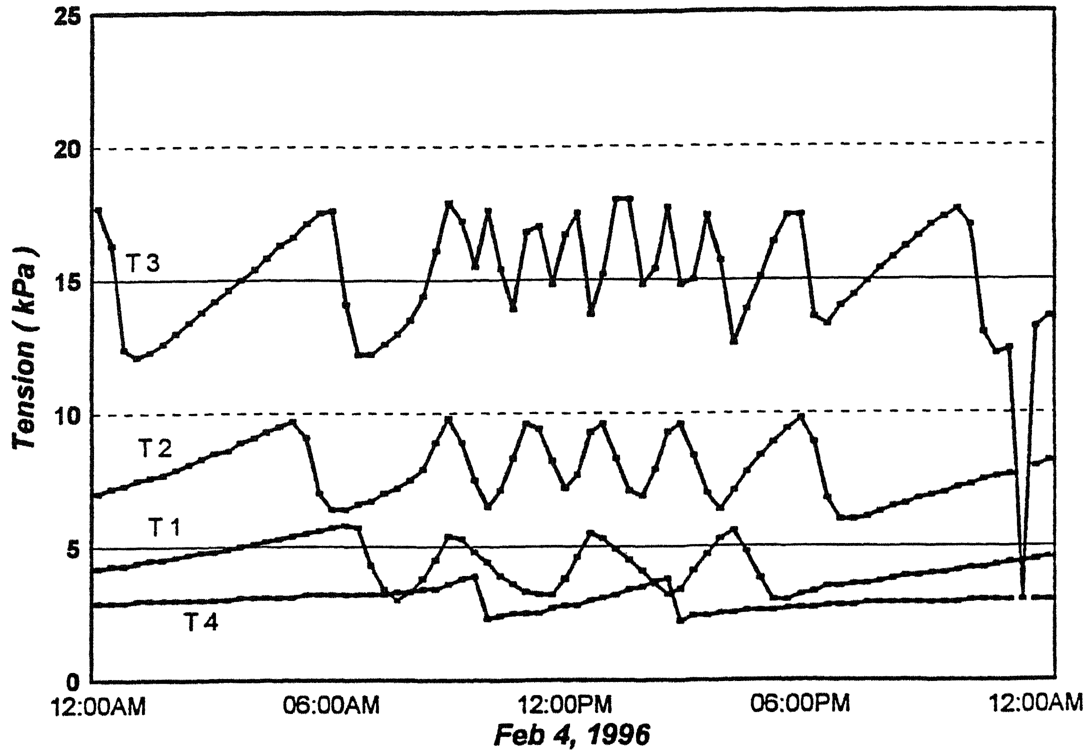

Figure 3. One-day history of moisture tension measurements for all four treatments during Feb 4.

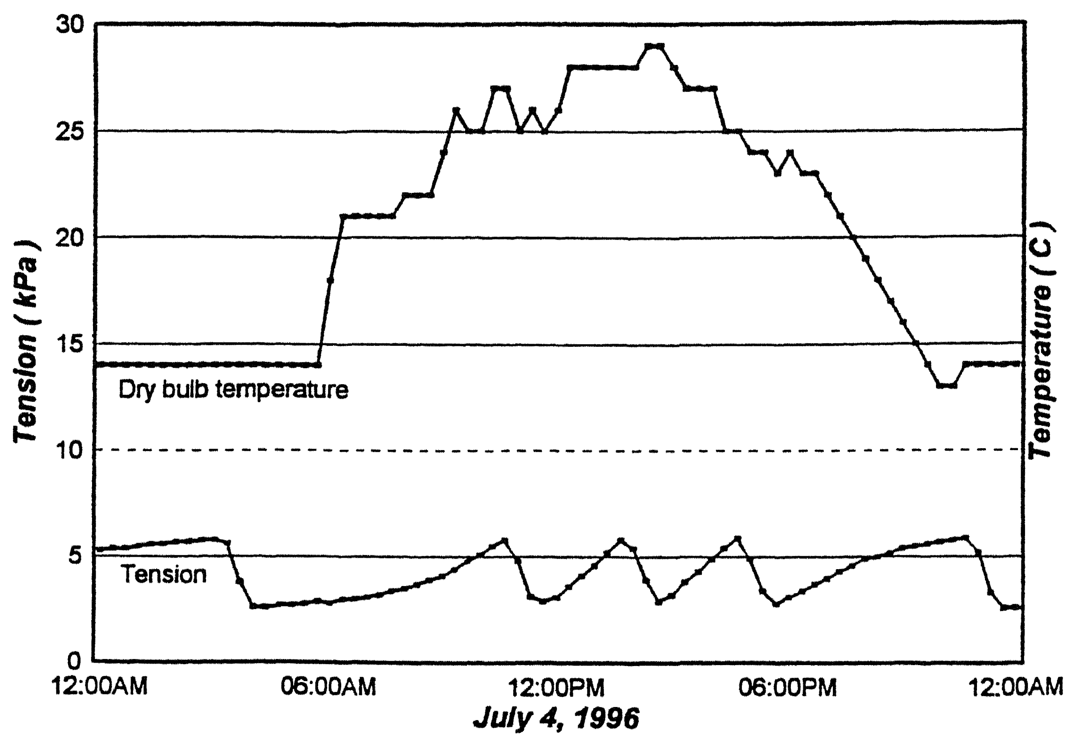

Figure 4. One-day history of moisture tension and dry-bulb temperature measurements for Treatment No.1 during July 4.

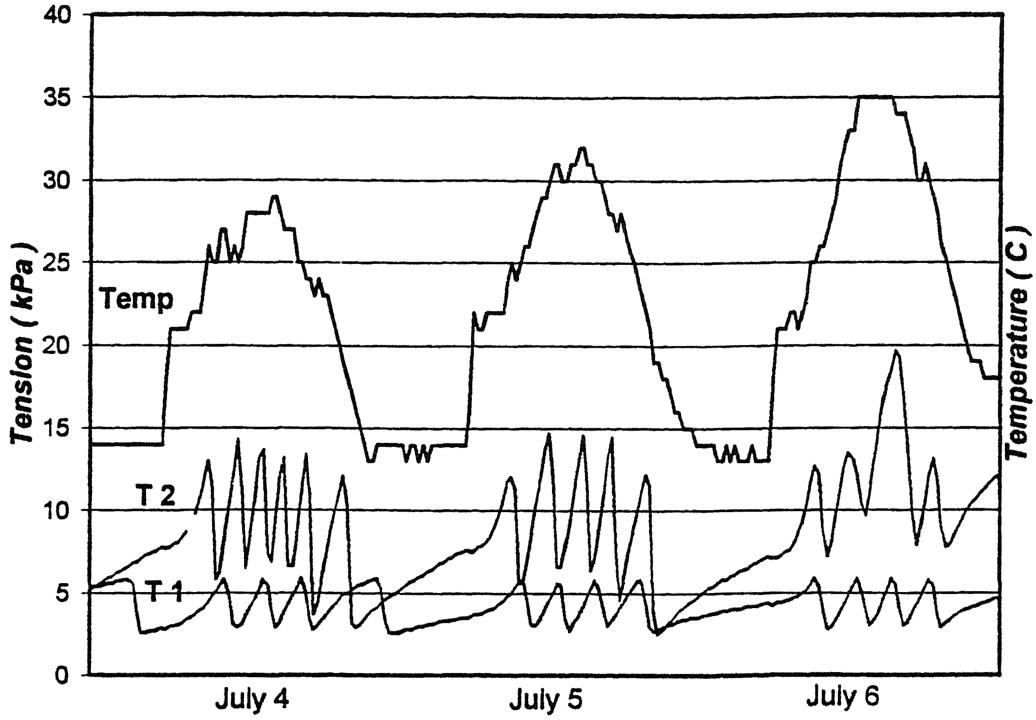

Figure 5. Three-day history of moisture tension and dry-bulb temperature measurements for Treatment Nos.1 and 2 beginning with July 4.

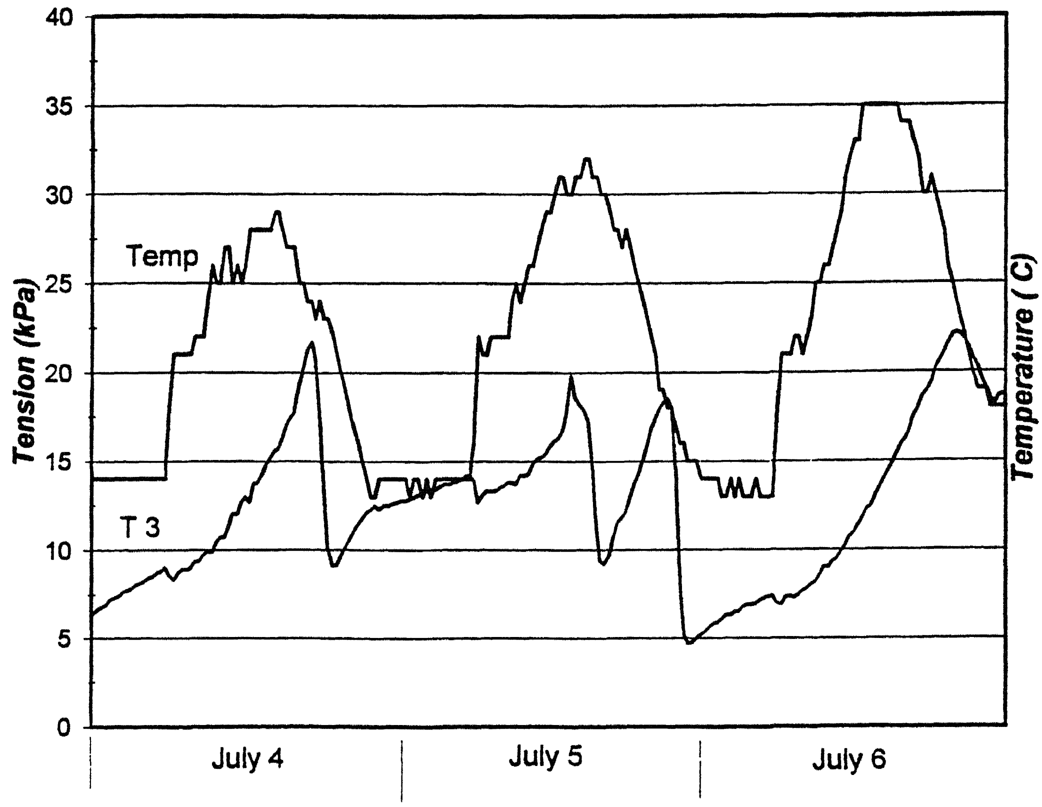

Figure 6. Three-day history of moisture tension and dry-bulb temperature measurements for Treatment No. 3 beginning with July 4.

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Red Thread (*Laetisaria fuciformis*) Control Study on Perennial Ryegrass

Joseph W. Rimelspach, Kerry Kline, Karl Danneberger, and Michael Boehm

A curative red thread fungicide study was initiated on a stand of perennial ryegrass (*Lolium perenne*) at the Ohio Turfgrass Foundation Research and Education Center in Columbus, Ohio. The perennial ryegrass (cultivar unknown) was maintained at 2.5 inch height of cut. The condition of the turf was fair. At the time of the application, May 28, 1997, the temperature was in the high 60s. Soil at the site was a clay loam with moderate moisture. Spray treatments were applied with a hand-held CO_2 pressurized sprayer with two 6503 nozzle tips, spaced 18 inches apart, at 40 psi, delivering 2 gallons water per 1,000 square feet. Plot size was 6 feet by 8 feet with each treatment replicated three times. The design of the experiment was a randomized complete block design. The number of red thread patches in each plot was counted on June 4 , seven days after treatment (7DAT), and on June 20, 23 days after treatment (23DAT).

Results

Heritage, Prostar, and Eagle at the 1.2 oz/M rate gave the best control, compared to the control of the other fungicides. Heritage showed rapid reduction of mycelium on the leaf blades with little present by June 20; all other plots had active mycelium present.

Treatments	Rate * oz/1,000 sq ft	Number of Red Thread Patches per Plot 6/4 (7DAT)	6/20 (23DAT)
Heritage 40WP	0.2	9.0	2.3
Heritage 40WP	0.4	13.7	2.3
Prostar 50WP	2.0	16.0	4.7
Eagle 40WP	1.2	13.7	5.3
Daconil Ultrex	3.8	19.7	5.7
EXP10790B	4.0	17.3	7.0
EXP10790A	4.0	17.0	8.0
RH-0611	8.0	12.7	9.0
Bayleton 25WDG	1.0	19.7	9.7
Eagle 40WP	0.6	21.0	12.0
Procymindone 50WP	1.0	23.7	14.7
Check (untreated)	—	17.3	15.7
LSD (0.05)		10.5	10.7

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Red Thread (*Laetisaria fuciformis*) Control Study on Kentucky Bluegrass

Joseph W. Rimelspach, Kerry Kline, Karl Danneberger, and Michael Boehm

A curative red-thread fungicide study was initiated on a stand of Kentucky bluegrass (*Poa pratensis*) at the Tru Green/Chemlawn Research Center in Delaware, Ohio. The Kentucky bluegrass, consisting of 'Julia,' 'Merit,' 'Schamrock,' and 'Touchdown' at 25% each, was maintained at 2-inch height of cut. No fertilizer was applied in 1997. The soil is a Blount silt loam, with a pH of 6.2. The condition of the turf was good to fair. At time of treatment application, May 30, 1997, the temperature was in the high 70s with moderate soil moisture. The spring was cool and wet. Thatch was minimal. Spray treatments were applied with a hand-held CO_2 pressurized sprayer with two 6503 nozzle tips, spaced 18 inches apart, at 40 psi, 2 gallons of water per 1,000 sq ft. Granular treatments were applied by hand. Plot size was 6 feet by 10 feet with each treatment replicated three times. The design of the experiment was a randomized complete block design. Percent red thread in each plot was determined on June 20, 21 days after application (21DAT), and July 7, 35 days after application (35DAT).

Results

Many of the products gave substantial reduction of the disease and gave fairly long suppression. Fertilizer alone improved turf quality but did not significantly reduce disease activity.

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Treatments	Rate ** (oz/1,000 sq ft)	% of Plot with Red Thread * 6/20 (21DAT)	7/7 (35 DAT)
Heritage 40 WP	0.2	0.0	0.0
Heritage 40 WP	0.4	3.3	0.0
Bayleton 25 WDG	1.0	3.3	0.0
Chipco 26019 FL	4.0	3.3	0.0
Sentinel 40WG	0.25	3.3	0.0
Daconil Ultrex	3.8	3.3	0.0
Eagle 40WP	1.2	10.0	6.7
EXP10790B	4.0	10.0	0.0
Prostar 50WP	2.0	10.0	0.0
Procymidone 50WP	1.0	10.0	0.0
Daconil ZN	6.0	13.3	3.3
Fertilizer (20-5-10)	1 lb N/M	13.3	16.7
Lynx 25DF	0.75	16.7	0.0
Chipco 26019 FL	2.0	16.7	6.7
EXP10790A	4.0	20.0	20.0
Daconil Weather Stick8.0	20.0	0.0	
Check (untreated)	—	20.0	23.3
LSD (0.05)		15.2	7.7

* The % disease was associated with a scale of 0 to 100, with 0 = no disease and 100 = to 100% of the plot being diseased.

** Ounces of product applied per 1,000 square feet.

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Red Thread — from Novelty to Nuisance

Joseph W. Rimelspach

Many can remember first seeing red thread (*Laetisaria fuciformis*) and the novelty of being able to see the strands of pink or reddish fungus at the ends of leaf blades. Twenty years ago this was a relatively "new" disease to be found in lawns and high-cut turf areas, and it was relatively unimportant in terms of causing serious damage to turf. This was not a new disease, since it was first observed in 1854 as a disease on ryegrass pastures in Australia. Reports in the United States were first made in the 1930s.

But today, especially over the past several years, there have been wide-spread reports of occurrence of this disease in Ohio and throughout much of the Midwest and northeastern United States. In the past five years, the disease has been observed to be active during every month of the year and on all the common cool season turfgrasses — perennial ryegrass, Kentucky bluegrass, fine fescue, creeping bentgrass, and tall fescue. The disease is most active when temperatures are cool and moderate, when the turfgrass foliage is wet, and when the grass is growing slowly.

Many are asking, is there so much more red thread these days? Some comments relative to this question are presented in this report.

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Changes in the Genetic Make-Up of Lawns

Lawns have shifted from predominately Kentucky bluegrass lawns to lawns that include more perennial ryegrass. Kentucky bluegrasses can be susceptible to red thread, but in general most cultivars have some degree of resistance. There have been great advances in the quality of perennial ryegrass cultivars available to the industry. The speed of germination and establishment are key factors in making perennial ryegrass very popular these days, especially in our instant-gratification society. The droughts of 1977, 1988, and 1991 and other minor drought years were periods when extensive lawn renovation and repair were done. In many of these situations, a bluegrass and ryegrass mixture of seed was used, and in many of these situations the ryegrass predominated.

Changes in Lawn Fertilization

Due to a number of factors, many lawns are receiving less or reduced fertility than in the past. The shift has been from heavy spring fertilization to fall and late-fall fertilization programs. There has also been strong environmental pressure to reduce nitrogen use in urban landscapes, and there are economic incentives and factors that may impact the rate of fertilization. At the same time urban "soils" in new developments continue to be low quality. These soils offer meager nutrients and consist of poor physical characteristics for grass growth and root development.

The Impact of Changing Weather Patterns

The last several springs have been cool and wet in many areas. These weather patterns have been ideal for the growth and development of the red thread fungus. The pathogen has been active over long periods, and turf quality has been reduced during these times. Always remember the importance of weather patterns and the role they play in turfgrass disease development. Are the weather patterns more favorable for growth of the fungal pathogen, or more favorable for the growth of healthy turfgrass?

Changes in Mowing Habits

During recent years there have been considerable shifts in mowing habits, moving from the common practice of, in many communities, removing clippings to the use of mulching or recycling lawn mowers. Some individuals in the lawn-care industry have noticed trends toward more persistent red thread in lawns where clippings are mulched compared to lawns where the clippings are removed. This is an interesting observation and one that needs additional research to determine the impact on disease development and severity. Other factors may also be involved that have not been identified.

Management Strategies

Some key strategies in managing healthy turfgrass and minimizing the severity of red thread are presented here. The goal is not to eradicate the disease but to manage the situation and maintain quality turfgrass.

- Evaluate the genetic susceptibility of grasses to red thread when establishing a new turf area and also when renovating lawns. Select the best red thread and other disease-resistant turfgrass varieties available.

- Evaluate the fertility program if there is a history of red thread. Do not skimp on the fertilization but do not overdo the fertilizer program and cause other problems.

- Keep the turfgrass healthy and growing. Management tools such as site preparation, aeration, and watering should be adjusted to maximize turf health.

- Use fungicide applications to help manage the disease in relatively rare cases. Where there is a history of the disease, a preventative application of an effective fungicide can give significant relief from the disease. Applications made after the disease is active (curatively) are often much less effective.

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Chrysanthemum Cultivars Differ in Response to Photoperiod When Grown Under Far-Red Absorbing Filters

M. J. McMahon

Two chrysanthemum [*Dendranthema* x *grandiflorum* (Ramat) Kitamura] cultivars, 'Bright Golden Anne' and 'Spears' were grown in unfiltered sunlight (control) or under filters that removed far-red (FR) light under long- or short-day photoperiods for a total of four treatments per cultivar. Eight pinched plants from each cultivar were exposed to each treatment. Tips of lateral branches were harvested every three days and preserved in formalin, acetic acid, and 70% ethanol (5:5:90 v:v), then observed and photographed under a dissecting microscope.

In 'Spears,' all short-day treatments developed floral primordia at the same time, and the rate and development were normal. Under long days and FR-absorbing filters, floral primordia initiated and developed normally, but were delayed several days compared to short days. Plants under long days and control filters also developed normal promordia, but at a slower rate than the other treatments.

In 'Bright Golden Anne,' only short-day treatments developed normal floral primordia. Under long days, plants under FR-absorbing filters eventually initiated floral primordia but development was abnormal. No floral primoridia developed under long-day and control-filter conditions. In all cases, 'Spears' primordia development was much more rapid than 'Bright Golden Anne.'

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Improving Fuchsia Cutting Performance by Grafting

D. M. Napier and M. J. McMahon

A difficulty in meeting market demand for some fuchsia (*Fuchsia* x *hybrida* [Hort.]) cultivars has been low production of cuttings. Grafting was investigated as a means to improve cutting production and performance.

Tip cuttings of the poor producer 'Little Beauty' were grafted as scions to unrooted cuttings from the more vigorous cultivars 'Beacon' and 'Dollar Princess,' which have well-developed root systems. 'Black Prince,' another poor producer with a weak root system, was grafted to unrooted cuttings of the cultivar 'Gartenmeister,' another cultivar with a vigorous root system. The grafted cuttings were placed in a white polyethylene tent on a greenhouse bench for seven to 10 days to allow the graft union to form and then placed under mist with bottom heat until roots formed. Controls were cuttings from ungrafted plants of the poor producers and from autografts of the poor producers.

Cuttings grown from grafted plants of 'Little Beauty' on 'Beacon' or 'Dollar Princess' were approximately 40% larger than cuttings from autografted or nongrafted plants. In the case of 'Black Prince,' the resulting cuttings were double the size of cuttings from autografted or nongrafted plants. The root systems of cuttings from grafted plants developed better than those cuttings from controls, resulting in greater successful propagation percentage.

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Paint/Paclobutrazol Mix on the Inside Surface of Rooting Wedge Cells to Control Poinsettia Cutting Height

Claudio C. Pasian

Summary

The effectiveness of applying a plant-growth regulator as a paint/paclobutrazol mixture coating the interior surface of wedge cells was evaluated. Cuttings of three poinsettia (*Euphorbia pulcherrima*, Willd. ex Klotzsch) cultivars ('Red Sails,' 'Nutcracker Pink,' and 'Nutcracker White') were rooted in wedge cells painted with a paint/paclobutrazol mix. Significant reductions in cutting heights were observed at most paclobutrazol concentrations. No signs of phytotoxicity were attributed to either paclobutrazol or the paint. These preliminary results suggest that the application of paclobutrazol in paint to the interior of wedge cells may be used to control the height of cuttings while they are being rooted. Chemical name used: β-((4-chlorophenyl) methyl)-α-(1,1-dimethyl)-1H-1,2,4,-triazole-1-ethanol (paclobutrazol).

Appreciation is expressed to Possum Run Greenhouses for rooting cuttings in their production facilities.

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No endorsement is intended for products mentioned in this article, nor is criticism meant for products not mentioned.

Introduction

Plant growth regulators are usually applied as drenches or sprays to poinsettia plants to maintain plant height in proportion with container size. Cuttings of vigorous cultivars may grow more than desired during the rooting process, especially if they remain in the wedges too long after rooting (e.g., transplanting delayed by lack of elements such as pots, labor, space, etc., or delayed shipping of the cuttings by the propagator).

Although not widely used, growth regulators in poinsettia cutting production may be very important for cultivars that stretch during the rooting process. The stretch tendency is compounded by crowding of cuttings in the wedges. Overlapping of plant parts reduces light intensity and changes light quality, resulting in light below plant canopies that is richer in near-infrared and far-red which encourages plant stretching. While drenching is the most effective application method for some growth regulators (e.g., paclobutrazol), it is impractical for the rooting of cuttings. Spraying, on the other hand, is possible but has some problems. Bonzi™ must be sprayed on the stems in order to be fully effective. Since cuttings are located very close to each other on the rooting wedges, reaching the stems with the sprays is not always easy. Developing a new method of growth regulator application to cuttings may provide growers with a more efficient and cost effective way of using paclobutrazol on rooting poinsettia cuttings.

The concept of using copper-coated interior containers to control root growth was introduced in the 1970s. Roots exposed to copper-treated surfaces absorb high amounts of copper (Arnold and Struve, 1989). Pasian and Struve (1996) showed that plant growth regulators could also be delivered using containers with coated interiors. They demonstrated that plant height of chrysanthemum [*Dendranthema grandiflora* (Ramat)] could be controlled using containers whose internal surface is coated with a paint/paclobutrazol mixture. The objective of this study was to determine the response of three poinsettia cultivars to paclobutrazol/paint mix applied to the interior of the wedge.

Materials and Methods

Paclobutrazol was stirred into two paints — a white interior flat latex paint (water solution of butyl acrylate/vinyl acetate copolymer, titanium dioxide, aluminum silicate, and amorphous silicate) and Spinout (Griffin Corp., Valdosta, Georgia) without the copper active ingredient specially prepared by the manufacturer for this experiment. After mixing each paint and paclobutrazol for 15 minutes, the mix (0.52 and 0.69 ml per cell for latex and Spinout respectively) was brushed uniformly onto the internal surface of plastic wedge cells. After painting, the cells were dried at room temperature for 24 hours before use.

The wedges (Oasis Grower Products, Kent, Ohio) had 17 cells that were filled with Oasis foam-medium with a central hole to support the unrooted poinsettia cutting. Wedge trays were divided into seven treatments — control (no paint and no paclobutrazol), paint only, and five paint/paclobutrazol mixes applied at rates of 12.5, 25, 50, 100, and 200 mg l^{-1} (6.5, 13, 26, 52, and 104 Fg a.i. per cell, respectively for the flat latex painted cells and 8.6, 17.3, 34.5, 69, and 138 Fg a.i. per cell, respectively for the Spinout painted cells). Poinsettia cuttings 'Nutcracker White' and 'Nutcracker Pink' were rooted during the summer of 1996; cuttings of 'Red Sails' were rooted in the summer of 1997. After sticking the cuttings in the Oasis foam, the wedges were placed on a commercial greenhouse grower's mist bench. Cutting height (the distance from wedge rim to the top of the apical bud) was measured with a ruler when cuttings were rooted. After measurement, cuttings of 'Nutcracker White' and 'Nutcracker Pink' were planted in 15 cm (1750 ml volume) plastic pots using a peat-light mix and located in a growing greenhouse to determine the duration of the plant growth regulator effect on plants.

Rate response to paclobutrazol was determined by regression analysis using the GLM procedure of SAS (SAS Inst., Cary, North Carolina). The same program was used to calculate the least significant difference for comparison among treatments.

Results and Discussion

Paint and/or plant growth regulator did not negatively affect above-ground appearance of the cuttings. Roots of cuttings rooted in the presence of paclobutrazol were shorter and thicker (larger diameter) than roots of control plants. 'Red Sails' cuttings rooted in cells painted with either paint (latex or Spinout) without the growth regulator were shorter than control cuttings. This result requires further investigation.

Most cuttings subjected to paclobutrazol were significantly shorter than control cuttings (Table 1). 'Nutcracker White' cuttings were significantly shorter than control cuttings only when rooted in cells with the two highest concentrations of paclobutrazol. Increasing paclobutrazol concentrations did not produce correspondingly shorter cuttings. This result contrasts with those presented by Pasian and Struve, 1996a and 1996b with chrysanthemums and plugs, respectively. In their work, they found that the rate response was highly significant. No explanation for this difference can be given based on the results presented in this work. Paint type (flat latex paint vs. Spinout) had no effect on 'Red Sails' cutting heights despite the fact that Spinout-painted cells had 32% more active ingredient than flat latex painted cells. Three weeks after pinching, transplanted plants in all treatments had the same heights, indicating that the growth regulator effect was short-lived.

The results obtained with 'Red Sails,' 'Nutcracker Pink,' and 'Nutcracker White' must also be validated with other cultivars. Until this method of application is described on the label of commercial growth regulators, it cannot be used by commercial growers.

Table 1. Height after rooting of cuttings of three poinsettia cultivars.

	Cutting Height (cm)			
Treatment	**'Red Sails'[z] (Latex)**	**'Red Sails' (Spinout)**	**'Nutcracker Pink' (Latex)**	**'Nutcracker White' (Latex)**
Control	7.5 a		9.1 b	6.9 a
Paint only	4.7 b	5.1 b	11.4 a	8.7 a
12.5 ppm	3.9 bc	5.0 b	5.9 c	6.0 bc
25 ppm	3.7 c	4.3 bc	5.9 c	5.4 bc
50 ppm	3.2 c	3.8 c	5.2 c	5.5 bc
100 ppm	3.5 c	3.8 c	5.0 c	5.2 c
200 ppm	3.6 c	3.6 c	5.0 c	4.9 c
	Significance			
Linear model	ns	ns	ns	ns
Quadratic model	ns	ns	ns	ns
LSD	0.995	0.994	1.26	1.23

Height after rooting of cuttings of three poinsettia cultivars — 'Red Sails,' 'Nutcracker Pink,' and 'Nutcracker White.' 'Red Sails' cuttings were rooted in wedge cells painted with flat latex/paclobutrazol mixes. The 'Nutcracker' cuttings were rooted on wedge cells painted with a mix of two paints/paclobutrazol mixes — flat latex paint and Spinout without copper.

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Response of Poinsettias to Paclobutrazol in Paint Applications

Claudio C. Pasian and Daniel K. Struve

The effectiveness of a paclobutrazol/paint mix in controlling growth of poinsettia plants *(Euphorbia pulcherrima)* cultivars Freedom Red and Angelica Red was evaluated. Plants were grown in containers whose interior walls were coated with a flat latex impregnated with varying concentrations of paclobutrazol — 0, 5, 20, 80, 100, 150, 200, and 300 mg per liter (0, 0.032, 0.128, 0.512, 0.64, 0.96, 1.28, 1.92 mg a.i. per container respectively). As a comparison, one treatment consisted of plants drenched with 118 ml/container of a paclobutrazol solution at 3 mg per liter.

Plants grown in containers with the paint-paclobutrazol mix were shorter than the control plants. Treatments involving concentrations of 100 mg per liter or more (even as much as doubled or tripled) did not produce proportionately shorter plants. Root dry weights of plants in all treatments were not significantly different. However, the length of roots touching the internal surface of the container decreased with increasing growth regulator concentrations. This may help explain why doubling concentrations of growth regulator-in-paint does not produce proportionately shorter plants — roots start absorbing the growth regulator as soon as they touch the wall of the container. As a consequence, all root elongation is reduced, resulting in less root-growth regulator contact and less growth regulator uptake. More measurements of root length and root area are required in order to prove this hypothesis. When paclobutrazol concentrations were higher than 100 mg per liter, some bracts showed evidence of "crinkling."

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Dynamic Transpiration of Highly Stressed Container-Grown *Acer rubrum*

Ted H. Short, Ahmet Irvem, and Robert C. Hansen

Irrigation rates and amounts are essentially equivalent to transpiration rates and amounts for most plants assuming there are no evaporative losses from the soil or potting mix. The primary purpose of this study was to evaluate the feasibility of accurately measuring and predicting transpiration rates of potted *Acer rubrum* (Red maple) trees in proportion to solar radiation, vapor pressure deficit (VPD), or a combination of both in the Combination Model.

The potted six-foot-tall trees were grown in a high-stress greenhouse environment. Transpiration was measured for 15 days with a highly accurate (plus/minus one gram) weighing scales. The Combination Model provided the best predictions of transpiration for the plants used in this study with a regression coefficient of 0.931. The next best predictors of transpiration were VPD with a coefficient of 0.8608 and solar radiation with a coefficient of 0.5904.

Transpiration rates averaged 470 gr. per tree per day for sunny days and 420 gr. per tree per day for partly cloudy days. The canopy resistances used in the Combination Equation were 50 seconds per meter for internal, 70 seconds per meter for external, and 200 seconds per meter for radiation resistance. The computer-controlled drip-irrigation system used in this research was accurately triggered by soil tensiometers. Set limits for soil moisture tension were 8 *kiloPascals* to start the irrigation and 1.6 *kiloPascals* to terminate it.

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Ted H. Short, Ahmet Irvem, Robert C. Hansen, Department of Food, Agricultural, and Biological Engineering/Ohio Agricultural Research and Development Center, The Ohio State University.
ASAE Paper 975003. Presented at the 1997 Summer ASAE Meeting.

Effects of Temperature on the Development of Asiatic Lilies

J. Steininger and C. C. Pasian

Temperature affects the rate of development of *Lilium* (Asiatic hybrid). The long-term objective is to evaluate thermal units as a tool for crop timing. The objective of this work was to determine Lilium base temperature (T_b). A total of 218 plants of two cultivars, 'Butter Pixie' and 'Horizon,' were used. Phenological observations were made on plants during eight plantings over a two-year period. Developmental stages observed were shoot visible out of the soil (SV), flower bud visible (BV), and open flower (OF). The two cultivars were grown in four different greenhouse compartments with settings at 13, 18, 24, and 27°C respectively.

During periods of extreme outdoor temperatures, actual temperature deviated from the settings. Actual temperatures were constantly monitored with copper-constantan thermocouples and stored in a datalogger. Rates of development were calculated as the inverse of the numbers of days to complete a given phenological phase. T_b values were obtained by calculating the x-interception of the linear regression describing rate of development as a function of mean air temperatures.

Tb for 'Butter Pixie' and 'Horizon' for the entire growth cycle (SV through FO) were -0.44°C and 0.48°C respectively. The production cycle can be divided into two phases: SV - BV and BV - FO. For 'Horizon,' T_b for these phases were -0.78 and 0.83°C respectively. For 'Butter Pixie,' these T_b were 1.99 and -0.8 respectively.

More observations of development at mean temperatures higher than 35°C and lower than 13°C will be attempted in the future in order to determine the temperature at which maximum rate of development occurs.

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New Publications for 1997–1998

Ohio Agricultural Research and Development Center Publications

Special Circular 156. Animal Sciences: Research and Reviews, 1996. Maurice Eastridge and Barb Gerard, Editors.

Special Circular 155. Turfgrass Research Report, 1996. David Shetlar, Editor. In press. Available in 1998.

Special Circular 154. Ornamental Plants: Annual Reports and Research Reviews. Mary Ann Rose and James A. Chatfield, Editors.

Special Circular 153. Turfgrass Research Report, 1995. David Shetlar, Editor.

Special Circular 150. Taxus and Taxol Research. Robert Hansen. In press. Available in early 1998.

For copies and information on other available publications, write to the Publications Distribution Center, Communications and Technology, Ohio Agricultural Research and Development Center, 1680 Madison Avenue, Wooster, Ohio 44691-4096.

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Ellett, C. E., M. A. Ellis, S. T. Nameth, H. A. Hoitink, N. J. Taylor, J. W. Rimelspach, J. A. Chatfield, M. A. Rose, and D. J. Shetlar. 1997. *Disease Control in the Landscape.* Ohio State University Extension Bulletin 614.

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