

# Biological Calendars: The Statewide Network of OSU Phenology Gardens

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

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

The development of both plants and insects is temperature dependent; thus, phenological events of plants, such as flowering time, may accurately track degree-day accumulation and predict insect development and emergence. To test this hypothesis, the phenology of 91

ornamental plant species and/or cultivars and 43 key insect and mite pests has been monitored every year since 1997 at the Ohio Agricultural Research and Development Center's Secret Arboretum in Wooster, Ohio (Herms 2000, 2003).

## The Biological Calendar

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

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

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

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

## OARDC's Phenology Web Site

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

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

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

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

## The Ohio State University Phenology Garden Network

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

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

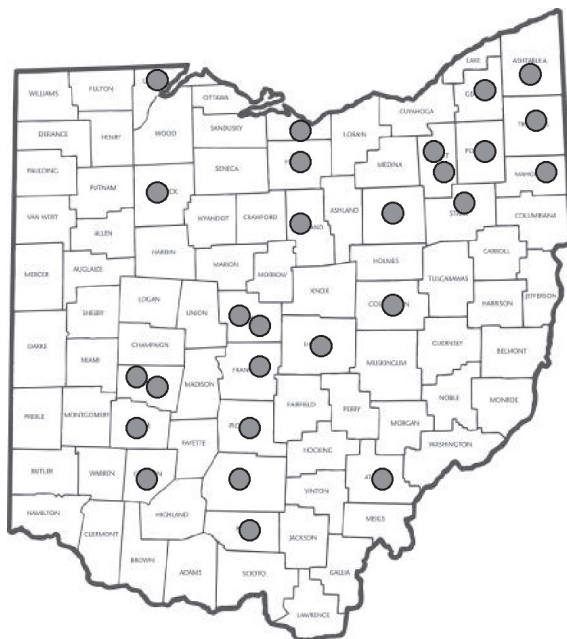
Beginning in 2005, volunteers at each site, including OSU Master Gardener volunteers, naturalists, OSU Extension staff, and others, will monitor the blooming sequence of plants in the gardens over the course of the season, beginning with the first bloom of Gold Tide™ Forsythia in early spring and ending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

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

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

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

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



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

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

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

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

For example, users could add additional plants (including weeds) or insects (including butterflies) to the calendar just by observing where in the sequence those

phenological events occur relative to those that are already included.

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

in nurseries and landscapes while decreasing pesticide use.

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

## References Cited

Herms, D. A. 2000. A biological calendar: using plant phenology to predict insect activity. In: Chatfield, J. A., J. F. Boggs, E. A. Draper, and G. Y. Gao, eds. *Ornamental Plants: Annual Reports and Research Reviews, 1999*. pp. 53-59. The Ohio State University, Ohio Agricultural Research and Development Center, Special Circular 173.

<b>Table 3. Nurseries That Donated the Plant Material to Establish the OSU Phenology Garden Network.</b>
Herman Losely and Son, Inc., Perry, Ohio Klyn Nurseries, Inc., Perry, Ohio Roemer Nursery, Inc., Madison, Ohio Studebaker Nurseries, New Carlisle, Ohio Sunleaf Nursery, Madison, Ohio The Cottage Gardens, Inc., Perry, Ohio Willoway Nurseries, Inc., Avon, Ohio

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