GUIDELINES FOR ESTABLISHING AN INTEGRATED PEST MANAGEMENT PROGRAM IN A PUBLIC GARDEN

Nancy J. Bechtol
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Introduction

During his first month of employment, the current Director of Longwood Gardens in Kennett Square, PA was sprayed with pesticide on two different occasions. Once, when ascending a staircase inside a building, the pesticide spray entered through an open window. The second incident occurred when pesticide was sprayed across the roadway and entered his opened car window. These two occurrences persuaded the Director to develop an integrated pest management (IPM) at Longwood Gardens. It was evident the pest management program needed refinement, and the Director knew IPM to be the safest, most effective way to control pest problems. An experience as dramatic as this should not have to occur for a public garden to contemplate developing an IPM program.

All public gardens must be conscience of the use of all pesticides in public areas. The public is becoming leary of all pesticide use and public gardens need to listen to this plea and begin to reduce the use of pesticides. Every day an article can be read in all major city newspapers regarding the misuse of pesticides or groundwater contamination. Public gardens should strive to be in the forefront of this anti-pesticide trend and begin to develop pest management programs which safely control the pest problems present. Each pesticide use should be carefully decided to eliminate any unnecessary spraying. This will help reduce the problem of surface and

groundwater contamination; a problem which each garden must analyze to ensure safe use of their water and land. A sound pest management program will help prevent possible liability suits concerning the misuse of pesticides near people and the environment. This program should use pesticides as a last resort after other safer pest control options have failed or are not possible.

Integrated Pest Management (IPM) is a decision - making process designed to prevent pest problems from occurring through regular monitoring. A pest problem primarily results from an insect, disease or weed problem. Regular inspections of plants, or monitoring will help determine why a pest problem has occurred if it could not prevent the pest problem in the first place. An IPM program uses a mixture of control strategies to suppress pest problems which are the least toxic to man and environment.

Adopting an IPM approach can make the management of pests more effective and reduce the amount of toxic pesticides. Pest control becomes more effective because monitoring and record-keeping programs determine exactly when and where pest control is required and how effective the controls are when applied. Ineffective treatments are therefore eliminated and effective treatments are refined in terms of timing and application. IPM is the most efficient, effective means to control pests and display the best quality crop. Longwood

Gardens is currently a living example of this. Since their IPM program began in October 1984, the quality of display has improved both under glass and in the outdoor garden. An IPM program will probably not save a garden money but the quality of display will improve.

The current state and federal pesticide related laws which require staff training and safe handling of all pesticides require public gardens to become organized and proficient in the handling of pest management practices. An integrated pest management program will eliminate the need for any unnecessary pesticides and provide for staff training on all aspects of pest management. Both aspects will help with compliance of these pesticide laws. A listing of the primary laws to research and a source for information on these laws is included in the "Selected Resources Available" section of this article.

The first step toward complying with these laws is to take an inventory of all hazardous substances on-site, listing their locations. Part of an IPM program will be to eliminate many of these hazardous substances from the workplace, thereby reducing the total number needed to inventory.

It is also important to contact the state office regulating ones state Right-To-Know Law. Portions of these laws which the federal law does not address must still be followed. It

is imperative that gardens determine which parts of the state law still remain enforceable, and comply with them.

Many other factors support the establishment of an IPM program. Conventional pest control tactics are not working anymore. Pesticide resistance is increasing and being documented for an increasing number of insects and diseases. We can no longer depend on chemical manufacturing companies to produce new chemicals to help deal with resistance. Pesticides are continually being removed from the market due to adverse health effects related to their use. During 1987, one popular miticide, plictran, was removed from the market leaving few alternatives labeled for mite control on ornamentals. Horticulturists must change their methods of pest control to help eliminate the continued spread of pesticide resistance.

ADMINISTRATIVE STEPS

Step 1: Staff Support and Commitment

Any staff member in a public garden can decide to pursue an IPM program and start the process, but eventually commitment and support must come from the entire staff. It is essential for the entire staff, and especially top management, to become involved from the beginning and actively support the program. This support must start at the director's level and trickle down to each gardener. With a unified team, each public garden can begin the process of analyzing the staff and

community resources available. The IPM program must involve the entire staff to be successful.

Step 2: Analyzing Staff and Community Resources

Any sized public garden can establish an IPM program. There are three starting options to consider. Many gardens can afford to hire a staff person with the expertise to establish an IPM program. This position could be filled by a horticulturist, plant pathologist or entomologist with training in IPM. Longwood Gardens and the Morris Arboretum, both in Pennsylvania, are examples of this option. The advantage of this method is that staff pest managers tend to know exactly how the public garden operates and the personalities involved. This can greatly facilitate the process of establishing a program.

The second option involves a compromise between the staff resources available and outside expertise. Many gardens can not afford to create new positions, but may have interest and expertise currently on staff. Management should review each staff member to determine if, in addition to their horticultural gardening background, any employees have course work or experience with pest management. Often employees will become interested on their own initiative and educate themselves using current pest management related books and periodicals. These employees should be assigned specific pest management tasks as

part of their job description. If employees are willing to perform above their assigned duties, they should receive official time set aside to perform the tasks.

The local extension service and the closest university should be consulted to assist the interested staff members. Other experts may need to be consulted depending on the major pest problems present at the garden. Gardens using this option are Birmingham Botanical Garden in Alabama, Mitchell Park Horticultural Conservatory in Wisconsin and the New York City Parks Department in New York. This method works well for lower budget facilities. A major problem with this option is if the interest individual(s) leave the institution, the program often leaves with them. It is imperative that each public garden support the IPM program from the director down, so that when this occurs, the vacated position(s) can be filled with other interested staff members.

A third option involves hiring a consultant to establish the IPM program for a contracted period of time. When no staff expertise or interest exists, this may be the only option. Grants can be solicited to offset some of the costs. An example of this method is Golden Gate Park Conservatory in California. They received a grant to fund the first year of their consultants services. Part of this consultant's job was to train the staff to take over the program after the first year. If funds or grant moneys are available, this is the least disruptive

method in terms of staff assignment changes necessary for starting a new program. The personality of the consultant must be compatible with the staff unit; otherwise this could become a disruptive method of establishing a program. The consultant must be well trained in educating the staff to take over the program.

Hopefully one of these three options, or a combination of them, will fit each public garden's situation. After selecting the method, the task should be approached slowly and conscientiously.

Step 3: Staff Training

Once a garden has decided to pursue an IPM program and has identified the resources necessary to conduct the program, the next step is to train the entire staff on the concept of IPM. The staff must be taught what IPM means, the many components of an IPM program and how it is implemented in a public garden. Longwood Gardens, Morris Arboretum and San Francisco Conservatory of Flowers ran extensive in-service training programs on pest management topics before and during the beginning process of establishing their IPM programs.

Training programs can be easily organized in-house and, if expertise exists on staff, can be taught by staff as well. Most public gardens will need to solicit speakers from local universities and the local extension service. These people

are often willing, and come free of charge, to speak on various pest management topics. The training should address local insect and disease problems, IPM concepts, current pesticide regulations and pesticide safety. Many other topics are also possible but these deserve consideration. It is important each employee leave the training understanding what IPM is and how it will benefit their work place. It is also important that each employee and management realize an IPM program will change every employees job to include monitoring for plant problems and analyzing why they exist.

Step 4: Determine the Locations to Initiate the IPM Programs

It is important for each public garden to start the IPM program slowly and on a small scale. Once successful, it is easy to expand in size. An IPM program can be initiated in outdoor gardens, greenhouses or conservatories, or turf areas. Deciding on which area will depend on the amount of pest problems present in each area, staff resources available in each area and the willingness of the personnel involved in these areas to participate in the IPM program. Initiate the program in the area most likely to succeed. It is important to be successful in the beginning and build upon this to keep staff support and commitment high.

Consider using outside assistance, through extension or an educated consultant in this area, to help determine what your most common pest problems are and where they are located.

Gardens with an educated staff member in this area are fortunate. It is important for the person doing this assessment to use gardeners in charge of each area as a reference tool to obtain information on the history of the plants which seem to have problems. Having an outside person who is not in charge of the areas assessed is beneficial, since their eyes tend to see more than the gardener in charge, who works their daily.

IMPLEMENTATION STEPS

Step 5: Establishing a Monitoring System

Monitoring means to regularly examine plants to record how well they are growing. This includes observing the plants for insects, disease or cultural problems which may be causing plant damage. Monitoring is the first step toward implementing an IPM program. The only tool necessary for monitoring is a hand lens. This helps to see if the spots on foliage are a disease or if spider mites are present on foliage. Most problems can be seen with a hand lens, though a dissecting scope to help verify the problem, later in an office, is handy. A monitoring system can be simply organized, and requires little effort per area, though many public gardens seem to set up this system last in an IPM program. An IPM program can only be effective if a complete system is developed and implemented.

The location in the public garden where the IPM program

will begin needs to be divided into sections which can be monitored in one-half to an hour of time. All monitoring should be performed by a person not in charge of this section. The scout, or person performing the monitoring, should monitor the section with the person in charge to continually teach the gardener in charge about the problems discovered in their section and reinforce the good cultural techniques used which help prevent pest problems. If a full or part-time position as scout is not possible, have a gardener from another section scout this section and vice versa. This helps to give the gardener in charge an objective opinion of the condition of their plants.

The frequency of each monitoring unit will depend on the complexity of the plants grown, the desired appearance wanted and the funds available. A minimum of biweekly is necessary to maintain quality plants for display. High visibility areas should be monitored weekly. Greenhouse environments require weekly monitoring because problems can develop quickly in a closed environment. Whatever the interval, the important thing is to do it.

Each monitoring visit should be recorded on a piece of paper and circulated to all concerned staff and filed for future reference. This record could be as brief as a half page sheet which includes the scout's name, date, section name, problems encountered, exact location, and seriousness of

problem and/or control method necessary. A place for additional comments is helpful. Some monitoring sheets can be as extensive as two full pages of questions and comments. The simplist form possible ends up being completed the most often due to time restraints.

The scout must be trained with enough knowledge in plant pathology, entomology and horticulture to identify common problems associated with each discipline. University plant diagnostic laboratories can be used to positively identify problems, but the scout must recognize a problem exists first. All public garden employees have access to a local extension agent which can help identify problems or they can mail a sample of the problem plant to the local university plant diagnostic laboratory. Staff training is essential to keep scouts abreast to new research in these disciplines.

Longwood Gardens, Morris Arboretum and the New York City Parks Department created a formalized monitoring system for the entire properties. Many public gardens have monitoring systems for the greenhouse/conservatory complex only. Examples of these are San Francisco Conservatory of Flowers, Botanical Garden of Leiden University and Denver Botanic Gardens.

Monitoring is the most important component of any IPM program. Each public garden must establish some degree of a monitoring system to establish an IPM program. Start small

and build as the finances allow. Scouting requires manpower and therefore money, but also saves on wasted chemical treatments due to mistiming or not being needed at all and longer survivability of plants. All public gardens will realize the benefits of a monitoring system by the increased quality of all display plants.

Step 6: Treatment Options

An IPM program uses a number of treatment options to control or prevent pest problems. The monitoring process will determine if a treatment of any sort is necessary. When a treatment is necessary, the following criteria should be followed in determining which treatment is selected. The treatment should be the:

1. Least harmful to natural enemies and non-target organisms.
2. Least hazardous to man and the environment.
3. Most likely to succeed, yet easily to perform.
4. Most cost effective method.

All of the treatment options can fit these criteria depending on the specific circumstances of the pest problem. Each treatment strategy is available to all public gardens. A brief summary of each treatment option is outlined below. Further research maybe necessary for some options which require more specific experience as in biological control and learning

to use insect traps.

Plant Selections: All horticulturists should have little difficulty with this treatment option. Many varieties, cultivars, or specific species of plants are resistant to certain insects and disease. If an insect or disease problem is known to be a problem in your area, prevent it by planting resistant plants when they are available. An example of this method is planting tomato varieties which have a VFN on the label or seed packet. This means they are resistant to verticillium, fusarium and nematodes, all of which are possible problems on tomatoes.

Habitat Modification: Pest problems can often be avoided if a habitat can be modified to better enhance the plant. Changing the habitat could either discourage the pest or enhance its natural enemies. Eliminating plant stress through habitat modification could prevent pest problems. Examples would be mulching to increase available water to the plant or removing plants to increase air circulation and light.

Cultural Controls: Each employee in public gardens must continually evaluate the cultural care given to all plants. Unintentionally we often become too settled in our methods, and having an objective scout monitor the landscape often helps give us new ideas. Modifying watering, fertilizing, pruning or cultivating techniques could prevent pest problems, enhance natural enemies and increase the plants ability to outgrow the

problem. All of these techniques are the easiest to do, but seem to create the most friction between scout and gardener.

Physical Controls: This treatment requires gardeners to physically perform the method of pest control using various tools. The physical control could be to simply pick off and kill the pest. An example of this is to remove bagworm from evergreens during the winter before they have a chance to hatch out in the spring. Vacuuming carpets often will help reduce a flea larva problem. Screening ones home helps reduce flies in the home. There are many traps and baits available on the market to catch and kill animals and insects. They tend to be specific against certain pests. Traps are often used as monitoring tools as well to help determine where and when pest outbreaks occur.

Biological Control: All treatments thus far are designed to conserve the naturally occurring biological controls already present in the environment. In outdoor environments we can enhance these natural enemies by providing a healthy habitat with enough water, light and nutrients. Greenhouse environments offer closed spaces where natural enemies do not occur naturally. These environments require specific releases of certain biological controls, at specifically determined times, for specific problem pests encountered in the greenhouse. Much literature is written on this topic and several public gardens have excellent biological control programs to help

answer questions related to this treatment option. The Denver Botanic Garden, San Francisco Conservatory of Flowers and Longwood Gardens each have excellent biological control programs in their conservatory/greenhouse complex. Regular monitoring is critical to achieve a successful biological control program since pest and prey populations must be constantly watched and recorded. Examples of this method of treatment are using ladybird beetles for aphid control and a parasitic wasp, Encarsia formosa for whitefly control.

Chemical Control: Chemical controls should be used as a last resort, after other treatment options have been attempted and have failed to suppress the pest to prevent plant damage. Choose the least toxic pesticide first, such as soap, oil or botanicals such as pyrethrum. Many selective pesticides are available which only kill specific pests such as Bacillus thuringiensis which kills certain caterpillars. These chemicals are the least disruptive to man and the environment. When forced to use a broad spectrum pesticide such as organophosphates and carbamates, choose the least toxic to man and the least residual in the environment.

Successful IPM programs incorporate several treatment options to solve each pest problem. Combinations of these treatments, timed properly by only using them when necessary, is the best known approach to successfully manage all pest problems.

Step 7: Evaluation

This last step of any IPM program is always the least likely to occur. Public gardens underestimate the importance of evaluating the successes and failures of the program. Each treatment used to suppress a pest must be evaluated afterwards to determine the short and long-term effects on the pest problem and the beneficial organisms present. If the pest problem were to develop again, the gardener would know whether to use the same treatment or try a new strategy. The pest control strategy often successfully suppresses the pest but creates intolerable secondary pest outbreaks which also demand control. This is due to the beneficial organisms being killed by the first treatment as well as the problem pest.

The monitoring system must also be evaluated continually to ensure it is thorough enough to identify pest problems before they reach levels which cause plant damage.

A yearly evaluation of the entire IPM program is necessary to ensure it still successfully meets the major goal of any public garden pest management program; to successfully prevent and control the necessary pest problems in the safest method possible to man and the environment.

Selected Resources Available

The resources below have been selected as the most useful for public garden pest management programs. Each will be a useful addition to your library.

IPM History and Basics

1. Bottrell, D.G. 1979. "Integrated Pest Management" Council of Environmental Quality, U.S. Govt. Printing Office. 120.

2. Flint, M.L.; R. van den Bosch. 1981. "Introduction to Integrated Pest Management". Plenum Press, N.Y. 240.

3. Olkowski, W.; H. Olkowski. 1979. "Integrated Pest Management: Some Basic Concepts for Plant Maintenance Personnel". John Muir Institute for Environmental Studies, Inc., CA. 11.

4. Stern, V.M.; R.F. Smith; R. van den Bosch; and K.S. Hagen. 1959. "The Integrated Control Concept". Hilgardia 29: 81-101.

Establishing IPM Programs

1. Ball, J. 1986. "Public Perception of an IPM Program", J. Arboriculture. 12: 135-140.

2. Holmes, J.J.; J.A. Davidson. 1984. "Integrated Pest Management for Arborists: Implementation of a Pilot Program in Maryland". J. Arboriculture. 9: 145-150.

3. Nielsen, D.G. 1986. "Planning and Implementing a Tree Health Care Practice". J. Arboriculture 12: 265-268.

4. Olkowski, H.; S. Daar. 1987. "Establishing an Integrated Pest Management Policy". Common Sense Pest Control. 3 (4): 4-6.

5. Raupp, M.J.; and R.M. Noland. 1984. "Implementing Landscape Plant Management Programs in Institutional and Residential Settings". J. Arboriculture. 10: 161-169.

6. Smith, D.C.; M.J. Raupp. 1985. "Economic and Environmental Assessment of an Integrated Pest Management Program for Community-Owned Landscape Plants". J. Economic Entomology. 79: 162-165.

Examples of IPM in Public Gardens: Contact institutions involved for copies of these publications.

1. Bechtol, N. 1988. "A Case Study Report: Public Gardens with Integrated Pest Management Programs". Masters Thesis, Longwood Program, University of Delaware. 72.

2. Milwaukee County Park System, Wisconsin. "Pest Control/ Pesticide Management Program and Procedures". 7.

3. Olkowski, W.; H. Olkowski. 1983. "Integrated Pest Management for Park Managers: A Training Manual". National Park Service, Washington, D.C. 90.

4. Rhoads, A. 1988. "Policy on Pest Management and Pesticide Use for the Morris Arboretum of the University of Pennsylvania". 8.

Pest Identification: Other regional books are available from local universities.

1. Carr, A. 1979. "Rodale's Color Handbook for Garden Insects". Rodale Press, Inc., PA. 241.

2. Chase, A.R. 1987. "Compendium of Ornamental Foliage Plant Diseases". The American Phytopathological Society Press, MN. 92.

3. Houston, D.R. 1981. "Stree Triggered Tree Diseases, The Diebacks and Declines". U.S. Forest Service. NS-INF-41-81. 36.

4. Johnson, W.T.; H.H. Lyon. 1976. "Insects that Feed on Trees and Shrubs, An Illustrated Practical Guide". Cornell University Press, NY. 464.

5. Pirone, P.P. 1978. "Diseases and Pests of Ornamental Plants". John Wiley and Sons, NY. 566.

6. Roane, M.K., et.al. 1986. "Compendium of Rhododendron and Azalea Diseases". American Phytopathology Society Press, MN. 65.

7. Rose, A.H.; O.H. Lindquist. 1985. "Insects of Eastern Spruces, Fir, and Hemlock". Canadian Government Publishing Centre. 159.

8. Sinclair, W.A.; W.T. Johnson; H.H. Lyon. 1987. "Diseases of Trees and Shrubs". Cornell University Press, NY. 574.

9. Smiley, R.W. 1983. "Compendium of Turfgrass Diseases". American Phytopathological Society, MN. 102.

10. Tashiro, H. 1987. "Turfgrass Insects of the United States and Canada". Comstock Publication Association, Ithaca, NY. 391.

11. Westcott, C. 1964. "The Gardener's Bug Book". Doubleday and Company, Inc., NY. 625.

Monitoring Techniques

1. Raupp, M.J. 1985. "Monitoring: An Essential Factor to Managing Pests of Landscape Trees and Shrubs". J. Arboriculture. 11: 349-355.

2. Raupp, M.J., et. al. 1985. "The Concept of Key Plants in Integrated Pest Management for Landscapes". J. Arboriculture. 11: 317-322.

3. Widin, K.D. 1987. "Integrated Pest Management: A Preventive Maintenance Approach to Landscapes". American Nurseryman. 165 (10):38-42.

Biological Control

1. Debach, P. 1974. "Biological Control of Natural Enemies". Cambridge University Press, NY.

2. Hoy, M.A.; R.P. Field. 1984. "Biological Control of Spider Mites on Greenhouse Roses". California Agriculture. 38(2): 29-32.

3. Norris, C.A. 1987. "Biological Controls Gain Momentum". Grower Talks. 51(2) :72-76.

4. Osborne, L.S.; J.R. Nechols; L.E. Ehler. 1985. "Biological Control of the Two-spotted Spider Mite in Greenhouses". University of Florida. 40.

5. Scopes, N.E. 1985. "Biological Pest Control: The Glasshouse Experience". Cornell University Press, NY. 240.

6. Steiner, M.Y.; D.P. Elliott. 1983. "Biological Pest Management for Interior Plantscapes". Alberta Environmental Center, Canada. 30.

Pesticide Laws

1. Superfund Amendment and Reauthorization Act (SARA) Title III:

   a. Environmental Protection Agency Hotline (1-800-535-0202)

   b. SARA Title III Lists of Lists: Office of Toxic Substances, U.S. Environmental Protection Agency, Washington, D.C. 20460.

   c. State Emergency Planning Commission Office - phone number available through EPA Hotline.

2. OSHA Hazard Communication Standard (HCS):

   a. 29 CFR 1910.1200. Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.

A CASE STUDY REPORT:

PUBLIC GARDENS WITH INTEGRATED PEST MANAGEMENT PROGRAMS

Nancy J. Bechtol
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The continued support and guidance of my thesis committee was invaluable. I thank Dr. John Davidson, Entomology Professor at the University of Maryland, Dr. Judy Hough-Goldstein, Entomology Professor at the University of Delaware, Dr. Ann Rhoads, Plant Pathologist at the Morris Arboretum and Dr. James E. Swasey, Coordinator of the Longwood Graduate Program for the numerous suggestions and hours of editing. I also wish to thank Susan Burnett, Purchasing Clerk at Longwood Gardens and dear friend for all of her assistance in typing and editing this thesis.

I wish to acknowledge the assistance and response from each institution represented in the case study section of this thesis. Without their input, this project would not have been possible.

Most importantly, I would like to thank Ted for his continued support and belief that I would finish.

TABLE OF CONTENTS

Introduction

Since 1982, when I commenced my research, interest in Integrated Pest Management (IPM) has soared and new IPM programs have surfaced throughout the country. The intent of my research is to summarize information on public garden IPM programs; thus I surveyed each garden known to have a program as of 1986. The results of the returned surveys are summarized in this report.

Fourteen gardens were sent surveys in July 1986 and are listed below. Nine institutions, representing 64%, completed and returned the survey by August 1986. A copy of the survey is included in Appendix A.

Returned Surveys:

Birmingham Botanical Gardens	Birmingham, AL
Botanical Garden of Leiden University	The Netherlands
Brookside Gardens	Wheaton, MD
Denver Botanic Gardens	Denver, CO
Longwood Gardens	Kennett Square, PA
Mitchell Park Horticultural Conservatory	Milwaukee, WI
Morris Arboretum	Philadelphia, PA
National Park Service, Capital Region	Washington, D.C.
New York City Parks Department	New York, NY

Surveys Not Returned:

Alberta Environmental Center	Alberta, Canada
Chicago Botanic Garden	Glencoe, IL
Epcot Center	Lake Buena Vista, FL
Golden Gate Park Conservatory	San Francisco, CA
John Muir National Historic Site	Martinez, CA

Information on institutions which did not return a survey, although limited, was available from other sources. This information deserves representation and will be included in this case study report.

Each case study will start with a brief introduction to the public garden followed by an overview of the pest management program as identified in the survey. Other information available on the program from magazine articles and telephone conversations is also included. Each case study will conclude with a critique that highlights the strengths and weaknesses of the program.

BIRMINGHAM BOTANICAL GARDENS

2612 Lane Park Road
Birmingham, Alabama 35223
(205) 879-1227

Introduction

Birmingham Botanical Gardens is a facility of the Birmingham Park and Recreation Board and was established in 1962 to display plants in both wild and cultivated conditions. The 67 acre garden is operated by 17 full-time workers, 12 of whom are gardeners. Over 1,500 different kinds of plants are grown in formal rose, wildflower, rhododendron, fern glade and Japanese gardens. The 26,000 square foot conservatory is one of the largest in the southeast. The main section of the conservatory houses tropical plants and a changing seasonal display. The conservatory also contains a desert and camellia house and orchid, fern and bromeliad collections.

Documentation

The IPM program, still in its infancy, is described as being new and experimental; thus no documentation is available. Birmingham Botanical Garden requires employees who use pesticides to become certified commercial pesticide applicators through the Department of Agriculture and Industries in Alabama. Any state regulation or policy which refers to pesticide disposal or storage is followed. Employees follow chemical label requirements for pesticide safety. The staff keeps a one month

supply of any pesticide on inventory. There was no mention of Right-To-Know Compliance in the survey.

Scope of IPM Program

The Horticultural Specialty Grower - Greenhouse Supervisor, Shirley Boehm, completed and returned the survey. The IPM program originated in the Spring of 1985. The employees still use pesticides, but hope to use only biological control if possible. The program currently involves the entire conservatory and 22 acres of outdoor gardens. The staff plans to expand the IPM program to include the entire garden in the future.

Staff-Time Requirements

Each gardener is responsible for monitoring the pest population and requesting beneficial insects when needed. There are 8 gardeners involved in monitoring, averaging a total of 20 hours per week. Shirley Boehm orders all beneficials and oversees the program. Each gardener is responsible for his or her own pesticide application. Before the IPM program was initiated, Shirley Boehm sprayed her area every 7 to 10 days if insect problems were present.

Resources

Birmingham Botanical Garden's only outside contact has

been the Bug Farm, in Grady, Alabama, their source for beneficials. This supplier is evidently limited in stock of mealybug and whitefly beneficials, which tends to be the reason for the slow progress of this program. The greenhouse supervisor plans to contact the San Francisco Conservatory of Flowers in Golden Gate Park for other sources of beneficials and to learn from their IPM program. The garden has also asked for the assistance of the local extension service.

Training

Formal training for the staff has never been offered at Birmingham Botanical Gardens. The staff is encouraged to attend local seminars on pest management at the expense of the Garden or its supporting plant societies. The majority of the needed training is performed by staff while working. The Bug Farm performed a slide presentation at the Garden for the staff in the beginning of the IPM program.

The concept of IPM and using IPM to improve the pest management practices at Birmingham Botanical Gardens were self taught through books, past experience and present knowledge.

Program Critique

This program seems limited in scope, but with no outside help or support the program has survived mainly because of

staff determination to try and experiment. The Garden needs to establish a rapport with other biological control supply companies to assist as a backup to the Bug Farm's limited supply.

Learning from the experience of other programs trying to accomplish similar tasks could benefit this program. I will send a finished copy of this thesis to Birmingham Botanical Gardens to assist with their program.

BOTANICAL GARDEN OF LEIDEN UNIVERSITY

University of Leiden
Nonnensteeg 3
2311 VJ Leiden
The Netherlands

Introduction

The Botanical Garden of Leiden University was founded on April 13, 1587 and is one of the oldest in Europe. Initially it measured 131 square feet, but was gradually expanded to cover over 5 acres. The greenhouses built in 1850 and 1890 were replaced by a large group of hothouses in 1938. Most of the plant collection at the Botanical Garden is maintained in these structures. The collection is used primarily for demonstration and study by biology and pharmacology students. The Botanical Garden is also open to the public.

Documentation

An excellent document which explains the specifics of the IPM program in the greenhouses of Botanical Garden at the University was written by M. Kole, J.C. Van Lenteren and G.J. Van Vleit. This short paper was published both in a Dutch publication and The IPM Practitioner in February 1986. The article addresses why the program was initiated, what biological control agents were released, monitoring techniques and the results of the program. This is the only article I am aware of documenting an IPM program in a botanical garden

greenhouse.

The garden follows University safety rules regarding pesticide safety issues. The University may have a written policy regarding pesticide use, but specifics were not sent with the survey.

Scope of IPM Program

The IPM program was initiated and still exists only in the conservatory. Whether there are outdoor gardens is not known. Marian Kole, a part-time employee in the conservatory, completed and returned the survey. The conservatory is ± 4000 square feet which represents approximately 5 acres under glass. Over 4000 plant species are grown within this structure.

Biological control is used within the entire conservatory to control all major pests. Occasionally spot treatments of insecticidal soap are necessary to reduce pest outbreaks. The biological control agents used are listed below.

BENEFICIALS USED AT THE BOTANICAL GARDEN AT LEIDEN UNIVERSITY

Pest Organism	Natural Enemy	First Introduced
Planococcus citri (Citrus Mealybug)	Cryptolaemus montrouzieri (Predatory Beetle)	February 1984
	Leptomastix dactylopii (Citrus Mealybug Parasite)	April 1984
Pseudococcus maritimus (Californian Mealybug)	Cryptolaemus montrouzieri (Predatory Beetle)	February 1984

Pest Organism	Natural Enemy	First Introduced
Trialeurodes vaporariorum (Greenhouse Whitefly)	Encarsia formosa (Parasitic Wasp)	November 1983
Tetranychus urticae (Two-spotted Spider Mite)	Phytoseiulus persimilis (Predatory Mite)	November 1983
Saissetia coffeae (Hemispherical)	Metaphycus helvolus (Soft Scale Parasite)	February 1984
Coccus hesperidum (Brown Soft Scale)	Coccophagus lycimnia (Soft Scale Parasite)	Already present
Diaspis bromeliae (Armoured Scales)	Aphytis melinus (Armoured Scale Parasite)	February 1984
Myzus persicae (Aphids)	Aphidius matricariae (Parasitic Wasp)	Already present
	Aphidoletus aphidimyza (Predaceous Midge Larva)	January 1984
	Chrysopa carnea (Lacewing Larva)	June 1984

The whitefly parasite and the predatory mite were both commercially reared in the Netherlands and were available for immediate release when the program started. The two scale parasites were imported from California. The other parasites and predators became locally available in time.

Staff-Time Requirements

Professor Dr. Joop Van Lenteren at the Botanic Garden initiated the IPM program in the greenhouses in 1983. To help in this endeavor, Marian Kole was hired for 20 hours per week to help order beneficials, set up cultures (since most natural enemies were not available right away in the Nether-

lands or Europe), scout and give staff training. The program further expanded to helping other botanical gardens set up IPM programs, and this led to the hiring of Madeli Hennekam. In 1985 these two women, with the assistance of Bas Nyhof, set up programs at the Botanic Garden of Utrecht University and Nour der Dierenpark.

The program at the Botanical Garden of Leiden University currently requires approximately 20 hours per week, using 2 managers and 3 staff members. The gardeners are responsible for most of the scouting. Plants heavily infested with insect pests are removed to another greenhouse and treated separately to eliminate the pest problem. The scouting report records information about the pest species on each individual plant, the damage level on each plant and the presence or absence of natural enemies. The damage level for each affected plant is coded 1 thru 4, light damage receiving a code 1. This number is called the "pest index number".

Resources

From April to October 1983 the Botanical Garden greenhouses were renovated and the plant collections were reorganized. During this time, plans were developed for an IPM program using Sheila Daar, from Bio-Integral Resource Center in Berkeley, California and Marilyn Steiner and Don Elliott from Alberta Environmental Centre, Canada. Local entomologists were also consulted.

Insect and disease problems are identified in-house. Unknown pests are sent to an outside institution for identification.

Training

All staff training was done in-house. Each staff member involved in the program was given a photograph album and documentation about the pests and their natural enemies. At the beginning of the program, several lectures were given to introduce the IPM program. The availability of further update training was not mentioned in the survey.

Program Critique

The IPM program at Leiden University uses the most advanced form of scouting I have seen. The entire monitoring and reporting process seems thorough and well documented. The garden has had success controlling mealybug, whitefly, aphids and spider mites. Limited success has been achieved for scale insects. The greenhouse staff considers the condition of many plants to be better with IPM than with strict chemical control. The Botanical Garden has a successful biological control program in the large display and production greenhouses. This is the only program which uses IPM in an entire 5 acre greenhouse facility. They are fortunate to be part of a University and have scientific support staff close by.

BROOKSIDE GARDENS

1500 Glenallan Avenue
Wheaton, MD 20902
(301) 949-8230

Introduction

Brookside Gardens is a public display garden, located 10 miles from Washington, D.C. in Wheaton, Maryland. It is managed and funded by the Montgomery County Department of Parks. Brookside Gardens features 50 acres of display gardens and two public conservatories. The conservatories and additional growing houses represent 20,000 square feet. Brookside employs 23 full-time people and uses many volunteers as garden guides.

Documentation

Brookside Gardens started contemplating a garden-wide pest management program in January 1982. The program was finalized and in written form by January 1984. The Pesticide Policy of Brookside Gardens of the Maryland-National Capital Park and Planning Commission is a 36 page report on their general pesticide policy, covering all aspects of pesticide management. The report also includes a brief statement of philosophy and goals of the Gardens and copies of all forms used in their program. Els Benjamin, Director of Brookside Gardens completed and returned the survey.

Scope of IPM Program

The pesticide policy includes all outdoor ornamental, woody and herbaceous plants, hardy to zone 7, as well as tropicals and herbaceous seasonal display crops grown indoors. The only plants with a specific exception to the policy are herbs grown in the Fragrance Garden. These plants are not treated with pesticides, because the public is encouraged to touch and taste them.

The Pesticide Policy of Brookside Gardens of the Maryland-National Capital Park and Planning Commission includes specific rules and regulations for pesticide inventory, safety, storage and disposal. Although the survey response claims the policy addresses the State and Federal Right-To-Know Laws, I could not find anything written on this in the policy. The staff and Director review the Policy annually and make any necessary changes.

Staff-Time Requirements

The full-time staff at Brookside developed the Policy and implemented the program without outside consultants. The program is administered by full-time staff, requiring approximately three hours per week per section. There are four sections at Brookside: two conservatories, outdoor display gardens, two propagation and growing houses and a research holding area. Approximately 624 person hours a year are

devoted to pest management in all four areas. This amounts to approximately one third the total work of one full-time person.

Resources

The program was initiated by the author, while employed at Brookside from 1980-1982. An 8-week inservice training program on pest management was organized for the entire staff and this training started the process. The staff also reviewed Federal and State Pesticide Laws and Maryland-National Capital Park and Planning Commission pesticide policies. Brookside uses the University of Maryland's Plant Disease Clinic throughout the year to help identify insect and diseases problems.

Training

The day to day operation of the program is performed by the gardeners and greenhouse supervisors responsible for their specific areas. Supervisors become involved only when needed. Staff members attend annual training sessions given by the local Extension Service to update their state licenses and to remain current on all pesticide laws and regulations. Brookside Gardens funds this training and allows employees to attend other sessions when warranted.

Program Critique

Brookside Garden's written policy is accurately titled: it

is a pesticide policy. The report clearly instructs and sets standards for safe and accurate pesticide use. All aspects of pesticide safety, disposal and storage are addressed and standards are set. Each department at Brookside has its own written policy on how insect and disease problems will be handled. Accountability is assigned and deadlines are identified.

The policy is neither a pest management policy nor an integrated pest management program. It does not formally address how insect and disease problems will be monitored, alternatives for pest control, or methods for evaluating the success of the control measures used. In the policy's goal statement, and throughout the policy, it is mentioned that preference will be given to nontoxic, cultural or biological control measures. The policy does not address specifically how this will occur. There are no forms for monitoring or evaluation, although an entire section of the policy is devoted to forms and deadlines. What Brookside Gardens has developed is an excellent policy for pesticide use and safety. It would be nice to see them take this a step further and address pest management and how these problems should be handled. A copy of the table of contents from the Pesticide Policy is included in Appendix B for reference.

DENVER BOTANIC GARDENS

909 York Street
Denver, CO 80206
(303) 575-2547

Introduction

Denver Botanic Gardens is a public display garden, located in Denver, Colorado. A staff of over 30 full-time people, with a large number of volunteers, care for the Gardens' 10,000 different types of plants. Denver Botanic Gardens features 18 intensively landscaped acres of outdoor display gardens and a 10,800 square foot conservatory. The Gardens is an agency of the City and County of Denver, Department of Parks and Recreation. The Assistant Director, Andrew Pierce, completed and returned the survey.

Documentation

Denver Botanic Gardens has no written policy for their program. Several articles have been written by Andrew Pierce on the biological control program in the conservatory. Specifics on the pest management program, beyond the biological control programs, were not supplied.

Scope of IPM Program

Denver Botanic Gardens started a biological control program in their conservatory in 1980. Andrew Pierce, then Conservatory Superintendent, established the biological control

program in the conservatory. Predators and parasites were purchased and released to control the major pests in the conservatory. The beneficials released are listed below. The Garden estimates 90-95% of the major pests are controlled using these predators.

BENEFICIALS USED AT DENVER BOTANIC GARDEN

Pests	Beneficial Control Organism
Coccus hesperidum (Brown Scale)	Cryptolaemus montrouzieri (Predatory Beetle)
Planococcus citri (Citrus Mealybug)	Cryptolaemus montrouzieri (Predatory Beetle)
Tetranychus urticae (Two-Spotted Spider Mite)	Amblyseius californicus Phytoseiulus persimilis Metaseiulus occidentalis (Predatory Mites)
Myzus persicae (Green Peach Aphid)	Chrysopa carnea (Lacewing Larva) Aphidius testacipes (Parasitic Wasp)
Trialeurodes vaporariorum (Greenhouse Whitefly)	Encarsia formosa (Parasitic Wasp)
Frankliniella tritici (Western Flower Thrips)	Orius insidiosus (Minute Pirate Bug)

Denver Botanic Gardens is also attempting to use biological control in the production greenhouses and outdoor gardens. Neither attempt has been as successful as the conservatory program. The City of Denver has a 120 day outdoor growing season, from June through September. Beneficials require one to two generations after being released to build up sufficient

numbers, so by the time their population is large enough to control the pests, the growing season has ended. Greenhouse plants are constantly moved in and out and thus it is difficult to keep the populations of predators and parasites high on transient plants. It is also difficult to monitor populations of pests and predators on these plants. Because of these difficulties, only the conservatory remains chemical free. Insecticidal soap is the only pesticide currently used in the conservatory, and use of even this pesticide did not occur until four years into the program.

Staff-Time Requirements

A formalized system for monitoring pest populations is not established. According to the survey response, the garden uses both gardeners and horticulturists to monitor during their normal daily responsibilities. The pest management program requires approximately 7-10 additional hours per week from one employee. All of the ornamental plants grown at the gardens are included in the program.

Resources

Denver Botanic Gardens received a grant of $1000.00 from the Colorado Horticultural Research Institute in 1980 to start the biological control program in the conservatory. The program was started with educational assistance from a local biological control company and Colorado State University. The

Gardens still uses Colorado State University to help identify difficult pest problems.

Training

In-house pest management training for the staff is not available. The staff attends local seminars on pest management, and the garden funds this training.

Program Critique

Denver Botanic Gardens' goal is to achieve tolerable levels of pests throughout the garden. This will keep predators and parasites fed, with plants not being noticeably damaged. It is interesting that Denver Botanic Gardens has chosen biological control as their first program for pest management. With seven years of biological control experience indoors, the Gardens offers a valuable source of information. Hopefully Denver Botanic Garden will learn from their indoor experience and attempt to professionalize their outdoor pest management program and document the program to benefit other public gardens.

LONGWOOD GARDENS

P.O. Box 501
Kennett Square, PA 19348
(215) 388-6741

Introduction

Longwood Gardens is a public display garden located 30 miles southwest of Philadelphia, PA. It is a not-for-profit institution, supported by an endowment left by Pierre S. du Pont. There are 190 full-time employees, 80 part-time employees and 40 students to maintain Longwood's 14,000 different types of plants. Longwood owns 1,000 acres, 350 acres formally maintained with 3 1/2 acres under glass (over 20 greenhouses total).

Documentation

During the Fall of 1985, pesticide safety practices were reviewed and evaluated. Many changes were needed, and during the following year updated policies were written for pesticide disposal and storage, cholinesterase and pulmonary function testing and for chemical inventory and ordering practices. Each policy was thoroughly researched and drafts were circulated to staff for review before the policies were approved in 1986.

Pest management maintenance policies were developed for specific plant genera needing special attention.

Maintenance policies were developed for Longwood's dogwood, elm and beech collections. Each genus has specific pest problems which require strict maintenance schedules to reduce the threat of disease and insect problems. The policies were developed using experts specializing in each area. Each policy includes a description of symptoms on the plant at each stage of development that the gardener and scout should watch for while monitoring. Each policy also includes a specific maintenance schedule, including watering, pruning and sanitation requirements and a pesticide spray schedule.

Scope of IPM Program

Longwood Gardens started the IPM program in October 1984 by hiring the author as a full-time Integrated Pest Manager. The program began outdoors and covered the entire 1,000 acres including all woody and herbaceous ornamental plants hardy to U.S.D.A. zone 7. Individual policies have been written on specific aspects of the IPM program, but a document which describes the entire program is not available. After having established the outdoor program and successfully completed two years under the program, an IPM program for the indoor conservatories and growing houses was established in June 1987. This program is in its infancy and will require two years to fully establish. The first step was to establish a scheduled monitoring program of all greenhouses by the head gardeners and the

Integrated Pest Manager. Plans are to initially establish a biological control program in four of the 20 greenhouses in February 1988, and expand from there. The beneficial organisms currently used are listed below.

BENEFICIALS USED AT LONGWOOD GARDENS

Pests	Beneficial Organism
Trialeurodes vaporariorum (Greenhouse Whitefly)	Encarsia formosa (Parasitic Wasp)
Frankliniella tritici (Western Flower Thrips)	Amblyseius cucumeris (Predatory Mite)
Pseudococcus longispinus (Long-Tailed Mealybug)	Chrysopa carnea (Green Lacewing)
Planococcus citri (Citrus Mealybug)	Chrysopa carnea (Green Lacewing)
Tetranychus urticae (Two-Spotted Spider Mite)	Phytoseiulus persimilis (Predatory Mite)
Myzus persicae (Green Peach Aphid)	Chrysopa carnea (Green Lacewing)
Otiorhynchus sulcatus (Black Vine Weevil)	Neoaplectana carpocapsae (Parasitic Nematode)

Staff-Time Requirements

Starting the Integrated Pest Manager on an outdoor program, in the fall of the year was an excellent idea. Time was available to organize the program before starting in the spring of the following year. Longwood's 1,000 acre tract is divided into fifteen sections, with a section head gardener in charge of each section. A monitoring schedule with specific dates

was developed to monitor each section weekly or bimonthly depending on the section's public visibility. The head gardener and Integrated Pest Manager scout each section together, walking the entire area. Records are kept after each scouting session, identifying the plants with pest problems that need control and the plants with pest problems that need to be watched. It is decided which control measure will be used and who will perform the task at the conclusion of each monitoring session. An example of the monitoring form used is included in Appendix C.

Currently the IPM program requires two full-time employees and one part-time employee. The Integrated Pest Manager spends 50% of her time scouting both the inside conservatories and outdoor gardens and 50% of her time researching problems, writing pest management policies and teaching students at Longwood. The Pesticide Applicator spends 60% of his time applying pesticides outdoors from March 15 through October 15 and 40% of his time scouting the outdoor garden areas. From October 15 through March 15, the Pesticide Applicator assists the Integrated Pest Manager with indoor scouting, pest management policies and chemical inventory and ordering. The program uses approximately 40 hours per week for the additional gardener workforce assisting with scouting. An arborist assists the Pesticide Applicator each week with 20 hours of pesticide spraying. Six arborists rotate weekly so that each arborist

sprays only once every six weeks. All pesticide application is performed using two employees, or a buddy system. An average of 10 additional gardener hours per week are used to spray the conservatory. The part-time employee, working 20-30 hrs. per week, is responsible for managing Longwood's compliance with State and Federal Right-To-Know, OSHA and EPA pesticide related laws.

Resources

Longwood Gardens consulted many pest management experts before establishing the program. For the elm policy, Dr. Richard Campana, from the University of Maine, was the key consultant. Many other dutch elm disease experts were consulted, but Dr. Campana made several visits to the garden and closely followed Longwood's elm problem. The dogwood and beech policies were written after many phone conversations and a visit from Margery Daughtrey of Long Island Horticultural Research Laboratory and Dr. David Houston of U.S.D.A. in Hamilton, Connecticut. Consultants used for the general IPM program include:

Entomology	- Dr. John Davidson, University of Maryland Dr. Hiram Larew, U.S.D.A. Beltsville, MD
Plant Pathology	- Ethel Dutky, University of Maryland Dr. Gary Moorman, Pennsylvania State Univ. Dr. Ann Rhoads, Morris Arboretum
IPM Specialists	- Sheila Daar, Bio-Integral Resource Center John Holmes, American Tree Care, Inc. Dr. Michael Raupp, University of Maryland

Pesticide Specialist - Dr. Winand Hock, Pennsylvania State Univ.

Botanist - Dr. Alex Shigo, Retired National Forest Service

Longwood Gardens also uses the plant clinics at both the University of Maryland and Pennsylvania State University to positively identify disease samples. Future plans to develop a Review Committee to meet approximately two times per year to review the existing IPM program and set goals for future developments are underway. The committee will be formed from consultants already reviewing portions of the program.

Training

The first in-service training session on pest management was organized and taught during January and February of 1985. The sessions trained gardeners on the safety aspects of handling pesticides and the major insect and disease problems found at Longwood. The training ran for 8 weeks, one 2 hour session per week. Since 1985, Longwood has organized three more winter in-service training sessions, each dealing partially with pest management. All in-service training sessions are taught by outside experts. A sample of the 1985 in-service training schedule is located in Appendix D. Employees are also able to attend local pest management training sessions, at Longwood's expense, given by the local Extension Service or University. The Integrated Pest Manager is funded to attend the branch and

national meetings of the Entomology Society of America, the American Phytopathology Society and the International Society of Arboriculture to keep abreast of current research on pest management.

Program Critique

During the 3½ years since the IPM program began, Longwood has greatly reduced the amount of pesticide used both in the conservatories and outside. The quality of the displays has improved due to careful monitoring for problems and solving the problems at the correct time. The scheduled sprays of the past were eliminated. Monitoring is the key element of this program.

The need to document Longwood's program in its entirety is evident. It is difficult to think of a program in its entirety, so we tend to work on one area at a time. It soon becomes many loose ends if not assembled into one clearly defined document. With time, Longwood will achieve this goal. Plans to expand the IPM program to include household pest problems are currently being organized using Dr. Gene Wood, Entomologist at the University of Maryland. This program will primarily monitor rodent, cockroach and ant problems in our Maintenance buildings, restaurant and fifty tenant houses. When complete, this program will add the last dimension to Longwood's garden-wide IPM program.

MITCHELL PARK HORTICULTURAL CONSERVATORY

524 S. Layton Boulevard
Milwaukee, Wisconsin 53215
(414) 278-4383

Introduction

Mitchell Park Horticultural Conservatory consists of 63 landscaped acres with three geodesic domes. The domes represent 45,000 square feet of growing space and house over 2,000 kinds of plants. The park, which is part of the Milwaukee County Park System, employees 50 full-time and 15 part-time staff. The current domes were built from 1959-1964. One dome is a tropical garden, one an arid dome, featuring 1,000 species species of desert plants and the third, a seasonal display dome which features six display changes per year.

Documentation

Policies are written regarding pesticide safety, inventorying chemicals, pesticide storage and disposal, and Federal and State Right-to-Know Laws. Detailed policies regarding these safety related pesticide issues are in effect in all parks within the Milwaukee County Park System.

The Pest Control/Pesticide Management Program and Procedures policy, written by the Milwaukee County Park System, is an excellent overall policy regarding pest management. Each component of an IPM program is specified in the policy. The

county requires each park to use the least toxic, least risky pest management control options. The policy requires monitoring of pest populations, evaluation of procedures and establishing "acceptable damage levels". A copy of this policy has been included in Appendix E.

An elaborate pesticide application record must be filled out for all county pesticide applications. In addition to this form, an annual report must be completed to record each pesticide application made that year, its location, amount and documentation as to its necessity and success.

A policy or document specifically regarding the pest management program at Mitchell Park Horticultural Conservatory is not currently available. All Milwaukee County pesticide policies already mentioned cover information for both IPM and standard pest management programs. The staff of the Mitchell Park Conservatory are following the IPM approach in the conservatory and desire to eventually extend it outside. A sheet was written for public relations purposes regarding the biological control program in the conservatory; it is enclosed in Appendix F.

Scope of IPM Program

The Horticultural Director, Richard Risch, completed and returned the survey. The IPM program in the conservatory was initiated in February 1984 and the first biological control

agents were used in early 1985. Currently biological control agents are used in the Tropical and Arid Domes only, representing 30,000 square feet. These two conservatory domes house over 1,500 tropical plants, cacti and succulents.

The biological control program currently uses Cryptolaemus montrouzieri, a predator for mealybugs and scales, Phytoseilus persimilis, a predatory mite for spider mite control, lady beetles for aphid control and frogs, toads, camel crickets, chameleons and lizards for cricket and slug control. The staff release these predators when pest populations increase. If an insecticide is needed in these two domes, insecticidal soap is used.

Staff-Time Requirements

A horticultural technician monitors the general pesticide spray program in the greenhouses where the biological control program is not used. The responsibility for the biological control program is divided among the people responsible for those areas. Monitoring is also their responsibility. One floriculturist coordinates the population counts of predators and pests and orders new predators and supplies.

Resources

Unfamiliar insect or disease problems are sent to the University of Wisconsin for identification. The floricul-

turists identify most of the pest problems in their areas. When developing the IPM program, the staff referred to the biological control programs used at Edmonton Conservatory, Denver Botanic Garden and San Francisco Golden Gate Conservatory. The staff also referred to current research related to IPM and biological control.

Training

All staff training is performed in-house. Analyzing the IPM program and evaluating its success is done frequently by staff. A formal training session on pest management is usually performed every two years. The current staff instructs new employees about the program. Outside training is allowed and funded by Mitchell Park Horticultural Conservatory when the garden determines attendance to be necessary.

Program Critique

The Mitchell Park Horticultural Conservatory has been a leader in establishing a biological control program in its conservatories. This program has been successfully operating for four years. Little funding was necessary to start and continue to operate this program. Individual staff members took the initiative to research and experiment with biological control techniques until they discovered a system that would work for the conservatories. This deserves recognition since little specific information was available as reference

regarding biological control in ornamental plantings.

Mitchell Park Horticultural Conservatory should expand their pest management program to include a complete IPM program throughout the 63 acre park and conservatory. They are fortunate to be a part of a county park system with set IPM policies already in effect. It is unusual for a county-wide pesticide policy to include all components of an IPM program. This is impressive. This Garden should give more emphasis to the need for formalized training and program expansion.

MORRIS ARBORETUM OF THE UNIVERSITY OF PENNSYLVANIA

9414 Meadowbrook Avenue
Chestnut Hill
Philadelphia, PA 19118
(215) 247-5777

Introduction

The Morris Arboretum is designed in a naturalistic style featuring 3,500 kinds of plants on 90 acres. It is an historical garden, educational institution and research facility affiliated with the University of Pennsylvania. The Arboretum is maintained by a staff of 30 full-time people. The arboretum features a Rose Garden, Formal Parterres, English Park, Magnolia Slope and an Azalea Meadow.

Documentation

A document which explains the specifics of the Morris Arboretum's IPM program was completed in February 1988. The Policy on Pest Management and Pesticide Use for the Morris Arboretum of the University of Pennsylvania is an eight page document which lists goals, policies and procedures governing pest management practices. The first page of this policy, listing the pest management goals of the institution, is included in Appendix I.

A monthly monitoring schedule was developed, which is circulated to all gardeners, arborists and interns to assist in the monitoring process. A schedule of classes for interns and

gardeners is developed each semester as part of in-service training. A sample of both of these documents is included in Appendix G & H.

The Morris Arboretum follows University of Pennsylvania's policy regulating pesticide disposal. State law is followed regarding pesticide application licensing, safety equipment and pesticide storage. Pesticides are inventoried annually.

Scope of IPM Program

The IPM program was established in 1981 and includes the entire 90 acre formal garden and an 85 acre support landscape. The staff plant pathologist, Ann Rhoads, initiated the program and also completed and returned the survey. The only exception to the IPM program occurs in the Formal Rose Garden. Weekly preventive sprays are necessary to grow quality roses in this climate. Alternative control measures which apply to rose culture are used in addition to pesticide sprays, such as milky spore disease and pheromone traps.

Staff-Time Requirements

The plant pathologist oversees the IPM program at the Morris Arboretum. The plant protection intern performs most scouting, monitoring and follow-up communication with the gardeners. Both responsibilities require approximately 20 hours per week. During the early years of the program, the

intern was required to perform certain projects relating to the IPM program. One intern spent her entire stay at the Morris Arboretum compiling information on each pest problem currently being controlled in the garden. Life history information and control for each insect and disease was recorded for each plant pest. The next consecutive intern took this information and designed a strategy for pest management on the entire property. This strategy emphasized chemical controls but listed the timing to monitor pests to determine if pesticide application was required to suppress the pest. This document is entitled Pest Control Strategies and lists the pest, plant host and control by month. A sample page of this form is included in Appendix G.

Monitoring is performed by the intern, gardeners and the plant pathologist. The Morris Arboretum is currently trying to develop more quantitative monitoring techniques to improve the Pest Control Strategies outline. The lack of precise aesthetic threshold levels for ornamentals continually poses a problem for knowing when controls are actually necessary.

Resources

The Morris Arboretum invited Bill and Helga Olkowski from the Bio-Integral Resource Center in Berkeley, California to give a workshop in February 1981 on Integrated Pest Management. This was an intensive four-day workshop which involved work-

shops, seminars, public meetings and environmental group meetings. During this visit, the Olkowski's presented a half-day seminar to Longwood Gardens in Kennett Square, Pennsylvania and Independence Park in Philadelphia, Pennsylvania. Both institutions showed little interest at the time, but currently have IPM programs. The Morris Arboretum decided to pursue IPM after this intense workshop with the Olkowski's.

The staff identifies most insect pest and disease problems. Unusual insects are sent to Pennsylvania State University or the Pennsylvania Department of Agriculture for identification.

Training

A major mission of the Morris Arboretum is education. The staff teaches excellent programs to the staff and public. Elaborate educational schedules are developed for each intern program each year. A sample of one schedule is included in Appendix H. Gardeners are encouraged to attend all programs.

The Morris Arboretum provides information to the public, as well as the staff, on proper pest management techniques and the concept of IPM. A Plant Clinic operates each day to answer telephone calls or visits from the public regarding plant problems. The Arboretum also publishes a seasonal newsletter to educate the public on various horticultural topics. Adult education classes on all aspects of pest management are taught

seasonally as well.

Program Critique

Complete approval from the Director and motivated staff support have allowed the Morris Arboretum to develop and expand one of the earliest IPM programs in the country. The Morris is the only garden I am aware of which emphasizes public education on IPM for homeowner use. This is accomplished using adult education programs, newsletters and newspaper articles. Having a plant pathologist on staff full-time has facilitated the design and implementation of the program. Having expertise on staff makes pest identification and the scientific concepts of IPM easier to attain. This has helped the Morris Arboretum achieve the quality program they developed. Assisting other public institutions in developing IPM programs is also a major component of their program. The new pest management policy can be used to facilitate this assistance. The policy can be used as a guide helping other institutions establish their own pest management policy.

NATIONAL PARK SERVICE

National Capital Region
1100 Ohio Drive S.W.
Washington, D.C. 20242
(202) 342-1443

Introduction

The National Park Service is broken into 10 separate regions throughout the country. The National Capital region encompasses National Parks in Washington, D.C. and limited areas in Maryland and Virginia, totaling 70,000 acres. The acreage is divided into urban and suburban parkland, managed woodland and formal gardens.

Documentation

We would expect our national government to have ample documentation on their IPM program, and it does. The earliest document, written in February 1983, was Integrated Pest Management for Park Managers: A Training Manual written by William and Helga Olkowski. This ninety page document thoroughly explains all IPM components. Chapters are devoted to monitoring, treatment strategies and evaluation. The manual also discusses how to establish a monitoring and pest management system. This reference was developed to teach park managers the IPM techniques and philosophies they are to use in managing the pest management problems in their parks.

The second publication is a consolidation of established

Department of the Interior and National Park Service policies, guidelines and procedures regarding the use of pesticides in the National Park System. These procedures supersede all previous instructions. The Guide for Pesticide Use in the National Park System was written by the Biological Resources Division of the National Park Service in September 1985. This is distributed to all National Park Service personnel using or supervising the use of pesticides in the National Park System.

Numerous publications have been written documenting the dutch elm disease program used in the National Capital region. This was one of the earliest successful dutch elm disease programs using all components of an IPM program. The National Capital Region plant pathologist, Jim Sherald, developed the dutch elm disease program and has written several other articles promoting IPM in the Park Service.

All Pesticide Applicators are certified and licensed by the Department of Agriculture of the state in which they work. Training for this license is performed by the D.C., MD and VA Extension Services. Inventorying chemicals and pesticide storage practices vary by site. Occasionally the IPM Regional Coordinator will call for a list of pesticides for disposal and these will be contracted to a licensed disposal firm for incineration. Compliance with state or federal Right-To-Know laws was not mentioned in the survey.

Scope of IPM Program

In 1981, the Department of Interior created a policy which stated:

> "It is the policy of the Department to utilize pest management research, control, education and assistance programs to develop, support and adopt integrated pest management (IPM) strategies wherever practicable."

This is quoted from the Guide for Pesticide Use in the National Park System, page 2. Each National Park must try to solve all pest problems using an IPM approach if possible. Every pest problem, whether weed, insect, rodent or disease, must be evaluated and an IPM solution developed. Some parks have the resources to do this better than others. The National Parks within the National Capital Region have access to many universities, leading experts and references; this has facilitated the success of their programs.

The National Capital Region's IPM program includes all landscape ornamentals, agricultural lands and structural and household pests. Specific horticultural crops include elm, cherry, azalea, turf and bulb crops. The program encompasses over 70,000 acres of land, with limited use under glass.

Staff-Time Requirements

The entomologist/IPM assistant, Carol DiSalvo, completed and returned the survey. The total number of people and hours required to complete the IPM program's responsibilities are not

known. The full-time plant pathologist/IPM coordinator for the National Capital Region also assists with the program. Both individuals are responsible for developing the IPM program for their region and assisting the park managers in other regions in developing their IPM programs.

The agricultural programs within the region hire scouts from the Maryland Extension Service. Selected maintenance and resource management personnel along with the Region's IPM Coordinator are responsible for scouting, pesticide application and developing alternatives to chemical control.

Resources

The National Capital Region has relied heavily on the John Muir Institute in Berkeley, California for training and policy information on IPM. The John Muir Institute was under a three year contract, funded by the National Park Service and Environmental Protection Agency, to write the IPM training manual for park managers.

The Center for Urban Ecology in Washington, D.C. provides staff and resources to identify all pest problems and establish control recommendations. Each region has an IPM Coordinator who assists with the identification and controls as well. A list of each region and its IPM coordinator is located in Appendix J.

Training

The National Park Service (NPS) developed a forty-hour IPM training program for NPS employees responsible for pest management. This training is taught using NPS personnel. Periodic training sessions are held for maintenance level employees, museum curators and resource managers on basic pest management. The NPS has occasionally used outside specialists to conduct training sessions on up-to-date topics relating to spray equipment and pest management. Training can occur both on the regional and individual park level. Additional training is encouraged and funded as the budget allows.

The Center for Urban Ecology has compiled an IPM binder series on various pests in the National Capital Region along with a computer program to help field workers identify pests.

Program Critique

The National Capital Region and its parks have established an excellent, scientifically based IPM program for most of the pest problems occuring within each park. This region was working on IPM programs before the Department of Interior made it NPS policy to establish IPM programs in each National Park. The individuals responsible in this Region, through their ability and determination have created model IPM programs on elms, turf and household pests.

Many National Parks within other regions are not as fortunate as the National Capital Region concerning availability of resources and expertise. The Department of Interior created a policy in 1981; this was the easy step. Trying to educate park personnel on what that policy means and how they are to adopt IPM strategies to solve their pest management problems is not easy. Each state is involved and the number of employees is enormous. I have seen every degree of compliance with this policy from a total lack of interest, some parks not knowing the policy even exists, to the degree with which the National Capital Region has expanded the policy. The National Park Service needs to make this existing policy a central issue within each park and provide the leadership and training necessary to facilitate the process.

NEW YORK CITY DEPARTMENT OF PARKS AND RECREATION

The Arsenal
Central Park
New York, New York 10021
(212) 628-1036

Introduction

The New York City Department of Parks and Recreation (NYCDPR) manages New York City's largest park, Central Park, and numerous city streets containing over 2.6 million street and park trees.

Documentation

Formal documents describing the program do not exist. Several forms for monitoring and pesticide usage were developed and various aspects of the dutch elm disease program in Central Park are documented in other publications. The former Director of Horticulture and founder of this IPM program, Geraldine Weinstein, wrote an article in the Journal of Arboriculture (January 1986) entitled Urban Tree Management: Problem Solving in the Public Eye, which emphasized the importance of explaining and gaining support from the public for their IPM program concerning street trees.

Scope of IPM Program

The survey refers to the IPM program used in Central Park's 843 acres. The current Director of Horticulture, Frank

C. Serpe, completed and returned the survey. All landscape plants within Central Park are included in the IPM program. This includes elms, shade trees, shrubs, ground covers, turf, perennials and annuals. The dutch elm disease program is the most advanced program within Central Park. The IPM program of Central Park was started in 1982 by Geraldine Weinstein.

In the Spring of 1985, the NYCDPR initiated an IPM program for nearly 600,000 street trees. The article in the Journal of Arboriculture by Geraldine Weinstein states that "The primary intent of New York City's IPM program is to preserve our urban forest by establishing a flow of information from the tree to the managers and from them to the public."

Pesticides are used only when there is a life or death pest problem, because of public pressure against pesticides. To alleviate some public concern, the NYCDPR wrote information bulletins describing the life cycle of specific pests and the strategy for control the park system would use. These bulletins often asked for public support in caring for the trees and stressed total tree health care. The Department of Parks also began writing a newsletter entitled "Branching Out" which highlights recent findings regarding insect, disease, plant cultivar and transplanting practices.

Staff-Time Requirements

The staff requirements for the dutch elm disease program

are divided among three arborists and total approximately twenty hours per week during the growing season. Specifics are limited both in the survey and journal article regarding the time required to complete the rest of the IPM program.

Resources

Numerous telephone contacts were made early in the program with other park systems attempting IPM programs and university professionals dealing with IPM in their research. Dr. Terry A. Tattar, Plant Pathology professor at the University of Massachusetts in Amherst, Massachusetts, actually visited the New York Parks Department on several occasions and led in-service training sessions for the staff. Currently outside consultants are not used. All pest and disease identification is performed by staff.

Training

In-service training is occasionally offered to the staff. All training is done in-house. The parks department allows and pays for employees to attend local seminars.

Program Critique

I had difficulty including this case study in my report since I know the IPM program described was due to the dream and determination of one individual out of the entire parks department. That individual has left the park system, and with

her departure the pest management progress and dreams have come to a screeching halt. The survey was completed by the new person responsible for all horticulture within the parks department. He makes no reference to expansion or even continuation of several of the programs established by Geraldine Weinstein. This is a frustrating but realistic example of how fragile several of our premiere IPM programs in this country really are. So often they are established and performed by the inner strength and determination of one individual as opposed to the entire organization being committed to the program. These programs exist only while their founders continue to work. For this reason, establishing institution-wide support and understanding is the first step in creating any successful IPM program. This is not always possible, but rarely without such support would an IPM program be successful. Hopefully, with community and employee support the IPM program in New York City will again come to life.

SURVEYS NOT RETURNED

A reasonable effort was made to obtain detailed information on the five remaining gardens claiming to have IPM programs. Surveys were sent to these institutions twice, and numerous phone calls were made. The information gathered is given below.

Alberta Environmental Centre
P.O. Bag 4000
Vegreville, Alberta
Canada TOB 4LO
(403) 632-6767
Contact: Marilyn Steiner,
Entomologist

Applied Bio-Nomics Ltd.
P.O. Box 2637
Sidney, British Columbia
Canada V8L 4C1
(604) 656-2123
Contact: Don Elliott,
Project Director

A biological control program for Crystal Gardens in Victoria, British Columbia was started in 1980 by Steiner and Elliott. The success of this program led to a biological control program in Muttart Conservatory in Edmonton, Alberta. A handbook entitled Biological Pest Management for Interior Plantscapes, written by both individuals, highlights the results of both of these programs. The book discusses the major interiorscape pests and their biological control, identifies recommended pesticides for use with biological control and lists suppliers of biological control agents. This text does not explain how the programs were developed or organized, but rather gives specific conclusions on how to use biological control in an interiorscape. This reference is listed under the resource section of the guidelines. Applied Bio-Nomics Ltd. is a supplier of many beneficial organisms and is also included in the resource section.

Chicago Botanic Garden
P.O. Box 400
Glencoe, Illinois 60022
(312) 835-5440
Contact: Dian Brown, Plant Protection Manager

Chicago Botanic Garden is attempting to establish an IPM program throughout its outdoor grounds and conservatory. Dian Brown is responsible for outdoor pest management only. The conservatory will be attempting to start a biological control program in the near future. Nothing has been written on this program to really know the status of its development.

Epcot Center-The Land
P.O. Box 40
Lake Buena Vista, Florida 32830
(305) 824-2222
Contact: Fred Pettit, Entomologist

In February 1984 the Bio-Integral Resource Center in Berkeley, California provided information on, and a starter culture of, the aphid predator Aphidoletes aphidimyza. The staff entomologist, Fred Pettit, was in the process of developing a biological control program for "The Land" exhibit at Epcot Center. This display is located in a large greenhouse where over 50 agricultural crops are grown simultaneously. Over 2,000 guests per hour tour this exhibit via a 14 minute "Listen to the Land" boat ride. Integrated pest management plays a key role in the maintenance of the exhibit. Heavy emphasis is placed on sanitation, use of resistant

cultivars and releases of beneficial organisms. Successful components of the program are a combination of parasitic wasps and yellow sticky tape to control leafminers, parasitic wasps and a predatory fly to control aphids and predatory mites to control spider mites. Spot treatments of insecticidal soap are occasionally necessary. A brief summary of this IPM program is included in the Common Sense Pest Control Quarterly, volume 1, number 4 (Fall 1985), p. 3.

San Francisco Conservatory of Flowers
McLaren Lodge
Fell and Stanyan Streets
San Francisco, California 94117
(415) 558-3973
Contact: Tom Bass, Conservatory Director

The Conservatory of Flowers is located in Golden Gate Park and is a 1879 Victorian structure. The 30,000 square foot glasshouse complex houses over 4,500 kinds of plants that are cared for by 9 full-time employees. The conservatory is toured by an estimated 300,000 visitors each year. The conservatories house tropical plant collections and seasonal floral displays.

Several problems motivated the conservatory director, Tom Bass, and his staff to develop an IPM program: a number of common pests in the conservatory no longer responded to pesticides, workers were concerned about health hazards associated with pesticide use and the garden was closed after spraying which resulted in a loss of income. Staff of Bio-

Integral Resource Center (B.I.R.C.) in Berkeley, California were consulted in 1982. The first year consulting costs of the program were covered by a contract from the California State Environmental License Plate Fund.

The IPM program emphasizes biological control but also incorporates cultural, physical and chemical controls. The biological control organisms used are listed below:

Mealybug destroyer	- Cryptolaemus montrouzieri
Mealybug parasite	- Leptomastix dactylopii (discontinued)
Mealybug parasite	- Pauridia peregrina (discontinued)
Mite predator	- Phytoseiulus persimilis
Mite predator	- Metaseiulus occidentalis
Mite predator	- Amblyseius californicus
Mite predator	- Amblyseius limonicus
Whitefly parasite	- Encarsia formosa
Aphid midge	- Aphidoletes aphidimyza
Green lacewing	- Chrysopa carnea
Convergent lady beetle	- Hippodamia convergens (discontinued)
Predatory nematode	- Neoaplectana carpocapsae
Scale parasite	- Metaphycus helveolus

A key feature of this program was to train the existing staff to perform the IPM program without consultants in the future. The consultants conducted training sessions routinely for approximately one-half hour each week using handout material, book and insect displays and slide shows. By the second half of the year, staff members were able to monitor plants as part of their daily routine.

The biggest problem with this program has been the difficulty of scheduling the arrival of beneficial organisms. This is currently still a problem. An article on this program entitled "IPM for a Conservatory and Greenhouses" by the

Olkowski's and Sheila Daar, is located in The IPM Practitioner volume 8 (1983), pages 4-9.

The John Muir National Historic Site
4202 Alhambra
Martinez, California 94553
(415) 228-8860
Contact: John Donahue, Gardener

The John Muir National Historic Site (N.H.S.) was the home of the founding father of our nation's conservation movement. This nine acre N.H.S. was once part of John Muir's twenty six hundred - acre fruit ranch. The grounds contain the Victorian mansion where Muir wrote most of his major works. The site also has a wide variety of orchards and vineyards.

In the Spring of 1983, the superintendent of John Muir N.H.S. invited B.I.R.C. of Berkeley, California to visit the park and make suggestions on how to reduce pesticide use in the orchards. B.I.R.C. recommended implementation of an IPM program. The superintendent and gardener on site attended the 40-hour IPM training course offered by the National Park Service. This provided the background necessary for both individuals to attempt developing an IPM program.

The staff developed an orchard management plan which outlines the day-to-day grounds operations involved in managing an orchard. An integrated pest management plan was also developed with emphasis on deterrence, early

recognition, biological control and cultural practices. Both of these plans stress cultural activities which promote vigorous and healthy plants.

A general summary of this program entitled "IPM in the John Muir National Historic Site Orchard", by John Donahue is published in The IPM Practitioner, volume 8, number 2 (February 1986), pages 5-6.

Conclusion

Each public garden represented in this case study report has helped to professionalize and forward the movement toward safe and efficient pest management. Hopefully the number of institutions attempting IPM programs will continue to grow in response to the publics desire for environmentally safe recreation areas. Public gardens must strive to be in the forefront of this trend and lead the way toward professional pest management.

New public garden IPM programs have surfaced since the survey was sent out in 1986. An increase in the number of inquiries received by Longwood Gardens requesting information on how to start IPM programs is noticeable in the past six months. These are signs of an increased awareness to the problem and need for IPM programs in botanic gardens and arboreta. The problem is these institutions are still the exceptions. To the best of my knowledge, they represent only a small fraction of the total number of public gardens in this country. Hopefully this report will further educate and persuade other public gardens to begin IPM programs.

APPENDIX A

STATUS OF INTEGRATED PEST MANAGEMENT PROGRAMS IN PUBLIC GARDENS

A SURVEY

1. Name of Institution _____ Date: _____

2. Person completing Survey _____ Title _____

3. Date program originated _____

4. Is there a document which explains the specifics of your program(s)? Explain. Please send copies of all pertinent documents: _____

_____

_____

5. Is the IPM Program institution-wide or segmented? (i.e. conservatory or outdoor grounds only): _____

_____

6. Are there plans for future development? Explain: _____

_____

_____

7. Please indicate the size of area managed by your pest management program:
   Under glass (sq.ft.) _____
   Outdoor acreage _____

8. List the major specific horticultural crops included in your program (i.e. elms, fruit trees, foliage plants, etc.): _____

_____

_____

9. Do these specific crops have written policies, or specific rules all their own? Please specify: _____

_____

_____

10. Please indicate the staff time required to complete program responsibilities. (This includes scouting, spraying, record keeping, etc.)
    Total number of people per week _____
    Total number of hours per week _____

SURVEY

11. Does your institution employ person(s) with the sole responsibility of operating the program? (i.e. full-time monitors, scouts, plant pathologists, entomologists):

12. Did your institution use outside consultants to develop the program? Explain:

13. Does your institution continue to use outside consultants to operate the program? Explain:

14. What references, example institutions or people did you consult with to help establish your program?

15. How do you identify your insect and disease problems? (i.e. extension, plant clinics, personnel):

16. If your institution uses staff to operate the program, how are the responsibilities organized? (i.e. gardeners' scout, arborists spray pesticides, etc.)

17. Does your institution offer staff training on pest management? Explain:

18. Who organizes the staff training? How often is it given? Do you use outside lecturers?

19. Does your institution allow employees to attend local seminars on pest management? Do you fund this training?_____

_____

20. Does your institution have a policy for the following? (please specify): Remember to send all related forms with survey.

Pesticide safety:_____

_____

_____

Inventorying chemicals:_____

_____

_____

Pesticide disposal:_____

_____ _____

_____

Pesticide storage:_____

_____

_____

Federal & State "Right-To-Know" Law:_____

_____

_____

21. Are there other components of your program not mentioned above which you could explain?_____

_____

_____

22. Are you aware of other public gardens using IPM programs?

Please list:_____

_____

Please return completed Survey with any additional written information on your program, by July 31, 1986 to:

Nancy Bechtol
Integrated Pest Manager
Longwood Gardens
Box 501
Kennett Square, PA 19348 0501

7/1/86

APPENDIX B

BROOKSIDE GARDENS PESTICIDE POLICY

TABLE OF CONTENTS

APPENDIX C

MONITORING REPORT

BiWeekly Monitoring Report

Scout: _____ Date: _____

Section: _____ Time: _____

Section Head Present: _____

Insect/s Pest Problems
Disease _____ Location _____ Control, by whom _____

Additional Comments: _____

_____

_____

4/85

Longwood Gardens
Kennett Square, PA

APPENDIX D

Insect and Disease Pest Management
In-Service Training, 1985

Tues., Jan 8 10:00-11:30 a.m.	I. Integrated Pest Management A. Define IPM, history of B. How to establish a program C. Components of an IPM program D. Treatment Strategies E. Benefits of an IPM program	Dr. Michael Raupp Extension Entomologist University of Maryland
Fri., Jan. 11 10:00-11:30 a.m.	II. Pesticides A. Types of pesticides, classes B. Formulations C. Toxicity D. Mode of action E. Choosing a pesticide	Dr. Winand Hock Extension Pesticides Specialist Pennsylvania State University
Tues., Jan. 29 10:00-11:30 a.m.	III. Insect Pests of Ornamentals A. Life cycles of insects B. Identifying insects specific to Longwood C. Control measures	Dr. John Davidson Extension Entomolgist University of Maryland
Thurs., Jan.31 10:00-11:30 a.m.	IV. Pesticide Safety, Equipment and Calibration A. Reading the label B. Mixing and application C. Disposal and storage D. Clothing E. Poisoning, What to do F. Current laws, record keeping G. Equipment H. Calibration	Dr. Mark Graustein Extension Specialist, Entomology University of Delaware

Tues., Feb.5
10:00-11:30 a.m.

Ethel Dutky
Faculty Extension Assistant
University of Maryland

V. Diseases of Ornamentals

A. Life cycles of diseases

B. Identify diseases specific to Longwood

C. Control options

D. Nematodes

Tues., Feb.12
12:45-2:15 p.m.

Dr. Larry Kuhns
Ornamental Horticulturi
Pennsylvania State University

VI. Turf Problems and Herbicides

A. Identification of lawn insects and disease problems

B. Weed control

C. Types of herbicides

D. Selecting an herbicide

E. Maintaining turf

Tues., Feb.26
10:00-11:30 a.m.

Dr. Ann Rhoads
Pathologist
Morris Arboretum

VII. Physiological Disorders

A. Environmental Problems

B. Mechanical Damage

C. Chemical Damage

D. Animal pests

Thurs.,Feb.28
10:00-11:30 a.m.

Dave Stiger
Pesticide Inspector
Pennsylvania Dept. of Agriculture

VIII. Wrap-up

A. Question and answer period

B. Administer Pennsylvania State core exam

APPENDIX E

DEPARTMENT OF PARKS, RECREATION AND CULTURE

PEST CONTROL/PESTICIDE MANAGEMENT PROGRAM AND PROCEDURES

Preventive pest control action/pesticide application should be taken only when the need for preventive action is documented.

Documentation can be based upon the area supervisor's past records as well as recommendations by Agricultural Extension agents, professional associations and from educational resources.

Corrective pest control action/pesticide application should be taken only when a problem is observed and documented.

Documentation such as that above will be used in decision making. This procedure ensures that a problem has been correctly identified so that the correct solution can be obtained.

After correctly identifying the pest problem, evaluate available alternative control methods and select the "lowest toxicity, least risk" option which will effect the required control.

A policy of Integrated Pest Management will be followed. To aid in this decision making process a two-part slide program "Integrated Pest Management Techniques for Urban Areas" is available. Possible solutions will include biological pest control, chemical pest control, proper cultural and sanitation procedures, and the choice of pest resistant varieties.

The choice of control methods and the selection of "lowest toxicity, least risk" options will be determined by the area Supervisor. These procedures will be reviewed by the appropriate Regional Manager or Division Head.

Where practical, establish "acceptable damage levels" resulting from the respective pest problems below which no control action will be taken unless required to prevent damage from exceeding the acceptable level.

This principle is most applicable to woody plant material such as trees and shrubs. "Acceptable damage levels" will be assessed by area Forestry Supervisors through periodic monitoring of pest populations. A similar approach will be used with outdoor herbaceous plants as well as insect damage to turf, damage levels being assessed by the area Supervisor. This concept can also be applied to the biological pest control program at The Conservatory, a program attempted primarily on plants located along the periphery of each Dome where damage is least noticeable.

The concept of "acceptable damage levels" cannot, however be extrapolated to weed populations in some turf; shrub and flower beds; greenhouses; and sidewalks/roadways. In these highly maintained and very visible areas of the Park System, weeds cannot be tolerated because of public concern for aesthetics and/or sanitation considerations. Disease control on golf courses in ornamentals is another area in which "acceptable damage levels" cannot be tolerated. In these cases, control is primarily preventive because damage is internal and difficult to eradicate once established.

Time the control action for maximum effectiveness and safety.

Factors influencing correct timing include: weather (temperature, wind, relative humidity, and rainfall); the pest's life cycle; ornamental cycles; affects of sunlight upon pesticide stability; and the public's possible exposure to treated areas.

Follow up and monitor control action results. Keep accurate records.

Record keeping will include:

1. the target pest
2. the area treated
3. the control method
4. application rates
5. date and time (length of exposure)
6. personnel involved
7. safety gear worn
8. type of application equipment used

Records are available to employees and are kept with the area Supervisor as well as in the Regional/Division office. Other information/records such as specimen labels and Material Safety Data Sheets are also available and maintained at the above locations.

Evaluate and modify the program as necessary.

This point is essential to any pest control program since pest populations and plant varieties are so variable. Secondly, technology and materials available are continually changing.

Annually estimate quantities of each product expected to be required during the subsequent pest control season and request blanket purchase order bids covering a reasonable range of quantities bracketing the estimated required quantity.

This is already in practice.

Utilizing the blanket purchase order system, request delivery of only such products and quantities as are required for immediate and near future use.

In the case of the horticultural work units, pesticides can be delivered in response to Blanket Order Releases as needed. This is possible because Mitchell Park Region is a year-round operation and suppliers inventory pesticides all year. The Forestry Division has specific times of pesticide applications and can thus time deliveries to coincide with applications. It may also be possible to similarly time deliveries of fungicides intended for golf course use. Golf course herbicides may be delivered to coincide with their application.

Require respective bidders to submit FIFRA required labeling information and Material Safety Data Sheets for each product covered by their bid as a required condition of their bid submittal. The Purchasing Division shall provide respective department/region/facility copies of the submitted labeling information and MSDS for each product ordered.

This is the established policy.

Pesticide/chemical deliveries should be scheduled to minimize exposure of the public in the event of a discharge, spill or leak of the products being delivered.

All deliveries will be timed to coincide with normal working hours of the staff. Deliveries are made to service buildings where the public is generally not allowed.

In compliance with SS 101.58-101.599 Wisconsin Statutes and in conjunction with chemicals list in 29 CFR Part 1910, Subpart Z, all label information and Material Safety Data Sheets will be available to employees in the Regional/Divisional office where copies may be readily made.

All pesticide inquiries should be directed to the Regional/Divisional office in which the pest control reports are on file. If additional information is requested, the field can be contacted directly by the Regional/Divisional office.

In public use areas, such as turf, signs reading "Pesticide Treatment Now in Progress" may be posted on portable signs by park entries. A major effort will be made to treat public areas during non-use periods to minimize possible exposure.

The restricted use pesticide record keeping requirements of FIFRA, SS 94.67-94.71, 101.58-101.599 Wisconsin Statutes, and Wisconsin Administrative Code Chapter Ag 29 will be extended to all pesticides and to all employees engaged in handling and applying pesticides. This

information is already contained in the pesticide report on file in the Regional/Divisional offices.

Employee and public complaints concerning pesticide activities will be recorded and kept in the Regional/Divisional office and available for periodic safety review.

Employees including Supervisors engaged in or working in the vicinity of pesticides or other toxic chemicals will receive training and/or information on the potential hazards, safety precautions and the required or prudent use of approved safety equipment, possible symptoms resulting from overexposure, and first aid measures to be taken in the event of a harmful exposure or accidental spill of toxic materials as required by SS. 101.58 - 101.599 Wisconsin Statutes. The Department of Parks, Recreation and Culture began an ongoing program of training for horticultural employees and Supervisors, utilizing the Wisconsin Department of Agriculture's Pesticide Applicator's Certification Program. Each year, monies will be allocated to send new employees as well as Supervisors to this training. Field training sessions involving safety procedures will subsequently be held prior to seasonal pesticide programs in the Parks.

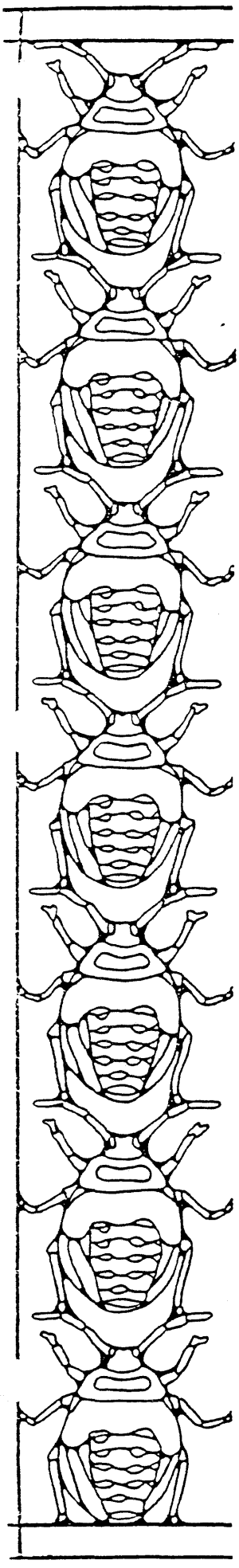
All pesticides will be stored in conformance to Wisconsin Administrative Code, Chapter Ag. 29 requirements, storage recommendations contained in the product labeling information and Material Safety Data Sheets, and other applicable requirements such as State and/or local building codes and Fire Department regulations.

Current and complete inventories, label information, and Material Safety Data Sheets for toxic material used at each storage location are to be maintained at both the storage site and the divisional/ regional office The Fire Department servicing each site shall also have copies of the seasonal inventory and Material Safety Data Sheets.

Before renewing contract services for pest control/pesticide applications, the Department of Parks should evaluate the need for and effectiveness of these services versus an in-house control program.

If outside contract services are used, all contracts will require the vendor to provide lists of the pesticides being used; the Material Safety Data Sheets; records of the dates, locations. application rates and quantities applied; and documentation of applicator certification (if restricted use materials are being applied), employee training, and conformance to all applicable Federal; State and local laws/regulations.

The Mitchell Park Horticultural Conservatory



Since the Domes opened in 1964, a war has been going on. The staff has compiled a vast arsenal of weapons to wipe out the enemy, but with little lasting effect. After each skirmish body counts have been high, but some of the battles have devastated valuable vegetation and the enemy population invariably rebounds with vigor. Only the continued vigilance of the staff has kept the Conservatory from being overrun.

But 1985 was to be different. We have hired an army of mercenaries to march on the enemy and protect the staff from the lethal chemical warfare that has gone on for twenty years. We pay these mercenaries peanuts (4¢ apiece for life) and provide room and board (at no cost to us). Since we first hired them, they have achieved impressive results. Though they engage in the disgusting habit of eating their victims, we have found it a very practical solution to the problem of waste disposal.

Who are these skullduggerous, but effective characters? With their spiny white fur coats they look like aliens, but in fact they are Australians. The adults look like black ladybugs 3/8" long. What is most delightful about them is that they eat mealybugs and soft brown scale by the thousands. They arrived from California in small ice cream cups covered with mesh. Amid much excitement we first released them at the recommended rate on two mealybug-infested plants in the Tropical and Arid Domes. A few flew suicide runs right into the glass and a few preferred hair to the plants, but most of them dutifully zeroed in on the mealybug targets. Two weeks later we released another batch. We found that releasing them on a cloudy day greatly reduced the suicide rate. Very few flew into the glass.

One month after the initial release, we became the proud parents of our first Australian larva. They were furry little white fellows, very similar in appearance to an adult mealybug, and did they eat! In less than one week the mealybugs were few and far between, and areas that had been mealybug problems for twenty years were visibly improved.

Our success with these predators has not eliminated our spray program. The beetles were released only in areas hard to get at with a sprayer. The beetles were not introduced into areas immediately adjacent to the walkways for aesthetic reasons. Also, we have other pests to deal with. As it warms up in the Arid Dome in spring we introduce predatory mites to decrease our spider mite population. Those beautiful long "hula skirts" on the fan palms make cozy homes for spider mites and are difficult to reach and penetrate with a sprayer. Our anti-mite mites are very effective in that location.

In early spring aphid populations also begin to explode. We have found in our enclosed environment that a second species of imported ladybugs is effective in eliminating occasional aphid outbreaks. Other interesting biological controls used are frogs and toads for camel crickets and cameleons and lizards for control of crickets and slugs.

Biological pest control is offering us the possibility of working with nature instead of against it. It promised to decrease our pest populations to the point where much less toxic sprays (like insecticidal soap) can be used. In the large, diverse habitat of the Domes, we will never be able to eliminate pest problems completely, but establishing a self-perpetuating system of natural controls may well provide an acceptable level of population management.

Philadelphia, PA

APPENDIX G

Monito. .g Report

Mid-April

Host	Pest	Monitoring	Control
Azalea	Exobasdium Leaf Gall	Azaleas by fernery especially vulnerable. Check plants for galled leaves April - Mid-May.	Pick and destroy infected plant parts
Pachysandra	Canker	Check for wilting, dying plants with black lesions on stem or leaves.	Remove infected plants or prune discarded diseased parts. Spray at budbreak 10-20 days later. Maneb 80% WP 1½ Tbsp./gal. or Dithane Z78 - 75% AI - 1 Tbsp./gal.
Pine	Sawfly	Check previous year's needles for chewing and presence of clusters of caterpillars which move in unison.	If only a few groups of sawfly larvae are present, consider pruning out. Sevin 50% WP 2 lb./100 gal. Methoxychlor.
Viburnum, Crabapple, Hawthorns	Aphid	Check tips of new shoots for curled or distorted leaves and clusters of aphids.	Insecticidal Soap or Orthene 15.6% 3 pt./100 gal.
Vinca	Canker	Check beds for wilted plants or dead patches.	Remove infected plant parts or prune and discard diseased parts. Benlate or thiobendazole - ½ to 1 lb./1000 sq. ft. as soil drench.
Malus, Prunus, Cotoneaster	Tent Caterpillars	Check trees for tents as leaves are emerging. Twigs can also be checked during the winter for egg clusters which ring the stem.	Prune and destroy tents as soon as they are seen. If needed, spray with BT-Dipel 3.2% ¼-½ lb./100 gal

APPENDIX H

TRAINEE COURSE OUTLINES

February - June 1981

Botany - Ann Rhoads - Feb. 12, 20, & March 5

Leaves - anatomy, shape and veination; Transpiration; Photosynthesis; Root anatomy and functions; Stem anatomy and functions; Flower structure and reproduction; Fruit.

Physical - Soil Modification - Dave Sedmak - Feb. 26

Soil profile; Four major components of soil; soil texture and structure; Sand silt and clay; Loams; Field evaluation of soils; Bulk density and factors effecting it; Porosity and pore space; Tillage and soil aggregation; Structural management of soils; Organic matter, compost, green manure, cover crops and other additives; Drainage; Subsoiling; Tillage equipment and procedures.

Plant Nutrition - Carrie Green - March 12 & 19

Genetic and environmental factors effecting plant growth; temperature, moisture, radiant energy, structure and composition of soil, soil reaction C.E.C., pH, biotic factors, nutrient elements; Macro and Micronutrients; Deficiency symptoms; Fertilizer types; Application techniques; Interpreting soil tests.

Grafting - Lynne Lamstein - March 26

Collecting and storage of rootstock and scion material; Physiology of grafting; Three or four popular grafting methods and their application; Treatment of grafted material; Advantages and disadvantages of grafting.

Basic Plant Pathology - Ann Rhoads - April 2 & 9

Fungi; Bacteria; Virus; Disease life cycles; Methods of disease control; Common diseases of ornamental plants.

Pest Control - Jerry Olsyn - April 16

Natural, cultural, mechanical, legal, biological, chemical, genetic, and integrated pest control; Diagnosing insect problems; Monitoring insects; Economic thresholds; Variables.

Pesticide Application and Safety - Bill Graham - April 23

Toxicities; Classification; Use and maintenance of protective equipment; Disposal of containers; Safe storage; Safety checklist; Mixing and application; First aid.

Plant Acquisition and Record Keeping - Paul Meyer - April 30

The scientific, horticultural and environmental reasons for keeping a collection of plants; Where plants are acquired: Collecting methods; Accessioning and deaccessioning procedures at Morris; The plant label; Collection policies at Morris; Arboretum grids and maps.

Herbicide Use - Bill Graham - May 7

Types of weeds; Methods of weed control; Using herbicides safely; Modes of herbicide action; Misuse of herbicides; Recognizing damage; Commonly used herbicides.

Seeds, Cuttings and Layers - Lynne Lamstein - May 14

Collecting and storing propagation materials: Special treatment procedures; Methods; Care of newly propagated plant material; Advantages and disadvantages of each method; Examples.

Plant Breeding - Jerry Olsyn - May 21

Improving plants; Hybridization techniques; Selection procedures for cross-pollenated plants; Testing new Plants.

Trees and Shrubs in Common Use - Paul Meyer - May 28, June 4, 11, 18, 25, July 2

100 selected plants; Lecture and lab.

Policy on Pest Management and Pesticide Use for the Morris Arboretum of the University of Pennsylvania February 29, 1988

I. Goals

To protect the specimen plants in the living collection from pests, diseases, or weeds which threaten their health or their scientific or aesthetic value.

To avoid exposure of Arboretum staff, volunteers, or visitors to toxic chemicals and other hazardous materials.

To avoid environmental contamination and disruption of natural systems caused by excessive or careless use of pesticides.

To educate the Arboretum staff, volunteers, members, and the general public regarding safe and environmentally responsible pest and weed management practices.

To comply with the relevant provisions of the Pennsylvania Right-To-Know Law (1984-159) and Occupational Safety and Health Administration Hazard Communication Standard; applicable U.S. Environmental Protection Agency regulations such as the Federal Insecticide, Fungicide and Rodenticide Act; and the Pennsylvania Pesticide Control Act of 1974 and amendments.

II. Policies

A. Arboretum Grounds and Greenhouses

Utilize an Integrated Pest Management (IPM) approach to the management of pests and weeds on the Arboretum grounds and greenhouses. This would include:

- regular monitoring;
- use of resistant species and cultivars;
- encouragement and/or introduction of beneficial insects;
- use of traps and other mechanical control devices;
- use of biological controls;
- spot treatment with narrow spectrum pesticides;
- cultural techniques to minimize pest and weed incidence;
- and other appropriate control strategies.

B. Education

1. Staff Training

a) All personnel who apply pesticides are required to be either Licensed Commercial Applicators or Registered Pesticide Application Technicians as defined by the Pennsylvania Department of Agriculture. The Chief Horticulturist, the Curator for Propagation, and the Rosarian will maintain current Commercial Applicator's Licences.

APPENDIX J

NATIONAL PARK SERVICE
REGIONAL INTEGRATED PEST MANAGEMENT COORDINATORS

Alaska:

Al Lovaas
Alaska 1 Regional Office
Science Division
2525 Gambell Street, Rm. 107
Anchorage, AK 99103
FTS-907-271-4212

Mid-Atlantic:

Mike Maule
Mid-Atlantic Regional Office
National Park Service
193 South 3rd Street
Philadelphia, PA 19106
FTS-597-5372

Midwest:

Ben Holmes
Midwest Regional Office
National Park Service
1709 Jackson Street
Omaha, NE 68102
FTS-864-3476

National Capital:

Dr. James Sherald
National Capital Regional Office
National Park Service
1100 Ohio Drive, SW
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