E-213-W

Ornamentals & Turf

Department of Entomology

DEVELOPING AN INTEGRATED PEST MANAGEMENT PROGRAM FOR NURSERIES

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GETTING STARTED

Integrated Pest Management (IPM) can help you produce healthy, marketable plants at a reasonable profit while using fewer and less toxic pesticide applications. With IPM you simply locate pest problems, assess the threat to crop health and appearance, and apply the appropriate pest control tactics when and where pests threaten plant marketability. Labor, however, is needed to inspect the crop on a regular basis. Costs associated with an IPM program can be reduced by concentrating your efforts on plants with pests that jeopardize your ability to meet customer demand. This bulletin guides you through the initial steps of a program, and provides you with helpful references.

Specific recommendations provided in this bulletin are based on experiences obtained during a pilot IPM program in northern Indiana nurseries that was jointly funded by Purdue University and the Indiana Department of Natural Resources. All parties involved in the program, especially the growers, participated in the development of this bulletin.

1. Define Your Management Objectives

Nursery crop production is a very complex operation. Hundreds of different species and cultivars must be managed to create an inventory of plant material of specific ages and heights. Some nurseries focus their efforts on just a small portion of the potential market for plant, whereas others diversify. Successful nurseries systematically review their production plans so they can respond to changing markets. IPM can be used to systematically allocate pest management resources in response to both fluctuating pest pressures and market needs. For example, it makes little sense to spend time and money controlling pests in a heavily harvested field of plants in late summer when the remaining plants will be destroyed to clear new ground during the following spring. In contrast, there is considerable reason to invest in a block of plants at the peak of its value in the production cycle. Knowing the value of the crop and the dollar return you need to get from each field will help you make more appropriate management decisions.

2. Think Big and Start Small

Restrict IPM activities to a few fields during the first year of your IPM program. This will give you the experience and the confidence you need to expand the approach to the rest of your operation.

3. Map Fields

Most nurseries already have a system for keeping track of the location and age of plant material. In the pilot Indiana IPM program we asked nursery managers to give each field a name and assign numbers or letters to blocks of plants separated by drive lanes within each field. Some nurseries fill each block with only one cultivar of a plant species. Others group plants in a block by plant genus, or species. Whatever your planting scheme, the map must be able to identify the part(s) of your nursery that need attention. In this way you can direct a spray rig or pruning crew to treat only the areas with specific problems.

4. Monitor and Keep Records of Pest Activity and Control Actions

Institute a regular schedule for plant inspection. In Indiana, we recommend scouting in the dormant season and then every two weeks from April through September (See section on scouting guidelines).

Make a standard IPM observation form. Record your information on a standardized observation sheet (See figures 1 and 2). Filing these forms by date will help you trace pest histories and determine effectiveness of pest control actions.

5. Decide If Action Is Needed

Pests only need to be controlled when they prevent you from meeting your marketing goals for a particular planting. Not all pest injury harms plant health. Injury that only affects plant appearance may not always hurt sales. For example, late summer defoliation of deciduous trees has a smaller effect on spring sales than a May defoliation.

When you detect early signs of insects, diseases, and weeds in your scouting program you can intervene before losses become considerable. Table 1 has been prepared to help determine whether the number of insects and mites you find are likely to cause problems. Consider this table an educated guess based on experiences from Indiana's pilot nursery IPM program. It is only a starting point. You will need to modify many of these action thresholds to better meet the specific needs of your nursery.

6. Choose a Management Tactic

Select tactics that are appropriate to the scale of your problem. This will help preserve natural enemies that are already present and feeding on pests. Consider non-pesticide management actions such as growing varieties resistant to common pests. When you regularly return to the field you do not need to use the longest lasting material because you have an opportunity to retreat problems after each round of scouting.

7. Evaluate Program Costs and Benefits

Break down costs into three categories: plant inspection, record handling, and pesticide application. This will identify where your program can be improved. It will also help you justify the expense of training programs or computer equipment.

Use past records to determine if your pest control methods have been effective. Ask yourself if your IPM program has helped you to meet or exceed the standards of plant quality set in your management objectives. Has there been an increase or decrease in the quantity of marketable plants produced? Compare current and previous pesticide usage to determine how it has changed since you started your program.

8. Use Past Records to Focus on Critical Problems

Use your IPM records to focus future pest management efforts and personnel training on critical problems. Past IPM programs have shown that most pest problems are caused by only a handful of pests. Identify these key pests by finding those which occurred most frequently. Similarly, you can benefit by determining problem prone plant cultivars and fields with serious problems.

PEST SCOUTING GUIDELINES

Nurseries in the Midwest employ a rich variety of growing methods. Plants can be grown in ground or in artificial media in containers. Crops are arranged in blocks that can be either small and diverse, or large and uniform. You need only record the problems you see, because at any given time most plants in the nursery are relatively problem free. These guidelines will provide a strategy for inspecting your fields when using the problem reporting form provided in this bulletin (See figures 1 and 2). Filing these forms by date and by field, or by container bay will enable you to rapidly determine the history of problems you encountered in each location, how you attempted to solve them, and the effectiveness of your actions.

Insects

a. Small and diverse blocks of plants and containers

With the aid of maps, walk across fields or along container bays and examine 10 plants of each variety you encounter. When you find a problem use the **field name** and **block** to identify your general location and the plant name to identify where you are in your nursery. Write down the **problem name** and determine the **% infested** by dividing the total number of infested plants by 10, and multiplying that proportion by 100.

Use the 1-5 scale described at the bottom of the form to rate severity of pest problems on individual plants. Report the **pest rank** as the average rank of infested plants. This is determined by dividing the sum of the ranks of ***all*** infested plants by the number of infested plants present. For example, if you had 5 infested plants with a ranking of 2, 3, 4, 2 and 2, your average rank should be 13/5 or 2.6.

Identify 3 of the infested plants with a bright colored flag, and inspect them carefully to record the **average pest density** and indicate the **stages** (i.e., egg, or adult) of the pests that you find. Similarly, use the scheme described at the bottom of the sheet to assign a **natural enemy rank** to describe the potential that local natural enemies have to correct the problem. Several references are provided to help you identify natural enemies.

Flagged plants serve as sensitive indicators of pest status in a specific part of your nursery. Visiting these same flagged plants each time you scout should help you determine if pest problems improved or became worse since your last visit. Going back to these flags after a treatment will help you determine treatment effectiveness. Noting when and how you attempted to control each problem will help you plan for better control actions in the future.

b. Large uniform blocks of a single kind of plant

Managing plants in large uniform blocks (>1 acre, or >1000 pots) requires some changes in sampling techniques. Three widely spaced locations should be scouted in each of these blocks. Examine 10 plants at each of these 3 sites. Set up one group of indicator plants for each problem that you detect.

c. *Large block with many different varieties of the same plant species.*

Usually, this kind of planting can be managed as a single block because most plants have similar cultural requirements and similar pest complexes. Use pest outbreaks as opportunities to determine which plant varieties are resistant. After the peak of pest activity evaluate each variety for pest incidence by estimating % defoliation, or by assigning a standard rating. In Purdue's pilot program we have routinely done this evaluation for Japanese beetle and apple scab resistance in a field containing over 40 varieties of crabapples (see Sadof and Pecknold, 1997).

Diseases

For many diseases it is too late to implement a control tactic after you see visible disease symptoms in the field. Although disease spores can be counted, it simply takes too much work to be practical. Use the disease incidence you note with figure 1 to identify susceptible cultivars and the parts of the nursery with problems. Armed with this information you can target areas that could benefit by preventative management programs in future seasons.

Weeds

Although many species of weeds are present in the nursery, most problems are caused by just a few persistent perennials that are transported into landscapes in the root ball. In many nurseries this includes weeds such as quackgrass, mugwort, and Canada thistle. Management programs designed to control these key species are likely to keep other weeds to a tolerable level. Other nurseries, however, may have different problems. When you scout, identify the key species to determine the effectiveness of past management activities and to target future management activities. At a minimum, scout three times a year, after the spring transplanting rush (June 15), mid-summer (August 15), and in mid-fall (November 1).

Use the sample form (figure 2) to identify parts of the field where weeds are present. With the aid of a map, examine the entire block to determine the percent of the soil covered by of all weeds combined (= % cover). Then, list each weed contributing to 10% of the cover and identify if it is an annual, a winter annual, or a perennial. For each of these weeds identify the predominant stage of development and the average height. Finally, describe how the weeds you found are distributed in the field.

REFERENCES

Biological Control

Lee, J. C. and D. A. Landis. 2000. Natural Enemies in Your Garden: A Homeowner's Guide to Biological Control. Michigan State University Extension Bulletin E-2679

McCullough, D. G., S. A. Katovitch, D. L. Mahr, D. D. Neumann, C. S. Sadof, and M. J. Raupp. 1999. Biological Control of Insect Pests in Forested Ecosystems: A Manual for Foresters, Christmas Tree Growers, and Landscapers. Michigan State University Extension Bulletin E-2679

Diseases

Pecknold, P. 2000. Common Tree Diseases of Indiana. Purdue Cooperative Extension Service BP-63

Putnam, M. P. Pecknold, G. Ruhl, and K. Rane. 1992. *Disease Control of Ornamental Trees, Shrubs, and Ground Covers.* Purdue University Cooperative Extension Service Publication BP-33.

Sinclair, W., H.H. Lyon, and W. T. Johnson. 1987. *Diseases of Trees and Shrubs.* Cornell University Press, Ithaca, NY. ISBN: 0-8014-1517-9

General Pest Management

Dreistadt, S. H., J. K. Clark, and M. L. Flint. 1994. *Pests of Landscape Trees and Shrubs: An Integrated Pest Management Guide.* Publication 3359. University of California Division of Agriculture and Natural Resources. ISBN 1-879906-18-X

Lloyd, D. C. 1997. *Plant Health Care for Woody Ornamentals: A Professional's Guide to Preventing and Managing Environmental Stress and Pests.* International Society of Arboriculture, Savoy, IL. ISBN 1-883097-17-7.

Sadof, C.S. and P. Pecknold. 2000. *Crabapples Resistant to Apple Scab and Japanese Beetle in Indiana.* Purdue University Cooperative Extension Service Publication ID-217.

Insect and Mite Management

Johnson, W. T. and H. H. Lyon. 1994. *Insects that Feed on Trees and Shrubs* (3rd ed.). Cornell, University Press, Ithaca, NY. ISBN 0-8014-2602-2

Herms, D. and D. Shetlar. 1999. *Insect and Mite Control on Woody Ornamentals and Herbaceous Perennials.* Purdue University Cooperative Extension Service Publication E-41, or Ohio State University Extension Bulletin 504

Weeds

Kuhns, L. 1998. *Controlling Weeds in Nursery and Landscape Plantings.* Pennsylvania State University, Publications and Distribution Office, 112 Ag. Administration Bldg., University Park, PA 16802. Phone 812-865-6713.

Wax et. al., 1981. *Weeds of the North Central States.* North Central Regional Publication 281, Bulletin 772 University of Illinois, Urbana, IL.

Uva, R. H., J. C. Neal and J. M. DiTomaso. 1997. *Weeds of the Northeast.* Cornell University Press, Ithaca, NY. ISBN: 0-8014-3391-6

Websites

General Information:

P.L.A.N.T.: Purdue Landscape and Nursery Thesaurus <http://bluestem.hort.purdue.edu/plant/>

Identification, Biology and Control of Insects, Diseases, and Weeds:

Purdue University Plant and Pest Diagnostic Laboratory <http://www.ppdl.purdue.edu/ppdl>

Purdue University Landscape Entomology Laboratory <http://www.entm.purdue.edu/Entomology/research/cs/>

Disease Control in the Landscape <http://ohioline.ag.ohio-state.edu/b614/index.html>

New Jersey Agricultural Weed Gallery <http://www.rce.rutgers.edu/weeds/index.html>

Controlling Weeds in Nursery and Landscape Plantings <http://ohioline.ag.ohio-state.edu/b867/index.html>

Laminated Card Sets of Landscape Pests and Beneficial Insects <http://www.inhs.uiuc.edu/chf/outreach/bad2/guysframes.htm>

Biological Control News <http://www.entomology.wisc.edu/mbcn/mbcn.html

The Less Toxic Home Garden <http://www.centralsan.org/education/ipm/hgonlineguide.htm>

Weather: Degree Day Calendars, Forecasts, Frost Alerts

Insect and Mite Controls for Woody Plants and Herbaceous Perennials <http://ohioline.ag.ohio-state.edu/b504/index.html>

Purdue University Weather and Climate Information <http://www.agry.purdue.edu/weather.htm>

Electronic Access to Publications

Purdue University Cooperative Extension Service Bulletins Online <http://www.agcom.purdue.edu/AgCom/Pubs/index.html>

Sources for Scouting Supplies

Ben Meadows Company, 3589 Broad St., Atlanta, GA 30341; PH: 800-241-6401

Forestry Suppliers, Inc., P. O. Box 8397, Jackson, MS 39284-8397; PH: 800-360-7788

Gemplers, P. O. Box 270, 211 Blue Mounds Rd., Mt. Horeb, WI 53572; PH: 800-382-8473

Great Lakes, IPM, 10220 Church Rd., Vestaburg, MI 48891; PH: 517-268-5693

Insects Limited Inc., 10505 N. College Ave., Indianapolis, IN 46280-1438; PH: 317-846-3399

Pest Management Supply Co., P.O. Box 938, Amherst, MA 01004; PH: 413-253-3747

Scentry Inc., P.O. Box 426, Dept. MPI, Buckeye, AZ 85326-0090; PH: 602-233-1772

Trécé Inc., P. O. Box 6278, 1143 Madison Lane, Salinas, CA 93912; PH: 408-758-0204

Table 1. Approximate[1] insect and mite action thresholds for key insect and mite pests of woody plants in the nursery

This table should be used to conserve the marketable appearance of healthy plants, or to maintain the health of plants that are stressed by some other factor. Initiate an appropriate control tactic when an unacceptable number of plants reach the threshold value. These values assume that scouts will visit the plant within 2 weeks to reassess the situation. See text on how to determine numbers of trees that should be sampled from each variety, which plant species to scout, and time of year to look. Consult relevant extension bulletins to determine how and when each pest should be controlled. When pests of regulatory concern are encountered, contact your state agency (e.g., Indiana Department of Natural Resources). Consult the American Association of Nurserymen Regulatory Guide or your state agency to determine shipping requirements for receiving states.

Pest	Damage	Sampling Unit	Sampling Time[2]	Action Threshold[3]
Aphids (except on honeysuckle)	Leaf curl, shoot distortion sooty mold	10 growing shoots per plant	begining of flush growth	7 of 10 shoots each with 50 aphids
			peak of flush growth	7 of 10 shoots each with 150 aphids
			towards end of flush growth	treatment not usually needed
Aphids (honeysuckle witches' broom)	Shoot distortion, stunted twigs	whole plant	dormant	1 egg present at base of stunted twigs.
			when shoots actively growing	1 aphid presence and early and signs of distortion
Bagworm	defoliation	whole plant	Before young caterpillars emerge and new bags form	1 (for hand removal)
				10 bags (for sprays)
			After new bags have formed (Usually June 1)	10 bags (for sprays)
Borers (producing holes in bark thicker than a pencil lead)				
on shrubs	dieback	stem at soil	all year	2 holes with fresh sawdust per stem
young trees	dieback	trunk	all year	2 holes with fresh sawdust per tree
mature trees	dieback	trunk	all year	4 holes with fresh sawdust per tree

[1] Used for training scouts in pilot IPM program. Adjust thresholds to meet your needs.
[2] Consult Herms and Shetlar 1999, to time scouting activity.
[3] Consider doubling the threshold when natural enemies are common (ranking is at least 3 according to scale in Figure 1).

TABLE 1. (CONTINUED)

Table 1. Approximate[1] insect and mite action thresholds for key insect and mite pests of woody plants in the nursery (continued)

Pest	Damage	Sampling Unit	Sampling Time[2]	Action Threshold[3]
Bark beetles (producing holes in bark as thin or thinner than a pencil lead)	dieback	linear foot of trunk	all year	5 holes with fresh sawdust
Caterpillars (e.g., yellownecked caterpillar)	defoliation	4 branches	seasonal	20 caterpillars per branch
Elm leaf beetle	skeletonization	4 branches	seasonal	4 egg masses per branch 30 leaf feeding grubs per branch
Gall makers (e.g., Cooley's spruce gall adelgid)	distorted abnormal growth	tree	dormant	10 galls per tree
Honeylocust plant bug	leaf distortion	5 clusters of 5 compound leaves on 4 branches	after bud break	1 live adult or immature per compound leaf (= 100 insects in 4 branch samples)
Japanese beetles	skeletonization	4 branches	during adult flight (check lindens starting in mid-June)	10 leaves with 3 beetles per leaf per branch
Lace bugs	leaf discoloration	4 branches	when spiny immature stages are seen under leaves	10 leaves with 10 immatures per leaf per branch
Leaf miners	leaf discoloration	4 branches	when leaves expand	10 mined leaves per branch
Leaf notching weevils	leaf notching girdling	whole shrub	June - July	5 new notches per shrub
Migratory leaf hoppers (on red maples) (other trees)	leaf distortion usually not a problem	4 branches	June - July	3 leaf hoppers per shoot per branch (=12 insects in 4 branch samples)
Pear slug	skeletonization	4 branches	when larvae feed	5 larvae per branch

[1] Used for training scouts in pilot IPM program. Adjust thresholds to meet your needs.
[2] Consult Herms and Shetlar 1999 to time scouting activity.
[3] Consider doubling the threshold when natural enemies are common (ranking is at least 3 according to scale in Figure 1).

TABLE 1. (CONTINUED)

Table 1. Approximate[1] insect and mite action thresholds for key insect and mite pests of woody plants in the nursery (continued)

Pest	Damage	Sampling Unit	Sampling Time[2]	Action Threshold[3]
Pine sawflies	defoliation	tree	half-inch long candles	2 larval clusters per tree
Scales (Armored)	branch dieback leaf discolor	10 shoots	all year	10 live scales per inch of shoot
Scales (Soft)	branch dieback leaf discolor sooty mold	10 shoots	all year	10 live scales per inch of shoot
Shoot borers on conifers	shoot dieback	whole tree	spring	1 infested terminal leader, or 5 infested shoots per foot of tree height
Spider mites				
cool season (Average evening temperature <60ºF)	leaf discoloration	beat 4 branches over white paper	spring/fall	24 mobile mites/beat
warm season (Average evening temperature >60ºF)	leaf discoloration	beat 4 branches over white paper	summer	24 mobile mites/beat
Twig chewing weevils on conifers (pales and Northern pine)	shoot dieback	whole tree	spring/fall	1 infested terminal leader, or 5 infested shoots per foot of tree height
Web makers				
Eastern tent caterpillar	defoliation	tree	April	1 nest
Fall webworm	defoliation and webs	tree	July-August	1 nest
Mimosa webworm	browned leaves	tree	First generation Second generation	5% of canopy browned 10% of canopy browned
Zimmerman pine moth	dieback and pitch mass	tree	May-October	1 wound with fresh sawdust

[1] Used for training scouts in pilot IPM program. Adjust thresholds to meet your needs.
[2] Consult Herms and Shetlar 1997, pages 27-28, to time scouting activity.
[3] Consider doubling the threshold when natural enemies are common (ranking is at least 3 according to scale in Figure 1).

Figure 1. Nursery Integrated Pest Management Problem Reporting Form — Insects and Diseases

Scouting Date / / Nursery Field Scout Name

Field or container bay	Block	Plant Name	Pest Name	Infest (%)[1]	Pest. Rank[2]	Average Density no.	Average Density unit[3]	Stage(s) Present[4] Pest/NE	Natural Enemy Rank[5]	Natural Enemy Type(s)[6]	Action Taken	Appl. Date
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Comments _____

[1a] Percent of inspected plants that are infested with pests

[2]Ranking of Pest Intensity (Avg. of infested plants)
1 = Pest is absent.
2 = Pest is present, but not a problem.
3 = Pest will soon affect plant appearance.
4 = Pest will soon affect plant health.
5 = Pest has killed plant.

[3]Sampling unit
Branch, Shoot,Leaf,Trunk, Whole plant

[4]Pest (P) and Natural Enemy (NE) Stages
Egg
Immature (= nymph or larva)
Pupa
Adult

[5]Ranking of Natural Enemy (NE) Abundance
1 = NEs are absent.
2 = NEs detected, but unlikely to control problem
3 = NEs common, likely to conserve plant health.
4 = NEs abundant, likely to maintain plant appearance.
5 = NEs have already prevented damage.

[6]Type of Natural Enemy Present (enter letter code)
Flowerfly, Fun**G**al disease, Lace**W**ing, **L**ady beetle, **P**arasitoid, **, V**irus, Predatory **B**ug, Predatory **M**ite, Preying Ma**N**tid, **S**pider, **V**irus, **O**ther_____

Figure 2. Nursery Integrated Pest Management Problem Reporting Form - Weeds

Scouting Date / / Nursery Field Scout Name

Field or container bay	Block	% total[1] weed cover	Weeds in field	% [2]of weed mix	Type[3]	Development [4] stage	Height[5] (Avg)	Within-block Distribution[6]	Action Taken	Date
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Comments

[1] **Percent of ground covered with weeds to nearest 10%**
[2] **Percent of weed cover to nearest 10 %**
[3] **WA= Winter Annual, A= Annual, P=Perrenial**
[4] **Seedling, vegative, flowering, or seed head**
[5] **Average height of weeds , ‘= feet, “= inches.**
[6] **Note if weed problem is uniformly distributed or identify location of problem areas.**

SCOUTING TIPS

• Carry these items when you scout.

◊ **Pocket knife and pruning shears**
Field diagnosis of some diseases can be diagnosed by cutting twigs and pealing back bark. Pruners are also handy when specimens need to be sent of for lab diagnosis.

◊ **Hand magnifying lens**
Insects, mites and fruiting bodies of diseases can be fairly small. Purchase a 10 X collapsible hand lens that can easily fit in your pocket or on a string.

◊ **Hand held tally meter**
These hand held counters allow you keep track of the number of insects or trees you sample while scouting.

◊ **Flagging tape and wire flags**
Use unique colored tape to mark the plants you use to track pest numbers. (see p. 2 Pest Scouting Guidelines - Insects)

◊ **Scouting forms and clipboard.**
Forms (figures 1 and 2) help you write concise notes. Use backs of forms to catch pests when sampling for spidermites.

• Concentrate on plants that are likely to have pest problems.

Learn when pests are active and which plants they attack. A table of insect and mite activity has been prepared to help guide your scouting emphasis during your first season (See pages 27-28 in Shetlar 1997). As your program develops, use your monitoring records to help predict where and when pests are likely to be active.

• Use readily available sampling tools to determine stage and extent of pest populations.

◊ ***Beating sticks, clip boards and collection sheets***
Tap the branches of a plant with a stick over a white collecting surface to knock off pests that are nestled in leaves and bark. This is especially useful for small pests such as spider mites, scale crawlers, thrips, and some leaf hoppers. After pests are identified with a magnifying hand lens, the population can be estimated by counting the number of moving insects on a collecting sheet.

◊ ***Sex pheromone traps***
These traps are baited with a scent that attracts only the males of a species. They are critical for timing the controls of several pests, including clearwing borers (lilac, ash, dogwood, peachtree, etc.), Nantucket and European pine shoot moths, and bark beetles. Place traps near plants that are likely to be attacked by these insects. Two trapping stations for each pest would probably be enough for each landscape firm or nursery to assess populations in their management area.

◊ ***Trap logs and trap disks***
Placing freshly cut disks of pine logs will attract pests that can readily be counted.

Revised 6/2001