2017
Cornell Pest Management Guide for Commercial Production and Maintenance of Trees and Shrubs

Cornell University
Cooperative Extension

These guidelines are not a substitute for pesticide labeling. Always read and understand the product label before using any pesticide.

1 Pesticide Information

1.1 Pesticide Classification and Certification

The Federal Insecticide, Fungicide and Rodenticide Act (FIFRA) created two classifications of pesticides – general-use and restricted-use. **General-use pesticides** may be purchased and used by anyone. **Restricted-use pesticides can** only be purchased by a certified applicator. Restricted-use pesticides must also be used by a certified applicator or someone under their supervision.

The same federal law that classifies pesticides divided applicators into two groups: private and commercial. **Private applicators** use or supervise the use of pesticides to produce agricultural commodities or forest crops on land owned or rented by the private applicator or their employer. A farmer must be certified as a private applicator in order to purchase and use restricted-use pesticides on agricultural commodities. (No certification is needed if a farmer does not use restricted-use pesticides.)

A **commercial applicator** uses or supervises the use of pesticides for any purpose or on any property not covered by the private applicator classification. In New York, a commercial applicator must be certified to purchase or use any pesticide whether it is general- or restricted-use.

More information about pesticide certification and classification is available from your Cornell Cooperative Extension office (cce.cornell.edu/localoffices), regional NYSDEC pesticide specialist (www.dec.ny.gov/about/558.html), the Pesticide Applicator Training Manuals (store.cornell.edu/c-876-manuals.aspx), or the Pesticide Management Education Program (PMEP) at Cornell University (psep.cce.cornell.edu).

1.2 Use Pesticides Safely

Using pesticides imparts a great responsibility on the user to be a good steward of their health and that of others. Keep in mind that there is more to "pesticide use" than the application. Pesticide use includes mixing, loading, transporting, storing, or handling pesticides after the manufacturer's seal is broken; cleaning pesticide application equipment; and preparation of a container for disposal. All of these activities require thoughtful planning and preparation. They are also regulated by state and federal laws and regulations intended to protect the user, the community, and the environment from any adverse effects pesticides may cause.

1.2.1 Plan Ahead

Many safety precautions should be taken *before* you actually begin using pesticides. Too many pesticide applicators are dangerously and needlessly exposed to pesticides while they are preparing to apply them. Most pesticide accidents can be prevented with informed and careful practices. **Always read the label on the pesticide container before you begin to use the pesticide.** Make sure you understand and can follow all directions and precautions on the label. Be prepared to handle an emergency exposure or spill. Know the first aid procedures for the pesticides you use.

1.2.2 Move Pesticides Safely

Carelessness in transporting pesticides can result in broken containers, spills, and contamination of people and the environment. Once pesticides are in your possession, you are responsible for safely transporting them. Accidents can occur even when transporting materials a short distance. You are responsible for a pesticide accident so take every effort to transport pesticides safely. Be prepared for an emergency.

1.2.3 Personal Protective Equipment and Engineering Controls

Personal protective equipment needs depend on the pesticide being handled. **Required personal protective equipment (PPE) are listed on pesticide labels.** These requirements are based on the pesticide's toxicity, route(s) of exposure, and formulation. Label PPE requirements are the minimum that must be worn during the pesticide's use. Pesticide users can always wear more protection than the label requires.

The choice of protective equipment depends on the activity, environment, and handler. The type and duration of the activity, where pesticides are being used, and exposure of the handler influences the equipment you should use. Mixing/loading procedures often require extra precautions. Studies show you are at a greater risk of accidental poisoning when handling pesticide concentrates. Pouring concentrated pesticide from one container to another is the most hazardous activity. More information on personal protective equipment can be found online at umes.edu/NC170/Default.aspx?id= 7184.

Engineering controls are devices that help prevent accidents and reduce a pesticide user's exposure. One example is a closed mixing/loading system that reduces the risk of exposure when dispensing concentrated pesticides. More information on engineering controls can be found online at umes.edu/NC170/Default.aspx?id=7196.

1.2.4 Avoid Drift, Runoff, and Spills

Pesticides that move out of the target area can injure people, damage crops, and harm the environment. Choose weather conditions, pesticides, application equipment, pressure, droplet size, formulations, and adjuvants that

2 Insect and Mite Pest Management of Trees and Shrubs

2.1 Introduction

More species and cultivars of ornamental plants are grown in nurseries and in the landscape than all other kinds of cultivated crops combined. While this is a statement of pride among ornamental horticulturists, it is likewise true that an even greater number of pest species find these plants and use them as food, causing an expenditure of time and dollars in added maintenance costs.

Concise pesticide guidelines are given in this publication for managing more than 150 species of insects and mites on over 50 kinds of ornamental trees and shrubs which grow in the four plant zones of New York. Practical and effective control of insects and mites that attack ornamental trees and shrubs can be achieved by recognizing the pests, understanding their life histories, and using a skillfully planned integrated pest management (IPM) program.

IPM goes beyond the use of chemical pesticides and includes every means of pest control that may be applied under a given set of circumstances. Useful pest control techniques must be compatible, so IPM programs may vary from nursery to nursery or landscape to landscape and may require professional assistance to organize and maintain. What follows are but fragments of the IPM concept.

2.2 How to Use the Insect and Mite Chapter

This chapter is divided into the following sections:

- 2.5 Text on Biorational Pest Management Tools and Tactics
- 2.6 Text on Chemical Insecticides
  - mode of action
  - phytotoxicity
  - timing of application
  - formulation
  - systemic insecticides
  - best management practices for soil application
  - oil sprays
  - shelf life
  - pesticide adjuvants
  - mist blowers
- 2.7 Registered Insecticides and Acaricides Table – arranged by active ingredient
- 2.8 Insects and Mites Destructive to Woody Ornamentals – arranged by host plant
- 2.9 Pest Management Timing - arranged by month/season with growing degree day (GDD) and plant phenology information (PPI)
- 2.10 Insect and Mite Pest Management – arranged by pest with IPM information, management options, and application timing

2.3 About the Tables

Sections 2.6 and 2.8 contain lists and tables that permit quick access to a mass of pest management information. Be certain that you understand the footnotes and how to use these tables. To assist in diagnosis (identification) of a pest, first look at Table 2.8.1. Find the plant of concern, then note the common or "key" pests associated with the plant. Numbers following the names of pests correspond to pages with descriptions in *Insects That Feed on Trees and Shrubs*, second edition, published by Cornell University Press. Plate numbers showing illustrations are indicated in boldface type.

Next, turn to Table 2.10.1, remembering the name of the suspect pest. Entries for each pest include signs and/or symptoms of infestation, management options, timing of treatment, and IPM considerations. If you are interested in the characteristics of a particular pesticide-what it will control, formulations available, EPA numbers, nursery versus landscape uses, restricted-entry intervals, phytotoxicity, and other precautions-see Table 2.7.1.

The proper biological timing of control measures for each pest in each locality can be achieved through experience, by using the growing degree-day system, or by phenological indicator plants (see Table 2.9.1). Keep a record of treatments and schedules used from year to year to accumulate seasonal experience for spraying. Records of normal growth phenomena such as bud development and flowering are useful in documenting the proper time for treatment in your geographical area.

2.4 Insect and Mite Control for Propagation Ranges, Greenhouses, and Perennials

Control of insect and mite problems for interior use in greenhouses, arboreta, and interiorscapes as well as herbaceous perennials are covered in the *Cornell Guide for the Integrated Management of Greenhouse Crops and Herbaceous Perennials*. This publication is available in print and online formats through the Cornell Store at Cornell University (844-688-7620 or online at: https://store.cornell.edu/c-875-pmep-guidelines.aspx).

2.5 Biorational Pest Management Tools and Tactics

2.5.1 "Biorational" Controls

Biorational tactics begin with cultural and mechanical practices such as diverse cropping, crop rotation, and roguing of sick plants. Traps using food baits, light, and color as attractants can be useful. These methods may not stand alone, however, and additional tactics for control may

Examples include Lindgren funnel traps baited with alpha-pinene and ethanol or frontalin for bark beetles, yellow sticky panels that attract fungus gnats and whiteflies, and pitfall traps or trap boards for black vine weevils.

Insect growth regulators (IGRs) were first recognized as useful with the discovery of the juvenile hormone biochemicals in insects. Some plants even use this chemistry as a form of protection. IGRs act on the hormonal system of immature insects; they generally do not kill adult insects and have a delayed effect. Therefore, timing applications to coincide with early immature stages is important and one should not expect to see immediate control. Treated insects may stop feeding, however. At least three major groups of IGR insecticides are now in use. *Juvenile hormone mimics* act like natural juvenile hormone in insects, the presence of which ensures that the next molt will be to another immature (larval) stage in treated insects. Affected insects usually do not reach adulthood or die while molting to the next larval stage. The insecticide pyriproxyfen (Distance) is a juvenile hormone mimic. *Chitin biosynthesis inhibitors* interfere with the production of chitin, an essential component of the insect shell or skin. Insects affected by these materials are not able to molt successfully. Novaluron and diflubenzuron are members of this group that primarily target butterfly and moth caterpillars, although they are also used for other kinds of insects. Diflubenzuron (Dimilin), for example, is used against early stages of gypsy moth and other caterpillars and also has some ovicidal activity. Cyromazine (Citation) is another kind of chitin biosynthesis inhibitor, disrupting molting of fly larvae such as serpentine leafminers. A third group called *ecdysone agonists* or *ecdysone antagonists* disrupt molting by interference with the normal operation of ecdysone, a hormone important in the insect molting process. Treated insects may not be able to emerge normally. Azadirachtin (Azatin O, Azatrol, etc.) and tebufenozide (*†Confirm) are in this category. Derived from neem seed oil, azadirachtin has been used for thousands of years but only recently commercialized for horticulture in this country. It has some systemic activity when applied to roots and Ornazin is also labeled for trunk injection, although azadirachtin is primarily a foliar insecticide.

Some pesticides are microbes or derived from them. *Bacillus thuringiensis kurstaki* (Btk) bacteria produce a protein crystal endotoxin that disrupts the gut of butterfly and moth caterpillars. Formulations of the endotoxin are important insecticides used on ornamentals, vegetables, and other plants. Abamectin and spinosad are derived from the soil microorganisms *Streptomyces avermitilis* and *Saccharopolyspora spinosa*, respectively. Several commercial preparations are available that consist of spores of the insect-killing fungi *Beauveria bassiana*, *Metarhizium anisopliae*, or *Isaria fumosoroseus*. Successful use of microbial pesticides requires detailed knowledge of the pest's biology and phenology and its relationship to its host plant(s). When this knowledge is used in planning, effectiveness can approach that of synthetic organic pesticides in some cases. Some IPM specialists include **horticultural mineral oils and insecticidal soaps** as biorational pesticides. Both are environmentally friendly in spray dilutions and degrade quickly.

Remember that most ornamental plants in urban and nursery settings are growing in an artificial, contrived environment. Left on their own many of them could not compete and would not survive. Selection often results in the propagation of plants not suitable to the truly natural environment. Such plants generally require more maintenance, including pest management, and in effect are dependent on a range of horticultural inputs.

2.6 Insecticides

2.6.1 Insecticide Classes and Modes of Action

Insecticides fall into *chemical classes* or groups such as,neonicotinoids, diamides, organophosphates, carbamates, pyrethroids, etc. For pests prone to develop insecticide-resistant populations, importance was, at one time, placed on rotating among them as one tactic to manage pesticide resistance. Sometimes materials in two different classes control pests in the same way, so now emphasis is placed on rotating among insecticides with different *modes of action*. To help simplify choosing among rotational partners,, the Insecticide Resistance Action Committee (IRAC) has developed a **Mode of Action classification** system, outlined on a chart at http://www.irac-online.org/modes-of-action/. Some labels now include IRAC numbers representing the material's mode of action group to help users in selecting among products.

2.6.2 Phytotoxicity of Insecticides

Some plants are sensitive to certain pesticides or combinations. The label will usually name plants or incompatible pesticide tank mixes where the product should not be used. Dimethoate is one of the more variable chemicals, causing foliage injury on elm, andromeda, some varieties of azaleas but not others, Burford and Chinese (but not Japanese) holly, honeylocust, dogwood, crabapple, and maple. Carbaryl may injure tender foliage if plants are wet when treated or present on foliage during several days of high humidity. Malathion may injure certain junipers, elaeagnus, hibiscus, and some rose varieties. Avid (abamectin) has injured some Shasta daisy cultivars and should not be applied to ferns. These few examples emphasize the importance of reading the label. Check Table 2.7.1 for additional information on specific products.

2.6.3 Timing Spray Applications

Pest biology and behavior affect the timing and frequency of applications. For example, birch leafminer adults emerge from the soil to lay eggs in foliage over an extended period of time. Control treatments to kill newly hatched larvae in

Table 2.7.1. Host plant guide to insect names: an aid to diagnosis and identification

Plant	Pest	Page No.	Plate No.
Andromeda	azalea bark scale	336	**160**
	azalea whitefly	318	**151**
	lace bugs	424	**204**
Apple (flowering crab)	aphids	296, 300, 316	**150**
	cankerworms	142, 44	**63, 64**
	leafhoppers	412–418	**216-218**
	leafrollers	172	**100, 101**
	oystershell scale	370	**177**
	redbanded leafroller	214	
	roundheaded appletree borer	278	**131**
Arborvitae	arborvitae leafminer	142	**14**
	arborvitae weevil	240	**244**
	bagworm	176	**80**
	black vine weevil	240	**112, 113**
	Fletcher scale	98	**42**
	gypsy moth	138, 140	**61, 62**
	hemlock looper	24	
	juniper scale	106	**46**
	spruce spider mite	118	**52, 53**
Ash	blackheaded ash sawfly	134	**59**
	lace bugs	426	
	lilac/ash borer	260	**122**
	oystershell scale	370	**177**
Azalea	azalea bark scale	336	**160**
	azalea leafminer	202	**93**
	azalea whitefly	318	**151**
	black vine weevil	240	**112, 113**
	fruittree leafroller (azalea leaftier)	172	
	lace bugs	424	**204**
	rhododendron borer	258,	**121**
	rhododendron stem borer	288	
	southern red mite	475	**229**
	twobanded Japanese weevil	244	**114**
Barberry	twobanded Japanese weevil	244	**114**
Beech	aphids	296, 310	**140, 147**
	cankerworms	142–144	**63, 64**
	woolly beech aphid	296	**140**
Birch (white, gray, yellow, and European white)	aphids	296, 310	**140, 147**
	birch leafminer	184	**84**
	birch skeletonizer	220	
	bronze birch borer	272	**128**
	European hornet	494	**238**
	potato leafhopper	414	**199**
Bittersweet	euonymus scale	388	**186**
Boxwood	boxwood leafminer	204	**94**
	boxwood mite	475	**229**
	boxwood psyllid	290	**137**
Butternut	butternut gall mite	488	**235**
	walnut caterpillar	150	**67**
Cedar	arborvitae weevil	240, 244	**244**
	bagworm	176	**80**
	spruce spider mite	118	**52, 53**

Table 2.8.1. Pest management timing by calendar, growing degree-day (GDD), and plant phenology indicator (PPI)

Host	Pest	Stage	GDD (Base 50°F)
June (mid-): Plants in bloom: mountain laurel, mock-orange, Japanese tree lilac, Washington thorn			
Arborvitae	arborvitae leafminer	adult	533–700
	bagworm	larva	600–900
	juniper scale	crawlers	707–1260
Azalea	azalea leafminer	moth/egg	450–800
	azalea whitefly	immature/adult	448–700
	lace bug	immature	448–618
	rhododendron stem borer	adult	298–802
Beech	woolly beech aphid	nymph/adult	363–707
Birch	birch leafminer	adult	530–700
	bronze birch borer	adult	440–800
Bittersweet	euonymus scale	crawler	533–600
Boxwood	boxwood leafminer	adult	350-600
	boxwood mite	adult	245–600
Butternut	walnut blister mite	adult	363–707
Deciduous plants	aphids	immature/adult	250–2800
Deciduous plants (most)	leafhoppers	immature/adult	618–802
	rust mite	immature/adult	533–802
Dogwood	dogwood borer	moth	148–700
Elm	elm leaf beetle	egg/larva	363–912
	European red mite	immature/adult	240–810
	twospotted spider mite	immature/adult	363–618
	woolly aphid	immature	710–1500
Euonymus	euonymus scale	crawler	533–600
Evergreens (broadleaf)	southern red mite	immature/adult	618–802
Flowering fruit trees	European red mite	immature/adult	240–810
	leafhoppers	immature/adult	618–802
	twospotted spider mite	immature/adult	363–618
	hawthorn leafminer	adult	NA
Hemlock	elongate hemlock scale	crawler/immature	360–700
	hemlock looper	larva	448–707
Holly	southern red mite	immature/adult	618–802
Juniper	arborvitae leafminer	adult	360–?
	juniper scale	crawler	707–1260
Lilac	lilac borer	moth	400 approx.
	oystershell scale	crawler	363–707
	white peach scale = prunicola scale	crawler	707–1151
Linden	twospotted spider mite	immature/adult	363–618
Magnolia	sassafras weevil	adult/egg	363–618
Maple	greenstriped mapleworm	larva	533–1645
Mountain ash	mountain ash sawfly	larva	448–707
Mountain laurel	azalea whitefly	immature/adult	448–700
	rhododendron stem borer	adult	298–802
Oak	golden oak scale	crawler	NA
	kermes oak scale	crawler	298–912
	leafminers	moth/egg	533–912
	oak skeletonizer	larva	448–707
Pachysandra	euonymus scale	crawler	533–820

Table 2.9.1 Insect and mite management[1]

NOTE: See Table 2.10.1 for pesticide trade names containing the active ingredients noted below. Where a specific product is listed after a recommended pesticide, only that product is labeled for that use. Always confirm that the site you plan to treat and the pest you wish to control are listed on the label before using any pesticide.

Symbols Used: * = Restricted-use pesticide; *[F] = indicates a federally restricted-use pesticide. † = Not for use in Nassau and Suffolk Counties. 🐝 = Active ingredient meets EPA criteria for acute toxicity to bees.

Arborvitae leafminers (14), *Argyresthia* sp. (moth)

Plant abnormalities:	Tips of shoots and foliage turn yellow then brown.
Management options:	Many effective larval and pupal parasites. Soil application of systemic insecticides (🐝imidacloprid), foliar sprays to control larvae (🐝acephate##), or moths (🐝bifenthrin, 🐝chlorpyrifos, 🐝lambda-cyhalothrin, 🐝permethrin, 🐝spinosad). Trunk injection (🐝emamectin benzoate). ##2(ee) recommendation of *Acephate 97 UP for use on unlabeled pest. The 2(ee) recommendation must be in the applicator's possession when using *Acephate 97 UP for control of arborvitae leafminer. See 2(ee) at http://www.dec.ny.gov/nyspad/products.
When to treat:	Soil application with 🐝imidacloprid to control larvae in early spring. Acephate foliar spray for larvae: mid-May, 150-260 GDD. Again mid-August, 1800-2200 GDD. Treat moth stage: mid-June, 533-700 GDD.
IPM considerations:	Parasites usually not abundant in specimen trees. For sprays, two applications may be required for first year of treatment; one application of spinosad during early moth flight has provided good control in one trial. If infestation is light, prune out infested tips.

Azalea bark scale (160), *Eriococcus azaleae* (felt scale)

Plant abnormalities:	Honeydew and sooty mold, yellowing leaves and dieback.
Management options:	One important chalcid wasp parasite. 🐝Acephate, 🐝acetamiprid (8.5SL, trunk spray or injection), 🐝carbaryl, 🐝cyfluthrin, horticultural oil, insecticidal soap, 🐝lambda-cyhalothrin, 🐝malathion.
When to treat:	Delayed dormant. Again late June to late July, PPI-*Rhododendron maximum*, *Philadelphus*.
IPM considerations:	Crawlers tend to settle in twig crotches, bark crevices, and axils of leaves. Hosts include azalea, rhododendron, and andromeda.

Azalea leafminer (93), *Caloptilia azaleella* (moth)

Plant abnormalities:	Brown blotch leaf mines and leaves tied together with silk.
Management options:	Pesticides used mostly to control larvae. Parasites not capable of reducing populations to an acceptable level. 🐝Abamectin, 🐝carbaryl, 🐝dimethoate, 🐝imidacloprid (soil application), 🐝permethrin.
When to treat:	June, 450-800 GDD, PPI-Kousa dogwood, beautybush. Again in late July for second generation, 1260-1500 GDD, PPI-Abelia, sourwood. 🐝Imidacloprid soil application in spring.
IPM considerations:	Do not apply sprays when in flower. Older larvae feed externally, tying leaves together with silk. Rake and destroy fallen leaves.

Azalea lace bug (204), *Stephanitis pyrioides* see Lace bugs

Azalea whitefly (151), *Pealius azaleae*

Plant abnormalities:	Honeydew and sooty mold, discolored foliage, yellowish mottle.
Management options:	Large populations require use of pesticides. 🐝Bifenthrin, 🐝chlorpyrifos, 🐝cyfluthrin, 🐝diazinon, 🐝dimethoate, flonicamid, 🐝fluvalinate, horticultural oil, 🐝imidacloprid, 🐝lambda-cyhalothrin, 🐝malathion, neem oil, spirotetramat (Kontos).
When to treat:	Sprays early June, mid-July, 448-700 GDD. Again in mid-August, 1250-1500 GDD, and again at 2032-2150 GDD. PPI-mt. laurel, mock-orange. 🐝Imidacloprid soil application in early spring.
IPM considerations:	Whitefly feeds on undersurface of leaves on azalea, rhododendron, mt. laurel, and andromeda. Most insecticides control both adults and immatures. Resistant azalea varieties are available.

Bagworm (80, 81), *Thyridopteryx ephemeraeformis* (moth)

Plant abnormalities:	Sparse foliage; spindle-shaped bags attached to twigs/foliage.
Management options:	Several parasitic insects present in most bagworm populations, but rarely an acceptable means of control. 🐝Acephate, *Bacillus thuringiensis* subsp. *kurstaki*, 🐝bifenthrin, 🐝carbaryl, chlorantraniliprole (1.67SC spray), 🐝chlorpyrifos, 🐝cyfluthrin, 🐝diazinon, diflubenzuron, 🐝dimethoate (juniper, arborvitae), 🐝emamectin benzoate (trunk injection or spray), flubendiamide, 🐝fluvalinate, 🐝gamma-cyhalothrin, 🐝indoxacarb, 🐝lambda-cyhalothrin, 🐝malathion, 🐝permethrin, 🐝spinosad, tebufenozide (Christmas trees).

Table 2.10.1. Insecticides and acaricides registered for ornamental trees and shrubs

Symbols Used: * = Restricted-use pesticide; *F = indicates a federally restricted-use pesticide. † = Not for use in Nassau and Suffolk Counties. 🐝 = Active ingredient meets EPA criteria for acute toxicity to bees.

Active Ingredient (*Mode of Action Group*)[A] Trade Name(s), Formulation, and Company	EPA Reg. No.	Organic Listed[B]	Use‡	REI§ (hrs.)	PPE *Applicator*	PPE *Early Entry*
Acequinocyl (*20B*)						
Shuttle 15SC (Arysta)	66330-38	–	N, L	12	acf	cfk
Shuttle O (15SC, OHP)	66330-38-59807	–	N, L	12	acf	cfk
Reduced-risk miticide for twospotted and spruce spider mites in landscapes, interiorscapes, nurseries, shadehouses and greenhouses. Test first before use on miniature roses or impatiens. Toxic to aquatic invertebrates; do not apply within 75 feet of aquatic areas. Store in a dry place away from heat. Do not mix with phosethyl fungicides (Alliette, Avalon, Chipco Signature, Flanker, Fosetyl-Al).						
🐝**Acetamiprid (*4A*)**						
TriStar 30SG (Cleary)	8033-94	–	N. L	12	abcj	bck
*TriStar 8.5SL (0.76SL)	8033-106-1001	–	N, L	12	acf	cfk
Reduced-risk insecticide labeled as a spray for control of aphids, adelgids, European pine sawfly, caterpillars, leafminers, mealybugs, leafhopper, plant bugs, psyllids, scale insects, whiteflies and certain other pests on greenhouse and outdoor ornamentals and vegetable transplants. 8.5SL formulation in NY labeled as a basal bark spray or injection for ornamental or non-bearing fruit and nut trees to control borers, scale insects and hemlock woolly adelgid. Translaminar activity; addition of a spreader-type adjuvant may improve control. Maximum four (SL) or five (SG) applications/year. Toxic to wildlife, very toxic to bees exposed to direct treatment. Store cool and dry. Not for use in woodlands or forest management.						
🐝**Azadirachtin (*18B*)**						
Azatin O 4.5% (0.34EC, OHP)	70051-9-59807	OMRI	N, L	4	acfh	cfkh
Ornazin 3% EC (SePro)[3]	5481-476-67690	–	N, L	12	acfh	begh
Molt-X (3% EC, BioWorks)[1]	68539-11	–	N, L	4	acf	acf
Azatrol EC (1.2%, PBI Gordon)	2217-836	OMRI	N, L	4	abc	bck
Amazin Plus 1.2% ME (Amvac)	5481-559	OMRI	N, L	4	abc	bcd
Aza-Direct (1.2%, Gowan)	71908-1-10163	OMRI	N,L	4	acf	cfk
*TreeAzin (5%, BioForest)[3]	82996-1	OMRI	L	NA	acfh	
AzaSol (6% WSP, SoluNeem)	81899-4	–	N, L	4	acf	acf
AzaGuard (0.28EC), BioSafe Systems)	70299-17	–	N, L	4	abc	abc
Insect growth regulator; biopesticide. Controls immature stages. Toxic to fish and aquatic invertebrates. Do not mix with Bordeaux mixture, lime sulfur, triphenyl tin hydroxide or other alkaline materials. Do not store near heat or open flame [1]Do not store above 100°F or below -20°F. [2]Buffer water to pH 3-7. [3]Label includes use as a trunk injection.						
***Bacillus thuringiensis* subsp. *aizawai* (*11A*)**						
Xentari DF (Valent Biosciences)	73049-40	OMRI, NOP	N, L	4	abcl	bck
Agree WG (Certis)	70051-47	OMRI, NOP	N, L	4	abcl	bck
Biopesticide. Contains spores and crystalline endotoxin. Labeled for certain caterpillar pests of forest and shade trees and ornamentals.						
***Bacillus thuringiensis* subsp. *galleriae* (*11A*)**						
beetleGONE!tlc (76.5% WDG, Phyllom)[1]	88347-3	NOP	N, L	4	abcl	bck
grubGONE!G (9% WDG, Phyllom)[2]	88347-2	–	N, L	4	abcl	bck
Biopesticide. Contains spores and crystalline endotoxin. Labeled for control of Japanese, oriental, Asiatic garden, green June and other scarab beetle adults[1] or grubs[2]. Works through ingestion, not on contact. Can be applied on or around ornamental plants in landscapes, field and container nurseries.						
***Bacillus thuringiensis* subsp. *kurstaki* (*11A*)**						
Dipel Pro DF (Valent Biosciences)[1]	73049-39	OMRI, NOP	N, L	4	abcl	bck
Javelin WG (Certis)	70051-66	OMRI, NOP	N, L	4	abcm	bck
Crymax (Certis)	70051-86	–	N, L	4	abcl	bchk
Foray 48B Flowable Concentrate (Valent Biosciences)[1,2]	73049-427	OMRI, NOP	L	4	abcl	bck
Foray XG (Valent Biosciences)[1]	73049-427	–	L	NA	abcl	bck
Deliver Biological Insecticide (Certis)	70051-69	OMRI, NOP	N, L	4	abcl	bck
Biobit HP (WP, Valent Biosciences)[1]	73049-54	NOP	N, L	4	abcl	bck
Biopesticide. Contains spores and crystalline endotoxin that larvae with a high gut pH must ingest in sufficient quantity to provide control. For control of early-instar caterpillars of butterflies and moths, best shortly after hatching. Caterpillars stop feeding within about an hour of ingestion and die in two to three days. Several applications may be required. Will not control sawfly caterpillars (e.g., willow sawfly, pine sawflies). [1]Labeled for certain caterpillars on forest trees. [2]For aerial application only in forestry and area-wide pest treatments.						

3 Disease Management for Trees and Shrubs

3.1 General Measures for Disease Prevention

Because trees and shrubs live for many years, their susceptibility to disease is influenced not only by current climatic and environmental conditions but also by conditions and care during previous years. Maltreatment and lack of care favor many diseases.Many issues in nurseries and outplantings can be minimized by selection of proper planting sites, avoidance of unnecessary wounding, routine care including fertilization and timely watering and pruning, and preventive measures such as those described below.

Trees and shrubs on sites subject to deep soil freezing should be mulched to prevent root injury. Evergreens susceptible to unusual winter drying, such as those planted in exposed areas, should be treated with an antidesiccant.

Disinfect your tools regularly when pruning to control diseases. An easy, effective way to do this is to swab the cutting blades with an aqueous solution of denatured alcohol prepared by mixing 7 parts alcohol with 3 parts water. A vial or other pocket-sized container will hold a saturated cotton swab.

Discoloration and decay following pruning are minimized if exposed tissues are allowed to close of their own accord. Applications of shellac or another wound dressing can be used where wound invasion by canker-causing fungi or bacteria is likely to occur.

For new plantings, choose pest-resistant plants where available. Named cultivars propagated in nurseries and offered for landscape use in the last 15 years have usually been monitored for insect and disease susceptibility in the nursery, and many highly susceptible individuals have been eliminated from production. Table 3.4.1 lists some disease-resistant selections.

3.2 Nursery Hygiene

Do not let sloppy nursery hygiene ruin your investment in clean plants and soil fumigation. Soilborne pathogenic fungi, bacteria, and nematodes are carried into the nursery and spread within it by dirty feet, implements, and machines; moving surface water; blowing soil; and infested or infected plants.

1. Insist on clean stock. Do not order or accept stock likely to be infested with nematodes, crown gall bacteria, the Verticillium wilt pathogen, or similar organisms.
2. Stabilize all open soil and maintain windbreaks. Cover dirt roads with gravel or oil.
3. Require equipment moving between nursery blocks to pass through a central area where soil is washed off. The equipment can be parked on a bed of cobblestones, and the soil particles will be carried down through the cobbles. A steel grating over a pit is a better arrangement for a permanent wash-down area. If not possible to clean equipment between blocks, make sure to work in any infected or infested blocks last, and clean equipment at the end of the day.
4. Clean boots and hand tools as you do other equipment.
5. When roguing diseased plants or pruning diseased parts of plants, bag and dispose of, destroy or bury the discards.
6. Do not allow surface water to run from one nursery block to another. Divert it into ditches or culverts.
7. Remember that irrigation water can carry pests and pathogens. Select a clean source and keep it clean.
8. Allow no direct traffic from outdoor areas to indoor propagation areas. Use properly maintained foot baths containing a germicidal agent at entrances if possible.
9. When collecting cuttings in the field, inspect stock plants carefully, and avoid any plants showing disease symptoms or abnormalities. For many leaf diseases, inspect stock plants late in the growing season before cuttings are actually to be taken, when leaf diseases are most apparent.

3.3 Diseases of General Importance or Occurrence

Because of the large number of crops covered in this document, and the wide variety of diseases that affect them, this section covers those dieases that have a broad host range and are most common in nurseries and landscapes.

3.3.1 Crown Gall

Crown gall, caused by *Agrobacterium tumefaciens*, occurs in nurseries and outplantings throughout New York State. The list of woody plants susceptible to the disease includes plants in at least 77 genera and 32 families.

The disease becomes established in nursery crops when clean stock is planted in infected soil and when infected stock is planted in previously clean soil. Once in the soil, the bacteria can persist indefinitely in decomposing debris from galls on susceptible plants. The wounds necessary for entry of the pathogen occur during planting, cultivating, grafting, and pruning.

Table 3.3.1. Provisional List Of Woody Plant Genera Not Susceptible To Crown Gall

Scientific Name	Common Name
Berberis	Barberry
Buxus	Boxwood
Carpinus	Hornbeam
Catalpa	Catalpa
Cedrus	True Cedars

3.4.1. Disease control guide

NOTE: See Section 3.5 for pesticide trade names containing the active ingredients noted below. Pesticides listed in this table may not be registered for both nursery and landscape use. Always confirm that the site you plan to treat and the pest you wish to control are listed on the label before using any pesticide.

Symbols Used: * = Restricted-use pesticide; † = Not for use in Nassau and Suffolk Counties; ‡ = Trade names are listed when: (a) two active ingredients are combined into one product or (b) where only one or two labels within a larger list of products are registered for that pest and host.

Plant and Disease[1]	Control
***Kalmia* (laurel)**	
Leaf spots caused by *Pseudocercospora kalmiae* (syn.=*Cercospora* sp.) (Plate *16*)	Handpick infected leaves and prune infected shoots if practical; destroy or compost fallen leaves. If disease has been severe, spray with mancozeb, triadimefon, thiophanate-methyl, myclobutanil, or chlorothalonil at budbreak and again 10 and 20 days later.
***Koelreuteria* (goldenrain tree)**	
Coral spot canker caused by *Nectria cinnabarina* (Plates 99, 100, ***87, 88***)	Prune back to sound wood and cover pruning wound with a dressing. Fertilize and water to maintain vigor.
***Ligustrum* (privet)**	
Anthracnose caused by *Glomerella cingulata* (syn. = *Colletotrichum gloeosporioides*) (Plate ***56***)	Prune and destroy infected branches during dry weather. Spray with chlorothalonil, mancozeb, thiophanate-methyl, *Spectro 90 WDG‡, Greencure‡, *ArmorTech TMI 2020‡, or *Junction‡ weekly as long as disease is active, or per label directions. Amur privet (*Ligustrum amurense*), Ibota privet (*L. ibota*), Regal privet (*L. obtusifolium* var. *regalianum*), and California privet (*L. ovalifolium*) are reported to be resistant.
Alternaria leaf spot caused by *Alternaria alternata*	Alternaria leaf spot was found to be prevalent on California Privet in Long Island during the 2009 and 2010 growing seasons, and appears to be causing leaf spot, yellowing and leaf drop. Do not confuse this with Anthracnose (see above). Although it is not yet known if other factors are contributing to this problem, several fungicides are registered for leaf spot diseases on privet and may be useful in managing the disease where it has become severe and include: Greencure‡, trifloxystrobin, *ArmorTech TMI 2020‡, Daconil Weather Stik, *Junction‡, Protect DF, and Terraguard SC. Make applications at 7-28 day intervals during the first half of the growing season as directed on product labels.
***Lonicera* (honeysuckle)**	
Leaf blight caused by *Insolibasidium deformans* (syn.=*Herpobasidium* sp.) (Plate 42, ***126***)	Remove and destroy fallen leaves. Spray with mancozeb, or *Junction‡ at 10-day intervals beginning in late May and continuing until late June.
***Malus* (apples, flowering crab)**	
See following list of disease-resistant varieties and cultivars. For home orchard guidelines, see other publications.	
Powdery mildew caused by *Podosphaera leucotricha* (Plate ***4, 5***)	Apply propiconazole, triadimefon, copper sulfate pentahydrate, myclobutanil, thiophanate-methyl, *Spectro 90 WDG‡, trifloxystrobin, neem oil, or potassium bicarbonate at two-week intervals when mildew first appears on twigs or foliage.
Fire blight caused by *Erwinia amylovora* (Plates 76, 77, ***187***)	Avoid overfertilization, especially heavy spring applications of nitrogen. Cut out cankers and blighted branches in mid-January when tree is dry, making cuts at least 1 ft. below the visible limits of infection. Cover wounds with shellac or other wound dressing. Disinfect tools between cuts. Remove worthless pear, apple, quince, and similar plants from the vicinity. Where disease has just begun to appear, apply copper sulfate pentahydrate or CuPRO 5000‡, use an appropriate formulation of one of the mono-and di-potassium salts of phosphorus acid for the site, or inject Tree Tech OTC‡ per label directions.
Rust caused by *Gymnosporangium* spp. (Plates 118, 119, ***129-133***)	Eliminate nearby red cedar and common juniper to whatever extent practical. Spray with myclobutanil, triadimefon, thiophanate-methyl, chlorothalonil, trifloxystrobin, propiconazole, (*Alamo or *Shepherd Fungicide‡), *Spectro 90 WDG‡, or mancozeb. Make three applications at 7- to 14-day intervals or per label directions beginning when orange rust masses develop on junipers (around mid-May).

Table 3.5.1. Some fungicides, bactericides, and nematicides registered for use on trees and shrubs in New York State

Symbols Used: * = Restricted-use pesticide; † = Not for use in Nassau or Suffolk Counties; ‡ = Site use: N = Nursery (may include field-grown and plantation-grown), L = landscape (may include residential or commercial landscapes); § = REI = restricted-entry interval; applies to nursery (or plantation) uses under the Worker Protection Standard, 40 CFR part 170; NA = not applicable

Example Trade Names, Formulation (Company)	EPA Reg. No.	Use ‡	REI§
Active Ingredient (*Mode of Action Group*)			
Mono- And Di- Potassium Salts of Phosphorous Acid (*NC*)			
Alude (Nufarm)	55146-83	N, L	4
Agri-Fos (Monterey Lawn & Garden Products)	71962-1-54705	L	4
Agri-Fos (Agrichem)	71962-1	N, L	4
*Arborfos (J.J. Mauget)	7946-26	N, L	NA
Arborfos HP (J.J. Mauget)	7946-31	N, L	NA
Reliant Systemic Fungicide (Quest)	83416-1	N	4
*Rampart T&O (Loveland)	34704-924	N, L	4
Products may be used for suppression or management of several diseases including some Phytophthora cankers of ornamental and forest trees. Arborfos products are for injection only and are also labeled for managing Armillaria. Injections may require the use of specialized injection equipment (see labels). Several of these products may also be applied as a directed trunk spray, and applications should be made using Pentra-Bark™ Bark Pentetrating Surfactant or another appropriate organosilicone based surfactant, where recommended. Lawn & Garden Agri-Fos is for application to residential lawns, gardens and ornamentals only. *Rampart T&O is for commercial landscapes, not residential landscapes. **Note:** Recommended applications to the trunk/bark are at high concentrations. To protect other plants around the base of the tree(s) from a possible phytotoxic reaction, cover them with a tarp before making the application.			
Myclobutanil (*3*)			
*†Eagle 20 EW (Dow AgroSciences)	62719-463	N, L	24
Broad-spectrum fungicide for control of leaf, flower, and twig blights. **Note:** Not approved for use on landscape, nursery, or greenhouse ornamentals in Nassau and Suffolk Counties, New York.			
Myrothecium Verrucaria, Dried Fermentation Solids and Solubles (*NC*)			
DiTera DF (Valent)	73049-67	N	4
Nematicide for pre-plant, planting, and post-plant suppression of labeled nematode species.			
Neem Oil, Clarified Hydrophobic (*NC*)			
Triact 70 (OHP)	70051-2-59807	N, L	4
For control of black spot of rose, powdery and downy mildews, scab, and rust on many plant species. **Note:** Do not apply to rose blossoms or to other sensitive plants listed on label. Follow label directions to avoid making applications that may cause phytotoxicity.			
Oxytetracycline Calcium Complex (*41*)			
*Tree Tech OTC (Florida Silvics)	64014-11	N, L	0
For injection to suppress Bacterial Leaf Scorch (Xylella) in Oak and Vascular Yellows in Ash and Elm and Fire Blight in labeled hosts.			
Phosphorous Acid (*NC*)			
Riverdale Magellan (NuFarm)	228-387	N, L	4
For control or suppression of *Phytophthora*, *Pythium*, downy mildew, and some bacterial blights on labeled hosts.			
Potassium Bicarbonate (*NC*)			
Greencure (H&I Agritech)	70870-1	L	NA
Milstop Broad Spectrum (BioWorks)	70870-1-68539	N, L	1
Kaligreen (Otsuka Agritechno)	11581-2	N	4
Fungicide for control of powdery mildew and Botrytis on a wide variety of plants and additional pathogens per individual labels. Kaligreen labeled for powdery mildew only.			
Propamocarb Hydrochloride (*28*)			
Banol T&O (Lesco)	432-942-10404	N	24
Banol T&O Fungicide (Bayer)	432-942	N	24
Fungicide for control of *Phytophthora* on woody ornamentals grown in greenhouses or in pots in nurseries. Not for use on field grown ornamentals.			

4 Weed Management in Nursery Crops

4.1 Establishing a Weed Management Program

4.1.1 The Need for a Weed Management Program

Weeds compete with crop plants for water, fertilizer, light, carbon dioxide, and other resources essential for plant growth. Weeds also harbor insect pests; reduce air flow around desirable plants, resulting in a microclimate more conducive to disease; and in some instances serve as alternate hosts to pathogenic organisms. In addition, the aesthetic quality of the landscape (and perceived quality of nursery stock) is reduced by weed growth. Consequently, weed management is an essential part of any nursery crop production or landscape management system.

4.1.2 Weed Identification

The first step in developing any pest management plan is to identify the pest, and a weed management program is no exception. The importance of proper identification cannot be overemphasized. Correct identification not only includes knowing the proper name but also provides information about the weed, particularly its life cycle. Weeds that infest ornamental plantings have one of four life cycles. Becoming familiar with the life cycle allows us to determine at what time of year the most susceptible growth stage is occurring. **Summer annuals** emerge in the spring, flower, and set seed before the first frost in the fall. **Winter annuals** germinate at the end of summer and overwinter as small, dormant seedlings. **Biennials** are similar to winter annuals but germinate earlier in the summer. As days lengthen and temperatures rise in the spring, both winter annuals and biennials are stimulated to flower, set seed, and die before the end of the summer. **Perennials**, as the name suggests, survive more than two seasons and generally can propagate by seed or by vegetative means. Weeds can also be classified into broad categories based on their growth types—grasses, sedges, and broadleaves—that are often useful in determining herbicide selectivity. Several weed and wild flower identification guides are available to assist in this identification effort. For a list of such resources appropriate to your region or for help in identifying unknown species, contact your local Cornell Cooperative Extension office (cce.cornell.edu/localoffices).

4.1.3 Weed Scouting

Scouting fields for weeds should begin the year before planting, paying particular attention to species that will be difficult or impossible to control after planting. These species must be controlled before planting. Integrating crop planting maps with weed maps has provided optimal weed control and reduced crop injury from inappropriate herbicide use, excessive cultivation, or weed competition for crop and weed management groupings.

After planting, fields should be scouted at least twice a year: **early summer** and **early autumn**. In early summer, any summer annual weeds that escaped control are still small but identifiable and may be controlled with cultivation or selective postemergent herbicides. Also at this time, many winter annuals and biennials are flowering so there still may be time to control them before seeds ripen. Perennial weeds may be identified and mapped early in the season to allow optimal timing of control procedures. Some perennials, such as quackgrass, are best controlled early in the season, whereas others are best controlled at other times. (See Table 4.2.1 for specific guidelines for perennial weed control.) In early autumn, winter annual seedlings, perennial weeds, and summer annuals that escaped control procedures are identifiable. Winter annuals will be easier to control postemergently at this time, before they have overwintered. The results of the autumn scouting are also useful in evaluating the effectiveness of your overall weed management program.

The actual scouting process can be accomplished in a fairly simple manner. The first and most important aspect is to map the areas, noting the species and locations of weeds as well as the species of ornamentals present. Many nurseries have already developed planting maps that may be adapted to this purpose. Using this map, conduct a weed inventory of each growing area or block. Walking fields in a wide zigzag pattern is an efficient way to do this. Note the general weed population and record relative densities. Take particular note of heavy infestations of a single species, perennial weeds, species you do not know (could this be a serious weed in the future?), and weeds that may be new to the area. As this inventory of information builds, notice which species are not controlled by your current management program, for these species will become more numerous unless you alter your management program to compensate.

4.1.4 Weed Management Options

Plan your weed management strategy based on the scouting report. Perennial weeds and other difficult-to-control species should be controlled before planting. Also before planting, consider the postplanting weed management strategies to be employed. Doing this before planting may help avoid costly weed problems later on. After planting, weeds may be controlled with cultivation, mulches, cover cropping (or living mulches), or herbicides. A combination of these control strategies, coupled with cultural programs that minimize weed infestations and introductions, is generally the most practical and effective option. When selecting the most appropriate options, consider the economics, crop safety, efficacy, environmental stewardship, and “fit” within your overall crop management program.

*Asulox

Common Name: sodium salt of asulam

Formulation: 3.34SC

Uses: Postemergent weed control in some ornamentals, turf, Christmas tree plantings, and non-cropland. For agricultural or commercial use only; not for use by homeowners.

	Amount of active ingredient	*Amount by formulation*
	3.34SC	
Per Acre	3.34 lb.	1 gal.
Per 1,000 sq. ft.		3 oz.

Major Weeds Controlled: Difficult to control grasses, including barnyard grass, crabgrass, fall panicum, foxtails, goosegrass, and horseweed (*Conyza canadensis*) and bracken fern. Field Horsetail (Equisetum arvensis) is controlled under a 2(ee) recommendation.

Major Weeds Not Controlled: Most broadleaf and perennial weeds.

For Best Results: Use a minimum of 20 gallons of solution per acre. Apply a single postemergent broadcast application per season.

Cautions and Precautions: Do not use surfactant in ornamental applications. Low temperature and humidity decrease absorption.

Residual Activity: Residual control of grasses germinating from seed will persist for 6 to 10 weeks, depending on field conditions.

Volatility and Leaching Potential: Leaching potential is high.

Symptoms and Mode of Action: Asulam is a carbamate herbicide; primary mode of action is to inhibit DHP synthase, an enzyme involved in folic acid synthesis. Asulam also appears to be a mitotic inhibitor preventing function in meristematic tissues. Symptoms include chlorosis in young weeds and plant stunting followed by necrosis.

Manufacturer: United Phosphorus, Inc.

EPA Reg. No.: 70506-139

*Restricted-use pesticide; may be purchased and used only by certified applicators or used by someone under the direct supervision of a certified applicator.

Table 4.9.1. Weed susceptibilities to PREemergence herbicides

KEY:
ful = full control is expected.
par = partial control is expected.
no = no control is expected.

Genus, species	Common name	*Barricade	Biathlon	*BroadStar/*SureGuard	Casoron	*†Dacthal	Devrinol	*ΔDimension	Goal 2XL	Harrell's 75	*Kerb	*†Marengo/*†Specticle	OH2	Pendulum	*†Pennant Magnum	Princep	*Ronstar	*Rout	Surflan	Treflan	XL
Rumex acetosella	sorrel, red				ful				ful	ful	par										
Rumex crispus	dock, curly				ful							ful									
Sagina procumbens	pearlwort, birdeye		ful	ful									ful					ful			
Salsola kali	thistle, Russian			ful	ful				ful	ful						ful				ful	
Senecio vulgaris	groundsel, common		ful	ful	ful		ful		ful	ful		ful	ful		par	ful	ful	ful	ful		ful
Sida spinosa	sida, prickly			ful					ful	ful		par									par
Sinapis arvensis/ Brassica kaber	mustard, wild				ful	no		ful	ful	ful	ful	ful				ful			par		
Sisymbrium altissimum	mustard, tumble					no			ful	ful											
Sisymbrium irio	rocket, London					no		ful	ful	ful	ful			ful					ful		ful
Solanum nigrum	nightshade, black			ful		par			ful	ful	ful				ful	ful			par		par
Solanum nodiflorum	nightshade, Am. black															ful					
Solanum sarachiodes	nightshade, hairy								ful	ful	ful	ful			par	ful					
Sonchus arvensis	sowthistle		ful															ful			
Sonchus oleraceus	sowthistle, annual			ful			ful		ful	ful		ful	ful				ful	ful	par		par
Spergula arvensis	spurry, corn								ful	ful											
Spergularia rubra	sandspurry, red								ful	ful											
Stellaria media	chickweed, common	ful	ful	ful	ful	ful	ful	ful		ful	ful	ful	ful	ful		ful		ful	ful	ful	ful
Taraxicum officianale	dandelion		ful	ful	ful							ful	ful					ful			
Trifolium pratense	clover, red								par	ful											
Trifolium procumbens	clover, hop													ful							
Trifolium repens	clover, white								par	ful		ful						ful			
Urtica dioica	nettle, stinging									ful										ful	
Urtica urens	nettle, burning					ful			ful	ful	ful										
Veronica arvensis	speedwell, corn							ful				ful		ful							
Veronica persica	speedwell, Persian/birdeye	ful							ful												
Veronica spp.	speedwell species															ful	ful				
Xanthium strumarium	cocklebur, common								ful	ful											
Avena fatua	oats, wild						ful	ful	ful		ful					ful	ful		ful	ful	ful
Avena sativa	oats, volunteer										ful										
Barbarea vulgaris	rocket, yellow			ful	ful																
Bromus catharticus	rescuegrass	par						ful		ful											
Bromus mollis	brome, soft						ful	ful		ful											
Bromus rigidus	brome, ripgut						ful	ful		ful							ful				
Bromus secalinus	brome, cheat						ful	ful		ful		ful								ful	
Bromus tectorum	brome, downy						ful	ful		ful	ful					ful					
Cynodon dactylon	bermudagrass																				
Cyperus compressus	sedge, annual											par			ful		ful				
Cyperus esculentus	nutsedge, yellow				ful	no						par			ful						
Dactylis glomerata	orchardgrass				ful						ful										
Digitaria ischaemum	crabgrass, smooth	ful		ful	ful	ful	ful	ful		ful		ful		ful	ful	ful	ful		ful	ful	ful
Digitaria sanguinalis	crabgrass, hairy/large	ful	ful	ful	ful	ful	ful	ful	par	ful	ful	ful	ful	ful	ful	ful	ful	ful	ful	ful	ful
Echinchloa crus-galli	barnyardgrass	ful	ful	ful		par	ful	ful	par	ful	ful	ful	ful	ful	ful	ful	par	ful	ful	ful	ful
Eleusine indica	goosegrass	ful	ful	ful		par	ful	ful	par	ful	ful	ful		ful	ful	ful	ful	ful	ful	ful	ful

Table 4.10.1 Herbicides registered for use on ornamentals in New York

Key: *Ornamental Species:* Several = 6 species or more registered; Few = 1-4 species registered; None = 0 species registered
f/c = field and container c = container use only f = field
* Restricted-use pesticide † = Not for use in Nassau or Suffolk Counties

			Ornamental species registered								
Application Type	**Long Island Use?**	**Trade Name**	*Shade Trees*	*Narrow Leaf (Needle) Ever-greens*	*Broad-leaf Ever-greens*	*Decid-uous Shrubs*	*Ground-covers (Woody &Semi - Woody)*	*Peren-nials (Herba-ceous)*	*Orna-mental Grasses*	*Bulbs*	*Annuals (Bedding Plants)*
pre	yes	Pendulum	Several (f/c)	Several (f/c)	Several (f/c)	Several (f/c)	Several (f/c)	Several (f/c)	Several (f/c)	Several (f/c)	Several (f/c)
pre	no	*†Pennant Magnum	Several (f/c)	Several (f/c)	Several (f/c)	Several (f/c)	Several (f/c)	Several (f/c)	Few (f/c)	Few (f)	Several (f)
post directed	yes	*ΔReward/ *Littora	Several (f)	Several (f)	Several (f)	Several (f)	None	None	None	None	None
pre	yes	*Ronstar (G)	Several (f/c)	Several (f/c)	Several (f/c)	Several (f/c)	Several (f/c)	Few (f/c)	Few (f/c)	None	None
post directed	yes	Roundup Pro	Several (f)	Several (f)	Several (f)	Several (f)	None	None	None	None	None
pre	yes	*Rout	Several (f/c)	Several (f/c)	Several (f/c)	Several (f/c)	Several (f/c)	Few (f/c)	None	None	None
post directed	yes	Scythe	Several (f)	Several (f)	Several (f)	Several (f)	Several (f)	Several (f)	Several (f)	Several (f)	Several (f)
post directed	yes	Sedgehammer+	Several (f)	Several (f)	Several (f)	Several (f)	Several (f)	None	None	None	None
pre	yes/no	Simazine (several)	Several (f)	Several (f)	Several (f)	Few (f)	None	None	None	None	None
pre	yes	*Sureguard	Several (f/c)	Several (f/c)	None	None	None	None	None	None	None
pre	yes	Surflan	Several (f/c)	Several (f/c)	Several (f/c)	Several (f/c)	Several (f/c)	Several (f/c)	Few (f/c)	Several (f/c)	Several (f/c)
pre	yes	Treflan	Several (f/c)	Several (f/c)	Several (f/c)	Several (f/c)	Several (f/c)	Several (f/c)	Several (f/c)	Several (f/c)	Several (f/c)
pre	yes	Westar	None	Several (f)	None	None	None	None	None	None	None
pre	yes	XL 2G	Several (f/c)	Several (f/c)	Several (f/c)	Several (f/c)	Several (f/c)	Several (f/c)	None	Several (f/c)	Several (f/c)

Table 4.10.2. Herbicides registered <u>for landscape use</u> in New York State

Trade Name	**Common Name**	**Spray or Gran-ular**	**Pre or Post**	**Plant Types that may be found on the Label ***Check Label for Species***					**Weeds Controlled**	**Appli-cation**	**Post-Plant Interval**	**Residential landscape restrictions[3]**
				Turf	**An-nuals**	**Peren-nials**	**Trees & Shrubs**	**Orn. Grasses**				
Acclaim Extra	fenoxaprop	S	post	✓	✓	✓	✓		ann grasses	OT	Established	
*Barricade 4L	prodiamine	S	pre	✓	✓	✓	✓	✓	ann grass & bl weeds	OT	Newly planted (after soil settles)	
*Barricade 65WG	prodiamine	S	pre	✓	✓	✓	✓	✓	ann grass & bl weeds	OT	Newly planted (after soil settles)	
Barrier	dichlobenil	G	pre	can injure turf			✓		ann & per grass & bl weeds	D	Established	

5 Vertebrate Pest Management

5.1 Integrated Pest Management (IPM)

No single, simple remedy can be relied on to solve rodent problems in a sustainable way. Rodent control must be considered in terms of the environment in which the pest is active. Control activities must have as an overriding principle the biology and behavior of the animal in concert with its whole environment. Integrated pest management (IPM) is a holistic, decision-making system – a process in which all interventions are brought to bear on a pest problem with the goal of providing the most effective, economical, and safe program possible. In short, IPM is a process for determining if, where, when, and what pest management intervention(s) are needed or justified.

5.2 Nonchemical Wildlife Damage Management Alternatives

A nursery owner can use a variety of nonchemical alternatives to reduce wildlife damage to nursery stock and ornamental shrubs. These techniques fall into several broad categories: exclusion, habitat modification, and wildlife population reductions. Although exclusion and habitat modification appear to be more expensive than population control, where possible, they may provide the greatest efficacy and longer-term relief from damage problems.

5.2.1 Exclusion

Fencing is the most reliable exclusion technique for preventing wildlife damage to nursery stock. Woven-wire designs are the most effective physical barrier to wildlife, with high-tensile woven-wire fencing providing the ultimate in protection and durability. Deer can be successfully eliminated from large areas (>50 acres) with an 8- to 10-foot woven-wire fence. The advantages of this design are its effectiveness and low maintenance requirements after construction. Disadvantages include the high initial cost and the difficulty in repairing damaged sections.

A variety of multi-strand, high-tensile, vertical or sloped, electric fence designs effectively exclude wildlife. Electric high-tensile fences may be complete physical barriers or, more commonly, may act as a behavioral deterrent. Deer can be excluded from crops with a 5- to 6-foot electric fence, even though they can easily jump over woven-wire fences of this height. The most frequent reasons why electric fences fail to prevent wildlife damage include the selection of an unsuitable fence design, failure to install fencing according to manufacturers' specifications, and inadequate maintenance. Electric fences will not exclude wildlife unless adequate voltage is constantly maintained on the wires. High-tensile electric fences are easily repaired and may cost half as much as 8- to 10-foot woven-wire designs. Disadvantages include frequent monitoring and the need for vegetation control to maintain shocking power.

Other physical barriers that can prevent wildlife damage include wire cages, plastic tubing, bud caps, and bird netting. Large-scale use of these materials may be uneconomical because of the labor required to apply and remove these barriers. Wire or plastic tree guards can be used to protect trees from trunk girdling by rodents or rabbits. The more expensive wire guards provide longer-term damage prevention.

5.2.2 Habitat Modification

Habitat modifications can make areas less suitable for nuisance wildlife. Damage prevention with cultural manipulations should begin with site selection and plant establishment. In nurseries, plowing or disking reduces vole populations, facilitates the establishment of the desired cover crop between rows, and simplifies future vegetation control. Removal of brush, stone piles, and nonmowable wet areas will reduce the attractiveness of sites to rodents and rabbits. Mowing in established plantings can reduce preferred wildlife foods, remove protective cover, enhance predation, and expose animals to severe weather conditions. Sites adjacent to croplands should also be mowed to reduce pest numbers.

5.2.3 Population Reduction

Wildlife population reductions may be necessary to reduce damage to tolerable levels. Snap-back or cage traps are effective for capturing small mammals. Larger rodents or carnivores can be caught with foothold or body-gripping traps. When trapping, care and experience are necessary to reduce captures of nontarget species. In more urban areas, live-capture cage traps are recommended to protect pets. In rural locations, shooting can be used to effectively remove problem animals.

A trapping license, small game license, or special permit may be required from the New York State Department of Environmental Conservation (DEC) for lethal control or transport of vertebrate pests. County and local laws vary in New York State, and some areas have trapping or shooting restrictions. Contact state and local officials before implementing any lethal or trapping and removal program for nuisance wildlife.

Reducing animal numbers by lethal methods may fail to provide long-term relief from damage. Where habitat conditions are suitable and exclusion is not attempted, most pest species will repopulate the site soon after control efforts have ceased, as animals will move into the control area from adjacent lands. Habitat modification and exclusion methods often require more initial effort and expense, but these techniques may provide longer-term damage prevention, especially when a few pest individuals can inflict substantial losses.