Crop Profile for Landscape Installation and Maintenance in North Carolina

Prepared: April 2005

General Production Information

The landscape installation and maintenance industry is an important commodity in North Carolina. Over the last 25 years the landscape industry has burgeoned across the Southeast, especially in North Carolina. North Carolina has 3,132,000 housing units (according to Census data). If each unit has two trees, the value of residential landscapes is a minimum of $626,400,000 just in the cost of removing those trees. Add to that the value of school campuses, athletic fields, cemeteries, industrial parks and commercial landscapes and the dollar value of landscapes in North Carolina becomes very large. The “farm gate”

value of the landscape industry in North Carolina is estimated to be over one billion dollars. Thirty years ago, residential landscape installation was considered a luxury, and commercial landscaping installation was limited to seeding or sprigging turfgrasses and planting small shrubs and saplings. Months or years were required for a landscape to become "established." Now landscapers regularly install large shrubs and trees of 5- to 6-inch caliper. Turfgrasses are rolled out like carpets, and bedding plants planted in full bloom. After any bare soil is covered with mulch, the brand new landscape appears to be established after only a few days.

Data are lacking on the number of professional landscapers in North Carolina. The North Carolina Pesticide Law requires landscapers who apply pesticides as part of their professional activities to have a pesticide license. The ornamental plant pest license category includes greenhouse and nursery pesticide applicators (most of whom do not work in landscapes) as well landscapers. Probably half of the landscapers in the state have licenses. In the late 1970's, the number of landscape contractor and designer businesses started growing, and the rate of growth has not peaked yet. Some of these businesses continue to develop into sizeable establishments throughout the state, and large, out-of-state landscape contractors have moved in as well. However, there remains room in the industry for part-time landscapers, who earn $20,000 to $30,000 a year. The growth of this industry seems to be directly related to our state's population growth and urbanization, which does not show signs of slowing. The Landscape and Grounds Maintenance Association of North Carolina has only 400 members, most of which are larger companies. Raleigh alone has at least 193 landscape contractors, consultants, and designers.

The landscape environment is unique due the intimate contact of the public with landscape plants and the large number of exotic plant species and varieties some of which have little natural resistance to insects and mites. In its native land, an exotic ornamental plant may have pests that are of little consequence because of naturally occurring parasites and predators. However, if the plant is introduced into a new landscape with its pests but without some of the beneficial insects, the pests may then cause considerable injury. An additional complication is that pesticides applied for one pest may eliminate parasites or predators of that pest (or another pest). For example, spraying for mites may eliminate parasites of aphids and as a result, aphids may suddenly become a major problem. Because much of the value of a landscape is dependent upon appearance and high aesthetic standards demanded by customers, gross pest damage cannot be tolerated in planting and maintaining turf, flowers, shrubs and trees.

Landscape installation and maintenance is a specialized and labor-intensive industry. Landscapes have a wide range of ornamental plants often with diverse cultural requirements. These plants may require different pest management programs, frequency of irrigation, rate of fertilization, and growing conditions. Species with similar environmental requirements are not necessarily grouped together in a landscape, which makes landscape pest management and maintenance much more complicated than pest management in a nursery or greenhouse. On the other hand, plant diversity and exposure to weather extremes seem to inhibit some ornamental plant pests such as whiteflies, aphids, and semi-tropical soft scales. The owner of a small landscape company participates in all areas of installation and maintenance. The owner must know plant cultivars, soil types, fertility, irrigation, pest control, building codes, building materials, business management and marketing. In larger operations key individuals are usually assigned fewer responsibilities, an important one of which is pest management. Landscape managers deal with

crops of great value, and to make a profit there is little room for error by allowing excessive damage by pests. In addition, concern for public safety, pest management principles, public pressure against the excessive use of pesticides, and the cost in labor and materials of pesticide application all restrain the extravagant application of pesticides.

Types of Landscapes

Outdoor landscapes include public areas such as city, county, and state parks, cemeteries, public school and college campuses, industrial campuses, athletic fields, and home grounds. Intensity of pest management and the tools available to the landscape manager vary with the type of landscape. For example, compared to a city park, cemeteries have fewer visitors. Most cemeteries have modest areas of bedding plants, but large areas of turfgrass and native trees that require relatively little pest management. Furthermore, visitors are not thinking about pest management at the time of the visit. On the other hand, city parks and industrial campuses usually have numerous visitors that are more likely to notice the quality of plant maintenance. Some visitors are likely to have a negative view of pest management with pesticides. This same view of pesticides plays a critical role in the selection of pest management strategies for public school campuses. It is not unusual to see small oaks on a public school campus that are unsightly and stunted because they have been defoliated year after year by orangestriped oakworms, a pest that could be safely controlled in the early instars by spraying or dusting *Bacillus thuringiensis*.

Interiorscapes are landscapes inside public buildings. Insect control on ornamental plants in enclosed public areas is a particularly sensitive topic. Because of public access to interiorscape plants and the potential for human exposure to pesticides, control measures must be safe for humans. The offensive odor of some pesticides is another problem for interiorscape pest management. Some interiorscapes have fish pools or may have adjacent pet stores. Pyrethroid insecticides are especially toxic to fish, so great care must be taken to protect non-target animals from exposure. The function of ornamental plants is primarily aesthetic so that pesticides must safe for the plants as well as effective for pest management. Failure to prevent accidental pesticide exposure problems may result in loss of clients and legal liabilities. In view of all the potential problems, correct identification of pests is very important so that proper pesticides can be selected for optimal control and minimal spraying.

Worker Activities

Worker Activities in Outdoor Landscapes - Workers use mechanized equipment most of the time in landscape installation and maintenance. During installation, workers drive to the site, grade, till, plant, and install sod, bedding plants, shrubs, and trees. In landscape maintenance, workers drive among work sites, mow, edge, shear, aerate, drop fertilizer, blow leaves and debris, and apply pesticides. During snow and ice storms, landscapers are often responsible for clearing driveways, parking lots, and sidewalks.

Worker Activities in Interiorscapes - Most interiorscape installation and maintenance is done by hand.

Workers typically put plants into an artificial potting mix of sand, peat moss or pine bark, vermiculite, lime, fertilizer and sometimes pesticides. Depending on the plant species and philosophy of the installer's pest management, plants are often drenched soon after planting with a fungicide to inhibit root diseases. Insecticides are sometimes applied to the plants to help manage insects and mite pests. Plants are irrigated periodically. Workers sometimes apply a weak fertilizer solution at each watering cycle, depending on the crop and philosophy of the interiorscape company. Interiorscape maintenance requires workers to have intimate contact with the plants they are installing and maintaining.

Time Line for Pest Management in Outdoor Landscapes

January - Pest management is a year-round process for landscapes. Landscape pests are dramatically affected by weather. Even during the winter, plants should be scouted for armored scales, rodent damage, and weeds. Drenches for petal blight and oils for armored scales and spruce spider mites, southern red mites and other pests are made in January, and plants are pruned to control unwanted growth. During snow and ice storms, driveways, parking lots, and sidewalks must be cleared.

February - Alcohol traps are used to detect the first flight of Asian ambrosia beetles, so a protective application of permethrin can be applied when these beetles appear in February or March. Preemergence herbicides are applied in plant beds in the eastern part of North Carolina. During snow and ice storms, driveways, parking lots, and sidewalks must be cleared.

March - Landscapes are scouted for insect, mite, disease, weed and vertebrate pests. Preemergence herbicides are applied in plant beds if not applied in February. During snow and ice storms, driveways, parking lots, and sidewalks must be cleared.

April - Plants are scouted to detect spring pests such as cool-season mites (eriophyid, southern red, spruce spider, and boxwood mites), aphids, azalea lacebugs, leafminers on boxwood and holly, eastern tent caterpillars, forest tent caterpillars, boxwood psyllids, Nantucket pine tip moth, and euonymus scale. Preemergence herbicides are applied (or reapplied) in plant beds. Pheromone traps are used for lilac/ash borer, banded ash clearwing borer and lesser peachtree borer and treatments made as needed. Plants at a high risk of severe anthracnose, leaf spots, or twig blights are sprayed. Scouts look for petal blight on azalea, leaf gall on rhododendron, fireblight on pyracantha and crabapple, cedar-apple rust on red cedar, anthracnose on river birch, and powdery mildew.

May - Plants are scouted at least twice for aphids, lacebugs (azalea and hawthorn), scales (cottony, lecanium, terrapin, euonymus and wax), bagworms, caterpillars, mites, leafminers (boxwood and holly), black vine weevils, white grubs, boxwood psyllids, leafhoppers, borers (dogwood, rhododendron, azalea/ dogwood twig and ash/lilac), spittlebugs, and maple petiole borers. Crabapples are treated for fire blight when blossoms are 20% open. When conditions are cool and wet, plants subject to aerial *Phytophthora* are sprayed, and new growth on junipers is protected from tip blight. Preemergence herbicides are applied

to plant beds (western North Carolina). Landscapes are scouted for emerging nutsedge Florida betony, mugwort, bindweed, and perennial grasses, and postemergence herbicides are applied, if needed.

June - Pests include aphids, lacebugs, bagworms, caterpillars, flower thrips, leafhoppers, June beetles, Japanese beetles, black vine weevils, mites, borers, boxwood psyllid, and spittlebugs. June is also the best time to treat the crawler stage of the cottony maple scale, cottony camellia scale, Indian wax scale, and lecanium scale, and other soft scale insects. Fungicide applications during periods of wet weather help prevent the spread of foliar, fungal pathogens such as *Botrytis*, *Alternaria*, *Colletotrichum*, and *Cercospora* leaf spot. Fungicides are applied to specimen trees as the buds begin to open. Hollies are drenched to protect them from black root rot. Trees are pruned to establish single leaders and control excessive growth, and weeds are controlled with directed postemergence herbicides. Preemergence herbicides are reapplied in June as well.

July - Plants should be scouted twice for aphids, caterpillars, Japanese beetles, June beetle, mites, scales (soft and gloomy), black vine weevils, and lacebugs, as well as *Rhizoctonia* web blight and *Phytophthora* aerial blight. Symptoms of *Botryosphaeria* dieback and bacterial scorch (*Xylella* sp.) occur in July, August, and September.

August - Plants are scouted for aphids, caterpillars, mites (two-spotted and false), gloomy scales, white grubs, and borers (peachtree and banded ash clearwing). Pheromone traps are used for peachtree borers and banded ash clearwing borers. Ornamental cherries, peaches, plums and cherrylaurels are treated for peachtree borers. Fungicide sprays for foliar fungal pathogens are applied if the weather is wet. Plants are monitored for signs of powdery mildew, and fungicide applications are made at the first sign of disease. Dead branches with *Botryosphaeria* and *Phomopsis* are pruned out. A fungicide application made after pruning protects fresh wounds from reinfection. Perennial weeds are controlled by glyphosate in late August or September.

September - Landscapes are scouted for insect, mite, disease and weed pests, including peachtree borer, white grubs, mites (two-spotted, false, southern red, and spruce spider), and scales (magnolia and tuliptree). Summer annual and perennial weeds that escaped summer control application are treated with "touch up" hand weeding. Preemergence herbicides are applied in plant beds for winter annuals. Scouting for scab on crabapples, black spot and downy mildew on roses, and powdery mildew on many woody ornamentals, continues in September.

October - Landscapes are scouted especially for cool season mites (eriophyid, spruce spider and southern red), powdery mildew and *Botrytis*. Treatments with horticultural oil are made if necessary.

November - Landscapes are scouted for diseased, cankered, and galled (cedar-apple rust on juniper; white pine blister rust; black knot of plum and cherry, and insect or mite galls) branches to be pruned out and destroyed. Severely infected trees are removed and destroyed. Fallen leaves are removed and destroyed from around trees and shrubs that had any leaf spotting diseases earlier.

December - Landscapes are scouted at least once for mites on conifers and armored scales and are

checked for rabbit, mouse or vole damage.

Time Line for Pest Management in Interiorscapes

Pests find their ways into interiorscapes throughout the year. Many interiorscape plants are foliage plants and are more or less perennial. These plants may have been infested with mealybugs, scales, spider mites, and other pests before the plants were first installed. Flowering plants may be introduced throughout the year (poinsettias during November and December, for example). Poinsettias are often infested with low populations of whiteflies and fungus gnats, pests that can infest foliage plants nearby. During warmer weather, aphids, spider mites, thrips, and other pests may be carried into interiorscapes on clothing. In the absence of natural controls, pests may completely destroy the aesthetic value of the interiorscape. Pest management is a year-round process in interiorscapes. Although some seasonality occurs with interiorscape pests, the sheltered growing conditions within a building allow for constant development of plant pests. Pests such as aphids, spider mites, scales, and whiteflies develop slowly in winter and rapidly in hot weather, so frequency of scouting is higher during the summer.

Pests and Resistance

Relatively few pests of ornamentals have developed resistance to pesticides. These include some whiteflies, aphids, spider mites, leafminer flies, a few thrips, a few diseases and some weeds. The large number of host plants and the several distinct sites and categories of uses complicate pest management on ornamentals. For example, to be used in a landscape, the pesticide must be labeled for use in a landscape or for ornamental plants outdoors in non-agricultural sites (the site requirements of some pesticide labels are vague). Because of the large number of host plants, commercial landscapers must deal with a myriad of insect, mite, disease and weed pests. No single pesticide lists all host plants, all pests, and all sites on a label, so landscapers are forced to stock multiple chemicals to deal with various aspects of pest management on ornamental plants.

Insect Pests

Insect, Mite, and Mollusk Pests of Landscape Ornamentals

Aphids - Aphid populations increase dramatically because they reproduce without mating and because they migrate into new areas on occasion. In cold weather, aphids may thrive because predators and parasites are inactive. In warm weather, parasitic wasps, lady beetles, syrphid fly maggots, lace wings and

other predaceous insects feed on aphids so that aphid populations often decrease rapidly as well. Aphid populations are sometimes devastated by *Cephalosporium lecanii*, a parasitic fungus. Because many bedding plants are somewhat sensitive to pesticides, plants should be irrigated thoroughly before spraying them. It is best to spray early in the morning or late in the evening so that the pesticide residue is dry before the plants are exposed to direct sunlight. Adequate coverage is important for aphid management as thick foliage may shelter the aphids from the pesticide. Of the pyrethroid, carbamate, and organophosphate insecticides, the organophosphate acephate works the best for aphid control. However, single ingredient acephate formulations have been phased out for most homeowner uses and professional landscapers may also be reducing uses in residential areas. Alternatives include relying on natural control, oils, and insecticidal soaps, as well as imidacloprid and other newer systemic pesticides.

Beetles - Japanese beetles feed on over 275 different plants, including many shade and fruit trees, ornamental shrubs, small fruits, garden crops, and weeds. Asian ambrosia beetles attack some herbaceous flowering plants as well as trees and shrubs. Bark beetles such as the southern pine beetle have occasional outbreaks that kill pines over wide areas. Black vine weevils attack the leaves of various shrubs and their grubs feed on the roots of rhododendrons, *Taxus*, and other plants. Twig girdlers infest the smooth-barked twigs of elms, oaks pecans, and zelkovas in late summer and cause undesirable dieback and multiple stems. Female twig girdlers chew through the bark from the outside. Twig pruners attack hardwood trees and weaken twigs and branches to the point they dieback and break off. Leaf beetles in the genera *Paria*, *Altica*, and *Rhabdopterus* chew holes in the new leaves of hollies, camellias, azaleas, and crapemyrtles at night.

Southern pine beetles are dark, reddish-brown in color, cylindrical, pencil-lead thick, and about 1/8 inch in length. They become active in the spring about the time dogwoods bloom. Pairs of beetles attack the middle and upper trunk of stressed or damaged yellow pines (especially loblolly). If the tree has sufficient vigor, it exudes pitch into the entrance hole, which oozes out onto the bark and hardens there. The beetles maintain a breathing hole through the pitch. This is called the pitch tube. The pitch tube eventually becomes about the size of a piece of popcorn. Each pair of beetles chews an S-shaped tunnel one foot in length between the bark and wood. The tunnels crisscross and girdle the tree. Eggs are deposited in niches along these tunnels. Grubs remain under the bark until they pupate and the new beetles emerge. The entire life cycle takes from 30 to 40 days (three to five generations per year). The last brood of the season overwinters in infested trees. Once the pitch tubes are noticed on the trunks of pines, it is usually too late to save the tree with pesticides because southern pine beetles introduce a fungus, blue stain fungus, that clogs the water-transporting tissue in the tree. Infested trees should be cut down and debarked or chipped to kill the developing southern pine beetle eggs and grubs. To lessen the chances of southern pine beetles, landscapers should avoid injuring pines during construction, and especially avoid excessive grading and fill dirt on the roots. High value trees can be protected with pesticides and treatments must reach and thoroughly soak the upper portion of trees to be effective.

Asian ambrosia beetles are almost 1/8 inch long, blackish-brown colored beetles with short legs. The eggs are oval and almost microscopic in size. The tiny grubs do not have legs. Eggs are laid in deep tunnels bored into the sapwood and heartwood. The young larvae hatch and chew out small egg “cradles” that radiate like teeth on a comb. The larvae apparently do not eat wood, but feed on a fungus (the

“ambrosia”) that grows on the surface of the wood in the tunnels and egg cradles. The adult beetles have special pouches in which they carry some of the fungi as they colonize new trees. When ambrosia beetles attack, they bore straight into the sapwood and heartwood of diseased or stressed ornamental hardwood trees and shrubs. These tunnels are sometimes as much as 10 to 12 inches deep in a large tree. Fortunately the ambrosia fungus is not systemic or highly pathogenic, but large numbers of ambrosia beetles may kill branches or whole plants. Because this insect attacks stressed trees, only healthy trees should be installed by landscapers. They should not over fertilize or over water small deciduous trees and provide adequate irrigation in dry weather. The Asian ambrosia beetle attacks many deciduous trees but seems to prefer plants such as cherries, magnolias, crapemyrtles, and styraxes that have stem diameters larger than 1½ to 2 inches. Very few pesticides are effective for Asian ambrosia beetle control.

Bugs - Hemipterans such as plant bugs, stink bugs, and lace bugs are insects that insert slender mouthparts into plants (or animals) and inject saliva as they feed. Some bugs then suck out the predigested plant juice and leave behind plant empty cells that are conspicuously pale. Bugs have a portion on the wing tips that is noticeably more “papery” and translucent than the remaining parts (except lace bugs that have uniformly lacy wings). Bugs lay their eggs on their host plants, and immature bugs feed on the same plant as their parents. Lace bugs and plant bugs are two families of bugs that most commonly attack ornamental plants. The azalea lace bug is the most frequently reported insect pest in landscapes and nurseries. After a short time, a heavy infestation of lace bugs causes the leaves to become bleached out and bronzed in appearance. Azalea lace bugs are difficult to control with contact insecticides because the eggs are inserted into the leaf tissue and covered with a drop of varnish like excrement and are thereby protected from insecticides. Plant bugs cause distorted growth and premature leaf drop.

Caterpillars - Armyworms, bagworms, borers, cutworms, tent caterpillars, handmaid moths and other prominent caterpillars (azalea caterpillars, yellownecked caterpillars), webworms, and sawfly larvae attack ornamentals in North Carolina. Most of the caterpillars that feed on ornamentals are immature stages of moths (the pansyworm is the immature stage of the variegated fritillary butterfly, and the spiny elm caterpillar is the immature stage of the mourning cloak butterfly). Moths usually lay their tiny eggs on leaves or stems. A few days later, tiny caterpillars hatch and begin feeding. Damage from the first three or four instars is insignificant. However, the latter part of the fourth, the fifth, and the sixth instar caterpillars consume a considerable amount of foliage and petals. These last few stages cause much more damage than the earlier stages, and the damage accrues quickly. Fully-grown caterpillars then pupate and in a few weeks or months, a new generation of moths emerges to mate and lay eggs for a new generation. In nature, caterpillars are pla gued with numerous parasites, predators, and diseases. One disease, *Bacillus thuringiensis*, is available as a biological control agent. *Bacillus thuringiensis* (*B.t.*) is much more effective against young, small caterpillars than it is for older, larger ones. Other strains of *B.t.* are specific to different groups of insects including beetles and mosquitoes.

The azalea caterpillar feeds primarily on azaleas. Young azalea caterpillars are green in color from the time they hatch until they are about ½ inch in length, then they molt into purple-striped worms. They finally grow to about 2 inch long black- and yellow-striped worms with reddish-colored heads and legs. The moths are light brown with darker brown stripes. Moths have a wingspan of almost 2 inches. Female azalea moths lay up to 100 eggs in masses on a leaf in early summer. Tiny azalea caterpillars hatch and

feed in a group. After the caterpillars mature, they crawl down into the soil to spend the rest of the fall, winter, and spring in the pupa stage. Azalea caterpillars usually completely defoliate one stem or area before moving on to another part of the plant. As the worms mature, they do more and more damage. Azalea caterpillars can be shaken from shrubs and trampled underfoot, and they are susceptible to pesticides.

Bagworms are caterpillars that grow from 1/16 inch to almost 2 inches in length. The caterpillars remain within a silken bag covered with pieces of the plant on which they feed. Female bagworm moths do not have wings or legs. Male moths are small, dark moths. Winter is spent as eggs (500 to 1000) inside the mother's bag attached to the plant stem. The new bagworms hatch in May and June and spin downward on silken threads. Although most land on the original host plant, some may be blown for miles on the silk thread. In August the worms mature and molt into the pupal stage inside a silk bag they spun and covered with bits of leaves. Bags are attached to twigs by sturdy silk bands. During August and September, adult male moths emerge from their bags to mate. After mating, each female lays eggs inside the bag and dies. Large numbers of bagworms cause excessive defoliation and may kill arborvitae and Leyland cypress within one or two seasons. Occasionally, the silk band girdles the twig as the twig enlarges. Bagworm bags can be removed from junipers and Leyland cypress by hand. If possible, the bags should be put into an open container far from susceptible host plants to allow parasites to escape and attack other bagworm eggs.

Moths of eastern tent caterpillar are brown to reddish-brown in color with two pale diagonal lines on the forewing. Eggs are laid in masses around twigs and covered with a foamy secretion that dries into a firm, brown covering. The black caterpillars are somewhat hairy with gold, white and blue markings. There is a white stripe down the back. The caterpillars grow to two inches in length. The cocoon is about one inch long and is spun of white or yellowish-white silk. Eastern tent caterpillars hatch, begin to feed and spin silken webbing in spring often at bud break of host trees like black cherry. They soon spin a tent in a crotch on flowering peach, cherry, crabapple or other related ornamentals. As they grow, the caterpillars spin successive layers on the tent. In good weather, they leave the tent several times each day to feed. In bad weather, the caterpillars remain in the tent. After feeding for about six weeks, the caterpillars leave the tent and spin cocoons on fences, tree bark, buildings, or debris. In early summer, adult moths emerge from the cocoons to mate and lay eggs. The caterpillars develop inside the eggs, but they do not hatch until the following spring. In spring as new leaves develop, the caterpillars leave the eggs and begin to feed and spin silken webbing. After two days, they begin weaving a tent in a crotch of a branch. Small trees may be completely defoliated. The silken tents become filled with caterpillars and frass. Aside from pesticides, eastern tent caterpillars can be controlled by destroying the tents with a stick and discarding the young caterpillars.

Fall webworm caterpillars are hairy and grow to 1 3/8 inches long. Female moths are small and white. Some have black spots. Male moths are small, brown and hairy with dark wings that become clear with age. Fall webworms hatch from groups of up to 900 eggs laid in spring. After feeding for 4 or 5 weeks, the caterpillars crawl to the ground, spin cocoons and pupate in mulch or soil. In July and August another generation of moths emerges from the cocoons to lay eggs for the fall generation. Fall webworms overwinter as pupae in cocoons hidden in mulch, litter, and soil. New caterpillars spin webbing over

leaves at the tips of branches and feed within the webs. The web is enlarged to enclose uneaten leaves until each web may become two to three feet in length, and small trees may be entirely webbed. Fall webworms prefer pecan, persimmon, and sourwood trees, but feed on other plants, too. The webbing looks awful, but their feeding usually does not damage the health of trees. Fall webworms can be controlled by pruning out the tents and discarding the young caterpillars as an alternative to insecticides.

The lesser canna leafroller is a small caterpillar related to the European corn borer, pickleworm, coneworm, sod webworm and others. The lesser canna leafroller overwinters as larvae in the leaves of canna and the moths emerge to mate and lay eggs after the new growth emerges in spring. When the larvae hatch, they feed within the new, still rolled leaves. The lesser canna leafroller is not cannibalistic. Several caterpillars can be found feeding inside one rolled leaf. The lesser canna leafroller caterpillars only feed on the upper epidermis and mesophyll. If not managed, lesser canna leafrollers may completely destroy the aesthetic value of cannas. Canna seems to be the only host plant for this pest, so that if the plants are somewhat remote from other cannas, it may be possible to drastically reduce the lesser canna leafrollers just by carefully removing all dead leaves and stems in the fall after the frost has killed it back. Leaf debris should be cleaned up every year. It is possible to eradicate this pest by using acephate as a spray several times during the growing season. *Bacillus thuringiensis* insecticides are also effective when sprayed directly downward into the rolled leaves so that the pesticide can soak into the shelter around the worms.

The orangestriped oakworm sometimes defoliates oaks in mid to late summer. The moths emerge in June and July and deposit their eggs in clusters of several hundred on the underside of oak leaves. The moth is brown with a white spot and a dark stripe on each forewing. The eggs hatch in about a week or so. The tiny, greenish caterpillars eventually grow into black worms with yellow or orange stripes running lengthwise along their bodies. These caterpillars have a prominent pair of spines or slender horns sticking up behind the head. Young caterpillars feed in groups, whereas older ones tend to be solitary although there may be thousands of caterpillars on a single tree. Even mature oaks may be defoliated to the point that there may be twig dieback due to sunscald or other factors. As the caterpillars mature, they are often seen crawling along sidewalks, driveways, and yards. They dig into the soil three or four inches and pupate there. There is usually one generation per year, and the worms overwinter as pupae in the soil. By the time the caterpillars descend and crawl about on the soil, insecticides are no longer effective.

Flies - Fly pests in landscapes include narcissus bulb flies, boxwood leafminers, and darkwinged fungus gnats. Narcissus bulb flies attack flowering bulbs in commercial landscapes and home gardens. The flies emerge in May and lay eggs for a new generation of maggots. Trichlorfon seems to be the only insecticide labeled for bulb fly control. Given the history of the development of pesticide resistance in fly populations, complete reliance upon chemicals for fly control is not a good management plan.

Boxwood leafminer adults are tiny (about 1/8 inch in length), orange-colored flies called gall midges. They swarm around or cling to infested boxwoods shortly after new growth has emerged in spring. After laying eggs inside the leaf, the flies die. Tiny, whitish maggots hatch and feed inside the leaf. As they grow, the maggots become bright yellow. Several maggots may develop in a single leaf. Their feeding causes galls that resemble blisters to form on the lower leaf surface. Boxwood leafminer maggots develop

inside these blisters for almost a year. The next spring, the blisters form a thin, gray, translucent spot called the window, and the maggots develop into pupae. Fully developed pupae wriggle through the windows and hang down. Soon adult flies emerge from the pupae to begin a new generation. There is one generation per year. Heavily infested boxwoods drop leaves prematurely and become unsightly. Boxwood leafminers do not seem to have effective predators and parasites. Systemic insecticides (except dimethoate) seem to give the best control, especially when applied to the soil. Boxwood leafminers are completely resistant to dimethoate. Late winter is a good time to apply systemic insecticides to the soil under boxwoods.

Darkwinged fungus gnats are small, dark, weak flying flies. The immature stages breed in soil mixtures and other areas where decomposing debris allows development of the fungi on which they feed. Adult fungus gnats can be serious nuisance problems in interiorscapes. The maggot stage feeds on fungi but sometimes damages roots. Controls should first give attention to correcting conditions that favor root diseases in containers and plant beds. Larval controls with insecticides are helpful. *Bacillus thuringiensis* H-14 (Gnatrol) is labeled for biological control but has given variable results as a soil drench.

Red imported fire ants feed mostly on soft-bodied insects such as maggots, grubs, and caterpillars. Occasionally, they have been reported consuming fleshy seedlings, buds or soft tissue of plants. These ants build mounds in any type of soil, but seem to prefer open, sunny areas such as lawns and pastures. The above ground part of the mound is only a small portion of the nest, which may penetrate three feet into the soil. Fire ants sting readily, and a few people are hypersensitive to fire ant stings, and they may have life-threatening systemic reactions. Baits or insecticide drenches control single mounds. Nests may reappear periodically. Red imported fire ants are a hazard to the workers and public. They are sometimes transported in containerized plants and mulch. Presently, the North Carolina Department of Agriculture and Consumer Services maintains a quarantine program to slow the spread of this ant into non-infested portions of the state.

Scale insects and mealybugs - Armored scale insects, such as euonymus scales, tea scales, and white peach scales, are usually more prevalent in landscapes than in nurseries or greenhouses. Some on the systemic insecticides, such as imidacloprid, give good control of soft scales and mealybugs, but systemic insecticides seem to have no effect on armored scale insects. Timing of spray treatments for soft scales and armored scales is important as the crawlers are much more susceptible to insecticides than older scales. Wax scales and the soft scales that lay their eggs in white, fluffy ovisacs are susceptible to sprays in late May and early June. Magnolia scale and tuliptree scale crawlers are susceptible to sprays in the fall and early winter. Horticultural oils are the most common and effective treatments used for armored scale insects.

Mites - Spider mites, false spider mites, tarsonemid mites (broad mite, cyclamen mite), and eriophyid mites damage ornamentals in North Carolina. Spider mites cause tiny, yellowish spots to form as they feed. Predaceous mites and small lady beetles feed on spider mites and parasitic fungi infect these mites, especially in humid weather. Hot, dry weather apparently inhibits the parasitic fungi and speeds up the life cycle of two spotted spider mites. Spruce spider mites and southern red mites often die out in hot weather in the Piedmont and Coastal Plain, leaving only their eggs to survive. Butterfly bushes, roses, and

some other shrubs are susceptible to spider mites. Daylilies and flowering bedding plants are often infested by spider mites during the summer. Horticultural oils and soaps are moderately toxic to spider mites. Soaps and oils have virtually no residual activity so both pesticides may have to be applied two or three times for complete control (about 5 days in between sprays). Seventeen active ingredients are now labeled for spider mite management on ornamentals (abamectin, bifenazate, bifenthrin, chlorfenapyr, clofentezine, fenpropathrin, fenpyroximate, fluvalinate, hexythiazox, horticultural oil, lambda-cyhalothrin, methiocarb, Neem oil, pyridaben, propargite, and soap).

Slugs - Slug damage resembles that of caterpillars or wireworms. Limacid and arionid slugs deposit a slimy mucous as they travel and they rasp away leaves and flowers as they feed. Methiocarb and metaldehyde are useful for slug management. Slugs and snails may consume several times their own body weight each night. Slugs are often attracted to fragrant blossoms and succulent leaves. Birds (up to 6% of the diet of starlings), ducks, moles, toads, shrews and carnivorous ground beetles, rove beetles, and firefly beetles feed on slugs. Sciomyzid flies and nematodes also parasitize slugs. In addition, omnivorous slugs such as the spotted garden slug prey upon other smaller slugs. Dry weather may occasionally kill up to 90% of slug eggs and young per year.

Insecticides, Miticides, and Molluscicides Labeled for Landscape Ornamentals

1. abamectin (Avid) - macrocyclic lactone: Abamectin is extracted from the soil bacterium *Streptomyces avermitilis*. Avid is useful for spider mite and leafminer control as well as aphids and a few other pests.

2. acephate (Orthene 97, PT 1300) - organophosphate: It is labeled for many insects in greenhouses and nurseries, including fire ants. Aphids resistant to diazinon and other traditional organophosphates are somewhat susceptible to acephate. It is also labeled as a tank mix with fenpropathrin, which makes fenpropathrin much more useful in nurseries and greenhouses. Recently, acephate uses by homeowners have been limited by the EPA.

3. azadirachtin (Azatin XL, Bioneem, Ornazin) - tetran- or triterpenoid plant extract: An insect growth regulator, azadirachtin provide moderate control of whiteflies, aphids, thrips, fungus gnats, caterpillars, beetles, mealybugs, and leafminers. It is labeled for commercial agriculture, landscapes, and interiorscapes.

4. *Bacillus thuringiensis kurstaki* (DiPel) -- bacterium: Specific to caterpillars, *B. t.* gives control of young worms without harming beneficial organisms.

5. *Bacillus thuringiensis israelensis* H-14 (Gnatrol) -- bacterium: Primarily used for darkwinged fungus gnat management, it is compatible with other biological control organisms. It is labeled for greenhouse and interiorscape use.

6. *Beauveria bassiana* (BotaniGard, Naturalis-H&G) - parasitic fungus: It is labeled for aphids, mealybugs, thrips, and whiteflies. It is compatible with other biological control organisms.

7. bifenazate (Floramite) - carbazate: It gives quick knock down and three weeks of residual control. It is compatible with biological controls. The manufacturer recommends rotating this product with other miticides for pesticide resistance management.

8. bifenthrin (PT 1800, Attain, Onyx, Talstar) - pyrethroid: This pyrethroid controls aphids, armyworms, cutworms, fire ants, loopers, mealybugs, mites, and whiteflies, and in some formulations is a tree borer protectant.

9. buprofezin (Talus) - insect growth regulator: This inhibitor of chitin biosynthesis is useful mainly for sucking pests (except spider mites) by suppressing oviposition of adults, and reducing viability of eggs. Treated pests may remain alive on the plant for 3 to 7 days, but feed little. Talus is not disruptive to beneficial insects and mites.

10. carbaryl (Sevin) - carbamate: This broad-spectrum insecticide kills as a contact and stomach poison. Carbaryl is used to manage armyworms, leaf-feeding beetles, caterpillars, centipedes, cutworms, loopers, millipedes, pillbugs and sowbugs.

11. chlorpyrifos (Dursban Pro) - organophosphate: This restricted use pesticide was at one time widely labeled for landscape use, but now seems to be restricted to turfgrasses on golf courses, road medians, and industrial plant sites.

12. cyfluthrin (Decathlon) - pyrethroid ester: This is broadly labeled for insects in greenhouses, nurseries, and landscapes (but not spider mites other than clover mites).

13. cyromazine (Citation) - insect growth regulator: This chitin synthesis inhibitor is labeled primarily for dipterous leafminers and fungus gnats in landscapes and interiorscapes.

14. diflubenzuron (Dimilin 25W, 4L) - insect growth regulator: The 25W formulation is labeled for greenhouse and interiorscape use. The 4L is a restricted use pesticide labeled for tree pests in forests and landscapes (but not greenhouses or interiorscapes).

15. fenbutatin-oxide (Vendex) - organotin: This restricted-use pesticide is labeled for control of various species of spider mites in nurseries and landscapes.

16. fenoxycarb (Award, Logic, Preclude, Precision) - carbamate and insect growth regulator: This juvenile hormone mimic acts on the immature stages of fire ants, fungus gnats, scale insects, shore flies, and whiteflies. Although alternative pesticides exist for these troublesome pests, it is always a good idea to maintain a mix of pesticides classes and modes of action for pest suppression so that growers can meaningfully rotate pesticides to minimize the acquisition of pesticide resistance by insects and mites.

17. fenpyroximate (Akari) - phenoxypyrazole miticide: It gives quick knockdown of mites and three to

four weeks of residual control. Fenpyroximate shares a similar (METI) mode of action with pyridaben, so it is not wise to rotate between these two chemicals. It is labeled for interiorscapes.

18. fluvalinate (Mavrik) - pyrethroid ester: This pyrethroid is used to manage aphids, mites, thrips and mealybugs (except for resistant species).

19. hexythiazox (Hexygon) - carbamate: This miticide acts on eggs of twospotted spider mites on ornamentals (plants, trees and vines) growing in greenhouses, commercial nurseries and established landscapes.

20. horticultural oil (Ultra Fine, Sun Spray) - highly refined petroleum oil: Although labeled for numerous pests, oils excel at controlling armored scale insects and (at the dormant season rate) spider mite and aphid eggs.

21. imidacloprid (Merit) - chloronicotinyl: This chemical works well against a number of otherwise insecticide-resistant aphids and whiteflies. Because it is labeled for numerous crops across the world, resistance will no doubt arise in aphids and whiteflies. It is labeled mostly for sucking pests (but not mites), leaf beetles, and sawflies as well as white grubs. This product is thought to be critically important by many landscapers.

22. kinoprene (Enstar II) - insect growth regulator: This juvenile hormone mimic is used for management of scales, whiteflies and mealybugs in greenhouses and interiorscapes.

23. *lambda*-cyhalothrin (Battle, Scimitar, Topcide) - pyrethroid ester: This insecticide is labeled for numerous landscape pests including aphids, caterpillars, mealybugs, soft scale insects, and spider mites.

24. malathion - organophosphate: This is one of the early organophosphate that still has usefulness primarily for mealybugs. It is relative safe to humans and generously labeled for landscape ornamentals.

25. metaldehyde (Deadline) - aldehyde: Metaldehyde is extremely useful for slug management.

26. methiocarb (Mesurol Pro) - carbamate: This insecticide is extremely useful for control of slugs and snails, aphids, mites and western flower thrips in greenhouses and mature ornamental plantings.

27. neem oil extract (Triact, Trilogy) - highly refined oil extracted from neem seeds: It is labeled for armored scales, aphids, leafhoppers, and spider mites.

28. permethrin (Astro, Permethrin Pro, Pounce, Pramex) - pyrethroid ester: This product is labeled for a variety of leaf-feeding and boring insects in landscapes. Although some aphids and whiteflies are resistant to it, permethrin is still useful for many other pests.

29. phosmet (Imidan) - organophosphate: Phosmet in its 70% WSB formulation is not a restricted use

pesticide, and it has good labeling for caterpillar and beetle pests ornamental trees.

30. pymetrozine (Endeavor) - pyridine azomethines: It apparently paralyzes the sucking mechanism of aphids and whiteflies.

31. pyrethrins (Py-Bo, Pyrenone) - plant extract: Although very susceptible to UV breakdown, these have excellent knockdown activity and are relatively safe for humans.

32. pyriproxyfen (Distance) - insect growth regulator: This product is labeled primarily for sucking pests, a few caterpillars, fire ants, shore flies and fungus gnats. This product is thought to be critically important by some landscapers.

33. soap (M-Pede, Olympic Insecticidal) - salt of fatty acid: Soap gives moderate knockdown of aphids, spider mites, and whiteflies. Soaps are compatible with biological control programs. Phytotoxicity may occur if insecticidal soaps are applied repeatedly.

34. spinosad (Conserve) - macrocyclic lactone: This insecticide has broad labeling for caterpillars, fire ants, and other pests of ornamental plants.

Insecticide, Miticide, and Molluscicide Use Estimates

In North Carolina landscapes, abamectin, acephate, *Bacillus thuringiensis* for caterpillars, bifenthrin, carbaryl, cyfluthrin, fenoxycarb, horticultural oils, imidacloprid, permethrin, pyrethrins, soaps, and spinosad are widely used throughout the industry. Bifenazate, chlorpyrifos, fluvalinate, hexythiazox, *lambda*-cyhalothrin, malathion, metaldehyde, methiocarb, and pyriproxifen are occasionally used. *Bacillus thuringiensis* H-14, *Beauveria bassiana,* cyromazine, diflubenzuron, neem oil extract, phosmet, and pymetrozine are seldom used in landscapes.

Current Insecticide Recommendations for Landscape Ornamentals in North Carolina

Current North Carolina Cooperative Extension Service recommendations for insecticide use on landscape plants (including information on formulations, application rates, reentry intervals, and precautions/ limitations) are provided in the following tables from the *North Carolina Agricultural Chemicals Manual*:

Table 5-16: Arthropod Control for Field-Grown and Landscape Flowers
http://ipm.ncsu.edu/agchem/chptr5/524.pdf

Table 5-18A: Arthropod Control for Trees and Woody Ornamentals (Any Plants)
http://ipm.ncsu.edu/agchem/chptr5/528a.pdf

Table 5-18B: Arthropod Control for Specific Trees and Woody Ornamentals
http://ipm.ncsu.edu/agchem/chptr5/528b.pdf

Weeds

Weed Pests in Landscapes

Many kinds of plants become weed pests in landscapes. Both weed plants and seeds can be transported in soil and root balls and introduced on equipment. Seeds can be blown into a site by the wind or carried by wildlife. Management of weeds should combine cultural as well as chemical control. Weeds compete for water, light, space, and nutrients and weeds can also harbor insect, mite, and diseases pests of ornamentals. Predominant weeds change by season, but the following are usually fairly common. Thus far, the acquisition of resistance to herbicides has not been a major problem in landscapes and rotation among classes of herbicides does not appear necessary.

Bermudagrass is a creeping perennial that is dormant during the winter and buds out from underground roots called rhizomes the following spring. It blooms throughout the summer. Seeds form on four or five very narrow fingers on the tip of a slender, leafless stalk. In plant beds landscapers use ground cover fabrics to suppress Bermudagrass. Hand pulling is not effective because the underground rhizomes are hard to pull up completely. The rhizomes that escape from hand pulling soon shoot up more plants. Selective grass herbicides can be used to control Bermudagrass in plant beds.

Bull thistle (also called common thistle) is a large, coarse, spiny winter biennial. During the first year, it grows into a flat rosette of leaves and sends down a large taproot. During the second year, it sends up a central stalk with “wings” running down the stalk from each side of each leaf. The branches are hairy, and the prickly leaves are hairy on the bottom and smooth on top. The attractive reddish or purple flowers form at the ends of short, prickly, winged stems from June through October. The flower heads are 1 to 2 inches in diameter and surrounded with spiny bracts. The seeds are readily blown about like dandelion seeds. For management in plant beds, bull thistle can be pulled by hand.

Carolina geranium or wild geranium is also called cranesbill. Stems are hairy and reddish in color. Leaves are round, but deeply lobed. The leaves are often on long petioles. The purple to pink flowers have five petals. Larger plants can be pulled by hand. Two to three inches of mulch on ornamental beds smothers seedlings. Herbicides are most effective on small plants.

Common chickweed is a fairly common winter and spring weed. Its flower petals vary from small, white, and star-shaped to inconspicuous or absent. The leaves are round, and the lower ones have petioles. The upper leaves sit against the stem. The stems are weak and the plants sprawl along the ground as they mature. Common chickweed reproduces by seed and occasionally becomes quite abundant, forming low, dense patches of bright green. The creeping stems root at the nodes where they form a fibrous root

system. Common chickweed prefers cool, moist, shady areas, although it can survive in compacted soils.

Crabgrasses germinate from March through early May and live until frost in the fall. When large crabgrass and smooth crabgrass are young, the plants are prostrate, with pale stems branching from the center. Crabgrasses become branched and upright when crowded. Both large and smooth crabgrass are common and grow best with adequate light and moisture. The leaves of large crabgrass are hairy, pale blue green in color, and two to six inches in length. Smooth crabgrass has smooth, dull green leaves one to four inches long with sharply pointed ends (leaves are slightly hairy near the stem). In August and September, the flowers and seeds of crabgrasses extend like fingers from the tip of a stalk.

Dallisgrass is a coarse, fast-growing, perennial grass that produces abundant seeds. Dallisgrass can rapidly invade landscapes. If not mowed, the plant grows one to four feet high in clumps. The seeds stalks are one foot or more tall, and the flower head has three to five terminal branches that open and then droop. The leaf sheath is a little flat and hairy at the base, and it is usually tinged red. The leaf sheath appears slightly bloated. Leaves are produced near the base of the plant on short shoots that form a knotty mass of very short rhizomes. Although the tillers do not root at the nodes as crabgrass does, dallisgrass grows faster than most desirable turfgrasses, which increases the need for frequent mowing.

Dock is the common name of a group of 20 species of plants. Two of these, broadleaf dock and curly dock, are common weeds. Both plants develop a low, bunchy, flat-topped, rosette of leaves. The flower stalk rises from the center of the basal rosette. The leaves on the flower stalk get smaller and narrower toward the top of the stalk. In the landscape, spot treatments of contact herbicides are preferred because hand pulling usually breaks off the tap root, from which another plant may grow.

Florida betony or rattlesnake weed grows in full sun to partial shade and tolerates both wet and dry soils. Some of the roots are tubers that resemble a rattlesnake's tail. In the fall, new plants sprout from seeds and tubers. Florida betony grows rapidly during the winter. Its narrow leaves grow in pairs on square stems. The pink- to white-colored flowers are shaped like those of other mints, and appear in late spring and early summer. The flowers occur in groups of three to nine at the base of the leaves. Hot weather and extremely cold weather force Florida betony to become dormant. Mulch and fabric weed barrier under the mulch will help to manage Florida betony. Pulling by hand when soil is moist to prevent tubers from breaking off and sprouting new plants can also help to manage this weed. Spot treatments with non-selective herbicides can be used if the Florida betony is not intertwined with ornamental plants.

Henbit is a small, wild mint that branches at ground level and grows from three to 12+ inches in height. When henbit is chopped into pieces, some pieces may root. The stems are square, and the opposite dark green leaves are hairy on top with crinkled edges. The lowest leaves have petioles, but the upper leaves attach directly to the stem and may wrap around the stem. From April to June, henbit has 3/4 inch, purple, tube-shaped flowers in groups just above the upper leaves. The plants die down in summer, and seeds survive to sprout in the fall.

Horseweed is also called mare's tail. If it is not cut, horseweed grows a long single stem that branches at the top. It may grow to six feet or more. Horseweed has crowded, dark green, hairy leaves that are smaller

toward the top of the stem. The flower heads grow at the tips of the branches. The ¼ inch flowers are yellow in the center and have white to slightly pink petals at the edge. In plant beds, horseweed can be pulled by hand if the infestation is small.

Poison ivy is a common weed in fields, woods, and landscapes. It climbs up trees using hairy, aerial roots along the stem. Poison ivy has compound leaves with three shiny green leaflets. The edges of the leaflets vary. The flowers are yellowish green in color and inconspicuous, but the clusters of white, waxy fruit are readily eaten by birds and the seeds spread into landscapes in their droppings. Poison ivy also spreads by rhizomes. Larger plants can be cut and the stump painted or treated with an herbicide. Smaller plants can be treated with an herbicide (as long as no ornamental plants are nearby) or pulled by rubber-gloved hand.

Prostrate spurge germinates at soil temperatures from about 60º F to over 90º F. Prostrate spurge grows right at the soil surface. It has a central taproot, and the branches form a mat up to two feet wide. The leaves are small (5/8 inch or less), oval, and close to the stem. They may be hairy or have small purple spots. Prostrate spurge blooms from June through October. The flowers are very small and occur in clusters at the bases of the leaves and at the tips of the branches. Landscapers pull this weed by hand in plant beds. Herbicides work when the situation allows their use.

Sandspur, or sandbur, germinates in the spring, grows during the summer and early fall, and dies with the first heavy frost. The leaves are rough like sandpaper, and the seeds are in sharp burs. Sandspur tends to be a problem on sandy soils from the Coastal Plain to the Sandhills. Sandspur can be pulled by hand in small areas. Mulch two to three inches deep on ornamental bed areas suppresses germinating weed seeds. Preemergence herbicides can be applied in early spring and again in 60 days.

Wild garlic is a small, dark green, grass-like weed that grows during the winter and spring and then dies down. The leaves are slender and almost round. It reproduces by forming new bulbs under ground and by producing bulblets at the tops of slender, flexible stems. Wild garlic sometimes blooms and produces seeds. Management practices for wild garlic are the same as those for biennial and perennial broadleaf weeds.

Woodsorrel (sometimes called *Oxalis*) is a perennial most obvious during the cool season, but new seedlings also emerge during the summer. The small, bushy, yellow-green plant grows from a central taproot. Woodsorrel leaves are up to 3/4 inch across and have three heart-shaped leaflets. The stems are slender and sometimes root at the nodes. It blooms from May to September. The yellow flowers are about 1/2 inch across and have five petals. One to four flowers appear at the end of each stem. The seedpods are about one inch tall and are on slender stalks. When dry, the pods break open suddenly if touched and throw the seed as far as six feet. Woodsorrel reproduces from stem pieces as well as from seed and should be hoed or hand pulled from plant beds.

Yellow nutsedge is a most conspicuous during the warm growing season where it appears like a pale-green, upright, weedy grass. Yellow nutsedge spreads rapidly in moist soils from rhizomes that produce nutlets. The leaves are shiny and waxy on top and dull on the backside. The fibrous roots are mixed with rhizomes. The nutlets form at the end of each rhizome. These nutlets are actually tubers that can persist in

the soil for months or years. Yellow nutsedge flowers are at the top of a triangular stem. The flowers form a branched, flat-topped, straw-colored burr. Yellow nutsedge blooms from July through September.

Herbicides Registered for Landscape Ornamentals

1. benefin + oryzalin (XL) - dinitroaniline: This product is a preemergent herbicide labeled for annual grass weeds and broadleaf weeds in landscape ornamentals.

2. bentazon (Basagran TO): - triazine: This photosynthesis inhibitor is labeled for sedges and other selected weeds in turf and some ornamentals.

3. clethodim (Envoy) - cyclohexanedione, chemically similar to sethoxydim: This product is a selective postemergent herbicide labeled for control of weedy grasses (but not sedges or broadleaf weeds).

4. clopyralid (Lontrel, Stinger) -dinitroaniline: This postemergent herbicide controls certain broadleaf weeds in turf and ornamentals grasses in nurseries and landscapes.

5. copper (Komeen) - elemental copper: This herbicide controls aquatic weeds without harming fish, wildlife, or humans in ponds in landscapes and golf courses, reservoirs, and recreation lakes.

6. dichlobenil (Barrier, Casoron) - nitrile: This preemergent herbicide is labeled for annual grass, broadleaf weeds, and perennial weeds.

7. diquat bromide (Diquat, Reward): This is a postemergent, quick-acting herbicide applied as a directed spray to kill most young annual weeds. It has no residual activity in the soil, and perennials are likely to re-sprout.

8. dithiopyr (Dimension) - pyridine: This is a preemergent herbicide for annual grass and broadleaf weeds in turf.

9. fenoxaprop-P (Acclaim Extra) - aryloxyphenoxy propionate, chemically similar to fluazifop-P: This is a postemergent herbicide for annual grass and perennial weed control.

10. fluazifop-P (Fusilade II, Ornamec) - aryloxyphenoxy propionate, chemically similar to fenoxaprop-P: This is a postemergent herbicide for annual grass and perennial weed control.

11. glufosinate (Finale) - phosphinic acid: This is a postemergence herbicide labeled for most annuals and perennials in the greenhouse.

12. glyphosate (Glyfos, Roundup Pro, Touchdown Pro) - glycine: This is a postemergent, nonselective herbicide that kills grasses, broadleaf weeds and sedges around container beds and in field nurseries.

Glyphosate is a systemic herbicide that requires between three and ten days to kill most weeds, but may require a second application for nutsedge, bermudagrass and other weeds that have underground storage organs.

13.halosulfuron (Manage) -sulfonylurea: This product is labeled as a postemergent selective herbicide for sedge management.

14.imazaquin (Image) - imidazolinone: This product is a preemergent or postemergent herbicide for annual grasses, broadleaf weeds, and sedges.

15. isoxaben (Gallery) - benzamide: This product is a preemergence herbicide labeled for annual grasses and broadleaf weeds.

16.isoxaben + trifluralin (Snapshot) - benzamide + dinitroaniline: This mixture is a preemergent herbicide for grasses and broadleaf weeds, including common chickweed, spurges, woodsorrel and annual grasses.

17. methylcarbamodithioic acid (Vapam): This is a soil fumigant that is useful for most annual and perennial weeds. The green industry is concerned about the loss of this product. It is an important alternative to methyl bromide. It can be used for pre-plant soil fumigation in nursery seedbeds, liner beds and fields. It can also be used in landscape beds. Currently it does not have wide usage in ornamentals, but when methyl bromide is no longer available use of this product is likely to increase dramatically unless another, more effective alternative is identified. It also controls soil insects and provides some control of nematodes and fungal pathogens.

18. napropamide (Devrinol) - acetamide: This is a preemergent herbicide labeled for annual grasses and broadleaf weeds.

19. oryzalin (Surflan) - dinitroaniline: This is a selective, preemergent herbicide used for the control of annual grasses and many broadleaf weeds.

20. oxadiazon (Ronstar plus fertilizer) - oxadiazole: This is a preemergent herbicide is effective on most weeds, but not spurges and common chickweed. It is labeled for landscapes other than home lawns.

21. oxyfluorfen (Goal) - diphenylether: This is a preemergent herbicide labeled for annual and broadleaf weeds is rarely used

22. oxyfluorfen + oryzalin (Rout) - diphenylether + dinitroaniline: This broad-spectrum, preemergent herbicide mixture used in the control of many weeds found in nurseries, including spurges is rarely used and not widely marketed for landscapes.

23. pelargonic acid (Scythe): This is a postemergent herbicide labeled for burn down of most annual and perennial weeds including use in greenhouses.

24.pendimethalin (Hurdle, Pendulum/Turf and Ornamental Weedgrass Control) - dinitroaniline: This preemergent herbicide used in the control of some annual grasses and some broadleaf weeds, including prostrate spurge, common chickweed and woodsorrel.

25. prodiamine (Barricade, Factor) - dinitroaniline: This is a broad-spectrum, preemergent herbicide used to control a range of weeds, including spurges. Prodiamine is the predominant preemergent herbicide used in the cut foliage industry.

26. sethoxydim (Vantage) - cyclohexanedione, chemically similar to clethodim: This product is a selective postemergence labeled for control of weedy grasses (but not sedges or broadleaf weeds).

27. simazine (Princep) - triazine: This is a preemergent herbicide used for annual grass and broadleaf weeds.

28. s-metolachlor (Pennant Magnum) - chloroacetamide: This is a preemergent herbicide used for annual grass and broadleaf weeds.

29. trifluralin (Preen, Treflan) - dinitroaniline: This is a preemergent herbicide labeled for annual and broadleaf weeds.

Herbicide Use Estimates

Glyphosate is the most used herbicide in North Carolina landscapes. Fluazifop-P, glufosinate, isoxaben, isoxaben + trifluralin, oryzalin, pelargonic acid, pendimethalin, and trifluralin are also widely used in the landscape. Dichlobenil, diquat bromide, dithiopyr, halosulfuron, prodiamine, and simazine are sometimes used in the landscape. Clopyralid, copper, and oxadiazon are seldom used, and methylcarbamodithioic acid is almost never used.

Current Herbicide Recommendations for Landscapes in North Carolina

Current North Carolina Cooperative Extension Service recommendations for herbicide use in landscapes (including information on formulations, application rates and precautions/limitations) are provided in the following table from the *North Carolina Agricultural Chemicals Manual*:

Table 8-14: Chemical Weed Control in Ornamentals
http://ipm.ncsu.edu/agchem/chptr8/820.pdf

Nematodes

Nematode Pests of Landscape Ornamentals

Nematode infestations should be considered whenever a particular plant species shows a general decline, stunting, and/or yellowing or bronzing of the foliage. Root rots and poor cultural care can cause very similar symptoms, so an accurate diagnosis is important. Japanese holly, juniper, aucuba, and boxwood are often infected by root-parasitic nematodes. Laboratory analysis of a soil sample is the only way to determine the presence and species of nematode associated with the problem. Although nematode feeding causes plant stress, established woody plants are rarely killed by nematodes. However, a plant that is weakened by nematode damage can be more susceptible to infection by other more aggressive pathogens. In a plant bed, nematode damage may be spotty since nematodes are usually not evenly distributed throughout the soil.

Landscapers should incorporate organic matter into the soil before planting to encourage the activity of other microorganisms that are natural enemies of nematodes. Tilled, moist soil can be solarized (heated to very high temperatures that kill nematodes) by covering it with clear polyethylene for six to eight weeks. Solarization works best on sandy soils in hot weather. Where the soil has extremely high numbers of plant parasitic nematodes, the soil can be replaced. This might be practical in planters and confined beds. Only top quality, nematode resistant cultivars should be selected for a landscape. Nematicides currently labeled for suppression of root parasitic nematodes in the landscape are not effective.

Nematicides Registered on Landscape Ornamentals

None are effective.

Diseases

Disease Pests of Landscape Ornamentals

Leaf Spots - Many pathogens**,** environmental conditions, cultural practices, and insects can cause leaf spots**.** Most ornamental plants are susceptible to one or more fungi that cause leaf spots. Leaf spot fungi generally cause circular or irregular lesions on the leaves. Lesions are typically brown, yellow, reddish or black and may have tan or light colored centers of dead tissue bordered by a distinct margin. Pinhead size, black bumps may be observed within the dead tissue. These structures are fruiting bodies contain large numbers of fungal spores. Fungal leaf spots typically show up during periods of warm, humid weather on the older leaves first. Water must be present on leaf surfaces for 4 to 12 hours (depending on the pathogen) for the fungal spores to germinate and infect the plant.

Common leaf spot diseases include *Entomosporium* leaf spot of Indian Hawthorn and red-tip Photinia, black spot of roses, spot anthracnose on dogwood, shot-hole on cherry laurel, and *Cercospora* leaf spot of pansy.

Bacteria can also cause leaf spots. English Ivy, cherry laurel, and chrysanthemum are commonly infected by bacterial leaf spot pathogens. Blossoms and stems can also become infected and may become spotted, wilt, and then die. Bacterial leaf spot diseases can be difficult to control in part due to the rapid rate of multiplication of the pathogen, but also by the limited effectiveness of bactericides.

The foliage of susceptible plants should be kept as dry as possible, especially in during warm, humid weather. Drip irrigation or early morning irrigation so that the foliage dries out during the day helps keep leaves from staying wet for long periods throughout the evening and night to retard leaf spots. Plants should be given enough space to allow good air circulation between plants. In highly valued plant beds, fungicides or copper-based bactericides can be applied during periods of warm, wet weather to protect new growth. Removal and disposal of spotted, fallen leaves is recommended.

Scab - Scab is a common fungal disease that causes defoliation and blemishes on fruit. The fungus that causes scab on crabapple is different from the one that causes scab on pyracantha, but the diseases they cause are very similar. Dull, olive-green fungal growth develops on the surface of leaves during the spring giving them a velvety appearance. Heavily infected leaves may turn yellow or reddish in color, and drop prematurely. Infected fruit have circular rough spots on their surface and when severe, the fruit can become completely covered with cracked, scabby, dark lesions. The scab fungus overwinters in infected plant tissue and in infected fallen leaves and fruit on the ground. The following spring, spores from these tissues are splashed by rain or forcibly shot out of fungal fruiting bodies to infest wet, young, emerging leaves. New spores that form on the infected tissue spread this disease throughout the growing season. Although apple scab does not immediate damage, losing leaves two or three years in a row can weaken a tree.

Leaves and fruit under infected trees should be raked up and destroyed. For long-term control, resistant cultivars should be used. The disease can be managed by fungicide applications made at 7- to 10-day intervals beginning when the leaf buds begin to swell in the spring and repeated until dry, warm summer conditions occur.

***Phytophthora* root rot** is common problem on azalea, rhododendron, camellia, and boxwood, and can infect over 900 other plant hosts. *Phytophthora* kills the roots and root crown of infected plants. All species of *Phytophthora* require extended periods of high soil moisture to cause disease, so overwatering and poor drainage should be avoided. Infected plants are often stunted, have small leaves, and the roots are brown and rotted. At the base of stems near the soil line, infected wood under the bark is brown instead of a healthy white. Leaves may wilt and plants may appear to die suddenly when hot, dry weather begins. The roots of resistant cultivars that have been stressed by drought or flooding become susceptible.

Removal and destruction of plants confirmed as infected with *Phytophthora* is recommended. Plants susceptible to root rot should be located in well-drained areas. In heavy clay or poorly drained soils, the

plants should be placed in raised beds. Organic amendments such as pine bark should be incorporated to a depth of 8 to 12 inches. Resistant cultivars that are healthy and disease-free should be selected when setting out plants in a new landscape. Plants that are off color or that have dark or discolored roots should be avoided. In areas where root-rot-susceptible plants have died, plants that are not susceptible to root rot should be used for replanting. In addition, nearby plants should be treated with a registered fungicide to protect them from infection. No fungicide can cure an infected plant, fungicides only delay an almost certain death.

***Pythium* root rot** infects ornamentals grown where soil conditions are wet and poorly drained. Infected plants are stunted and grow poorly, and severely infected plants die. The fungus survives in the soil on dead plant material. Plants that are crowded and too succulent are particularly vulnerable. Using pathogen-free potting media and disease-free plants help control *Pythium* in growing areas. Fungicides for the control of *Pythium* on many ornamental plants include fosetyl-aluminum, propamocarb, mefenoxam, etridiazole, and thiophanate-methyl + etridiazole.

Rhizoctonia causes root rot of some flowering crops (annuals, chrysanthemum, lily, and poinsettia) and stem rot of other flowers (begonia, celosia, impatiens, poinsettia, salvia, and zinnia). *Rhizoctonia* also causes web blight of azalea and other bunchy shrubs during hot, humid weather when infected soil splashes onto the leaves. Aerial symptoms can develop rapidly. Fludioxonil and thiophanate-methyl are considered moderately effective in managing *Rhizoctonia* diseases, but pathogen-free potting media and other sanitation practices are probably more important.

Black root rot (*Thielaviopsis* sp.) is favored by high soil pH and low soil temperatures. This fungus can persist in the soil for many years, even in the absence of susceptible plants. When roots of a susceptible plant grow near the persistent black root rot spores in the soil, the spores germinate, infect the root tip, and turn it black as infection progresses. More spores are formed on the root. The fungus is dispersed by spores carried by water, wind, equipment and infected transplants. Black root rot reduces plant vigor and causes stunting of terminal growth, shortening of internodes and interveinal chlorosis. Diseased plants usually decline over a period of months and frequently die during or following dry periods. Black root rot is an ongoing problem in bedding plant production, especially on pansy, annual vinca, petunia, and million bells. In nursery production, Japanese hollies are highly susceptible to black root rot, so landscapers need to examine the roots of plants before purchasing them to make sure the root system is clean and healthy.

Gray Mold (*Botrytis*) - *Botrytis* attacks senescing plant tissue and the petals of flowering ornamentals such as begonia, chrysanthemum, geranium, impatiens, marigold, snapdragon, and flowering ornamentals particularly during periods of high humidity and little air movement. Leaves often become infected where petals have fallen on the leaf tissue. Lesions on infected plants become fuzzy with billions of light gray spores giving the disease its common name “gray mold.” Air currents, watering, or any worker-associated activity such as pruning or spraying pesticides liberates the spores. Fenhexamid, chlorothalonil and strobilurin fungicides provide some prevention of disease whereas fungicide resistance is common to thiophanate-methyl and dicarboximide based fungicides.

Powdery Mildew - Many ornamental plants are susceptible to one or more species of powdery mildew fungi. The first signs of powdery mildew are patches of white powdery-looking fungal colonies on the leaf surfaces and stems. Infection is favored by cool nights with high relative humidity (above 85%) followed by warm dry days with temperatures between 70° F and 80° F. Unlike most other fungal leaf spot diseases, free water on the leaf surfaces suppresses spore germination. Azalea, begonia, calendula, chrysanthemum, crabapples, crapemyrtle, dogwood, euonymus, gerbera, grape ivy, hydrangea, phlox, poinsettia, rose, snapdragon, verbena, veronica, and zinnia are often infected with powdery mildew. Infected leaves may become puckered and distorted. New growth may become twisted and deformed, and infected flower buds do not open properly. Once powdery mildew growth is extensive, it is usually too late for fungicides to restore plant appearance. Selective pruning to increase air movement around the plant helps reduce humidity, and pruning out heavily infected plant parts reduces the amount of inoculum that can start new infections. When choosing new plants for the landscape, one should consider using resistant cultivars. A registered fungicide should be applied as soon as new growth begins to emerge or when fungal growth is first observed. Regular fungicide applications are needed until conditions are no longer favorable for infection.

Fire Blight - Fireblight is a bacterial disease that infects plants in the rose family, such as apples, pears, hawthorn, *Pyracantha*, cotoneaster, and *Amelanchier*. It causes a sudden wilting and blackening or browning of shoots, blossoms, or fruit. Infected shoots appear scorched and dead leaves remain attached to the twigs. Cankers may form on the twigs and branches that may dieback. Branches and trunks may become infected when the bacterium moves downward in the plant from infected flowers, twigs, and shoots. The bacteria overwinter in plant tissue around cracked, sunken cankers on infected trees. During warm, wet, or humid weather, bacteria ooze from around the cankers. The bacterium is then spread to flowers by many species of flying or crawling insects. Infection occurs through the blossoms. Once flowers are infected, the bacterium can be spread by bees and splashing water from one flower to another. Fire blight may kill susceptible cultivars if cankers develop in the main trunk.

For long term control, only resistant cultivars should be planted and all infected twigs and cankers pruned out before growth starts in the spring. Cuts should be made four to six inches below any evidence of dead tissue. During the growing season, pruning cuts 12 inches below a canker or blighted tissue should be made. Pruning tools should be disinfected frequently. Fertilization practices that minimize excessive succulent growth are recommended.

Timing of bactericide applications is critical for effective control. Applications of registered bactericides should begin several days before the first flower buds open and continue every four to five days until petal fall. However, repeated use of antibiotics may result in the development of strains of the bacterium that are resistant and can no longer be controlled by the treatment.

Vascular Wilts - Various fungi and bacteria can cause vascular wilt diseases of ornamentals. Wilt diseases are usually fatal, and young plants usually die quickly. Older plants may take several years to die. Dutch elm disease, *Fusarium* wilt of mimosa, and bacterial leaf scorch (*Xylella*) are examples of vascular wilt diseases. Symptoms of bacterial leaf scorch occur during mid to late summer and symptoms are similar to those of other diseases and cultural problems, so a diagnostic laboratory should be consulted

for confirmation of this disease. Wilt diseases disrupt the vascular system that transports water and nutrients to different plant parts. The vascular tissues often turn brown and become clogged with fungal hyphae and spores, bacteria, or other substances produced by the plant in response to infection. The needles or leaves may begin to fade, turn yellow or brown, and then wilt. Preventative fungicide applications can be made to highly valued trees to help prevent Dutch elm disease, but fungicides/ bactericides are ineffective in controlling *Fusarium* wilt and bacterial leaf scorch.

Fungicides Registered for Landscape Ornamentals

1. azoxystrobin (Heritage) - strobilurin: This product is labeled for greenhouse, nursery, and landscape for downy mildew, fungal leaf spots, powdery mildew, root rots, and rust control on annual, perennial, bedding, and flowering potted plants as well as woody ornamentals.

2. chlorothalonil (Concorde, Daconil Ultrex, Echo 720, Manicure, 2787) - chloronitrile: This product is one of the most widely used fungicides in the green industry. The product is labeled on numerous crops and has long-standing grower acceptance and is valuable in pesticide resistance management of fungal leaf spots, powdery mildew, rust and *Botrytis* diseases. The use of some formulations of this fungicide in home lawns is prohibited by the label.

3. chlorothalonil + thiophanate methyl (Spectro 90) - chloronitrile + benzimidazole: This product is labeled for *Alternaria* leaf spot, *Botrytis* blight, powdery mildew, rust, and *Phytophthora* aerial shoot blight on foliar diseases annual, perennial, bedding, and flowering potted plants in nurseries, greenhouses, landscapes and interiorscapes.

4. copper hydroxide (Kocide 2000 T/N/O, Nu-cop): This inorganic fungicide helps control *Alternaria* diseases, anthracnose, bacterial leaf spots, *Botrytis*, *Entomosporium*, and *Volutella*.

5. copper hydroxide + mancozeb (Junction) - dithiocarbamate: This product is labeled for bacterial leaf spots, *Botrytis* blight, and fungal leaf spots on foliar diseases, annual, perennial, bedding, and flowering potted plants in greenhouses and “outdoors”.

6. copper sulfate pentahydrate (Phyton 27) - complex copper: This product is labeled for bacterial leaf spots, *Botrytis*, downy mildew, and scab control on annual, perennial, bedding, and flowering potted plants in landscapes and interiorscapes.

7. etridiazole + thiophanate methyl (Banrot) - thiadiazole + benzimidazole: This mixture is applied to the soil mix at seeding or transplanting or as a drench on bedding, foliage, and container plants to manage *Fusarium* root and crown rot, as well as root rots and damping-off in greenhouses, nurseries, landscapes and interiorscapes where *Pythium, Rhizoctonia* or *Thielaviopsis* is a problem.

8. fenhexamide (Decree) - hydroxyanilide: This product is labeled for *Botrytis* blight on geranium and other flowering ornamentals in greenhouses, nurseries and outdoor-grown ornamentals.

9. fludioxonil (Medallion) - phenylpyrrole: This product is labeled for *Alternaria* leaf spot, *Botrytis* blight, *Cylindrocladium* root rot, *Rhizoctonia* stem blight, *Rhizoctonia* damping off and root rot, and *Thielaviopsis* spp. root rot in greenhouses, nurseries, landscapes and interiorscapes.

10. flutolanil (Contrast) - anilide (oxathiin): This product is labeled for *Rhizoctonia* aerial blight, stem blight, and root rot, as well as *Sclerotium* blight in greenhouses and nurseries.

11. fosetyl-aluminum (Aliette): This systemic organic phosphate fungicide is sprayed and drenched in greenhouses, nurseries, and landscapes to control downy mildew and fire blight, as well as diseases caused by *Phytophthora*, *Pythium*, and *Xanthomonas*.

12. iprodione (18 Plus, 26GT, Sextant) - dicarboximide: This contact fungicide is drenched or sprayed in greenhouses, nurseries and landscapes (except residential use) to control diseases caused by *Alternaria*, *Bipolaris*, *Botrytis*, *Drecholera*, *Exserohilum*, *Fusarium*, *Monilinia* and *Rhizoctonia*.

13. kresoxim-methyl (Cygnus) - strobilurin: This product is labeled for powdery mildew, rust, and black spot in greenhouses, nurseries, and non-resident landscapes.

14. mancozeb (Dithane T/O, Fore, Mancozeb DB, Pentathlon, Protect T/O) - ethylene (bis) dithiocarbamate (EBDC): This fungicide is widely used in the ornamental industry. It is labeled for use on numerous crops and pathogen species. This fungicide is very old but is critical in fungicide resistance management.

15. mancozeb + dimethomorph (Duosan, Zyban) - ethylene (bis) dithiocarbamate (EBDC)+ Cinnamic Acid Derivative: This mixture is a broad-spectrum, systemic protectant spray to control anthracnose, black spot, downy mildew, flower blight, powdery mildew, scab and rust in greenhouses, nurseries, and landscapes.

16. mefenoxam (Mefenoxam 2, Subdue MAXX) - acylamine benzenoid: This chemical controls *Phytophthora* and *Pythium*, as a seed treatment to control damping-off, and as a foliar spray for bedding, foliage, flowering and woody ornamentals in greenhouses, nurseries, and landscapes.

17. myclobutanil (Systhane, Eagle, Immunox) - triazole: This product is labeled for powdery mildew, rust, leaf spots, scab, and petal blight in greenhouses, nurseries, and landscapes.

18. neem oil (Triact 70) - Clarified hydrophobic extract of neem oil: This product is labeled for powdery mildew on annual, perennial, bedding, and flowering potted plants in greenhouses, nurseries, and commercial landscapes.

19. PCNB (Terraclor, Revere) - aromatic hydrocarbon: This chemical is labeled for landscapes and interiorscapes as a drench at transplanting or as a premix into the potting mix. It is useful on bedding

plants, flowers, and woody ornamentals for *Botrytis*, *Ovulinia*, *Pellicularia*, *Rhizoctonia*, *Sclerotinia*, *Sclerotinium*, and *Stromatinia* control.

20. propiconazole (Alamo, Banner MAXX, Spectator) - triazole: This is a systemic fungicide sprayed on bedding plants, flowers and woody ornamentals only in nurseries to control anthracnose, *Entomosporium*, powdery mildew, rust, and scab, but as Alamo it can be root injected to control wilt diseases in elm, oak, and sycamore, and leaf diseases of crabapple.

21.sulfur dust - mineral: This homeowner product is labeled for powdery mildew on flowers and for spider mite management.

22. thiophanate methyl (Cleary's 3336, Fungo Flo, OPH 6672, Sys Tec 1998, T-Storm) - benzimidazole: This is one of the most widely sprayed and drenched fungicides in the landscape industry, the nursery industry and in the greenhouse floral industry. It is systemic and effective on a wide variety of fungal pathogens such as *Botrytis*, *Fusarium*, *Penicillium*, *Rhizoctonia*, *Sclerotinia* and *Thielaviopsis*. It seldom causes phytotoxicity. There is resistance in several fungal pathogens to this active ingredient. Many newer fungicides are as effective as or more effective than thiophanate methyl but many growers use this product because they have confidence in both its effectiveness and its non-phytotoxic nature. This product is widely labeled for ornamentals.

23. triadimefon (Bayleton, Strike 50) - triazole: This chemical is labeled for leaf blights, leaf spots, leaf gall of azalea, powdery mildews, *Sclerotinia* flower blight, and twig rust of annual, perennial, bedding, and flowering potted plants.

24. trifloxystrobin (Compass O) - strobilurin: This product is labeled for powdery mildew and *Rhizoctonia* web blight of annual, perennial, bedding, and flowering potted plants in interiorscapes, but not landscapes.

25. triflumizole (Terraguard) - imidazole: This product is labeled for powdery mildew, *Rhizoctonia* aerial blight, rust, and *Rhizoctonia* root and stem rot of annual, perennial, bedding, and flowering potted plants in interiorscapes, but not landscapes.

Fungicide Use Estimates

In North Carolina landscapes, chlorothalonil, copper hydroxide, mancozeb, mefenoxam, myclobutanil, and thiophanate methyl are all widely used for disease control. Copper sulfate pentahydrate and fosetyl-aluminum are sometimes used for leaf spot control and root rot suppression. Azoxystrobin, etridiazole + thiophanate methyl, neem oil, PCNB, sulfur dust, triadimefon, trifloxystrobin, and triflumizole are seldom used.

Current Fungicide Recommendations for Landscape Ornamentals in North Carolina

Current North Carolina Cooperative Extension Service recommendations for fungicide use on landscape plants (including information on formulations and application rates, methods and schedules) are provided in the following tables from the *North Carolina Agricultural Chemicals Manual*:

Table 6-12: Diseases of Forest, Christmas, and Ornamental Trees
http://ipm.ncsu.edu/agchem/chptr6/608.pdf

Table 6-13: Commercial Landscape and Nursery Crops Disease Control
http://ipm.ncsu.edu/agchem/chptr6/609.pdf

Plant Growth Regulators for Landscape Ornamentals

Plant growth regulators (PGRs) are pesticides that affect plant growth. Because growing conditions vary from landscape to landscape, applying PGRs may take some experience to achieve the desired plant growth. PGRs are maintenance tools, like water and fertilizer and not as remedies for poor cultural practices. PGRs are most effective when applied at the correct time to regulate plant development (growth retardants cannot "shrink" an overgrown plant, they must be applied before plants stretch). Chemical pinchers such as dikegulac sodium, ethephon, or methyl esters of fatty acids increase plant branching for bushy plants.

Plant growth regulators vary in their impacts on ornamental plants. Some inhibit plant growth and others encourage vegetative growth, flowering, or rooting. Plant growth regulators that have high activity require a higher degree of management to use as the slightest error in measurement while mixing may have disastrous results. The higher the level of activity, the more care must be used in measuring and applying the plant growth regulator. When two plant growth regulators of low activity are tank mixed, the combined impact moves from low to moderate.

Plant Growth Regulators Registered for Landscape Ornamentals

1. ancymidol (A-Rest) - substituted pyrimidine: This gibberellic acid synthesis inhibitor is labeled for greenhouses, nurseries, and interiorscapes. It has moderate activity.

2. ethyl 1-napthaleneacetate (Sucker-Stopper RTU): This sucker inhibitor is labeled for use after pruning of woody ornamentals in landscapes and interiorscapes.

3. dikegulac sodium (Atrimmec) - unclassified: This DNA synthesis inhibitor is labeled for controlling growth of shrubs and to prevent fruit-set in landscapes. It has high activity.

4. ethephon (Florel Brand Growth Regulator) - phosphonic acid: This ethylene generator promotes branching and is labeled for greenhouses and nurseries. It has medium activity.

5. paclobutrazol (Bonzi, Piccolo, Profile) - triazole: This gibberellic acid synthesis inhibitor is labeled for greenhouses, nurseries, landscapes, and interiorscapes. It has high activity.

Plant Growth Regulator Use Estimates

In North Carolina landscapes only paclobutrazol is widely used. Ethyl 1-napthaleneacetate and ethephon are occasionally used. Ancymidol and dikegulac sodium are seldomly used.

Current Plant Growth Regulator Recommendations for Landscape Ornamentals in North Carolina

Current North Carolina Cooperative Extension Service recommendations for plant growth regulator use on landscape plants (including information on formulations, application rates, reentry intervals, and precautions/limitations) are provided in the following tables from the *North Carolina Agricultural Chemicals Manual*:

Table 9-5: Growth Regulators for Floricultural Crops
http://ipm.ncsu.edu/agchem/chptr9/904.pdf

Table 9-6: Growth Regulators for Woody Ornamental Crops
http://ipm.ncsu.edu/agchem/chptr9/905.pdf

Contacts

Stephen B. Bambara
Department of Entomology
North Carolina State University
Box 7613
Raleigh, NC 27695-7613
Phone: 919-515-1661
E-mail: steve_bambara@ncsu.edu

D. Michael Benson
Department of Plant Pathology
North Carolina State University
Box 7616

Raleigh, NC 27695-7616
Phone: 919-515-3966
E-mail: mike_benson@ncsu.edu

Theodore E. Bilderback
Department of Horticulture Science
North Carolina State University
Box 7609
Raleigh, NC 27695-1201
Phone: 919-515-5374
E-mail: Ted_Bilderback@ncsu.edu

Brian E. Whipker
Department of Horticulture Science
North Carolina State University
Box 7609
Raleigh, NC 27695-7609
Phone: 919-515-5374
E-mail: brian_whipker@ncsu.edu

Stephen J. Toth, Jr.
Department of Entomology
North Carolina State University
Box 7613
Raleigh, NC 27695-7613
Phone: 919-515-1661
E-mail: steve_toth@ncsu.edu

References

1. 2003. North Carolina Department of Agriculture & Consumer Services. 130 pp.
2. Floriculture and Nursery Crops Situation and Outlook Yearbook. Market and Trade Economics Division, Economic Research Service, U.S. Department of Agriculture, FLO-2003, June 2003.
3. Garber, M.P., W.G. Hudson, J.G. Norcini, R.K. Jones, A.R. Chase, and K. Bondari. 1996. Pest management in the United States greenhouse and nursery industry: I. Trends in chemical and nonchemical control. HortTechnology 6:192•198.
4. Pesticide Usage Estimates. Personal communication from Dr. Bruce Fraedrick of Bartlett Tree Research Laboratories, Pineville, North Carolina.

Prepared by:

James R. Baker (retired), Stephen B. Bambara, and Stephen J. Toth, Jr., Entomology; D. Michael Benson, Plant Pathology; Theodore E. Bilderback, and Brian E. Whipker, Horticultural Science.

Photograph of landscape with dogwoods provided by the Department of Communication Services, North Carolina State University.