State Survey of White-Tailed Deer (*Odocoileus virginianus* Zimmerman) Impacts on Residential Landscapes and the Green Industry of Alabama and an Evaluation of Commercial Deer Repellents

by

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Abstract

Four studies, funded by Mississippi State University, were done to determine white-tailed deer (*Odocoileus virginianus* Zimmerman) damage to ornamental plants and their impact on homeowners, as well as the nursery and landscape industries. The initial steps of this research included developing two surveys to assess deer damage and pressure throughout the state. The next step was to test commercial deer repellents on the market.

The first survey was used to gather information from around the state relating to deer damage to residential landscapes. The survey asked many questions including have you experienced any deer damage on your property, what preventative methods to deter deer are being used, and what types of plants suffered the most damage.

The second survey determined the amount of deer damage to nursery and landscape professionals located throughout the state. This survey includes 30 questions, and reached Alabama growers and retailers to establish their opinion on deer damage. Results indicate that most deer damage occurs in east central and southwest Alabama, with 68% and 66% of the total number of respondents from those areas answering “yes” to deer damage respectively.

Six commercial deer repellents were evaluated for their toxic properties on snapdragon (*Antirrhinum majus* L.) and dianthus (*Dianthus plumaris* L.).

Products tested in this study were Deer Off®, Liquid Fence®, Deer Stopper®, Plantskydd®, Deer Pharm (organic), Deer Stopper® (organic). Through testing it was concluded that all of the repellents used in this study were safe to use on annual landscape species.

The final test was completed at the Auburn University Deer Research Facility in Camp Hill, Alabama. Products tested in this study were Buck Off!, Deer Off®, Deer Stopper®, Liquid Fence®, and Plantskydd®. Three plant species were used including 'G.G. Gerbing' azalea (*Rhododendron indicum* L.'G.G. Gerbing'), 'Gumpo White' azalea (*Rhododendron eriocarpum* L. 'Gumpo White'), and indian hawthorn (*Rhaphiolepis indica* L.),. In Experiment 1, Liquid Fence® provided most protection compared to other treatments, and in Experiment 2, Deer Stopper® provided most protection against white-tailed deer damage.

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CHAPTER I

INTRODUCTION AND LITERATURE REVIEW

Urban sprawl is a problem affecting wildlife due to the infringement of cities on once rural areas. These rural areas serve as habitats for many wildlife species, and consequently wildlife are being driven out of their native habitats and into urban areas. It is predicted that during the next twenty years urban wildlife will become a main focus to many wildlife professionals (1). Of these urban wildlife species, deer have become a major problem in the United States. Deer or closely related relatives are currently living in all forty-eight contiguous states in America, and are located throughout the world, including eight Canadian provinces, Mexico, Central America, northern South America, and have been introduced to Asia, and Europe (2).

Members of the deer family (Cervidae) native to North America include black-tailed deer, mule deer, moose, reindeer (commonly known as caribou), wapiti (better known as elk), and white-tailed deer. In the United States the most abundant of the deer species is the white-tailed deer (*Odocoileus virginianus* Zimmerman) having thirty-eight subspecies and are typically found in the eastern half of the United States. Black-tailed deer species are found along the Pacific coast, and the Rockies have a mix of white-tailed and mule deer (2). White-tailed deer native to the northern states tend to be larger, often weighing up to 430 pounds, whereas southern species tend to weigh less, usually around

155 pounds (19).

Populations of white-tailed deer have grown exponentially over the past hundred years, mainly due to the loss of natural predators, allowing deer to adapt, leading to the drastic population increase. In the early to mid-1600s, it was estimated that there were approximately twenty million white-tailed deer roaming the North American continent. Due to massive deforestation and hunting by early settlers, at the end of the 1800s, it was estimated that only five hundred thousand deer were left in North America. The heavy decline in population numbers was associated with lack of designated hunting seasons and no limits to the number of deer killed by hunters. After the steady decline in numbers, around the early 1900s, hunters began to take steps to reverse the population decline by urging the end of open season hunting and enforcing a bag limit, which can be defined as a limit on the number of deer harvested per season. These rulings worked so well that deer numbers in North America steadily increased over the years to the point they are today. The deer population in the United States was estimated between fifteen and twenty-five million (2). Of these twenty-five million, it is estimated that there are about 1.8 million white-tailed deer living in Alabama (7).

Most species of deer live in woodland areas, but some species prefer swamps, marshes, or grassy areas. Deer are considered to be an edge species, which means that they prefer habitats at the edges of woodlands or forests rather than deep interiors. As urbanization continues, human interaction with deer increases. This movement creates new edges for deer to live (2). With the increase in exurban areas, or a patchwork of residential and commercial areas with wooded areas, some homeowners and businesses

consider deer to be a serious pest. Regularly irrigated and fertilized residential landscapes tend to attract deer (2).

Deer require large home ranges of 220-2,200 acres. Deer are also very adaptable to the environment around them and the changes in seasons, from spring and summer with abundant lush green leaves, grasses, and fruits to harsh winters with very little food or water. Winter is typically the most difficult time for deer to find suitable food, and often this is the time that they turn to landscaped areas (2). Vast amounts of nutritious foods are required daily by white-tailed deer in order to grow, maintain health, and reproduce. The amount and quality of food consumed by deer will affect its productivity, rate of antler growth, health, and size. On average, a deer will eat four to six pounds of food daily for every 100 pounds of body weight. Food is often selected according to availability, however; nutritional value and taste are preferred (27).

Visuals indicators of deer damage include deer beds, tracks, and deer excrement also known as scat. Packed down areas of grass or mulch that are roughly three feet in diameter and located near a food source indicate a deer bed. Deer tracks are typically three inches long and can appear in mud, dirt, or snow. Scat will be in an elongated form and often clumped together on the ground (2). Deer and rabbit scat can often be easily confused, however; rabbit scat is round in form and deer scat is elongated. Recent or green new growth on plants is typically most damaged due to deer feeding. Deer tend to prefer the new growth because it is the most succulent portion of the plant (5).

Deer damage. Deer can cause a variety of problems including automobile accidents or damage to personal property such as gardens, landscapes, nurseries, orchards, and agricultural crops. Deer cause between 300,000 to 500,000 vehicular accidents a year

and about 100 deaths (2). Deer have even been reported to dash onto airport runways (3). In 1999, an estimated $4.5 billion in economic loss to growers was attributed to wildlife depredation (2).

There are several states that have reported devastating losses due to deer damage including $30 million in damages in New Jersey to crops such as: corn, hay, soybeans, string beans, strawberries, apples, pumpkins, and others (2). Seventy percent of producers in Virginia experienced deer damage in 1995, and homeowners in Virginia also estimated annual losses to be between $20 and $1,000. Farmers in Ohio claim that 20 to 55 percent of corn, pumpkin, and pine trees were lost to damage annually. Throughout eastern counties of North Carolina so much damage occurs that officials have permitted farmers to hold depredation permits, which allow farmers to harvest white-tailed deer in order to defend their cash crops. In Iowa, deer annually consume up to $7 million in corn crops. In West Virginia, Christmas tree farmers have been forced to replant thousands of seedlings lost to deer and many mature trees have suffered due to browsing and rubbing. The majority of this damage is due to the increasing population of white-tailed deer, and the increasing rise in urbanization, causing the loss of deer habitats along with movement of humans from rural to suburban areas.

There have been several surveys conducted in order to determine both the perceived and actual damage to an area due to white-tailed deer. In 2004 the New York Agriculture Statistics Service estimated that agriculture in New York returns close to $3.4 billion annually, and wildlife damage to crops continues to be a dilemma for farmers (9). According to farmers surveyed in New York state, white-tailed deer are the leading cause of wildlife damage to crops. This survey was used to determine farmers' estimates of

deer damage to major crops throughout the state, assess the use of New York's nuisance permit system, and estimate the total ratio of deer damage to total wildlife damage to crops. Farmers were classified according to crops grown and grouped: farms with sales of bees and honey only, farms with aquacultural sales only, farms with sales of greenhouse products only, farms with sales of livestock only, and other farms with <$1,000 in total sales. The population of participants totaled 3,808 and the total number of surveys returned were 1,927, for a total response rate of 50.6%. Conclusions showed that 56.7% of respondents estimated annual damage at $1,000 or less. About 13.7% of respondents estimated annual damage to exceed $5,000, while 6.8% of respondents estimated between $10,000 to $500,000 damage annually.

Another survey gathered information on community attitudes toward suburban deer management strategies, particularly contraception (20). Deer management is continually difficult and controversial, and often methods that involve harming the animals are frequently opposed by some citizens. Alternative or nontraditional methods have been proposed in suburban settings including contraception, which is a technique that could possibly be used to control white-tailed deer numbers. Smaller white-tailed deer populations in suburban areas would result in a decline in deer damage to landscape ornamentals for homeowners. Two surveys were developed and mailed to Irondequoit, New York residents. The initial survey was conducted in January 1997 and the second survey in September 1998. Respondents were interested in white-tailed deer management, deer-related troubles, and concerned about reducing the local deer populations. Results showed that there was a significant interaction between information given about contraception and concerns. As a result, information given to citizens about

contraception had an essential influence on the attitudes of Irondequoit residents toward implementing the alternative method. Respondents receiving effectiveness or humaneness information were less likely to support contraception as an effort to decrease white-tailed deer populations. This survey concludes that contraception is not a practical resource in controlling deer populations in suburban areas, and residents of areas with high deer densities will need to turn to other options to control white-tailed deer numbers and damage.

Deer feeding preference. Deer are strictly herbivores, and their means of finding food is through browsing (19). Deer diets include a wide variety of plants, with a preference for certain plants. However, during times of need or starvation deer will eat almost anything (16). In many orchards and nurseries, deer particularly damage young, fertilized, highly nutritious seedlings (3). Deer damage can be seen on plants by torn or jagged leaf or twig edges due to the fact that deer have no upper incisors (16). They can't cut twigs as neatly as other animals, and must use their bottom incisors and tough upper pad to tear the plant. Deer must grab the plant and shake their head from side to side to pull the vegetation loose (2). In dry summer months and cold winter months, hilly terrain provides little if any forage for deer, so they naturally spend their summers and winters in valleys and canyons and winters searching for suitable food. Here food is more plentiful, but in contrast these areas are usually where homes and gardens first occur during urban sprawl (19).

Deer feeding preference may also change with seasons and plant palatability may alter depending on time of year (31). When compiling extension lists from the Southeastern United States, it was observed that many plants were more or less palatable

depending upon the state in which the plant species is located (Appendix C). For example, red maple (*Acer rubrum* L.) is considered a tree with moderate damage in Florida, a tree with a high degree of deer tolerance in Georgia, a deer attracting tree in Alabama, and a tree occasionally severely damaged in South Carolina. This shows that deer feeding preference is not only dependent on season, but also dependent on region of the country that deer are located.

Tripler *et al*. (30) examined the relationship between soil nitrogen availability and luxury consumption and herbivory by white-tailed deer. Deer tend to prefer new, succulent growth and can significantly reduce a sapling's ability to generate new spring growth, which in turn can decrease the total photosynthetic output for saplings. When availability of nitrogen is elevated in the soil, some tree species can exhibit luxury consumption of nitrogen and saplings can benefit from this, but this increase may also increase the risk of white-tailed deer herbivory. In this study, saplings of nine tree species were either fertilized or left unfertilized. The species used in this study were: yellow birch (*Betula alleghaniensis* Britt.), black cherry (*Prunus serotina* Ehrh.), sugar maple (*Acer saccharum* Marshall), white ash (*Fraxinus Americana* L.), eastern hemlock (*Tsuga Canadensis* (L.) Carriere), red maple (*Acer rubrum* L.), red oak (*Quercus rubra* L.), American beech (*Fagus grandifolia* Ehrh.), and white pine (*Pinus strobes* L.). Frequency of browse and damage was recorded on fertilized and unfertilized saplings. Results showed that browse frequency was elevated on fertilized saplings, and saplings that had been previously identified as luxury nitrogen consumers had higher browse rates.

Control Methods. The most common problem caused by deer is feeding damage to garden and landscape plants. There is a great demand for controlling and reducing

damage to plants due to deer browsing. The most common methods for the control and management of deer can be grouped into six different categories that include: exclusion, scare tactics, habitat modification, removal (culling or trapping), alternative plantings, and commercial deer repellents (4, 22). Homemade techniques, such as soap and human hair, are also often used by homeowners as management strategies. The effectiveness of these products is often based upon weather, deer density, and availability of food choices (28).

Exclusions. Exclusions can be defined as some type of fencing used in order to reduce the entry of deer into areas that they can potentially cause damage. A deer fence should be between eight and ten feet tall and buried 2 to 3 feet in the ground. Using fencing is a common method of deer control and can reduce damage up to seventy-five percent (22). Fences can be made of high-tensile wire, mesh, or electric wiring. Placement of the fence can be angled to prevent deer from jumping over the fence. Angled fencing uses the combination of height and width to reduce deer entry. Due to poor depth perception deer might are unable to clear a double fence (16).

Other types of fencing include double row fences, which are constructed by using two smaller fences side by side. The two fences should be no taller than four to five feet and should be placed at least four to five feet apart (16). If fencing a large area is cost prohibitive, fencing might be used in small plantings or around single plants. When using a wooden fence, slats should be close to the ground (19). Fencing should be close to the ground or preferably below ground because white-tailed deer have the ability to crawl under fencing (8). Fencing is quite effective in reducing deer damage, however; it

is also quite costly. Costs can range from $185 to $5000 an acre depending on the type of fencing (2).

Several airports have reported collisions involving deer, and have turned to electric fencing to reduce the probability of deer related accidents (24). ElectroBraid™ fencing is one type of electric fence being used in order to keep deer off runways. These fences consist of fiberglass posts that are at fifteen-meter intervals with a 0.6 centimeter polyester rope woven with copper wire. Several tests were done and the results showed that the ElectroBraid™ fencing served as a successful barrier, about 88-99% effective, for reducing the number of deer on runways at airports. There are many benefits to installing an electric fence including: being more economical to install than woven fencing and the fence may be easily set up, taken down, and moved. Fencing can be effective for large areas such as airports, but may not be as economical for small-scale control, such as residential and commercial areas.

Another study in New York tested the effectiveness of a vertical 3-wire electric fence that had been modified with either attractants or repellents (17). Each of the study sites contained four 6 x 6 meter enclosures which were electrified, electrified with an attractant, electrified with a deer repellent, or a non-electrified control. The density of the deer in the study areas were not known, but each of the enclosures was baited with apples to guarantee visitation by deer. Twelve apples were placed in the center of each plot, and data were recorded daily by determining the number of apples missing or damaged. After 116 days, the electric fence with the deer repellent deterred the most deer, with only 7.5% of apples missing or damaged. This was followed by the electric fence without an attractant at 11.9% of apples lost or damaged, electric fence and attractant with 13.8% of

apples lost or damaged, and the non-electrified fence with 20.1% of apples lost or damaged.

Exclusions were also used in an experiment to determine the impact of white-tailed deer on agricultural landscapes in three national historic parks located in Maryland (26). It is estimated that the current deer density for Mid-Atlantic regions, such as Maryland, exceeds 40 deer/km^2 (247 ac.) for both rural and suburban national parks. Three national historic parks were used as study sites for this experiment including Antietam National Battlefield, Monocacy National Battlefield, and the Chesapeake and Ohio Canal. Fields were selected in all parks and corn was planted for 2 years. Non-electric fencing that was 5×5-m was erected in certain fields after seeding but before emergence. Results concluded plots that were fenced had a far less significant crop loss than unfenced plots.

Scare tactics. Scare tactics are another option for deer control and management. This form of control is useful for a period of time, but often deer become accustomed to the noise and the scare tactic is no longer useful. Some scare tactics that have a long-lasting effect include scarecrows, fluttering metallic ribbons, flags, balloons, and cassette or videocassette recorder tape (removed from the cartridge). Motion detection lighting also may help protect against feeding damage because the bright lights are only triggered when a deer enters the premises, and is designed to frighten the deer into running away (2). Similarly, timed sprinklers can be used in order to scare deer. Sprinklers set off by timers or motion detection can be used as scare tactics in order to repel deer from a desired area (16).

A recent study used bio-acoustics, or animal communication signals that are often in the form of alarms or distress calls, as frightening devices to reduce damage to corn fields (13). When tested, however, there were no differences between the control and frightening device cornfields. This means that the device did not work and deer continued to enter and feed in both fields.

In a similar experiment, propane exploders and electronic guards were used to reduce deer damage in corn fields (14). These electronic guards were formatted to fire at fifteen-minute intervals throughout the night. The electronic guards were set at seven-minute intervals and contained a flashing white light and siren. This test also proved to be unsuccessful, and showed little to no difference in feeding. Studies show that there might have been some success at the beginning, but that deer quickly became accustomed to the scare tactic and continued to feed. Scare tactics involving noise are often not a realistic control method, especially in suburban settings where noise can often disturb other residents.

Culling. Culling is an unrealistic control method in urban areas due to safety concerns. In most cases killing problematic deer will not solve the problem as a whole or the long-term problem of deer damage. Property owners may feel better by killing one deer, but in reality very little is accomplished by culling. Most likely when using culling as a management technique, deer will simply change or modify their habits feeding on crops at different times of the day or after dark (23).

Repellents. Deer repellents have become the most common means of deterring deer feeding. Deer have a very keen sense of smell and rely on it heavily. Repellents can be classified into two different categories: direct repellents and indirect repellents. Direct

repellents repel directly through bad taste. Many commercial direct repellents contain Thiram™, which is a widely used fungicide to prevent disease on certain crops and can be used as a bittering agent in some deer repellents. An indirect repellent repels through sight, smell, or sound (19). As stated before, deer are highly adaptable creatures and can become accustomed to new odors over time, so the best option is to keep the deer guessing by periodically changing the location and type of repellent (16).

In 1987, Byford (11) reported that researchers in Connecticut tested the effectiveness of six common deer repellents including: human hair collected from local barber shops and placed in nylon mesh bagging, Magic Circle Deer Repellent (putrescent egg solids), Big Game Repellent (also known as Deer Away®, made of putrescent egg solids), Hinder® (a repellent made from ammonium soaps of higher fatty acids), Miller Hot Sauce (containing capsaicin from hot peppers), and Thiram™. All repellents were applied according to labeled directions on Japanese yew (*Taxus cuspidate* Siebold & Zucc.), which is considered to be a highly palatable plant species to deer. There was no mention of a control used in this experiment. Results showed: human hair was 34% effective, Magic Circle 18% effective, Big Game Repellent 46% effective, Hinder® 43% effective, Miller Hot Sauce 15% effective, and Thiram™ 43% effective. All repellents in the study were only partially effective, with Big Game Repellent having the highest percentage of effectiveness, but almost all repellents tested reduced deer damage. Cost of the product per hectare (2.47 acres) based on label rates was also analyzed. Costs included: $24 (hair), $74 (Magic Circle), $990 (Big Game Repellent), $75 (Hinder®), $26 (Miller Hot Sauce), and $555 (Thiram™).

In a similar study, five commercial deer repellents were used on ornamentals in a nursery setting (21). The five commercial repellents were: TreeGuard™, Deer-Off®, Bobbex™, Holly Ridge, and Deer-Away®. Several plants used in the study were considered to be deer attracting including Keteleeri juniper (*Juniperus chinensis* L. 'Keteleeri'), meserve hybrid holly (*Ilex x meserveae* S. Y. Hu 'Blue Princess', *Ilex x meserveae* S. Y. Hu 'China Girl'), hybrid yew (*Taxus x media* Rehd. 'Densiformis', *Taxus x media* Tehd. 'Nigra), and English yew (*Taxus baccata* L., *Taxus baccata* L. 'Repandens'). In both trials, plots were broken into blocks and then divided into experimental units, which contained one to sixteen plants of a single species. In the first trial occurring from October 1997 to March 1998, Deer-Away® (consisting of putrescent egg solids), TreeGuard™ (containing bitrex), Holly Ridge (containing putrescent egg solids and capsaisin), and Bobbex ™ (containing food processing by-products) were all used. The results showed that Deer-Away® and Holly Ridge both reduced deer damage compared to other products tested. Only two out of thirty-four plants treated with Deer-Away® were damaged and none treated with Holly Ridge were damaged. The second trial occurred from October 1998 to March 1999, and Bobbex™ was eliminated and Deer-Off®, containing putrescent egg solids, capsaicin, and garlic, was added to the study. The results were similar to those in the first trial and Deer-Away® and Holly Ridge resulted in the lowest percent browse regardless of species in all studies. These two repellents share the same active ingredient, egg solids.

Another study was conducted in Georgia using only Milorganite® as a type of deer repellent. Milorganite® is a fertilizer product that is derived from activated sewage sludge (25). This organic product is a slow release fertilizer that can be applied directly

to plants with no harm of burning the plants. This test was conducted at Berry College in north Georgia with the use of chrysanthemums. Plant damage was measured by the bud number. Each of the plants received application of four ounces of Milorganite®, and data were collected every seven days. Plants treated with the product had more terminal buds per plant and less terminal buds damaged due to deer browse. Although the product did not completely eliminate deer damage to the plants, it did significantly reduce damage. However, the disadvantage of this product is that effectiveness is dependent on weather conditions, and the product must be reapplied often.

There have been several studies using organic products to deter deer feeding (12). One study at Auburn University used organic products to reduce deer damage on ornamental landscape plants. Several plant species were used including: hosta (*Hosta fortunei* L.H. Bailey 'Francee'), globe amaranth (*Gomphrena globosa* L. 'Rose'), and annual vinca (*Catharanthus roseus* L. 'Pacifica Red'). The organic treatments that were used included: Deer Away®, Garlic Barrier®, and Fish-Agra®. These three products contain putrescent egg solids, garlic, and fish oil, respectively. A non-organic product, Deer and Rabbit Repellent® whose active ingredient is Thiram™, was also used because of its effectiveness in previous studies. Deer were contained in a 0.4 ha (1 ac.) enclosure, containing 13 does, 1 buck, and an unknown number of fawns, so feeding pressure was high. Each of the treated plants was randomly placed inside the feeding pen with the deer and damage was surveyed. Damage was surveyed each day for a total of six days. Data was taken in several different ways according to plant species. Hostas were evaluated according to the number of leaves not eaten, but the amaranth and annual vinca were analyzed on a rating scale from zero to three (0 = no damage, 1 = 1/3 plant removed, 2 =

2/3 plant removed, 3 = plant cut at soil line or uprooted). All treatments reduced damage compared to the non-treated control plants regardless of species. Results suggest that application of the repellents provided some form of protection to the plants. However, the hostas did receive damage over the six-day period, and the globe amaranth appeared to best exhibit the effectiveness of the products. According to observations of feeding damage hosta, globe amaranth, and annaual vinca were categorized as having high, medium, and low palatability to white-tailed deer, respectively.

A similar study was done where 21 different odor and taste repellents were used to decrease browse to apples or apple shoots (10). Treatments included: Big Game Repellent™, Hot Sauce Animal Repellent, Lifebuoy bar soap, Lifebuoy soap chips, Lifebuoy perfume, Hinder®, Thiram 65 WP, Off-Shoot T, bubble gum flavor, baby powder fragrance, diallyl sulfide, piperine, broccoli extract, Pine Sol®, tree paint, ICI L-22, dried cabbage, cedar leaf oil, vapor gard, deer blood. Apple or apple shoots were dipped or sprayed with the various repellents. Of the 21 repellents tested, Big Game Repellents™, Hot Sauce Animal Repellent, and Lifebouy soap were all used all used as repellents and proved to be the most effective, but only for a short period of time.

Research conducted by the USDA National Wildlife Research Center directly compared the effectiveness of 20 commercially available deterrent products on the market. Products used included: Detour ™, Deerbuster's ™ Coyote Urine Sachet, Wolfin, Deerbuster's ™ Deer and Insect Repellent, Deer Away® Big Game Repellent Powder, Deer Away® Big Game Repellent Spray, Bye Deer, Hinder®, Plantskydd®, Miller Hot Sauce, Get Away Deer and Rabbit Repellent, Ropel®, Tree Guard®, Orange TKO, Deer Stopper®, Not Tonight Deer!®, Plant Pro-Tec®, Dr. T's Deer Blocker,

N.I.M.B.Y.®, and Deerbuster's™ Deer Repellent Sachets (29). The variety of products used in the experiment repelled through fear, pain, conditioned avoidance, and taste. All products were applied to western red cedar (*Thuja plicata* Donn. *ex* D.Don.) seedlings according to label directions. Five pastures were used to complete the test all varying in size from two to five acres, and each pasture contained five to six captive black-tailed deer (*Odocoileus hemionus columbianus*). Seedlings were planted in 21 plots, and a separate plot was used for each type of repellent with a control of non-treated seedlings in one plot. Plots were scattered evenly across the pasture, and each held three rows of western red cedar seedlings that were planted at approximately three foot intervals. Seedlings planted were about 20 inches tall and contained numerous lateral branches. Browse damage was assessed at 24 hours after planting, 48 hours after planting, one week after planting, and then at one week intervals for a total of 18 weeks. Damage was determined by carefully counting the number of bites taken from each seedling. The maximum number of bites recorded was 25. Typically after 25 bites or more the seedlings were considered completely defoliated, and seedling pulled entirely from the ground were labeled with 25 bites and considered to be destroyed. Conclusions showed that none of the repellents used completely eliminated browse damage throughout the 18 week period. However, it was observed that topical repellents generally performed better than area repellents. Of the total 20 repellents, eight of the repellents considered to be most effective in the study released sulfurous odors. Other repellents considered to be effective included: Deer Away® Big Game Repellent Powder and Liquid, Bye Deer Sachets, Deerbuster's™ Sachet, and Plantskydd®. All of these products include decaying animal proteins such as egg or slaughterhouse wastes.

In 2001, Wagner and Nolte (31) performed similar research by testing 20 commonly available deer repellents on the market to evaluate current products and determine their efficiency. A captive herd of black-tailed deer from the National Wildlife Research Center located in Olympia, Washington, was used for this test. Repellents were tested in both spring and winter. Products tested included: Detour™, Deerbuster's™ Coyote Urine Sachet, Wolfin, Deerbuster's™ Deer and Insect Repellents, Deer Away® Big Game Repellent, Bye Deer®, Hinder®, Plantskydd™, Hot Sauce®, Deer Away® Deer and Rabbit Repellent, Ropel®, Tree Guard®, Orange TKO, Deer Stopper™, Not Tonight Deer™, Plant Pro-Tec®, Dr. T's Deer Blocker, Deerbuster's™ Deer Repellent Sachets, and N.I.M.B.Y.®. Repellent were applied to western red cedar seedlings (*Thuja plicata* Donn. *ex* D.Don.). Damage was recorded by observing the number of bites taken from each seedling and was recorded at weekly intervals for a period of 18 weeks. Results showed that repellents that induced fear were more effective than repellents that used taste as a mode of action. In the spring, Planskydd™ and Deer Away® Big Game Repellent both reduced damage, and in the winter months Deerbusters's™ and Bye Deer® sachets reduced deer foraging.

A study conducted at the Pennsylvania State University Deer Research Facility tested 14 white-tailed deer repellents (15). The repellents included: feather meal, mothballs, creosote, hot sauce, hair, blood meal, meat meal, Big Game Repellent, Magic Circle, Spotrete™ F, Hinder®, Gustafson 42-S, Chaperone, and Nott Chew-Not. Each of the repellents was applied according to manufacturer's labeled directions or by the literature and personal communications for "home remedy" repellents to shelled corn. The deer population consisted of nine deer of various ages and sexes. Individual deer

were used to test one product daily until each deer had been offered all repellents. Orders of repellents as well as the daily test order for deer were randomized. The percentage of time each deer chose a certain repellent treatment over the control was calculated using the formula: $percent\ choice = \frac{number\ of\ times\ treatment\ chosen}{total\ number\ of\ choices} \times 100$. Results showed that five of the repellents: mothballs, creosote, human hair, Magic Circle, and blood meal, were considered to be less effective than other products tested. Repellents including meat meal, Big Game Repellent, feather meal, Hinder®, hot sauce, Chew-Not, Chaperone, Gustafson 42-S, and Spotrete™ F were believed to be most effective and exhibited the most promise as deer repellents. It can also be noted that Chew-Not, Chaperone, Gustafson 42-S, and Spotrete™ F all include the same active ingredient (Thiram™) and all rank similarly.

Another study looked at technical-grade hydrolyzed casein (HC) to reduce white-tailed deer damage to trees and shrubs (18). All deer used in this study were hand-reared captive white-tailed deer ranging from two to four years of age. Three different experiments were done and all provided evidence that HC is an effect deer repellent. Damage to evergreen shrubs, such as salal (*Gaultheria shallon* Pursh.) and conifers like western red cedar (*Thuja plicata* Donn. *ex* D.Don.), was completely eliminated with the use of technical-grade HC during periods of testing. However, researchers observed that retail sources of HC were not as effective in repelling deer as pure hydrolyzed protein, but retail sources do offer some protection against browse damage. Results showed that application of HC could be an effective deer repellent in large scale situations such as nurseries or orchards. For smaller scale operations such as private homes, a less complex

form of HC can be used to eliminate deer damage to landscapes, which can be found in HC-containing baby formula powders.

Phytotoxicity of deer repellents. There have been many experiments testing the effectiveness of commercially available deer repellents, but very few tests look at phytotoxicity of common deer repellents. In 1996, Bergquist and Orlander (6) tested efficiency of eight deer repellents to reduce roe deer (*Capreolus capreolus* L.) damage to 2-year-old containerized seedlings of Scots pine (*Pinus sylvestris* L.) and Norway spruce (*Picea abies* L.) at the Swedish University of Agricultural Sciences. Repellents tested included: Anipel, Gyllebo blood meal, Gyllebo seedling protection, Gyllebo granulate, I.A.- Game Repellent, Cervacol Extra, freeze tape, fish oil, and Dendrocol Extra. The following repellents caused a significant phytotoxic effect on treated plants: Anipel, fish oil, Gyllebo blood meal, and Cervacol Extra. Similar deterrent products that caused phytotoxic effects are available and commonly used in the United States, like fish oil and blood meal. Plantskydd® is a natural blood-based Swedish animal repellent that is manufactured and sold in the United States. Commercial deer repellents can decrease deer damage to plants, but some can also harm or diminish plant growth. Although much work has been done concerning effectiveness of deer repellents, more testing should be done to determine if commercial deer repellents are plant safe.

Research objectives. Research has been done to evaluate techniques to reduce deer damage to plants, but there is still no effective way to completely eliminate deer damage to ornamental plants. More research is needed, and the effectiveness of current repellents needs to be improved. One goal of this research was to determine the amount of deer damage experienced in Alabama to nursery and landscape professionals as well as

homeowners. This will help determine in which section of the state most damage occurs and strategies to control damage. Surveys were used to collect information such as deer pressure in an area, cost of deer damage annually, and any preventative measures being used to deter deer. By analyzing what deterrent methods are being used and their effectiveness according to respondents, the search for a successful management strategy can be narrowed. Another goal included discovering which commercial deer repellents are most successful in preventing deer damage. By analyzing commercial products that are on the market a better understanding of what type of products are effective and ineffective can be established, while determining if the commercially available products have any phytotoxic effects on treated plants. The last goal is to analyze deer repellent costs and application timing to discover which products are most cost effective for homeowners.

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CHAPTER II

SURVEY OF WHITE-TAILED DEER (*Odocoileus virginianus* Zimmerman) IMPACTS ON RESIDENTIAL LANDSCAPES THROUGHOUT THE STATE OF ALABAMA

Abstract

To determine white-tailed deer damage impacts on homeowners' landscapes throughout the state of Alabama, a twenty-six question survey was developed. This survey was mailed to a total of nine Master Gardener associations in the state, for a sample of 207 respondents. Survey questions inquired if homeowners experience any white-tailed deer damage in their landscape, what types of preventative methods are being used, when most deer damage occurred, plants deer typically browse, what type of environment surrounded their property, and how much of their landscape suffered deer damage annually. Of the respondents, 36.6% answered "yes" to damage problems, and of the respondents that experienced damage, 60.6% were employed preventative methods to reduce deer browse. The majority of respondents reported most damage was experienced during the spring (18%), and the most listed plant for damage was hosta (*Hosta* spp.) at 21%. When asked what type of environment surrounded their property, the majority of respondents who experienced damage reported that their landscape was surrounded by a wooded area (89.9%). Fifteen percent of respondents reported up to 50% damage to their landscape annually, and 5.6% of respondents stated they experience

up to a 50% reduction or loss to plant material in their landscape annually due to deer damage.

Index Words: Survey, deer repellent, plant damage, deer browse.

Significance to the Industry

Damage to ornamental plantings by white-tailed deer is a serious concern not only to nursery and landscape professionals but to homeowners as well. As white-tailed deer populations in non-rural areas of Alabama increase, mainly due to growth of exurban environments of the 21st century, residential landscapes sustain more feeding damage. There is no previous record of the amount of damage suffered by homeowners in Alabama annually. In this study, a survey was developed to determine the amount of white-tailed deer damage sustained by homeowners' landscapes annually and determine what types of commercial deterrent products are being used. It was discovered that 36.6% of respondents experienced white-tailed deer damage to their landscape, and 60.6% of the population experiencing injury used some type of deer deterrent to reduce damage. With an understanding of how much damage occurs in the state and the location of the majority of damage, more research can be done to determine effective ways to control deer damage and educate homeowners on preventative methods.

Introduction

As populations of white-tailed deer continue to rise, many homeowners in the rural/urban interface contend with feeding damage to ornamental and garden plants (11). It is estimated that there are 1.8 million white-tailed deer living in Alabama, with a total of twenty-five million inhabiting the United States (1, 4). Increasing urbanization of rural landscapes continues to drive white-tailed deer out of their native habitats creating

new challenges in suburban wildlife management due to direct human contact and interactions (5). Increased deer numbers in suburban areas are due to the exurban environments of the 21st century. These environments provide a patchwork of suburban areas separated by portions of wooded areas which provide suitable habitats for white-tailed deer (14). White-tailed deer can better coincide with urban expansion by creating exurban environments with larger suburban lots and patches of native vegetation between housing (13). These ideal environments combined with overpopulation and a keen adaptability of white-tailed deer has led to the current problems experienced by homeowners (3). Therefore, there is a need to discover more effective and cost efficient methods to manage white-tailed deer to reduce damage in suburban/exurban areas of Alabama.

Surveys have been used as a successful tool in determining the amount of deer damage in a specified area. In 1989, Sayre and others (15) conducted a survey throughout New York State to determine the quantity of deer damage to ornamentals, and examine perceptions from nursery producers, landscape firms, and homeowners on that damage. Forty-nine percent of homeowners reported that they had seen some evidence of deer damage to plants on their property. They also stated that most damage to their landscape occurred during the winter and spring seasons. Results of this survey also concluded that both homeowners and producers believe that improved and more reliable information on management strategies is greatly needed. Connelly and others (7) conducted a survey in 1987 to examine public tolerance of deer in suburban environments through a survey of property owners. Results illustrated that the majority of respondents (66%) had seen some evidence of deer feeding on their property during

the past year. Residents also expressed their concern for other deer related issues including the risk of Lyme disease and vehicular accidents. Another survey, conducted by Connelly and others (6) in 2008, was used to assess deer impacts and management options on a landscape scale. This survey evaluated landowner perceptions of deer impacts and management policies, in particular hunting, and provided an estimate of deer harvested on their properties annually. Results showed that approximately one-third of respondents would like to see a decline in the population of deer in their area, and the majority of respondents believe that hunting is necessary in order to control deer populations in their area and reduce crop damage.

Common methods to control unwanted deer damage for homeowners can be divided into six categories including: exclusions, scare or frightening tactics, habitat modification, population reduction through culling, commercial repellents, and alternative plantings (11). Landscaping based on deer feeding preferences may provide an alternative to chemical repellents and unsightly physical barriers for homeowners (9). However, other more in depth methods have been studied including a survey of community attitudes toward contraception of suburban deer as a management technique. In 1997 and 1998, Lauber and Knuth (10) designed a study to communicate ideas and techniques about contraception to the public in hopes of determining perspectives and attitudes toward contraception as a management strategy in place of hunting. Immunocontraceptive drugs have shown to be effective in stimulating immune systems of captive deer to produce antibodies that prevent pregnancy (12). It was concluded that particular concerns for homeowners were more likely to influence their attitudes about contraception methods as control options as opposed to traditional control methods.

The objectives of this research were to develop and conduct a survey specified for homeowners throughout Alabama to determine the amount of deer damage suffered annually along with providing insight on promising preventative methods. Specific concerns for homeowners included: experience of deer damage on your property, use of any preventative methods, what types of methods are being used, timing of the majority of problems, types of plants deer typically browse, type of environment surrounding the property, and size of the property. By determining the significance of deer damage throughout Alabama and discovering the most effective preventative methods, more research can be done to find and educate homeowners on effective management strategies.

Materials and Methods

The population surveyed consisted of Master Gardeners throughout the state of Alabama. A listing of county and association presidents was obtained from Kerry Smith, Alabama Home Grounds and State Master Gardener Program Coordinator. Master Gardener presidents were contacted via email and asked to participate in the survey. Willing participants returned the email and provided addresses for sending surveys by mail in bulk amounts. Since most Master Gardener groups only meet once monthly or bimonthly, surveys were mailed out according to the date of each association's meeting schedule. A total of nine associations took part in the homeowner survey including the Capital City Association, Central Alabama Association, Blount County, Baldwin County, Barbour County, Chilton County, Jefferson County, Calhoun County, and Coffee County. Homeowner surveys were also given to random homeowners visiting the Huntsville Botanical Garden on October 10, 2009. The combined number of homeowners surveyed

was 207. In order to boost response rates, several of Dillman's Principles (8) were implemented including: clear and easy to comprehend questions, a detailed cover letter (Appendix A, Figures 1 and 2) explaining why it was important to respond, return envelopes and stamps were provided, and the survey was kept as short as possible.

The main objective of this survey was to determine the amount of deer damage that homeowners experience throughout the state of Alabama, along with discovering common types of preventative methods used by homeowners and their success. The survey for homeowners contained twenty-three questions to determine the overall impact of deer browse damage in landscape settings. Homeowners were asked a variety of different types of questions to get an overall impression of how much deer damage occurs in residential landscapes throughout the state of Alabama (complete survey in Appendix A, Figure 2). The majority of questions on the survey were closed-ended questions, but there were several questions that were open-ended where respondents could write-in their responses. Closed-ended questions consisted of multiple choice and likert-scale question types. For several questions respondents were able to select more than one answer, so percentages did not always add up to 100. At the conclusion of the survey collection data were entered into an Excel spreadsheet (Microsoft, 2007), and uploaded into SPSS 17.1 (SPSS, 2008) for analyses.

Results and Discussion

At the conclusion of the survey, 668 surveys were distributed and 207 responses were returned for a response rate of 31%. When asked if homeowners encounter any deer damage problems in their landscape, 36.6% responded they do experience browse trouble, while 63.4% of respondents stated they do not experience damage issues.

However, of the 36.6% of participants that claim they experienced deer browsing, 60.6% used some type of preventative method to reduce white-tailed deer damage to their landscape. The majority of respondents who encountered damage issues were located in the east central section of the state (50%). Other areas of the state that frequently see damage are west central sections of the state (17.6% of respondents), northeast (15.2%), and southeast (13.2%). According to the white-tailed deer density map of the state from the Alabama Department of Conservation and Natural Resources, east central Alabama has one of the highest deer densities within the state, with 30 or more deer per square mile (2) (Appendix A, Figure 3). West central Alabama and northeast Alabama also have 30 or more deer per square mile, and the density of white-tailed deer in southeast Alabama is 16 to 30 deer per square mile (2). This shows that deer damage to landscape plants coincides with white-tailed deer density of a specific region.

The majority of homeowners who were using preventative methods stated they were using some type of deer fencing (9.7%). Fencing could be ranked highly among homeowners as a preventative method because fencing is commonly used by homeowners for privacy reasons or separation from neighboring properties. Repellents and mechanical deterrents were not widely used by homeowners. Liquid Fence® and Deer Away® were the most frequently used liquid repellents by homeowners, with 2.4% of homeowners using each of these products. Other repellents used by homeowners included Deer Stopper® at 1.4% and Deer Off® at 1% of participants. Several deer repellents listed on the survey were not used by any of the respondents including Buck Off! and Plantskydd®. Plantskydd® has been in production since 1988, but Buck Off!, which was developed in 2007, can be considered a fairly new product to homeowners and

might explain the lack of usage. Plantskydd® may also discourage homeowner usage because it is a blood-based product and product handling can be more complicated than some other commercial deer repellents. Mechanical methods employed by homeowners included motion lighting (2.4%), frightening sounds (1.4%), and motion irrigation (0.5%). Motion lighting was the mechanical method most employed by homeowners. This method could have high usage because many homeowners might already utilize this technology for security/crime prevention, arriving home after dark, and saving money on lighting costs. Other means of deer deterrents written-in on the survey included dogs and human hair. Many other types of deterrents were written-in by homeowners, but dogs and human hair were the only two methods with more than one occurrence.

Respondents were asked to rank the preventative methods they use according to effectiveness. Effectiveness of these products were categorized based on a likert-scale of not effective, fairly effective, moderately effective, effective, and highly effective. Of those homeowners using fencing, 37.5% of respondents rated fencing effective and 20% rated it highly effective, although, 20% of participants also stated that fencing was not effective. White-tailed deer have the capability of climbing under fencing, so an effective deer fence should be buried under the ground 3 to 4 feet. Height of fencing was not asked in the survey, so it is quite possible that those respondents with ineffective fencing were simply not tall enough to prevent deer from entering the property. Homeowners who rated fencing with a low effectiveness rating might not employ the correct type of fencing to properly prevent deer damage. Fifty percent of respondents believed that Deer Away® was effective, however; 25% rated it fairly effective, and 25% stated that it was not effective. Deer Off® was also rated at 50% effective and 50% fairly

effective. Deer Stopper® was listed at 50% highly effective and 50% not effective. Liquid Fence® had the overall highest effectiveness rating at 60%, but it also had 20% list it as moderately effective or fairly effective. According to respondents, motion lighting was 75% not effective and 20% moderately effective. Respondents might have stated that motion lighting was not effective because of deer adaptability, and often deer can become accustomed to scare tactics such as motion lighting. Motion lighting might frighten deer for a short period of time, but using a combination of liquid repellents and motion lighting might be the best option for homeowners to prevent deer browse. Scare tactics or frightening sounds were also ranked highly on the effectiveness rating scale at 50% effective. These sounds might only be rated at 50% effective because deer can become accustomed to frightening sounds, similar to motion lighting.

Respondents were asked to state the time of year that they experienced the majority of deer damage. Seasons in Alabama are generally considered to be winter (December – February), spring (March – May), summer (June – August), and fall (September – November) by homeowners. Eighteen percent of homeowners reported experiencing the most damage to their landscape in the spring. This could be due to the large amount of new, tender growth exhibited by plants during this time of year that deer typically prefer. Respondents also experienced an immense amount of damage during the summer and fall with 16% of the population seeing damage in each season. Winter was listed as the season with only 15% of damage, however; all of the seasons experienced similar amounts of damage. In this survey most homeowners stated that they experienced damage in the spring, and similarly in a survey by Sayre and others (15) one of the times most deer damage occurred was in spring months.

To understand the timing of deer damage, it is best to understand the basic life cycle of white-tailed deer in Alabama. The white-tailed deer breeding season is later in Alabama than all other sections of the country. Typically breeding begins in November, but in Alabama the peak of breeding season is from January 18th to 20th, with a gestation period of 200 days. In spring the females are pregnant and have high nutritional demands. However, females have the highest nutritional demands in the fall after giving birth and beginning lactation. White-tailed deer antlers are deciduous, which means that bucks shed their antlers every spring and begin to grow another set for the following year. New antler growth begins around April and continues until the end of summer. Deer antlers are one of the fastest growing tissues in the animal kingdom, so bucks reach their highest nutritional demands when gaining a new set of antlers. Bucks have higher nutritional demands when putting on new antlers than females during pregnancy. Most respondents reported damage in the spring, which is when bucks have the highest nutritional demands and females are pregnant. Fall was also rated high among respondents for experiencing damage, and this is when females are going through the lactation process and reach their highest nutritional demands. According to the white-tailed deer life cycle in Alabama, the timing of damage experienced to homeowners' landscapes coincides with highest nutritional demands for bucks and the second highest demand for females.

Homeowners were asked to list three plants that deer typically browse in their landscape by scientific or common name. Over sixty different types of plants were recorded, however; there were seven plants that were listed most frequently. The most frequently browsed plant according to respondents was hosta (*Hosta* spp.) with 10% of

participants claiming they experienced deer injury. Other species that were highly ranked according to frequency of damage included hydrangea (*Hydrangea* spp.) 7%, pansy (*Viola* x *wittrockiana*) 6%, rose (*Rosa* spp.) 4%, and pea (*Pisum sativum*), daylily (*Hemerocallis* spp.), and azalea (*Rhododendron* spp.) each with 3%. Ninety-two percent of respondents claimed that they had a garden located on their property. Of those 92%, 35% had only a flower garden and 2% had only a vegetable garden. However, 54% of respondents claimed they had both a flower and vegetable garden.

To determine the typical amount of deer damage experienced annually to homeowner landscapes, participants were asked to give the percentage of plants on their property that suffered damage due to deer browse annually along with the percentage of plants that were lost annually. Of the respondents' landscapes that suffered damage, 16.4% maintained that they experience 1% damage or less annually, yet 13.7% encountered 10% damage to their property annually. Fifteen percent reported up to 50% damage to their landscape, and 4.1% suffered up to 90% plant damage. Similarly, 18.5% of participants stated they lost 1% of their plant material annually to deer damage, however; 11.1% saw up to 5% loss, 18.5% confronted a 10% loss, 7.4% experienced a 20% loss, 5.6% witnessed a 25% loss, 5.6% encountered a 50% loss, and 3.7% of participants lost up to 90% of their plants annually due to deer injury.

When asked if participants believed that the deer population in their area had decreased, remained the same, or increased over the past five years, 28.4% maintained that deer populations had increased and only 6.8% believed that populations had decreased. However, 24.2% stated deer densities within their area have remained the same over the past five years. To understand the connection between respondents who

suffered damage and the basis of the damage, we asked respondents to describe the environment that surrounded their property. Of the participants that encountered damage, 89.9% lived in a wooded area, 20% were surrounded by fields, 14.7% lived in a suburban setting, and 12% lived near a water source (Figure 1). The majority of damage can be seen in wooded areas and fields which are characteristic native habitats for white-tailed deer. However, suburban areas are becoming more frequently inhabited by deer because of urbanization and the increase of exurban environments, which are a patchwork of suburban areas and white-tailed deer native habitats (14).

Respondents were also asked to report the size of their property in conjunction with the development age of the area in which they lived. Four percent of respondents maintained a property less than ¼ of an acre in size, 14% lived on ¼ to ½ acre, 13% lived on ½ to one acre of land, and 69% lived on greater than one acre of land (Figure 2). Three percent of respondents reported the development in which they lived was less than five years old, but the majority of respondents stated their development age to be between five and twenty years (41%). Thirty-two percent of respondents confirmed the age of their development to be between twenty and forty years, 15% claimed a development age between forty to sixty years, and 10% of participants listed their development age at greater than sixty years (Figure 3). Newer developments tend to experience a greater amount of white-tailed deer damage because these developments are usually farther away from the city center. Urbanization of cities has caused new developments to push outward and disturb forests and white-tailed deer native habitats. As a result, exurban environments provide a suitable habitat for white-tailed deer. Therefore, of the

respondents that experienced frequent deer damage, 63.9% considered their property to be a white-tailed deer habitat.

Seventy-two percent of respondents indicated they have pets that use the outdoors on their property which may influence the amount of deer damage suffered. White-tailed deer can be frightened by dogs, and the smell of canine or feline urine can deter deer from an area.

Of the respondents that answered "yes" to deer damage (36.6%), 43.3% have used some type of repellent product and 25% had used some type of deer fencing to minimize deer damage issues. When asked what repellent brands were most familiar to participants, Deer Off® was the most highly recognized commercial deer repellent (6%). Liquid Fence® and Deer Away® were also recognized, each with 5% of respondents familiar with these brands. Other brands that were recognized were Deer Stopper® (2%) and Not Tonight Deer (1%). Seventy-four percent of the respondents considered deer repellents to not be a cost effective means of deterring deer. However, interestingly, 75% claimed repellent applicator scent did not play a role in their purchase of the product.

Thirty-one percent of homeowners contacted responded to the white-tailed deer survey. The majority of respondents did not suffer any deer damage, however; 36.6% claimed they experienced some deer damage to their landscape. This survey determined which areas of the state were most susceptible to white-tailed deer damage, what preventative methods homeowners utilized, which plant species suffered most damage, and what type of environment was most vulnerable to deer damage. These survey results can be used to explore more effective ways to control deer damage throughout the state by analyzing homeowner effectiveness ratings of commercial products and determining

which plants and landscape settings tend to attract white-tailed deer. The best option for homeowners who wish to control white-tailed deer damage in their landscape is to use a combination of management strategies. This could be to select certain ornamentals that show some deer resistance to plant in combination with deer susceptible species and use deer repellents to avoid any deer browse damage. For larger landscapes, fencing might be a practical control method, but remember to install the correct type of fencing and remember that it should be buried 3 to 4 feet underground. It is most important for homeowners to determine if they have deer damage in their landscape and begin management techniques before significant damage is seen.

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Figure 1. Type of environment surrounding respondent's property reporting white-tailed deer damage to their landscape.

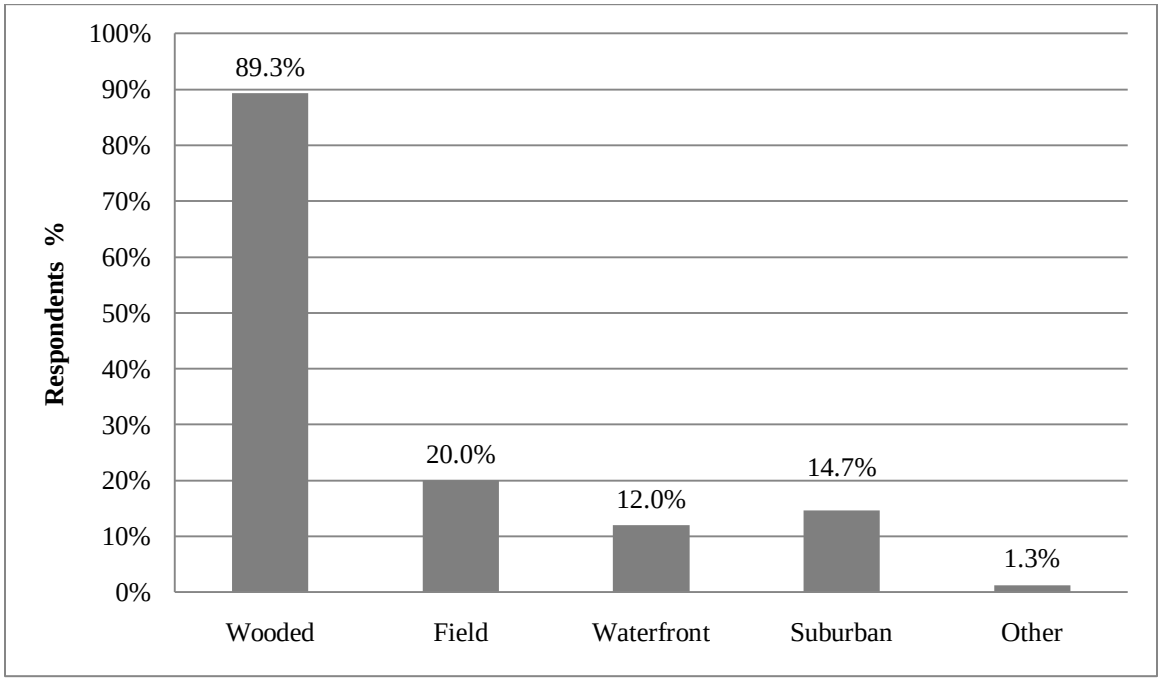


Figure 2. Landscape size occupied by respondents experiencing white-tailed deer damage to their landscape.

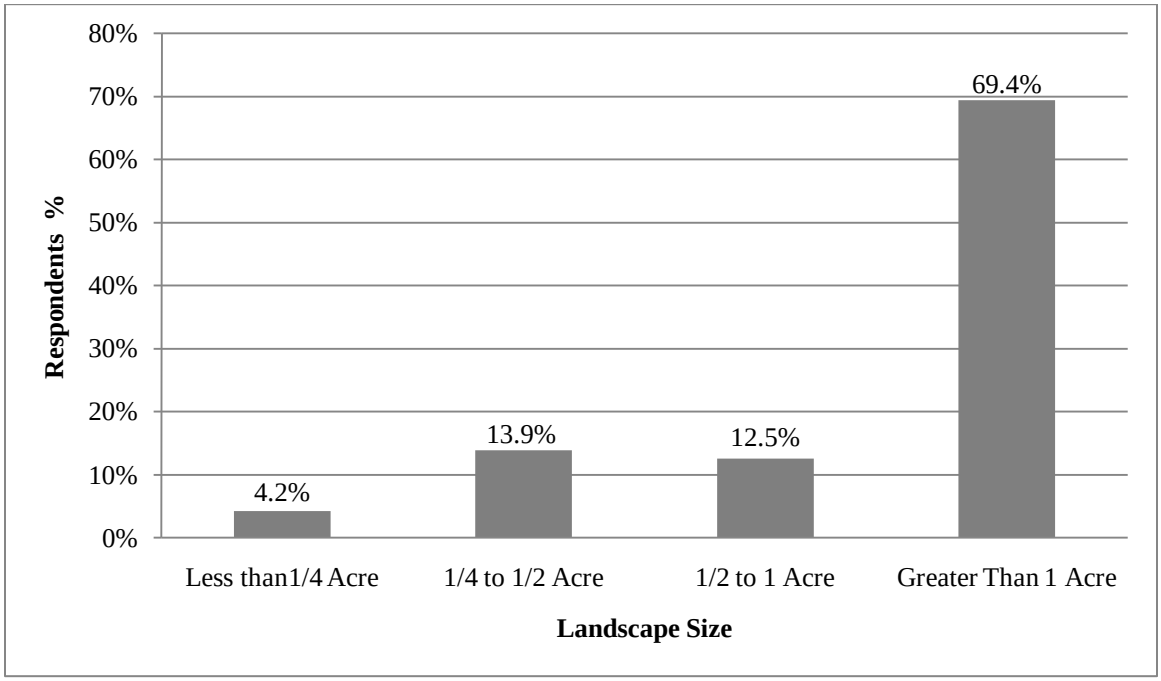
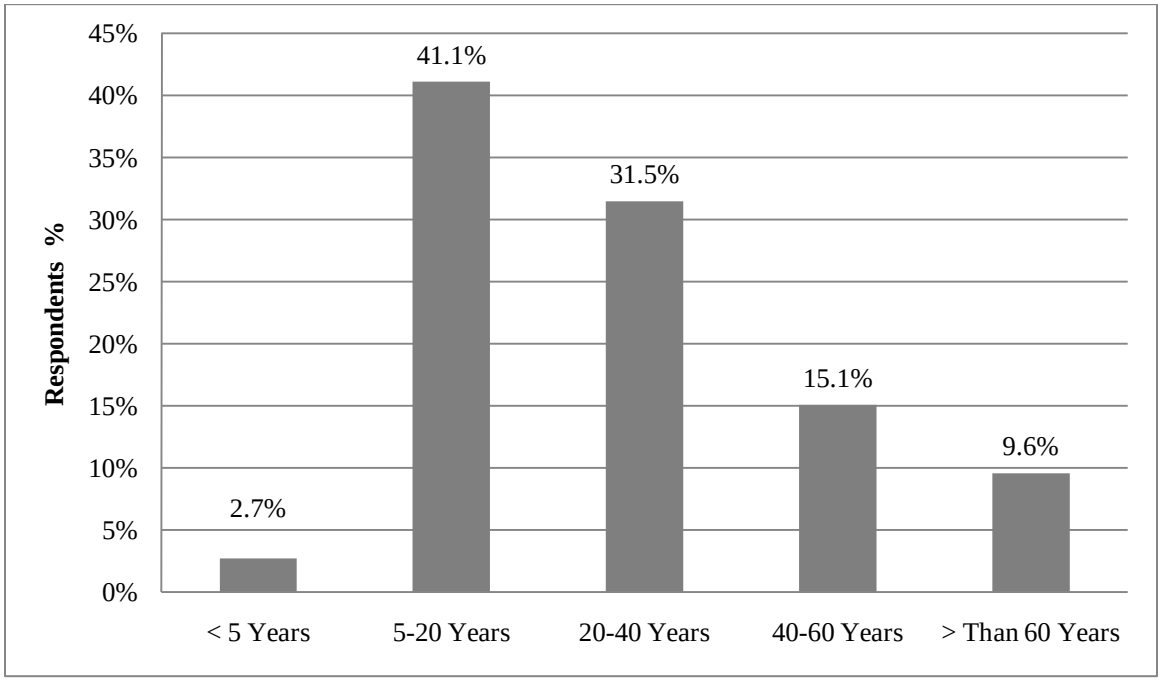


Figure 3. Age of development in which respondents reside experiencing white-tailed deer damage to their landscape.



CHAPTER III

SURVEY OF WHITE-TAILED DEER (*Odocoileus virginianus* Zimmerman) IMPACTS ON ORNAMENTALS IN THE ALABAMA NURSERY AND LANDSCAPE INDUSTRIES

Abstract

Nursery and landscape professionals throughout the state of Alabama continue to experience deer damage to ornamental plants due to the increasing populations of white-tailed deer (*Odocoileus virginianus* Zimmerman). Research has been done in an effort to determine effective means of deterring deer from feeding on ornamentals, however, no research has been done to determine the total impact of deer on the green industry throughout the state. To understand the extent of damage occurring in Alabama, a thirty question survey was developed and mailed to members of the Alabama Nursery and Landscape Association whose businesses were located within the state, totaling 223 professionals in the sample. Participants were given one month to complete and return the survey. Survey questions inquired if professionals encountered any injury in their business, what types of preventative methods they were using if any, and how the damage influenced their business. Of the 223 professionals in the sample, 81 surveys were returned resulting in a 36.3% response rate. Sixty-eight percent of the total respondents from east central Alabama answered “yes” to damage problems. Similarly, in southwest Alabama, 66% of the total respondents answered “yes” for deer damage. Based on a

white-tailed deer density map provided by the Alabama Department of Wildlife and Conservation, many counties in east central and southwest Alabama have more than thirty deer per square mile, which represents the highest populations within the state. High fencing, electric fencing, Liquid Fence®, and motion irrigation had the highest means of the eleven preventative measures listed by participants, so these four products were rated most effective by respondents. Indian hawthorn (*Rhaphiolepis indica* L.) was reported to have the most damage, with 26 growers and landscapers reporting damage. Other plants highly damaged according to respondents include: holly, pansy, azalea, rose, hosta, and hydrangea. Time of the year that most damage occurred was also determined, and participants reported that most damage occurred during the winter and fall months of January, February, October, November, and December. Because availability of natural foods for deer is typically lowest during this period, these results are not surprising.
Index words: Wildlife management, survey, growers, landscape professionals, damage, browsing.

Significance to Industry

White-tailed deer are considered to be the most numerous of large mammals in North America. With the continuing population increase of white-tailed deer, a significant amount of nursery professionals, landscape professionals, and homeowners have experienced damage to ornamental plantings. This research was conducted to determine the amount of deer damage experienced annually by nursery and landscape professionals throughout the state of Alabama. A survey was developed to establish the pattern of damage throughout the state and to inquire about deterrent methods currently being employed by the survey respondents. The majority of respondents were located in

east central Alabama (23%), and 66% of the total population from this area experienced some type of white-tailed deer damage to their landscape. Of the respondents using a preventative method to deter deer (41%), Deer Away® was most frequently used by nursery and landscape professionals (36.4%). Determining the amount of damage in the state of Alabama along with types of preventative methods being used, can help lead to further research and testing to provide effective means of deterring deer for professionals.

Introduction

It is estimated that there are fifteen to twenty million white-tailed deer living in the United States, and 1.8 million living in Alabama alone (1, 3). White-tailed deer damage is becoming more prevalent as the green industry in Alabama continues to grow and develop. The economic impact of the green industry in Alabama has drastically increased from $1.9 billion in 2003 to $2.9 billion in 2007 and provides jobs for more than 43,000 Alabama residents (5). Growers and landscapers continue to search for innovative and effective means of safely diminishing deer damage to ornamentals.

To accomplish this nursery owners, and homeowners alike, have several options to manage deer damage including putting up fences, using repellents, and considering deer feeding preferences (9). One way to discover which of these methods is most successful in reducing white-tailed deer damage could be to use surveys. Surveys have been used as a successful tool in identifying the amount of deer damage endured annually to nurseries as well as potentially effective deer deterrents. In 1997, Lemieux et al. (6) surveyed nurseries and orchards throughout nine Northeast states and discovered that 65% of respondents reported having deer damage issues. Respondents reported losses in crops totaling $1,727,156, with the majority of damage due to browsing, although

rubbing and trampling were also reported. To control these problems, respondents were spending up to $528,348 with a median expenditure of $1,000. In a previous study in 1987, Purdy et al. (7) conducted a survey to gauge concerns to orchardists in New York about crop damage. New York is the second leading state in apple production within the United States, and 90% of survey orchardists reported experiencing deer damage to their crops. Through surveying, Sayre et al. (8) reported that damage to nurseries and suburban landscapes was becoming more rampant in areas of the Northeast, and 62% of respondents specified that information on damage prevention and additional research to improve deterrent methods was necessary. Increasing information and better education for green industry professionals and homeowners on preventative measures to reduce damage, could in turn help minimize damage through proper planning and determination of feasible management strategies. Therefore, conducting surveys may help determine the deer pressure statewide, affects on the green industry, and effective means of deterring deer feeding damage on ornamentals.

The objective of this research was to develop and administer a survey to determine the amount of deer damage suffered annually to nursery and landscape businesses. Since little research has been compiled on white-tailed deer damage to nurseries and landscape companies throughout the state, this survey was developed in order to determine the following information: how much deer damage is experienced, areas of the state most prone to damage, what types of preventative methods professionals utilized, plants most vulnerable to injury, and timing of the majority of damage.

Materials and Methods

The population surveyed in this questionnaire included current nursery and landscape professional members of the Alabama Nursery and Landscape Association (ALNLA). The current membership list was obtained from Mr. James Harwell, Executive Director of ALNLA, and was then thinned to only include nurseries and landscape companies located in Alabama. The total number of professionals sampled was 223.

This survey was produced in order to determine the amount of deer damage that nursery and landscape professionals throughout Alabama experience, along with discovering the types of deterrent techniques that professionals are currently employing, and determining familiarity with commercially available products on the market (Appendix B, Figure 3). This information was collected by developing a survey that included thirty questions to determine the overall impact of deer browse damage to nursery and landscape professionals throughout the state of Alabama. The target population was asked a variety of questions to determine their perspective on deer damage in their business and throughout the green industry. Questions were primarily closed-ended questions that were either multiple choice, categorical, likert-scale, ordinal, or numerical. However, there were a small number of questions that were open-ended, in which the participant could respond with a written response. The survey contained a chart to rank effectiveness of white-tailed deer preventative methods where: 0= not effective, 1 = fairly effective, 2 = moderately effective, 3 = effective, and 4 = highly effective.

There was one set of questions for both nursery and landscape professionals and additionally, professionals were directed to one of two sets of questions based upon their business type. Nursery professionals were asked information about their nursery in relation to deer damage, and landscape professionals were asked the amount of damage that clients experience.

The surveys were mailed to recipients in ALNLA envelopes along with a pre-paid envelope for return of the survey. Two cover letters were also included in the survey, one of which was a letter affirming support from the ALNLA and requesting timely responses (Appendix B, Figure 1). The second cover letter explained the purpose of the survey along with a description of research related to the survey (Appendix B, Figure 2). Surveys were mailed to participants on September 25, 2009. Participants were then given one month to complete the survey, and surveys were to be post marked no later than October 25, 2009. This survey was also set up online through www.surveymonkey.com, which gave respondents the option to take the survey online. The second cover letter contained the website, www.auburn.edu/deersurvey, where the online survey could be accessed. Due to the short time period to complete this survey, no reminder post cards were sent. However, several of Dillman's principles were implemented in order to boost response rates including: clear and easy to comprehend questions, a detailed cover letter explaining why it is important to respond, return envelopes and stamps were provided, and the survey was kept as short as possible (4).

After the conclusion of the survey all data were entered into an Excel spreadsheet (Microsoft, 2007). Data were then uploaded into SPSS 17.1 (SPSS, 2008) to be

analyzed, where each of the variables was labeled and given a value in order to calculate frequencies.

Results and Discussion

At the conclusion of the survey, 78 mailed surveys and three internet surveys had been completed, bringing the total number of surveys returned to 81, for a response rate of 36.3%. The breakdown of survey respondents included 47 nursery professionals (67%), 14 landscape professionals (20%), 8 professionals that had both nursery and landscape operations (11%), and the remaining professionals did not specify their business type (2%).

Sixty-nine percent of the total respondents from east central Alabama answered "yes" to damage problems (Figure 1). Similarly, in southwest Alabama 67% of the total respondents for the area answered "yes" for deer damage. Based on a white-tailed deer density map provided by the Alabama Department of Wildlife and Conservation, many counties in east central and southwest Alabama have more than 30 deer per square mile (2), representing some of the highest densities within the state (Appendix A, Figure 3).

The majority of respondents (55%) responded that they currently have deer damage or have experienced deer damage in the past. However, of the 55% that answered "yes" to damage, only 41% were using preventative measures to control or eliminate damage in their business. These differences in percentages could be due to the lack of familiarity with common methods of controlling deer damage, budget restrictions of the business, or cost comparisons of loss to gain. Of the 41% of respondents using preventative measures, when asked what types of control methods were being used, the greatest number of respondents reported using electric fencing (27%) and high fencing

(23%). These two methods might be ranked highly among respondents because many nursery owners and landscape clients use fencing for privacy, separation from neighboring properties, or theft prevention. Respondents were asked to identify any preventative measures that they were currently using or have used in the past, so participants were able to select more than one product on the chart provided (Figure 2).

Several repellents were also represented on the survey including Buck Off!, Deer Away®, Deer Off®, Deer Stopper®, Liquid Fence®, and Plantskydd®. The repellent that was utilized by most respondents was Deer Away® at 36.4% of all individuals that employed some type of preventative method. Deer Off® and Deer Stopper® were two other repellents that were reported to be widely applied by respondents both with 32% of respondents using these products. Liquid Fence® was ranked next according to usage with 25% of respondents who used preventative method having applied this product as a deer deterrent. Five percent of respondents characterized using Buck Off! as a preventative method, and 0% reported using Plantskydd® as a preventative method. Plantskydd® is a blood-based repellent which might discourage some professionals from using this product, and Buck Off! is a fairly new product to the market, so this might explain its low usage percentage.

Other preventative methods included in the survey were motion lighting, motion irrigation, and frightening sounds. Of the mechanical methods, motion lighting was most frequently used by 17.4% of the population, followed by motion irrigation (16.7%), and frightening sounds (4.8%). Nursery professionals commonly use above ground irrigation to supply water to their crops, which could be used as a frightening device to deter deer without investing time, effort, and money to apply a repellent product. Ninety percent of

the total number of respondents who answered “yes” to using preventative methods did not use alternative methods in order to control deer damage in their businesses. Alternative methods that were commonly classified on the survey included netting at 4.7% usage and dogs to deter deer at 7% usage.

Each of the preventative methods listed in the chart were also ranked according to effectiveness (Figure 2). Effectiveness ratings were determined on a likert-scale, including not effective, fairly effective, moderately effective, effective, and highly effective. These categories were represented by the numbers 0-4, respectively. Both types of fencing were rated highest among all of the preventative methods with high fence at 50% effective and electric fence at 42.9% highly effective. Nursery and landscape professionals clearly consider electric fencing to be the most effective resource in diminishing deer injury to their crops. Though these two means were highest and considered most effective by the majority of participants, 16.7% and 28.6% of participants placed high fencing and electric fencing, respectively, in the fairly effective category. The contrasting effectiveness of these two products demonstrates that preventative methods are not always as effective in all situations and occasionally there can be variance in efficiency depending on outside constraints. To achieve optimal crop protection when using fencing, the fence must be buried 3 to 4 feet underground. This prohibits deer from climbing under the fencing. Height and if the fence was buried was not asked on this survey, so it is possible that respondents who ranked fencing ineffective did not have fencing tall enough to prevent deer from entering the property.

Some repellents also exhibited favorable effectiveness percentages including Deer Away® with 50% of respondents ranking it moderately effective and 50% of respondents

ranking it fairly effective according to the 36.4% of respondents who use the product. Deer Off® was reported to be moderately effective according to 42.9% of respondents, and 42.9% of respondents believed it was only fairly effective, however; 14.3% of the respondents who use this product expressed that it was not effective. Liquid Fence® was another product that ranked high on the effectiveness scale and 20% of respondents stated it was highly effective, 40% of respondents said it was effective, 20% of respondents listed it as moderately effective, and 25% of respondents ranked it fairly effective. Of the respondents who use Deer Stopper® (31.8%), 14.3% of respondents stated it was effective, 57.1% stated it was moderately effective, and 28.6% stated it was fairly effective. Of the 5.3% of respondents who use Buck Off! 100% believe the product is only fairly effective.

Mechanical deterrent methods were also ranked on a likert-scale according to their effectiveness. Motion irrigation was rated highest with a 25% effective rating according of the total number of respondents who use this method and a 75% moderately effective rating. Motion lighting was 50% moderately effective, 25% fairly effective, and 25% not effective according to the population surveyed that employed this method. One hundred percent of the respondents who use frightening sounds as a deterrent believe that it is only fairly effective. Frightening devices, such as motion irrigation, motion lighting, and frightening sounds may not be the most effective way to deter deer for nursery and landscape professionals because deer are very adaptable and often become accustomed to these devices.

Respondents were asked to list plants that deer typically browse at their nursery or clients' landscaped areas by common or scientific name (Figure 3). Over forty plants

were listed as susceptible to deer feeding damage, however; there were seven species that were revealed to have the most damage throughout the survey. These species were Indian hawthorn (*Rhaphiolepis indica* L.) with 21% of growers and landscapers reporting damage, holly (*Ilex* spp.) with 10% reporting damage, pansy (*Viola* x *wittrockiana*) with 8% reporting damage, azalea (*Rhododendron* spp.) with 7% reporting damage, rose (*Rosa* spp.) with 6% reporting damage, hosta (*Host*a spp.) with 5% reporting damage, and hydrangea (*Hydrangea* spp.) with 3% reporting damage.

Most respondents reported damage to occur in winter, with 45.5% of participants experiencing damage during this season (Figure 4). Damage could be highest in winter because deer are continually looking for green vegetation during the winter months, and most nursery and landscape professionals supply their crops with constant fertilization throughout the entire year. Thirty-four percent of respondents stated that they experienced the majority of damage in the fall. According to respondents, the smallest amount amount of damage occurred in spring and summer, with 9.1% and 11.4%, respectively. Participants were also asked to disclose the month in which most feeding damage occurs. Most damage was reported in January with 15.4% of respondents observing damage. Other months having significant damage included February at 11.5%, October with 11.5%, November with 10.3%, and December with 11.5% observing damage. January, February, and December were all months that had considerable deer damage, which coincides with respondents reporting most damage to occur in winter. Damage also corresponds to the white-tailed deer lifecycle. Respondents reported a significant amount of damage to occur in the fall, and this is the time that female deer have the largest nutritional demands. Breeding season occurs in January, and there is a

200 day gestation length. Females give birth to fawns in the early fall and then begin the lactation process. During the lactation process female deer have the highest nutritional demands because they must provide for their young, so it is not surprising that nursery and landscape professionals reported high amounts of deer damage in the fall.

Participants were asked to estimate the amount spent annually on management techniques. Five percent reported spending $100 annually, 35% spend $100-$300, 10% spend $301-$600, 25% spend $601-$1000, 15% spend $1001-$2500, 5% spend $3,000, and 5% spend up to $5,000. Ten percent of the population reported spending $3,000 or more, which could be a one-time investment, such as installing fencing.

To determine familiarity with commercial deer repellents, professionals were asked if they were familiar with any repellents on the market, what brands they were familiar with, if they believed deer repellents are cost effective, and if scent played a role in purchasing the product. Fifty-two percent of respondents maintained they were familiar with some name brand of commercial deer repellents on the market. Deer Stopper® was the most well-known brand to nursery and landscape professionals with 10 occurrences out of 36 responses. Liquid Fence® was also documented by professionals with 9 occurrences. Deer Away® and Deer Off® both were recognizable with four occurrences each. When determining if repellents were cost effective, 61% percent were unsure if deer repellents were cost effective, while 33% of respondents claim that deer repellents were not cost effective. This only leaves 6% of participants who believed that deer repellents were cost effective. When asked if scent played a role in purchasing a deer repellent, 31% said “yes” and 69% of respondents said “no”. Some repellents can smell offensive to the applicator, so it is important to note that most respondents were

more concerned with effectiveness rather than application scent. According to responses, the majority of professionals concurred that they were familiar with some types of repellents on the market, most commercial products were not cost effective, and that scent did not restrict purchasing.

Nursery Professional Responses

Nursery professionals were asked to inventory the percentage of plants that suffer damage annually along with the percentage of plants lost annually to deer damage. Growers reported that 15.1% experienced 1% damage annually, 11.3% experienced 5% damage, 11.3% experienced 10% damage, 3.8% experienced 20% damage, and 43.4% experienced no damage. It was also revealed that 19.2% of growers lost 1% of their product annually, 11.5% lost 2%, 5.8% lost 10%, and 57.7% did not lose any plants to deer damage.

During the last five years, 35.2% of growers believed that the deer population has continued to increase in their area however, 27.8% think that deer populations have remained the same. Some growers were not sure if populations had increased or decreased over the past five years (20.4%), and 16.7% of growers believed that deer populations were in decline in their area. The majority of growers believed that deer populations are continuing to increase in their area, but this could be due to location of most nurseries. It could also be contributed to urban sprawl pushing more deer into rural areas, leading to an increased concentration, but not necessarily an increased population. Most nurseries are in remote rural locations near a water source, which is an optimal habitat for white-tailed deer. Forty-eight percent of growers would consider their property to be a deer habitat. When asked what type of environment surrounded their

nursery, 52.6% of growers reported a wooded surrounding, 28.2% reported fields, 3.8% reported waterfront, and 11.5% reported a suburban area. Sixty-eight percent of nursery owners also reported having animals around their nursery which might deter deer. The most popular animals were dogs with 15 occurrences, cats with 11 occurrences, cows with 5 occurrences, and horses with 5 occurrences.

Landscape Professional Responses

Seventy-two percent of landscape professionals claimed that clients complain of deer browse problems. Of the clients that experienced damage 11.1% reported 5% damage annually, 33.3% reported 10% damage, 16.7% reported 15% damage, 11.1% reported 25% damage, and 5.6% reported up to 80% damage. Landscapers had clients disclose the percentage of plants lost annually due to deer damage and 33.3% experienced a 10% loss, 11% reported a 15%-20% loss, and 11% had a 40%-50% loss. Over the past five years it was reported that deer damage complaints from landscape clients have increased (32%) along with 36% of clients expressing that deer populations in their area have increased. This increase could be due to the increasing number of exurban environments. These areas tend to be fairly new suburban developments where homes are divided by patches of woods, and the location of these environments are farther away from city centers. These exurban environments make suitable habitats for white-tailed deer because deer are provided with high-quality food sources in gardens, fertilized lawns, and ornamental plantings. Because of the increased amount of clients' complaints about deer damage, 30.4% of landscape professionals offered deer repellent application to their clients as an add-on maintenance cost.

Results show that the majority of landscape and nursery professionals throughout the state have experienced some type of deer damage, although most are not using any type of preventative method in order to eliminate or reduce damage. At the conclusion of the survey it is clear that several sections of the state are more prone to deer damage, which correlates to the white-tailed deer density map provided through the Alabama Department of Wildlife and Conservation. These survey results can be used to determine the amount of deer damage throughout the state, and may help determine how to better educate nursery and landscape professionals in order to reduce the amount of deer damage done annually.

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Figure 1. Percentage of respondents from each geographic section of Alabama indicating white-tailed deer damage.

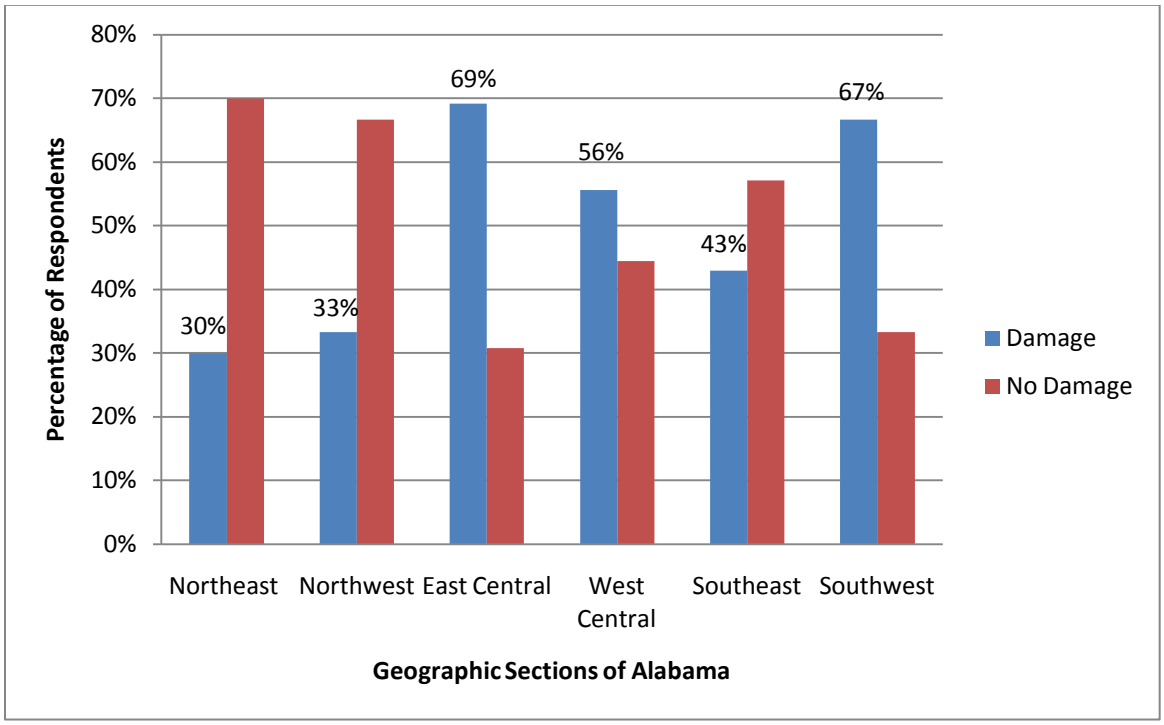


Figure 2. Effectiveness ratings of deer preventative methods by Alabama nursery and landscape professionals where: 0 = not effective, 1 = fairly effective, 2 = moderately effective, 3 = effective, and 4 = highly effective.

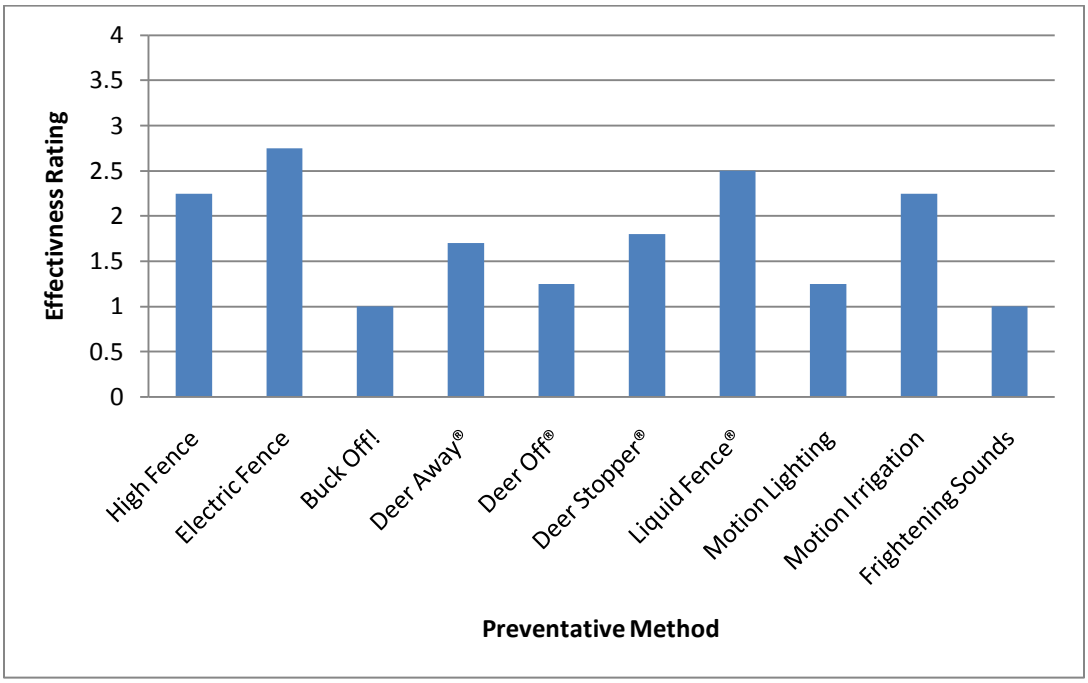


Figure 3. Top 7 plant species exhibiting white-tailed deer feeding damage, as indicated by Alabama growers and landscapers out of over 40 plant species listed.

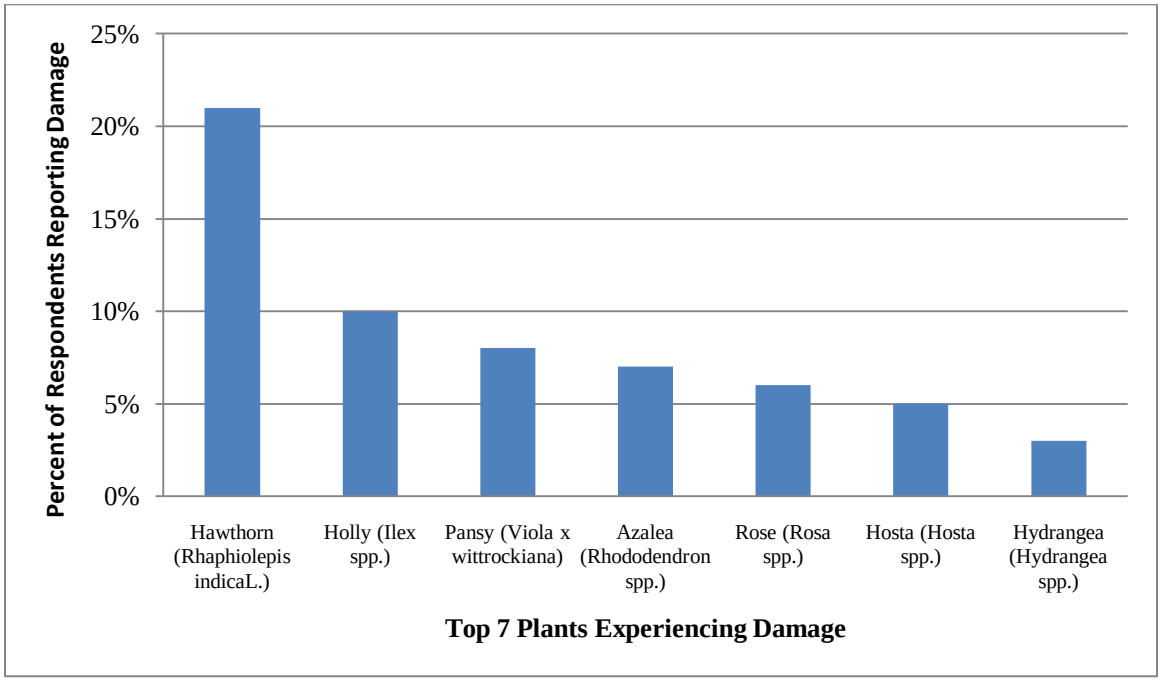
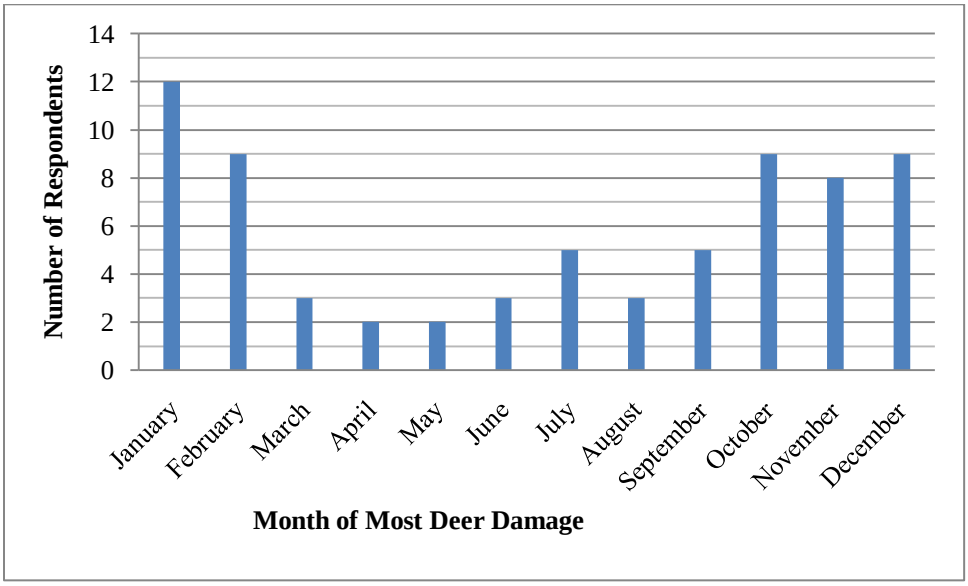


Figure 4. Month that most white-tailed deer damage is experienced by Alabama nursery and landscape professionals in the state.



CHAPTER IV

PHYTOTOXICITY OF COMMERCIAL DEER REPELLENTS ON TWO COMMON ANNUAL LANDSCAPE SPECIES

Abstract

Six commercial deer repellents were evaluated for their toxic properties on dianthus (*Dianthus plumarius* L.) and snapdragon (*Antirrhinum majus* L.). Repellents were tested on annual landscape plants considered highly palatable to deer in order to determine their phytotoxicity levels. The six products tested were: Deer Off®, Liquid Fence®, Deer Stopper®, Plantskydd®, Deer Pharm (organic), Deer Stopper® (organic). Each of these repellents was applied at 1x and 2x rates excluding the organic products, which were ready-to-use. An untreated control was included, resulting in a total of eleven treatments. Dianthus and snapdragon were replicated six and five times, respectively. Quality ratings were taken the day after treatment and then at 21 days after treatment (DAT). Quality was rated on a scale from 1 to 5, where 1 represented very poor quality and 5 represented commercial quality. Growth index or the average of one height and two width measurements [$(height1 + width1 + width2)/3$] were also taken 21 DAT. Leaf greenness was measured at 28 DAT using a SPAD-502 Chlorophyll Meter (Minolta Camera Co., Ltd., Japan). Data were analyzed using the general linear model procedure in SAS, and Tukey's Multiple Range Test was used for separation of means. No

differences in growth or leaf greenness of either species was observed 21 DAT due to repellent application. Only Plantskydd® reduced plant quality 1 DAT due to staining, but no differences were observed by day 21. All products tested appear to be safe for use on these annual landscape species.

Index Words: Commercial deer repellent, toxicity.

Species used in this study: Dianthus (*Dianthus plumarius* L.) and snapdragon (*Antirrhinum majus* L.).

Significance to Industry

Commercial deer repellents are commonly used by homeowners as well as nursery and landscape professionals to deter white-tailed deer feeding damage. This research was conducted to test the toxicity of commercially available repellent products to common annual landscape species. Six commercial deer repellents were selected and tested on dianthus (*Dianthus plumarius* L.) and snapdragon (*Antirrhinum majus* L.). All repellents tested caused no harm to plant growth, however; Plantskydd® left a purplish-red stain on snapdragon 1 DAT (day after treatment), but by the end of the test the stain faded to a point not visible.

Introduction

Commercially available white-tailed deer repellents are continually gaining popularity with homeowners as well as nursery and landscape professionals as an option to control deer damage in landscape settings. Effectiveness of commercial deer repellents have been tested abundantly, but very few tests have taken into consideration toxicity of chemical repellents.

Often phytotoxic effects of chemical deer repellents are dependent upon the rate at which they are applied. Thiram® is a widely used fungicide that is most often applied to seed to protect against disease, but Thiram® has also shown potential as a deer repellent. Thiram® creates a bitter taste, which deters deer from eating treated species. This product has been shown effective at the 1.25% rate in reducing ground squirrel damage to newly-planted corn (6). Thiram® has been tested as a deer repellent at 1.25 and 2.5% rates, and it was discovered that neither rate exhibited phytotoxic effects (7). Higher rates of Thiram® could be potentially toxic to plant species, but further testing on this product needs to be done. Similarly, increased concentrations of Miller Hot Sauce (6.2% and 11.5%) were applied to apple trees, and these concentrations were shown to be nonphytotoxic (2). Although plants treated with Miller Hot Sauce exhibited no symptoms of phytotoxicity, but the main ingredient in this product is capsaicin, which is a highly concentrated extract from hot peppers, and limited applications are necessary because the active ingredient may alter fruit production or taste (3).

Hinder® was applied to buttonbrush (*Cephalanthus occidentals* L.) in a similar study to reduce deer damage (8). The product was applied according to the label directions, at a 1:1 ratio, however, when plants were placed in full sun a severe burning of the leaves occurred. Results concluded that Hinder® was an effective deer repellent at 1:1, but due to phytotoxic effects this repellent would be better suited for use on dormant plants. The same study tested two different predator urines, feline urine and canine urine. Results concluded that feline urine was more effective in reducing deer damage than canine urine, but both urines caused phytotoxic damage to young treated species during the growing season.

Phytotoxicity may also be dependent on application method (5). Commercial deer repellents can be divided into three categories: area repellents, contact repellents, and systemic repellents. El Hani and Conover (5) looked at all three categories of repellents. No occurrences of phytotoxicity have been reported for area repellent. However, some systemic repellents, such as selenium, have caused symptoms of phytotoxicity. Quadrivalent selenium is taken up by the plant and causes the plant to produce a garlic odor that deters deer. Allan *et al*. (1) reported that a foliar level of 100 ppm of quadrivalent selenium was fatal to Douglas fir (*Pseudotsuga menziesii*) seedlings. Three other species exhibited phytotoxic symptoms at 5-10 ppm including: Western white pine (*Pinus monticola*), Ponderosa pine (*Pinus ponderosa*), and Western red cedar (*Juniperus scopulorum*). It was concluded that a foliar concentration of 1-2 ppm was an effective concentration for repelling deer and did not display any phytotoxic effects.

As new commercial deer repellents continue to enter the market, there is a need for further testing of efficacy and phytotoxicity of repellents when applied to landscape plants. The objectives of this study were to evaluate phytotoxicity of six common commercial deer repellents on two landscape annual species.

Materials and Methods

Fifty-five dianthus (*Dianthus plumarius* L.) and 72 snapdragon (*Antirrhinum majus* L.) were provided by Mississippi State University Coastal Research and Extension Center. Plants were placed in trade gallon containers on November 24, 2008 and placed on a full-sun nursery pad at the Paterson Greenhouse complex on the Auburn University campus in Auburn, AL. The growing medium was a 6:1 pine bark to sand ratio, amended with 3 kg/m^3 (5 lbs/yd^3) dolimitic lime and 0.9 kg/m^3 (1.5 lbs/yd^3) Micromax® (Scott's

Co., Marysville, OH). Pots were top dressed using Osmocote® (Scott's Co.) 13-13-13 control release fertilizer at a rate of 0.17 kg (6 oz.) per container. Overhead irrigation was supplied once daily at 0.25 in.

Plants were treated on November 25, 2008 with one of six different repellents. Commercial deer repellent treatments included Deer Off® (putrescent egg solids), Deer Stopper® concentrate (putrescent whole egg solids, rosemary oil, mint oil), Liquid Fence® Deer and Rabbit Repellent (putrescent egg solids), Plantskydd® (dried blood porcine and/or bovine), Deer Pharm (soybean oil, citric acid, garlic acid), Deer Stopper® organic (putrescent whole egg solids), and a non-treated control. Both Deer Pharm and Deer Stopper® products are considered to be organic. Repellents were applied at rates of 1x and 2x excluding the organic products of Deer Pharm and Deer Stopper® organic. There were a total of ten treatments and one control. Three different forms of repellents were used in this study: concentrate, ready-to-use, and powder. Deer Off®, Deer Stopper®, and Liquid Fence® were concentrates, while Deer Pharm and Deer Stopper® organic were ready-to-use products, and Plantskydd® was a powder form. All products were applied to plants according to label directions using a one gallon lawn and garden sprayer.

The experimental design was a complete randomized block design with five replications of dianthus and six replications of snapdragon. Growth indices were taken 21 days after treatment (DAT), and quality ratings were taken at 1 DAT and 21 DAT. Quality ratings were assessed on a scale from one to five, where 1 represented very poor quality and 5 represented commercial quality. SPAD levels were taken 28 DAT using a SPAD-502 Chlorophyll Meter (Minolta Camera Co., Ltd., Japan) by taking the average of three SPAD levels from three separate leaves. The SPAD Meter was used to evaluate

levels of leaf greenness or relative chlorophyll content of leaves (9, 10). Data were analyzed using the general linear model procedure in SAS with mean separations using Tukey's Multiple Range Test ($P<0.05$) (SAS Institute, Inc., 2004).

Results and Discussion

None of the repellents in this test affected plant growth for the two species tested. At 21 DAT there were no differences in growth indices for dianthus or snapdragon (Table 1). However, there were differences in plant quality 1 DAT for snapdragon.

Quality ratings 1 DAT for dianthus and snapdragon were 3.29 and 3.19 respectively, and ratings 21 DAT were 3.22 and 3.26. There were no differences in quality rating 1 DAT for dianthus, but quality ratings for snapdragon were significantly lower on plants treated with Plantskydd® at the 2x rate compared to all other products at 1 DAT. This is due to Plantskydd® being a blood based product, which caused a dark purplish-red stain on foliage. This stain was more easily visible on snapdragon due to a larger plant size in comparison to dianthus and the light yellow flower color, whereas dianthus flower color was dark pink. The darker flower color allowed for the stain to blend, and it was less visible to the eye. The staining from Plantskydd® lasted longer than any other product used, but by 21 DAT the staining faded from sight and there were no differences for quality of snapdragon.

Commonly, SPAD levels range anywhere from 0 to 80 (9). SPAD levels for dianthus and snapdragon were 49.93 and 41.26, respectively. SPAD levels were similar and there were no differences for both dianthus and snapdragon at 28 DAT. No differences in SPAD readings between species indicates that the deer repellents tested had no phytotoxic or toxic effect on leaf greenness.

Growth indices and leaf greenness were not different among treatments at 21 DAT and 28 DAT, respectively, even at 2x rates. Therefore, deer repellents used in this study did not have a negative effect on growth when applied to dianthus and snapdragon. Based on this work, products tested were determined to be safe to use on dianthus and snapdragon when provided with daily irrigation. As a result, these products might be best used in nursery settings where irrigation is provided daily. Landscape plants that receive much less irrigation than provided in this test could potentially suffer phytotoxic effects from deer repellents. Further testing should be done on landscape plants with low irrigation to determine if irrigation could mask phytotoxic effects.

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Table 1. Growth indices 21 DAT, quality ratings 1 DAT and 21 DAT, and spad levels 28 DAT for dianthus (*Dianthus plumarius* L.) and snapdragon (*Antirrhinum majus* L.).

Treatments	Growth Indices 21 DAT[z]		Quality Rating[y] 1 DAT		Quality Rating 21 DAT		SPAD 28 DAT	
Commercial Product	Dianthus	Snapdragon	Dianthus	Snapdragon	Dianthus	Snapdragon	Dianthus	Snapdragon
Deer Off®	14.3a[x]	23.2a	3.8a	2.5ab	3.6a	2.5a	54.3a	38.6a
Liquid Fence®	15.1a	26.4a	3.8a	3.8a	3.6a	3.3a	44.5a	46.9a
Deer Stopper®	13.3a	27.2a	3.4a	4.0a	3.8a	3.8a	51.4a	36.3a
Plantskydd®	13.5a	26.2a	2.6a	2.8ab	3.0a	3.2a	43.7a	42.8a
Deer Off®2x	13.8a	27.0a	3.0a	3.5ab	3.0a	3.5a	47.7a	41.7a
Liquid Fence®2x	14.0a	28.0a	3.4a	3.8a	3.0a	3.8a	43.8a	43.2a
Deer Stopper®2x	13.2a	24.5a	3.4a	3.0ab	3.0a	3.2a	50.0a	46.5a
Plantskydd®2x	14.9a	24.5a	3.2a	2.2b	4.0a	3.0a	51.0a	38.0a
Deer Pharm	13.0a	26.7a	3.6a	3.5ab	3.6a	2.8a	63.0a	40.2a
Deer Stopper®Organic	13.3a	24.4a	3.0a	2.8ab	3.8a	2.7a	48.8a	40.7a
Control	12.7a	25.6a	3.0a	3.2ab	3.2a	3.0a	51.3a	39.0a

[z]DAT = Days after treatment.

[y]Quality rating based on a scale from 1 to 5 where 1 represents the lowest quality and 5 represents commercial quality.
[x]Means within column followed by the same letter are not significantly different (Tukey's Multiple Range Test at α=0.05).

CHAPTER V

EVALUATION OF COMMERCIAL DEER REPELLENTS AS WHITE-TAILED DEER DETERRENTS ON ORNAMENTAL PLANT SPECIES

Abstract

Commercial deer repellents applied to plant foliage are becoming one of the most popular means of controlling white-tailed deer (*Odocoileus virginianus* Zimmerman) damage to ornamental plants. This study evaluated five commercially available deer repellents for effectiveness on highly palatable ornamentals including 'G.G. Gerbing' azalea (*Rhododendron indicum* L. 'G.G. Gerbing'), 'Gumpo White' azalea (*Rhododendron eriocarpum* L. 'Gumpo White'), and indian hawthorn (*Rhaphiolepis indica* L.). Growth indices and damage ratings were taken 7, 14, 21, and 31 days after treatment (DAT). In Experiment 1, there were no differences in growth indices for 'G.G. Gerbing' azalea and indian hawthorn. However, 'Gumpo White' azalea plants treated with Liquid Fence® were larger than plants treated with Buck Off! or the control plants at 7 DAT, but by 14 DAT there were no differences between any of the treatments. In Experiment 1, damage was similar at 7, 14, 21, and 31 DAT. For Experiment 2, there were no differences in growth indices at 7, 14, 21, and 31 DAT for 'G.G. Gerbing' azalea and 'Gumpo White' azalea. However, at 31 DAT indian hawthorn control plants were smaller than Buck Off!, Deer Off®, Deer Stopper®, and Plantskydd®. Damage ratings for indian hawthorn control plants were 1.8 at 31 DAT, and different from all other treatments.

Index words: White-tailed deer (*Odocoileus virginianus* Zimmerman), browse, deer damage.

Species used in this study: 'G.G.Gerbing' azalea (*Rhododendron indicum* L. 'G.G. Gerbing'), 'Gumpo White' azalea (*Rhododendron eriocarpum* L. 'Gumpo White'), and Indian hawthorn (*Rhaphiolepis indica* L.),.

Chemicals used in this study: Buck Off! (Cleary Chemical Corporation), Deer Off® (Woodstream Corporation), Deer Stopper® (Messina Wildlife Management), Liquid Fence® (Liquid Fence Co., Inc.), Plantskydd® (Tree World, Inc.).

Significance to the Industry

As white-tailed deer damage to ornamental plants continues to increase, commercial deer repellents are becoming a popular way to deter deer from feeding on ornamentals. This research was conducted to determine efficiency of popular commercial repellents. The commercial repellents tested included: Buck Off!, Deer Off®, Deer Stopper®, Liquid Fence®, and Plantskydd®. In Experiment 1, all treatments provided similar amounts of control to all three plant speices. However, in Experiment 2, plants treated with Deer Stopper® did not experience any damage regardless of species throughout the entire testing period.

Introduction

The green industry in Alabama, including nursery, greenhouse, turfgrass, sod, lawn, and landscaping operations, has shown considerable growth over the past five years. The economic impact of the green industry in Alabama has swelled from $1.9

billion in 2003 to $2.9 billion today, an increase of 51.5% (4). Nursery, lawn, and landscaping operations contribute about half of the economic impact at $1.5 billion annually. With the combination of green industry growth and the rise in deer populations throughout Alabama, many nursery operations and landscape firms are experiencing more deer damage issues. In 1994, it was estimated that there were greater than 25 million deer in the United States (12). With 1.8 million white-tailed deer in Alabama, and urbanization of once rural areas, deer damage to ornamentals is more likely, especially in winter months when natural foods are diminished (1, 12).

Nursery and landscape professionals have several options for controlling deer damage including using fencing, repellents, or deer resistant food preferences (12). Deer-proof fencing is an effective remedy to control deer damage to ornamentals, however fencing is expensive to install and maintain, and may not be economical in small scale landscape or nursery situations (2). Repellents have become a popular method of controlling deer browse, and when treated, plants become less palatable and desirable to white-tailed deer. Chemical repellents have been shown to help reduce damage to ornamental plantings as well as in nursery settings (8).

Commercially available deer repellents fall into two categories: indirect repellents or direct repellents. Direct repellents are taste-based repellents and repel directly through taste. Indirect repellents are often odor-based repellents and repel through smell (7). Odor-based repellents discourage deer from feeding on plants by producing an offensive odor to deer (8). Indirect repellents may also deter deer through sight or sound, most commonly referred to as frightening devices (7).

Commercial deer repellents are increasing in popularity due to the escalating populations of white-tailed deer and subsequent plant damage. Due to their increasing popularity, deer repellents are becoming more available to homeowners as well as nursery professionals and new products are being developed to increase efficiency in hopes of further reducing deer browse. Observations show that the market and demand for effective products have lead to popular companies advertising their products on television. Several studies in the past have tested the efficiency of commercial deer repellents as well as homemade products. However with the increasing numbers of deer repellents on the market, there is a need to continue testing commercial deer repellents to find a safe and productive product for nursery and landscape operations.

A previous study was done to determine effectiveness of homemade and commercial deer repellents and concluded that products containing the ingredient Thiram™ were more likely to deter deer browsing than other products tested (5). However, it has been reported that when Thiram™ is applied to plants it leaves a white residue on the plant that is clearly visible to the human eye. Due to the nature of Thiram™, products with this active ingredient may not be useful in nursery situations because marketability greatly declines when the plants are stained (2).

Many homeowners turn to homemade deer repellents to reduce deer browse in their landscapes. Ivory soap was tested for effectiveness against commercial deer repellents and reduced deer damage up to 36.7% compared to controls (10). However, a commercial deer repellent, Big Game Repellent® (BGR) was tested along with Ivory soap, and BGR® produced a reduction in deer damage of 76% when compared to the control (11). Another study showed that BGR® appeared have the greatest reduction

compared to other commercial repellents tested (9). Milorganite®, which is a sludge product often used for soil amendment purposes with low Nitrogen-Phosphorus-Potassium (6-2-0) values, is another product that has been used to repel white-tailed deer. Results show that Milorganite® has the potential to work as a deer repellent because the product reduced the overall deer impact, yet did not completely eliminate damage.

There are several other commercial deer repellents, which include organic and inorganic formulations that have been tested for efficiency. Many organic products contain an active ingredient of putrescent egg solids, and it was reported that these products are the most effective of the commercially available deterrents (3). Other results conclude that Deer Away™ and Holly Ridge are both commercial repellents that are ranked very high in effectiveness through testing. In the same test, Tree Guard™ also reduced damage by 28% compared to controls (6). Another study compared twenty commercially available repellents, and gathered that eight of the nine repellents thought to be most effective during the first eleven weeks of testing emitted sulfurous odors (13). These odors were of animal proteins, such as egg or slaughterhouse waste, and tend to support Coker's previous claim that products derived from putrescent egg solids can be considered the most effective repellents on the market.

There is a limited amount of information available concerning the efficacy of the latest commercial deer repellents released on the market. As a result, research should be done on new products as they emerge to determine if they are safe and effective. Therefore, the objective of this study was to determine efficiency of popular commercial deer repellents that are fairly new to the market including: Buck Off!, Deer Off®, Deer Stopper®, Liquid Fence®, and Plantskydd®.

Materials and Methods

This study was conducted at the Auburn University Deer Lab, located within the boundary of the Piedmont Substation in Camp Hill, Alabama. The study area was approximately 430 acres enclosed by a deer-proof fence. The population of free-ranging deer located within the facility was estimated at one hundred during the study. Green vegetation was available to deer throughout the study, and deer were provided with a pelleted ration of food by Piedmont station staff members.

A simulated landscape was constructed approximately 400 yards from the south entrance gate to the deer research facility. Landscape fabric was laid in rows of 100ft. by 50ft and held by sod staples, in order to simulate a landscape setting and reduce weed pressure in the plot. Overhead irrigation was installed using 4 feet tall risers with MP2000 rotator heads dispersing 0.25in of water per day. The plot was covered with pine bark mulch to replicate a landscape situation.

When selecting ornamental species used in this test, several previous projects were used in order to help determine the best ornamentals for the project. Deer resistant and attracting extension lists were compiled from Alabama, Arkansas, Florida, Georgia, Michigan, South Carolina, Tennessee, and Texas (Appendix C). These lists were assembled into one excel spreadsheet where plant species repeated in more than one state could be detected. Plants were examined that showed variance between deer attraction and resistance between states, and then six of these species were used in a deer feeding preference test at the Auburn University Deer Research Lab located at the Piedmont Substation. The species selected in the deer feeding preference test were wax myrtle (*Morella cerifera* L.), indian hawthorn (*Rhaphiolepis indica* L.), 'Gumpo White' azalea

(*Rhododendron eriocarpum* L. 'Gumpo White'), 'Dwarf Burford' holly (*Ilex cornuta* L. 'Dwarf Burford'), Chinese witch-hazel (*Loropetalum chinensis*), and 'G.G. Gerbing' azalea (*Rhododendron indicum* L. 'Mrs. G. G. Gerbing'). For example, wax myrtle (*Morella cerifera* L.) was selected because it is listed as attracting in Alabama, a resistant shrub in Arkansas, and a shrub with rare damage in Florida. These plants were placed in a completely randomized block design on the landscape plot at the deer research facility and were held in place with galvanized steel nursery container hooks. No deer repellents were applied and feeding damage was taken daily to determine which ornamental species were preferred by white-tailed deer. Damage was rated on a scale from 0 to 3, with 0 representing no damage, 1 representing 1/3 of the plant eaten, 2 representing 2/3 of the plant eaten, and 3 representing total destruction of the plant. Observations yielded the top three most preferred species for white-tailed deer to be 'G.G. Gerbing' azalea (*Rhododendron indicum* L. 'G. G. Gerbing'), 'Gumpo White' azalea (*Rhododendron eriocarpum* L. 'Gumpo White'), and indian hawthorn (*Rhaphiolepis indica* L.).

Selected ornamental species for the commercial deer repellent test at Auburn University Deer Research Facility was based upon previous results from the white-tailed deer feeding preference test. Forty-eight of each 'G.G. Gerbing' azalea (*Rhododendron indicum* L. 'G. G. Gerbing'), 'Gumpo White' azalea (*Rhododendron eriocarpum* L. 'Gumpo White'), and indian hawthorn (*Rhaphiolepis indica* L.) were obtained from Moore & Davis Nursery, L.L.C. in Shorter, Alabama. The experimental design used in this study was a completely randomized design with eight replications per species. Plants were treated with commercially available deer repellents on November 2, 2009 in Experiment 1 and January 27, 2010 in Experiment 2. Treatments included Buck Off!

(putrescent whole egg solids and potassium sorbate, 178 Ridge Road, Suite A, Dayton, NJ 08810-1501), Deer Off® (putrescent egg solids, 69 North Locust Street, Lititz, PA 17543), Deer Stopper® (putrescent whole egg solids, rosemary oil, mint oil, PO Box 122, Chester, NJ 07930), Liquid Fence® (putrescent egg solids, PO Box 300, Brodheadsville, PA 18322), Plantskydd® (dried blood porcine and/or bovine, PO Box 4821, DesMoines, IA 50306), and an untreated control. All repellents were applied according to manufacturer's label directions.

Feeding damage was assessed at 7, 14, 21, and 31 days after treatment (DAT). Differences or reductions in growth were recorded using growth indices, which can be defined as an average of the height measurement and two width measurements $[\frac{height+width1+width2}{3}]$. Damage ratings were also assessed on a rating scale from 0-3 (0 = no damage, 1 = 1/3 plant eaten, 2 = 2/3 plant eaten, 3 = total plant destroyed) at 7, 14, 21, and 31 DAT. All data taken were analyzed using paired contrast statements and letters were assigned to determine differences ($\alpha = 0.05$) (SAS Institute, Inc., 2004).

Results and Discussion

Experiment 1. When 'G.G. Gerbing' azalea, 'Gumpo White' azalea, and indian hawthorn were treated and placed inside of the deer research facility, an interaction ($\alpha = 0.05$) was observed between plant species and treatments. This indicated that protection provided by repellents from deer browse was directly related to the plant species in which the product was applied (Table 1). 'G.G.Gerbing' azalea and indian hawthorn were observed to be preferred by white-tailed deer in previous work, however; in Experiment 1 (November 2, 2009 to December 3, 2009) there were differences at 7 DAT for 'Gumpo White' azalea between different repellent treatments. There were differences between

Buck Off! along with control plants and plants treated with Liquid Fence®. Liquid Fence® plants were larger than Buck Off! plants or control plants, but at 14 DAT there were no differences between any of the repellent treatments and the control.

Across all treatments and species, damage ratings were small, less than one, indicating less than 1/3 of the plant was damaged during the entire testing period (31 days) (Table 2). From this it can be concluded that all repellents provided some type of protection against white-tailed deer damage. However, damage was only taken weekly, and re-growth could have masked some of the damage experienced during this test. During the testing period (late fall) female white-tailed deer begin the lactation process, and reach their highest nutritional demands of the year, so much more damage was expected. If damage were taken daily more observations could be made on the amount of damage sustained and its effect on new growth.

Experiment 2. In Experiment 2 more feeding pressure was observed (January 27, 2010 until February 26, 2010). In winter months there tends to be a lack of natural forage for white-tailed deer, therefore highly fertilized ornamentals usually experience a greater amount of browse damage. Both repellent treatments and DAT had an effect on browse damage. The differences between treatments and species indicated that protection from the repellents were dependent on the species in which they were applied (Table 3). Indian hawthorn was observed to be preferred by white-tailed deer in Experiment 2. This could mean that white-tailed deer feeding preference can shift according to season. Indian hawthorn control plants were smaller than plants treated with Buck Off!, Deer Off®, Deer Stopper®, or Plantskydd®. Liquid Fence® treated indian hawthorn were similar to the control plants. All treatments provided adequate protection

for ‘G.G. Gerbing’ azalea and ‘Gumpo White’ azalea. Buck Off!, Deer Off®, Deer Stopper®, and Plantskydd® all provided protection for indian hawthorn plants in comparison to Liquid Fence® and control plants.

As with growth indices, there was an interaction between repellent treatment and DAT (Table 4) for browse damage. At 7 and 14 DAT only control plants experienced a very small amount of browse damage for ‘G.G. Gerbing’ azalea. However, by 21 and 31 DAT plants treated with Liquid Fence® displayed a small amount of deer browse damage, and damage slightly increased for control plants. The damage on ‘G.G. Gerbing’ azalea could be due to deer sampling. Deer are considered browsers and continually eat due to a very slow digestive system, so deer may have sampled ‘G.G. Gerbing’ azalea treated with Liquid Fence® and the control plants.

‘Gumpo White’ azalea showed a similar trend to ‘G.G. Gerbing’ azalea. Control plants and plants treated with Liquid Fence® were the only treatments that had damage at 7 and 14 DAT. Damage for these two treatments slightly increased over the 31 day testing period. However, damage was not significant enough to cause differences between treatments. Plants treated with Deer Off® also experienced a small amount of damage at 21 and 31 DAT, but similar to ‘G.G. Gerbing’ azalea and may also be due to sampling.

At 7 and 14 DAT for indian hawthorn there was only a small amount of damage present on the control plants. By 31 DAT the control plants for indian hawthorn showed increased browse damage compared to all other treatments. Control plants at 31 DAT had a damage rating of 1.8, which meant that almost 2/3 of the plants were eaten. For indian hawthorn at 31 DAT all treatments exhibited some damage except for plants

treated with Deer Stopper®. Because of the damage on indian hawthorn during testing it can be concluded that white-tailed deer preferred indian hawthorn to 'G.G. Gerbing' azalea or 'Gumpo White' azalea during the winter months. Also in Experiment 2, plants treated with Deer Stopper® did not experience any damage regardless of species throughout the entire testing period, so Deer Stopper® was the only treatment that provided protection for all three species compared to other treatments.

All of the products were applied according to label rates, and all products were to be re-applied monthly excluding Planskydd® where one application could last up to six months. Damage was seen for most treated plants in Experiment 2 at 21 DAT, therefore Liquid Fence® and Deer Off® may need to be applied bi-weekly for optimal control. In contrast, damage was seen at 7, 14, 21, and 31 DAT consistently for all three plant species in Experiment 1. New growth was observed in the late fall during Experiment 1, and it was believed that the new growth seen at that time of the test masked the actually damage experienced. It was also observed during both tests that plants treated with Plantskydd® appeared to be greener in color. Plantskydd® is marketed as an organic repellent that acts as a foliar feed fertilizer for many types of plants due to its active ingredient of bloodmeal which has a high iron content. For future experiments, damage might be better quantified using repeated measures.

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Table 1. Effects of selected commercial deer repellents at 7, 12, 21, and 31 DAT[z] on growth indicies[y] (inches) of 'G.G. Gerbing' azalea, 'Gumpo White' azalea, and indian hawthorn, Experiment 1 installed November 2, 2009.

	'G.G. Gerbing' azalea (Rhododendron indicum 'G.G. Gerbing')				*'Gumpo White' azalea (Rhododendron eriocarpum 'Gumpo White')*				*Indian hawthorn (Rhaphiolepis indica)*			
Treatment	**7 DAT**	**14 DAT**	**21 DAT**	**31 DAT**	**7 DAT**	**14 DAT**	**21 DAT**	**31 DAT**	**7 DAT**	**14 DAT**	**21 DAT**	**31 DAT**
Buck Off!	24.5a[x]	24.1a	24.6a	23.6a	13.6b	13.5a	13.4a	13.4a	13.0a	13.4a	13.1a	12.7a
Deer Off®	24.1a	24.7a	23.9a	24.0a	14.2ab	13.7a	14.0a	13.8a	12.9a	12.7a	12.5a	12.5a
Deer Stopper®	25.1a	25.4a	25.2a	23.4a	13.8ab	13.5a	13.7a	13.7a	12.0a	11.6a	11.4a	11.7a
Liquid Fence®	23.7a	23.8a	23.8a	23.6a	15.6a	14.8a	14.8a	14.6a	13.3a	13.1a	13.0a	13.1a
Plantskydd®	25.5a	25.2a	26.0a	26.1a	13.8ab	13.9a	14.2a	13.5a	12.7a	13.1a	12.8a	12.6a
Control	24.6a	24.3a	24.7a	24.6a	13.3b	13.6a	13.4a	13.3a	12.4a	12.6a	12.4a	11.6a

[z]DAT = days after treatment.

[y]Growth index = (height + width 1 + width 2)/ 3.

[x]Means within column followed by the same letter are not different based on Tukey's Standardized Range Test at $\alpha = 0.05$.

Table 2. Damage ratings[z] for 'G.G. Gerbing' azalea, 'Gumpo White' azalea, and indian hawthorn treated with selected commercial deer repellents at 7, 14, 21, and 31 DAT[y] , Experiment 1 installed November 2, 2009.

	'G.G. Gerbing' azalea (Rhododendron indicum 'G.G. Gerbing')				*'Gumpo White' azalea (Rhododendron eriocarpum 'Gumpo White')*				*Indian hawthorn (Rhaphiolepis indica)*			
Treatment	**7 DAT**	**14 DAT**	**21 DAT**	**31 DAT**	**7 DAT**	**14 DAT**	**21 DAT**	**31 DAT**	**7 DAT**	**14 DAT**	**21 DAT**	**31 DAT**
Buck Off!	0.3a[x]	0.4a	0.4a	0.4a	0.1a	0.1a	0.1a	0.1a	0.1a	0.3a	0.3a	0.3a
Deer Off®	0.1a	0.1a	0.1a	0.1a	0.1a	0.1a	0.1a	0.1a	0.1a	0.2a	0.2a	0.2a
Deer Stopper®	0.2a	0.3a	0.3a	0.3a	0.1a	0.2a	0.2a	0.2a	0.1a	0.1a	0.1a	0.1a
Liquid Fence®	0.2a	0.2a	0.2a	0.2a	0.0a	0.1a	0.1a	0.1a	0.1a	0.3a	0.3a	0.3a
Plantskydd®	0.1a	0.3a	0.3a	0.3a	0.0a	0.0a	0.0a	0.0a	0.1a	0.3a	0.3a	0.3a
Control	0.1a	0.2a	0.2a	0.2a	0.1a	0.1a	0.1a	0.1a	0.1a	0.1a	0.1a	0.1a

[z]Damage ratings based on scale from 0 to 3 (0 = no damage, 1 = 1/3 of the plant eaten, 2 = 2/3 of the plant eaten, and 3 = plant completely destroyed.

[y]DAT = days after treatment.

[x]Means within column followed by the same letter are not different based on Tukey's Standardized Range Test at $\alpha = 0.05$.

Table 3. Effects of selected commercial deer repellents at 7, 12, 21, and 31 DAT[z] on growth indicies[y] (inches) of 'G.G. Gerbing' azalea, 'Gumpo White' azalea, and indian hawthorn, Experiment 2 installed January 27, 2010.

	'G.G. Gerbing' azalea (Rhododendron indicum 'G.G. Gerbing')				*'Gumpo White' azalea (Rhododendron eriocarpum 'Gumpo White')*				*Indian hawthorn (Rhaphiolepis indica)*			
Treatment	**7 DAT**	**14 DAT**	**21 DAT**	**31 DAT**	**7 DAT**	**14 DAT**	**21 DAT**	**31 DAT**	**7 DAT**	**14 DAT**	**21 DAT**	**31 DAT**
Buck Off!	22.0a[x]	22.4a	22.4a	22.0a	20.3a	20.2a	19.8a	19.6a	12.3a	11.9a	12.2a	11.5a
Deer Off®	22.3a	20.6a	22.2a	22.1a	20.9a	20.3a	20.4a	20.0a	12.5a	12.2a	12.4a	11.4a
Deer Stopper®	22.6a	22.0a	22.1a	21.6a	20.3a	20.1a	19.7a	19.9a	13.5a	13.3a	13.1a	12.7a
Liquid Fence®	22.7a	22.5a	22.8a	22.0a	20.2a	20.3a	19.5a	19.8a	12.3a	11.5a	11.8a	11.0ab
Plantskydd®	22.6a	22.0a	22.4a	22.1a	20.6a	19.4a	19.4a	19.1a	13.2a	12.6a	12.6a	11.9a
Control	22.4a	22.3a	22.6a	21.1a	19.9a	19.9a	19.3a	19.1a	12.3a	11.8a	11.2a	8.1b

[z]DAT = days after treatment.

[y]Growth index = (height + width 1 + width 2)/ 3.

[x]Means within column followed by the same letter are not different based on Tukey's Standardized Range Test at $\alpha = 0.05$.

Table 4. Damage ratings[z] for 'G.G. Gerbing' azalea, 'Gumpo White' azalea, and indian hawthorn treated with selected commercial deer repellents at 7, 14, 21, and 31 DAT[y] , Experiment 2 installed January 27, 2010.

	'G.G. Gerbing' azalea (Rhododendron indicum 'G.G. Gerbing')				*'Gumpo White' azalea (Rhododendron eriocarpum 'Gumpo White')*				*Indian hawthorn (Rhaphiolepis indica)*			
Treatment	**7 DAT**	**14 DAT**	**21 DAT**	**31 DAT**	**7 DAT**	**14 DAT**	**21 DAT**	**31 DAT**	**7 DAT**	**14 DAT**	**21 DAT**	**31 DAT**
Buck Off!	0.0a[x]	0.0a	0.0a	0.0a	0.0a	0.0a	0.0a	0.0a	0.0a	0.0a	0.0a	0.3b
Deer Off®	0.0a	0.0a	0.0a	0.0a	0.0a	0.0a	0.1a	0.3a	0.0a	0.0a	0.1a	0.1b
Deer Stopper®	0.0a	0.0a	0.0a	0.0a	0.0a	0.0a	0.0a	0.0a	0.0a	0.0a	0.0a	0.0b
Liquid Fence®	0.0a	0.0a	0.1a	0.1a	0.1a	0.1a	0.2a	0.3a	0.0a	0.0a	0.0a	0.3b
Plantskydd®	0.0a	0.0a	0.0a	0.0a	0.0a	0.0a	0.1a	0.1a	0.0a	0.0a	0.0a	0.0b
Control	0.1a	0.1a	0.3a	0.3a	0.1a	0.1a	0.4a	0.4a	0.1a	0.1a	0.6a	1.8a

[z]Damage ratings based on scale from 0 to 3 (0 = no damage, 1 = 1/3 of the plant eaten, 2 = 2/3 of the plant eaten, and 3 = plant completely destroyed.

[y]DAT = days after treatment.

[x]Means within column followed by the same letter are not different based on Tukey's Standardized Range Test at $\alpha = 0.05$.

CHAPTER VI

COST ANALYSIS OF COMMERCIAL DEER REPELLENTS[1]

Introduction

As cities continue to expand and grow outward, forests and natural areas are being converted to urban landscapes. The exurban landscape of the 21st century can best be described as a patchwork of residential areas and wildlife habitat. More and more wildlife are residing in these areas and are commonly seen living among people. As a result, some homeowners find that wildlife can be serious pests in landscape settings.

The most common wildlife species considered to be a pest in Alabama landscapes is the white-tailed deer. Deer are considered to be both agricultural and exurban pests due to their large populations and propensity to feed on agricultural and ornamental plants. Because white-tailed deer are the most numerous of mammals in North America, with 1.8 million white-tailed deer in Alabama alone, the potential for this species to cause wildlife-human conflicts is tremendous.

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[1]Published as ACES publication ANR-1370. Access at: http://www.aces.edu/pubs/docs/A/ANR-1370/

Recognition of deer damage

Deer are considered an edge species, which means they adapt well to transitional areas between agricultural land, forests, grasslands, and exurban landscapes. Exurban areas often provide high quality food sources in gardens, fertilized lawns, and ornamental plantings. Because of hunting restrictions in these areas, as well as a general lack of natural predators, deer densities sometimes are greater in exurban than rural areas. As deer densities increase in these neighborhoods and competition for food escalates, damage to ornamental plantings increases. If you find damage to ornamental plants in your landscape, you should first determine if deer are to blame. Deer lack upper incisors, but have lower incisors, therefore browsing appears as torn or jagged edges on foliage (Fig. 6.1).

Deer must jerk or tear plant tissues, leaving ragged edges where leaves or twigs were removed. Similar browsing animals, such as rabbits, cause damage to ornamentals as well, but they have upper incisors which leave a smooth, clean cut unlike deer. Additionally, damage caused by rabbits or other herbivores will only be found within one to two feet from the ground, because of the diminutive size of these animals. Deer also prefer specific portions of different plants. Typically, plants less than three feet tall suffer damage to the tops and sides. The most desirable parts of shrubs, fruit trees, and forest seedlings, tend to be buds, twig ends, and foliage. In situations where deer regularly browse the same plants, they have a tendency to create a browse line where they have eaten. This browse line often includes destruction of the majority of limbs or foliage within their reach, usually below the height of about six feet. This damage, accompanied

by deer tracks, are a sign you are a victim of significant deer browsing. Deer tracks can be recognized by their cloven-hoof shape (Fig. 6.2).

Other signs of deer presence might include trampled plants, antler rubbing on tree trunks, deer droppings, and deer beds. Bucks use small trees and saplings to polish their antlers removing the velvet once antler growth is complete (Fig. 6.3). Additionally, bucks also make these antler rubs to serve as communication posts between deer during breeding season. Rubs to remove velvet usually occur sometime in September and conclude in late November, and rubs during breeding season will occur from late November through January. Deer droppings, also called scat (Fig. 6.4), can be easily confused with rabbit scat (Fig. 6.5). Pellets left behind by deer differ by having pinched off ends, unlike rabbit pellets which are rounded. In addition to these signs, you may also find small circular areas in landscape mulch or flattened plant material in an oblong shape, two to five feet long by two to three feet wide. This is a sign that deer have bed at night in that area.

Management Options

There are several control options for deer damage in the landscape. Most nonlethal management techniques are more widely accepted by the public, but lethal methods can still be an option in some cases. Several management techniques include: habitat modification, scare tactics, exclusions, deer resistant plantings, culling, and repellents.

Habitat Modification

Humans can manipulate habitats to make them less attractive to deer browse. Often, habitat modifications made to minimize deer presence is rarely practical because

deer adapt well to most human-modified environments. However, deer do not adapt well to highly-developed downtown areas or any areas devoid of easily accessible cover. As a result, deer populations decrease as you move toward more urban settings and increase as you move into suburban areas. Because suburban areas with patches of woods are equally attractive to most homeowners and deer, habitat modification is not a feasible strategy in most cases.

Scare Tactics

Scare tactics are techniques used to scare deer away from a desired area. These frightening devices can range from motion sensing irrigation or lighting to pyrotechnic devices. Motion sensing irrigation or lighting works by sensing movement by the animal, which automatically sets off the irrigation or lighting. Pyrotechnics (e.g. fireworks, gunfire, etc.) or propane cannons can be used to deter deer from farmlands, but are not practical in suburban settings because loud noises have the potential to disturb other residents. Scare tactics are also not widely used because deer tend to become accustomed to the sound or disturbance over time.

Exclusions

Exclusion is a more reliable method of controlling deer damage in an area. Fencing is used as a barrier to surround areas where deer are unwelcome. Both electric and barrier type fences can be used to exclude deer from an area (Fig. 6.6). There are several important factors to consider when determining if fencing is the best option for a situation, including deer pressure in the area and size of the area to be protected. Fencing can be less economical for smaller areas, so most fencing is used as a barrier around large areas or in large management situations.

Deer Resistant Plantings

Deer are considered foragers, but they do have preferences for certain types of plants. Knowing what types of plants are highly palatable to deer can be significant for a homeowner. Frequently, careful selection of plant material in combination with the usage of a repellent can help minimize deer damage to suburban landscapes.

Culling

Culling is population reduction through sport hunting. This is not a realistic method of management for suburban areas because laws and regulations usually restrict hunting in populated areas.

Repellents Overview

Of all the options discussed, deer repellents have become the most common deer deterrents for homeowners. There are many common types of deer repellents on the market. When selecting a deer repellent for home use, keep several key factors in mind including: mode of action of the repellent as well as aesthetics of the product, application method, reapplication timing, using the right repellent on the right plant species, cost, and coverage of the product. All of these aspects will be discussed in detail in order to help you determine the best product for your situation.

Repellents work by reducing the palatability and attractiveness of a plant species, making the plant undesirable to the deer. Repellents can be divided into two groupings: direct and indirect repellents. Direct repellents repel through bad taste and often contain a bittering agent. Bittering agents work by sticking to the leaf surface of plants, making your plants undesirable to deer due to the bad taste of the agent. The major disadvantage to taste repelling products is that the deer must sample the plant to determine that the

plant is undesirable, so some damage will occur. In contrast, indirect repellents repel through sight, smell, or sound. Putrescent egg solids are a common ingredient in many deer repellents, and tend to use both odor and bad taste for effectiveness. This would be an example of a product that is considered both a direct and indirect repellent. Other ingredients such as dried animal blood may theoretically signal to deer that there is a predator in the vicinity or that an animal has been killed in the area. Because these types of repellents are targeted to deter strictly through smell, they are classified as indirect repellents. Table 6.1 lists some of the most common commercial deer repellents currently on the market. The second column lists the active ingredients in each product, which can be used to determine if the product will deter directly or indirectly. The active ingredients may also influence your choice of product, because specific attributes such as a distinctive and sometimes potent odor during the application process may be personally offensive.

Mode of action & application method

Table 6.2 lists the same repellents as above along with the mode of action and application method. Mode of action of the repellents is generally through odor or taste. However, the Deer Stopper® Plotsaver Deer Barrier System Kit can be considered a barrier as well as an odor and taste repellent. Application methods are listed in the third column. The application of repellents is most often determined by the form in which the product is marketed. Most products are applied as sprays, which means they come in a liquid form that is either concentrated or ready to use. Concentrated products must be diluted in water to form a solution that will not be harmful to the plants. Some repellents can also be purchased in a ready-to-use form, meaning, that the repellent has already been

diluted for convenience. For example, Plantskydd® is listed as a soluble powder, which is a concentrate in a powder form in contrast to a concentrated liquid. However, this product must still be diluted in water. Deer Scram™ and Shake-Away® are both granular products that are typically applied around borders and serve as a barrier to decrease deer browse. Plant Pro-Tec® Probes are release probes that clip on plants and discharge a garlic odor to repel deer.

Reapplication Timing

For a repellent to be effective to its full potential, understanding and following reapplication timing is a key aspect to successfully deterring deer from a desired area. Repellents must be applied and reapplied according to manufacturer guidelines to achieve their full effect. However, most people prefer convenience, so a longer reapplication time is often desired, which means that fewer applications are required. Table 6.3 lists the common deer repellents along with their suggested reapplication timings.

Repellent Labels

When purchasing deer repellents, another key factor to consider for increasing product effectiveness, is to determine what brands of repellents are labeled exclusively for different plant groups. Repellents can be applied to various plant species for protection from deer browsing depending on label recommendations, so be sure to read each label carefully in order to identify what types of repellents are safe for your plant species. This is especially important when considering repellents for vegetable crops because all repellents are not labeled for edibles. Table 6.4 lists the common deer repellents and the plants that each is labeled to protect.

Cost

Deer repellents are often sold in a gallon concentrate form, though some repellents may also be purchased in a ready-to-use form. These ready-to-use forms are often less expensive than the concentrate, but will not cover as large of an area as concentrates. There are benefits to purchasing either type of repellent. Typically, purchasing concentrated products is more cost effective than purchasing ready-to-use products. However, ready-to-use products are more convenient for the applicator and do not require any advanced preparations. Table 6.5 lists the common repellents along with their current cost. You can see that ready-to-use products tend to be priced lower than most concentrated products.

Coverage

Coverage is an important issue when dealing with any type of deer repellent. Table 6.6 lists the maximum area covered by each product. Typically, application areas for homeowners are much smaller than commercial areas. Because a lower quantity is needed for home use, calculations have been done based upon application of each product to a 100 square foot area. Table 6.7 shows the cost of one application per 100 square feet and the cost of reapplying the product, according to reapplication timing on each label, for a complete year.

From the cost analysis, it is relatively inexpensive to treat a 100 square foot area with one application of a repellent. However, be sure to look at the reapplication timing because it can drastically increase the yearly cost, as seen in Miller Hot Sauce. The most cost effective repellent for yearly application is Deer Out™, with a cost of $1.00 per year for a 100 square foot area. Other repellents that cost less than two dollars for yearly

application are Plantskydd® and Spotrete™ F. Other products range from $2.20 for yearly application to $518.18. Also keep in mind that the cost of a product is totally independent of the effectiveness of the product.

Other information including the manufacturer name, address, and website can be found in tables 6.8, 6.9, and 6.10.

When purchasing deer repellents you should consider all of the factors including: mode of action of the repellent, application method, reapplication timing, using the right repellent on the right plant species, cost, and coverage of the product. Other ideas might be to use a combination of the management techniques listed in order to prevent deer browse. An example of this could be the selection of ornamental plants that are less frequently browsed by deer along with the use of repellents. Other options might be to use fencing to protect larger areas and repellents in smaller areas. Lastly, remember to begin management techniques before significant damage takes place. Once deer become accustomed to browsing an area, deterrents become less effective.

Figure 1. White-tailed deer damage to Indian hawthorn (*Rhaphiolepis indica*).

Figure 2. White-tailed deer track.

Figure 3. White-tailed deer rub on a tree.

Figure 4. White-tailed deer scat.

Figure 5. Rabbit scat.

Figure 6. Homeowner fencing around garden.

Table 1. Active ingredients in common commercial deer repellents.

Repellent Name	Active Ingredients
Bobbex™	Garlic oil, acetic acid, cloves, gelletin, fish meal, edible fish oil, onions, eggs
Buck Off!	Putrescent whole egg solids, potassium sorbate
Deer Off®	Putrescent egg solids, capsaicin and related capsaicinoids, garlic
Deer Out™	High peppermint content
Deer Pharm	Soybean oil, citric acid, garlic oil
Deer Scram™	Blend of selected organic components
Deer Stopper® Plotsaver	Putrescent whole egg solids, rosemary oil, mint oil, sodium chloride, potassium sorbate
Deer Stopper® Repellent	Putrescent whole egg solids, rosemary oil, mint oil, sodium chloride, potassium sorbate
Deerbusters™	Putrescent egg, garlic and hot pepper
Hinder®	Ammonium soaps of higher fatty acids
Liquid Fence®	Putrescent egg solids, garlic, sodium lauryl sulfate, potassium sorbate
Miller Hot Sauce	Extremely concentrated hot pepper
No Deer Zone™	Denatonium benzoate or Benzyldiethyl*
Plant Pro-Tec®	Oil of garlic
Plantskydd®	Dried blood (porcine and/or bovine)
Shake-Away®	Garlic oil
Spotrete™ F	Thiram*
Tree Guard®	Denatonium benzoate or Benzyldiethyl*

*Indicates bittering agent

Table 2. Mode of action and application method of common commercial deer repellents.

Repellent	Mode of Action	Application Method
Bobbex™	Odor and taste	Spray
Buck Off!	Taste	Spray
Deer Off®	Odor and taste	Spray
Deer Out™	Odor and taste	Spray
Deer Pharm	Odor	Spray
Deer Scram™	Odor	Granular
Deer Stopper® Plotsaver	Odor, taste, and barrier	Spray and barrier
Deer Stopper® Repellent	Odor and taste	Spray
Deerbusters™	Odor and taste	Spray
Hinder®	Odor	Spray
Liquid Fence®	Odor	Spray
Miller Hot Sauce	Odor and taste	Spray
No Deer Zone™	Taste (Bittering Agent)	Spray
Plant Pro-Tec®	Odor	Garlic Odor Release Probe
Plantskydd®	Odor	Soluble Powder Concentrate
Shake-Away®	Odor, taste, and barrier	Granular
Spotrete™ F	Taste (Bittering Agent)	Spray
Tree Guard®	Taste (Bittering Agent)	Spray

Table 3. Reapplication timing of common commercial deer repellents.

Repellent	Reapplication Timing
Bobbex™	Reapply every 2 months
Buck Off!	Reapply monthly
Deer Off®	Reapply every 2 to 3 months
Deer Out™	Reapply every 3 to 4 months
Deer Pharm	Spray as needed
Deer Scram™	Reapply monthly
Deer Stopper® Plotsaver	1 package protects 3 months
Deer Stopper® Repellent	Reapply monthly
Deerbusters™	Reapply every 3 to 4 months
Hinder®	Reapply monthly depending on rainfall
Liquid Fence®	Reapply 1 week later and then monthly
Miller Hot Sauce	Apply every 2 to 3 weeks
No Deer Zone™	Reapply every 3 to 4 months
Plant Pro-Tec®	Reapply every 6 to 8 months
Plantskydd®	Reapply every 3 to 6 months
Shake-Away®	Twice montly
Spotrete™ F	Reapply every 1 to 3 months
Tree Guard®	Reapply every 4 months

Table 4. Label recommendations of common commercial deer repellents.

Repellent	Application Labeling
Bobbex™	Ornamental and flowering shrubs
Buck Off!	Flowers, bulbs, non-bearing food crops, hedges, shrubs, and trees
Deer Off®	Edible crops, flowers, grass, bulbs, shrubs, seedlings, and trees
Deer Out™	Flowers, shrubs, vegetable plants, row crops, trees, and vines
Deer Pharm	Plants, fruits, berries, edibles, and herbs
Deer Scram™	Ornamental plants
Deer Stopper® Plotsaver	Shrubs, flowers, edible crops, forest and fruit trees
Deer Stopper® Repellent	Shrubs, flowers, edible crops, forest and fruit trees
Deerbusters™	Ornamental plants and vegetable gardens
Hinder®	Flowers, trees, shrubs, crops, and food crops
Liquid Fence®	Landscaped garden areas, flowers, shrubs, trees, and vines
Miller Hot Sauce	Ornamental plants
No Deer Zone™	Conifers and deciduous, non-bearing fruit trees, shrubs, flowers, and ornamentals
Plant Pro-Tec®	Tree, shrubs, and flowers
Plantskydd®	Broadleaf plants, row crops, conifers, and deciduous trees
Shake-Away®	Small gardens, flower beds, and yards
Spotrete™ F	Deciduous and evergreen trees, shrubs, and non-bearing vines and orchards
Tree Guard®	Conifers and deciduous, non-bearing fruit trees, shrubs, flowers, and ornamentals

Table 5. Cost of common commercial deer repellents.

Repellent	Cost
Bobbex™	$97.98 per gallon concentrate
Buck Off!	$87.50 per gallon concentrate
Deer Off®	$146.04 per gallon concentrate
Deer Out™	$99.00 per gallon concentrate
Deer Pharm	$95.00 per gallon concentrate
Deer Scram™	$18.95 per 2.5 pound container
Deer Stopper® Plotsaver	$49.95 per kit
Deer Stopper® Repellent	$124.95 per gallon concentrate
Deerbusters™	$165.95 per gallon concentrate
Hinder®	$37.99 per gallon concentrate
Liquid Fence®	$124.99 per gallon concentrate
Miller Hot Sauce	$289.00 per gallon concentrate
No Deer Zone™	$29.95 per 1 gallon ready-to-use
Plant Pro-Tec®	$35.10 per 50 unit bag
Plantskydd®	$24.95 per lb. soluble powder
Shake-Away®	$14.95 per 20 oz. container
Spotrete™ F	$39.00 per gallon concentrate
Tree Guard®	$47.95 per gallon ready-to-use

Table 6. Coverage of common commercial deer repellents.

Repellent	Area Covered
Bobbex™	1 gallon concentrate protects 3,000-4,000 sq. ft.
Buck Off!	1 gallon concentrate protects 8,000 sq. ft.
Deer Off®	1 gallon concentrate protects 16,000 sq. ft.
Deer Out™	1 gallon concentrate protects 40,000 sq. ft
Deer Pharm	1 gallon concentrate protects 4,000 plants or 100,000 sq. ft.*
Deer Scram™	2.5 pounds protects 1,600 sq. ft.
Deer Stopper® Plotsaver	One kit protects 5,000 sq. ft.
Deer Stopper® Repellent	1 gallon concentrate protects 40,000 sq. ft.
Deerbusters™	1 gallon concentrate protects 1,200 to 1,600 plants or 30,000-40,000 sq. ft.*
Hinder®	1 gallon concentrate protects 4,400 sq. ft.
Liquid Fence®	1 gallon concentrate protects 32,000 sq. ft.
Miller Hot Sauce	1 gallon concnetrate protects 1,450 sq. ft.
No Deer Zone™	1 gallon RTU protects 20 medium shrubs or 500 sq. ft.*
Plant Pro-Tec®	3 to 4 units per plant or 200 sq. ft. per 50 unit bag*
Plantskydd®	1 pound powder protects 200-300 plants or 7,200-10,800 sq. ft.*
Shake-Away®	20 oz. container covers 600 linear ft.**
Spotrete™ F	1 gallon protects one acre or 43,560 sq. ft.
Tree Guard®	1 gallon RTU protects 1,000 sq. ft.

*Plants were assumed to be a medium size of 5ft. by 5ft. and consume 25sq.ft. of space

**Granular repellent outlines protected area; measured in linear ft.

Table 7. Cost analysis of common commercial deer repellents.

Repellent	Cost /100 sq. ft. Area	Cost/100 sq. ft. Area/ Year
Bobbex™	$3.27/ 100 sq. ft.	$19.62/ 100 sq. ft.
Buck Off!	$1.09/ 100 sq. ft	$13.08/ 100 sq. ft.
Deer Off®	$0.91/ 100 sq. ft.	$5.46/ 100 sq. ft.
Deer Out™	$0.25/ 100 sq. ft.	$1.00/ 100 sq. ft.
Deer Pharm	$0.09/ 100 sq. ft.	$2.16/ 100 sq. ft. **
Deer Scram™	$1.18/ 100 sq. ft.	$14.16/ 100 sq. ft.
Deer Stopper® Plotsaver	$1.00/ 100 sq. ft.	$4.00 / 100 sq. ft.
Deer Stopper® Repellent	$0.31/ 100 sq. ft.	$3.72/ 100 sq. ft.
Deerbusters™	$0.55/ 100 sq. ft.	$2.20/ 100 sq. ft.
Hinder®	$0.86/ 100 sq. ft.	$10.32/ 100 sq. ft.
Liquid Fence®	$0.39/ 100 sq. ft.	$5.07/ 100 sq. ft.
Miller Hot Sauce	$19.93/ 100 sq. ft.	$518.18/ 100 sq. ft.
No Deer Zone™*	$5.99/ 100 sq. ft.	$23.96/ 100 sq. ft.
Plant Pro-Tec®	$17.55/ 100 sq. ft.	$35.10/ 100 sq. ft.
Plantskydd®	$0.35/ 100 sq. ft.	$1.40/ 100 sq. ft.
Shake-Away®	$2.49/ linear ft.	$59.76/ linear ft.
Spotrete™ F	$0.09/ 100 sq. ft.	$1.07/ 100 sq. ft.
Tree Guard®*	$4.80/ 100 sq. ft.	$14.40/ 100 sq. ft.

*Indicates ready-to-use product

**Calculated for reapplication every 2 weeks

Table 8. Manufacturer names of commercial deer repellents.

Repellent	Manufacturer
Bobbex™	Bobbex, Inc.
Buck Off!	Cleary Chemical Corporation
Deer Off®	Woodstream Cooperation
Deer Out™	Deer Out
Deer Pharm	Pharm Soultions
Deer Scram™	Deer Scram
Deer Stopper® Plotsaver	Messina Wildlife Management
Deer Stopper® Repellent	Messina Wildlife Management
Deerbusters™	Trident Enterprises International Inc.
Hinder®	Pace International
Liquid Fence®	Liquid Fence Co., Inc.
Miller Hot Sauce	Miller Chemical & Fertilizer Corporation
No Deer Zone™	Monterey Lawn and Garden Products, Inc.
Plant Pro-Tec®	Plant Pro-Tec, LLC
Plantskydd®	Tree World, Inc.
Shake-Away®	Shake Away
Spotrete™ F	Cleary Chemical Corporation
Tree Guard®	Becker Underwood Inc.

Table 9. Commercial deer repellents manufacturer addresses.

Repellent	Address
Bobbex™	52 Hattertown Road, Newtown, CT 06470
Buck Off!	178 Ridge Road, Suite A, Dayton, NJ 08810-1501
Deer Off®	69 North Locust Street, Lititz, PA 17543
Deer Out™	PO Box 290, South Plainfield, NJ 07080
Deer Pharm	2023 E. Sims Way Suite #358, Port Townsend, WA 98368
Deer Scram™	27 Link Drive, Suite C, Binghamton, NY 13904
Deer Stopper® Plotsaver	PO Box 122, Chester, NJ 07930
Deer Stopper® Repellent	PO Box 122, Chester, NJ 07930
Deerbusters™	9735A Bethel Road, Frederick, MD 21702
Hinder®	1011 Western Ave., Suite 505, Seattle, WA 98104
Liquid Fence®	PO Box 300, Brodheadsville, PA 18322
Miller Hot Sauce	Box 333, 120 Radio Road, Hanover, PA 17331
No Deer Zone™	PO Box 35000, Fresno, CA 93745
Plant Pro-Tec®	PO Box 902, Palo Cedro, CA 96073
Plantskydd®	PO Box 4821, DesMoines, IA 50306
Shake-Away®	2330 Whitney Ave., Hamden, CT 06518
Spotrete™ F	178 Ridge Road, Suite A, Dayton, NJ 08810-1501
Tree Guard®	801 Dayton Ave., Ames, IA 50010

Table 10. Commercial deer repellents manufacturer websites.

Repellent	Website
Bobbex™	www.bobbex.com
Buck Off!	www.clearychemical.com
Deer Off®	www.havahart.com
Deer Out™	www.deerout.com
Deer Pharm	www.organicpharmsolutions.com
Deer Scram™	www.deerscram.com
Deer Stopper® Plotsaver	www.messinawildlife.com
Deer Stopper® Repellent	www.messinawildlife.com
Deerbusters™	www.deerbusters.com
Hinder®	www.paceint.com
Liquid Fence®	www.liquidfence.com
Miller Hot Sauce	www.millerchemical.com
No Deer Zone™	www.montereylawngarden.com
Plant Pro-Tec®	www.plantprotec.com
Plantskydd®	www.plantskydd.com
Shake-Away®	www.shakeawayproducts.com
Spotrete™ F	www.clearychemical.com
Tree Guard®	www.treeguard-deer.com

CHAPTER VII

SUMMARY AND CONCLUSIONS

Survey of white-tailed deer (*Oldocioleus virginianus* Zimmerman) impacts on residential landscapes throughout the state of Alabama and on ornamentals in the Alabama nursery and landscape industries

Thirty-six percent of surveyed homeowners experienced some white-tailed deer damage to their landscape, and the majority of surveyed nursery and landscape professionals stated they experienced damage in their businesses. This survey helped to determine many factors that were of concern to homeowners, growers, and landscape professionals. By understating the extent white-tailed deer damage in Alabama, more effective ways to control deer damage can be explored. Dissemination of information collected from this survey could educate homeowners as well as professionals about improved and reliable damage prevention and could also determine which methods of control are most feasible.

Phytotoxicity of commercial deer repellents on common annual landscape species

Analysis of data revealed that there was no evidence to suggest that any deer repellents used in this test had phytotoxic effects on dianthus (*Dianthus plumarius* L.) or snapdragon (*Antirrhinum majus* L.). Plants in this test received large amounts of irrigation throughout the testing period, so repellents in this test would be best used in a nursery setting where large amounts of irrigation are provided daily to ensure no

symptoms of phytotoxicity. Consequently, further testing for phytotoxicity should be done on landscape plants that might not receive irrigation water daily as nursery plants to determine if irrigation could have an effect on phytotoxicity.

Evaluation of commercial deer repellents as white-tailed deer deterrents on ornamental plant species

In Experiment 1, Liquid Fence® was the repellent that provided protection for all three species compared to other treatments. However, in Experiment 2, Deer Stopper® provided the best protection for all three species compared to other treatments. Growth data and damage ratings for this study were collected on a weekly basis. For future research, data should be taken daily so new growth due to feeding damage would not conceal actual damage experienced. Data should also be collected and analyzed using repeated measures, so that damage to specific regions of the testing area can be detected.

Cost analysis of commercial deer repellents

Many commercial deer repellents are a cost effective technique to reduce deer browse damage to landscape ornamental plants in small scale landscape situations. As a homeowner, when selecting a deer repellent, there are many factors to remember. First, determine the mode of action of the repellent and the application method. Repellents can deter through smell or taste, which are both modes of action. Application method lets the homeowner determine how the repellent should be applied. Reapplication timing is factor to consider when purchasing a deer repellent, because some repellents uphold longer than others. Convenience is important to many homeowners, so a longer reapplication time is optimal. However, effectiveness might be sacrificed when using products with longer reapplication timings. It is important for a homeowner to always

read the label and follow labeled directions when using deer repellents. Labels tell you how to apply the product, and plant species that will not be harmed by the product. Not all repellents are labeled for all plants; for example, there are very few products that are labeled for edible crops. If repellents are applied to unlabeled plant species, the homeowner might experience some phytotoxic effects. Cost and coverage are two more important factors to consider when selecting the appropriate deer repellent. Ready-to-use products are generally cheaper than concentrated products, but will not cover large areas as concentrates. Concentrates are generally most cost effective, but ready-to-use products are more convenient for the applicator. All of these factors should be considered when selecting a deer repellent, so that homeowners can find the repellent to best suit individual situations.

APPENDICES

APPENDIX A: Residential Survey

Figure 1. Residential survey introduction page explaining the survey and data collected.

DEPARTMENT
OF
HORTICULTURE

AUBURN UNIVERSITY

COLLEGE OF AGRICULTURE

Deer Repellent Survey

Thank you for helping complete our survey! My name is Ashley Baker, and I am currently a graduate student in horticulture at Auburn University. The main objective of my research is to test deer repellents for their effectiveness in landscape situations. This survey will help us determine how many homeowners use, or are familiar with, commercial deer repellents that are currently on the market. Data and results from this survey, and my other related research, will be available in spring 2010. If you have any questions feel free to email me. Thank you again for helping complete our survey!

L. Ashley Baker
BAKERL3@AUBURN.EDU
Graduate Student

Auburn University Department of Horticulture
101 Funchess Hall
Auburn University, AL 36849
334-844-7192

101 Funchess Hall, Auburn, AL 36849-5408; Telephone: 334-844-4862; Fax: 334-844-3131
www.auburn.edu

Figure 2. Residential survey of deer damage and preventative methods.

Deer Repellent Survey

Auburn University Horticulture Department

1. Are you answering this survey for your primary residence?
   - ☐ Yes
   - ☐ No

   If you answered no for question 1, what residence are you referring to in this survey?

   - ☐ Lake Home
   - ☐ Beach Home
   - ☐ Cabin in wooded area
   - ☐ Other _____

2. In which section of Alabama is your residence located?
   - ☐ Northeast Alabama
   - ☐ Northwest Alabama
   - ☐ East Central Alabama
   - ☐ West Central Alabama
   - ☐ Southeast Alabama
   - ☐ Southwest Alabama

3. Do you experience deer damage problems on your property?
   - ☐ Yes
   - ☐ No

4. Are you using any preventative measures to reduce deer damage?
   - ☐ Yes, **please continue to question 5**
   - ☐ No, **please skip to question 10**

5. What types of preventative methods are you using or have you used in the past, and how would you rate the overall effectiveness of those methods?

		Do Not Use	Not Effective	Fairly Effective	Moderately Effective	Effective	Highly Effective
Fencing							
	High Fence	☐	☐	☐	☐	☐	☐
	Electric Fence	☐	☐	☐	☐	☐	☐
Repellents							
	Buck Off	☐	☐	☐	☐	☐	☐
	Deer Away	☐	☐	☐	☐	☐	☐
	Deer Off	☐	☐	☐	☐	☐	☐
	Deer Stopper	☐	☐	☐	☐	☐	☐
	Liquid Fence	☐	☐	☐	☐	☐	☐
	Plantskydd	☐	☐	☐	☐	☐	☐
	Other _____	☐	☐	☐	☐	☐	☐
Mechanical							
	Motion Lighting	☐	☐	☐	☐	☐	☐
	Motion Irrigation	☐	☐	☐	☐	☐	☐
	Frightening Sounds	☐	☐	☐	☐	☐	☐
Other							
	_____	☐	☐	☐	☐	☐	☐
	_____	☐	☐	☐	☐	☐	☐

6. What time of year do you have the majority of deer browse problems?
   - ☐ Winter
   - ☐ Spring
   - ☐ Summer
   - ☐ Fall

7. What plants do deer typically browse (please list three plants by common name or scientific name)?
   1. _____
   2. _____
   3. _____

8. What percentage of plants on your property <u>suffers damage</u> due to deer annually?
   _____

9. What percentage of plants do you <u>lose</u> annually due to deer damage?
   _____

10. During the past five years has the deer population in your area:
    - ☐ Decreased
    - ☐ Remained the same
    - ☐ Increased
    - ☐ Not Sure

11. What type of environment surrounds your property?
    - ☐ Wooded
    - ☐ Field
    - ☐ Waterfront
    - ☐ Suburban area
    - ☐ Other _____

12. What is the size of your property?
    - ☐ Less than ¼ of an acre
    - ☐ ¼ - ½ of an acre
    - ☐ ½ - 1 acre
    - ☐ Greater than 1 acre

13. What is the development age of the area in which you live?
    - ☐ Less than 5 years
    - ☐ 5 -20 years
    - ☐ 20-40 years
    - ☐ 40-60 years
    - ☐ Greater than 60 years

14. Do you consider your property a deer habitat?
    - ☐ Yes
    - ☐ No

15. Do you have a garden located on your property (flower or vegetable)?
    - ☐ Yes
        - ☐ Flower
        - ☐ Vegetable
        - ☐ Both
    - ☐ No

16. Are you familiar with any types of deer repellents on the market?
    - ☐ Yes
    - ☐ No

17. If so, what brands are you familiar with?

    _____

18. Do you believe that deer repellents are cost effective?
    - ☐ Yes
    - ☐ No

19. Does the scent of a repellent play a role in your purchase of the product?
    - ☐ Yes
    - ☐ No

Information About You

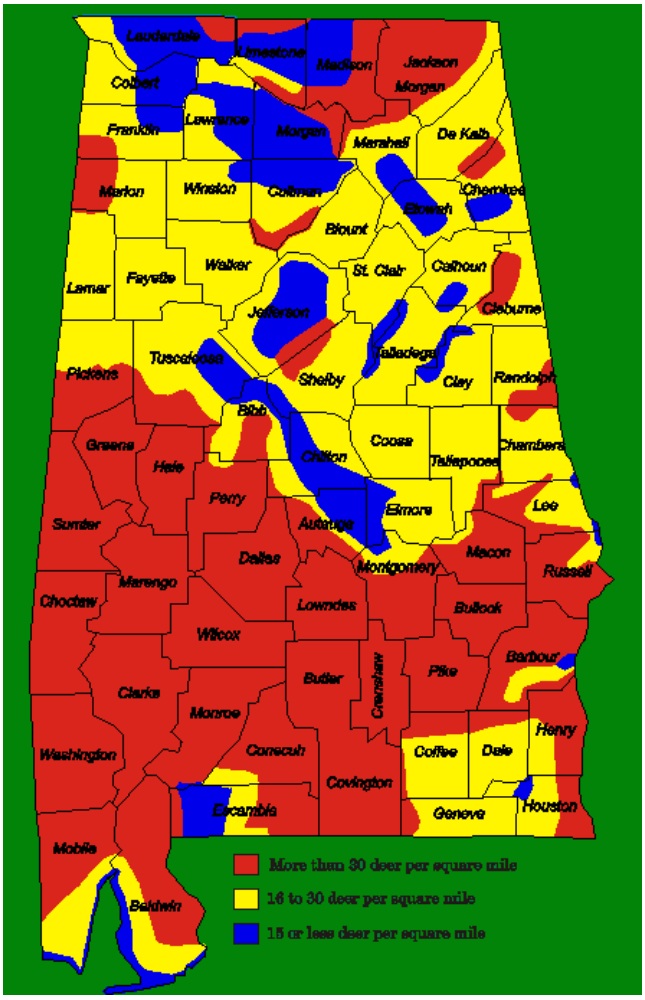
20. What is your age?
    - ☐ 18 & younger
    - ☐ 19-30
    - ☐ 31-50
    - ☐ 51-70
    - ☐ Over 70

21. What is your gender?
    - ☐ Male
    - ☐ Female

22. Do you have any pets that use the outdoors?
    - ☐ Yes
    - ☐ No

23. If yes, what type of pet?
    - ☐ Dog
    - ☐ Cat
    - ☐ Other

Figure 3. White-tailed deer density map from the Alabama Department of Conservation and Natural Resources where red indicates more than 30 deer per square mile, yellow represents 16 to 30 deer per square mile, and blue represents 15 or less deer per square mile.



APPENDIX B: Nursery and Landscape Survey

Figure 1. Mr. James Harwell's letter of support encouraging responses from nursery and landscape professionals.

ALABAMA NURSERY & LANDSCAPE ASSOCIATION

"To promote the success and professionalism of its membership."

President
Jim Van Antwerp
Flowerwood Nursery,Inc.
Loxley
888-922-7374

Vice President
Philip Hunter
Hunter Trees
Birmingham
256-268-5890

Secretary-Treasurer
Stephen Presley
Landscape Workshop, Inc.
Bessemer
205-424-0244

Director
Bethany O'Rear
Landscape Services, Inc.
Birmingham
205-991-9584

Director
Maarten van der Giessen
van der Giessen Nursery, Inc.
Semmes
251-649-9477

Allied Director
Andy Zimlich
Nursery Supplies, Inc.
Mobile
251-476-6867

Director Emeritus
J. Harvey Cotten
Huntsville Botanical Gardens
Huntsville
256-830-4447

Past President
Steve Thomas
Greene Hill Nursery, Inc.
Waverly
334-864-7500

Executive Director
James Harwell
Auburn
334-821-5148

Dear ALNLA Member:

As white-tailed deer (*Odocoileus virginianus*) numbers continue to increase in the state of Alabama, many landscape and nursery professionals experience deer damage. Deer are considered an agricultural and urban pest due to their large populations and feeding damage to herbaceous and woody plant materials. There are several common ways to manage deer damage in a nursery or landscape situation including fencing or repellents. The growing rise of deer damage to nurseries and landscapes leads to the rise in the use of deer deterrents or repellents.

The Alabama Nursery and Landscape Association is partnering with the Auburn University Department of Horticulture to develop a survey to assess deer damage impacting nursery professionals and landscape professionals throughout the state of Alabama. L. Ashley Baker, an Auburn University graduate student, is heading the study. In the enclosed envelope there is a survey that will help us determine the amount of deer damage throughout the state along with management techniques commonly used to deter deer. Please take a few minutes to answer the survey and express your opinion on the matter.

The Alabama Nursery and Landscape Association is here to support and promote Alabama's Green Industry, so if you have any questions or comments feel free to call or email me.

[redacted]

James Harwell
Executive Director, ALNLA

P.O. Box 9, Auburn, AL 36831 • Phone: 334-821-5148 • Fax: 334-502-7711 • Web: www.alnla.org • E-Mail: info@alnla.org

Figure 2. Cover letter for nursery and landscape survey.

DEPARTMENT
OF
HORTICULTURE

AUBURN UNIVERSITY

COLLEGE OF AGRICULTURE

Dear Green Industry Professional,

My name is Ashley Baker, and I am currently a graduate student in horticulture at Auburn University. The main objective of this research is to test deer repellents for their effectiveness in nursery and landscape situations. This survey will help us determine how many nursery and landscape professionals use, or are familiar with, commercial deer repellents that are currently on the market.

You have been invited as a grower or landscape professional in the green industry to participate in this survey to help us determine the overall impact of deer damage and management techniques throughout the state. The survey enclosed should only take about 10 minutes to complete. After completing the survey, please place it in the self-addressed stamped envelope for return. If you would prefer to take the survey online, you can access it at www.auburn.edu/deersurvey.

Results from the survey are confidential. Participation and prompt return of the survey is greatly appreciated. Please return the survey in the enclosed envelope by November 30, 2009. Data and results from this survey, and my other related research, will be available in spring 2010. If you have any questions feel free to call or email me. Thank you again for helping complete our survey!

L. Ashley Baker
BAKERL3@AUBURN.EDU
Graduate Student

Auburn University Department of Horticulture
101 Funchess Hall
Auburn University, AL 36849
334-844-7192

101 Funchess Hall, Auburn, AL 36849-5408; Telephone: 334-844-4862; Fax: 334-844-3131

www.auburn.edu

Figure 3. Nursery and landscape professional survey of deer damage throughout the state of Alabama.

Deer Repellent Survey

Nursery/Landscape

Auburn University Horticulture Department

1. Which section of Alabama is your business located?
   - ☐ Northeast Alabama
   - ☐ Northwest Alabama
   - ☐ East Central Alabama
   - ☐ West Central Alabama
   - ☐ Southeast Alabama
   - ☐ Southwest Alabama

2. Do you experience any deer damage problems in your business?
   - ☐ Yes
   - ☐ No

3. Are you using, or have you used, any preventative measures to reduce deer damage in your business?
   - ☐ Yes, please continue to question 4
   - ☐ No , please skip to question 5

If you answered NO to both question 2 and 3 please skip to question 9.

4. What types of preventative methods are you using or have you used in the past, and how would you rate the overall effectiveness of those methods?

Fencing		Do Not Use	Not Effective	Fairly Effective	Moderately Effective	Effective	Highly Effective
	High Fence	☐	☐	☐	☐	☐	☐
	Electric Fence	☐	☐	☐	☐	☐	☐
Repellents							
	Buck Off	☐	☐	☐	☐	☐	☐
	Deer Away	☐	☐	☐	☐	☐	☐
	Deer Off	☐	☐	☐	☐	☐	☐
	Deer Stopper	☐	☐	☐	☐	☐	☐
	Liquid Fence	☐	☐	☐	☐	☐	☐
	Plantskydd	☐	☐	☐	☐	☐	☐
	Other _____	☐	☐	☐	☐	☐	☐
Mechanical							
	Motion Lighting	☐	☐	☐	☐	☐	☐
	Motion Irrigation	☐	☐	☐	☐	☐	☐
	Frightening Sounds	☐	☐	☐	☐	☐	☐
Other							
	_____	☐	☐	☐	☐	☐	☐
	_____	☐	☐	☐	☐	☐	☐

5. What plants do deer typically browse (please list three plants by common name or scientific name)?
   4. _____
   5. _____
   6. _____

6. What time of year do you suffer the majority of deer damage?
   - ☐ Winter
   - ☐ Spring
   - ☐ Summer
   - ☐ Fall

7. Please list the month that you experience the most deer damage.

_____

8. How much do you spend annually on deer management techniques?

_____

9. Are you familiar with any types of deer repellents on the market?
   - ☐ Yes
   - ☐ No

10. If so, what brands are you familiar with?

_____

11. Do you believe that deer repellents are cost effective?
    - ☐ Yes
    - ☐ No
    - ☐ Not Sure

12. Does the scent of a repellent play a role in your purchase of the product?
    - ☐ Yes
    - ☐ No

13. How would you classify your business
    - ☐ Nursery
    - ☐ Landscape
    - ☐ Nursery & Landscape

If you are in the nursery profession please continue with number 14, and if in the landscape profession please skip to 23. If you are in both the nursery and landscape profession please answer all of the questions below.

Nursery Professional Questions (14-22)

14. What percentage of plants at your nursery suffers <u>damage</u> due to deer annually?

_____

15. What percentage of plants do you <u>lose</u> annually due to deer damage?

_____

16. During the past five years do you believe the deer population in your area:
    - ☐ Decreased
    - ☐ Remained the same
    - ☐ Increased
    - ☐ Not Sure

17. What type of environment surrounds your nursery?
    - ☐ Wooded
    - ☐ Field
    - ☐ Waterfront
    - ☐ Suburban area
    - ☐ Other _____

18. Do you consider your property a deer habitat?
    - ☐ Yes
    - ☐ No

19. What is the size of your nursery (please list in acres)?

_____

20. Do you have any animals around your nursery?
    - ☐ Yes
    - ☐ No

    If yes, what types of animals?

    _____

21. What is your age?
    - ☐ 18 & younger
    - ☐ 19-30
    - ☐ 31-50
    - ☐ 51-70
    - ☐ Over 70

22. What is your gender?
    - ☐ Male
    - ☐ Female

Landscape Professional Questions (23-30)

23. Do any of your clients complain of deer browse problems?
    - ☐ Yes
    - ☐ No

24. Please list the average percentage of <u>damage</u> to your clients' plants due to deer annually.

_____

25. What is the average percentage of plants that your clients <u>lose</u> annually due to deer damage?

_____

26. Over the last five years have customer complaints about deer problems:
    - ☐ Decreased
    - ☐ Remained the same
    - ☐ Increased
    - ☐ Not Sure

27. During the past five years do you believe the deer population in your area:
    - ☐ Decreased
    - ☐ Remained the same
    - ☐ Increased
    - ☐ Not Sure

28. Do you currently charge customers to apply deer repellents to commercial or residential areas?
    - ☐ Yes
    - ☐ No

29. What is your age?
    - ☐ 18 & younger
    - ☐ 19-30
    - ☐ 31-50
    - ☐ 51-70
    - ☐ Over 70

30. What is your gender?
    - ☐ Male
    - ☐ Female

APPENDIX C: State Extension Lists

Table 1. Compiled state extension lists of susceptible and resistant plant species to white-tailed deer damage.

Scientific Name	Common Name	State	Comments
Abelia spp.	Abelia	TN	Resistant
Abies concolor	White Fir	MI	Occassionally Damaged
Abies spp.	Fir	GA	Trees w/ high degree deer tolerance
Acer griseum	Paperbark Maple	SC*	Occassionally Severely Damaged
Acer griseum	Paperbark Maple	MI	Occassionally Damaged
Acer negundo	Boxelder	AL	Attracting
Acer platanoides	Norway Maple	MI	Frequently Damaged
Acer rubrum	Red Maple	FL	Trees w/ moderate damage
Acer rubrum	Red Maple	GA	Trees w/ high degree deer tolerance
Acer rubrum	Red Maple	AL	Attracting
Acer rubrum	Red Maple	SC*	Occassionally Severely Damaged
Acer rubrum	Red Maple	MI	Occassionally Damaged
Acer saccharinum	Silver Maple	SC*	Occassionally Severely Damaged
Acer saccharinum	Silver Maple	MI	Occassionally Damaged
Acer saccharum	Sugar Maple	SC*	Occassionally Severely Damaged
Acer saccharum	Sugar Maple	MI	Occassionally Damaged
Achillea filipendulina	Yarrow	TN	Resistant
Achillea filipendulina 'C.G.'	Yarrow 'Coronation Gold'	MI	Rarely Damaged

Table 1. Compiled state extension lists of susceptible and resistant plant species to white-tailed deer damage, continued.

Scientific Name	Common Name	State	Comments
Achillea spp.	Yarrow	GA	Herbaceous Perennials/Bulbs w/ high deer tolernce
Achillea spp.	Yarrow	AK	Resistant Perennials
Achillea spp.	Yarrow	MI	Rarely Damaged
Acoelorrhaphe wrightii	Paurotis Palm	FL	Trees w/ rare damage
Aconitum spp.	Monkshood	AK	Resistant Perennials
Acuba japonica	Gold-Dust Plant	AK	Resistant Shrubs
Acuba japonica	Acuba	TN	Resistant
Aesculus hippocastanum	Common Horsechestnut	SC*	Occassionally Severely Damaged
Aesculus parviflora	Bottlebrush Buckeye	GA	Shrubs w/ high degree deer tolerance
Aesculus pavia	Red Buckeye	AK	Resistant Trees
Agapanthus spp.	Lily of the Nile	FL	Annuals/Perennials & Bulbs w/ rare damage
Agapanthus spp.	Lily of the Nile	TN	Resistant
Agave americana	Century Plant	FL	Annuals/Perennials & Bulbs w/ rare damage
Ageratum houstonianum	Ageratum	MI	Rarely Damaged
Ageratum houstonianum	Ageratum	GA	Annuals w/ high deer tolerance
Ageratum spp.	Ageratum	FL	Annuals/Perennials & Bulbs w/ rare damage
Ageratum spp.	Ageratum	TN	Resistant
Aiuga reptans	Carpet Bugle	TN	Resistant
Ajuga spp.	Bugleweed	GA	Vines/Groundcovers w/ high deer tolerance
Allamanda cathartica	Allamanda	FL	Vines & Groundcovers w/ rare damage
Allium spp.	Chives	AK	Resistant Perennials
Allium spp.	Allium	MI	Rarely Damaged

Table 1. Compiled state extension lists of susceptible and resistant plant species to white-tailed deer damage, continued.

Scientific Name	Common Name	State	Comments
Allium spp.	Allium	GA	Herbaceous Perennials/Bulbs w/ high deer tolernce
Aloe spp.	Aloe	FL	Annuals/Perennials & Bulbs w/ rare damage
Amaranthus tricolor	Amaranth	MI	Rarely Damaged
Amelanchier arborea	Downy Serviceberry	SC*	Occassionally Severely Damaged
Amelanchier arborea	Downy Serviceberry	MI	Occassionally Damaged
Amelanchier laevis	Allegheny Serviceberry	SC*	Occassionally Severely Damaged
Amelanchier laevis	Allegheny Serviceberry	MI	Occassionally Damaged
Amsonia spp.	Blue Star	AK	Resistant Perennials
Amsonia tabemaemontana	Amosonia	MI	Rarely Damaged
Anemone spp.	Anemone	AK	Resistant Perennials
Angelonia angelonia	Angel Flower	FL	Annuals/Perennials & Bulbs w/ rare damage
Anisacanthus wrightii	Flame Acanthus	TN	Resistant
Anthemis tinctoria	Golden Marguente	MI	Rarely Damaged
Antirrhinum majus	Snapdragon	GA	Annuals w/ high deer tolerance
Antirrhinum majus	Snapdragon	MI	Rarely Damaged
Aquilegia spp.	Columbine	AK	Resistant Perennials
Aquilegia spp.	Columbine	MI	Rarely Damaged
Arelia sieboldii	Japanese Arealia	TN	Resistant
Arescastrum romanzoffianum	Queen palm	FL	Trees w/ rare damage
Artemisia spp.	Wormwood	GA	Herbaceous Perennials/Bulbs w/ high deer tolernce
Artemisia spp.	Wormwood	AK	Resistant Perennials
Artemisia spp.	Wormwood	MI	Rarely Damaged

Table 1. Compiled state extension lists of susceptible and resistant plant species to white-tailed deer damage, continued.

Scientific Name	Common Name	State	Comments
Asclepias spp.	Butterfly Weed	AK	Resistant Perennials
Asclepias tuberosa	Butterfly Weed	MI	Rarely Damaged
Asculus arguat	Texas Buckeye	TN	Resistant
Asparagus densiflorus	Asparagus Fern	FL	Vines & Groundcovers w/ rare damage
Aspidistra lurida	Cast-Iron Plant	TN	Resistant
Aster spp.	Aster	FL	Annual/Perennials & Bulbs w/ moderate damage
Aster spp.	Autumn Aster	TN	Resistant
Baptisia spp.	Wild Indigo	GA	Herbaceous Perennials/Bulbs w/ high deer tolernce
Bauhinia variegata	Orchid Tree	FL	Trees w/ rare damage
Beaucarnea recurvata	Ponytail, Bottle Palm	FL	Trees w/ rare damage
Begonia semperflorens	Wax Begonia	GA	Annuals w/ high deer tolerance
Begonia semperflorens	Wax Begonia	MI	Rarely Damaged
Begonia spp.	Begonia	FL	Annual/Perennials & Bulbs w/ moderate damage
Begonia spp.	Begonia	TN	Resistant
Beloperone guttata	Shrimp Plant	FL	Annuals/Perennials & Bulbs w/ severe damage
Berberis spp.	Barberry	GA	Shrubs w/ high degree deer tolerance
Berberis spp.	Barberry	SC*	Rarely Damaged
Berberis spp.	Barberry	MI	Rarely Damaged
Berberis thunbergii	Barberry	AK	Resistant Shrubs
Berberis thunbergii	Red-Leaf or Japanese Barberry	TN	Resistant
Berberis trifoliolata	Agarita	TN	Resistant
Berberis vulgaris	Common Barberry	SC*	Rarely Damaged

Table 1. Compiled state extension lists of susceptible and resistant plant species to white-tailed deer damage, continued.

Scientific Name	Common Name	State	Comments
Berberis vulgaris	Common Barberry	MI	Rarely Damaged
Berchemia scandens	Rattan Vine	AL	Attracting
Betula nigra	River Birch	AK	Resistant Trees
Betula nigra	River Birch	GA	Trees w/ high degree deer tolerance
Betula papyrifera	Paper Birch	SC*	Rarely Damaged
Betula papyrifera	Paper Birch	MI	Rarely Damaged
Betula pendula	European White Birch	SC*	Seldom Severely Damaged
Bignonia capreolata	Trumpetvine	GA	Vines/Groundcovers w/ high deer tolerance
Boltonia asteroides	Boltonia	GA	Herbaceous Perennials/Bulbs w/ high deer tolernce
Bouganvillea spp.	Bouganvillea	FL	Shrubs w/ severe damage
Buddleia davidii	Butterfly Bush	AK	Resistant Shrubs
Buddleia davidii	Butterfly Bush	GA	Shrubs w/ high degree deer tolerance
Butia capitata	Pindo Palm	TX	Resistant
Buxus microphylla	Littleleaf Boxwood	AK	Resistant Shrubs
Buxus microphylla	Japanese boxwood	FL	Shrubs w/ rare damage
Buxus microphylla	Boxwood	TN	Resistant
Buxus sempervirens	Boxwood	AK	Resistant Shrubs
Buxus sempervirens	Boxwood	SC*	Rarely Damaged
Buxus sempervirens	Boxwood	MI	Rarely Damaged
Buxus spp.	Boxwood	GA	Shrubs w/ high degree deer tolerance
Calastrus scandens	American Bittersweet	SC*	Seldom Severely Damaged
Calastrus scandens	American Bittersweet	MI	Seldom Damaged

Table 1. Compiled state extension lists of susceptible and resistant plant species to white-tailed deer damage, continued.

Scientific Name	Common Name	State	Comments
Callicarpa americana	American Beautyberry	AL	Attracting
Callistemon spp.	Bottlebrush	FL	Shrubs w/ rare damage
Calycanthus floridus	Sweetshrub	GA	Shrubs w/ high degree deer tolerance
Camellia spp.	Camellia	FL	Shrubs w/ rare damage
Campsis spp.	Trumpet Vine	AK	Resistant Vines
Campsis radicans	Trumpet Vine	FL	Vines & Groundcovers w/ moderate damage
Campsis radicans	Trumpet Creeper	AL	Attracting
Campsis radicans	Trumpet Creeper	SC*	Occassionally Severely Damaged
Campsis radicans	Trumpet Creeper	MI	Occassionally Damaged
Capsicum annuum	Ornamental Pepper	MI	Rarely Damaged
Carissa spp.	Carissa	FL	Shrubs w/ rare damage
Caryota spp.	Fishtail Palms	FL	Trees w/ rare damage
Casusrina equisetifolia	Australian Pine	FL	Trees w/ rare damage
Catharanthus alba rosea	Annual Periwinkle	GA	Annuals w/ high deer tolerance
Catharanthus roseus	Periwinkle	MI	Rarely Damaged
Cedrus deodara	Deodara Cedar	AK	Resistant Trees
Cedrus deodara	Deodar Cedar	GA	Trees w/ high degree deer tolerance
Celastrus scandens	American Bittersweet	MI	Seldom Damaged
Celosis argenta	Celosia	FL	Annuals/Perennials & Bulbs w/ severe damage
Cenaurea cyanus	Cornflower	GA	Annuals w/ high deer tolerance
Cephalotaxus	Plum Yew	GA	Shrubs w/ high degree deer tolerance
Cepyalanthus occidentalis	Buttonbrush	AL	Attracting

Table 1. Compiled state extension lists of susceptible and resistant plant species to white-tailed deer damage, continued.

Scientific Name	Common Name	State	Comments
Cercis canadensis	Eastern Redbud	AK	Resistant Trees
Cercis canadensis	Eastern Redbud	SC*	Frequently Severely Damaged
Cercis canadensis	Eastern Redbud	MI	Frequently Damaged
Chaenomeles japonica	Flowering Quince	AK	Resistant Shrubs
Chaenomeles japonica	Flowering Quince	MI	Occassionally Damaged
Chaenomeles speciosa	Japanese Flowering Quince	SC*	Occassionally Severely Damaged
Chamaecyparis spp.	False Cypress	GA	Trees w/ high degree deer tolerance
Chamaecyparis thyoides	Atlantic White Cedar	SC*	Frequently Severely Damaged
Chilopsis linearis	Desert Willow	TN	Resistant
Chionanthus virginicus	Fringtree	AK	Resistant Trees
Chrysalidocarpus spp.	Butterfly/Cabada Palms	FL	Trees w/ rare damage
Chrysanthemum spp.	Shasta Daisy	GA	Herbaceous Perennials/Bulbs w/ high deer tolernce
Chrysanthemum spp.	Chrysanthemum	TN	Resistant
Chrysanthemum superbum	Shasta Daisy	FL	Annuals/Perennials & Bulbs w/ rare damage
Chrysanthemum x morifolium	Chrysanthemum	AK	Resistant Perennials
Citrus spp.	Citrus	FL	Trees w/ moderate damage
Clematis spp.	Clematis	FL	Vines & Groundcovers w/ severe damage
Clematis spp.	Clematis	SC*	Frequently Severely Damaged
Clematis spp.	Clematis	MI	Frequently Damaged
Cleome hasslerana	Cleome	GA	Annuals w/ high deer tolerance
Cleome hasslerana	Spider Flower	MI	Rarely Damaged
Clethra alnifolia	Sweet Pepperbush	AL	Attracting

Table 1. Compiled state extension lists of susceptible and resistant plant species to white-tailed deer damage, continued.

Scientific Name	Common Name	State	Comments
Cocoos nucifera	Coconut Palms	FL	Trees w/ rare damage
Convallaria majalis	Lily-of-the-Valley	MI	Rarely Damaged
Cordyline terminalis	Ti Tree	FL	Annuals/Perennials & Bulbs w/ rare damage
Coreopsis lanceolata	Coreopsis	MI	Rarely Damaged
Coreopsis spp.	Coreopsis	GA	Annuals w/ high deer tolerance
Coreopsis spp.	Tickseed	AK	Resistant Perennials
Coreopsis spp.	Coreopsis/Tickseed	FL	Annuals/Perennials & Bulbs w/ rare damage
Coreopsis spp.	Coreopsis	TN	Resistant
Coreopsis spp.	Coreopsis	MI	Rarely Damaged
Coreopsis verticilla	Coreopsis	MI	Rarely Damaged
Cornus drummondii	Roughleaf Dogwood	TN	Resistant
Cornus florida	Flowering Dogwood	AL	Attracting
Cornus florida	Dogwood	AK	Resistant Trees
Cornus florida	Flowering Dogwood	FL	Trees w/ rare damage
Cornus florida	Flowering Dogwood	SC*	Seldom Severely Damaged
Cornus florida	Flowering Dogwood	MI	Seldom Damaged
Cornus kousa	Kousa Dogwood	AK	Resistant Trees
Cornus kousa	Kousa Dogwood	SC*	Seldom Severely Damaged
Cornus kousa	Kousa Dogwood	MI	Seldom Damaged
Cornus mas	Cornelian Dogwood	SC*	Frequently Severely Damaged
Cornus mas	Cornelian Dogwood	MI	Frequently Damaged
Cornus racemosa	Panicled Dogwood	SC*	Occassionally Severely Damaged

Table 1. Compiled state extension lists of susceptible and resistant plant species to white-tailed deer damage, continued.

Scientific Name	Common Name	State	Comments
Cornus racemosa	Panicled Dogwood	MI	Occassionally Damaged
Cornus sericea	Red Osier Dogwood	SC*	Seldom Severely Damaged
Cornus sericea	Red Osier Dogwood	MI	Seldom Damaged
Cortaderia spp.	Pampas Grass	FL	Vines & Groundcovers w/ rare damage
Cortaderia spp.	Pampas Grass	TN	Resistant
Cosmos bipinnatus	Cosmos	TN	Resistant
Cosmos bipinnatus	Cosmos	MI	Rarely Damaged
Cotinus coggygria	Smoketree	AK	Resistant Shrubs
Cotinus coggygria	Smokebush	AL	Occassionally Severely Damaged
Cotinus coggygria	Smokebush	MI	Occassionally Damaged
Cotoneaster apiculatua	Cranberry Cotoneaster	AK	Resistant Shrubs
Cotoneaster apiculatua	Cranberry Cotoneaster	SC*	Occassionally Severely Damaged
Cotoneaster apiculatua	Cranberry Cotoneaster	MI	Occassionally Damaged
Cotoneaster dammeri	Cotoneaster	TN	Resistant
Cotoneaster horizontalis	Rockspray Cotoneaster	AK	Resistant Shrubs
Cotoneaster horizontalis	Rockspray Cotoneaster	SC	Occassionally Severely Damaged
Cotoneaster horizontalis	Rockspray Cotoneaster	MI	Occassionally Damaged
Cotoneaster spp.	Cotoneaster	GA	Shrubs w/ high degree deer tolerance
Cotoneaster spp.	Cotoneaster	SC*	Occassionally Severely Damaged
Cotoneaster spp.	Cotoneaster	MI	Occassionally Damaged
Crataegus laevigata	English Hawthorn	SC*	Seldom Severely Damaged
Crataegus laevigata	English Hawthorn	MI	Seldom Damaged

Table 1. Compiled state extension lists of susceptible and resistant plant species to white-tailed deer damage, continued.

Scientific Name	Common Name	State	Comments
Crataegus spp.	Hawthorn	AK	Resistant Trees
Crinum amoenum	Crinum Lily	GA	Herbaceous Perennials/Bulbs w/ high deer tolernce
Croton lineraris	Croton	FL	Shrubs w/ rare damage
Cryptomeria japonica	Japanese Cedar	SC*	Occassionally Severely Damaged
Cryptomeria japonica	Japanese Cedar	MI	Occassionally Damaged
Cuphea hyssopifolia	Mexican Heather	TX	Deer Resistant
Cupressocyparis x leylandii	Leyland Cypress	GA	Trees w/ high degree deer tolerance
Cynoglossum amabile	Chinese Forget-Me-Not	MI	Rarely Damaged
Cyrilla racemiflora	Swamp Cyrilla	AL	Attracting
Cyrtomium falicatum	Holly Fern	TN	Resistant
Cytisus scoparius	Scotch Broom	TN	Resistant
Dahlia spp.	Dahlia	FL	Annuals/Perennials & Bulbs w/ severe damage
Dahlia spp.	Dahlia	GA	Herbaceous Perennials/Bulbs w/ high deer tolernce
Daphne spp.	Daphne	AK	Resistant Shrubs
Daphne spp.	Winter Daphne	GA	Shrubs w/ high degree deer tolerance
Dasylirion spp.	Sotol	TN	Resistant
Datura spp.	Angles Trumpet	FL	Annuals/Perennials & Bulbs w/ rare damage
Datura spp.	Devil's Trumpet	FL	Annuals/Perennials & Bulbs w/ rare damage
Delphinium spp.	Delphinium	AK	Resistant Perennials
Dendranthema spp.	Chrysanthemum	MI	Rarely Damaged
Dianthus spp.	Pinks	GA	Herbaceous Perennials/Bulbs w/ high deer tolernce
Dicentra eximia	Bleeding Heart	MI	Rarely Damaged

Table 1. Compiled state extension lists of susceptible and resistant plant species to white-tailed deer damage, continued.

Scientific Name	Common Name	State	Comments
Dicentra spectabilis	Bleeding Heart	MI	Rarely Damaged
Dicentra spp.	Bleeding Heart	AK	Resistant Perennials
Dicentra spp.	Bleeding Heart	MI	Rarely Damaged
Dictamnus albus	Gas Plant	MI	Rarely Damaged
Digitalis grandiflora	Foxglove	MI	Rarely Damaged
Digitalis purpurea	Foxglove	MI	Rarely Damaged
Digitalis spp.	Foxglove	AK	Resistant Perennials
Digitalis spp.	Floxglove	TN	Resistant
Digitalis spp.	Foxglove	MI	Rarely Damaged
Dimorphotheca spp.	Marigolds	FL	Annuals/Perennials & Bulbs w/ rare damage
Diospyros spp.	Persimmion	FL	Trees w/ rare damage
Diospyros texana	Texas Persimmon	TN	Small Trees/Large Shrubs
Diospyros virginiana	Common Persimmon	AL	Attracting
Diospyros virginiana	Persimmion	AK	Resistant Trees
Dracaena spp.	Lilly Family	FL	Annuals/Perennials & Bulbs w/ rare damage
Dryopteris spp.	Shield Fern	FL	Vines & Groundcovers w/ rare damage
Dryopteris spp.	Wood Fern	TN	Resistant
Echinacea spp.	Purple Coneflower	AK	Resistant Perennials
Echinacea angustifolia	Purple Coneflower	TN	Resistant
Echinacea purpurea	Coneflower	GA	Herbaceous Perennials/Bulbs w/ high deer tolernce
Echinacea spp.	Coneflower	FL	Annuals/Perennials & Bulbs w/ rare damage
Echinops exaltatus	Globe Thistle	MI	Rarely Damaged

Table 1. Compiled state extension lists of susceptible and resistant plant species to white-tailed deer damage, continued.

Scientific Name	Common Name	State	Comments
Elaeagnus angustifolia	Russian Olive	SC*	Rarely Damaged
Elaeagnus angustifolia	Russian Olive	MI	Rarely Damaged
Elaeagnus spp.	Silver Thorn	FL	Shrubs w/ rare damage
Eleaegnus pungens	Thorny Eleaegnus	AK	Resistant Shrubs
Eleagnus spp.	Eleagnus	TN	Resistant
Enkianthus campanulatus	Redvein Enkianthus	SC*	Seldom Severely Damaged
Eriobotrya japonica	Loquat	FL	Trees w/ rare damage
Eschscholzia californica	California Poppy	GA	Annuals w/ high deer tolerance
Eucalyptus cinerea	Eucalyptus	FL	Trees w/ rare damage
Euonymus alatus	Winged Euonymus	AK	Resistant Shrubs
Euonymus alatus	Winged Euonymus	SC*	Frequently Severely Damaged
Euonymus alatus	Winged Euonymus	MI	Frequently Damaged
Euonymus americanus	Strawberry Bush	AL	Attracting
Euonymus fortunei	Wintercreeper	SC*	Frequently Severely Damaged
Euonymus fortunei radicans	Wintercreeper	MI	Frequently Damaged
Euphorbia marginata	Snow-on-the-Mountain	MI	Rarely Damaged
Euphorbia milii	Crown of Thorns	FL	Annuals/Perennials & Bulbs w/ rare damage
Fagus grandiflora	American Beech	FL	Trees w/ rare damage
Fagus spp.	Beech	MI	Seldom Damaged
Fagus sylvatica	European Beech	SC*	Seldom Severely Damaged
Feijos spp.	Pineapple Guava	FL	Trees w/ rare damage
Ficus carica	Edible Fig	FL	Trees w/ rare damage

Table 1. Compiled state extension lists of susceptible and resistant plant species to white-tailed deer damage, continued.

Scientific Name	Common Name	State	Comments
Ficus spp.	Fig	TN	Resistant
Forsythia spp.	Forsythia	GA	Shrubs w/ high degree deer tolerance
Forsythia spp.	Forsythia	SC*	Seldom Severely Damaged
Forsythia spp.	Forsythia	MI	Rarely Damaged
Forsythia x intermedia	Forsythia	AK	Resistant Shrubs
Forsythia x intermedia	Forsythia	SC*	Occassionally Severely Damaged
Forsythia x intermedia 'Lynwood'	Border Forsythia	MI	Occassionally Damaged
Fraxinus spp.	Ashes	AL	Attracting
Gaillardia pulchella	Gaillardia	GA	Annuals w/ high deer tolerance
Galium spp.	Sweet Woodruff	AK	Resistant Perennials
Gamolepis chrysanthemoides	Bush Daisy	FL	Annuals/Perennials & Bulbs w/ rare damage
Gardenia spp.	Gardenia	FL	Shrubs w/ rare damage
Gardenia spp.	Gardenia	GA	Shrubs w/ high degree deer tolerance
Garrya lindheimeri	Mexican Silktassle	TN	Resistant
Gelsemium sempervirens	Yellow Jessamine	AL	Attracting
Gelsemium sempervirens	Carolina Jessamine	AK	Resistant Vines
Gelsemium sempervirens	Yellow Jessamine	FL	Vines & Groundcovers w/ rare damage
Gelsemium sempervirens	Carolina Jessamine	GA	Vines/Groundcovers w/ high deer tolerance
Gelsemium sempervirens	Carolina Jessamine	TN	Resistant
Geranium spp.	Cranesbill Geranium	AK	Resistant Perennials
Gerbera jamesonii	Gerbera Daisy	GA	Herbaceous Perennials/Bulbs w/ high deer tolernce
Ginkgo biloba	Gingko	AK	Resistant Trees

Table 1. Compiled state extension lists of susceptible and resistant plant species to white-tailed deer damage, continued.

Scientific Name	Common Name	State	Comments
Ginkgo biloba	Ginkgo	GA	Trees w/ high degree deer tolerance
Gleditsia tricanthos	Honey Locust	SC*	Seldom Severely Damaged
Gleditsia tricanthos	Honey Locust	MI	Seldom Damaged
Gleditsia triacanthos var. inermis	Thornless Honeylocust	AK	Resistant Trees
Gomphrena globosa	Globe Amaranth	MI	Rarely Damaged
Gloriosa superba	Gloriosa Lily	GA	Herbaceous Perennials/Bulbs w/ high deer tolernce
Gordonia lisianthus	Gordonia	GA	Trees w/ high degree deer tolerance
Gypsophila paniculata	Baby's-Breath	MI	Rarely Damaged
Hamelia patens	Mexican Firebush	FL	Shrubs w/ severe damage
Hammamelis virginiana	Witchhazel	AK	Resistant Shrubs
Hammamelis virginiana	Witchhazel	SC*	Occassionally Severely Damaged
Hammamelis virginiana	Common Witchhazel	MI	Occassionally Damaged
Hedera helix	English Ivy	FL	Vines & Groundcovers w/ rare damage
Hedera helix	English Ivy	SC*	Frequently Severely Damaged
Hedera helix	English Ivy	Mi	Frequently Damaged
Helianthus spp.	Perennial Sunflower	GA	Herbaceous Perennials/Bulbs w/ high deer tolernce
Heliconia spp.	Heliconia	FL	Annuals/Perennials & Bulbs w/ rare damage
Helleborus orientalis	Lenten Rose	AK	Resistant Perennials
Helleborus orientalis	Lenten Rose	GA	Herbaceous Perennials/Bulbs w/ high deer tolernce
Helleborus x hybridus	Lenten Rose	GA	Resistant
Hesperalae parvifloria	Red Yucca	TN	Resistant
Heuchera sanguinea	Coralbells	MI	Rarely Damaged

Table 1. Compiled state extension lists of susceptible and resistant plant species to white-tailed deer damage, continued.

Scientific Name	Common Name	State	Comments
Hibiscus spp.	Hibiscus	FL	Shrubs w/ severe damage
Hibiscus syriancus	Rose of Sharon	SC*	Occassionally Severely Damaged
Hibiscus syriancus	Rose of Sharon	MI	Occassionally Damaged
Hippeastrum spp.	Amaryllis	GA	Herbaceous Perennials/Bulbs w/ high deer tolernce
Hydrangea anomala petiolaris	Climbing Hydrangea	AK	Resistant Vines
Hydrangea anomala petiolaris	Climbing Hydrangea	SC*	Occassionally Severely Damaged
Hydrangea anomala petiolaris	Climbing Hydrangea	MI	Occassionally Damaged
Hydrangea arborescens	Smooth Hydrangea	SC*	Occassionally Severely Damaged
Hydrangea aborescens	Smooth Hydrangea	MI	Occassionally Damaged
Hydrangea paniculata	Panicle Hydrangea	SC*	Occassionally Severely Damaged
Hydrangea paniculata	Paniculated Hydrangea	MI	Occassionally Damaged
Hydrangea quercifolia	Oakleaf Hydrangea	AK	Resistant Shrubs
Hypericum spp.	St. John's Wart	AK	Resistant Perennials
Hypericum calycinum	Aaron's Beard	AK	Resistant Groundcovers
Hypericum calycinum	Aarons Beard	TN	Resistant
Hypericum spp.	Goldcup	TN	Resistant
Ilex cornuta	Chinese Holly	FL	Shrubs w/ rare damage
Ilex cornuta	Dwarf Chinese Holly	TN	Shrubs
Ilex cornuta	Chinese Holly	SC*	Seldom Severely Damaged
Ilex cornuta	Chinese Holly	MI	Seldom Damaged
Ilex cornuta 'Burfordii'	Burford Holly	AK	Resistant Shrubs
Ilex crenata	Japanese Holly	SC*	Occassionally Severely Damaged

Table 1. Compiled state extension lists of susceptible and resistant plant species to white-tailed deer damage, continued.

Scientific Name	Common Name	State	Comments
Ilex crenata	Japanese Holly	MI	Occassionally Damaged
Ilex crenata 'Carissa'	Carissa Holly	AK	Resistant Shrubs
Ilex crenata 'Compacta'	Dwarf Japanese Holly	AK	Resistant Shrubs
Ilex crenata 'Convexa'	Convexa Holly	AK	Resistant Shrubs
Ilex glabra	Inkberry	SC*	Seldom Severely Damaged
Ilex glabra	Inkberry	MI	Seldom Damaged
Ilex myrtifolia	Myrtle-Leaf Holly	FL	Shrubs w/ rare damage
Ilex opaca	American Holly	AK	Resistant Trees
Ilex opaca	American Holly	SC*	Rarely Damaged
Ilex opaca	American Holly	MI	Rarely Damaged
Ilex spp.	Hollies	AK	Resistant Shrubs
Ilex spp.	Hollies	AL	Attracting
Ilex spp.	Hollies	MI	Occassionally Damaged
Ilex spp.	Hollies	GA	Shrubs w/ high degree deer tolerance
Ilex vomitoria	Yaupon	FL	Trees w/ rare damage
Ilex vomitoria	Dwarf Yaupon	TN	Resistant
Ilex vomitoria 'Nana'	Dwarf Yaupon Holly	AK	Resistant Shrubs
Ilex x 'Nellie R. Stevens'	Nellie R. Stevens	AK	Resistant Shrubs
Ilex x attenuata	Foster Holly	AK	Resistant Shrubs
Ilex x meserveae	China Girl Holly	SC*	Occassionally Severely Damaged
Ilex x meserveae 'China Boy'	China Boy Holly	MI	Occassionally Damaged
Ilex x meserveae 'China Girl'	China Girl Holly	MI	Occassionally Damaged

Table 1. Compiled state extension lists of susceptible and resistant plant species to white-tailed deer damage, continued.

Scientific Name	Common Name	State	Comments
Illicium spp.	Anise	GA	Shrubs w/ high degree deer tolerance
Impatiens spp.	Impatiens	FL	Annuals/Perennials & Bulbs w/ severe damage
Ipomoea spp.	Morning Glory	GA	Annuals w/ high deer tolerance
Ipomoea spp.	Sweet Pea	GA	Annuals w/ high deer tolerance
Iris spp.	Iris	AK	Resistant Perennials
Iris spp.	Iris	FL	Annual/Perennials & Bulbs w/ moderate damage
Iris spp.	Iris	GA	Herbaceous Perennials/Bulbs w/ high deer tolernce
Iris spp.	Iris	TN	Resistant
Iris spp.	Iris	MI	Rarely Damaged
Itea virginia	Virginia Sweetspire	AL	Attracting
Ixora spp.	Ixora	FL	Shrubs w/ rare damage
Jasminum nudiflorum	Winter Jasmine	AK	Resistant Shrubs
Juniperis chinensis	Chinese Junipers (green)	SC*	Seldom Severely Damaged
Juniperis chinensis	Chinese Junipers (blue)	SC*	Seldom Severely Damaged
Juniperis chinensis	Chinese Junipers	MI	Seldom Damaged
Juniperis chinensis 'Hetzi'	Chinese Junipers (green)	MI	Seldom Damaged
Juniperis chinensis 'Pfitzerana'	Chinese Junipers (green)	MI	Seldom Damaged
Juniperus spp.	Juniper	AK	Resistant Shrubs
Juniperus spp.	Juniper	FL	Shrubs w/ rare damage
Juniperus spp.	Juniper	GA	Shrubs w/ high degree deer tolerance
Juniperus spp.	Juniper	TN	Resistant
Juniperus virginiana	Eastern Redcedar	AL	Attracting

Table 1. Compiled state extension lists of susceptible and resistant plant species to white-tailed deer damage, continued.

Scientific Name	Common Name	State	Comments
Juniperus virginiana	Eastern Redcedar	SC*	Occassionally Severely Damaged
Juniperus virginiana	Eastern Redcedar	MI	Seldom Damaged
Juniperus virginiana 'Canaertii'	Eastern Redcedar	MI	Seldom Damaged
Kaempferia spp.	Rotunda	FL	Annuals/Perennials & Bulbs w/ rare damage
Kalmia latifolia	Mountain Laurel	SC*	Seldom Severely Damaged
Kerria japonica	Japanese Rose	GA	Shrubs w/ high degree deer tolerance
Koelreuteria paniculata	Goldenraintree	AK	Resistant Trees
Kolkwitzia amabilis	Beautybush	SC*	Seldom Severely Damaged
Kolkwitzia amabilis	Beautybush	MI	Seldom Damaged
Lagerstroemia indica	Crape Myrtle	FL	Trees w/ rare damage
Lagerstroemia indica	Crape Myrtle	GA	Trees w/ high degree deer tolerance
Lamium spp.	Dead Nettles	AK	Resistant Perennials
Lantana camara	Lantana	FL	Shrubs w/ rare damage
Lantana camara	Lantana	GA	Herbaceous Perennials/Bulbs w/ high deer tolernce
Lantana camara	Lantana	TX	Resistant
Lantana spp.	Lantana	MI	Rarely Damaged
Lantana horrida	Lantana	TN	Resistant
Larix decidua	European Larch	SC*	Occassionally Severely Damaged
Lavandula angustifolia	Lavender	MI	Rarely Damaged
Lavandula spp.	Lavender	AK	Resistant Perennials
Lavandula spp.	Lavender	TN	Resistant
Lavandula spp.	Lavender	MI	Rarely Damaged

Table 1. Compiled state extension lists of susceptible and resistant plant species to white-tailed deer damage, continued.

Scientific Name	Common Name	State	Comments
Leucojum aestivum	Summer Snowflake	GA	Herbaceous Perennials/Bulbs w/ high deer tolernce
Leucophyllum frutescens	Green Cloud' Cenzio	TX	Deer Resistant
Leucophyllum spp.	Ceniza/Texas Sage	TN	Resistant
Leucothoe axillaris	Dog-Hobble	AK	Resistant Shrubs
Leucothoe fontanesiana	Drooping Leucothoe	SC*	Rarely Damaged
Liatris spicata	Gay-Feather	MI	Rarely Damaged
Ligustrum spp.	Ligustrum	FL	Trees w/ rare damage
Ligustrum spp.	Ligustrum	SC*	Occassionally Severely Damaged
Ligustrum spp.	Ligustrum	MI	Occassionally Damaged
Liliaceae spp.	Day Lilly	FL	Annuals/Perennials & Bulbs w/ severe damage
Liliaceae spp.	Ginger Lilly	FL	Annuals/Perennials & Bulbs w/ rare damage
Limonium latifolium	Statice	GA	Herbaceous Perennials/Bulbs w/ high deer tolernce
Linum perenne	Flax	MI	Rarely Damaged
Liquidambar styraciflua	Sweetgum	AL	Attracting
Liquidambar styraciflua	Sweetgum	AK	Resistant Trees
Liquidambar styraciflua	Sweetgum	GA	Trees w/ high degree deer tolerance
Liriodendron tulipifera	Yellow Poplar	AL	Attracting
Lobelia laxiflora	Lobelia	GA	Annuals w/ high deer tolerance
Lobelia spp.	Cardinal Flower	GA	Herbaceous Perennials/Bulbs w/ high deer tolernce
Lobularia maritima	Sweet Alyssum	MI	Rarely Damaged
Lomariopsis kunzeana	Holly Fern	FL	Vines & Groundcovers w/ rare damage
Lonicera japonica	Japanese Honeysuckle	AL	Attracting

Table 1. Compiled state extension lists of susceptible and resistant plant species to white-tailed deer damage, continued.

Scientific Name	Common Name	State	Comments
Lonicera sempervirens	Honeysuckle	GA	Vines/Groundcovers w/ high deer tolerance
Lonicera x heckrottii	Goldflame Honeysuckle	SC*	Occassionally Severely Damaged
Lonicera x heckrottii	Goldflame Honeysuckle	MI	Occassionally Damaged
Lupine spp.	Lupine	FL	Annuals/Perennials & Bulbs w/ rare damage
Lupinus polyphyllus	Lupine	MI	Rarely Damaged
Lupinus texensis	Bluebonnet	TN	Resistant
Lychnis coronaria	Rose Champion	MI	Rarely Damaged
Lypersicon esculentum	Tomatoes	FL	Annuals/Perennials & Bulbs w/ severe damage
Magnolia fuscata	Banana Shrub	FL	Shrubs w/ rare damage
Magnolia grandiflora	Southern Magnolia	AK	Resistant Trees
Magnolia grandiflora	Southern Magnolia	GA	Trees w/ high degree deer tolerance
Magnolia spp.	Magnolia	FL	Trees w/ rare damage
Magnolia stellata	Sweetbay Magnolia	AK	Resistant Trees
Magnolia virginiana	Sweetbay	AL	Attracting
Magnolia x soulangiana	Saucer Magnolia	AK	Resistant Trees
Magnolia x soulangiana	Saucer Magnolia	SC*	Occassionally Severely Damaged
Magnolia x soulangiana	Saucer Magnolia	MI	Occassionally Damaged
Mahonia aquifolium	Oregon Grape Holly	AK	Resistant Shrubs
Mahonia bealei	Leatherleaf Mahonia	AK	Resistant Shrubs
Mahonia bealei	Leatherleaf Mahonia	GA	Shrubs w/ high degree deer tolerance
Mahonia spp.	Mahonia	FL	Shrubs w/ rare damage
Mahonia trifoliolata	Agarito	TX	Resistant

Table 1. Compiled state extension lists of susceptible and resistant plant species to white-tailed deer damage, continued.

Scientific Name	Common Name	State	Comments
Malavaviscus arboreus	Turks Cap	FL	Annuals/Perennials & Bulbs w/ rare damage
Malvaviscus arboreus	Turks cap	TN	Resistant
Malus angustifolia	Southern Crabapple	AL	Attracting
Malus spp.	Crabapple	FL	Trees w/ severe damage
Malus spp.	Apples	SC*	Frequently Severely Damaged
Malus spp.	Apples	MI	Frequently Damaged
Marabilis jalapa	Four O'Clocks	GA	Herbaceous Perennials/Bulbs w/ high deer tolernce
Matthiola incana	Stock	MI	Rarely Damaged
Melaleuca quinquenervia	Bottlebrush	FL	Trees w/ rare damage
Melampodium lecanthum	Blackfoot Daisy	TN	Resistant
Melampodium leucanthum	Melampodium	GA	Annuals w/ high deer tolerance
Menta spicata	Spearmint	TN	Resistant
Metasequoia gylptostroboides	Dawn Redwood	SC*	Occassionally Severely Damaged
Metasequoia gylptostroboides	Dawn Redwood	MI	Occassionally Damaged
Michelia fuscata	Banana Shrub	GA	Shrubs w/ high degree deer tolerance
Mimosa borealis	Fragrant Mimosa	TN	Resistant
Monarda spp.	Beebalm	AK	Resistant Perennials
Monarda didyma	Beebalm	GA	Herbaceous Perennials/Bulbs w/ high deer tolernce
Muhlenbergia lindheimeri	Big Muhly	TX	Resistant
Myosotis scorpioides	Forget-Me-Not	GA	Annuals w/ high deer tolerance
Morella cerifera	Waxmyrtle	AL	Attracting
Morella cerifera	Wax Myrtle	AK	Resistant Shrubs

Table 1. Compiled state extension lists of susceptible and resistant plant species to white-tailed deer damage, continued.

Scientific Name	Common Name	State	Comments
Morella cerifera	Wax Myrtle	FL	Shrubs w/ rare damage
Morella cerifera	Wax Myrtle	TN	Resistant
Nandina domestica	Heavenly Bamboo	AK	Resistant Shrubs
Nandina domestica	Dwarf Nandina	AK	Resistant Shrubs
Nandina spp.	Heavenly Bamboo	FL	Shrubs w/ rare damage
Nandina spp.	Heavenly Bamboo	GA	Shrubs w/ high degree deer tolerance
Nandina spp.	Nandina	TN	Resistant
Narcissus spp.	Narcissus	MI	Rarely Damaged
Narcissus spp.	Daffodils	GA	Herbaceous Perennials/Bulbs w/ high deer tolernce
Nepeta catarina	Catmint	GA	Herbaceous Perennials/Bulbs w/ high deer tolernce
Nepeta spp.	Catnip	AK	Resistant Perennials
Nephrolepis spp.	Boston Fern	FL	Vines & Groundcovers w/ rare damage
Nephrolepis spp.	Sword Fern	TN	Resistant
Nerium oleander	Oleander	AK	Resistant Shrubs
Nerium oleander	Oleander	FL	Shrubs w/ rare damage
Nerium oleander	Oleander	GA	Shrubs w/ high degree deer tolerance
Nerium oleander	Oleander	TN	Resistant
Nerium oleander 'Carnival'	Carnival Oleander	TX	Resistant
Nicotiana alata	Flowering Tobacco	GA	Annuals w/ high deer tolerance
Nierembergia hippomanica	Cupflower	MI	Rarely Damaged
Nolina spp.	Sacahuista/Bear Grass/Nolina	TN	Perennials, Succulents & Lilies
Nyssa sylvatica	Blackgum	AL	Attracting

Table 1. Compiled state extension lists of susceptible and resistant plant species to white-tailed deer damage, continued.

Scientific Name	Common Name	State	Comments
Ophiopogon japonica	Mondo Grass	AK	Resistant Groundcovers
Ophiopogon japonica	Monkey Grass	TN	Resistant
Ophiopogon japonicus	Aztec Grass	FL	Vines & Groundcovers w/ rare damage
Opuntia spp.	Cacus	TN	Perennials, Succulents & Lilies
Origanum spp.	Oregano	AK	Resistant Perennials
Osmanthsus fragrans	Tea Olive	FL	Shrubs w/ rare damage
Osmunda cinnamomea	Cinnamon Fern	GA	Herbaceous Perennials/Bulbs w/ high deer tolernce
Oxydendrum arboreum	Sourwood	AL	Attracting
Pachysandra terminalis	Pachysandra	AK	Resistant Groundcovers
Paeonia lactiflora	Peony	AK	Resistant Perennials
Papaver orientale	Oriental Poppy	MI	Rarely Damaged
Papaver spp.	Poppy	GA	Annuals w/ high deer tolerance
Parthenocissus quinquifolia	Virginia Creeper	SC*	Occassionally Severely Damaged
Parthenocissus quinquifolia	Virginia Creeper	MI	Occassionally Damaged
Pentas lanceolata	Pentas	GA	Annuals w/ high deer tolerance
Persea borbonia	Redbay	AL	Attracting
Persovskia spp.	Russian Sage	AK	Resistant Perennials
Petroselinum spp.	Parsley	GA	Annuals w/ high deer tolerance
Phalaris arundinacea var. picta	Ribbon Grass	AK	Resistant Groundcovers
Philadelphus coronarius	Sweet Mock Orange	SC	Occassionally Severely Damaged
Philadelphus coronarius	Sweet Mock Orange	MI	Occassionally Damaged
Philadelphus spp.	Mock Orange	AK	Resistant Shrubs

Table 1. Compiled state extension lists of susceptible and resistant plant species to white-tailed deer damage, continued.

Scientific Name	Common Name	State	Comments
Philodendron spp.	Philodendron	FL	Shrubs w/ rare damage
Phlox spp.	Phlox	FL	Annuals/Perennials & Bulbs w/ severe damage
Phlox subulata	Creeping Phlox	AK	Resistant Perennials
Phoenix spp.	Date Palms	FL	Trees w/ rare damage
Picea abies	Norway Spruce	SC*	Seldom Severely Damaged
Picea abies	Norway Spruce	MI	Seldom Damaged
Picea pungens glauca	Colorado Blue Spruce	MI	Rarely Damaged
Picea spp.	Spruce	GA	Trees w/ high degree deer tolerance
Pieris japonica	Japanese Andromeda	AK	Resistant Shrubs
Pieris japonica	Japanese Pieris	SC	Rarely Damaged
Pimpinella anisum	Anise	FL	Annuals/Perennials & Bulbs w/ rare damage
Pinus echinata	Shortleaf Pine	MI	Rarely Damaged
Pinus mugo	Mugo Pine	AK	Resistant Shrubs
Pinus mugo	Mugo Pine	SC*	Seldom Severely Damaged
Pinus mugo	Mugo Pine	MI	Seldom Damaged
Pinus nigra	Austrian Pine	SC*	Seldom Severely Damaged
Pinus nigra	Austrian Pine	MI	Seldom Damaged
Pinus resinosa	Red Pine	SC*	Seldom Severely Damaged
Pinus resinosa	Red Pine	MI	Seldom Damaged
Pinus rigida	Pitch Pine	SC*	Seldom Severely Damaged
Pinus spp.	Pines	GA	Trees w/ high degree deer tolerance
Pinus strobus	Eastern White Pine	SC*	Occassionally Severely Damaged

Table 1. Compiled state extension lists of susceptible and resistant plant species to white-tailed deer damage, continued.

Scientific Name	Common Name	State	Comments
Pinus strobus	Eastern White Pine	MI	Occassionally Damaged
Pinus sylvestris	Scots Pine	SC*	Seldom Severely Damaged
Pinus sylvestris	Scots Pine	MI	Seldom Damaged
Pinus taeda	Loblolly Pine	MI	Rarely Damaged
Pisum sativum	Peas	FL	Annuals/Perennials & Bulbs w/ severe damage
Pittosporum tobira	Pittosporum	FL	Shrubs w/ severe damage
Plumbago auriculata	Plumbago	FL	Shrubs w/ rare damage
Plumbago spp.	Plumbago	TX	Resistant
Podocarpus spp.	Podocarpus	FL	Trees w/ rare damage
Poliomintha longifolia	Mexican Oregano	TN	Resistant
Polygonum capitatum	Polygonum	MI	Rarely Damaged
Polystichum acrostichoides	Christmas Fern	GA	Herbaceous Perennials/Bulbs w/ high deer tolernce
Portulaca spp.	Portulaca	FL	Annuals/Perennials & Bulbs w/ severe damage
Potentilla fruticosa	Bush Cinquefoil	SC*	Occassionally Severely Damaged
Prunus avium	Sweet Cherry	SC*	Occassionally Severely Damaged
Prunus avium	Sweet Cherry	MI	Occassionally Damaged
Prunus caroliniana	Carolina Laurel Cherry	FL	Trees w/ severe damage
Prunus caroliniana	Carolina Cherrylaurel	AK	Resistant Shrubs
Prunus caroliniana	Cherry Laurel	GA	Trees w/ high degree deer tolerance
Prunus persica	Peaches	MI	Frequently Damaged
Prunus serotina	Blackcherry	AL	Attracting
Prunus serotina	Black Cherry	FL	Trees w/ severe damage

Table 1. Compiled state extension lists of susceptible and resistant plant species to white-tailed deer damage, continued.

Scientific Name	Common Name	State	Comments
Prunus serrulata	Flowering Cherry	AK	Resistant Trees
Prunus serrulata	Japanese Flowering Cherry	SC*	Seldom Severely Damaged
Prunus serrulata	Japanese Flowering Cherry	MI	Seldom Damaged
Prunus spp.	Cherries	SC*	Frequently Severely Damaged
Prunus spp.	Plums	SC*	Frequently Severely Damaged
Prunus spp.	Cherries	MI	Frequently Damaged
Prunus spp.	Plums	MI	Frequently Damaged
Prunus umbellata	Flatwoods Plum	FL	Trees w/ severe damage
Prunus umbellata	Hog Plum	FL	Shrubs w/ severe damage
Pseudotsuga menziesii	Douglas Fir	SC*	Occassionally Severely Damaged
Pulmonaria spp.	Lungwort	AK	Resistant Perennials
Punica granatum	Pomegranate	FL	Trees w/ rare damage
Pyracantha coccinea	Pyracantha	TN	Resistant
Pyracantha coccinea	Pyracantha	AK	Resistant Shrubs
Pyracantha coccinea	Firethorn	SC*	Occassionally Severely Damaged
Pyracantha coccinea	Firethorn	MI	Occassionally Damaged
Pyracantha spp.	Firethorn	GA	Shrubs w/ high degree deer tolerance
Pyrus calleryana 'Bradford'	Bradford Callery Pear	SC*	Occassionally Severely Damaged
Pyrus calleryana 'Bradford'	Bradford Callery Pear	MI	Occassionally Damaged
Pyrus communis	Common Pear	SC*	Occassionally Severely Damaged
Pyrus communis	Common Pear	MI	Occassionally Damaged
Pyrus spp.	Pear	FL	Trees w/ severe damage

Table 1. Compiled state extension lists of susceptible and resistant plant species to white-tailed deer damage, continued.

Scientific Name	Common Name	State	Comments
Pyrus spp.	Pear	MI	Occassionally Damaged
Quercus alba	White Oak	FL	Trees w/ moderate damage
Quercus alba	White Oak	SC*	Occassionally Severely Damaged
Quercus alba	White Oak	MI	Occassionally Damaged
Quercus prinus	Chestnut Oak	SC*	Occassionally Severely Damaged
Quercus rubra	Northern Red Oak	SC*	Occassionally Severely Damaged
Quercus rubra	Northern Red Oak	MI	Occassionally Damaged
Quercus spp.	Oakes	AL	Attracting
Quercus spp.	Oakes	MI	Occassionally Damaged
Quercus virginiana	Live Oak	FL	Trees w/ rare damage
Rhapidophyllum hystrix	Needle Palm	FL	Shrubs w/ rare damage
Rhododendron carolinianum	Carolina Rhododendron	SC*	Occassionally Severely Damaged
Rhododendron carolinianum	Carolina Rhododendron	MI	Occassionally Damaged
Rhododendron catawbiense	Catawba Rhododendron	SC*	Frequently Severely Damaged
Rhododendron catawbiense	Catawba Rhododendron	MI	Frequently Damaged
Rhododendron maximum	Rhododendron	AL	Attracting
Rhododendron maximum	Rosebay Rhododendron	SC*	Occassionally Severely Damaged
Rhododendron maximum	Rosebay Rhododendron	MI	Occassionally Damaged
Rhododendron periclymenoides	Pinxterbloom Azalea	SC*	Frequently Severely Damaged
Rhododendron spp.	Evergreen Azaleas	FL	Shrubs w/ severe damage
Rhododendron spp.	Rhododendrons	FL	Shrubs w/ severe damage
Rhododendron spp.	Southern Indian Azaleas	FL	Shrubs w/ rare damage

Table 1. Compiled state extension lists of susceptible and resistant plant species to white-tailed deer damage, continued.

Scientific Name	Common Name	State	Comments
Rhododendron spp.	Deciduous Azalea	SC*	Occassionally Severely Damaged
Rhododendron spp.	Rhododendrons	SC*	Frequently Severely Damaged
Rhododendron spp.	Evergreen Azaleas	SC*	Frequently Severely Damaged
Rhododendron spp.	Deciduous Azalea	MI	Occassionally Damaged
Rhododendron spp.	Rhododendrons	MI	Frequently Damaged
Rhododendron spp.	Evergreen Azaleas	MI	Frequently Damaged
Rhus lanceolata	Flameleaf Sumac	TN	Resistant
Rhus spp.	Sumacs	AK	Resistant Shrubs
Rhus typhina	Staghorn Sumac	SC*	Occassionally Severely Damaged
Rhus typhina	Staghorn Sumac	MI	Occassionally Damaged
Rhus virens	Evergreen Sumac	TN	Resistant
Ricinus communis	Castor Bean	MI	Rarely Damaged
Rosa multiflora	Multiflora Rose	SC*	Occassionally Severely Damaged
Rosa multiflora	Multiflora Rose	MI	Occassionally Damaged
Rosa rugosa	Rugosa Rose	SC*	Occassionally Severely Damaged
Rosa rugosa	Rugosa Rose	MI	Occassionally Damaged
Rosa spp.	Roses	FL	Shrubs w/ severe damage
Rosa spp.	Roses	MI	Occassionally Damaged
Rosa x hybrid	Hybrid Tea Rose	SC*	Frequently Severely Damaged
Rosa x hybrid	Hybrid Tea Rose	MI	Frequently Damaged
Rosmarinum officinalis	Rosemary	GA	Herbaceous Perennials/Bulbs w/ high deer tolernce
Rosmarinus officinalis	Rosemary	TN	Resistant

Table 1. Compiled state extension lists of susceptible and resistant plant species to white-tailed deer damage, continued.

Scientific Name	Common Name	State	Comments
Roystoea spp.	Royal Palm	FL	Trees w/ rare damage
Rubus spp.	Blackberry, Raspberry, Dewber	AL	Attracting
Rubus spp.	Blackberry	FL	Shrubs w/ rare damage
Rubus spp.	Blackberry (Thorny Only)	TN	Resistant
Rudbeckia hirta	Black-Eyed Susan	FL	Annuals/Perennials & Bulbs w/ rare damage
Rudbeckia hirta	Black-Eyed Susan	TN	Resistant
Ruellia spp.	Petunia	FL	Annuals/Perennials & Bulbs w/ rare damage
Ruttya ruspolia	Rutty	FL	Shrubs w/ rare damage
Sabal spp.	Cabbage/Palmettos	FL	Trees w/ rare damage
Salix matsudana 'Tortuosa'	Corkscrew Willow	AK	Resistant Trees
Salix matsudana 'Tortuosa'	Corkscrew Willow	SC*	Seldom Severely Damaged
Salix matsudana 'Tortuosa'	Corkscrew Willow	MI	Seldom Damaged
Salix spp.	Willow	FL	Trees w/ moderate damage
Salix spp.	Willow	SC*	Occassionally Severely Damaged
Salix spp.	Willow	MI	Occassionally Damaged
Salvia spp.	Meadow Sage	AK	Resistant Perennials
Salvia farinacea	Mealy Blue Sage	TN	Resistant
Salvia farinacea	Sage	MI	Rarely Damaged
Salvia farinacea	Mealy Blue Sage	TX	Resistant
Salvia greggii	Autumn Sage	TN	Resistant
Salvia leucanthia	Mexican Bush Sage	TN	Resistant
Salvia officinalis	Garden Sage	AK	Resistant Perennials

Table 1. Compiled state extension lists of susceptible and resistant plant species to white-tailed deer damage, continued.

Scientific Name	Common Name	State	Comments
Salvia officinalis	Sage	MI	Rarely Damaged
Salvia roemeriana	Cedar Sage	TN	Resistant
Salvia sclarea	Sage	MI	Rarely Damaged
Salvia splendens	Sage	MI	Rarely Damaged
Salvia spp.	Sage	FL	Annuals/Perennials & Bulbs w/ rare damage
Salvia spp.	Scarlet Sage	GA	Annuals w/ high deer tolerance
Salvia spp.	Indigo Spires	TN	Resistant
Salvia spp.	Sage	MI	Rarely Damaged
Salvia viridis	Salvia	MI	Rarely Damaged
Sambucus canadensis	Elderberry	AL	Attracting
Santolina chamaecyparissus	Lavender Cotton	MI	Rarely Damaged
Santolina spp.	Santolina	AK	Resistant Groundcovers
Santolina spp.	Santolina	TN	Resistant
Sanvitalia procumbens	Sanvitalia	MI	Rarely Damaged
Sassafras albidum	Sassafras	AL	Attracting
Sassafras albidum	Sassafras	AK	Resistant Trees
Sassafras albidum	Sassafras	SC*	Seldom Severely Damaged
Sassafras albidum	Sassafras	MI	Seldom Damaged
Satureia spp.	Savory	TN	Resistant
Schefflera actinophylla	Schefflera	FL	Trees w/ moderate damage
Sempervivum spp.	Hen and chickens	TN	Resistant
Senecio cineraria	Dusty Miller	FL	Annuals/Perennials & Bulbs w/ rare damage

Table 1. Compiled state extension lists of susceptible and resistant plant species to white-tailed deer damage, continued.

Scientific Name	Common Name	State	Comments
Senecio cineraria	Dusty Miller	GA	Annuals w/ high deer tolerance
Senecio cineraria	Dusty Miller	TN	Resistant
Senecio cineraria	Dusty Miller	MI	Rarely Damaged
Smilax spp.	Greenbrier	AL	Attracting
Solanum pseudocapsicum	Jerusalem Dherry	TN	Resistant
Solidago spp.	Goldenrod	AK	Resistant Perennials
Solidago spp.	Goldenrod	GA	Herbaceous Perennials/Bulbs w/ high deer tolernce
Sophora secundiflora	Mountain Laurel	TN	Resistant
Sophora secundiflora	Texas Mountain Laurel	TX	Resistant
Sorbus aucuparia	European Mountain Ash	SC*	Frequently Severely Damaged
Spathiphullum spp.	Peace lilly	FL	Annuals/Perennials & Bulbs w/ rare damage
Spiraea prunifolia	Bridalwreath Spiraea	SC*	Occassionally Severely Damaged
Spiraea prunifolia	Bridalwreath Spiraea	MI	Occassionally Damaged
Spiraea spp.	Spiraea	GA	Shrubs w/ high degree deer tolerance
Spiraea x bumalda	Anothony Waterer Spiraea	MI	Occassionally Damaged
Spiraea x bumalda	Anothony Waterer Spiraea	SC*	Occassionally Severely Damaged
Spiraea x bumaldi	Bumald Spiraea	AK	Resistant Shrubs
Spiraea x vanhouttei	Vanhoutte Spiraea	AK	Resistant Shrubs
Stachys spp.	Lamb's Ear	AK	Resistant Perennials
Stachys byzantia	Lamb's Ear	MI	Rarely Damaged
Strelitzia reginae	Bird of Paradise	FL	Shrubs w/ rare damage
Styrax japonicum	Japanese Snowbell	AK	Resistant Trees

Table 1. Compiled state extension lists of susceptible and resistant plant species to white-tailed deer damage, continued.

Scientific Name	Common Name	State	Comments
Symplocos tinctoria	Sweetleaf	AL	Attracting
Syringa reticulata	Japanese Tree Lilac	SC*	Occassionally Severely Damaged
Syringa reticulata	Japanese Lilac Tree	MI	Occassionally Damaged
Syringa spp.	Lilacs	MI	Occassionally Damaged
Syringa villosa	Late Lilac	SC*	Occassionally Severely Damaged
Syringa villosa	Late Lilac	MI	Occassionally Damaged
Syringa vulgaris	Common Lilac	AK	Resistant Shrubs
Syringa vulgaris	Common Lilac	SC*	Seldom Severely Damaged
Syringa vulgaris	Common Lilac	MI	Seldom Damaged
Syringa x persica	Persian Lilac	SC*	Occassionally Severely Damaged
Syringa x persica	Persian Lilac	MI	Occassionally Damaged
Tagetes patula	French Marigold	MI	Rarely Damaged
Tagetes spp.	Marigold	GA	Annuals w/ high deer tolerance
Tagetes spp.	Mexican Mint Marigold	TN	Resistant
Tagetes tenuifolia	Signet Marigold	MI	Rarely Damaged
Taxodium distichum	Bald Cypress	GA	Trees w/ high degree deer tolerance
Taxus baccata	English Yew	SC*	Frequently Severely Damaged
Taxus baccata	English Yew	MI	Frequently Damaged
Taxus brevifolia	Western Yew	SC*	Frequently Severely Damaged
Taxus brevifolia	Western Yew	MI	Frequently Damaged
Taxus cuspidata	Japanese Yew	SC*	Frequently Severely Damaged
Taxus cuspidata	Japanese Yew	MI	Frequently Damaged

Table 1. Compiled state extension lists of susceptible and resistant plant species to white-tailed deer damage, continued.

Scientific Name	Common Name	State	Comments
Taxus spp.	Yews	SC*	Frequently Severely Damaged
Taxus spp.	Yews	MI	Frequently Damaged
Taxus x media	English/Japanese Hybrid Yew	SC*	Frequently Severely Damaged
Taxus x media	English/Japanese Hybrid Yew	MI	Frequently Damaged
Tecoma stans	Esperanza	TX	Resistant
Teucrium spp.	Germander	TN	Resistant
Thrinax spp.	Thatch Palm	FL	Trees w/ rare damage
Thuja occidentalis	American Arborvite	SC*	Frequently Severely Damaged
Thuja occidentalis	American Arborvite	MI	Frequently Damaged
Thymus spp.	Thyme	AK	Resistant Groundcovers
Thymus spp.	Thyme	TN	Resistant
Tilia americana	American Basswood	SC*	Occassionally Severely Damaged
Tilia americana	American Basswood	MI	Occassionally Damaged
Tilia cordata 'Greenspire"	Greenspire Littleleaf Linden	SC*	Occassionally Severely Damaged
Tilia cordata 'Greenspire"	Greenspire Linden	MI	Occassionally Damaged
Tilia spp.	Basswood	MI	Occassionally Damaged
Trachelospermum asiaticum	Asiatic Jasmine	AK	Resistant Groundcovers
Trachelospermum asiaticum	Asiatic Jasmine	TN	Resistant
Trachelospermum jasminoides	Star Jasmine	AK	Resistant Vines
Trachelospermum jasminoides	Star Jasmine	FL	Vines & Groundcovers w/ rare damage
Trachelospermum jasminoides	Star Jasmine	TN	Resistant
Tradescantia zebrina	Wandering Jew	FL	Vines & Groundcovers w/ rare damage

Table 1. Compiled state extension lists of susceptible and resistant plant species to white-tailed deer damage, continued.

Scientific Name	Common Name	State	Comments
Trientalis borealis	Star Flower	FL	Annuals/Perennials & Bulbs w/ severe damage
Trillium maculatum	Trillium	FL	Annuals/Perennials & Bulbs w/ rare damage
Tsuga canadensis	Eastern Hemlock	SC*	Occassionally Severely Damaged
Tsuga caroliniana	Carolina Hemlock	SC*	Occassionally Severely Damaged
Tulbaghia violacea	Society Garlic	FL	Vines & Groundcovers w/ rare damage
Tulbaghia violacea	Society Garlic	GA	Herbaceous Perennials/Bulbs w/ high deer tolernce
Tulipa spp.	Tulips	MI	Frequently Damaged
Ungnadia speciosa	Mexican Buckeye	TN	Resistant
Vaccinium spp.	Blueberry, Huckleberry	AL	Attracting
Veitchia spp.	Christmas Palms	FL	Trees w/ rare damage
Verbena spp.	Verbena	FL	Annuals/Perennials & Bulbs w/ rare damage
Verbena spp.	Verbena	GA	Annuals w/ high deer tolerance
Veronica spp.	Speedwell	MI	Rarely Damaged
Viburnum carlesii	Koreanspice Viburnum	SC*	Occassionally Severely Damaged
Viburnum carlesii	Koreanspice Viburnum	MI	Occassionally Damaged
Verbena spp.	Verbena	TN	Resistant
Viburnum plicatum tomentosum	Doublefile Viburnum	MI	Occassionally Damaged
Vibrunum plicatum tomentosum	Doublefile Viburnum	SC*	Occassionally Severely Damaged
Viburnum rhytidophyllum	Leatherleaf Viburnum	SC*	Occassionally Severely Damaged
Viburnum rhytidophyllum	Leather	MI	Occassionally Damaged
Viburnum spp.	Viburnum	FL	Shrubs w/ rare damage
Viburnum spp.	Viburnum	GA	Shrubs w/ high degree deer tolerance

Table 1. Compiled state extension lists of susceptible and resistant plant species to white-tailed deer damage, continued.

Scientific Name	Common Name	State	Comments
Viburnum x juddii	Judd Viburnum	SC*	Occassionally Severely Damaged
Viburnum x juddii	Judd Viburnum	MI	Occassionally Damaged
Vinca major	Myrtle	TN	Resistant
Vinca rosea	Periwinkle	FL	Annuals/Perennials & Bulbs w/ rare damage
Vinca rosea	Periwinkle	TN	Resistant
Vitex spp.	Vitex	TX	Resistant
Vitis spp.	Wild Grapes	AL	Attracting
Weigela florida	Oldfashion Weigela	SC*	Occassionally Severely Damaged
Weigela florida	Weigela	MI	Occassionally Damaged
Wisteria floribunda	Japanese Wisteria	SC*	Seldom Severely Damaged
Wisteria floribunda	Japanese Wisteria	MI	Seldom Damaged
Wisteria spp.	Wisteria	AK	Resistant Vines
Yucca filamentos	Yucca	AK	Resistant Shrubs
Yucca spp.	Yucca	TN	Resistant
Yucca spp.	Yucca	FL	Annuals/Perennials & Bulbs w/ rare damage
Zea mays	Corn	FL	Annuals/Perennials & Bulbs w/ severe damage
Zexmenia hispida	Zexmenia	TN	Resistant

Table 1. Compiled state extension lists of susceptible and resistant plant species to white-tailed deer damage, continued.

Scientific Name	Common Name	State	Comments
Zinnia angustifolia	Zinnia	MI	Rarely Damaged
Zinnia elegans	Zinnia	GA	Annuals w/ high deer tolerance
Zinnia elegans	Zinnia	MI	Rarely Damaged
Zinnia spp.	Zinnia	FL	Annual/Perennials & Bulbs w/ moderate damage
Zinnia spp.	Zinnia	TN	Resistant

* South Carolina and Nebraska use Cornell Cooperative Extension Fact Sheet for their state lists.