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January 1996

"Reduced Herbicide Application Rates for Crabgrass and Goosegrass Control in Bermudagrass" B. J. Johnson, pp. 1-6
Keywords: bermudagrass, growth regulators, multiyear application, POST (postemergence) herbicide, PRE (preemergence) herbicide, reduced-rate application, sequential application, tank-mixed single application.

Bermudagrass is widely used on golf courses, athletic fields, lawns, industrial areas, parks, and other turf areas throughout the southern United States. To maintain a desirable quality turf, herbicides must be included for weed control in the overall management program. Several programs utilizing lower herbicide rates for full-season weed control in turfgrasses have been developed at the University of Georgia. These programs are: a) sequential applications of preemergence (PRE) and postmergence (POST) herbicides applied at different dates, b)tank-mixes of PRE and POST herbicides applied as a single application after weeds emerge, c) multiyear use of PRE herbicides applied at reduced rates over years, and d) role of turfgrass species on competition with weeds when treated with herbicides at reduced rates. PRE herbicides applied at 50 to 75% lower than the recommended rate in late winter and followed by one timely POST herbicide application in late spring or early summer controlled crabgrass and goosegrass in common bermudagrass as effectively as the maximum labeled rate of PRE herbicides applied alone. In general, tank-mixtures of PRE and POST herbicides applied in a single application at reduced rates were not as effective as sequential applications of PRE and POST herbicides in controlling crabgrass and goosegrass. When PRE herbicides are applied to the same plots for one to three years, the rates for selected herbicides for crabgrass can be reduced. For crabgrass, the rates can be reduced by 50% the first year and by 75% the following years. Reduced PRE herbicide rates were less effective on goosegrass than on crabgrass during the first year of treatment. However, the rates for selected PRE herbicides can be reduced from 50 to 75% the following two years. Most PRE herbicides did not control crabgrass as effectively in tall fescue as when applied to common bermudagrass.

"Herbicide-Resistant Weeds in Turfgrasses" Tim R. Murphy, pp. 7-10
Keywords: herbicide-resistance, goosegrass, dinitroaniline-resistance, dithiopyr-resistance.

In 1992, a Georgia golf course superintendent reported that goosegrass populations were increasing on fairways that had a history of annual applications of dinitroaniline herbicides. Field experiments were conducted at this golf course in 1993 and 1994 to determine if this population of goosegrass was resistant to dinitroaniline herbicides. Oxadiazon, prodiamine, pendimethalin, oryzalin and dithiopyr were applied at maximum labeled rates to separate plots on a common bermudagrass fairway either as single or sequential treatments. The initial herbicide application was in mid-February of 1993 and 1994. Sequential applications were made approximately 8 weeks later (mid-April) after the initial February application. Goosegrass control was recorded at 4 and 5 months after the initial February application in 1993 and 1994, respectively. Pendimethalin, oryzalin, prodiamine and dithiopyr did not control goosegrass either as a single or sequential application. Oxadiazon provided > 90% goosegrass control. Additional research showed that diclofop and MSMA + metribuzin applied postemergence at labeled rates would also control this population of goosegrass. Dinitroaniline-resistant goosegrass has been detected in turfgrasses; however, it can be controlled with oxadiazon, diclofop and MSMA + metribuzin. Additionally, dinitroaniline-resistant goosegrass is cross-resistant to dithiopyr.

"Conducting a Bioassay for Herbicide Residues" Joseph C. Neal, pp.10-12
Key Words: bioassay, chemicals, herbicides, residues.

The bioassay, a technique for determining if herbicide (or other chemical) residues are present in soil or water in high enough concentrations to adversely affect plant growth, is discussed. It is a simple and direct method that is useful in determining whether it is safe to seed or plant into areas previously treated with herbicides or into soil with an unknown history of herbicide use. This technique is also sometimes used to estimate herbicide concentrations in soil and water, and to identify unknown herbicide residues from the symptoms of injury. Step by step instructions on how to conduct a bioassay are given; as are options on steps that can be taken if residues are present.

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"Managing Turf for Maximum Root Growth: Are You Making Your Job More Difficult by Not Getting to the 'Roots' of Many Turf Management Problems?" Richard J. Hull, pp. 1-9

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Keywords: cool-season grass, cultural management, photorespiration, photosynthetic partitioning, root growth, sinks, sources, warm-season grass.

Turfgrasses acquire all water and most mineral nutrients through their roots. An extensive efficient root system enables turf to resist environmental stresses, recover from injury, and tolerate the assault of insect and disease pests. The turfgrass manager might minimize many problems by considering the impact of cultural practices on the condition of turf roots. In cool-season grasses, root growth follows an annual cycle of increase and decline but this pattern can be moderated by appropriate management strategies based on manipulating the source -sink relations within the grass. Mowing height, fertilization, irrigation and pest control practices can all be altered to maintain root condition. However, because root status is not obvious nor easily monitored, managing a turf root system requires an understanding of the physiology underlying root growth and development. This article attempts to outline some interactions between turf management practices and the physiological processes which control the growth and maintenance of roots. There is little doubt that root based turf management will pay dividends in the form of fewer and less serious problems in maintaining a high quality resilient turf.

"Maximizing Disease Control with Fungicide Applications: The Basics of Turfgrass Fungicides-Part One: Fungicide Use and General Properties"
Eric B. Nelson, pp. 10-17
Keywords: contact fungicide, disease control, fungal pathogens, fungicide labeling, penetrant fungicide, formulations, fungicides.

Fungicide applications have been the mainstay of golf course superintendents, lawn care operators, and other turfgrass managers for the control of fungal turfgrass diseases. Fungicides have revolutionized the turfgrass industry; however, turfgrass managers have become overly dependent on them. This has led to situations in which abuses of fungicide applications have become commonplace. Despite the dependency on fungicides for effective disease control, turfgrass managers have generally had insufficient information with which to make logical decisions regarding the selection and application of turfgrass fungicides. This article reviews some of the current trends in fungicide applications, as well as important information on types of fungicides available to the turfgrass manager and how these fungicides behave in plants and suppress fungal pathogens. This is the first part of a multipart series on fungicide use in turfgrasses.

"U.S. Environmental Protection Agency and Turf Organizations Form Partnership" Sherry L. Glick and Anne Leslie, pp. 17-19
Key Words: EPA, Golf Course Superintendent's Association of America, Pebble Beach, PESP, Pesticide Environmental Stewardship Program, pesticides, Professional Lawn Care Association of America, U.S. Environmental Protection Agency, US Golf Association.

The U.S. Environmental Protection Agency's voluntary program to reduce risk and use of pesticides is described. The voluntary program, called the Pesticide Environmental Stewardship Program (PESP) has both Partners and Supporters involved in reducing risk and use of pesticides. The turfgrass organizations that participate in PESP are named and several of their projects are described. The turfgrass organizations included in PESP are: the Golf Course Superintendent's Association of America, Pebble Beach, Professional Lawn Care Association of America and the US Golf Association.

March 1996

"Growth Regulators and *Poa annua*" Thomas L. Watschke, pp. 1-4
Key Words: annual bluegrass, GA, gibberellin, growth regulators, mitotic inhibitors, *Poa annua*, seedhead suppression, stand conversion.

The use of growth regulators for managing turf has increased greatly in the last 10 - 15 years; this is due to an expanded number of product choices, research into potential uses, and an experience base of successes among users. It is now considered a viable option for the management of fine turf. Two types of growth regulators are discussed: mitotic inhibitors, which provide growth suppression by reducing cell division, and gibberellin (GA) suppressers, which suppress growth by interrupting the plants ability to synthesize GA, a hormone which is necessary for the natural elongation of plant cells. The advantages and disadvantages of using either type of growth regulator for the management of *Poa annua* is also discussed.

"Maximizing Disease Control with Fungicide Applications: The Basics of Turfgrass Fungicides - Part Two: Behavior of Soil"
Eric B. Nelson, pp. 5-11
Keywords: adsorption, fungicide behavior, leaching, microbial degradation, soil properties, turfgrass pathogens, volatile losses.

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The efficacy of fungicide applications to turfgrass soils can be related, in part, to their behavior in soil. Since turfgrass pathogens are generally soil inhabiting fungi, turfgrass fungicides must find their way to the soil or thatch for effective disease control. However, the soil-thatch interface under a mature turfgrass canopy is one of the most difficult environments in which to apply fungicides successfully. In this zone, fungicides can be immobilized, degraded, dissipated, and inactivated quite rapidly. This is related to a number of factors, including the degree of sorption of fungicides to organic matter and soil particles, the amount of microbial and chemical degradation, photodecomposition, root absorption, and movement out of the soil profile through volatilization and leaching. An understanding of these factors that effect fungicide behavior can ultimately lead to more effective fungicide applications by helping to maintain maximum amounts of fungicidal activity with the least amount of undesirable side effects. This article reviews some of the major soil factors affecting fungicide performance in turfgrass systems.

"Poa Annua Management" Bridget Ruemmele, pp.11-14
Key Words: Poa annua, annual bluegrass, weed controls.

Poa annua, or annual bluegrass, has variable growth habits and adaptability to harsh environments. Compacted soils, inadequate drainage, excessive close mowing, high nitrogen, adequate water, and mild summers favor its growth. Annual bluegrass is susceptible to anthracnose, dollar spot, brown patch, pythium, and snow mold. Ice cover and repeated thawing and freezing can decrease *Poa annua* survival. New sites may be treated with soil sterilants. Pre-emergent chemical controls include benefin, bensulide, oxadiazon, prodiamine, pendimethalin, DCPA, and isoxaben. Post-emergent chemical control of plants is limited to ethofumesate, while seedhead suppression chemicals include maleic hydrazide, chlorfluorenol, mefluidide, and Paclobutrazol.

April 1996

"Maximizing Disease Control with Fungicide Applications: The Basics of Turfgrass Fungicides - Part Three: Plant and Pathogen Factors Affecting Fungicide Efficacy" Eric B. Nelson, pp. 1-7
Keywords: excessively-growing turfgrass, fungicide efficacy, fungicide resistance, inoculum, pathogen factors, phloem, translocation, vigorously-growing turfgrass, xylem.

Most often, turfgrass fungicides are applied to diseased turfgrass plants that are in a state of poor health or decline. In many cases under severe disease pressure, the effectiveness of many turfgrass fungicides is less than optimal or they may fail altogether. This is related to a large degree to several plant and pathogen characteristic that affect the uptake and distribution of fungicides inside the plant and the sensitivities of the pathogen to the fungicide. In this section, these and other aspects of the physiology of turfgrass plants and the life stages of the pathogens will be discussed in relation to the performance of fungicides.

"Herbicide Effects on Bermudagrass Turf" Fred Fischel, pp. 8-13
Key Words: Dimension, dithiopyr, Ronstar(r), oxadiazon, pendimethalin, Barricade, prodiamine, Surflan, oryzalin, bermudagrass, soil persistence.

Several experiments were conducted in recent years to evaluate the influence of pre-emergence herbicides on rooting characteristics of bermudagrass turf. The specific objectives of these experiments were to determine the effect of pre-emergence herbicides on root growth over time and to determine if such herbicides have the potential to cause root injury at various depths in the soil profile. Turf was treated in field plots, plugs were removed at various time intervals and grown in the greenhouse, and rooting characteristics were determined after six weeks of growth. Root fresh weight was reduced the greatest with Dimension(r) or Barricade(r). Pendimethalin caused fewer fresh weight reductions compared to Dimension or Barricade and these reductions were usually for only a short period of time. Lower root weight in these plots could be attributed to fewer roots produced and malformed roots. Additionally, greater numbers of malformed roots were observed for longer periods where Dimension or Barricade had been applied. Barricade and Surflan(r) were detected as deep as three inches in a light-textured soil which had received relatively high amounts of rainfall. In the top one-inch of the soil profile, Barricase, Dimension, Surflan and pendimithalin all caused a reduction in root weight. These findings were based upon a bioassay using Tifgreen bermudagrass as an indicator species.

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"Multiple Considerations in Turfgrass and Landscape Pest Management" Michael G. Villani, pp. 1-7
Keywords: IPM (integrated pest management), pesticide hazards, risk assessment.

Growing pesticide use has created concerns about urban pesticide hazards to the environment and human health. The public considers risk factors such as: how well the action being considered is understood; how equitably the danger is distributed; how well individuals can control their exposure; and whether risk is assumed voluntarily. IPM (integrated pest management) involves consumers and professionals to control pest damage through scouting, pest identification, records keeping, and using the appropriate intervention technology rather than applying pesticides through pre-scheduled applications. Consumer awareness can be raised through education, use of cultural means, optimized pesticide use, and chemical alternatives for pest control. IPM Ornamentals Program addresses additional IPM techniques for the ornamentals producers. These tactics are: advancing host plant resistance, developing complex landscapes, better environmental management, use of natural biological control agents, pest barriers, traps, and quarantining imported plants. Consumer pressure has warranted the development and implementation of IPM techniques.

"The First Registered Biological Control Product for Turf Disease: Bio-Trek 22G" G.E Harman and C.T. Lo, pp.8-14
Key Words: Trichoderma, Trichoderma harzianum, Nontarget organisms.

The first registered biological control product, Bio-Trek 22G, for the control of turf diseases is now available. This product contains a strain of the beneficial fungus, Trichoderma harzianum, and is designed for broadcast application to turf. The fungus establishes on the roots and in the soil of turf and persists for months after application. Once establishment occurs, it can become a component of a healthy soil microbial community and reduce soilborne disease. It cannot, however, control foliar diseases and therefore must be used in conjunction with compatible fungicides. We anticipate that Bio-Trek 22G will be the first of several products for turf disease control. Other biological and integrated biological-chemical control products will be manufactured by TGT and they will extend usefulness of Bio-Trek 22G.

June 1996

"Enhancing Turfgrass Disease Control with Organic Amendments" Eric B. Nelson, pp. 1-15
Keywords: amendments, composts, disease suppression, organic fertilizers, peats, root-zone amendments, sludges, topdressing.

Organic amendments are gaining wider use in the turfgrass industry both as a means of increasing nutrient and water retention in sand-based growing media but also as fertilizers, thatch reducers, and materials to suppress turfgrass diseases. Among the more effective types of amendments have been composed amendments containing high levels of microbial activity and capable of inducing high levels of microbial activity in treated soils. Many of the microbes found in composts and in soils treated with composts can act as biological disease control agents. In this article, the author reviews some of the basic aspects of organic amendments in turfgrass management and some of the microbial aspects of composting that relate to the suppression of turfgrass diseases.

July 1996

"Heat Stress and Decline of Creeping Bentgrass" Leon T. Lucas, pp. 1-8
Keywords: anaerobic soil, bentgrass, heat stress, irrigation practices, North Carolina, Phthium root rot, Rhizoctonia brown patch, soil condition.

Heat stress is a major factor in the decline of bentgrass golf greens during hot and humid weather. Many factors are involved including temperature, metabolism, environmental factors, soil conditions and diseases. Bentgrass does not grow when temperatures are above 90 degrees and root growth ceases at 77 degrees. The photorespiration process of metabolism is less efficient at higher temperatures resulting in weaker plants that decline and do not recover from stresses and diseases during hot weather. Wet soil conditions result in low oxygen levels and encourage the development of diseases. Diseases such as Pythium root rot and brown have been shown to be involved in the summer decline of bentgrass. Modification of environmental conditions around greens and management practices have helped bentgrass to tolerate summer stress conditions. A fungicide program that includes Aliette plus Fore or Aliette plus Daconil has helped to manage summer decline of bentgrass in hot and humid regions in the country.

"The Oriental Beetle" Steven R. Alm, pp. 9-13
Keywords: oriental beetle, *Exomala orientalis*, distribution, pheromone, biological and chemical control.

The distribution, life history and habits, and turf damage caused by oriental beetles, *Exomala orientalis* (Waterhouse) are described. The use of a newly identified pheromone for monitoring and possible population suppression is discussed, as well as control of larvae with entomopathogenic nematodes, *Bacillus thuringiensis* var. japonensis strain Buibui, and insecticides.

August 1996

"Field Testing of Biological Pesticides" David J. Shetlar, pp. 1 - 9
Keywords: biological controls, entomopathogenic nematodes, field testing, LD50, pathogenic controls, target pests.

Biological controls ("biological pesticides") can be developed and used as a regular pesticide by determining the pathogens of target insect pests. The process includes discovering the pathogen, producing the pathogen, testing in small plots, testing in large production scale, and marketing the new product. The collection of pathogens involves looking at native populations of target pests or closely related insects for naturally occurring diseases or finding new forms of pathogens from soil and dust samples taken worldwide. Screening of new biological controls uses a uniform age-class of insects, therefore, field testing will result in more accurate efficacy results of the new controls. Biological pesticides are difficult to compare to a chemical standard because biological pesticides work much slower, over weeks or into the next season, but can be progressively more lethal over time. A case study on entomopathogenic nematodes, *S. carpocapsae, S. scapterisci,* and *S. riobravos* is highlighted.

"The Basics of Trufgrass Fungicides - Part Four: Handling and Applying Fungicides" Eric B. Nelson, pp. 10-15
Keywords: EC (emulsifiable concentrates), F (flowables), FLO (flowables), fungicide application, fungicide efficacy, WDG (water dispersable granules), WP (wettable powders).

The vast majority of turfgrass managers do not actually apply the rates of fungicides that they think they are applying. Nearly all make mistakes in mixing, loading, configuring equipment, and calibrating delivery devices. National losses due to these mistakes have been estimated to be in the billions of dollars. Additional losses have occurred because of reduced fungicide effectiveness resulting from improper measuring and calibration. This article reviews many of the important reasons and methods for careful measuring, mixing, and loading fungicides and in routinely calibrating and maintaining equipment. Additional problems such as proper timing and placement of fungicide applications are also reviewed.

September 1996

"Back to Basics-Insecticide Primer, Part One: What Insecticides Can and Cannot Do" Dr. Patricia J. Vittum, pp. 1-8
Keywords: insecticide, larva, leaching, pesticide, pH, Run-off, white grub.

Some turf managers and their customers expect insecticides and other pesticides to solve many, if not most, turf management problems. However, there is a limit to what insecticides can and cannot do. This article, which is the first in a six part series, discusses some of those limits, and points out a few areas where attention to detail can increase the effectiveness of insecticides. Many of the points made in this article hold true for other kinds of pesticides (for example, fungicides and herbicides) as well. The topics discussed include: reasonable expectations of the insecticide, accurate identification of the problem, choosing an appropriate material, using that material correctly (timing of application, accurate application, and use of water), and a few environmental considerations.

"Where to Find Product Information" Michael G. Villani, pp. 3
Keywords: Arthropod Management Tests, Handbook of Turfgrass Insect Pests, insecticide efficacy, product labeling, target insect pests.

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Turfgrass managers can find reliable information on insecticides by using some of these resources. The Arthropod Management Tests is an unbiased technical comparison of available insecticides based on a compilation of hundreds of field experiments conducted throughout the country. The Handbook of Turfgrass Insect Pests includes a listing of university turfgrass entomologists. Chemical company representatives can be knowledgeable of their company's products.

"Fungicide Index: EPA Registered Fungicides for Turfgrass Applications in the United States" Eric B. Nelson and Dan Dinelli, pp. 13-18
Keywords: active ingredient, EPA (Environmental Protection Agency), formulations, registered fungicides, registration number, trade name.

This is a list of all registered fungicides in the United States by active ingredient, trade name(s), formulation(s), EPA registration number, manufacturer's (or sub-registrant's) address and phone number, if available.

October 1996

"Managing Turf for Minimum Water Use" Richard J. Hull, pp. 1-8
Keywords: boundary layer, canopy resistance, cool-season grass, ET (evapotranspiration), stomates, warm-season grass, water conservation.

As water becomes increasingly in short supply for turf irrigation, a concept of efficient water use is emerging and being applied to refine irrigation practices. The basic physical laws governing water use by turf are outlined and the idea of water requirement is being challenged. Evapotranspiration (ET) is the primary route of water loss from turf and this process is discussed in relation to the function of stomates and the elements of plant canopy resistance to water movement. Efficiency of water acquisition is discussed as a function of root length density and its generic variability among turfgrasses. The role of turf management in promoting root growth is considered as well as the impact of soil drying on ET. Relationships between these two factors are developed as the basis for water deficit irrigation. These concepts offer the basis for a water management strategy that may reduce turf water use by fifty percent.

"Turfgrass Diagnostic Laboratories in the United States and Canada" Eric B. Nelson and Erin Kennedy, pp. 2-5
Keywords: disease diagnosis, insect identification, pest diagnosis, nematode detection, plant and weed identification.

This is a list of state-supported diagnostic laboratories current as of October 1996. Each entry includes a "Laboratory Services" key at the bottom of its entry.

November 1996

"Effect of Nitrogen Fertilization on Turfgrass Disease Injury" John E. Watkins, pp. 1-5
Keywords: dollar spot, brown patch, crown rust, nitrogen rate.

A study at the University of Nebraska-Lincoln showed that nitrogen levels of 6 and 8 lb. of actual N/1000 ft2/season caused significantly greater brown patch injury than 4 or less lb. on a Rebel tall fescue turf. The turf in those plots receiving no nitrogen was chlorotic, lacked vigor and was not aesthetically acceptable. At 2 or 4 lb. of nitrogen, turf quality was acceptable while disease injury remained low to moderate. A similar study comparing the effect of nitrogen rates on brown patch and crown rust injury in perennial ryegrass showed that as nitrogen rate increased from 0 to 8 lb., disease injury decreased. The color and quality of the plots fertilized at 4 and 8 lb. N was visibly better that that at 0 and 2 lb. N. These plots at the higher N rates recovered quickly from the disease injury and maintained a good verdure, color, and quality. Dollar spot injury to creeping bentgrass was effectively suppressed at the 6 and 8 lb. nitrogen rates in a 3-year study that compared quick-release urea (46-0-0) with slow-release, sulfur-coated urea (32-0-0) at 0, 2, 4, 6, and 8 lb. N/1000 ft2/year. There was no interaction between nitrogen rates and the slow- or fast-release carrier, however, by mid-season the quick-release urea was giving greater disease suppression than the sulfur-coated urea. At the higher rates, the bentgrass is able to quickly recover from dollar spot injury.

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"Nitrogen Usage By Turfgrasses" Richard J. Hull, pp. 6-15
Keywords: nitrogen chemical properties, nitrogen mobility, nucleic acid, peptide bonds, protein catalysts.

Nitrogen is the most abundant mineral nutrient in plant tissues. Its abundance is a result of its roles in establishing and maintaining the structure of proteins and nucleic acids. Proteins function as catalysts for virtually all metabolic reactions and nucleic acids provide the genetic code and the template for the synthesis of all proteins. This review outlines those chemicals properties of nitrogen which are responsible for its role in protein and nucleic acid structure and function. The peptide bond is discussed as are those functions of nitrogen derived from its properties as a hard base: hydrogen binding resulting in cation formation, metal bonding in pigment and enzyme function, and electropositive group function in hormone action and stress tolerance. Variable nitrogen content of plant tissues is explained based on plant responses to enzyme inefficiency and the mobility of nitrogen in response to deficiency conditions. Turf management strategies for maximizing the efficiency of nitrogen use are reviewed in the context of nitrogen's basic physiological functions.

December 1996

"The Basics of Turfgrass Fungicides - Part 6: Human Health and Enviornmental Quality Considerations" Eric. B. Nelson, pp. 13-17
Keywords: fungicide toxicity, acute toxicity, LD50, chronic toxicity, nontarget effects, fungicide safety.

The impacts of fungicides on human health and the environment is becoming an increasing concern in golf course management. Fungicides, as all pesticides, have certain human risks associated with their handling and application. Since fungicides, like insecticides and herbicides, are designed to kill living organisms, they are potentially hazardous to humans as well as to the fungi they are intended to kill. Furthermore, they have the potential for exerting considerable environmental impacts and ecological disturbances. However, compared to other pesticides, fungicides generally are among the least toxic. In this article, I discuss the potential risks associated with fungicide use, the toxicities of turfgrass fungicides, and ways to maximize the human and environmental risks associated with these materials.

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