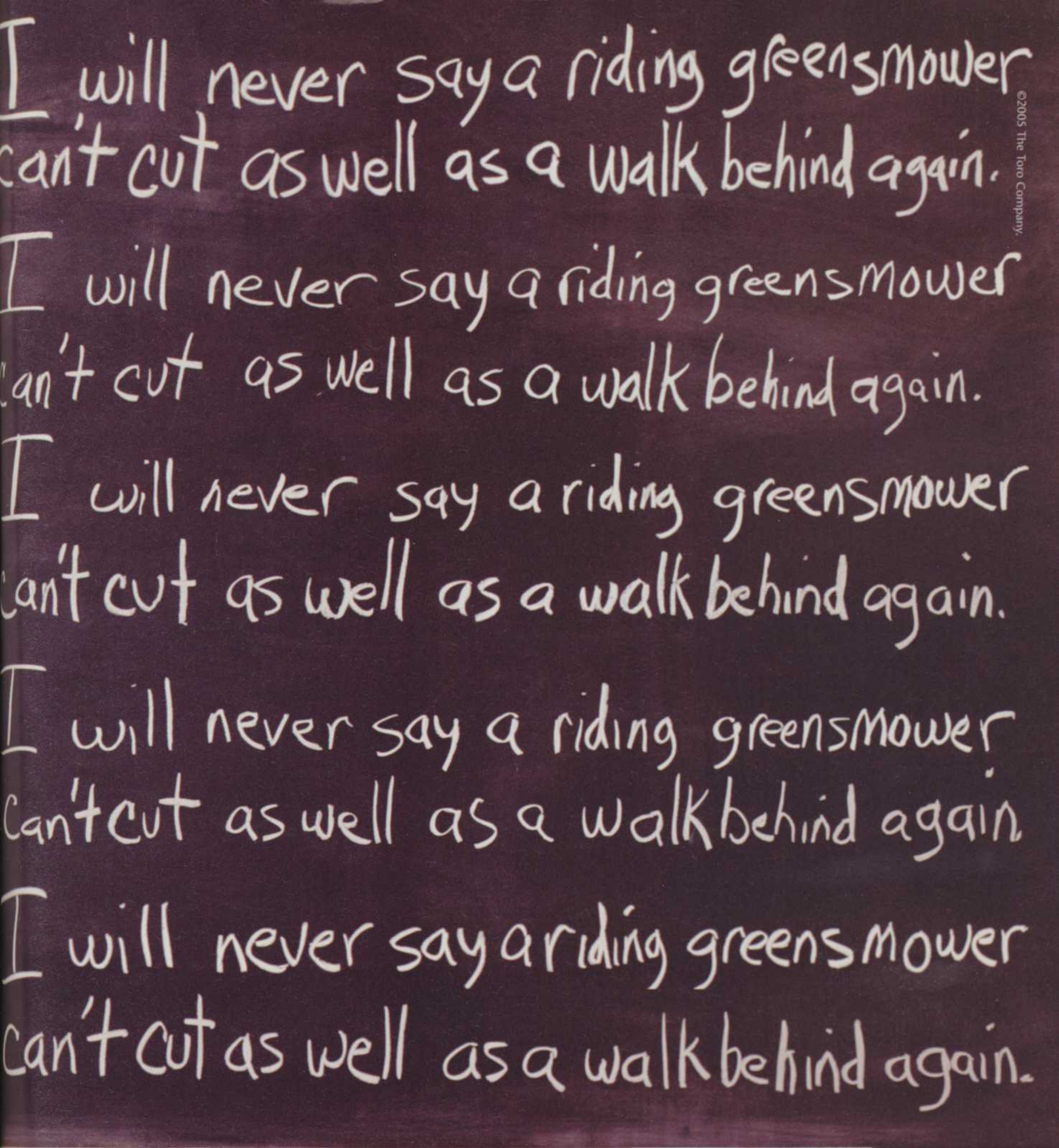

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Continued from page 60

(25 percent o 45 percent) after eight weeks in 2001. The plug/seed combination had the greatest increase in average density (43.3 percent) over 15 weeks.

A significant ($P > 0.05$) soil amendment effect was observed during the first 10 weeks of production in 2001 and after the 10th week in 2004. ZeoPro GB-30 and sphagnum peat provided significantly ($P > 0.05$) greater mean density (30 percent to 65 percent and 30 percent to 55 percent, respectively) and color (medium green) after 12 weeks as compared to Profile or unamended sand (30 percent to 50 percent and 25 percent to 50 percent mean density, respectively; light green color)(Figures 2 and 3).

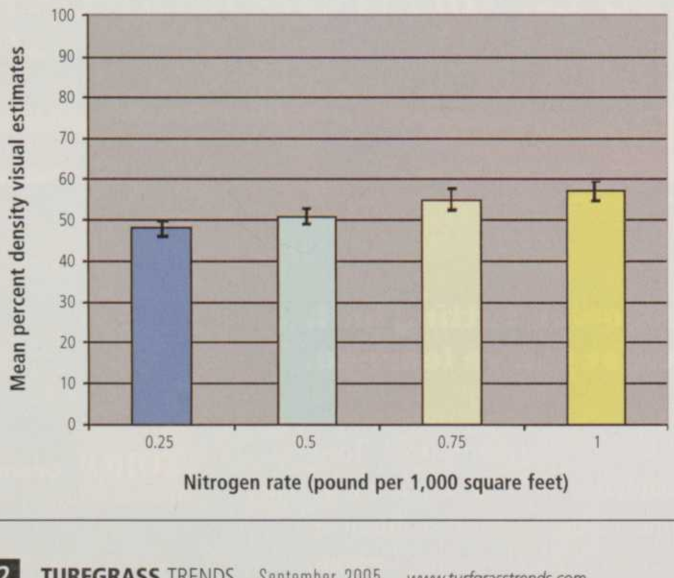
The only exception to these results was that Profile provided greater mean density than sphagnum peat in one of the 2001 studies.

Nitrogen rate significantly ($P > 0.05$) influenced both turfgrass density and color, either directly or by interacting with propagule and soil amendment treatments. In two of the studies, the 0.75 pound and 1 pound per 1,000-square-feet application rates provided higher mean density (53 percent to 72 percent and 58 percent to 75 percent, respectively) and darker green color than the 0.25 pounds per 1,000 square feet application rate (41 percent to 52 percent mean density) (Figure 4). Higher nitrogen rates did not significantly influence sod production in one 2001 study. However, nitrogen rate was observed to interact with the propagule and soil amendment treatments to provide improved sod density and color. ZeoPro GB 30 and sphagnum peat amendments were found to have a greater response in both density and color to higher nitrogen rates as compared to Profile or sand alone in 2001 (Figure 5).

Also, the plug/seed propagule treatment had the least response to increased nitrogen rates (Figure 6).

FIGURE 4

Mean percent density visual estimates as influenced by application rates of nitrogen on July 8, 2004. Bars represent standard deviation at $P < 0.05$.



Conclusion

Results were not always consistent between studies due to climatic differences that increased variability in annual bluegrass growth and crown and basal rot pressure. Plugs were found to provide the quickest establishment and best sod quality overall of the three propagation techniques studied. At the 0.75 cubic foot rate, plugs provide 25 percent to 35 percent turfgrass density at the initiation of the propagation procedure. The seed and seed/plug combination failed to equal the turfgrass density of the plugs until 12 weeks to 14 weeks into production.

ZeoPro GB-30-amended sand provided the darkest green color and quickest establishment in all studies. The sphagnum peat amendment also provided acceptable sod quality with a slightly lower density and lighter green color. Profile-amended sand did not significantly ($P > 0.05$) improve turfgrass density or color as compared to the pure sand.

It is difficult to explain why the Profile amendment did not improve establishment rate or sod quality since this does not agree with previous research (Bigelow *et al*, 2000). Some possible explanations could be variation in the amount of amendment added and climatic differences between studies.

The optimal nitrogen application rate in the production of annual bluegrass sod for this central Californian climate was 0.75 pounds per 1,000 square feet per month. Increasing nitrogen above this rate did not significantly improve establishment rate or color, which agrees with previous research (Frank, 2000; Furguson et al, 1986; Turgeon, 1999; Vargas, 1996). Results suggest that ZeoPro GB-30-amended sands have a lower nitrogen rate requirement than other amendments. Further research is necessary to define the optimal rate of nitrogen when ZeoPro GB30 is used in a

Continued on page 64

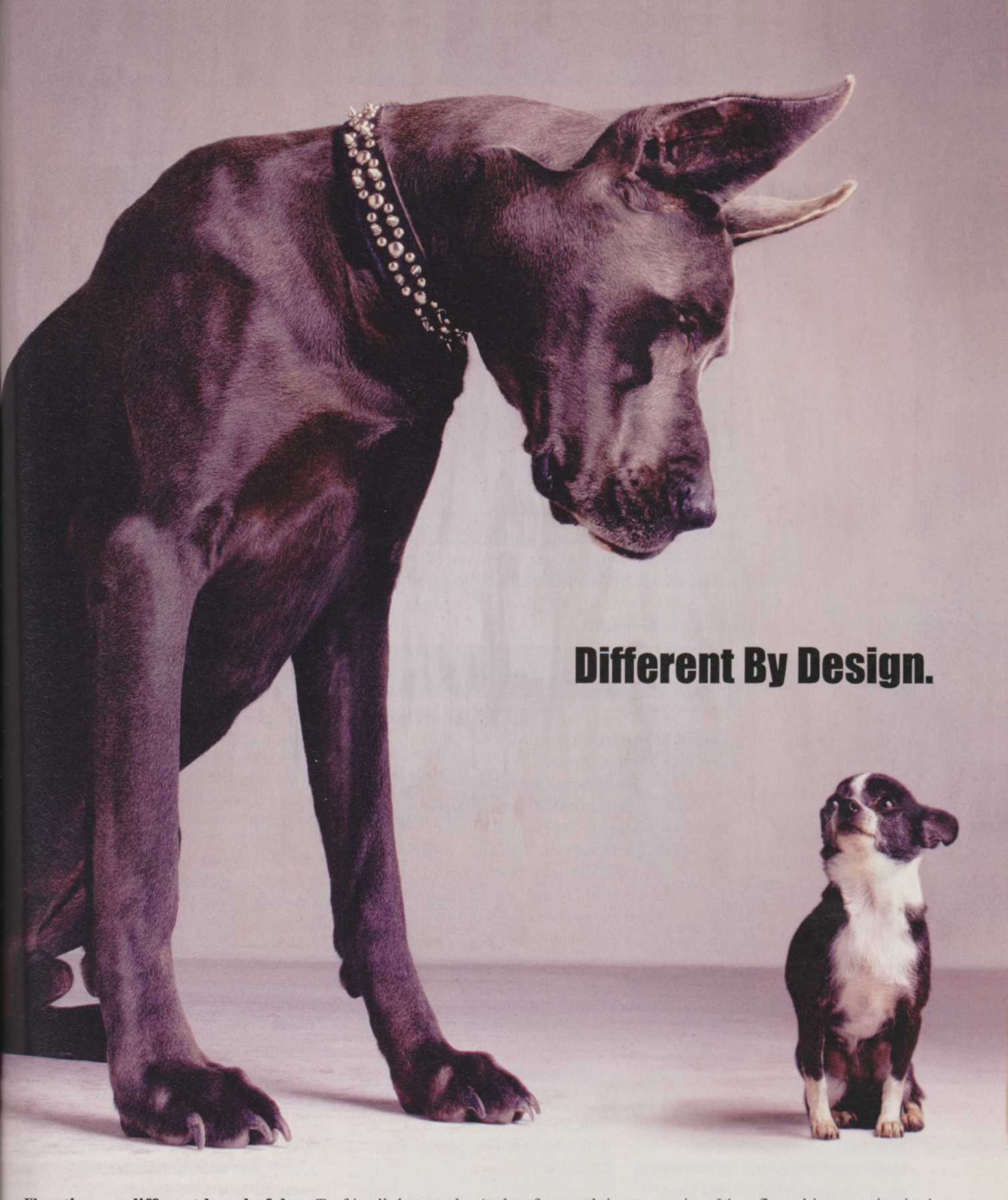
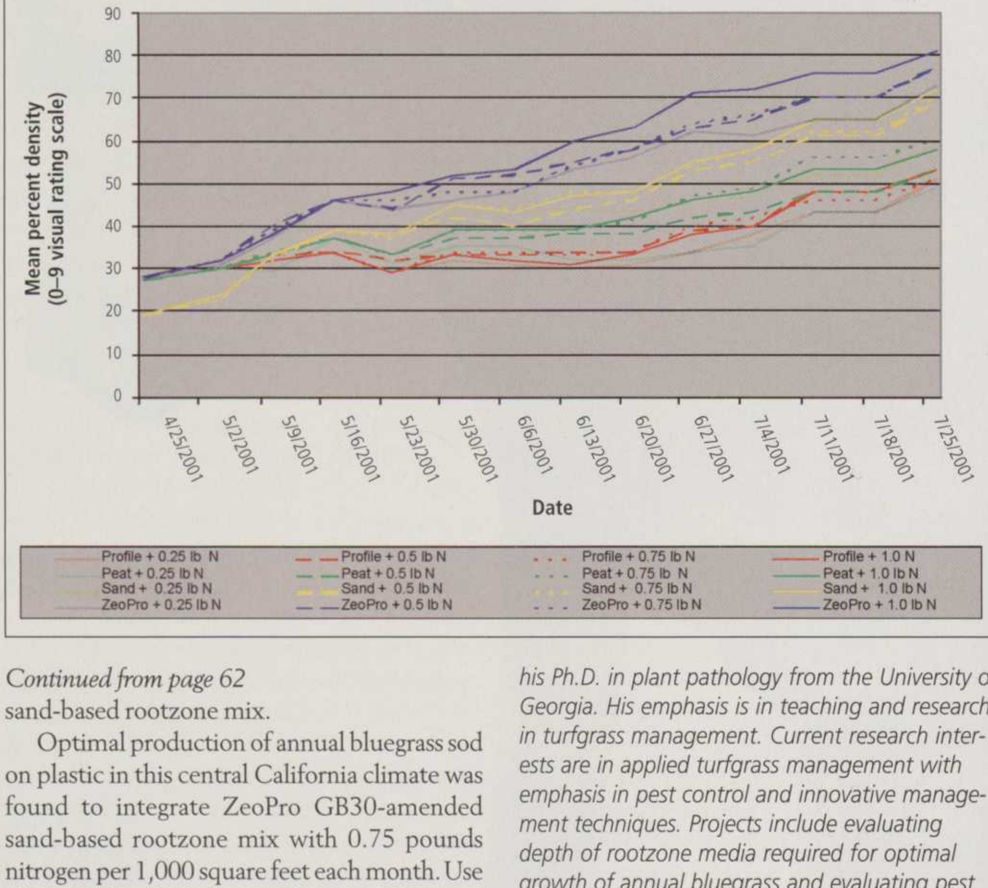

Different By Design.

FIGURE 5

Mean percent density visual estimates as influenced by the interaction between soil amendment and application rates during 2001.



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sand-based rootzone mix.

Optimal production of annual bluegrass sod on plastic in this central California climate was found to integrate ZeoPro GB30-amended sand-based rootzone mix with 0.75 pounds nitrogen per 1,000 square feet each month. Use of 0.75 cubic feet of 1/4-inch annual bluegrass plugs provided the quickest establishment rate; however, these propagules were infested with weed seed, which decreased sod quality.

David Green II is an assistant professor at California Polytechnic State University. He received his Ph.D. in plant pathology from the University of Georgia. His emphasis is in teaching and research in turfgrass management. Current research interests are in applied turfgrass management with emphasis in pest control and innovative management techniques. Projects include evaluating depth of rootzone media required for optimal growth of annual bluegrass and evaluating pest control techniques in turf. M. Facciuto, Sacramento, Calif.; M. Deuel, Sunset Hills Country Club, Thousand Oaks, Calif.; and R. Cenell, Coeur d'Alene Golf Course, Coeur d'Alene, Idaho, participated in this research as part of their senior project, completed to fulfill partial requirement of a bachelor of science degree.

REFERENCES

Bigelow, Cale A., Bowman, Dan and Cassel, Keith, 2000. "Sand-Based Rootzone Modification with Inorganic Soil Amendments and Sphagnum Peat Moss." *USGA Green Section Record.* July–Aug. 2000.

Cook, Tom Ph.D. 1996. "Living with annual bluegrass." *Golf Course Management* 64(1):59-62.

Davis, William B., Pratt, Charles A, 1982. "Sod Rooting, New Turfgrass Installations." *California turfgrass culture* Vol. 32:3-5.

Frank, Merrill J. CGCS. 2000. "Pointers for perfect *Poa.*" *Golf Course Management* 68(10):106-112.

Furgurson, G., Pepper, I. and Kneebone, W, 1986. "Growth of creeping bentgrass on a new medium for turfgrass growth: clinoptilolite zeolite-amended sand." *Agronomy Journal* 78:1095-1098.

Renaud, J.E. and Turgeon, A.J, 1975. "Comparison of Washed (Soilless) and Unwashed Sod." *Proc Ill Turfgrass Conf* Vol. 1:38-39.

Shaw, James W. and Andrews, Richard D, 2001. "Cation exchange capacity affects greens' turf growth." *Golf Course Management* March 2001:73-77.

Turgeon, A.J. Turfgrass Management, 1999. 5th ed. Prentice Hall, New Jersey.

Vargas Jr., J.M. Ph.D. 1996. "Annual bluegrass: A fierce competitor." *Golf Course Management* 64(2):49-50.

Does Night Lighting Harm Trees?

By William R. Chaney

Whether it's along the driving range at night, close to the clubhouse and pro shop, or around the parking areas at the golf course, lighting is ubiquitous. The question superintendents need to ask is whether night lighting harms the plantings that typically are found on the borders of these and other lighted areas around a golf course.

The simple answer is yes, excessive night lighting is now recognized as a form of pollution with the potential for causing damage to some trees. However, effects of supplemental lighting on trees are complex, and understanding tree response depends on the type of lamps used and the spectrum of radiation they emit, the intensity of that radiation and the role of light in certain biological processes.

Prior to widespread use of outdoor electric lighting, the night sky was a stunning view with several thousand stars visible on a clear moonless night. But with the increase in lighting to provide safety, security, advertisement and aesthetics, light pollution has grown to be a vexing problem. Today our earth is wrapped in a luminous fog called skyglow caused by artificial lighting reflecting off airborne water droplets and dust particles that obscure much of the heavens from view. As a consequence, 20 percent of us can no longer see the Milky Way.

Much of the artificial light provided is so bright and inefficiently directed that its use has negative effects.

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TABLE 1

Sensitivity of Woody Plants to Artificial Light

High	Intermediate	Low
Acer ginnala (Amur maple)	*Acer nigrum* (Black maple)	*Fagus sylvatica* (European beech)
Acer negundo (Boxelder)	*Acer palmatum* (Japanese maple)	*Fraxinus americana* (White ash)
Acer platanoides (Norway maple)	*Acer rubrum* (red maple)	*Fraxinus nigra* (Black ash)
Betula alleghaniensis (Yellow birch)	*Acer saccharum* (Sugar maple)	*Fraxinus pennsylvanica* (Green ash)
Betula lenta (Sweet birch)	*Cercis canadensis* (Redbud)	*Fraxinus quadrangulata* (Blue ash)
Betula nigra (River birch)	*Cornus sanquinea* (Bloodtwig dogwood)	*Ginkgo biloba* (Ginkgo)
Betula papyrifera (Paper birch)	*Gleditsia triacanthos* (Honeylocust)	*Ilex opaca* (American holly)
Betula pendula (European white birch)	*Ostrya virginiana* (Ironwood)	*Liquidamber styraciflua* (Sweetgum)
Betula populifolia (Gray birch)	*Phellodendron amurense* (Corktree)	*Magnolia grandiflora* (Southern magnolia)
Carpinus caroliniana (Hornbeam)	*Quercus alba* (White oak)	*Malus sargenti* (Sargent's crabapple)
Catalpa bignonioides (Southern catalpa)	*Quercus rubra* (Red oak)	*Picea engelmanni* (Engelmann spruce)
Catalpa speciosa (Northern catalpa)	*Quercus montana* (Rock chestnut oak)	*Picea glauca* (White spruce)
Cornus florida (Flowering dogwood)	*Quercus stellata* (Post oak)	*Picea glauca densata* (Black Hills spruce)
Cornus sericea (Redosier dogwood)	*Sophora japonica* (Japanese pagoda tree)	*Picea mariana* (Black spruce)
Fagus grandifolia (American beech)	*Tilia cordata* (Littleleaf linden)	*Picea pungens* (Colorado blue spruce)
Liriodendron tulipifera (Tuliptree)		*Pinus banksiana* (Jack pine)
Platanus hybrida (London planetree)		*Pinus flexilis* (Limber pine)
Platanus occidentalis (Sycamore)		*Pinus nigra* (Austrian pine)
Populus deltoids (Cottonwood)		*Pinus ponderosa* (Ponderosa pine)
Populus tremuloides (Quaking aspen)		*Pinus resinosa* (Red pine)
Robinia pseudoacacia (Black locust)		*Pinus rigida* (Pitch pine)
Tsuga canadensis (Hemlock)		*Pinus strobus* (White pine)
Ulmus americana (American elm)		*Pyrus calleryana* (Bradford pear)
Ulmus pumila (Siberian elm)		*Quercus palustris* (Pin oak)
Zelkova serrata (Zelkova)		*Quercus phellos* (Willow oak)

Compiled from Cathey and Campbell (1975) and Hightshoe (1988)

TABLE 2

Wavelength emitted by different types of light sources and their potential effects on photobiological processes in trees.

Light source	Wavelengths emitted	Potential effect on trees
Fluorescent	High blue, low red	Low
Incandescent	High red and infrared	High
Mercury vapor	Violet to blue	Low
Metal halide	Green to orange	Low
High-pressure sodium	High in red to infrared	High

Continued from page 65

One of the harmful effects of excessive night lighting is the tremendous waste of energy and environmental damage associated with producing electricity from mining, drilling, refining, combustion and waste disposal. For example, it is estimated that 30 percent of the electricity generated for outdoor illumination is simply squandered by being misdirected into the sky.

The International Dark-Sky Association estimates this wasted electricity costs $1.5 billion annually and results in 12 million tons of carbon dioxide in its generation. Many high traffic streets and similar areas are so intensely lit that visibility is actually reduced because of glare and poorly shielded fixtures.

Another negative impact is that the annual cycles of growth and reproduction in trees controlled by day length can potentially be altered by supplemental night lighting.

Electromagnetic spectrum

To understand the potential effects of night lighting on trees, it's important to be aware of the nature of the wide spectrum of radiant energy to which trees are exposed. The electromagnetic spectrum refers to all the radiant energy that travels in wave form varying in wavelength from a fraction of a nanometer (nm) to kilometers.

For convenience, several segments of the electromagnetic spectrum are grouped together. All segments of this spectrum have important roles in the functioning of our biosphere. For a consideration of the effects of night lighting, it is the visible and infrared segments that are important. Visible light is 380 nm to 760 nm along the spectrum.

This narrow band of radiation is very important because it is the part our eyes detect, making vision possible, and it is also essential for photosynthesis and processes that control growth and development of plants. Collectively the visible wavelengths produce white light, but it can be separated into a spectrum of colors. Infrared radiation (760 nm to 1,000,000 nm) we detect as heat. These are the wavelengths absorbed by increasing levels of so-called greenhouse gases in the earth's atmosphere, causing air temperature to increase and responsible for global warming.

Although not visible to our eyes, the infrared wavelengths are as biologically important as the visible part of the electromagnetic spectrum.

Trees & electromagnetic radiation

Trees are dependent for normal growth and development on three aspects of electromagnetic radiation: quality (wavelength or color), intensity (brightness) and duration during a 24-hour period (photoperiod).

It doesn't matter to a tree whether the radiation comes from the sun or artificial sources as long as the required wavelength, intensity and duration are provided. Two important photobiological processes in trees and the wavelengths required are:

1) Photosynthesis requiring visible blue (400 nm to 450 nm) and red (625 nm to 700 nm);

2) Photoperiodism requiring visible red (625 nm to 760 nm) and infrared (760 nm to 850 nm).

The role of light in photosynthesis and the conversion of this radiant energy to a chemical form in sugars that trees can use is well-known. The role of day length or photoperiod in control of vegetative growth and reproductive activities may be less appreciated.

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Snow Mold Control – Update

The long warm days of summer will soon yield to the crisp, cooler days of fall and the first outbreaks of snow mold will again appear as they seem to do every year. For golf course superintendents in northern areas, preparing for snow mold control can be a daunting task, whether they are making multiple fungicide applications under "no snow" conditions or one single application just prior to snowfall. The multitude of control products, fears of potential resistance, environmental constraints, and pressure from the golfing public or club members to have disease-free playing surfaces can make the design of a snow mold protection program a difficult assignment.

The snow mold free strips in the photo at left were treated with the Andersons FFII 14-3-3. Winter 2001 and 2002 Pullman, WA

Since control measures can vary, knowing the type of snow mold species prevalent at a particular site is a critical first step in designing a snow mold defense program. Pink snow mold (Microdochium nivale) occurs under snow but can occur the year around under non-snow conditions in locations where air temperatures are below 65 degrees F with persistent drizzle and fog. A distinguishing characteristic from gray snow mold is the absence of sclerotia. This disease is most severe where a thick thatch layer exists, nitrogen fertility is too high, the soil pH is above 6.5, and shade is prevalent most of the day.

Gray snow mold (Typhula spp.) usually occurs under conditions of prolonged snow cover of sixty days or more, and is most devastating with deep snow on unfrozen ground. Typhula incarnata is more prevalent and is favored by snow cover of two to three months and forms reddish brown sclerotia. Typhula ishikariensis has been seen in severe disease pressure areas. It is favored by snow cover of one hundred days or more and produces small black sclerotia. Typhula ishikariensis typically causes more damage and has proven to be more difficult to control. Gray snow mold is more severe with turf maintained at high nitrogen levels with excessive thatch.

Cultural controls should be a crucial part of a snow mold defense program. Some measures to implement should include: removing excess thatch, improving surface drainage, reducing shade, snow removal, using resistant cultivars, and avoiding lush growth in the fall.

A preventative fungicide program is the centerpiece of an effective snow mold control strategy. Granular products are easy to apply, especially in the fall when cold temperatures make using the sprayer more difficult. The Andersons FFII®14-3-3 (PCNB) was originally developed by The Scotts Company® and has been consistently rated as one of the top snow mold control products in university testing over the years, either by itself or when combined with another active ingredient for enhanced Typhula Ishikariensis control. For locations anticipating heavy gray snow mold pressure or long periods of snow cover, an application of Andersons granular Fungicide IX® (Thiophanate-methyl & Chloroneb) or Fungicide V® (Chloroneb) along with FFII is recommended. Applications are most effective when made just prior to snowfall or when soils have frozen. Repeat applications can be made if snow cover disappears during mid winter.

Under non-snow conditions, FFII or Andersons 10-0-14 with PCNB can be applied at the onset of periods of wet, overcast or foggy weather. A follow up application with Fungicide VIII, (Thiophanate-methyl & Iprodione) Fungicide X, (Iprodione) or Systemic Fungicide (Thiophanate-methyl) within thirty days, followed by another application of FFII or Andersons 10-0-14 with PCNB have proven effective.

New Data Available – A recent study of FFII performance conducted during the winter of 2004 – 2005 at two high disease locations in Utah confirms the continued effectiveness of FFII for snow mold control. For this study, special emphasis was also placed on examining concerns about possible root pruning in over-application situations. Results confirm that root pruning is not a concern up to 4x of the normal application rate. For details of the study, contact The Andersons.

The Andersons continues to evaluate through an extensive yearly snow mold testing program, new prototypes, and new combinations of active ingredients with different granular carriers, with the goal of producing even more effective products in the future.

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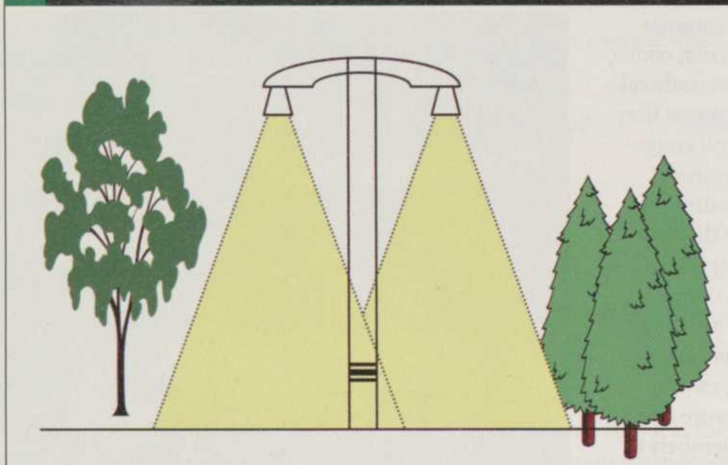
FIGURE 1



Best lighting design, with proper choice of lamp type, provides night light and minimizes light pollution and effects on trees.

Continued from page 66

Relatively high light intensity of 1,000 microeinsteins (μ) per square meter per second (μE/m2/sec) is adequate for photosynthesis in most trees (200 μE/m2/sec for shade-adapted trees) but photoperiod responses may be induced with as little as 0.06 to 3 μE/m2/sec, only a fraction of that needed for photosynthesis. As a point of reference, indoor lighting sufficient for reading is about 4.6 μE/m2/sec and full moon light is about 0.004 μE/m2/sec.

A 100-watt incandescent bulb provides 5 $\mu E/m^2/sec$ at 5 feet away and a 150 watt fluorescent cool-white bulb provides 17 $\mu E/m^2/sec$ at the same distance.

It has been known since the 1940s that it is the duration of uninterrupted darkness during a 24-hour cycle that governs developmental processes in trees, such as dormancy, shoot growth and flowering. A photo-reversible pigment called phytochome is able to perceive the length of the day and night period depending on whether it absorbs red (625 nm to 760 nm) or infrared (760 nm to 850 nm) wavelengths of radiation. Even a momentary flash of light during the dark period is sufficient to create the physiological condition induced by a short night or conversely, a long day.

Trees as well as other plants are classified as short-day, long-day, or day-neutral, according to their response to day length. Short-day trees flower and enter dormancy when day length shortens in late summer. Long-day trees flower in early summer and continue vegetative growth until days shorten in the fall. Day-neutral trees are not affected by day length at all. Photoperiod can also influence leaf shape, surface hairiness (pubescence) and drop in the fall; pigment formation; and root development as well as onset and breaking of bud dormancy. Some types of night lighting can alter the natural photoperiod and, consequently, upset these developmental processes.

Effect of night lighting on trees

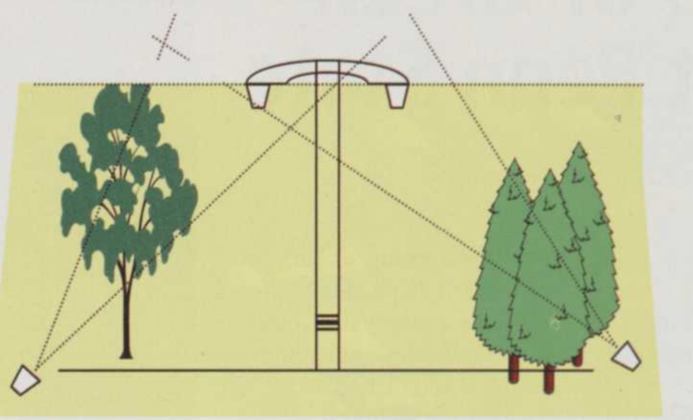
It should be clear from the above discussion that most night lighting does not have the intensity to affect photosynthesis, but it might affect trees that are sensitive to day length. Artificial lighting, especially from a source that emits in the red to infrared range of the spectrum, extends the day length and can change flowering patterns and most importantly, promote continued growth, preventing trees from developing dormancy that allows them to survive the rigors of winter weather.

Young trees, because of greater vigor and a tendency to grow longer naturally, will be more subject than older mature trees to cold injury as a result of growth prolonged by artificial illumination.

Continuous lighting, which unfortunately is the most common, is potentially even more damaging than lighting that is turned off late in the evening. The foliage of trees grown in continuous lighting may be larger in size and more susceptible to air pollution and water stress during the growing season because the stomatal pores in leaves remain open for longer periods. There is a good deal of variation in the susceptibility of woody plants to artificial lighting (Table 1). Highly sensitive trees should be avoided in areas where high-intensity lighting rich in red and infrared wavelengths is used.

Different light sources have different emission spectra. That's to say that one type of lamp gives off more light of certain wavelengths (color) than another type of lamp. For example, fluorescent light is high in blue and low in red wavelengths whereas light from incandescent bulbs is lacking in the blue part of the visible spectrum, but high in red and infrared. Mercury vapor lamps emit principally violet to blue wavelengths and metal halide emit in the green to orange range. High-pressure sodium (HPS) lamps emit high intensities rich in the red and infrared wavelengths (Table 2).

FIGURE 2



Poor lighting design, with an unshielded fixture and upward directed spots, and despite proper selection of lamp type to minimize direct effects on trees, promotes wasteful night sky pollution.

In the early days of street lighting, the lamps used most commonly were either low-intensity incandescent filaments or higher intensity fluorescent, mercury vapor or metal halide lamps. These light sources, although attractive to insects, had little effect on plants because they emitted predominately the shorter wavelengths of the visible portion of the electromagnetic spectrum, except for incandescent filaments which emit a relatively balanced spectrum of all wavelengths but at an intensity too low to effect most trees. In the mid-1960s, HPS lamps were developed that emit considerable high-intensity light in the red and infrared regions. Increased injury to woody plants has been reported since the widespread introduction of this type of artificial lighting.

What to do

When artificial lighting is considered essential, mercury vapor, metal halide or fluorescent lamps should be used in this order of preference.

HPS lamps should be avoided, and even low-intensity incandescent is best excluded due to its high output of infrared and potential impact on some tree species. Fixtures shielded so that all of the light is directed toward the ground onto pedestrians and vehicular traffic and away from plants should be employed to reduce light pollution and harm to trees (Figure 1).

In all cases, up-lighting and shining light over great horizontal distances should be avoided (Figure 2).

Lights should be turned off or dimmed during off-peak hours to avoid continuous lighting of trees, which has the greatest potential for upsetting normal growth patterns. When planting trees where supplemental night lighting already exists, select those with low sensitivity to light (Table 1).

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FOR MORE INFORMATION

A significant number of private organizations and government agencies exist today with the objective of preserving the night sky by alerting the public to the problems and providing solutions. For more information contact:

Illuminating Engineering Society, 120 Wall Street, Floor 17, New York, NY 10005, http://www.iesna.org

International Dark-Sky Association, 3225 N. First Avenue, Tucson, AZ 85719, http://www.darksky.org

75 Years of Green Grass at Penn State

By Krista M. Weidner

In 1928 a determined group of turfgrass advocates paid a call to Ralph Hetzel, president of The Pennsylvania State College. Joseph Valentine, the golf course superintendent at Merion Golf Club, T.L. Gustin of Philadelphia Toro, and James Bolton, the superintendent of Reading Country Club, told Hetzel that they wanted the same kind of help for professional turf growers that Penn State was providing to farmers. Hetzel agreed readily and assigned H. Burton Musser, a young red-clover breeder in the department of agronomy, to work half-time on turfgrass.

This was the beginning of Penn State's Turfgrass Management Program — a program that has grown to become one of the finest of its kind in the country. Today nine faculty members from the departments of crop and soil sciences, plant pathology, and entomology, as well as numerous support staff and graduate students, are involved in turfgrass research and education at Penn State. In 2004 the turfgrass program celebrated its 75th anniversary.

It's been said that the sun never sets on a Penn State turfgrass variety. H. Burton Musser and Joseph M. Duich, pioneers in Penn State turfgrass breeding, developed varieties such as Penncross creeping bentgrass, Pennfine perennial ryegrass, Pennlawn creeping fine fescue and Pennstar bluegrass, which are found all over the world. Penncross, one of the best-known Penn State varieties, is used worldwide on putting greens and tennis courts. It serves as the standard against which all new bentgrasses are compared.

Penn State turfgrass research has contributed to many aspects of athletic field management, improving safety and playability on fields throughout the country. Research on turfgrass nutrition, runoff, weed control and growth regulators and disease and insect management also has played an integral part in the turfgrass program.

From its early days, the turfgrass management program has had a strong outreach component. Research field days, initiated in the early 1930s and held every other year at Penn State, provide an opportunity for turfgrass managers from around the state to look at turf selections in evaluation plots and to learn about the results of new research. Penn State turfgrass specialists also participate in annual conferences and trade shows, conduct workshops and produce publications, covering topics such as selecting grass varieties, controlling weeds and diagnosing and managing turf diseases.

The industry component of Penn State's turfgrass program has been integral from the earliest years. In 1930 Joseph Valentine helped form the Turfgrass Research Advisory Committee, which Valentine chaired until 1955, when the present-day Pennsylvania Turfgrass Council was established.

The PTC is dedicated to the improvement of the turfgrass industry through education and research. Today its membership of more than